The Role of Endovenous Thermal Ablation in the
Treatment of Varicose Veins

A thesis submitted to Imperial College London for the degree MD

by

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Abstract

Varicose veins are a common problem affecting approximately 30% of the Western population. The majority of patients present to secondary care complaining of a number of commonly experienced symptoms, however, some present with severe complications of venous disease including venous ulceration. For hundreds of years varicose veins have been treated with compression and surgery. In the last decade, technological advances have lead to the introduction of minimally invasive therapies for varicose veins, with the aim of providing rapid treatment with minimum discomfort to the patient at acceptable cost to the healthcare provider.

This study examined the current use of endovenous ablation procedures in the United Kingdom amongst consultant vascular surgeons using an online questionnaire and also explored the patient’s views regarding treatment of varicose veins and potential therapeutic options. Prior to conducting a randomised clinical trial comparing early outcomes following laser and radiofrequency ablation in patients with primary varicose veins, an observational pilot study was carried out in the department. In parallel, the use of disease specific quality of life tools were compared to clinical, anatomical and haemodynamic outcome measures in this cohort of patients.

The findings of the study have shown that although endovenous ablation procedures appear to be increasing in popularity, traditional surgery remains the most frequently performed procedure. Overall, patients overall have little knowledge of potential treatment options and the majority would be in favour of a single treatment under a local anaesthetic. However, most would be strongly influenced by the advice and opinion of the surgeon to whom they were referred.

Results from the pilot study and a randomised clinical trial showed that radiofrequency ablation is significantly less painful than laser ablation for up to 10 days post procedure. Clinical improvements and gains in quality of life were significantly improved at 6 weeks and 6 months post intervention compared with baseline scores and were comparable between the groups. No significant difference was observed in anatomical outcomes between the two treatments.

Although radiofrequency may be less painful than laser ablation, both endovenous thermal ablation treatments result in significant improvements in quality of life and are likely to become increasingly popular in the future.
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<tbody>
<tr>
<td>ATV</td>
<td>Anterior Thigh Veins</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>ANCOVA</td>
<td>Analysis of Co-Variance</td>
</tr>
<tr>
<td>ASVAL</td>
<td>Ambulatory Selective Varices Ablation under Local Anaesthetic</td>
</tr>
<tr>
<td>AVF</td>
<td>American Venous Forum</td>
</tr>
<tr>
<td>AVVQ</td>
<td>Aberdeen Varicose Vein Questionnaire</td>
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<tr>
<td>BCE</td>
<td>Before the Common Era</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>CEAP</td>
<td>Clinical Etiologic Anatomic Pathophysiologic</td>
</tr>
<tr>
<td>CE</td>
<td>Common Era</td>
</tr>
<tr>
<td>CHIVA</td>
<td>Conservatrice et Hemodynamique de l’insuffisance Veineuse en Ambulatoire</td>
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<tr>
<td>CIVIQ</td>
<td>Chronic Venous Insufficiency Questionnaire</td>
</tr>
<tr>
<td>Cm</td>
<td>centimetre</td>
</tr>
<tr>
<td>COPD</td>
<td>Chronic Obstructive Pulmonary Disease</td>
</tr>
<tr>
<td>CT</td>
<td>Computed Tomography</td>
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<tr>
<td>CVI</td>
<td>Chronic Venous Insufficiency</td>
</tr>
<tr>
<td>DVT</td>
<td>Deep Vein Thrombosis</td>
</tr>
<tr>
<td>ECM</td>
<td>Extracellular Matrix</td>
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<tr>
<td>EFE</td>
<td>Endovenous Fluence Equivalence</td>
</tr>
<tr>
<td>ESCHAR</td>
<td>Comparison of surgery and compression with compression alone in chronic venous ulceration (ESCHAR study)</td>
</tr>
<tr>
<td>EVLA</td>
<td>Endovenous Laser Ablation</td>
</tr>
<tr>
<td>EVLT®</td>
<td>Endovenous Laser Treatment</td>
</tr>
<tr>
<td>FS</td>
<td>Foam Sclerotherapy</td>
</tr>
<tr>
<td>GA</td>
<td>General Anaesthesia</td>
</tr>
<tr>
<td>GSV</td>
<td>Great Saphenous Vein</td>
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<tr>
<td>HHD</td>
<td>Hand Held Doppler</td>
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<tr>
<td>HIF</td>
<td>Hypoxia Inducible Factor</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>---------</td>
<td>-------------</td>
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<tr>
<td>ICER</td>
<td>Incremental Cost Effectiveness Ratio</td>
</tr>
<tr>
<td>HRG</td>
<td>Healthcare Resource Group</td>
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<tr>
<td>HTA</td>
<td>Health Technology Assessment Programme</td>
</tr>
<tr>
<td>IQR</td>
<td>Interquartile Range</td>
</tr>
<tr>
<td>IVC</td>
<td>Inferior Vena Cava</td>
</tr>
<tr>
<td>J</td>
<td>joules</td>
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<tr>
<td>LA</td>
<td>Local Anaesthetic</td>
</tr>
<tr>
<td>LEED</td>
<td>Linear Endovenous Energy Density</td>
</tr>
<tr>
<td>ml</td>
<td>millilitres</td>
</tr>
<tr>
<td>m</td>
<td>Meters</td>
</tr>
<tr>
<td>MCS</td>
<td>Mental Component Score of SF12</td>
</tr>
<tr>
<td>MMP</td>
<td>Matrix Metalloproteinase</td>
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<tr>
<td>MPFF</td>
<td>Micronized Purified Flavinoid Fraction</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Service</td>
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<tr>
<td>NICE</td>
<td>National Institute for Clinical Excellence</td>
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<tr>
<td>NIHR</td>
<td>National Institute for Health Research</td>
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<tr>
<td>NHSLA</td>
<td>National Health Service Litigation Authority</td>
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<tr>
<td>nm</td>
<td>nanometre</td>
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<tr>
<td>NSAID</td>
<td>Non-Steroidal Anti-inflammatory Drugs</td>
</tr>
<tr>
<td>PCS</td>
<td>Physical Component Score of SF12</td>
</tr>
<tr>
<td>PE</td>
<td>Pulmonary Embolus</td>
</tr>
<tr>
<td>PIN</td>
<td>Perforation Invagination Stripper</td>
</tr>
<tr>
<td>PPG</td>
<td>Digital Photoplethysmography</td>
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<tr>
<td>PROM</td>
<td>Patient Reported Outcome Measure</td>
</tr>
<tr>
<td>QALY</td>
<td>Quality Adjusted Life Year</td>
</tr>
<tr>
<td>QoL</td>
<td>Quality of Life</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised Clinical Trial</td>
</tr>
<tr>
<td>RFA</td>
<td>Radiofrequency Ablation</td>
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<tr>
<th>Abbreviation</th>
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<tr>
<td>RFITT</td>
<td>Radiofrequency Induced Thermo Therapy</td>
</tr>
<tr>
<td>s</td>
<td>Second</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>SF12</td>
<td>Short Form 12</td>
</tr>
<tr>
<td>SF36</td>
<td>Short Form 36</td>
</tr>
<tr>
<td>SFJ</td>
<td>Saphenofemoral Junction</td>
</tr>
<tr>
<td>SPJ</td>
<td>Saphenopopliteal Junction</td>
</tr>
<tr>
<td>SQOR-V</td>
<td>Specific Quality of Life and Outcome Response-Venous</td>
</tr>
<tr>
<td>SRM</td>
<td>Standardised Response Mean</td>
</tr>
<tr>
<td>SSV</td>
<td>Small Saphenous Vein</td>
</tr>
<tr>
<td>STD</td>
<td>Sodium Tetra-Decyl Sulphate</td>
</tr>
<tr>
<td>TIA</td>
<td>Transient Ischemic Attack</td>
</tr>
<tr>
<td>TIMP</td>
<td>Tissue Inhibitor of MMP</td>
</tr>
<tr>
<td>TEDS</td>
<td>Thrombo Embolic Deterrent Stocking</td>
</tr>
<tr>
<td>UGFS</td>
<td>Ultrasound Guided Foam Sclerotherapy</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USS</td>
<td>Ultrasound Scan</td>
</tr>
<tr>
<td>VAS</td>
<td>Visual Analogue Score</td>
</tr>
<tr>
<td>VALVV</td>
<td>VNUS® ClosureFAST™ Ablation versus Laser for Varicose Veins</td>
</tr>
<tr>
<td>VCSS</td>
<td>Venous Clinical Severity Score</td>
</tr>
<tr>
<td>VDS</td>
<td>Venous Disability Score</td>
</tr>
<tr>
<td>VEINES</td>
<td>Venous Insufficiency Epidemiological and Economic Study</td>
</tr>
<tr>
<td>VRT</td>
<td>Venous Refill Time</td>
</tr>
<tr>
<td>VSDS</td>
<td>Venous Segmental Disease Score</td>
</tr>
<tr>
<td>VSGBI</td>
<td>Vascular Society of Great Britain and Ireland</td>
</tr>
<tr>
<td>VSS</td>
<td>Venous Severity Score</td>
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<tr>
<td>w</td>
<td>Watts</td>
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I would like to thank a number of people who have made this MD possible. Primarily my supervisors Professor Alun Davies and Mr Manj Gohel to whom I am greatly indebted, they have encouraged and supported me at every stage. I am exceedingly grateful for their support, guidance and all that they have done for me over the past 2 and half years, I have been exceptionally fortunate and my sincere thanks to them both.

The trial would not have been possible without the funding from the Mason Medical Research group and the Royal Society of Medicine to whom I am very grateful.

In addition, this trial was made possible with the help of all the Vascular Scientists at Charing Cross Hospital, in particular thank you to Mary Ellis and Samina Qureshi whose help and support throughout was greatly appreciated.

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I would also like to thank the members of the Vascular Society of Great Britain & Ireland who completed the varicose vein survey and contributed to the data reported in Chapter 2.

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Author's Declaration

I declare the work in this dissertation was conducted by myself in accordance with the regulations of Imperial College and the University of London. The research is to the best of my knowledge original, and any views expressed are those of the author.

Signed .........................................................  Date 13/09/2010
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Chapter 1. Introduction
1.1 Introduction to Varicose Veins

The term “Varicose Vein” is defined as a dilated and tortuous vein and most frequently refers to the superficial veins in the leg. They are common and affect 15-40% of the adult population in the United Kingdom (Callam 1994; Evans, Fowkes et al. 1999). Varicose veins have affected mankind for thousands of years and there is documentation of their existence from as early as 3500 BCE (van den Bremer et al. 2010). A variety of methods are now available to treat varicose veins and it is estimated that approximately 40,000 procedures are performed annually to treat varicose veins in the UK in the National Health Service (NHS). The number of procedures performed for varicose veins in the UK is available from the Hospital Episode Statistics website (http://www.hesonline.nhs.uk) and a summary of recent data is shown in Table 1. Although the numbers have fallen in recent years, the cost to the NHS remains considerable. Costs include not only those incurred for the treatment of varicose veins, but the management of chronic venous disorders including venous leg ulceration, which is estimated at approximately £600 million per annum in the UK, and hence an important clinical problem.

<table>
<thead>
<tr>
<th>Year</th>
<th>Surgery</th>
<th>Radiofrequency</th>
<th>Laser</th>
<th>Foam Sclerotherapy</th>
<th>Total Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of procedures</td>
<td>%</td>
<td>Number of procedures</td>
<td>%</td>
<td>Number of procedures</td>
</tr>
<tr>
<td>2004-2005</td>
<td>36207</td>
<td>96</td>
<td>unknown</td>
<td>unknown</td>
<td>1689</td>
</tr>
<tr>
<td>2005-2006</td>
<td>34318</td>
<td>92</td>
<td>unknown</td>
<td>unknown</td>
<td>2819</td>
</tr>
<tr>
<td>2006-2007</td>
<td>30482</td>
<td>84</td>
<td>unknown</td>
<td>2104</td>
<td>3824</td>
</tr>
<tr>
<td>2007-2008</td>
<td>26969</td>
<td>73</td>
<td>454</td>
<td>1</td>
<td>3986</td>
</tr>
<tr>
<td>2008-2009</td>
<td>23863</td>
<td>65</td>
<td>1589</td>
<td>4</td>
<td>5163</td>
</tr>
</tbody>
</table>

Table 1. Procedures performed for varicose veins in the UK 2004-2009

The majority of patients with varicose veins have incompetence of the saphenofemoral junction (SFJ), resulting in reflux of blood from the deep venous system into the superficial great saphenous vein (GSV)(Labropoulos et al. 1994). In addition they will frequently have tributary vessels arising
from the incompetent SFJ or GSV resulting in additional varicosities. Reflux may also involve the small saphenous vein (SSV), usually as a result of incompetence at the sapheno-popliteal junction (SPJ), and may also occur in perforator veins joining the deep and superficial venous system. For many years, the gold standard treatment was junctional ligation, disconnection and stripping of the great saphenous vein. In the last decade the introduction of minimally invasive endovenous treatments for varicose veins has meant that a wide variety of treatment options now exist from which surgeons can choose. Consequently the treatment of varicose veins is moving away from being performed under general anaesthesia in the operating theatre to treatment in an outpatient setting under local or tumescent anaesthesia.

1.1.1 Aetiology and Pathogenesis of Varicose Veins

Despite the high prevalence, the aetiology and pathogenesis of varicose veins remains poorly understood. There is currently much interest in the pathogenesis of varicose veins and research suggests several plausible theories exist (Raffetto and Khalil 2008; Lim and Davies 2009). It is known that the valves in the superficial venous system and possibly perforator valves become incompetent, allowing blood from the higher pressure deep venous system to reflux into the superficial veins giving rise to the characteristic dilated and tortuous vessels. It is thought that in individuals predisposed to the development of varicose veins, increased venous hydrostatic pressure causing increased wall tension and endothelial injury leads to changes in the extracellular matrix, venous smooth muscle and endothelium causing vein wall dilatation and valvular dysfunction (Raffetto et al. 2008). It is not known whether the primary pathology is valvular dysfunction or vein wall dilatation, and there is evidence to suggest that both processes may be involved (Raffetto et al. 2008). It has been suggested that pathological changes occur in the connective tissues, extra cellular matrix, elastin and smooth muscle cells in the walls of these varicose veins (Rose et al. 1986; Mashiah et al. 1991; Borden et al. 1997; Gomez et al. 1997; Nagase 1997). Matrix metalloproteinases (MMPs) and tissue inhibitors of MMPs (TIMPs), are endopeptidase enzymes involved in the degradation of the extracellular matrix and are known to be involved in some of these changes. They have been shown to cause alterations to the vascular endothelium and smooth muscle in early venous disease and the activity of MMPs correlates with the severity of skin changes in later disease with associated leukocyte interactions and inflammatory processes (Raffetto et al. 2008a; Raffetto et al. 2008b). MMPs 1, 2, 3, 7 and 9 and TIMP 1 and 3 are up-regulated in varicose veins and TIMP 2 appears to be decreased (Lim et al. 2009). Smooth muscle cell apoptosis, hypoxia and endothelial cell dysfunction are also thought to be involved in the pathogenesis of varicose veins and have been showed to lead to venous relaxation in vitro (Lim et al. 2010). Hypoxia Inducible Factor (HIF) is an upstream regulator
of many cellular processes including MMPs and has been shown to be increased in varicose veins (Lim et al unpublished data). These findings have implications for the development of medications and the future treatment of venous disease, with many of these molecules and signalling pathways being considered as therapeutic drug targets (Naoum et al. 2007; Lim et al. 2010).

1.1.2 Risk Factors for the Development of Varicose Veins

Predisposing factors for the development of varicose veins include increasing age (Evans et al. 1999; Maurins et al. 2008; Robertson et al. 2008) and increases in pressure exerted on the venous system due to obesity, intra-abdominal pathology or pregnancy (Laurikka et al. 2002; Maurins et al. 2008). Hypertension has been shown to contribute to chronic venous disease (Maurins et al. 2008) and poor mobility, previous injury and phlebitis have also been shown to induce varicose veins. Recent evidence suggests that both smoking and alcohol may lead to an increased risk of developing varicose veins, particularly in women (Ahti et al. 2010). Although no specific gene abnormality has been discovered, there is also a strong familial tendency (Scott et al. 1995; Carpentier et al. 2004) and varicose veins are also associated with a number of rare genetic disorders.

1.1.3 Epidemiology of Varicose Veins

The prevalence of varicose veins varies throughout populations and increases with age (Callam 1994; Evans et al. 1999; Maurins et al. 2008). The Edinburgh Vein Study found the prevalence of venous disorders was 32% in women and 40% in men (Evans et al. 1998; Evans et al. 1999). Similarly, the Bonn Vein Study conducted in Germany found 35.3% of the population had pathological reflux of greater than 0.5 seconds (Maurins et al. 2008) and the overall prevalence is thought to be between 15 and 40% of the western population (Callam 1994; Lee et al. 2003). Females have been shown to present more frequently than males (Lee et al. 2003). The prevalence may be higher in males, although discrepancies exist between studies (Callam 1994; Evans et al. 1998). The prevalence of deep venous insufficiency in patients presenting with apparently superficial venous incompetence has been shown to be approximately 20% (Labropoulos et al. 2000; Maurins et al. 2008), with the majority of patients demonstrating small sections of deep venous incompetence which frequently improve following intervention (Labropoulos et al. 2000).

1.1.4 Symptoms of Varicose Veins

The symptoms caused by varicose veins have been notoriously difficult to determine accurately, as many patients with varicose veins report a number of non-specific symptoms such as aching,
heaviness, itching and swelling which occur frequently in the absence of venous disease. Symptoms are more likely to be attributed to venous disease if they occur when the legs are in a dependent position and worsen in hot weather, although proving a causal relationship is very difficult (Campbell et al. 2007). The most frequently reported symptoms include: ache; heaviness/ tension in the legs; swelling; restless legs; cramps; itching and tingling (Bradbury et al. 1999). Evidence suggests that commonly reported symptoms are likely to be related to the presence of venous insufficiency rather than varicose veins per se (Kurz et al. 2001) which are often asymptomatic. The Edinburgh Vein Study found only a weak association between discomfort and truncal reflux (Bradbury et al. 1999) and Labroupoulos et al found that only 70% of those with GSV reflux reported symptoms (Labropoulos et al. 1994). The overall poor correlation of symptoms with venous insufficiency has meant that there is insufficient evidence to attribute the majority of symptoms to a venous cause (Bradbury et al. 1999; Campbell et al. 2007). Indeed, many patients presenting with varicose veins have been found to have a wide variety of additional concerns relating both to potential venous complications and general concerns about the future (Campbell et al. 2006).

1.2 Natural History of Disease Progression of Varicose Veins

The aetiology of chronic venous disease is classified as either primary venous disease, with no identifiable cause for the presence of valvular dysfunction, or secondary venous disease, following a precipitating event. A large number of cases are idiopathic, however, a significant proportion arise following deep venous thrombosis, causing deep venous obstruction and subsequent deep venous reflux in many patients. Both reflux and obstruction contribute to venous hypertension, and the majority of treatments are thought to improve symptoms by reducing venous hypertension.

To date, the natural history of the progression of primary venous disease is poorly understood. Current information is based on patients self-reporting their symptoms, many of whom subsequently undergo treatment, and the natural history of the condition is infrequently documented. In a small study (56 limbs) of uncomplicated varicose veins, where superficial venous surgery was delayed by a median of 20 months, 2% of limbs developed lipodermatosclerosis and none developed ulceration (Sarin et al. 1993). In a larger study of over 300 patients on an NHS waiting list for varicose vein surgery, 22% of patients with previously uncomplicated disease developed skin changes over a median of 4 years and 4% developed ulceration, although the degree of clinical severity at baseline in those who developed ulceration was not reported (Brewster et al. 1991). The number of patients with superficial reflux who are likely to progress to oedema, skin
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

changes and ulceration is unknown, however, the overall incidence of oedema and skin changes in the general UK population is thought to be around 1% per year (Tran et al. 2002).

In patients with secondary venous disease following acute deep venous thrombosis, the natural history of the disease is better understood, and approximately 30% will go on to develop post-thrombotic syndrome, with 3-6% developing venous ulceration (Prandoni et al. 1996).

In summary, the natural progression of mild venous disease to lipodermatosclerosis and venous ulceration is poorly understood, with few studies in the published literature. However, it is known that disease progression is related to the severity of venous reflux and duration of disease (Tran et al. 2002). The most recent evidence from the Bonn Vein Study II, surveyed over 1978 patients in Germany and reported that progression of C2 disease to higher C classes (see section 1.3) was 31.8% in patients with saphenous reflux and 19.8% in patients with non-saphenous reflux over 6.6 years (Rabe et al. 2010). The sensation of leg swelling in otherwise mild disease was found to be an indicator of likely disease progression and a poorer prognosis. Other factors such as obesity, prolonged standing, and non-compliance with compression hosiery have also been shown to increase the progression of chronic venous disease (Kostas et al. 2010). Deep venous incompetence, skin changes including eczema and lipodermatosclerosis, a raised BMI and popliteal vein reflux are independently associated with the risk of developing venous ulceration in patients with varicose veins (Robertson et al. 2009), and the majority of those presenting with venous ulceration have had venous disease for more than 20 years (Hoare et al. 1982; Brewster et al. 1991).

1.2.1 Complications of Venous Disease

Although a large number of patients with venous insufficiency remain asymptomatic (Lee et al. 2003), and the majority of those presenting report mild to moderate symptoms, a proportion of patients progress to developing skin changes, lipodermatosclerosis and venous ulceration. Although venous ulceration was initially attributed to deep venous incompetence, the majority of patients with venous leg ulcers have only superficial truncal incompetence (Gohel et al. 2007b).

1.3 Classification of Venous Disease

Until the 1990s there was no uniformly accepted way of classifying varicose veins. The First classification was proposed by Heyerdale and Stalker in 1941 which classified varicosities into 3 groups: Group I spider veins and telangiectatic veins; group II mild to moderate varicosities in
patients with no demonstrable incompetence of the great or small saphenous veins and group III mild, moderate or marked varicosities with incompetence of the great or small saphenous vein (Heyerdale et al. 1941). This was not solely a clinical classification, but relied on the confirmed presence of anatomical reflux. The classification written by Widmer et al in 1978 was used in the Basle study (Biland et al. 1988) and later in the Edinburgh Vein Study. Patients were classified as either having no venous disease, hyphen webs, reticular veins, trunk varices or chronic venous disease with I) corona phlebectatica, II) hyperpigmented or depigmented areas and III) open or healed ulceration. Since then other classifications by Duffy in 1988 and Weiss in 1993 have been published but neither were widely used. The original reporting standards in venous disease of the Ad Hoc Committee of the Society for Vascular Surgery and International Society for Cardiovascular Surgery published in 1988 suggested a classification for Chronic Venous Insufficiency according to clinical symptoms graded from 0-3 [asymptomatic, mild, moderate or severe (ulceration)], anatomical location graded from 0-7 [Unknown(0), superficial veins(1), perforator veins(2) , deep calf(3) , deep thigh(4), deep ilio-femoral (5), deep caval (6), or combination of 2-5(7)] and disease origin was classified as unknown, congenital or post thrombotic (Ad Hoc Committee on Reporting Standards 1988). None of the previous classifications described were widely used or considered sufficiently adequate, and for these reasons an International Ad Hoc committee of the American Venous Forum produced a consensus document for the Clinical Etiologic Anatomic Pathophysiologic (CEAP) classification of chronic venous disease in 1995 (Porter et al. 1995). This was objectively tested in 102 patients and found to accurately identify categories of venous disease (Kistner et al. 1996). Details of the CEAP classification are shown in Figure 1.

1.3.1 CEAP Classification

The CEAP classification is now well established and widely used in the reporting of venous disease. It provides a static description of the severity of venous disease and attributes a grade for each of the 4 domains; Clinical severity, Aetiology, Anatomical distribution of the veins and the Pathological process involved, thus forming a basis on which decisions regarding treatment can be made. Although 4 domains exist, the clinical component graded C0-C6 is the most frequently used.

Rapid developments in varicose vein therapies lead to the need for revision of the original CEAP classification. Details of the revised CEAP classification were published in a consensus statement from the American Venous Forum in 2004 (Eklof et al. 2004). The original structure of the classification was maintained, however, additions and refinements were made to definitions and a “basic” and “advanced ” CEAP were introduced. The C4 clinical category was sub-divided into (a) and
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

(b) as described in Figure 1 and a category of “no venous cause identified” denoted “n” was introduced to categories E, A and P. Different levels of investigation were described from I-III, level I being office based assessment including clinical examination and hand held Doppler, level II included non-invasive investigations, including duplex scanning and plethysmography and level III included invasive or complex imaging such as venography, CT or MRI scanning. Basic CEAP involves the description of all of the above categories and uses the single highest descriptor for the clinical classification. Advanced CEAP incorporates all elements of basic CEAP, plus the full clinical description, and it identifies 18 venous segments that can be used to locate venous pathology (Eklof et al. 2004) (Figure 2).

<table>
<thead>
<tr>
<th>Clinical Signs-C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>No visible signs of venous disease</td>
</tr>
<tr>
<td>C1</td>
<td>Telangiectasia or reticular veins</td>
</tr>
<tr>
<td>C2</td>
<td>Varicose Veins &gt; 3mm</td>
</tr>
<tr>
<td>C3</td>
<td>Oedema</td>
</tr>
</tbody>
</table>
| C4               | Skin changes including: a) pigmentation or eczema  
|                  | b) lipodermatosclerosis or atrophie blanche |
| C5               | Healed venous ulcer |
| C6               | Active venous ulcer |

<table>
<thead>
<tr>
<th>Aetiology-E</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>Ec-</td>
</tr>
<tr>
<td>Primary</td>
<td>Ep- unknown cause</td>
</tr>
<tr>
<td>Secondary</td>
<td>Es (known cause- post thrombotic/ obstructive /other)</td>
</tr>
<tr>
<td>No venous cause identified</td>
<td>En</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anatomy-A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>As</td>
</tr>
<tr>
<td>Deep</td>
<td>Ad</td>
</tr>
<tr>
<td>Perforator</td>
<td>Ap</td>
</tr>
<tr>
<td>No venous cause identified</td>
<td>An</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pathophysiology-P</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflux</td>
<td>$P_r$</td>
</tr>
<tr>
<td>Obstruction</td>
<td>$P_o$</td>
</tr>
<tr>
<td>Reflux and obstruction</td>
<td>$P_{ro}$</td>
</tr>
<tr>
<td>No venous cause identified</td>
<td>$P_n$</td>
</tr>
</tbody>
</table>

*Patients are classed as symptomatic or asymptomatic*

**Figure 1. CEAP classification**
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Superficial Veins</th>
<th>Deep Veins</th>
<th>Perforating Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Telangiectasia or reticular veins</td>
<td>6 IVC</td>
<td>17 Thigh</td>
</tr>
<tr>
<td>2 GSV above knee</td>
<td>7 Common iliac</td>
<td>18 Calf</td>
</tr>
<tr>
<td>3 GSV below knee</td>
<td>8 Internal iliac</td>
<td></td>
</tr>
<tr>
<td>4 SSV</td>
<td>9 External iliac</td>
<td></td>
</tr>
<tr>
<td>5 Non saphenous vein</td>
<td>10 Pelvic, gonadal, broad ligament</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 Common femoral vein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Deep femoral vein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 Femoral vein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 Popliteal vein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 Crural (anterior tibial, posterior tibial and peroneal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 Muscular- gastronemial, soleal, other</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Venous segments used in advanced CEAP

1.3.2 Venous Severity Scoring

Although a useful descriptive tool, the CEAP classification is not appropriate for the assessment of outcomes following intervention. A new clinical outcome assessment score, the Venous Severity Score (VSS) was proposed by the American Venous Forum Ad Hoc Committee in 2000 (Rutherford et al. 2000) to enable quantification and comparison of changes following interventions. This consisted of 3 components: 1) the Venous Clinical Severity Score (VCSS) 2) the Venous Segmental Disease Score (VSDS) and 3) the Venous Disability Score (VDS).

1.3.2.1 Venous Clinical Severity Score

The VCSS is a scoring system of 10 domains based on the original CEAP classification which provides a score out of 30 based on the presence or absence of symptoms and signs, such as pain, swelling, the presence of skin changes, ulceration and the use of compression (Figure 3).
### Venous Clinical Severity Score

<table>
<thead>
<tr>
<th></th>
<th>Absent</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pain</strong></td>
<td>None</td>
<td>Occasional, non restricting/no analgesia</td>
<td>With moderate activity, occasional analgesia</td>
<td>Daily, severe limitations, regular analgesia</td>
</tr>
<tr>
<td><strong>Varicose veins&gt;4mm</strong></td>
<td>None</td>
<td>Few</td>
<td>Multiple GSV</td>
<td>Extensive GSV and LSV</td>
</tr>
<tr>
<td><strong>Venous oedema</strong></td>
<td>None</td>
<td>Evening/ankle</td>
<td>Afternoon/above knee</td>
<td>Morning/requiring elevation</td>
</tr>
<tr>
<td><strong>Skin pigmentation</strong></td>
<td>None</td>
<td>Limited and old/brown</td>
<td>Diffuse lower third/purple</td>
<td>Wide/ purple</td>
</tr>
<tr>
<td><strong>Inflammation</strong></td>
<td>None</td>
<td>Mild cellulitis in marginal area</td>
<td>Moderate involving most of gaiter area</td>
<td>Severe cellulitis or significant eczema</td>
</tr>
<tr>
<td><strong>Induration</strong></td>
<td>None</td>
<td>Focal &lt;5cm</td>
<td>Medial or lateral less than lower 1/3</td>
<td>1/3 of lower leg or more</td>
</tr>
<tr>
<td><strong>Number of active ulcers</strong></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Active ulcer duration</strong></td>
<td>None</td>
<td>&lt;3 months</td>
<td>&gt;3 and &lt;12 months</td>
<td>&gt;12 months</td>
</tr>
<tr>
<td><strong>Active ulcer diameter(cm)</strong></td>
<td>None</td>
<td>&lt;2</td>
<td>2-6</td>
<td>&gt;6</td>
</tr>
<tr>
<td><strong>Compression</strong></td>
<td>Not used or non-compliant</td>
<td>Intermittent use</td>
<td>Stockings worn most days</td>
<td>Stockings worn daily</td>
</tr>
</tbody>
</table>

*Figure 3. Venous Clinical Severity Score*

### 1.3.2.2 Venous Segmental Disease Score

The Venous Segmental disease Score (VSDS) combines the anatomical and pathological components of the CEAP score. Each leg is given a reflux and obstructive component score, both out of a possible maximum score of 10 as detailed in Figure 4.
### Anatomical Segment

<table>
<thead>
<tr>
<th>Anatomical Segment</th>
<th>Reflux score</th>
<th>Obstruction Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small saphenous vein</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Great saphenous vein</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Thigh perforator</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Calf perforator</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Calf veins multiple or Posterior tibial alone</td>
<td>2 or 1</td>
<td>1</td>
</tr>
<tr>
<td>Popliteal vein</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Superficial femoral vein</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Profunda femoris</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Common femoral vein</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Iliac vein</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Inferior vena Cava</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 4. Venous Segmental Disease Score**

#### 1.3.2.3 Venous Disability Score

The VDS grades patients from 0-3 based on their degree of symptoms and reliance on compression. (Figure 5)

<table>
<thead>
<tr>
<th>Score</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>1</td>
<td>Symptomatic, but able to carry out usual activities without compression therapy</td>
</tr>
<tr>
<td>2</td>
<td>Able to carry out usual activities only with compressive therapy and/or limb elevation</td>
</tr>
<tr>
<td>3</td>
<td>Unable to carry out usual activities even with compression and/or elevation</td>
</tr>
</tbody>
</table>

**Figure 5. Venous Disability Score**

The VCSS and VDS have been shown to correlate with CEAP scores pre-operatively and have been shown to be valid for differentiating between patients with normal venous anatomy and those with venous disease, and to correlate with the severity of venous disease (Meissner et al. 2002; Ricci et al.)
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

2003). They are also sensitive to change following therapy (Kakkos et al. 2003) and have been advocated as complementary tools to the CEAP classification. Although initially designed to be used as a complementary tool, the VSDS is time consuming to calculate and is reliant on an accurate duplex scan. In general the VSDS and VDS are infrequently used in routine clinical practice. The VCSS is straightforward to use and has become increasingly popular, however, it is currently under revision. The revised VCSS aims to modify the language in certain categories to make it easily applicable to patients, without affecting the sensitivity, and, therefore, making it an easier tool for clinicians to utilise as part of their routine practice as well as in clinical research (Vasquez et al. 2008).

1.4 Investigation and Outcome Assessment in Venous Disease

The severity of venous disease varies widely, as demonstrated by the wide range of clinical signs and patient reported symptoms. Investigation and confirmation of venous disease is frequently made using colour duplex scanning and haemodynamic measurements of venous function, but the clinical severity of venous disease and its functional impact is more difficult to evaluate. Patients with moderate and severe venous disease (skin changes and venous ulceration), present less frequently compared with those who report clinical symptoms in the absence of measurable signs. The assessment of disease severity and outcomes following intervention in these patients is consequently more difficult. The introduction of endovenous therapies for the treatment of varicose veins has lead to a greater interest in the evaluation of outcomes and the reliable assessment of disease severity in order to draw meaningful comparisons between studies, to evaluate the efficacy of different treatment modalities and to assess improvements in individual patients.

A variety of different outcome measures exist which can be broadly classified as anatomical, haemodynamic, clinical and functional as illustrated below (Figure 6).
Figure 6. Outcome Assessment in Venous Disease
1.4.1 The use of Colour Duplex in the Management of Varicose Veins

Duplex ultrasonography was introduced into UK clinical practice in the 1980s and in the last 20 years its use has shifted from being only available for selected patients in certain hospitals in the mid 1990s (Campbell et al. 1996), to replacing venography as the current gold standard investigation in the assessment of venous disease (Vasdekis et al. 1989; Baker et al. 1993). It uses a combination of B mode ultrasound and colour Doppler to provide a detailed anatomical assessment and haemodynamic measurements of the venous system. The accuracy of the scan is operator dependent and reliably reproducible images can be achieved with a qualified Vascular Scientist or experienced Vascular Surgeon. Prior to the widespread use of duplex, the hand held Doppler (HHD) was frequently used in the outpatient setting to detect reflux at the SFJ, SPJ or in the great and small saphenous veins, to plan operative management in the context of clinical examination. However, it has been shown that relying on clinical expertise and examination with a HHD can be unreliable even in experienced hands, with specialists missing 3% -11% of GSV and 4%-11% of SSV reflux (Campbell et al. 1997; Campbell et al. 2005). The presence of deep venous incompetence was also frequently miss-diagnosed in patients with symptomatic superficial reflux (Makris et al. 2006). For this reason it is recommended that all patients, even those with primary varicose veins should undergo duplex imaging prior to intervention (Mercer et al. 1998). In one randomised trial pre-operative duplex did not appear to improve early quality of life outcomes or recurrence rates up to 12 months (Smith et al. 2002), but it has been shown to reduce recurrence rates and re-operation rates at 2 years in a randomised clinical trial of patients undergoing surgery (Blomgren et al. 2006).

The introduction of endovenous ablation procedures has resulted in a huge increase in the use of duplex ultrasonography, not only in the assessment of the suitability of patients for the procedure, but in the delivery of tumescent anaesthesia and the cannulation of the saphenous vein. Based on current evidence (Makris et al. 2006) all patients presenting with symptomatic venous disease should undergo a full colour duplex scan prior to intervention.

1.4.2 Venous Haemodynamics and Digital Photoplethysmography

Venous haemodynamic assessment involves measuring the changes in venous pressure in the lower leg. Haemodynamic factors have been shown to correlate with physical changes associated with venous insufficiency and to improve following superficial venous surgery. The gold standard for venous haemodynamic assessment is invasive measurement of ambulatory venous pressure by
cannulating a vein in the foot and measuring pressure changes using a transducer. Digital photoplethysmography (PPG) is a non-invasive and validated alternative to invasive measurements. It uses light rheography to measure venous refill time (VRT) by measuring the light reflected from the blood in skin capillaries in the dermis. An initial reading is taken and then the patient performs 10 foot dorsiflexions in order to empty blood pooled in the calf veins using the muscle pump (Figure 7). The change in infrared absorption in the skin is then measured, and the time taken for this to return to 90% of the baseline value is calculated as the VRT. A recordable trace is produced as shown in Figure 8.

Figure 7. Digital PPG machine

![Digital PPG machine](image)

Figure 8. Venous refill time trace produced by digital PPG

![Venous refill time trace](image)

Improvements in VRTs following superficial venous surgery correlate with reduced venous ulcer recurrence (Gohel et al. 2007a). It has been suggested that digital PPG may be useful in order to
differentiate patients with cosmetic varicose veins, from those with genuine haemodynamic dysfunction (Beraldo et al. 2007), although there has been little investigation into the relationship of VRTs with functional outcomes. Both anatomical reflux and haemodynamic function are surrogate measures of the impact of venous disease and, although pre-operative VRTs have been shown to correlate significantly with clinical CEAP and validated disease specific quality of life outcomes (Aberdeen Varicose Vein Questionnaire- see section 1.4.4.2.1) there was no correlation with scores following foam sclerotherapy, or between the changes in disease specific quality of life and VRT (Darvall et al. 2010a).

Unlike invasive ambulatory venous pressure, digital PPG readings are subject to a number of patient related factors including the technique of ankle dorsiflexions, the patient’s body habitus, the presence of significant subcutaneous oedema and skin changes including haemosiderin deposition and lipodermatosclerosis which can affect the absorption of the infra red wavelength. Therefore, digital PPG is not appropriate for use in all patients.

1.4.3 Clinical Severity

A detailed description of clinical classifications used as outcome measures are described in section 1.3.

1.4.4 Quality of Life

In 1997 a panel of experts from the World Health Organisation agreed upon the concept of Quality of Life (QoL) and defined it as “Individuals’ perception of their position in life in the context of culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the person’s physical health, psychological state, level of independence, social relationships and their relationship to salient features in their environment” (Saxena et al. 1997). It is closely related to an individual’s “health” defined as “a state of complete physical, mental and social well being and not merely the absence of disease or infirmity” (http://www.who.int/hac/about/definitions/en). Measuring the state of health with the aim of improving quality of life is of major importance throughout all branches of medicine.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Many patients with venous disease report a huge range of symptoms of varying severity, despite the absence of clinical signs (Campbell et al. 2007). These symptoms frequently impact on their daily activities, ability to work and social lives, and, therefore, have a functional impact on their quality of life to a varying degree. In order to investigate this impact, quality of life can be evaluated using questionnaires. In 1997 Beattie et al (Beattie et al. 1997) suggested that the ideal quality of life measure should be:

- Equally applicable to any disease process or outcome.
- Equally applicable across all levels of illness and degrees of invalidity.
- Of proven validity, with a high level of convergence within patient groups, when applied across geographic, linguistic and cultural boundaries.

A number of questionnaires evaluate quality of life and can be broadly classified into 2 categories: Generic (applicable to the population in general, frequently assessing physical and mental components of health) or System/disease specific (designed to assess quality of life in patients with a particular condition or disease process).

1.4.4.1 Generic Quality of Life Assessment Tools

Generic health questionnaires such as the Short form 36 (SF36) and Short form 12 (SF12) have been shown to be reliable for the assessment of generic quality of life in patients with a variety of health problems including varicose veins (Smith et al. 1999; Michaels et al. 2006). Patients with symptomatic varicose veins have been shown to have poorer quality of life scores when compared with the general population (Smith et al. 1999) and surgical treatment can improve quality of life in comparison to conservative treatment (Michaels et al. 2006). The Nottingham health profile (Franks et al. 2001) and the EuroQol (EQ-5D) are also effective at assessing generic quality of life and have been used in studies of patients with varicose veins and venous leg ulceration (Iglesias et al. 2005; Michaels et al. 2009b). Generic quality of life changes are helpful in evaluating the impact of a condition on quality of life in general and can be used to compare the impact of different disease processes in different populations where normal values for age and sex matched populations are available for comparison. This allows health economic analysis to be carried out in order to compare the cost effectiveness of different treatments. Although important in allowing the evaluation of quality of life between different disease processes and allowing economic evaluation, they may lack the sensitivity to detect subtle but important differences in quality of life related to a specific disorder.
1.4.4.2 Disease Specific Quality of Life Tools

Disease specific questionnaires were designed in order to detect subtle changes in health related quality of life specific to a particular disease process and, therefore, be responsive to changes following intervention. The views of the patient and the impact of symptoms on their quality of life is considered important in all disease processes, but particularly in the management of venous disease where clinical, anatomical and haemodynamic measurements do not always fully evaluate the impact of the disorder. A variety of questionnaires now exist and are detailed below.

1.4.4.2.1 Aberdeen Varicose Vein Questionnaire

The Aberdeen Varicose Vein Questionnaire (AVVQ) designed by Garratt et al was the first disease specific questionnaire validated for use in patients with varicose veins (Garratt et al. 1993). It was designed with the aim of creating “a valid and reliable measure of patient outcome” that would “1) be sensitive to small yet clinically significant changes in health status; 2) have greater power to discriminate between patients who’s health is only mildly affected by their varicose veins; 3) contain questions that clinicians ask routinely when taking a clinical history” and 4) contain questions that would be “familiar to patients” (Garratt et al. 1993). It attributes a score based on the clinical severity of the disease, symptoms experienced and their impact on quality of life. The questionnaire was based on questions commonly asked to assess patients presenting with varicose veins. Two consultants independently allocated scores to responses based on their perceived contribution of the response to disease severity. Scores were averaged and scaled from 0 (no disease) to 100 (severe disease). Question comprehensibility was assessed by interviewing in a small group of patients. The original questionnaire consisted of 15 questions and was completed by 281 patients with varicose veins. It showed good internal consistency and validity as confirmed by a strong correlation with all aspects of the SF36 (Garratt et al. 1993). Two questions did not appear to represent any clinically distinct health factor and were subsequently removed from the questionnaire. The study also confirmed that patients with varicose veins had a poorer perceived health than the general population when matched for age and sex (Garratt et al. 1993). Since its initial publication, the AVVQ consisting of 13 questions has been shown to be responsive to changes following intervention and to correlate significantly with clinical scoring systems, generic quality of life and improvements in quality of life following surgery, particularly for patients with significant clinical disease (Smith et al. 1999). It has also been shown to be more responsive to changes following surgery than generic quality of life questionnaires (Garratt et al. 1996). It remains the most frequently used and well validated of the disease specific questionnaires and has been used in
numerous clinical trials to evaluate outcomes (Garratt et al. 1993; Smith et al. 1999; Rasmussen et al. 2007; Darwood et al. 2008).

1.4.4.2.2 Chronic Venous Insufficiency Questionnaire (CIVIQ)

The original version of the CIVIQ was developed from a cross sectional observational study in over 2000 patients, of which over 50% had venous insufficiency as diagnosed on clinical signs and reported symptoms. The CIVIQ 2 was devised following a second analysis using a questionnaire of 20 equally weighted questions in 1001 patients with venous disease based on 4 criteria including physical, psychological, social and pain as parameters. The CIVIQ 2 questionnaire has been shown to be appropriate, specific and reliable for the assessment of chronic lower limb venous insufficiency (Launois et al. 1996). Since its development in 1996, it has been shown to be reliable and responsive in the assessment of patients with chronic venous insufficiency following venous outflow stenting and has also been used successfully to evaluate improvements following endovenous thermal ablation procedures in a number of clinical trials (Lurie et al. 2003; Almeida et al. 2009b).

1.4.4.2.3 Venous Insufficiency Epidemiologic and Economic Study (VEINES) Questionnaire

In 2003, Lamping et al published the Venous Insufficiency Epidemiologic and Economic Study (VEINES-QOL/Sym) questionnaire (Lamping et al. 2003). Previous disease specific tools were thought to have been insufficiently validated in English (Launois et al. 1996) or designed specifically to evaluate a small part of the spectrum of venous disorders (either venous ulceration or varicose veins (Garratt et al. 1993)). The VEINES questionnaire was, therefore, designed as an effective tool for assessing disease specific quality of life across all degrees of chronic venous disease and has been validated in French and English in 5 countries as part of the VEINES study in 1531 patients (Lamping et al. 2003). It consists of 35 items split into a symptom questionnaire (10 items) and the QoL questionnaire (25 items). Criticisms of the study include the fact that there was no anatomical confirmation of the venous insufficiency, which was diagnosed solely on clinical grounds and that statistically significant correlations observed may not necessarily translate into clinically meaningful results (Padberg 2003).
1.4.4.2.4 Specific Quality of life and Outcome Response – Venous Questionnaire

The latest patient reported outcome questionnaire was designed by JJ Guex et al (Guex et al. 2007) entitled the SQOR-V questionnaire (Specific Quality of life and Outcome Response – Venous). It was felt that previously designed questionnaires may not be sufficiently sensitive to evaluate symptoms and their impact on activities and quality of life in patients who may not have obvious clinical signs of venous insufficiency, i.e. patients with C0-C3/mild-moderate venous disease. A Total of 46 questions were carefully composed in order to evaluate symptoms, with a rating scale of 1-5 instead of yes/no answers in order to improve accuracy and sensitivity. Questions were divided into 5 domains, relating to physical discomfort, appearance, restriction in movement, risk or perceived risk and threat to health and emotional consequences. Each domain was moderated to a possible score of 4-20, giving a possible range of total scores from 20 (no disease) to 100 (severe disease). Although developed in English, it was originally validated in French, with the SF12 and a Centre for Epidemiologic Studies-Depression scale (CES-D) in a group of 202 patients (Guex et al. 2007). It has been shown to have internal consistency, reproducibility, structural validity, convergent validity and clinical validity (Guex et al. 2007) and has now been validated in several other languages including English and Spanish (Guex et al. 2009).

1.4.4.2.5 The Charing Cross Venous Ulceration Questionnaire (CXVUQ)

The Charing Cross Venous ulceration questionnaire was designed to assess quality of life in patients with venous leg ulceration. An ulcer specific questionnaire was designed with questions relating to physical discomfort, the effects on daily activities and social activities, emotional consequences, perspectives regarding dressings and patient’s mobility. It was validated with the SF36 in a group of 98 patients and has been found to be reliable and responsive to treatment in patients with venous leg ulcers (Smith et al. 2000).

In summary, there are validated disease specific and generic health questionnaires that can be used in combination with clinical scoring systems to assess the impact of varicose veins on the quality of life of patients and to evaluate improvements following treatment. A number of patient, surgical and operative factors have been shown to have a significant influence on the impact of superficial venous surgery on disease specific quality of life (Mackenzie et al. 2002). Patients with recurrent disease (Beresford et al. 2003a) and those with more severe disease at baseline are likely to continue to have a worse quality of life, but the degree of improvement seen after intervention appears to correlate with increasing severity of disease (Mackenzie et al. 2002). Those with more
advanced disease who require more complicated procedures are also likely to have a worse quality of life at 2 years (Mackenzie et al. 2002).

There are enthusiastic advocates for the use of physician and patient reported outcome measures (Vasquez et al. 2007) and controversy exists as to which is the most useful (Guex 2008). Few studies have compared the efficacy of objective clinical scoring systems with disease specific quality of life tools (Beresford et al. 2003b), and no advantage of one scoring system over another has been conclusively demonstrated. There is a current trend for the assessment of patient reported outcome measures (PROMs) in the United Kingdom which is likely to continue.

1.4.4.3 Patient Reported Outcome Measures (PROMs)

Patient reported outcome measures (PROMs) are “measures of a patient's health status or health-related quality of life (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance). In 2009 patient reported outcome measures were introduced in the UK to evaluate health improvements after surgical procedures including hip and knee replacements, hernia operations and varicose vein therapies. Patients undergoing varicose vein procedures from April 2009 onwards were asked to complete questionnaires composed of questions from validated generic (EQ-5D visual analogue score and profile) and disease specific (Aberdeen Varicose Vein) questionnaires pre-operatively and were sent a postal questionnaire at 3 months. Data from PROMs may be used “To evaluate the relative clinical quality of providers of elective procedures and benchmark performance and to help patients and GPs exercise choice”. They may also be used in research to “evaluate the efficiency and cost-effectiveness of different technical approaches to care” and for the assessment of the appropriateness of referrals to secondary care, to reduce inequality and “establish the quality of services PCT commissioners are contracting with providers” (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance).

The first PROMs data from April- November 2009 were published on the Hospital Episode statistics website in April 2010 (http://www.hesonline.nhs.uk). Only pre-operative data are currently available, and to date 10,533 questionnaires have been received out of a possible 25,963 episodes (40.6%) of which 79.7% have been linked to treatment episodes. Although the largest data set to date, problems include the fact that the overall response rate is at present poor, with only 40% of potential data being captured. In addition, it has not been possible to link all data with treatment
episodes, and, therefore, data should be interpreted with caution. Post-operative data is likely to be available in 2010, but is likely to be of poor quality. The co-operation of both patients and hospital staff in the recording of patient reported outcomes will have to be addressed in order that clinically useful data can be obtained for the purposes for which it was originally designed.

### 1.4.5 Measuring the Burden of Venous Disease and Cost Effectiveness of Treatments

At present no single method of investigation allows a full evaluation of the extent of venous disease. Because life threatening and severe events are rare, not all patients require an intervention and no simple investigation exists to evaluate disease progression or improvements after intervention. The evaluation of the true cost of venous disorders to a state based healthcare system is unknown and at present sub-optimally managed (Barnes et al. 2010). At present the societal costs and cost effectiveness of treatments in the UK is calculated in quality of adjusted life years (QALYs). A year in perfect health is equal to 1.0 QALY, and years of ill health are given reduced scores in proportion to the severity. QALYs form the basis of health economic analysis, where the cost effectiveness of a particular intervention is frequently judged by its incremental cost effectiveness ratio (ICER). This is the ratio of the difference in cost between two interventions divided by the change in effect. Treatments with an ICER of <£20,000 per QALY are usually deemed cost effective to the NHS, and those > £30,000 per QALY are usually not funded. However, it has been argued that generic questionnaires may not be sufficiently sensitive to evaluate improvements for certain disease processes. In the case of other chronic disorders the “disease burden” has been calculated and takes into account the cost of patients living with chronic conditions such as osteoarthritis as well as the costs of treatments (Bitton 2009). This allows the targeted use of healthcare resources for prevention and treatment of early disease. At present it is proposed that the burden of venous disease should be calculated in a similar way to that of patients with osteoarthritis, in order to convince international organisations that better management of chronic venous disease is necessary and cost effective to society.

The allocation of scarce healthcare resources to the management of venous disorders is in constant flux and under continuous review. Many patients with varicose veins have mild symptoms and are often concerned with cosmesis. This has lead to the rationing of varicose vein treatments by the majority of healthcare regulators in the UK, with referral to secondary care for treatment restricted to those with late clinical signs or very severe symptoms, although it is highly variable throughout the country (Lindsey et al. 2006; Nasr et al. 2008). The introduction of outpatient based vein
treatments potentially allows the treatment of a greater number of patients, saving money by reducing the need for an operating theatre, overnight stay or an anaesthetist. Recently the cost effectiveness of radiofrequency has been compared with traditional surgery and it is proposed that the increased cost of the equipment is offset by the quicker return to work and normal activities (Rautio et al. 2002; Subramonia et al. 2009a). To date, few comparative cost analysis studies have been performed. However, using a Markov model based on published randomised studies, NHS HRG tariffs and device manufacturers costs, foam sclerotherapy was most likely to provide the cheapest option, even taking into account the cost of further treatments at 5 years. However, EVLA, RFA or surgery performed as day case procedures in an outpatient or office based setting with sequential treatment of varicosities if necessary, are also likely to be cost effective treatment strategies (Gohel et al. 2010) (Gohel et al. 2008). A current multicentre trial in progress (CLASS Trial- Comparing LAser Surgery and Sclerotherapy in the treatment of varicose veins) aims to make a detailed analysis of the costs of the treatments as part of the secondary analysis.

1.5 Evidence Supporting the Treatment of Venous Disease

The term venous disease encompasses a wide spectrum of conditions with varying degrees of severity. Many patients with mild or moderate venous disease may be asymptomatic (Bradbury et al. 1999). Patients with severe venous disease including those with significant skin changes or ulceration are usually evaluated using objective clinical signs of ulcer healing or recurrence. However, venous disease at both ends of the spectrum has an impact on quality of life, the evidence for the treatment of venous disease is discussed below.

1.5.1 Uncomplicated Venous Disease

Although the benefits of intervention are clear for patients with venous ulceration, the treatment of uncomplicated varicose veins remains controversial and varies widely throughout the UK (Nasr et al. 2008). The National Institute of Clinical Excellence published guidelines in 2001 to advise primary care practitioners when to refer to secondary care. They advise that “most varicose veins require no treatment” (National Institute for Clinical Excellence Issued 20 December 2001) and primary care physicians are encouraged to educate patients about exercise, leg elevation and weight reduction and to oversee the use of compression hosiery and compression bandaging when appropriate. Referral priorities from NICE are summarised in Table 2.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Referral Priority</th>
<th>Symptoms and Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient should be seen immediately (within 1 day)</td>
<td>Bleeding from a varicosity that has eroded the skin</td>
</tr>
<tr>
<td>Patient should be seen urgently (within a maximum of 2 weeks)</td>
<td>Previous bleeding from a varicosity and at risk of further bleeding</td>
</tr>
<tr>
<td>Patient should be seen soon (will depend on local waiting times)</td>
<td>A leg ulcer which is progressive and/or painful despite treatment</td>
</tr>
<tr>
<td>Patient should have a routine appointment (will depend on local waiting times)</td>
<td>• An active or healed ulcer and/or progressive skin changes that may benefit from surgery</td>
</tr>
<tr>
<td></td>
<td>• Recurrent superficial thrombophlebitis</td>
</tr>
<tr>
<td></td>
<td>• “Troublesome symptoms attributable to their varicose veins, and/or they and their GP feel that the extent, site and size of the varicosities are having a severe impact on quality of life”</td>
</tr>
</tbody>
</table>

Table 2. Summary of NICE referral priorities to secondary care for varicose veins by primary care physicians

Until recently, success after varicose vein treatment was frequently judged on recurrence rates and haemodynamic assessment. Surgery has been shown to reduce the overall patient reported symptoms frequently attributable to venous disease (Campbell et al. 2007), however, the accurate measurement of functional improvement is complex. The introduction of validated generic and disease specific quality of life questionnaires have provided an objective assessment tool to evaluate improvement and provide credible evidence for the treatment of superficial reflux.

Patients with chronic venous disease have been shown to have significantly worse generic quality of life scores than the general population, with quality of life impairment being proportional to the severity of the disease (Kaplan et al. 2003).

Since the publication of the recommendations from NICE in 2001, evidence from a number of studies has shown that superficial venous surgery results in improvements in generic (Sam et al. 2004) and disease specific quality of life (Smith et al. 1999), and evidence from a randomised trial by Michaels et al 2006 confirmed that patients with uncomplicated varicose veins gained significant improvements in quality of life following surgery compared with conservative management, assessed using validated quality of life questionnaires (Michaels et al. 2006). Treatment was also shown to be cost effective at £4682 per QALY, well below the £20,000 per QALY threshold recommended as cost effective by NICE (Ratcliffe et al. 2006).
Other studies have shown that improvements in generic quality of life using the Short Form 12 questionnaire following varicose vein treatments are comparable to those achieved after laparoscopic cholecystectomy in patients with C2-C4 disease (Sam et al. 2006).

1.5.2 Ulcer Healing

Rates of ulcer healing may be affected by a number of different factors. Increasing age, ulcer chronicity (Gohel et al. 2005b) and deep venous incompetence have been associated with significantly slower rates of healing (Moffatt et al. 2010), and significant seasonal variations have been observed, with ulcers appearing in the Spring or Autumn healing more rapidly that those appearing in the Summer or Winter (Simka 2010). Compression bandaging has been shown to be the most effective technique for healing leg ulcers, with the type of dressing used including the presence or absence of silver or other antimicrobial dressings being relatively unimportant (Michaels et al. 2009a). Many researchers have hypothesised that the treatment of superficial venous reflux can increase rates of ulcer healing, although evidence supporting this is lacking. Smaller studies have suggested that treating superficial reflux with foam sclerotherapy in patients with recalcitrant ulcers may increase ulcer healing (Cabrera et al. 2004), however, this has not been replicated in randomised clinical trials (RCTs). To date the ESCHAR trial is the largest randomised study of ulcer healing and recurrence but failed to show significantly improved healing in the surgery group (Barwell et al. 2004). Other studies including a randomised trial (van Gent et al. 2006) have also shown superficial venous surgery to reduce ulcer recurrence but failed to show any benefit in rates of ulcer healing (Barwell et al. 2000; Zamboni et al. 2003; Barwell et al. 2004).

1.5.3 Ulcer Recurrence

Published evidence confirms that patients with venous ulceration have a significantly worse quality of life compared with the general population (Kurz et al. 2001). Until recently, the advantages of treating superficial reflux were believed by many, however, high quality evidence supporting the treatment of superficial reflux in patients with venous ulceration, and those with co-existing deep venous incompetence was scarce. The ESCHAR Trial published in 2004 and 2007 randomised 500 patients with venous ulcers to superficial venous surgery and compression versus compression alone and showed a clear benefit of reduced ulcer recurrence in patients randomised to the surgical treatment group (12% ulcer recurrence) in comparison with those randomised to compression alone (28% ulcer recurrence)(Barwell et al. 2004). However, healing rates at 24 weeks were 65% in both groups based on an intention to treat analysis. Although a small study into the use of foam
sclerotherapy in patients with venous ulceration suggested that treatment was likely to reduce ulcer recurrence (Darvall et al. 2010a), a randomised trial comparing foam sclerotherapy with compression to compression alone failed to show an advantage of foam sclerotherapy. However, a formal comparison was not performed as insufficient numbers of patients were recruited (O'Hare et al. 2010a). It is likely that abolition of superficial truncal reflux by any modality will result in a significant reduction in leg ulcer recurrence in patients with isolated superficial and co-existing deep venous insufficiency. In addition, the treatment of superficial reflux has been shown to lead to the correction of deep venous reflux in some cases, which is likely to aid further clinical improvements (Walsh et al. 1994; Barwell et al. 2004; Gohel et al. 2005a).

1.6 Treatment Goals

The treatment of venous diseases consumes approximately 1% of hospital in patient costs in many European countries. Although the evidence to support the treatment of complicated venous disease is unequivocal, the treatment of symptomatic varicose veins in the absence of skin changes remains controversial, with many NHS Healthcare Trusts refusing to fund treatment (Lindsey et al. 2006). It has, however, been shown that the treatment of uncomplicated varicose veins results in significant improvements in the quality of life, the cost of which is below the threshold recommended by NICE (O'Hare et al. 2007). Despite this, the number of varicose vein treatments in recent years has significantly declined (http://hesonline.nhs.uk).

Litigation claims for varicose vein surgery were previously the most frequently occurring claims of all vascular surgical, including arterial procedures (Campbell et al. 2002). Nerve damage was the commonest reason for complaint, followed by major vascular injury and deep venous thrombosis (Scurr et al. 2007). Even in the absence of permanent or serious complications, a number of patients will remain dissatisfied with the results of their treatment (Davies et al. 1995). This has lead to much interest in the development of alternative treatments for varicose veins.
Attributes of an ideal treatment should include:

- A minimally invasive therapy
- Ability to be performed as an outpatient procedure
- Minimal discomfort to the patient intra and post-operatively
- Rapid to perform
- Provided in a single visit
- Minimal reliance on complex or expensive imaging or that requiring radiation
- No follow up required
- Durable long term results
- Minimal complications, risks or side effects
- Cost effective

The treatment is likely to require the abolition of truncal reflux and the removal of visible varicosities in order that symptoms and cosmetic concerns are addressed, and the risk of developing further complications of venous disease are reduced.

1.7 Treatment Options

Many patients with varicose veins will require no treatment for their condition but in those who present with complications or significant symptoms, a variety of different treatment options exist. The current treatment options for varicose veins are discussed below.

1.7.1 Compression Hosiery

Compression of the superficial venous system reduces venous pooling in the legs and assists the calf muscle pump, alleviating symptoms such as swelling and aching. Graduated compression stockings deliver a specific pressure at the ankle and are graded from I to III. In the UK grade I compression and grade II compression are the most frequently prescribed level of compression for patients with superficial venous incompetence. The grading systems for different degrees of compression vary between the UK, Europe and the United States which can cause considerable confusion. A table detailing the different grades of compression is presented below (Table 3).
Table 3. Classification of compression hosiery in the UK, Europe and USA

<table>
<thead>
<tr>
<th>Grade</th>
<th>UK</th>
<th>Europe</th>
<th>USA</th>
</tr>
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<td>14-17mmHg</td>
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<td>III</td>
<td>25-35mmHg</td>
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A Cochrane review has confirmed that compression improves ulcer healing and reduces the recurrence of venous leg ulcers (O’Meara et al. 2009). A systematic review of randomised clinical trials confirmed that compression of 10-20 mmHg improved venous haemodynamics, reduced venous reflux and venous oedema and lead to a reduction in symptoms such as pain and discomfort (Amsler et al. 2008). However, a recent systematic review evaluating its role in uncomplicated varicose veins found the evidence for its use was equivocal in this patient group (Palfreyman et al. 2009). Disadvantages of compression hosiery include discomfort to patients, especially in hot weather, difficulty donning stockings, especially for patients with co-existing musculoskeletal pathology, particularly those affecting the hands, hips or knees and cosmetic concerns. Studies have shown that in many patients, compliance with compression hosiery is poor (Raju et al. 2007).

Compression hosiery is also frequently used following varicose vein treatments. Perceived advantages include reduced bruising and thrombophlebitis, however, evidence from RCTs do not support the prolonged use of compression either following surgery (Houtermans-Auckel et al. 2009) or endovenous ablation (Hamel-Desnos et al. 2010; O’Hare et al. 2010b).

1.7.2 Pharmacological Management of Varicose Veins

Although the management of venous disease in the UK predominantly consists of compression therapy or ablation of truncal reflux, a number of pharmacological therapies currently exist and are frequently used to alleviate venous symptoms and reduce sequelae of chronic venous disease. In Europe they are frequently used in combination with compression or abolition of truncal reflux, but at present few are licensed in the UK. Pharmacological agents are frequently classified as either venoactive/ phlebotrophic (drugs acting on the venous tone or capillary permeability) or non-venoactive and consist of naturally occurring or synthetic drugs. Of the venoactive drugs that have been available for many years, the most widely known is Micronized Purified Flavonoid Fraction
(MPFF) or Daflon® (Servier France). This has been shown to improve venous tone and decrease venous pressure. Although the exact mechanism of action is not completely understood, it is thought to inhibit noradrenaline degradation, leukocyte adhesion and activation, reduce inflammation, inhibit platelet function and improve lymphatic drainage (Gohel et al. 2009a). A meta-analysis supported the use of Daflon to improve healing in patients with venous ulcers and Daflon has also been reported to reduce pain, oedema and leg cramps (Jantet 2002; Smith 2005). However, large prospective randomised trials supporting the use of many of the available drugs are lacking.

Similar pharmacological agents to Daflon include Oxerutins and Rutosides, which are thought to act on capillary permeability and have been shown to reduce swelling and improve haemodynamic function (Petruzzellis et al. 2002). Some have been compared favourably with Daflon in prospective studies (Cesarone et al. 2006). Side effects are rare with venoactive drugs, but can include nausea, vomiting and abdominal pain (Guilhou et al. 1997).

Non-venoactive drugs such as pentoxifyline, ergotamine and aspirin are thought to affect the inflammatory response associated with venous disease. Actions include reduced white cell activation, fibrinolysis and platelet inhibition and these drugs may provide some benefit in patients with venous ulceration. Some studies suggest that venous ulcer healing is improved with pentoxiphyline although evidence from different studies is conflicting and, therefore, inconclusive, with good quality evidence being scarce (Jull et al. 2002).

Although medical treatment for venous disease is a desirable notion, and a number of drugs have been shown to significantly improve symptoms and ulcer healing, the majority of studies have been small and non-randomised. To date few medications are readily available in the UK and they remain adjuncts to endovenous and surgical options, which are considered more definitive treatments.

1.7.3 Traditional Surgery

The first recorded treatments for varicose veins were found in the Ebers papyrus in ancient Egypt over 3500 years ago. It is thought that initial attempts at surgery lead to fatal haemorrhage and were, therefore, not advised. Detailed descriptions of varicose veins can be found in the writings of Hippocrates in the Hippocratic Treatises in 460 BCE. He describes applying compression following multiple puncture sites and also describes cautery (van den Bremer et al. 2010). Further descriptions of varicose vein surgery were detailed by the Romans; Celsus and Galen describe the technique of
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phlebectomy which remains similar to that used today. The first recorded surgical procedures involving ligation of the great saphenous vein were from Paulus Aegineta (CE 607-690) in ancient Greece. He describes placing a tourniquet onto the thigh and asking the patient to walk, the dilated veins were then marked with ink to determine the site for the incision and the vein was ligated in the thigh, divided and bandaged. Removal of the GSV through multiple incision sites along the vein was described in the surgical text books written by the Arabian surgeon Al-Zahrawi around 960 CE, and the technique remained relatively unchanged until the 17th century. Advances in venous anatomy, physiology, anaesthetics and antisepsis meant that during the 19th century significant advances in the treatment of varicose veins were made. In the 1800s Friedrich Trendelenburg published the technique of ligation of the GSV in the mid and lower thigh (Trendelenburg 1980). This became a popular treatment with reported recurrence rates of 22% at 4 years, however, it was his student Perthes who recognised the importance of saphenofemoral ligation and groin dissection which did not become established until the early 1900s. The 20th century saw the introduction of stripping of the GSV. Mayo described an extraluminal stripper and Babcock and Keller (Keller 1905) described internal strippers similar to the perforation invagination (PIN) strippers used today. In 1916 John Homans (Homans 1917) was credited with the first description of crossectomy and recognised the importance of preventing new vessel formation by careful dissection of tributary vessels in the groin, he also described performing the procedure under local anaesthetic. In the 1930s, Linton described the association of leg oedema with GSV incompetence and also with perforator incompetence (Linton 1938) and subsequently described subfascial division of perforating veins, although the necessity of treating them remains controversial to date. Stripping of the GSV became increasingly popular from the 1950s, when evidence of its superiority over crossectomy alone was published (Lofgren et al. 1958).

Since the early descriptions of varicose vein surgery, treatments have been modified, but the principle has remained similar for hundreds of years. Until the last decade, the gold standard for the treatment of varicose veins due to GSV reflux was saphenofemoral disconnection, stripping of the great saphenous vein and phlebectomies for superficial varicosities as shown in Figure 9. The treatment of short saphenous vein (SSV) reflux involves ligation of the saphenopopliteal junction, but frequently does not involve stripping of the SSV due to the risk of neurological injury.
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a. Groin dissection  
b. Saphenofemoral disconnection  

c. Stripping of the Great saphenous vein  
d. Great saphenous vein and stripper  

e. Phlebectomy using an Oesh hook

Figure 9. Stripping of the great saphenous vein and phlebectomies
1.7.3.1 Complications Associated with Traditional Surgery

Traditional surgery is associated with a number of adverse events, with approximately 20% of patients experiencing some degree of complication (Critchley et al. 1997). Bruising, post-procedural discomfort and phlebitis are frequently experienced following surgery with many patients requiring several weeks off work and up to 40% experiencing temporary sensory abnormalities (Subramonia et al. 2005). Skin infections and haematomas are thought to occur in 3-10% of patients (Critchley et al. 1997).

For many years the GSV was stripped as far as the knee only, as rates of permanent saphenous nerve paraesthesia were reported to be lower if the veins was stripped to the knee (7%) compared with those stripped to the ankle (39%) (Holme et al. 1990). However, a recent case series reported permanent paraesthesia rates of only 2% when the GSV was stripped to the ankle (Uncu 2009), perhaps reflecting the advantages of performing procedures under ultrasound guidance. Sural nerve injury has been reported to occur in up to 20% of small saphenous vein operations (Perkins 2009) and peroneal nerve injury has also been reported following varicose veins surgery but is extremely rare (Herman et al. 2009; Perkins 2009).

Deep Vein Thrombosis (DVT) has been shown to occur in up to 5% of cases following surgery (van Rij et al. 2004), although other vascular injuries are rare and occur in less than 1% of cases. The most frequent vascular complications include injury to the common femoral vein, and partial stripping of the femoral vein and femoral artery, which have been reported with poor outcomes (Perkins 2009).

Recurrence after traditional surgery remains a significant problem and a recent meta-analysis suggested that success rates are around 75% at 5 years (Van den Bos et al. 2009a). Recurrence rates increase with time and have been reported to be as high as 62% at 11 years (Winterborn et al. 2004). Unsurprisingly, surgery has been associated with a significant degree of patient dissatisfaction (Davies et al. 1995). In recent years there has been much interest in the development of new, minimally invasive techniques for the treatment of varicose veins in order to reduce the morbidity, complications and recurrence associated with traditional surgery.
1.7.4 Conservatrice et Hemodynamique de l’insuffisance Veineuse en Ambulatoire (CHIVA)

CHIVA is a minimally invasive surgical technique based on the principle of interruption of venous reflux with preservation of the truncal vein in order to improve haemodynamic function. It was originally described in the 1980s and is frequently performed in many European countries (Mowatt-Larssen et al. 2010), however, it is practiced infrequently in the UK. Treatment relies on an accurate venous duplex scan in order to identify abnormal blood flow between venous compartments, which leads to the formation of re-entry flow loops of blood. Flush ligation at the proximal origin of the abnormal flow interrupts the recirculation and encourages drainage into the deep system via perforator veins. This, in combination with disconnection of tributary veins, aims to correct haemodynamic abnormalities, thereby reducing venous hypertension and alleviating symptoms.

90% of patients have reflux according to one of two types of shunts described below (Zamboni et al. 2003). The first shunt arises from the saphenofemoral junction and blood drains into the deep system via a perforating vein, usually in the calf, with tributaries arising from the segment of incompetent GSV. Correction involves disconnection of the saphenofemoral junction, encouraging blood to drain into the deep system via distal perforators, and disconnection of tributaries arising from the great saphenous vein. Alternatively the commonest shunt pattern observed arises from incompetence at the saphenofemoral junction, with blood draining back into the deep system via tributary veins. Correction involves flush ligation of the tributaries with phlebectomy of proximal tributaries and may also required saphenofemoral ligation in those patients with an incompetent terminal valve in the GSV (Zamboni et al. 2003). The advantages of this technique compared with traditional surgery are that it is minimally invasive, can be performed easily under local anaesthesia and may reduce rates of saphenous nerve paraesthesia (Mowatt-Larssen et al. 2010). Data from 2 randomised clinical trials comparing CHIVA to traditional stripping of the GSV suggest that recurrence rates are lower following CHIVA, possibly due to the haemodynamic advantages of preservation of the GSV (Carandina et al. 2008; Pares et al. 2010). Good results including low recurrence rates and high levels of patient satisfaction following CHIVA are also reported from large case series (Maeso et al. 2001; Zamboni et al. 2001; Escribano et al. 2003) and CHIVA has also been shown to reduce rates of venous leg ulcer recurrence (Zamboni et al. 2003). Disadvantages include the fact that it is heavily reliant on accurate duplex scanning. In addition, patients may require multiple or staged procedures, particularly if they have significant incompetence of the terminal GSV value, and the appearance of tributary veins frequently takes longer to improve compared with patients who have undergone extensive phlebectomy (Mowatt-Larssen et al. 2010). To date there
are no randomised trials or observational studies comparing CHIVA to endovenous ablation therapies, although endovenous thermal ablation may be used in conjunction with the CHIVA technique to treat short segments of vein instead of ligation or phlebectomy (Mowatt-Larssen et al. 2010).

1.7.5 Ambulatory Selective Varices Ablation under Local Anaesthetic (ASVAL)

ASVAL is an alternative minimally invasive surgical treatment option for varicose veins. It is based on an alternative hypothesis to the theory that venous reflux originates from the SFJ, resulting in descending truncal reflux affecting the GSV and the subsequent development of tributary varices. ASVAL is based on a newer concept that reflux can originate from multifocal sites in the superficial venous network and then ascend to the SFJ, and, therefore, the treatment of this superficial varicose reservoir can lead to the improvement or elimination of saphenous reflux. Careful duplex ultrasonography of the limb maps tributary varicosities into 32 different zones of the leg based on anterior, posterior, medial and lateral views, each with 8 segments. Treatment involves phlebectomy of varicosities in patients with out deep venous reflux with preservation of the GSV. The technique has been shown to lead to reductions in GSV diameter and a reduction in patient symptoms in prospective studies (Pittaluga et al. 2010). A retrospective study of 811 limbs treated with ASVAL reported that 88.5% of patients were free from recurrent varices at 4 years, resulting in a significant improvement in symptoms and elimination of truncal reflux in some cases (Pittaluga et al. 2009). The technique is more successful in patients with fewer zones requiring treatment and appears to be successful for the treatment of mild and moderate disease (Pittaluga et al. 2009).

It shares some similarities with CHIVA, in that the GSV is preserved, however, it significantly differs from CHIVA because it does not rely on the identification of perforator vessels and does not involve the disconnection of tributary vessels or the selective ligation of the SFJ. Unlike CHIVA there are no randomised trials of ASVAL and alternative treatment strategies, and further evidence to support its effectiveness will be required before it can be recommended for widespread use.
1.7.6 Sclerotherapy

1.7.6.1 History of Sclerotherapy

Sclerotherapy of varicose veins involves the injection of a sclerosant substance into the vein lumen, which induces an inflammatory reaction in the vein intima, leading to fibrosis and obliteration of the vein. The first reported attempts at treating varicose veins with the injection of sclerosants are recorded in the 17th century but were largely unsuccessful. In the 1850s Cassaignac, Debout and Panus, injected perchloride of iron into varicose veins with some success (Yao 1997), however, complications such as phlebitis and infections were common, leading in some cases to gangrene. Other sclerosants such as carbonic acid were tried in the 1800s, but at a surgical congress in Lyon in 1894, it was decided that the technique should be abandoned due to the frequent complications. The technique of injecting liquid sclerosants resurfaced in the 1920s but was still associated with considerable side effects. The first recorded descriptions of foam sclerotherapy were by McAusland in 1939 who described shaking sodium morrhuate in a vial with air to create a froth to treat telangiectasia (Wollmann 2004). The invention of foam sclerotherapy for the treatment of larger veins is frequently credited to Orbach, who in 1944 described a technique of injecting air prior to liquid sodium tetradecyl sulphate (STD), in order to improve contact between the vein wall and sclerosant. He later published a description of producing a foam mixture by shaking STD with air prior to injection (Orbach et al. 1950). Between 1940 and 1970, numerous descriptions of a variety of techniques to create foam used successfully to treat varicose veins were published (Wollmann 2004), however, liquid sclerosants were still used in the majority of treatments at the time.

1.7.6.2 Liquid Sclerotherapy

Sclerotherapy liquid STD became increasingly popular in the 1960s as a minimally invasive alternative to traditional surgery to treat the GSV and tributaries (Fegan 1963). Unfortunately for many, results were disappointing, with high recurrence rates. In the 1970s and 80s Hobbs published initial and 10 year data from a randomised trial comparing surgery to liquid sclerotherapy. Results suggested that surgery produced significantly better results in comparison with Sclerotherapy (Hobbs 1974). Around the same time Beresford et al published results from a 5 year randomised clinical trial, reporting that patients were significantly more likely to require further treatment following sclerotherapy in comparison with traditional surgery (Beresford et al. 1978). The use of liquid sclerosants for the treatment of truncal veins subsequently declined and were predominantly reserved for the treatment of tributaries.
1.7.6.3 Foam Sclerotherapy

Despite its decline during the 1980s and 1990s, sclerotherapy became increasingly popular following the publication of studies by Cabrera et al, who reported that larger veins could be successfully treated with the injection of a foam sclerosant. The proposed mechanism was that the foam displaced blood from the vessel, allowing increased contact between the sclerosant and the vein wall, with substantial increase in efficacy (Cabrera et al. 1997). Although sclerotherapy had existed for decades, the introduction of simple techniques to create large volumes of foam of consistent quality, such as that described by Tessari (Tessari 2000) lead to a rapid increase in the popularity of foam sclerotherapy. Foam sclerotherapy was shown to be more effective at eliminating truncal reflux than liquid sclerosants (Hamel-Desnos et al. 2003; Yamaki et al. 2004) and has been used successfully to treat truncal reflux with few side effects (Belcaro et al. 2003; Jia et al. 2007). However, despite its success in comparison to liquid sclerosants, a recent meta-analysis reported truncal occlusion rates of 81% at 12 months and 74% at 5 years (Jia et al. 2007; Van den Bos et al. 2009a), with as many as a third requiring further treatments (O’Hare et al. 2007). Because of this, ultrasound guided foam sclerotherapy (UGFS) is still considered by many to be inferior to traditional surgery or endothermal ablation. Disadvantages include poorer cosmetic outcomes with skin pigmentation and phlebitis occurring in up to a fifth of cases (Jia et al. 2007). There have also been recent concerns over safety following reported visual disturbances and cerebrovascular events, although these are extremely rare (Coleridge Smith 2009) and STD remains licensed for use in the UK. A postal survey published in 2007 investigated the use of foam sclerotherapy amongst members of the Vascular Society of Great Britain and Ireland. Of 281 respondents a quarter regularly used foam Sclerotherapy, in the majority of cases this was for recurrent varicose veins, for elderly patients and for tributary varicosities (O’Hare et al. 2007). Recently a large cohort study reported significant improvements in disease specific quality of life following foam sclerotherapy treatment for GSV reflux. Results were comparable to those reported following endovenous thermal ablation in other studies (Darvall et al. 2010b). UGFS has also been shown to be effective in patients with SSV insufficiency (Darvall et al. 2009c). In addition UGFS offers a minimally invasive treatment to those unfit for general anaesthesia, or those with veins too tortuous for endothermal ablation. Moreover, UGFS results in significantly reduced discomfort and a quicker return to normal activities compared with traditional surgery (Darvall et al. 2009a). Results following UGFS are frequently reported to meet or exceed patient expectations, and are satisfactory for the majority of patients (Darvall et al. 2009b). Foam sclerotherapy certainly appears to be significantly less expensive than endovenous thermal ablation procedures at least in the short term, however, when multiple treatment episodes
are taken into account, it may not be significantly more cost effective than endovenous thermal ablation treatments. At present it certainly appears the cheapest option (Gohel et al. 2008) and, therefore, has significant potential for widespread use in the future.

1.7.7 Endovenous Thermal Ablation Procedures

1.7.7.1 Endovenous Laser Ablation (EVLA): Development and Efficacy

EVLA was first described by Boné in 1999 (Boné 1999) and has been used in the UK since 2001. The procedure involves the introduction of an endovenous catheter into the great saphenous vein using the seldinger technique, under ultrasound guidance. The catheter tip is positioned 2cm from the SFJ and the activated laser is withdrawn along the course of the vein. During this process heat from the laser probe results in the formation of steam bubbles in the blood causing damage to the endothelium by coagulative necrosis (Proebstle et al. 2002a; Proebstle et al. 2002b). This causes thrombus and occlusion of the vein lumen which involutes over approximately 6 weeks until it is no longer visible. In addition, contact between the vein wall and the laser probe also contributes to the heating effect. The first endovenous laser to be developed and used to treat GSV reflux had a wavelength of 810 nm (Min et al. 2001; Navarro et al. 2001) which is specific for haemoglobin, however, other wavelengths rapidly became available including 940nm, 980nm 1320nm and 1470nm. The shorter wavelengths target haemoglobin and the longer wavelengths (1320nm and 1470nm) target water. Since its introduction, numerous studies have been published supporting the efficacy of endovenous laser ablation of various wavelengths, although to date there is no conclusive evidence that one wavelength is superior to the others (Van den Bos et al. 2009a). It has been suggested that the longer wavelengths targeting the water molecules lead to a more uniform heating effect with reduced post-operative pain and bruising in comparison to the 810, 940 and 980nm wavelengths (Proebstle et al. 2005; Kabnick 2006; Van den Bos et al. 2008). Indeed the 980nm laser has been shown to result in less pain than the 810nm with no decrease in efficacy(Kabnick 2006) and the 1320nm laser has been shown to be less painful than the 940nm laser and cause less bruising (Proebstle et al. 2005).

Since its introduction, EVLA has become increasingly popular and has been compared with traditional surgery in a number of clinical trials. Outcomes have been variable and although some have shown EVLA to be less painful than surgery (Rasmussen et al. 2007), and others have shown an
earlier return to normal activities (Darwood et al. 2008), results have been conflicting. Nevertheless, a recent meta-analysis of the outcomes after 5 years found EVLA to be superior to all other treatments, with success rates of 93% at 12 months and 95% at 5 years (Van den Bos et al. 2009a). Despite the excellent success of EVLA in terms of the abolition of reflux, post-procedural pain and bruising are important side effects. This has been attributed to areas of direct contact between the laser catheter and the vein wall causing vein wall perforations and extravasation of blood. Early laser fibres used a pulsed waveform and continuous external pressure was applied over the vein segment being treated. Extrinsically compression has since been shown to be unnecessary for successful occlusion and resulted in increased pain, so current lasers use a continuous waveform.

Linear Endovenous Energy Density (LEED) has been shown to be related to outcome success and complications. It is believed that a LEED of >60 j/cm of vein wall is required for successful abolition of the vein (Theivacumar et al. 2008a). Very high LEEDs >100 j/cm are thought to cause more vein wall perforations and increased pain (Timperman et al. 2004; Timperman 2005; Pannier et al. 2009). Using the laser setting at a higher power (watts) has also been shown to increase side effects in some studies (Proebstle et al. 2006; Theivacumar et al. 2008a), however, another study used energies of up to 160 j/cm with no significant increase in complications (Carradice et al. 2010).

In addition to the LEED, the diameter of the treated vein is thought to be important. Studies have suggested that the Endovenous Fluence Equivalent (EFE) in j/cm², taking into account vein diameter and not only power and withdrawal speed, is likely to predict successful closure. Proebstle et al suggested the need for adjusting the dose depending on the vein diameter (Proebstle et al. 2006). Although appropriate threshold EFE values have been suggested, vein diameter is subject to positional and physiological variation, and robust data supporting the success rates of the treatment of large veins of >2cm with endovenous thermal ablation are still awaited.

1.7.7.2 Endovenous Laser: Coated Fibres

Preventing contact between the laser fibre and the vein wall has been suggested as a mechanism to reduce side effects. In one study, centring the catheter and preventing vein wall contact with a tulip shaped 980nm laser reduced contact with the vein wall and resulted in less post-procedural pain and ulceration (Vuylsteke et al. 2009).

Based on a similar mechanism, coated laser fibres have recently been introduced in order to try and reduce post-procedural pain by preventing contact with the vein wall and thus reducing vein wall perforations. The coat consists of either a metallic (gold) or ceramic material around the energy
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emitting area of the laser fibre. Preliminary data have shown reduced post-procedural pain scores with the gold coated 600um fibre in comparison to a 980nm bare tip laser and scores were similar to those following segmental RFA (Kabnick 2009; Kabnick 2010). The manufacturers suggest that the coating of the fibre introduces a divergent angle, indirectly increasing the diameter of the fibre. This reduces the power density by up to 56%, resulting in coagulation, rather than a cutting mechanism, thus reducing the pain experienced. Results of a pilot study of 20 patients suggested that pain following ablation with the gold coated 980nm laser from AngioDynamics resulted in significantly less pain (rated a mean average of 0.96 out of 10) compared with a 980nm bare laser fibre (on average 1.87 out of 10) at 72 hours post procedure (Kabnick 2009). Results from larger, independent studies are awaited and the devices are not currently in widespread use in the UK.

1.7.7.3 Endovenous Laser: Radial Fibres

Early lasers consisted of forward firing laser beams, however, the 1470nm ELVeS® Radial laser from Biolitec® emits a beam radially and is thought to have a more uniform heating effect on the vein wall. It is proposed that this leads to fewer vein wall perforations and results in less post-operative pain and bruising and would, therefore, provide superior treatment to traditional forward firing laser fibres (Almeida et al. 2009a). It is proposed that the unique delivery of the energy will allow closure of veins at significantly lower LEEDs and, therefore, reduce complications such as post-procedural pain, bruising and paraesthesia and potentially negate the need for tumescent anaesthesia. To date there are few published studies. In 2009 Almeida et al found the 1470nm radial firing laser to result in reduced pain in comparison with historical controls treated with a 980nm bare fibre laser (Almeida et al. 2009a). In addition the mechanical effects of the tumescent anaesthesia are proposed to have resulted in a reduction in the vein diameter and, therefore, more efficient delivery of energy to the vein, which resulted in 100% primary occlusion rates at 3 months, in comparison to 87% in those who had no tumescent anaesthesia. The authors concluded that using an energy delivery of 30j/cm at a power of 5 watts with tumescent anaesthesia yielded excellent occlusion rates with minimal side effects (Almeida et al. 2009a). The only published RCT comparing the 980nm bare fibre laser with the 1470 nm radial laser found significant reductions in post-procedural pain and improvements in the VCSS scores at 1 month in the patients treated with the 1470nm radial laser (Doganci et al. 2010). Reductions in post-procedural pain and bruising are advantages of using a longer wavelength. However, a further non-randomised study comparing a 1470nm bare fibre to the 1470nm radial fibre reported significant reductions in post-procedural pain and ecchymosis with the radial fibre with no difference in closure rates (Schwarz et al. 2010), providing evidence that the
radial beam is likely to be superior to forward firing lasers. Currently there is no data available about long term outcomes and because the precise mechanism of heat transfer is incompletely understood, the necessary degree of destruction of the outer layers of the vein wall is unknown. Further large studies are required to support the efficacy of the 1470nm radial laser over forward firing lasers in the future.

1.7.7.4 VNUS® Closure FAST™ Radiofrequency Ablation

The initial technique using radiofrequency ablation was described by Goldman in 2000 (Goldman 2000). The original VNUS® Closure™ radiofrequency catheter consisted of electrodes that remained in contact with the vein wall. The heating effect was achieved secondary to resistance of the tissues in the vein wall which allowed the flow of current in order to reach a target temperature of 85°C. The ClosurePLUS™ device resulted in successful vein occlusion with a favourable side effect profile, but the long procedure times meant that it was less appealing than laser catheters. This was addressed by the development of the VNUS® ClosureFAST™ segmental ablation catheter. The technique involves the insertion of a 7cm radiofrequency heating element into the GSV using the seldinger technique under ultrasound guidance. The probe is positioned 2cm from the SFJ and the GSV is segmentally ablated with the catheter withdrawn by 6.5 cm after each treatment to allow a 0.5cm overlap. The temperature is maintained at 120° and controlled by a feedback system measuring venous wall temperature and impedance. The radiofrequency probe powered by a bipolar generator heats the vein wall directly, resulting in damage to the endothelium and obliteration of the vein. Results following VNUS® ClosureFAST™ are excellent, with a series of 252 veins treated with 50% of patients returning to normal activity the same day and occlusion rates at 6 months of 99.6% (Proebstle et al. 2008). Initial results of the early ClosurePLUS™ device which operated at 85°C showed higher re-canalisation and re-treatment rates compared with laser treatment, suggesting that injury to the intima and media alone may be insufficient for long term success (Luebke et al. 2008). Initial results from the ClosureFAST™ appear promising, but longer term follow-up data are still awaited. The technique of endovenous ablation with the VNUS ClosureFAST™ catheter is illustrated in Figure 10.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Figure 10. Endovenous thermal ablation

- a. Identification of GSV
- b. Cannulation of GSV
- c. Insertion of sheath and catheter
- d. Tumescent anaesthesia
- e. Extrinsic compression to GSV on activation of RFA device
1.7.7.5 Radiofrequency Induced ThermoTherapy (RFiTT)

The Radiofrequency Induced Thermotherapy (RFiTT) device produced by Olympus (RFiTT, Celon, AG, Berlin) is an alternative radiofrequency device to the VNUS® ClosureFAST™ segmental ablation catheter. RFiTT consists of a bipolar catheter with two cylindrical electrodes arranged in an in-line configuration, separated by an insulator. In a similar fashion to the original VNUS® Closure device, RFiTT relies on the resistance of the vein wall to produce thermal energy. The catheter heats the vein wall to 85-95°C using a high frequency current (470kHz) at 18-20 watts when activated and venous impedance is continually monitored. This is interpreted by the operator by means of an acoustic signal and the energy delivered to the vein wall is dependent on the pull back speed. The advantages of the RFiTT device include being able to instantly stop heating, preventing further pain and injury to the patient if tumescent anaesthesia is inadequate. In addition the device immediately cuts out when contact with the vein wall is lost, meaning that it is impossible to treat if the catheter is misplaced outside the vein, or if the catheter is in the sheath. This feature also reduces the risk of overtreatment and skin burns. A multicentre study of 462 patients (672 limbs) reported occlusion rates of 98.4% at 6 months and a comparable side effects profile to other laser and radiofrequency devices (Braithwaite 2010). Although tumescent anaesthesia is not essential when using RFiTT, the incidence of saphenous neuralgia is increased in the absence of tumescence (Braithwaite 2010). A randomised trial compared RFiTT with a 980nm endovenous laser. The trial had 2 separate arms for patients with bilateral and unilateral disease. In patients with bilateral GSV incompetence there was less post-operative pain and bruising in the leg treated with RFiTT compared with the leg treated with laser therapy (BLARA trial)(Goode et al. 2010). However, no significant differences were seen in patients undergoing unilateral varicose vein treatment (ULARA trial)(Goode et al. 2010). Although the popularity of this new device is increasing, follow up data are limited (Braithwaite et al. 2007; Hnatek et al. 2007; Goode et al. 2010).

1.7.7.6 Steam

In 2009 Steam was proposed as a new endovenous thermal ablation treatment for varicose veins. The device from GUTMANN MD GmbH (Gutman Medical Devices (GutmannMDGmbH) 2010) involves the injection of pressurised water into a 0.1mm tube. This is heated using an electrical current to produce bursts of steam at 150°C, which are delivered to the intima of the vein via a catheter, with each pulse thought to deliver approximately 65 joules of energy. Proposed advantages include the rapid production of steam leading to faster treatment times, on contact with the vein wall steam rapidly condenses to water, reducing the potential for side effects and
complications and steam can also be used to treat superficial veins and tortuous veins that would be unsuitable for treatment with laser or radiofrequency. A pilot study of 20 limbs in 19 patients found that 13 veins were completely occluded at 6 months and 7 veins had very small segments of re-canalization (Van den Bos et al. 2010). There are no published clinical trials using the device to date, however, an ongoing randomised clinical trial in France is reported to have promising results at 6 months in comparison with those of laser ablation.

1.7.7.7 Outcomes Following Endovenous Thermal Ablation Procedures

Recently published trials comparing traditional surgery and EVLA by Rasmussen et al and Darwood et al (Rasmussen et al. 2007; Darwood et al. 2008) showed that EVLA treatments lead to significant improvements in quality of life post-operatively compared with baseline scores, that were comparable to those achieved with traditional surgery. However, patients reported less post-operative pain (Rasmussen et al. 2007) and were able to return to work earlier following EVLA (Darwood et al. 2008). Despite perceived advantages in early outcomes with EVLA, data from randomised trials comparing EVLA with surgery have been variable, and unable to demonstrate any superiority in clinical improvements and quality of life scores at 1 or 2 years post-intervention with EVLA compared to surgery (Christenson et al. 2010; Rasmussen et al. 2010). Clinical trials comparing the original VNUS ClosurePLUS device with traditional surgery have reported favourable outcomes of minimal pain and a more rapid return to work with RFA compared with surgery (Lurie et al. 2003; Subramonia et al. 2009b). Medium term data at 2 years have found similar recurrence rates compared with traditional surgery (Lurie et al. 2005; Elkaffas et al. 2010), although improvements in quality of life scores favoured the RFA group (Lurie et al. 2005). Outcome data following truncal vein ablation with the VNUS ClosureFAST devices is scarce to date. In 2008, Proebstle et al reported occlusion rates of 99.6% at 12 months using VNUS® ClosureFAST™ with 70% of patients experiencing little or no post-operative pain and over 50% returning to work the following day (Proebstle et al. 2008). Several non-randomised studies and retrospective analyses comparing EVLA and RFA have been published. Almeida et al reported marginally superior primary occlusion rates with EVLA compared with RFA (98% vs 94% respectively) (Almeida et al. 2006). A non-randomised trial published by Puggoni et al showed initial occlusion rates of 94% and 91% for EVLA and RFA respectively at 1 month, with no significant differences in complication rates (Puggioni et al. 2005). Randomised trials comparing the older 810nm laser and VNUS ClosurePLUS reported that bruising and VCSS scores were lower with RFA compared with EVLA, however no differences were observed
at 1 month. However, at 1 year, significantly higher rates of re-canalization were observed in the RFA group (Roddy 2010).

To date the only randomised trial comparing laser with VNUS® ClosureFAST™ radiofrequency is the RECOVERY Trial sponsored by VNUS Medical Technologies. VNUS® ClosureFAST™ has been shown to result in significantly less post-operative discomfort and bruising at 48 hrs, 1 week and 2 weeks compared with 980nm laser in 68 patients, but there were no differences at 1 month and longer term outcomes were not investigated (Almeida et al. 2009b). Both EVLA and RFA treatments have been shown to significantly improve disease specific quality of life as well as clinical disease severity scores following treatment (Lurie et al. 2003; Mekako et al. 2006; Rasmussen et al. 2007; Darwood et al. 2008). Improvements in quality of life following endovenous ablation were greater than those following traditional surgery in some studies (Lurie et al. 2003; Mekako et al. 2006). Although both endovenous techniques are safe and effective, the lack of data from randomised clinical trials directly comparing EVLA and RFA means that choosing between treatments on the basis of clinical success, patient satisfaction and cost effectiveness is extremely difficult. At present, decisions are made on clinician preference and local availability and resources. Data suggested that RFA may lead to less post-operative pain and quicker recovery times than EVLA as the lower temperatures and the pull back method used lead to fewer vein wall perforations and subsequently less pain and bruising (Proebstle et al. 2002a; Proebstle et al. 2004; Kabnick 2006; Roth 2007). However, studies have been insufficiently powered and subject to significant conflicts of interest.

### 1.7.7.8 Complications following Endovenous Thermal Ablation Procedures

Complications following EVLA and RFA occur infrequently. Three systematic reviews of endovenous laser treatment have been published (Mundy et al. 2005; Darwood et al. 2009; Van den Bos et al. 2009b) detailing frequently occurring complications encountered, the commonest being superficial thrombophlebitis occurring in up to 25% of cases. Temporary paraesthesia occurs in approximately 4-11% of patients in the majority of studies but has been reported to be as high as 22% (Van den Bos et al. 2009b). The use of adequate tumescent anaesthesia has been shown to result in lower incidences of saphenous nerve paraesthesia. DVT, skin burns and other neurological injuries are rare and occur in approximately 1% of patients (Van den Bos et al. 2009b). Unusual cases of arteriovenous fistulae following laser ablation, and device related complications where parts of laser catheters have been left inside patients have been reported but are extremely uncommon (Van den Bos et al. 2009b). Hyperpigmentation as a result of thermal damage to the skin can lead to undesirable cosmetic outcomes, but can be greatly reduced with appropriate tumescent anaesthesia and most
manufacturers advise not to treat veins within 1cm of the skin due to the increased risk of pigmentation and skin burns.

There are few reported studies detailing complications following VNUS® ClosureFAST™, and the majority of evidence in the published literature relates to the Closure PLUS device. Complications are infrequent and similar to those experienced with EVLA, however, the incidence of thrombophlebitis is reportedly lower on average than that experienced following EVLA, (approx 2.9%)(Gohel et al. 2009b). Skin burns and DVT remain low (<1%) and comparable to laser ablation.
1.8 Aims of the Thesis

In the last decade the introduction of minimally invasive endovenous therapies has changed the management of varicose veins. In particular, the use of endovenous thermal ablation is increasing in popularity. In view of the current published literature, a number of questions remain unanswered regarding the current role of endovenous thermal ablation treatments. The current use of these new procedures amongst surgeons in the UK is unknown, in addition, patient preference regarding endovenous treatment modalities for varicose veins has not been investigated. To date, limited evidence is available regarding patient reported outcomes following endovenous ablation modalities, particularly with regard to direct comparisons between laser and radiofrequency ablation and indeed, the choice of outcome measures for use in venous disease is a contentious issue.

Based on the current literature the following aims and objectives have been identified and will be addressed in this thesis.

- Investigate of the current use of endovenous thermal ablation amongst consultant Vascular Surgeons in the United Kingdom using an online web based questionnaire of current practice.

- Evaluation of patient knowledge and opinions of varicose vein treatments and their preferences regarding different therapies by means of an anonymous questionnaire in a vascular outpatient clinic at Charing Cross Hospital.

- Perform a comparison of RFA and EVLA, by designing, setting up, and conducting a randomised clinical trial concentrating on the investigation of early patient reported outcome measures, including post-procedural pain and quality of life. Prior to this conduct a pilot study to investigate post-procedural pain following RFA and EVLA.

- Evaluate the commonly used outcome measures currently available for the assessment of venous disease including the use of Venous Severity Scoring, digital photoplethysmography to measure venous refill times, and generic and disease specific quality of life questionnaires.
Chapter 2. The Use of Endovenous Thermal Ablation Procedures in the United Kingdom: A Consultant Survey
2.1 Introduction and Review of the Literature

Recent technological advances in the treatment of varicose veins have meant that specialists are faced with an ever increasing choice of treatment modalities for varicose veins. Until the last decade surgical treatment consisting of saphenofemoral disconnection and stripping of the great or small saphenous vein with phlebectomies to treat varicosities was the gold standard of treatment. Although a relatively effective treatment, problems included wound complications, high recurrence rates (Tenbrook et al. 2004; Winterborn et al. 2004; Allegra et al. 2007) and significant patient dissatisfaction (Davies et al. 1995; Campbell et al. 2003). A survey of members of the Vascular Society conducted in 1999 showed that traditional surgery was the most popular treatment for primary and recurrent great and small saphenous vein reflux, although sclerotherapy was used selectively by 60% of surgeons (Lees et al. 1999). In recent years, minimally invasive endovenous techniques have become increasingly popular in the United Kingdom as an alternative to traditional surgery. Postal surveys conducted in 2005 showed that endovenous treatments, including laser and radiofrequency ablation were used by around 30% of surgeons in the UK (Lindsey et al. 2006). Interestingly, over 50% of surgeons reported that local referral guidelines restricted the treatment of varicose veins and in the majority of cases, the use of endovenous techniques was restricted to private practice (Lindsey et al. 2006; Winterborn et al. 2008). Foam sclerotherapy was reported to have been used by 20-42% of surgeons in postal surveys conducted in 2006 and 2007 (Lindsey et al. 2006; O'Hare et al. 2007; Winterborn et al. 2008).

More recent surveys have suggested an increase in the use of endovenous thermal ablation therapies, particularly in the private sector (Edwards et al. 2009), however, traditional surgery remained the most frequently performed procedure.

In this chapter the use of endovenous therapies for varicose veins by consultant vascular surgeons in the UK was evaluated by means of an online questionnaire survey in order to establish trends in current practice.

2.2 Methods

A questionnaire consisting of 16 multiple choice questions was designed and an online survey was created using the academic online survey website Bristol Online Surveys (BOS) (www.survey.bis.ac.uk). Consultant members of the Vascular Society of Great Britain and Ireland
(VSGBI) with published email addresses in the Vascular Society handbook 2008 were invited to participate by email. The questions related to: routine treatments offered to patients with varicose veins; use of venous duplex scanning; indications for re-intervention; anaesthesia and the location in which the treatment was performed; factors influencing the decision regarding treatment; the use of post-operative compression and thromboprophylaxis, restrictions imposed by primary care trusts regarding treatment of varicose veins and the nature of treatments offered in the private sector (see Appendix 1). All responses were anonymous and all participants were sent one reminder email in an attempt to maximise responses. Where responses were incomplete, the number of responses received for that particular question is given as the denominator.

2.3 Results

A total of 352 Consultant members of the VSGBI were invited to complete the survey. There were 108 responses, of which 80 were complete (31% response).

2.3.1 Current Use of Endovenous Treatments

In patients deemed suitable for all treatment modalities 60/108 (55.6%) of surgeons would perform traditional surgery, whereas 24/108 (22.2%) preferred EVLA. Radiofrequency ablation (6/108) and foam sclerotherapy (11/108) were used relatively less frequently (5.5% and 10.2% respectively). Of the surgeons offering endovenous treatment, half performed concomitant phlebectomies for varicosities and half performed subsequent phlebectomy or sclerotherapy for varicosities, if required. Surgeons were also asked specifically about the treatments they would routinely offer for primary great and small saphenous vein reflux.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Values in parentheses are raw data

**Figure 11.** First line treatment of primary great saphenous vein reflux

**Figure 12.** First line treatment of primary small saphenous vein reflux.

Values in parentheses are raw data
Traditional surgery remained the commonest treatment for primary GSV (Figure 11) and SSV (Figure 12) reflux. Interestingly, although 77/108 (71.3%) of surgeons stated that patient preference was the most important factor when deciding which treatment to offer, (more important than time taken for the procedure, cost or space considerations), it is unclear how many surgeons informed patients of all potential treatment options and the risks and benefits of individual treatment modalities.

### 2.3.2 Anaesthesia

Local/ tumescent anaesthesia alone was used by 36/51 (70.6%) of surgeons performing endovenous thermal ablation treatments, whereas 1 surgeon used regional anaesthesia and the remaining 14/51 (27.5%) preferred general anaesthesia. Almost half of respondents reported performing concomitant phlebectomy with endothermal treatments (25/51, 49.0%) with the intention of completing treatment in a single hospital visit (Figure 13).

![Chart showing anaesthesia used for endovenous thermal ablation procedures]

*Values in parentheses are raw data*

**Figure 13. Anaesthesia used for endovenous thermal ablation procedures**

### 2.3.3 Treatment Location

Endothermal treatments were performed in an operating theatre by 30/51 (58.8%) of surgeons, and the remainder conducted treatments in an adapted outpatient clinic or outpatient theatre.
2.3.4 Thromboprophylaxis

A Total of 66/98 (67%) of respondents prescribed subcutaneous heparin or low molecular weight heparin and 42/98 (43%) advised Thrombo-embolic deterrent stockings (TEDS). Of those prescribing subcutaneous heparin, 42/66 (64%) would use a single dose only, 18/66 (27%) would prescribe it for the duration of their inpatient stay and two surgeons would routinely advise it for 1 week. Two surgeons prescribed subcutaneous heparin for bilateral or recurrent varicose veins only and many commented that they may alter thromboprophylaxis based on the individual risk of the patient. Four surgeons stated they would not use pharmacoprophylaxis for patients undergoing foam sclerotherapy, but would for endovenous thermal ablation or traditional surgery. A total of 16/98 (16%) did not routinely prescribe any form of thromboprophylaxis, of these 6/16 (38%) were performing surgery and foam sclerotherapy only, 6/16 (38%) were performing all treatments, one was performing EVLA and foam sclerotherapy and 3/16 (19%) were performing surgery only.

2.3.5 Compression

Post-intervention compression was most frequently recommended for 7-14 days by 37% of surgeons (Figure 14), although 17% of surgeons continued to use compression for 6 weeks.
Over half of the surgeons 54/101 (53.4%) applied compression bandaging immediately following the procedure, which was replaced with TED stockings (<18mmHg) prior to discharge (usually within 24 hours), whereas 6/101 (5.9%) replaced the bandaging with TEDS after 24 hours. Some surgeons 14/101 (13.8%) did not use elastic compression hosiery and preferred bandaging, usually crepe, Pannelast® (Vernon Carus, Preston) or Coban™ (3M™, Berkshire). There was considerable variation in regimens and duration of compression as illustrated in Figure 15.

Values in parentheses are raw data

Figure 15. Type of compression used following treatment

2.3.6 Post-Procedural Management

Following traditional surgery, only 2/108 (1.9%) surgeons would routinely perform colour duplex, whereas 30/48 (62.5%) would investigate patients with colour duplex after EVLT or RFA and 33/71 (46.5%) would do so following foam sclerotherapy. The commonest stated reason for post-operative duplex was to ensure successful ablation of the treated vein 29/38 (76.3%) following EVLA, 17/21 (81.0%) following RFA and 29/44 (65.9%) following foam sclerotherapy. Of the surgeons who performed colour duplex following treatment, 10/51 (19.6%) would re-intervene following endothermal treatments and 14/68 (20.6%) following sclerotherapy, if a patient had residual truncal incompetence even in the absence of clinical symptoms. No surgeons reported they would offer additional intervention in the absence of clinical symptoms following traditional surgery.
2.3.7 Restrictions in the Availability of Varicose Vein Treatment

Local restrictions in the provision of varicose vein treatment were reported by 48/108 (48%) of respondents. Restrictions were imposed on 28/108 (25.9%) of surgeons offering open surgery and 23/80 (28.8%) of those offering foam sclerotherapy, however, 48/80 (60.0%), and 48/61 (78.7%) of surgeons reported restrictions regarding the use of EVLT and RFA respectively. The lack of funding for endovenous equipment was stated by many surgeons 28/80 (35%) as the reason for not performing endovenous procedures, although a lack of theatre time or space, the lack of a laser approved room and the fact that traditional surgery was cheaper than laser or radiofrequency were also given as reasons why endovenous procedures were not offered. Further details of reasons given by surgeons for not offering treatments are reported in (Table 4). When asked about the treatment of private patients, 33/108 (30.6%) of surgeons stated that they would advise venous treatments that they were unable to offer in their NHS practice.

Figure 16. Reported rationing of different varicose vein therapies
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Nature of restriction</th>
<th>Surgery (n=27)</th>
<th>EVLA (n=43)</th>
<th>RFA (n=44)</th>
<th>Sclerotherapy (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCT specify their own referral guidelines</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Referral allowed for complications only (bleeding and ulceration)</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Referral allowed for &gt; C4/ skin changes only</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Referral allowed for C3 and above</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>No referrals for cosmesis alone</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Lack of theatre space</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Lack of equipment/ cost of equipment/ higher tariff than surgery</td>
<td>N/A</td>
<td>33</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>Equipment available but lack of appropriate facilities</td>
<td>N/A</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lack of Training</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Procedure performed by a colleague trained in endovenous ablation</td>
<td>N/A</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Dislike the procedure</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Colleagues not interested in performing</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>EVLA not RFA available</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 4. Reasons given by surgeons for restrictions in varicose vein treatments offered.

2.4 Discussion

This online survey of Consultant Vascular Surgeons in the UK conducted in 2008 showed that traditional surgery was still the most widely offered treatment for varicose veins, despite the apparent increasing popularity of endovenous procedures. These findings mirrored the results from a recent postal survey of Consultants and vascular trainees published in 2008, which reported the majority (96%) of surgeons were performing conventional surgery, 27% were offering foam sclerotherapy, 19% were offering EVLT and 3% were offering RFA to NHS patients (Winterborn et al. 2008) and indeed showed that the most popular treatment has not changed since 1999 (Lees et al. 1999). However, these data did show an increase in the use of endovenous therapies, compared with previous surveys (Lindsey et al. 2006; O’Hare et al. 2007), suggesting a slow movement towards newer techniques. Many surgeons who performed endovenous treatments favoured local anaesthetic and a significant number performed treatments on an outpatient basis, which is likely to
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

be more cost effective than performing traditional surgery under general anaesthesia (Gohel et al. 2008). The lack of uptake of endovenous procedures may be due to the high initial costs of endovenous equipment and training in endovenous techniques, at a time when varicose vein surgery is subject to increasing scrutiny and significant funding restrictions by a large number of healthcare providers (Nasr et al. 2008; Winterborn et al. 2008). At present, both laser and radiofrequency equipment are readily available, but the cost of the generator and catheters vary. Undoubtedly, the cost effectiveness of new therapies will be under great scrutiny prior to widespread use.

At present consensus is lacking regarding the nature and duration of post-operative compression that should be applied following surgical or endovenous procedures. Evidence suggests that TEDS are adequate following foam Sclerotherapy (Partsch et al. 2008), and indeed, results from a recent randomised trial found no differences in outcomes or complications in the presence or absence of compression following foam Sclerotherapy (Hamel-Desnos et al. 2010). A randomised trial investigating the use of compression stockings for 4 weeks following the application of compression bandaging after varicose vein stripping found no advantage to continued compression after 72 hours versus no compression (Houtermans-Auckel et al. 2009). However, the most appropriate use of compression following endovenous thermal ablation has not been fully investigated and despite recently published evidence regarding traditional surgery and foam sclerotherapy, post-procedural compression varies widely throughout the country (Partsch et al. 2008). This study highlighted the wide variations in practices in terms of thromboprophylaxis and the use of duplex imaging. This was also reported in 1999, when only 27% of surgeons prescribed routine thromboprophylaxis (Lees et al. 1999) in comparison to 84% in this survey. Interestingly, post-operative duplex use and treatment of residual truncal reflux varied noticeably between traditional and endovenous treatments, with many surgeons performing routine post-operative duplex scans and treating asymptomatic truncal reflux. This may, in part be due to the need to establish the efficacy of these new treatments, however, with evidence to suggest that truncal reflux may not correlate with symptoms (Bradbury et al. 1999; Theivacumar et al. 2008b), this practice may become less widespread in the future. As the prevalence of varicose veins is high, it is likely that patient demand for treatment will remain high for years to come. Each treatment modality has advantages and disadvantages, but long term outcomes are unclear. This confusion is demonstrated by the huge variability in treatment modality, type of anaesthetic, location of therapy and post-operative management in this survey. With patient choice regarding treatment becoming ever more important, further evaluation of patient preferences regarding treatment strategy is required. Despite the introduction of minimally invasive treatments for varicose veins, traditional surgery remains the most frequently performed treatment for varicose
veins in the United Kingdom, and in Europe (Perrin et al. 2003; www.e-dendrite.com. 2009). Of the surgeons performing endovenous treatments, peri-operative management varies greatly. It is clear that further clinical trials are needed to clarify some of these issues and guide clinical practice.

Despite reminder e-mails, the response rate in this survey was disappointingly low. Response rates from postal surveys in the UK are extremely variable. Postal surveys sent to both consultants and vascular trainees had significantly higher response rates (Lindsey et al. 2006; Winterborn et al. 2008), but other postal surveys achieved similarly poor responses (Jones et al. 2006). Our response rate may be due to inaccurate or unavailable e-mail addresses, but may also reflect a reluctance to engage with online surveys by Consultant Vascular Surgeons. Indeed, responses to previous email surveys appear to have had a poorer response rate compared with postal surveys amongst vascular surgeons (Nasr et al. 2008). Research into response rates comparing postal surveys with email/web surveys sent to medical professionals confirms that response rates are frequently lower from electronic surveys, however, they have been shown to result in a more rapid response time and at a lower cost compared with postal surveys (Raziano et al. 2001; McMahon et al. 2003; Beebe et al. 2007). The author acknowledges that these limitations may mean that the findings are not truly representative of the entire United Kingdom practice, with enthusiastic advocates for endovenous therapies, or more computer literate surgeons potentially being more likely to respond.
Chapter 3. The Patient’s Perception of Venous Disease and Patient Preferences in the Management of Varicose Veins.
3.1 Introduction

The allocation of NHS resources for the treatment of varicose veins is controversial, with many healthcare trusts refusing to fund treatment for uncomplicated varicose veins (see chapter 2). In 2008-2009 36,000 procedures were performed in the UK for varicose veins (http://www.hesonline.nhs.uk), with the majority of patients treated with traditional surgery (Lindsey et al. 2006; O'Hare et al. 2007; Winterborn et al. 2008). However, traditional surgery may be associated with significant complications, high recurrence rates (Winterborn et al. 2004) and considerable patient dissatisfaction (Davies et al. 1995; Campbell et al. 2003). Patients seek treatment for a number of reasons some of which are purely cosmetic, but most report a wide variety of physical symptoms and some patients may be concerned about venous complications or general concerns about their future (Campbell et al. 2006). Due to the high prevalence of varicose veins and the variety of symptoms reported, proving a causal relationship between symptoms and varicose veins remains difficult (Lee et al. 2003; Campbell et al. 2007). It has been suggested that symptoms are likely to relate to the presence of venous disease rather than actual varicosities (Kurz et al. 2001). The unequivocal clinical benefits and cost effectiveness of treating both complicated and uncomplicated varicose veins have been well documented (Barwell et al. 2004; Ratcliffe et al. 2006; Gohel et al. 2007b). The introduction of minimally invasive endovenous techniques offers the prospect of treatment under local anaesthetic, as an outpatient or office based procedure with quicker treatment times and rapid return to normal activities. Early outcomes following endovenous ablation are promising, meaning that choosing between different treatment modalities has become increasingly difficult. Consideration of patient preferences may help decide which treatments are best for individual patients. In the last decade patient preference has become an increasingly important consideration in all areas of medicine and surgery. The views of the patient are now considered essential to achieve high quality healthcare (Black et al. 2009), and national surveys of patients’ views of NHS healthcare have been introduced in recent years. Patient preference in the management of cardiovascular disease has been evaluated for over a decade. Early surveys explored patient preference regarding coronary re-vascularisation (Hornberger et al. 1999) and more recently with the introduction of endovascular aneurysm repair (EVAR), the patient’s perspective of minimally invasive versus open surgery has been investigated (Winterborn et al. 2009; Reise et al. 2010). With so many different therapies to choose from, the importance of patient preference in the management of varicose veins cannot be underestimated. It has been shown that most patients wish to have an active role in their care and that patient involvement is important in order to ensure sustainable, effective and efficient healthcare (Coulter 2007).
The aim of this study was to evaluate patient knowledge of varicose vein treatments and assess the factors that patients considered to be important when contemplating therapy.

### 3.2 Methods

General practitioner referral letters sent to one consultant surgeon at a tertiary referral centre were scrutinised to identify patients who had been referred with symptomatic varicose veins. Consecutive patients with primary symptomatic varicose veins were invited to complete an anonymous questionnaire prior to their consultation with the Vascular Surgeon. Questions related to occupation, physical symptoms, patient knowledge of existing treatments, concerns about complications and recurrence, preferred treatment options and factors that might influence decisions regarding treatment (Appendix 2). No information was given to patients prior to completing the survey. Where questions were not completed by every participant, the number of complete responses is shown as the denominator.

### 3.3 Results

Over a 6 month period, 111 patients were invited to complete the questionnaire. A total of 83 (75%) complete and 28 partially complete responses were received. A total of 80/109 (73%) of patients were female, 2 patients did not state their gender. 43/108 (40%) were full time employees, 19/108 (17%) were part time employees and 46/108 (43%) were not employed. Ages ranged between 18 and 83 years, with the majority of patients 79/111 (72%) aged between 18 and 60 years. Reported co-morbidities included: hypertension 18/111 (16%); previous DVT 8/111 (7%); asthma (5%); diabetes 4/111 (4%), epilepsy 2/111(2%); chronic obstructive pulmonary disease (COPD) 2/111(2%); ischemic heart disease 2/111(2%) and transient ischemic attack (TIAs) 1/111 (1%). The remaining 61% reported no co-morbidities.
3.3.1 Reasons for Seeking Treatment

Moderate or severe pain/discomfort was reported by 77/103 (75%) (Figure 17) and the appearance of varicosities moderately or severely affected 75/97 (77%) of patients.

![Figure 17. Pre-operative concerns of patients presenting with varicose veins](image1)

When asked “Which outcome following treatment is most important to you”, answers varied greatly between improvement of physical symptoms, reduction in complications, improved cosmesis and a combination of the above (Figure 18).

![Figure 18. Treatment outcomes considered most important by patients](image2)
There was no apparent trend in the symptoms reported and employment status. The majority of patients 54/96 (56%) were not concerned about taking time off work for treatment. Of these 35/54 (65%) were not employed, 11/54 (20%) were employed full time and 8/54 (15%) were employed part time. However, discomfort after treatment and recurrence of varicose veins were of great concern to many patients (Figure 19).

Figure 19. Patient concerns regarding varicose vein treatment

3.3.2 Treatment Awareness

The majority of patients were aware of surgery (89/103, 89%), although far fewer were aware of endovenous techniques. Of those who were aware of additional treatments, the most frequently known was laser (Figure 20).
3.3.3 Treatment Preferences

Most patients 74/103 (72%) stated that they did not know enough about the different treatments to express a preference. However, 24/103 (23%) expressed a preference for endovenous treatments over surgery, (either EVLA, RFA or Sclerotherapy) and of the endovenous treatments, laser was the most popular (Figure 21). There were no apparent trends in treatment preference according to occupational status, as 10/43 (23%) of patients employed full time, 4/18(22%) of those employed part time and 10/41(24%) of those not employed expressed a preference for endovenous treatments respectively.

Values in parentheses are raw data

Figure 21. Preferred treatment modalities of surveyed patients
### 3.3.4 Location and Anaesthesia

Although 23/102 (22%) of patients expressed a preference for office based/outpatient treatment, 65/102 (64%) had no location preference. In response to the statements “I would prefer my treatment to be carried out in a single visit rather than several separate visits” and “I would prefer my treatment to be carried out under local anaesthetic rather than general anaesthetic”, the majority expressed a preference for a single visit and for local anaesthetic (Table 5). A third 30/90 stated that the type of anaesthetic would have no influence on their choice of treatment.

<table>
<thead>
<tr>
<th></th>
<th>Agree Strongly</th>
<th>Agree Moderately</th>
<th>I don’t mind</th>
<th>Disagree Moderately</th>
<th>Disagree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients preferring a single visit for treatment (n=93)</td>
<td>46%</td>
<td>25%</td>
<td>27%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Patients preferring treatment under local anaesthetic (n=92)</td>
<td>37%</td>
<td>26%</td>
<td>31%</td>
<td>4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 5. Patient preference regarding treatment strategy and anaesthesia

### 3.3.5 Factors Affecting the Patient’s Decision

Some 74/92 (80%) stated that their treatment decision would be influenced by the opinion of their Vascular Surgeon. Regarding the number of visits required for treatment, 30/88 (34%) of patients stated that it would have no effect on their choice of treatment, 29/88 (33%) said that it may influence their choice of treatment and only 9/88 (10%) said it would definitely affect their choice of treatment. Similarly 30/90 (33%) patients stated that the type of anaesthesia would have no effect on their choice of treatment, with only 13/90 (14%) stating that it would definitely affect their choice of treatment.

Although some patients expressed preferences about anaesthesia and the number of visits required, these were far less likely to influence decisions about treatments. Interestingly, previous experience of varicose vein treatment was reported to have no influence on decisions regarding future therapy by nearly half of patients 38/83 (46%). Furthermore, most patients stated that what they had read in magazines or on the internet would have no influence on their treatment decision (Figure 22).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

3.4 Discussion

This study demonstrated that most patients referred with varicose veins have little knowledge of the available treatment options. Most were aware of surgery, but far fewer were aware of minimally invasive procedures. The findings indicated that the majority of patients rely strongly on advice and opinions of the Vascular Surgeon at the initial consultation. Interestingly, the majority of patients stated that information in magazines, internet or in the media would have no influence on their decision regarding treatment. Most respondents expressed some preference towards having treatment under local anaesthetic, but also would prefer treatment to be completed in a single visit. Although performing phlebectomy or foam sclerotherapy under local anaesthetic at the time of treating the truncal vein is feasible in many patients (Almeida et al. 2008), for those with bilateral disease and large numbers of varicosities it may be severely uncomfortable or impossible. Patients appeared to be divided as to which factors were more important to them. Some patients do have specific treatment preferences, which may be related to their occupation, concerns regarding cosmesis or previous experience. Understandably, the prospect of minimal discomfort and rapid
return to normal activities is attractive to all patients. Previous surveys of patient preferences in the United Kingdom published in 1998 were also conducted in patients with varicose veins prior to their initial consultation. Results suggested that 38% of patients would be in favour of foam sclerotherapy because of not having to take time off work and 31% were in favour of avoiding a general anaesthetic. Paradoxically 80% were in favour of surgery due to a lower recurrence rate and overall 63% preferred surgery over sclerotherapy for the reasons above. The majority of patients also expressed a preference for a single procedure (Campbell et al. 1998). Similarly, patient preference surveys in patients with abdominal aortic aneurysm also found that prior to being provided with information, only 23% of patients were willing to express a treatment preference, however, following a comprehensive information pack, almost half in one study (Reise et al. 2010) and 84% in another (Winterborn et al. 2009) were in favour of minimally invasive treatment options. Interestingly, significant variation amongst patients was observed and many (20%) still felt unable to express a preference after reading the information. Nearly all felt that the provision of the information pack would facilitate future discussions with clinicians (Reise et al. 2010).

As the majority of patients in this study had little or no knowledge of varicose vein treatments, the importance of providing suitable verbal and written information at the initial consultation is clear (Reise et al. 2010). Despite this, a survey of ordinary members of the Vascular Society conducted in 2006, suggested that 70% of surgeons would give verbal information about potential treatment options for varicose veins to patients at an outpatient consultation and only 53% would also give some form of written information. Of the written information given, only 62% and 65% gave specific treatment details or details about complications respectively, and less than 10% of patients would be referred to online information resources (Edwards et al. 2009). A recent investigation of the information available to patients with varicose veins on the internet found that less than 50% of websites discussed all treatment options and many failed to warn of potential complications (Scurr et al. 2008). Ideally, patients should be provided with information about all potential treatment options, including the advantages and disadvantages, even if they are not available at that particular hospital, and should be allowed to express a preference as to where they are treated.

Recommendations published by NICE in 2001 stated that varicose vein surgery should not be provided solely for cosmetic reasons. However, in 2006, 20% of surgeons reported that they were still permitted by their primary care trust to offer treatment for cosmetic varicose veins (Edwards et al. 2009). With recurrence of varicosities stated as being one of the most concerning issues for many patients in addition to cosmetic concerns, and with many preferring a single visit for treatment, foam sclerotherapy is unlikely to be the patient’s preferred treatment modality. Up to a third of patients receiving foam sclerotherapy require additional treatments in the first 3 months (Barrett et
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

al. 2004) and cosmetic results and recurrence rates are often thought to be poorer than those achieved with traditional stripping or endovenous thermal ablation (Rigby et al. 2004; Van den Bos et al. 2009a).

This small non-validated questionnaire study provided interesting information about patient opinion regarding varicose veins in West London. However, in our group of patients, more than a quarter were over the age of 60 years, suggesting that the study population may not be representative of the entire varicose vein population. More detailed questionnaires of larger populations may provide more robust information on preferences than this small study.

Patient’s perspective is becoming increasingly important and healthcare professionals are encouraged to involve patients in their treatment decisions in order to improve healthcare (Coulter 2007). Varicose veins procedures are recognised as highly litigious (Tennant et al. 1996; Campbell et al. 2002), frequently as a result of poor outcomes experienced by the patient. As only patients can report the symptoms they experience and the impact on their quality of life, adequate assessment of the patient’s concerns, preferences and expectations, along with adequate verbal and written information is essential in order that patients have realistic expectations from their treatment. Further studies investigating the patients’ preferences regarding the treatment of varicose veins are likely to be helpful to plan for future service provision.

This study investigated the knowledge and opinions of patients prior to consultation before they had been provided with any formal information, an area that is rarely studied. The findings suggest the majority of patients with varicose veins are unaware of potential treatment options, highlighting the need for clear communication and the provision of sufficient information for patients prior to varicose vein treatment in order to ensure informed consent. With so many potential modalities currently available for the treatment of varicose veins, patient’s concerns and preferences are clearly extremely important and should be evaluated in all patients prior to deciding on treatment options.
Chapter 4. Prospective Study of Endovenous Thermal Ablation at Charing Cross Hospital
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

4.1 Introduction

The introduction of novel, minimally invasive treatment modalities has revolutionised the management of superficial venous reflux over the last decade. Specifically, endothermal treatments including endovenous laser ablation (EVLA) and radiofrequency ablation (RFA) have been shown to be highly effective techniques to close refluxing venous channels (Luebke et al. 2008; Van den Bos et al. 2009a). One year occlusion rates over 90% have been reported consistently in prospective clinical studies (Darwood et al. 2008; Proebstle et al. 2008). Other potential advantages include minimal post-operative discomfort, rapid return to work and normal activities and potentially reduced neovascularisation and varicose vein recurrence (Rautio et al. 2002; Lurie et al. 2003; Kianifard et al. 2006; Rasmussen et al. 2007). The most popular RFA system is the ClosureFast™ segmental ablation catheter produced by VNUS® Medical Technologies Inc., (San Jose, CA, USA). The 980nm laser (Biolitec) is one of the most frequently used laser devices at present and has been used at Charing Cross since 2002. As direct comparative studies of RFA and EVLA are scarce, choosing between interventions is extremely difficult, leading to huge inconsistencies in patient care between centres and clinicians. As anatomical measures of treatment success are excellent with both RFA and EVLA, other factors such as patient acceptance and post-operative pain may be important factors to help decide between treatments. To date, few studies have evaluated these issues.

Prior to conducting a blinded randomised clinical trial comparing 980nm laser and VNUS ClosureFAST™ radiofrequency ablation a pilot study of patients undergoing endovenous thermal ablation procedures was conducted. This enabled us to evaluate likely differences in post-procedural pain and analgesia use which will provide the basis of a sample size calculation for the randomised trial. It also allowed us to identify important predictive factors for post-procedural pain and highlight potential confounding factors requiring adjustment in the statistical analysis.

The aim of this pilot study was to evaluate post-operative pain in patients treated with endovenous laser and radiofrequency ablation and also to identify predictors of post-procedural pain.
4.2 Methods

4.2.1 Patients and Setting

Patients treated with segmental RFA or EVLA between 1st January and 31st July 2008 at Charing Cross Hospital vascular surgery department were studied prospectively. Patients with primary or recurrent great (GSV) or small (SSV) saphenous veins confirmed on colour venous duplex scanning were included. All patients were invited to complete the Aberdeen Varicose Vein Questionnaire (AVVQ) (Garratt et al. 1993) prior to intervention and their Clinical, Etiological, Anatomical, Pathophysiological (CEAP) (Eklof et al. 2004) grade and Venous Clinical Severity Score (VCSS) (Rutherford et al. 2000) was recorded by a clinician on the morning of their planned procedure. Demographic information and operative details were recorded prospectively.

4.2.2 Interventions

Segmental RFA was performed using the VNUS® ClosureFast™ catheter and EVLA was performed using a 980nm laser generator (Biolitec ELVes). The specific procedure performed was dictated by the availability of the equipment and the preference of the patient. Patients requiring bilateral treatment were offered the same treatment to both legs at the same sitting. All procedures were performed by surgeons with endovenous experience of at least 100 procedures and both RFA and EVLA were performed under general anaesthesia with concomitant phlebectomies (Appendix 9).

In brief, the technique involved cannulation of the refluxing truncal vein under ultrasound guidance at the distal point of reflux or as close to this site as possible. The laser or radiofrequency catheter was then passed into the vein to be ablated and positioned 2cm from the saphenofemoral or saphenopopliteal junctions. With the patient in the Trendelenberg position, tumescent anaesthesia was then infiltrated around the vein (under ultrasound guidance) prior to ablation. Tumescent anaesthesia was composed of 50ml 1% lidocaine + 1:200,000 adrenaline in 1000mls of normal saline, and was standardised for all patients. Segmental RFA involved a double treatment of the most proximal venous segment to be ablated, followed by single treatments of the remaining venous segments as per manufacturer’s guidance. All procedures were performed on a day case basis. Concomitant phlebectomies were performed in all patients using a standard technique with an Oesch hook and closed with 6.0 prolene sutures. Initially legs were bandaged with crepe bandaging which was removed after 2-3 hours and patients were discharged with TED stockings and advised to wear them day and night for 1 week.
4.2.3 Assessment of Pain

Following treatment, patients were asked to complete a diary card for 10 days to record the level of pain using a 100mm visual analogue scale (Darwood et al. 2008) (see Appendix 3). They were also asked to specify the day on which they were able to return to normal activities and recommence work duties. They were given stamped addressed envelopes to return completed diary cards.

4.2.4 Statistical Analysis

Average pain scores over 3 and 10 days were calculated and compared between treatment groups using the Mann Whitney U test. Demographic and anatomical factors were compared between the two treatment groups using Mann Whitney U and Chi Squared tests. In order to identify independent risk factors for post-operative pain after EVLA and RFA, the relevant factors were tested using a multivariate linear regression model. Specific correlations were tested using Spearman Rank correlation for non-parametric data. All statistical tests were performed using SPSS V17.0 (SPSS Inc, Chicago, Ill) and p values <0.05 were considered significant.

4.3 Results

4.3.1 Study Population

Over the study period, 81 patients completed pain score assessments, of which 46/81 (57%) underwent segmental RFA and 35/81 (43%) were treated with EVLA. The majority of patients were female 62/81 (77%), the median age was 47 years (range 24-77) and 31/81 patients (38%) underwent bilateral procedures. CEAP scores were C2 (n=19), C3 (n=12), C4 (n=13), C5 (n=1) and C6 (n=1) in the RFA group and C2 (n=17), C3 (n=13), C4 (n=1), C5 (n=3) and C6(n=1) in the EVLA group. Patient age, sex, AVVQ score, VCSS and number of bilateral procedures were comparable between the groups treated with RFA and EVLA (Table 6). However, the overall length of vein ablated was greater in the group treated with RFA (p=0.005, Mann Whitney U test). All patients were discharged from hospital on the same day as surgery and no immediate complications or incidences of DVT were encountered.
Table 6. Comparison of assessed risk factors between studied groups

<table>
<thead>
<tr>
<th>Factor assessed</th>
<th>RFA (n=46)</th>
<th>EVLA (n=35)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Age (years)</td>
<td>46 (26-74)</td>
<td>47 (24-77)</td>
<td>0.614*</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>11:35</td>
<td>8:27</td>
<td>1.000†</td>
</tr>
<tr>
<td>Initial AVVQ score</td>
<td>15.2 (2.5-71.5)</td>
<td>19.3 (2.7-42.3)</td>
<td>0.119*</td>
</tr>
<tr>
<td>VCSS</td>
<td>4 (1-8)</td>
<td>5 (2-13)</td>
<td>0.062*</td>
</tr>
<tr>
<td>Bilateral surgery</td>
<td>18/46</td>
<td>13/35</td>
<td>1.000†</td>
</tr>
<tr>
<td>Length of vein ablated (cm)</td>
<td>37 (14-133)</td>
<td>31 (10-75)</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

Results presented as median (IQR) unless stated otherwise * Mann Whitney U test, † Chi Squared test

4.3.2 Pain Scores

Average reported post-procedure pain scores were highest for the first 3 days in both treatment groups (Figure 23). Median pain scores at 3 days were 14.5mm (range 1-81) following RFA compared with 25.8mm (range 0-80) after EVLA (p=0.053, Mann Whitney U test). Over 10 days, average pain scores were significantly lower after RFA (median 13mm, range 0-68) in comparison to EVLA (median 23.3mm, range 0-85) (p=0.014 Mann Whitney U test) (Figure 23).

4.3.3 Use of Analgesia

Information regarding analgesia use was available for 73/81 (90%) patients. Patients were prescribed paracetamol and ibuprofen and instructed to take them only if required. Sixteen patients (n=11 in EVLA group, n=5 in RFA group) chose to take their own analgesia including codeine phosphate 30 mg or tramadol 50 mg. Analgesia use was greatest over the first 3 days. Median (range) total tablets taken over 3 days was 6(0-21) in the EVLA group compared with 5(0-26) in the RFA group (p=0.903 Mann Whitney U). Median (range) number of pain killers taken over 10 days were 11(0-58) in the EVLA group and 8(0-59) in the RFA group (p=0.474 Mann Whitney U). After 10 days patients in the RFA group were also more likely to have stopped using any analgesia (60% no analgesia vs 53% no analgesia in the EVLA group).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

![Box plots showing average pain scores at 3 and 10 days post procedure](image)

*Figure 23. Box plots showing average pain scores at 3 and 10 days post procedure*

### 4.3.4 Return to Work and Normal Activities

The time to return to normal activities was similar after RFA (median 3 days, range 0-11) and EVLA (median 5 days, range 0-11, p=0.358, Mann Whitney U test). However, patients in employment (n=56), returned to work sooner after RFA (median 5, range 1-11 days) than EVLA (median 9, range 1-11 days, p=0.022 Mann Whitney U test).

### 4.3.5 Energy Delivered for EVLA

The mean (SD) energy delivered was 75.0 (10.3) joules per cm of vein, with only 1 vein receiving less than 60 joules/cm (54.3 J/cm) and 7 veins receiving >80 joules/cm. No correlation was observed between the energy delivered per cm and post-procedural pain. (Spearman Coefficient 0.038, p=0.837 and Spearman Coefficient -0.004, p=0.987 at day 3 and 10 respectively.)

### 4.3.6 Predictors of Post-Procedure Pain

A multivariate linear regression model was used to test the predictive value of the independent variables listed in Table 6. However, for both 3 day and 10 day average pain scores, the regression model was found to be non-significant (p=0.402, R²=0.123 and p=0.197, R²=0.163 respectively). This is likely to be because the small number of patients recruited to the study was insufficient to allow the use of the regression model. Therefore, the relationship of individual factors to post-procedural...
pain was evaluated. No factors including bilateral disease or the total length of vein correlated with average 3 or 10 day pain scores following RFA (Spearman Coefficient 0.006, \(p=0.97\); 0.086, \(p=0.572\) respectively) or EVLA (Spearman Coefficient 0.234, \(p=0.183\); 0.103, \(p=0.562\) respectively).

4.4 Discussion

This prospective observational study demonstrated that segmental RFA is likely to be less painful than EVLA in the early post-procedure period in this cohort of symptomatic patients. A quicker return to work was also seen in employed patients treated with RFA, although the time to return to normal activities was similar when considering the entire population. Interestingly, a wide range of pain scores were seen in both treatment groups, although no significant risk predictors of post-procedure pain could be identified in this cohort.

The pain scores seen in this study mirror those obtained from previous studies using similar visual analogue pain diaries, where 3 day average pain scores of 7 +/- 16mm after RFA (Proebstle et al. 2008) and 7 day average scores of 11mm (range 4-31) after EVLA have been reported (Darwood et al. 2008). Observed differences in post-procedure pain scores may be explained by differences in the mechanism of action of the ablation devices. Segmental RFA using the VNUS® ClosureFAST™ catheter causes venous closure by venous wall denaturing at 120°C, whereas laser ablation causes coagulative necrosis with temperatures of 1200-1400°C recorded at the tip of the fibre. EVLA is thought to be associated with more vein wall perforations and, therefore, more pain and bruising (Fan et al. 2008). It would, therefore, seem logical that the length of vein ablated would correlate with post-operative pain, particularly after EVLA, although this was not supported by the results of this study. The relatively small sample sizes in this study may partly explain these findings.

Interestingly, employed patients undergoing RFA did appear to return to work earlier than those undergoing EVLA. The potential implications are significant in terms of patient and societal costs, but it should be noted that the incidence of self-employment or non-physical occupations was not recorded and may have contributed to these findings. We recognise that other factors may have contributed significantly to post-procedure pain, which were not assessed in this study. These include the number and location of phlebectomies, volume of tumescent anaesthesia used, depth of the vein from skin and other factors. Indeed, the low \(R^2\) values in the multivariate regression models suggest that the factors assessed in this study may only contribute a small amount to post-procedure pain in these patients. At a time when many efficacious endovenous interventions are available and patients are becoming increasingly involved in decisions about their healthcare,
comparative studies are urgently needed. Occlusion rates alone are likely to be insufficient to distinguish between treatment modalities as many studies have reported excellent anatomical results following traditional and endovenous therapies (Merchant et al. 2005; Darwood et al. 2008; Luebke et al. 2008; Proebstle et al. 2008; Van den Bos et al. 2009a). Assessments of patient acceptance and early outcomes are likely to be more discerning.

In conclusion, this prospective study demonstrated that pain scores were low following both EVLA and segmental RFA. However, the results strongly suggested that segmental RFA using the VNUS® ClosureFAST™ catheter was associated with significantly less post-operative pain and may be associated with a quicker return to work. These results highlight the need for high quality randomised clinical trials comparing endovenous procedures. The limitations highlighted in this study including the number of phlebectomies performed, diameters of veins and tumescent anaesthesia will be considered and taken into account as part of the study design of the randomised trial and are discussed in detail in Chapter 5.
Chapter 5. VNUS ClosureFast™
Radiofrequency Ablation versus Laser for Varicose Veins (VALVV): A Randomised Clinical Trial
5.1 Introduction

Published clinical series and randomised trials with radiofrequency ablation have demonstrated less post-procedural discomfort in comparison with traditional surgery (Rautio et al. 2002; Luebke et al. 2008; Proebstle et al. 2008; Subramonia et al. 2009b), however, results following laser ablation have been less conclusive. Rasmussen et al 2007 reported that although post-procedural pain was higher in patients randomised to receive surgery in comparison with EVLA, this did not translate into quicker recovery times, and safety and efficacy in terms of clinical improvements (VCSS) and Quality of life scores (AVVQ) were similar (Rasmussen et al. 2007). In contrast the RCT published by Darwood et al. 2008 did not demonstrate a significant difference in post-procedural discomfort, clinical improvement or quality of life, but did find that patients were able to return to work and normal activities significantly earlier following EVLA in comparison to surgery (Darwood et al. 2008). Although a number of studies have compared RFA or EVLA with traditional superficial venous surgery, (Lurie et al. 2003; Hinchliffe et al. 2006; Mekako et al. 2006; Rasmussen et al. 2007; Darwood et al. 2008), studies comparing EVLA with RFA are scarce and findings have been inconclusive (Morrison 2005; Puggioni et al. 2005; Almeida et al. 2006). At the time this RCT was designed and when recruitment commenced, there were no published randomised trials comparing EVLA and RFA. To date, one small randomised trial (Radiofrequency Endovenous ClosureFAST versus LAser Ablation for the Treatment of Great Saphenous Reflux: A Multicentre Single-blinded study (RECOVERY Study) comparing VNUS® ClosureFAST™ and 980nm bare fibre EVLA has been published in June 2009 (Almeida et al. 2009b). Data from the RECOVERY Study of 69 patients from 5 treatment centres suggest that RFA is likely to be less painful than EVLA and may result in quicker recovery times and that it would be cost effective and preferable to patients. It has been suggested that RFA may result in less post-procedural pain and quicker recovery times than EVLA as the lower temperatures and the pull back method used lead to fewer vein wall perforations and subsequently less pain and bruising (Roth 2007; Van den Bos et al. 2008). In ex- vivo and in animal models it has been shown that Laser ablation results in more vein wall perforations and bruising than radiofrequency ablation (Schmedt et al. 2006; Schmedt et al. 2007) (Weiss 2002). Vein wall perforations have also been observed in human models following endovenous laser ablation (Proebstle et al. 2002b). Data from a departmental cohort study of 81 patients has also suggested that RFA is significantly less painful than EVLA and has formed the basis for the proposed randomised trial (Chapter 4).
5.1.1 Ongoing Clinical Trials

The CLASS Trial (Comparison of LAser, Surgery and foam Sclerotherapy) is an ongoing multicentre randomised trial comparing foam sclerotherapy, alone or in combination with endovenous laser therapy, with conventional surgery as a treatment for varicose veins (ISRCTN51995477) and is funded by the HTA. This study aims to compare the cost-effectiveness in incremental cost per quality adjusted life year of foam sclerotherapy compared with surgery or laser therapy, using the AVVQ and EQ-5D as primary outcome measures. This trial does not seek to evaluate the use of radiofrequency ablation which is becoming increasingly popular in the UK.

We proposed that a randomised trial directly comparing the EVLA and RFA would be of value to surgeons and healthcare trusts when making decisions regarding patient treatment, the purchasing of equipment and would also be complementary to the results of the CLASS Trial.

5.1.2 Study Aim

The aim of the study was to conduct a randomised clinical trial to compare early outcomes following segmental radiofrequency ablation and 980nm endovenous laser.

5.1.3 Study Hypothesis

Radiofrequency ablation using VNUS® ClosureFAST™ (RFA) will result in significantly less post-procedural pain and greater improvements in quality of life in comparison to 980nm bare fibre endovenous laser (EVLA)

5.1.4 Study Objectives

This study aimed to investigate the effectiveness of EVLA and RFA, the study objectives were as discussed below.

5.1.4.1 Post-Procedural Pain and the Use of Analgesia

Endovenous thermal ablation procedures are associated with mild to moderate pain for many patients, however, data from our departmental study (chapters 3 and 4) and previous patient surveys suggest that post-procedural discomfort is extremely important to patients. In a survey of patients undergoing day surgery, post-procedural pain was ranked as the post-operative outcome
patients would most want to avoid (Jenkins et al. 2001). Significant post-procedural pain also impairs recovery and discourages mobilisation and is, therefore, a highly important outcome measure (Hutchison 2007). Reduced post-procedural pain allows patients to use less analgesia, reducing costs and the likely hood of side effects and may also allow an earlier return to work, making therapies more cost effective.

5.1.4.2 Quality of Life

The patient’s perspective of healthcare has become increasingly important and a large emphasis is now placed on patient reported outcome measures (PROMs) in order to improve the patient’s experience and the quality of healthcare provided (Black et al. 2009). Validated PROMs are likely to be used as the primary outcome measure for elective surgical procedures in the UK, and will be used to evaluate the efficacy, cost effectiveness and the quality of services delivered by healthcare providers (Patient-Reported-Outcome-Measures. 2010). The international consensus on recommended reporting standards for endovenous ablation for the treatment of venous insufficiency advises the use of a generic and a system specific questionnaire in clinical trials (Kundu et al. 2009).

5.1.4.3 Abolition of Reflux

To assess the successful occlusion of the GSV and elimination of truncal reflux colour duplex scanning was performed. The interpretation of patient reported outcomes in the context of anatomical success is important in assessing the effectiveness of the different treatments.

5.1.5 Trial Endpoints

5.1.5.1 Primary end point

- Post-procedural pain after 3 days

5.1.5.2 Secondary end points

- Average pain scores 10 days after surgery
- Use of analgesia
- Return to work and normal activities
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

- Improvement in QOL scores measured with AVVQ and SF12
- Clinical improvement in CEAP and VCSS scores
- Abolition of reflux at 6 months
- Complications

5.2 Methods

5.2.1 Participants

5.2.1.1 Patient Selection

The target population consisted of consecutive adult patients presenting to one Consultant with symptomatic primary varicose veins due to reflux in the great saphenous vein. The study was set in the Department of Vascular Surgery at a London Teaching Hospital (Charing Cross Hospital). All patients underwent colour duplex ultrasonography (Philips iU22, Andover, MA, USA). All scans were performed by an accredited vascular scientist and reflux was defined as retrograde flow >0.5 seconds after compression. All patients were given a standard information leaflet explaining the purpose of the trial and what their involvement would require (Appendix 7).

5.2.1.2 Eligibility Criteria

The inclusion and exclusion criteria for the trial are detailed in Table 7.

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 18 years</td>
<td>Patients unfit for general anaesthesia</td>
</tr>
<tr>
<td>Venous reflux &gt; 0.5 seconds in the GSV</td>
<td>Current DVT on venous duplex</td>
</tr>
<tr>
<td></td>
<td>Previous venous surgery</td>
</tr>
<tr>
<td></td>
<td>Significant peripheral vascular disease / ABPI &lt;0.8</td>
</tr>
<tr>
<td></td>
<td>Unwillingness to take part or complete questionnaires</td>
</tr>
</tbody>
</table>

Table 7. Inclusion and exclusion criteria
5.2.2 Randomisation

Consenting patients were randomised to either VNUS® ClosureFAST™ (RFA) or 980 nm laser (EVLA) using a bare fibre, with an internet randomisation service (sealedenvelope.com) by the trial co-ordinator ACS. In patients with bilateral GSV incompetence, the leg that was the most symptomatic (according to the patient) was randomised and the same treatment was performed on both legs.

5.2.3 Ethical Approval

Ethical approval for the study was sought by the author and granted by Charing Cross Research Ethics Committee (Ref: 08/H0711/19). The trial was registered with Current Controlled Trials (ISRCTN66818013). Trust approval was also obtained from Imperial College NHS Foundation Trust.

5.2.4 Blinding

All patients were blinded to treatment allocation, however, for practical reasons assessors were not blinded to patients’ treatment allocation.

5.2.5 Outcome Measures

5.2.5.1 Primary Outcome

Patients were asked to record the worst pain they experience each day following the procedure for 10 days post-operatively in a diary that was collected at the time of the 10 day appointment. Although a record of post-procedural pain was recorded for 10 days, the primary end point was post-procedural pain at 3 days.

5.2.5.2 Secondary Outcomes

5.2.5.2.1 Analgesia Diary and Return to Work

All patients were given a diary card (Appendix 3) and asked to record daily analgesia taken and specify the day they returned to work and the day they resumed normal activities. All patients received standardised post-procedural instructions and advice and were discharged with analgesia consisting of paracetamol 1g QDS and Ibuprofen 400mg TDS with instructions to take them only if
required. All patients were advised to return to work and normal activities as soon as they felt able. Outcome analysis was adjusted for the use of analgesia.

5.2.5.2.2 Quality of Life

Pre-operatively all patients completed two disease specific questionnaires [Aberdeen varicose vein questionnaire (AVVQ), and Specific Outcome Response Venous (SQOR-V) questionnaires] and the generic Short Form 12(SF12) all of which are validated for measuring quality of life outcomes in patients with varicose veins (Smith et al. 1999; Guex et al. 2007). Questionnaires were also given to patients at 6 weeks and 6 months post-operatively (Appendices 5, 6 and 11). Data from the SQOR-V questionnaire will be reported in Chapter 6.

5.2.5.2.3 Clinical Disease Severity

Patients were assessed using the CEAP Classification and Venous Clinical Severity Score at baseline and post-operatively at 6 weeks and 6 months by means of an interview.

5.2.5.2.4 Abolition of Reflux

Occlusion of the vein treated was assessed with colour duplex 6 months following intervention.

5.2.5.2.5 Complications

All complications were recorded with particular reference to haematoma, infection, thrombophlebitis, deep vein thrombosis, pulmonary embolism, temporary and permanent paraesthesia, skin staining and recurrence.

5.2.6 Sample Size Calculations

5.2.6.1 Post-Procedural Pain Scores

Power calculations were based on the primary outcome measure of post-procedural pain at 3 days using data from our departmental cohort study (Chapter 4) and the published literature (Rasmussen et al. 2007; Darwood et al. 2008; Proebstle et al. 2008). Power calculations were based upon detection of a 20mm difference in pain scores over 3 days with a standard deviation of pain score of 20mm, which was considered to be a significant clinical difference. To attain 90% power at the 5%
significance level, a minimum target sample size of 47 legs per group was required. This figure was increased to allow for 10% non-compliance with randomised groups and 20% dropout at 6 weeks. This resulted in an overall target recruitment of 170 patients.

5.2.6.2 Disease Specific Quality of Life

Based upon the published Aberdeen Varicose Vein Questionnaire (AVVQ) data (Rasmussen et al. 2007; Darwood et al. 2008; Proebstle et al. 2008), there appears to be a difference of approximately 10 points (Standard deviation of 5) between baseline data and that at 3 months for the laser group (Darwood et al. 2008). If we anticipate this improvement will increase to 15 points with radiofrequency treatment at 6 weeks and assume a larger standard deviation of 10 for 90% power at the 5% significance level, 45 patients are required per group based on analysis of Covariance (ANCOVA).

To sufficiently power the study to examine post-operative pain and quality of life, allowing for 10% protocol violations including cross over, this required a sample size of 140 patients. Assuming 20% of patients will be lost to follow up at 6 weeks, the sample size increased to 168 patients.

Therefore, in order that the study be sufficiently powered to detect a clinically significant difference in post-procedural pain at 3 days and the AVVQ at 6 weeks, ethical approval for the recruitment of up to 170 patients was obtained. A summary of the sample size calculation is displayed in Figure 24.

| 45 patients per group required to detect a difference in pain at 3 days and AVVQ score at 6 weeks |
| recruitment target n=90 |
| Estimated 20% loss to follow up at 6 weeks |
| recruitment target n=108 |
| Estimated 10% cross over/ protocol violations in each group |
| Total recruitment target 170 |

Figure 24. Sample size calculation summary
5.2.7 Time Scale of Recruitment and Follow up

During the three months from October to December 2007, 104 endovenous procedures were performed for varicose veins by the team at Charing Cross. During this study we aimed to recruit at least 170 patients (85 per group). Based on these figures a recruitment of 4 patients per week was predicted. The total recruitment period was set at 12 months. Each patient was followed up for a minimum of 6 months before discharge.

5.2.8 Measurement of Outcomes

5.2.8.1 Visual Analogue Scale

An un-graduated visual analogue score has been successfully validated and used in a number of clinical trials to quantify post-operative discomfort following varicose veins procedures (Hinchliffe et al. 2006; Darwood et al. 2008). Patients were asked to record the maximum discomfort they experienced on a 100mm line for 10 days following the procedure. (Appendix 3)

5.2.8.2 Duplex Ultrasonography

All patients underwent a pre-operative colour duplex scan performed by a qualified vascular scientist using a Phillips iU22 machine. All patients were scanned immediately prior to treatment by the surgeon performing the procedure. The diameter of the GSV at the SFJ and at the largest point along the course of the GSV was noted by an accredited vascular scientist with the patient in a standing position on the morning of treatment.

Follow up duplex scans were performed at 6 months by a qualified vascular scientist. Reflux of greater than 0.5 seconds was deemed significant reflux, deep veins were assessed as patent or occluded and the development of any new tributary varicosities was recorded.

Classification of Post-Procedural Reflux

Post-intervention GSVs were classified into one of 3 categories:

1) Absence of reflux: The treated segment of the GSV had been completely ablated and, therefore, the GSV was either occluded with no residual reflux or competent.
2) Above knee ablation: The intended segment of GSV was ablated above the knee, with below knee reflux of >0.5 seconds. This was either new or residual.

3) Failed ablation: GSV with reflux of > 0.5 seconds present. Failed ablations were due to:
   a. Inability or failure to ablate to within 2cm of the SFJ
   b. Re-canalization

Post-intervention SSVs were classified as:

1) Completely ablated/ no reflux: SSV occluded with no residual reflux.
2) Partially ablated: Small areas of residual reflux.
3) Failed ablation: Reflux > 0.5 seconds throughout the SSV.

5.2.8.3 CEAP

The basic CEAP classification was documented for each patient by the author according to the guidelines by the American Venous Forum (Kundu et al. 2009). Measurements were made at baseline only as the CEAP classification was not designed to be responsive to changes following intervention. (Details of the CEAP classification can be found in Chapter 1.3.1).

5.2.8.4 Venous Clinical Severity Score

The Venous Clinical Severity Score Developed by the American Venous Forum used clinical observations and symptoms reported by the patient to attribute a numerical score with a maximum of 30 and has been shown to be valid and reliably reproducible and responsive to change following intervention (Rutherford et al. 2000). (Details of the VCSS can be found in Chapter 1.3.2)

5.2.8.5 Short Form 12

The short form 12 is a generic health-related quality of life measure derived from the longer SF36 by Ware in 1988. It is recommended that clinical trials include both generic and disease specific quality of life assessments in order that patients with additional co-morbidities can be compared. A physical and mental component score for each patient is given and can be compared with normal values for the population (Appendix 6).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

5.2.8.6 Aberdeen Varicose Vein Questionnaire

The Aberdeen Varicose Vein Questionnaire designed by Garratt et al (Garratt et al. 1993) is a disease specific questionnaire consisting of 13 domains (Appendix 5). It has been shown to correlate well with clinical scoring systems and is responsive to changes following treatment (Garratt et al. 1996).

5.2.8.7 Demographic Data

Pre-operatively demographic data were recorded including: age; sex; medications; BMI; race; previous DVT and previous surgery.

5.2.8.8 Operative Details and Procedures

Surgical procedures were performed under general anaesthesia. Operative details were recorded by the operating surgeon at the time of surgery and included: length of vein ablated, vein diameter, watts used, total number of cycles (RFA) or total joules used (EVLA), time taken for the vein ablation, volume of tumescence used and the number of stab avulsions. For details of the procedure protocols and operative detail recording see Appendices 8 & 9.

5.2.8.9 Statistical Analysis

All analyses were performed according to a pre-defined analysis plan, designed with the help of Dr Louise Brown, Medical Statistician, who performed the analysis of post-procedural pain, quality of life and occlusion rates using Stata software v10.0 (Stata Corporation, Texas, USA). All analyses were performed on an intention-to-treat basis. Student’s t-tests and Chi-squared tests were used to compare baseline characteristics between groups to check whether any differences had occurred by chance. The distributions of continuous variables were checked using normal plots with transformation of any skewed variables. Post-procedural pain scores were analysed using linear regression with two levels of adjustment. Primary adjustment was made for age, sex, BMI, clinical disease severity, the number of truncal veins ablated on the trial leg, the total length of vein ablated on the trial leg and the number of phlebectomies on the trial leg as primary adjustment. Secondary adjustment was made for all covariates in the primary analysis as well as for the use of analgesia.

Secondary outcomes including quality of life and clinical improvements were analysed using Analysis of Co-Variance (ANCOVA) which adjusted changes in outcome from baseline values. In addition,
primary adjustment was made using the same variables as those used for the pain score analysis and also for the presence of bilateral disease and presence of deep venous incompetence.

### 5.2.9 Summary of the Trial Design

A summary of the trial design is shown in the flow diagram Figure 25.

Figure 25. Flow diagram summarising trial methodology
5.3 Results

5.3.1 Patient Recruitment

Over 12 months from July 2008-2009, 313 patients were screened for inclusion in the study. A total of 171 met the eligibility criteria and were invited to participate and 131 patients consented to randomisation. After 12 months of recruitment, patient attendance for follow up had been more successful than expected and the minimum target recruitment of 47 patients per group, followed up at 6 weeks had already been met. This provided sufficient numbers for analysis of the primary and secondary outcomes and it was decided that recruitment should be stopped at 12 months as initially planned.

128 patients were treated within 24 hours of randomisation and overall patients were treated at a median (range) of 0 (0-48) days following randomisation. One patient was cancelled due to problems with theatre equipment, and therefore 130 patients were treated as part of this study (see Consort flow diagram Figure 26). One patient who was randomised to RFA received EVLA due to non-availability of RFA equipment. For patients treated with EVLA, the mean (S.D) energy density delivered to the GSV was 71.71 (12.98) joules/cm.

5.3.2 Reasons for Patients Declining Entry to the Trial

40 patients declined to be included in the trial, patients were not required to give reasons for refusal, however, some were happy to give their reasons which are detailed in Figure 27. Patients for whom English was not a first language or who had difficulties with reading and comprehension were offered the services of a translator, however, many of them stated that this was why they were unwilling to participate and unfortunately the questionnaires used were only available in English. Unwillingness to complete questionnaires, attend follow up and preferences for a particular treatment allocation were other reasons cited.
Figure 26. Consort diagram illustrating patient flow and follow up
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Figures in parentheses are raw data

Figure 27. Reasons for declining entry to the trial

- Poor English
- No Reason given
- Preference for EVLA
- Preference for RFA
- Preference for LA
- Unwilling to attend for follow up
- Unwilling to answer questionnaires
- Wanted to know treatment allocation

**Figures in parentheses are raw data**

**Figure 27. Reasons for declining entry to the trial**
5.3.3 Baseline Characteristics

The patient group consisted of 89 female and 42 male patients with a mean (S.D) age of 49 (16) years. The baseline characteristics were comparable between the randomised groups and are summarised in Table 8.

<table>
<thead>
<tr>
<th></th>
<th>RFA (n = 67)</th>
<th>EVLA (n = 64)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex ratio (F : M)</td>
<td>47 : 20</td>
<td>42 : 22</td>
<td>0.579‡</td>
</tr>
<tr>
<td>Age (years)*</td>
<td>49(15)</td>
<td>48(16)</td>
<td>0.540†</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30</td>
<td>61 (91)</td>
<td>61 (95)</td>
<td>0.334‡</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>6 (9)</td>
<td>3 (5)</td>
<td></td>
</tr>
<tr>
<td>VCSS*</td>
<td>5.1(2.1)</td>
<td>4.7(2.1)</td>
<td>0.278†</td>
</tr>
<tr>
<td>AVVQ*</td>
<td>20.6(9.4)</td>
<td>19.2(9.5)</td>
<td>0.412†</td>
</tr>
<tr>
<td>CEAP class</td>
<td></td>
<td></td>
<td>0.467‡</td>
</tr>
<tr>
<td>C1–C2</td>
<td>23 (34)</td>
<td>26 (41)</td>
<td></td>
</tr>
<tr>
<td>C3–C4</td>
<td>39 (58)</td>
<td>46 (56)</td>
<td></td>
</tr>
<tr>
<td>C5–C6</td>
<td>5 (8)</td>
<td>2 (3)</td>
<td></td>
</tr>
<tr>
<td>Deep vein disease</td>
<td></td>
<td>0.178‡</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13 (19)</td>
<td>7 (11)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>54 (81)</td>
<td>57 (89)</td>
<td></td>
</tr>
<tr>
<td>Pattern of disease</td>
<td></td>
<td>0.727‡</td>
<td></td>
</tr>
<tr>
<td>GSV</td>
<td>54 (81)</td>
<td>50 (78)</td>
<td></td>
</tr>
<tr>
<td>GSV and small saphenous vein</td>
<td>13 (19)</td>
<td>14 (22)</td>
<td></td>
</tr>
<tr>
<td>Unilateral or bilateral disease</td>
<td></td>
<td>0.433‡</td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>31 (46)</td>
<td>34 (53)</td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>36 (54)</td>
<td>30 (47)</td>
<td></td>
</tr>
<tr>
<td>Procedural parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length ablated (cm)*</td>
<td>49(16)</td>
<td>46(14)</td>
<td>0.177†</td>
</tr>
<tr>
<td>Total no. of phlebectomies above or below knee*</td>
<td>6.2(4.0)</td>
<td>6.2(3.6)</td>
<td>0.945†</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages unless indicated otherwise; *values are mean(S.D.). RFA, radiofrequency ablation; EVLA, endovenous laser ablation; VCSS, Venous Clinical Severity Score; AVVQ, Aberdeen Varicose Vein Questionnaire; CEAP, Clinical Etiologic Anatomic Pathophysiologic; GSV, great saphenous vein. †Student’s t test; ‡χ² test

Table 8 Baseline characteristics by randomised group
5.3.4 **Primary Outcome: Post-Procedural Pain at 3 Days**

Diary cards were available for 127 patients; unadjusted post-procedure pain scores after EVLA (61 patients) and RFA (66) are shown in Figure 28. Patients receiving RFA reported less pain over the first 3 days, with a mean (S.D.) pain score of 26.4 (22.1) for RFA and 36.8 (22.5) for EVLA (primary adjusted difference = −10.2; \( p=0.012 \)) (Table 9).

![Figure 28. Reported pain scores for 10 days following intervention- unadjusted data.](image)

5.3.5 **10 Day Pain Scores**

Patients in the RFA group also reported less pain over the first 10 days, with mean (S.D) scores of 22.0 (19.8) for RFA and 34.3 (21.1) for EVLA (primary adjusted difference = −12.8; \( p=0.001 \)) (Figure 28 and Table 9).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th></th>
<th>RFA (n=66)</th>
<th>EVLA (n=61)</th>
<th>Crude unadjusted difference*</th>
<th>( p )</th>
<th>Primary adjusted difference( ^\dagger )</th>
<th>( p )</th>
<th>Secondary adjusted difference( ^\ddagger )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean(S.D) pain score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 3 days</td>
<td>26.4(22.1)</td>
<td>36.8(22.5)</td>
<td>(-10.4) (-18.2, -2.6)</td>
<td>0.010</td>
<td>(-10.2) (-18.1, -2.3)</td>
<td>0.012</td>
<td>(-6.4) (-14.3, 1.6)</td>
<td>0.115</td>
</tr>
<tr>
<td>Mean(S.D.) pain score</td>
<td>22.0(19.8)</td>
<td>34.3(21.1)</td>
<td>(-12.3) (-19.5, -5.1)</td>
<td>0.001</td>
<td>(-12.8) (-20.2, -5.5)</td>
<td>0.001</td>
<td>(-6.3) (-13.3, 0.7)</td>
<td>0.079</td>
</tr>
</tbody>
</table>

*Values in parentheses are 95 per cent confidence intervals. \( ^\dagger \)Primary adjustment for age, sex, body mass index of 30 kg/m\(^2\) or above, Venous Clinical Severity Score in the randomized leg (as a measure of varicose vein disease severity), pattern of disease (great saphenous vein (GSV) versus GSV and small saphenous vein), length of vein ablated, number of phlebectomies (above or below knee). \( ^\ddagger \)Secondary adjustment: adjusted primary model for use of analgesia. RFA, radiofrequency ablation; EVLA, endovenous laser ablation.

Table 9. Linear regression analysis of pain scores after RFA and EVLA

### 5.3.6 Analgesia Use

Patients in the RFA group took fewer analgesic tablets than those in the EVLA group: mean (S.D.) over 3 days 8.8 (9.5) tablets after RFA versus 14.2 (10.7) tablets after EVLA (\( p=0.003 \)) and over 10 days 20.4 (22.6) and 35.9 (29.4) tablets respectively (\( p=0.001 \)) (Figure 29).

![Figure 29. Analgesia use for 10 days following intervention](image-url)
Analgesia use was considered when performing a secondary analysis, so as to compare reported pain scores in patients who took the same number of analgesia tablets in both groups. This was to ensure that analgesic tablets were being taken in proportion to the pain experienced (patients were advised to take them only if necessary), and not taken prophylactically or under used for any reason. When pain scores were adjusted for the number of analgesic tablets taken, differences between the groups were reduced and of borderline significance only at 10 days. This strongly suggested that the behaviour of patients in both groups regarding the use of analgesia was similar and, therefore, confirmed that recorded differences in pain and analgesia use were highly likely to be due to true differences in discomfort experienced and not as a result of differences in patient behaviour between the two groups (Figure 30).

Figure 30. Crude and adjusted pain scores at 3 and 10 days following EVLA and RFA

### 5.3.7 Phlebectomies Performed

Two patients included in the analysis did not require concomitant phlebectomy, although primary and secondary analyses were adjusted for the number of phlebectomy incisions. Interestingly, no correlation was observed between pain and the number of avulsions in the EVLA or RFA group at 3 days (p=0.54 and p=0.93) or at 10 days (p=0.54 and p=0.90).
5.3.8 Disease Specific Quality of Life and Clinical Disease Severity

Quality of life was assessed at a median (IQR) of 48 (43-54) days following intervention, data were available for 115 patients (RFA n=60, EVLA n=55). Improvements in quality of life at 6 weeks were seen in both groups and were significantly improved compared with baseline scores (AVVQ, VCSS and SF12 PCS p<0.001 and SF12 MCS p=0.001 Wilcoxon Signed Ranks). However, no significant differences in AVVQ, SF12, or VCSS were observed between the two groups. Improvements in scores at 6 weeks were maintained at 6 months with no significant differences from those observed at 6 weeks and no significant difference between the RFA and EVLA groups.

5.3.8.1 Aberdeen Varicose Vein Questionnaire

![AVVQ Scores](image)

Figure 31. AVVQ unadjusted baseline 6 week and 6 month scores

Patients in both RFA and EVLA groups experienced approximately a 10 point improvement in their scores from baseline. No significant differences were observed between the groups with unadjusted data (Figure 31) or adjusted data (p=0.828 and p=0.308 at 6 weeks and 6 months ANOVA) (Raw data are reported in Appendix 10).
5.3.8.2 Venous Clinical Severity Score

Patients in both RFA and EVLA groups experienced approximately a 3 point improvement in their scores from baseline. No significant differences were observed between the groups with unadjusted data (Figure 32) or adjusted data (p=0.969 and p=0.332 at 6 weeks and 6 months ANOVA) (Raw data are reported in Appendix 10).

5.3.8.3 Short Form 12

Patients experienced approximately a 3 point improvement in the physical component of the SF12 and a 2.5-4 point improvement in the mental component scores. Differences in unadjusted data were not significant between the 2 groups (Figure 33 and Figure 34) and no significant difference was observed in adjusted data (p=0.580 and 0.380 PCS 6 weeks and 6 months and p=0.476 and p=0.080 MCS 6 weeks and 6 months ANOVA)(Raw data is reported in Appendix 10).
5.3.8.3.1 Short Form 12- Physical Component Score

Figure 33. SF12 PCS unadjusted baseline 6 week and 6 month scores

5.3.8.3.2 Short Form 12- Mental Component Score

Figure 34. SF12 MCS unadjusted baseline 6 week and 6 month scores
5.3.9 Return to Work and Normal activities

Data detailing return to normal activities were available for 62 patients after RFA and for 50 patients after EVLA. The majority of patients returned to normal activities within 3 days, this was 60% (37/62) in the RFA group and 50% (25/50) in the EVLA group. 77% (48/62) and 74% (37/50) of patients had resumed normal activities within 7 days in the RFA and EVLA groups respectively. There was, however, a trend towards earlier return to normal activities on days 1 and 2 in the RFA group in comparison with the EVLA group. Return to work data were available for 41 patients in the RFA and 34 in the EVLA group. Results were similar, with 15/41 (37%) and 14/34 (41%) patients returning to work within 3 days, and 29/41 (71%) and 24/34 (71%) returning to work within 7 days in RFA and EVLA groups respectively. Overall there was no significant difference in return to normal activities or to work between the two groups (p=0.158 and p=0.975 respectively Mann Whitney U test).

The days on which patients returned to normal activities are displayed below (Figure 35 and Figure 36).

![Figure 35. Day on which patients were able to resume normal activities](image-url)
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Figure 36. Day on which patients were able to return to work

5.3.10 Duplex Results: Assessment of Occlusion Rates at 6 Months

Duplex scans were available for 109 patients (84%) at a median (IQR) of 189 (174-210) days. Follow up duration was comparable between the RFA and EVLA groups being 189 (179-205) and 186 (174-232) days respectively p=0.266 (t test).

5.3.10.1 Ablation of Great Saphenous Veins

In both groups the majority of patients had a successful ablation of their GSV and in a further 29% (RFA) and 28% (EVLA) the above knee segment of the GSV was successfully ablated, leaving only below knee incompetence (Figure 37). These were judged as anatomical treatment successes. In total, 10 patients were classed as anatomical failures either due to re-canalization (RFA n=5, EVLA n=1) or failure to ablate to within 2cm below the SFJ (RFA n=1, EVLA n=3), usually due to a technical difficulty in passing the catheter due to the presence of a thigh tributary. Overall patients in the laser group experienced fewer failures, however, due to the small numbers of patients this was not significant. Overall anatomical success rates at 6 months were 89% in the RFA group and 93% in the EVLA group at 6 months (p=0.527 Chi square).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

5.3.10.2 Below Knee Reflux

In 53% and 46% of the patients in the RFA and EVLA groups, persistent GSV reflux below the knee of >0.5 S in a vein >3mm diameter was observed. This was either residual, due to an untreated segment of vein, or new, in a segment of GSV that was previously competent and, therefore, not ablated. Results between the RFA and EVLA groups were similar (Figure 38).

5.3.10.3 Clinical Significance of Below Knee Reflux

Patients were classified into groups according to whether they had no reflux, below knee reflux (either residual or de novo) or treatment failures who either had re-canalization or a segment of refluxing GSV above the knee. Interesting, overall patterns between 6 month AVVQ and VCSS scores with residual reflux were poor, particularly in the EVLA group where there was no apparent trend. Due to the small numbers of patients, statistical analysis of these sub-groups was not performed. (Figure 39 and Figure 40).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

**Figure 38. Distribution of below knee reflux**

Values in parentheses are raw data

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No reflux</th>
<th>Residual reflux</th>
<th>New reflux</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFA</td>
<td>18% (10)</td>
<td>47% (26)</td>
<td>35% (19)</td>
</tr>
<tr>
<td>EVLA</td>
<td>20% (11)</td>
<td>54% (29)</td>
<td>26% (14)</td>
</tr>
</tbody>
</table>

**Figure 39. Relationship between the AVVQ and residual reflux**

Values in parentheses are raw data
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

5.3.10.4 Anatomical Failures

The aim was to deliver >60 j/cm LEED to the vein in the EVLA group. The one patient who experienced a re-canalization only received 40.6 j/cm. Despite this, he was very pleased with the results of his phlebectomies, and had no residual varicosities or symptoms at the 6 month follow up. Treatment options were discussed with him and he chose to return in 18 months time for further duplex imaging and clinical assessment.

5.3.10.5 Small Saphenous and Anterior Thigh Veins

27 patients underwent additional endovenous thermal ablation procedures for a refluxing short (n=21) or anterior thigh vein (n=6) on the randomised leg. Veins were classified as re-canalized, partially occluded or occluded. The results are shown in Figure 41.

Further endovenous ablation was required by 1 patient in the EVLA group for persistent symptomatic SSV reflux following re-canalization, however, the remaining patients were asymptomatic or declined further treatment. 3 patients did not attend for a duplex scan (RFA n=2 EVLA n=1).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Figure 41. Duplex outcomes following endovenous thermal ablation of short and anterior thigh veins.

5.3.11 Further Treatments Required

At 6 months following randomisation, a total of 15 patients (12%) required further intervention for residual varicosities or truncal reflux Table 10.

<table>
<thead>
<tr>
<th>Treatment required</th>
<th>RFA (n=55)</th>
<th>EVLA (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSV ablation + phlebectomies</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SSV ablation</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ATV ablation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Phlebectomies</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Foam Sclerotherapy</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 10. Further treatments required

In the RFA group, further ablation to the GSV was required due to re-canalization (n=2) and persistent symptomatic GSV reflux (n=1). In the EVLA group further GSV ablation was due to technical failures (n=2) and persistent symptomatic below knee GSV reflux (n=1). In the EVLA group, one patient presented at 9 months with symptomatic recurrent varicosities originating from groin...
tributaries which appeared to be neovascular tissue on duplex imaging (Figure 42). Of the patients who underwent further treatments, the majority were performed after the duplex scan at 6 months. 1 patient in the RFA group underwent further ablation after his 6 week appointment due to immediate re-canalization and 1 patient in the EVLA group underwent further phlebectomies. All other treatments were performed after 6 months and were successful with the exception of one patient in the EVLA group who had a large tributary arising from the GSV and had a second failed ablation procedure complicated by an abscess at the cannulation site that required drainage and several weeks of antibiotics.

Figure 42. Recurrence following endovenous laser ablation

5.3.12 Complications

At 6 months, two major complications were observed. One patient randomized to RFA suffered a pulmonary embolus 2 weeks after intervention (the patient was treated with warfarin, although no evidence of DVT or clot extension in the leg veins was found on duplex imaging). One patient in the
EVLA group developed a lymphatic leak from the cannulation site, and lymphoscintigraphy confirmed increased lymphatic collateral flow consistent with trauma at the site. In this particular case, cannulation of the vein below the knee was difficult and the operating surgeon performed a cut down onto the GSV. It was from this site that copious amount of clear, colourless fluid began to drain several days following surgery which then became infected. The patient was treated with antibiotics and has been referred to specialist lymphatic services and is currently treated with Daflon and graduated compression.

Overall minor complications included wound infection (5%), haematoma (2%), thrombophlebitis (6%), saphenous nerve paraesthesia (10%) and skin staining (6%) (Table 11). Two patients in the EVLA group reported an increase in spider veins, and despite the intention to perform procedures as a day case, four patients (3%) required overnight admission after the procedure because of nausea (RFA, 1; EVLA, 1), hypotension secondary to general anaesthesia (RFA, 1) or pain requiring opioid analgesia (RFA, 1).

<table>
<thead>
<tr>
<th></th>
<th>RFA (n=67)</th>
<th>EVLA (n=64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td>4 (6)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Haematoma</td>
<td>0 (0)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Thrombophlebitis</td>
<td>5 (7)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Paraesthesia</td>
<td>8 (12)</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Staining to skin</td>
<td>6 (9)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Seroma</td>
<td>2 (3)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>1 (1)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages.

Table 11. Complications at 6 weeks following EVLA and RFA by randomised groups

At 12 months, one further patient in the EVLA group reported a DVT which was diagnosed after 5 months and treated at his local hospital. He has declined to attend for further follow up appointments.
5.4 Discussion

The results of this randomised clinical trial confirmed that VNUS® ClosureFAST™ resulted in significantly less pain than 980nm endovenous laser ablation. However, reported pain and analgesia usage was very variable in both groups. Because of the small sample size we are unable to conclude whether the apparent trend of an earlier return to normal activities seen in the radiofrequency group was significant, however, differences in the time to return to work were very small. Despite earlier advantages of RFA as regards post-procedural pain, at 6 weeks there was no significant difference in clinical disease severity or quality of life scores and the degree of improvement in the AVVQ and VCSS was similar to that reported in other randomised trials (MacKenzie et al. 2004; Lurie et al. 2005; Darwood et al. 2008). The results of this study support the findings of other studies which have shown less post-procedural pain with RFA (Morrison 2005; Almeida et al. 2009b). The exact heating mechanism occurring during endovenous thermal ablation is incompletely understood. Temperatures of up to 1334°C have been recorded at the laser tip in animal models (Weiss 2002) which is much higher than that of the RFA probe, heated to 120°C. However, in human subjects, maximum temperatures of 43°C, 42°C and 36°C were recorded at 3, 5 and 10mm from the GSV using an 810nm diode laser with tumescent anaesthesia (Beale et al. 2006), which is likely to be similar to that experienced with RFA. In animal models, vein wall perforations have been shown to occur in 100% of the 122 cases treated with the 810nm laser, but did not occur in the 3 cases treated with the older VNUS® ClosurePLUS RFA device (Schmedt et al. 2007). Vein wall perforations have also been shown to occur in humans, and one explanation for the reduced pain scores following RFA may be that the controlled heating and segmental ablation technique of VNUS® ClosureFAST™ reduces the number of vein wall perforations and the extravasation of blood into the tissues (Schmedt et al. 2007; Fan et al. 2008). There are no published studies to date which have looked at the number of vein wall perforations following segmental ablation below the knee, however, it remains a popular theory.

The rate of paraesthesia at 6 weeks of 12% and 8% in the RFA and EVLA groups respectively is similar to that reported in some studies, although rates recorded in the published literature vary widely between studies from 0-22% for EVLA (Van den Bos et al. 2009b). Minimal data regarding rates of paraesthesia are available following segmental ablation below the knee, however, Creton et al have reported rates of 3.4% at 1 year (Creton et al. 2010). Irreversible neuronal injury in animal models has been found to occur at temperature of >47°C and should theoretically be a rare occurrence if adequate tumescent anaesthesia is used, although the temperatures required to produce temporary
paraesthesia are unknown. In addition, all but 2 patients underwent phlebectomies, which were below the knee in the majority of cases and may have significantly contributed to the rates of paraesthesia observed.

The only other published randomised trial found greater improvements in VCSS scores at 1 month but did not show differences in disease specific quality of life in the RFA group, compared with EVLA (Almeida et al. 2009b). Interestingly, predicted differences in quality of life and VCSS scores were not observed in VALVV trial patients at 6 weeks. Discrepancies between the studies may be explained by variations in procedure technique and follow up times. In contrast to the Recovery trial (Almeida et al. 2009b), minor complications including paraesthesia, thrombophlebitis and skin infections were not more prevalent in the EVLA group at any time point. Rates of deep venous thrombosis in patients following EVLA and RFA are reported to be <1% overall, however, rates as high as 5.7% have been reported (Van den Bos et al. 2009b). The overall rate of venous thromboembolism in patients in this trial at 6 months was 1.5%. One patient in the RFA group experienced a pulmonary embolus on day 10 post intervention, which was diagnosed and treated at a different hospital and no deep venous thrombosis in the leg veins was found on duplex scanning at his 6 week follow up appointment. The cause of this pulmonary embolus remains unknown, the patient had no known risk factors for thromboembolic disease at the time of surgery and remains on warfarin. In addition a patient in the EVLA group experienced a deep vein thrombosis in the treated limb 5 months following intervention. This presented as a rapid onset pain and swelling of the leg and he attended his local GP and subsequently his local emergency department where a DVT was diagnosed. He was warfarinised as an outpatient and has declined to attend further follow up for the trial. He was not known to have any risk factors for venous thromboembolism and it is unknown whether this DVT was related to his endovenous thermal ablation procedure. Interestingly, both patients had had recurrent episodes of thrombophlebitis in superficial veins prior to their interventions.

One patient experienced a lymphatic leak as a result of damage to lymphatic vessels at the site of cannulation. Although lymphatic injuries at puncture sites have been reported following traditional surgery (Disselhoff et al. 2008) there are no reports in the published literature of confirmed lymphatic injury following endovenous laser ablation to date(Van den Bos et al. 2009b), although fluid collections, likely to have been seromas, following EVLA have been reported (Janne D’Othee et al. 2008).

This trial was sufficiently powered to evaluate post-procedural pain and both procedures were performed under identical conditions. Post-procedural ecchymosis was not evaluated due to
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difficulties in accurately quantifying bruising, and because previous studies have shown that it does not necessarily correlate with post-procedural pain (Min et al. 2005) or time taken to resume normal activities (Rasmussen et al. 2007). Patients were blinded to treatment allocation, which significantly reduced the potential for bias and allowed a direct comparison of the outcomes of the two procedures. Although the assessors were not blinded, the primary outcomes were patient reported and, therefore, very unlikely to have been affected by the assessors. Patients also underwent concomitant phlebectomies if necessary, with the aim of completing all treatments in a single visit. This approach has been shown to be preferable for many patients, and associated with improvements in clinical and quality of life outcomes and a reduced need for further procedures (Carradice et al. 2009). Limitations include the fact that all procedures were performed under general anaesthesia, meaning that the assessment of the adequacy of the tumescence during the procedure was not possible. However, the technique of tumescent anaesthesia infiltration under ultrasound guidance was standardised for both procedures and volumes of tumescent anaesthesia used were recorded. The authors accept that a significant proportion of endovenous thermal ablation procedures are performed as outpatient or ‘office based’ procedures (Chapter 2), and that performing concomitant phlebectomy is feasible as an office based procedure (Almeida et al. 2008). However, in patients with bilateral disease or in those with large numbers of varicosities this may be difficult. As the aim was to complete all treatments in one visit, all patients were offered general anaesthesia. Patients with SSV incompetence were also included to ensure the study population were representative of the population presenting with primary varicose veins. Moreover, the groups in this randomised study were well matched in terms of disease pattern and analyses were adjusted for numerous variables including number of phlebectomies performed and the length of vein ablated to ensure that detected differences were truly due to the ablation technique.

Results confirm that the improvements in quality of life seen in both groups at 6 weeks were maintained at 6 months with no difference in outcomes between the groups in terms of generic, disease specific quality of life or the VCSS. At 6 months, successful anatomical and functional outcomes were observed in both groups. Although true re-canalization rates were higher in the radiofrequency group than in the EVLA group, technical failures and the subsequent need for re-intervention were higher in the EVLA group, but these differences were not significant.

In both treatment groups the average maximum vein diameter of the GSV measured with the patient standing on the morning of surgery was 8.7 and 8.8 mm in the RFA and EVLA groups respectively. The reasons for the 5 re-canalisations in the RFA group are unclear. However, reported
occlusion rates following VNUs\textsuperscript{TM} ClosureFAST\textsuperscript{TM} at 12 months have been excellent in one study, but data from other sources is scarce (Creton et al. 2010; Perrin 2010). All veins were of diameter 8mm or greater (8mm, 10mm, 12mm, 12mm and 13mm) and may have re-canalized as insufficient energy was transferred to the vein wall. Proebstle et al. suggested that the Endovenous Fluence Equivalence (EFE) in $\text{j}/\text{cm}^2$ is important for successful occlusion (Proebstle et al. 2006) and threshold values for adequate EFE of $>20 \text{j}/\text{cm}^2$ have been suggested (Proebstle et al. 2006; Vuylsteke et al. 2008). It has also been suggested that the number of cycles should be increased in larger veins, and reduced in veins of small calibre to ensure optimum closure rates and minimise side effects (Proebstle UIP Monaco September 2009 unpublished data). At present there is no formal guidance regarding this and the manufacturers recommend a double treatment of the first segment closest to the SFJ, and single treatment cycles for each subsequent segment. They do state that additional cycles can be given at the discretion of the physician but advise against more than 3 treatment cycles per segment (www.vnus.com 2010).

Successful abolition of reflux following EVLA is improved by ensuring the LEED is greater than 60$\text{j}/\text{cm}$ (Theivacumar et al. 2008a). In the case of the patient who experienced a re-canalization in the EVLA group, the average energy delivered was 40.6 $\text{j}/\text{cm}$ to his vein of 10mm in diameter, and this may explain the reason for the treatment failure. Vein diameter has been shown to be an independent predictor of treatment success (Kim et al. 2006), however, vein diameter is variable and subject to change depending on posture and a variety of physiological parameters. It is likely that the thickness of the vein wall and the level of energy required for successful closure is more important than the vein diameter alone. To date, the degree of damage required to the outer layers of the vein wall in order to result in permanent closure remains unknown.

Technical failures, frequently due to an inability to advance the laser catheter to within 2cm of the SFJ were more common in the EVLA group. This may reflect the different design of the catheter, the laser fibre being more flexible and less rigid than the RFA catheter, or may be relate to the small sample size.

In a number of patients, de novo reflux was observed at 6 months. In the majority of cases this was in the GSV, below the knee, however, in a few patients new ATV branches from the groin were observed, which resulted in the development of symptomatic varicosities. One patient presenting with new varicosities at 9 months following EVLA appeared to have neovascularisation at the groin similar to that observed following traditional groin dissection. He required further treatment with EVLA to this new branch with concomitant phlebectomies. It remains unclear whether this was true
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neovascularisation or occurred as a result of a previously existing small tributary. Neovascularisation has been shown to occur following EVLA, although is significantly less common than following open surgery (Theivacumar et al. 2009a). The clinical significance of tributaries in the groin is not completely understood, although data suggest that they may not necessarily be associated with adverse clinical outcomes (Theivacumar et al. 2007). The development of further recurrences in this cohort of patients may be helpful in the understanding of the relationships between anatomical recurrence and functional outcomes following endovenous thermal ablation, which is poorly understood at present.

Although the small numbers in this study prohibited sub-group analysis, it appeared that the majority of patients gained a significant improvement in their quality of life, despite some having residual or new below the knee reflux and even patients with almost complete re-canalizations reported improvements. Although we were unable to evaluate whether residual reflux was a significant contributor to ongoing functional or clinical impairment, the data provided further evidence to support the poor relationship observed between anatomical reflux and clinical signs and symptoms found in previous studies (Bradbury et al. 1999). Persistent below knee great saphenous reflux in patients who had undergone ligation and stripping has been associated with worsening clinical signs and symptoms between 6 month and 2 years following intervention (van Neer et al. 2009), and treating below knee reflux where possible resulted in improvements in quality of life and reduced the need for further interventions following endovenous laser ablation (Theivacumar et al. 2009b). The functional benefits reported in quality of life, despite significant segments of re-canalization may be explained by published studies which have shown that re-canalized veins often remain small and that in some cases persistent reflux is limited and of no clinical significance (Theivacumar et al. 2008b).

To date, the majority of studies provide data supporting the short term efficacy of EVLA and RFA, but long term data are scarce. EVLA would appear to have the better occlusion rates of around 95% compared to 80% for the early RFA catheters at 5 years (Van den Bos et al. 2009a). Results from VNUS® ClosureFAST™ appear promising from this study and previously published data (Proebstle et al. 2008) and are likely to be superior to the original RFA Closure device in the long term. Long term studies of venous occlusion and recurrence are required to support the durability of endovenous thermal ablation procedures.

Both this study and the smaller Recovery trial (Almeida et al. 2009b) support the premise that VNUS® ClosureFAST™ is less painful than 980nm EVLA. However, to reduce the post-procedural
discomfort associated with EVLA, newer radial fibres and longer laser wavelengths have been developed. These newer techniques have been shown to be associated with low post-intervention pain scores (Almeida et al. 2009a; Kabnick 2009; Maurins et al. 2009; Pannir et al. 2009; Doganci et al. 2010; Schwarz et al. 2010) and are likely to replace the 980nm bare tip laser fibre. However, further data from randomised trials supporting the use of these newer devices are awaited.

Recent research has shown that there has been a rapid increase in the popularity of endovenous thermal ablation in recent years and this trend is likely to continue (Lindsey et al. 2006; Winterborn et al. 2008; Edwards et al. 2009). Patients seeking superficial venous interventions are frequently concerned about post-procedural discomfort, recovery times and recurrence (Chapter 3). It is, therefore, important to provide sufficient patient information about all the available procedures, in order that patients and physicians can reach evidence based decisions about treatment options.
Chapter 6. Measuring Venous Disease Severity and Evaluating Treatment Outcomes
6.1 Introduction

Venous disease is a significant cause of patient morbidity in the United Kingdom, particularly for those with venous ulceration, however, studies have shown that even patients with uncomplicated varicose veins have a poorer quality of life compared with the general population (Smith et al. 1999; MacKenzie et al. 2004) and improvements in quality of life following treatment of superficial reflux have been found to be comparable to those following laparoscopic cholecystectomy (Sam et al. 2006). Assessing the severity of venous disease pre-operatively and following intervention is important to establish the efficacy of the intervention and assess the need for further procedures.

The measurement of outcomes following treatment of superficial venous reflux is a contentious issue and there are a wide range of investigations, from surrogate end points (anatomical occlusion rates and haemodynamic improvement), to clinical and functional improvements. Numerous generic and disease specific quality of life questionnaires are available to choose from, each with their own advantages and disadvantages (Vasquez et al. 2008).

Early studies into the efficacy of endovenous ablation techniques and traditional surgery had concentrated primarily on occlusion rates and haemodynamic function (Goldman 2000; Min et al. 2001; Navarro et al. 2001) as outcomes that could be objectively measured. Although the importance of establishing the efficacy of these new treatments is clear, surrogate end points do not necessarily reflect the patients’ experiences of treatment with regards to clinical or functional outcomes (Kulkarni et al. 2007). There are few studies directly comparing quality of life with anatomical, haemodynamic and clinical outcomes.

Measurement of Outcomes for Endovenous Thermal Ablation Therapies: Recommended Reporting Standards for Clinical Trials

The publication of an international consensus on reporting standards in Chronic Venous Disease (CVD) in 1996 included a recommendation for assessments following surgery, which would record clinical outcomes at 6 months as: +3 Asymptomatic, +2 Moderate Improvement, +1 Mild improvement 0 Unchanged, -1 Mild worsening, -2 Significant worsening and-3 severe worsening. Incorporated into this was the CEAP Classification for CVD which was revised in 2004. The introduction of minimally invasive endovenous ablation procedures has lead to the publication of further recommendations in reporting standards for post-operative outcomes. In 2007 the American
Venous Forum (AVF) published recommended reporting standards advocating the use of disease specific patient reported outcome measures, in combination with a measurement of generic quality of life and clinical assessment in all clinical trials evaluating the use of endovenous therapies (Kundu et al. 2007). These guidelines were revised in 2009 (Kundu et al. 2009). The use of the venous clinical severity score in addition to CEAP classification and an assessment of quality of life was recommended. The venous clinical severity score correlates well with the CEAP classification and has the advantage of allowing the evaluation of changes in reported clinical signs and symptoms following intervention. The use of a generic QOL assessment tools such as the SF36 to assess overall morbidity in conjunction with a disease specific questionnaire was recommended. Acceptable validated disease specific questionnaires included the Aberdeen Varicose Vein Questionnaire (Garratt et al. 1993) the VEINES-QOL (Lamping et al. 2003; Kahn et al. 2006) and the CIVIQ-2 (Launois et al. 1996). In those with mild to moderate disease (frequently classed as C0-C4), it has been suggested that patient reported outcomes may be more useful than physician reported outcomes for assessing improvement (Guex 2008). The use of follow up imaging, usually colour duplex, in the context of clinical trials is also required, but may not be done routinely in clinical practice. Because of the wide variety of outcome measures currently in use, it is important to consider the relationship between these outcome measures, if comparisons between studies are to be made. At present these relationships are poorly understood.

The aim of this study was to compare anatomical, haemodynamic and clinical outcomes with disease specific quality of life tools, including the newest SQOR-V questionnaire and the original AVVQ in patients undergoing treatment for varicose veins.

6.2 Methods

Patients referred with symptomatic varicose veins and deemed suitable for intervention over an 18 month period were invited to complete the (AVVQ)(Garratt et al. 1993), the SQOR-V questionnaire and the Short Form 12 (SF12). In addition, the CEAP grade (Eklof et al. 2004), VCSS (Rutherford et al. 2000) and demographic details were recorded prospectively. All patients had previously undergone duplex ultrasonography (Philips iU22) by an accredited vascular scientist and all patients with truncal venous reflux of >0.5 seconds with a vein diameter of >3mm were considered candidates for thermal ablation. Those who were unsuitable were offered open surgery. Patients with recurrent disease and deep venous reflux were included in the study.
All patients underwent endothermal ablation using VNUS® ClosureFAST™ or EVLT according to the technique described in appendix 9. Some of the patients included were participants on the VNUS® ClosureFAST™ Radiofrequency ablation versus Laser for Varicose Veins (VALVV) Trial (Chapter 5) and were, therefore, randomised to their treatment allocation. Patients who were not on the trial were treated according to the patient’s preference of treatment modality or equipment. All patients were assessed at 6 weeks where all measurements except colour duplex were repeated.

6.2.1 Measurement of Outcomes

Outcomes were grouped into 4 categories according to: Venous anatomy, haemodynamic function, clinical disease severity and functional assessment. Outcomes were recorded as a score per patient (AVVQ, SQOR-V and SF12) or as a score per leg (VRT, VSDS). VCSS and CEAP scores were noted per leg and for comparisons with quality of life outcomes, the score of the worst leg was used. Where disease specific quality of life was compared with haemodynamic function (VRT) or anatomical reflux (VSDS) patients with bilateral disease were excluded from the analysis.

6.2.1.1 Anatomical

Based on the findings of the duplex ultrasonography, patients were categorised as having either unilateral or bilateral disease, and also according to the number of refluxing veins per leg. This was defined as either GSV reflux, SSV reflux, ATV reflux or a combination of 2 of the above. Each leg was also scored according to the reflux component of the venous segmental disease score (VSDS)(Rutherford et al. 2000). The presence or absence of deep vein incompetence was also recorded. The proforma used is shown in Figure 43.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

6.2.1.2 Haemodynamic

Clinical venous refill times (VRTs) were assessed using digital photoplethysmography with the patient in a seated position on the morning of treatment. An average of 2 reading were taken, and a third was taken if the first 2 readings varied by more than 10%. VRTs of greater than 30 seconds were considered normal. Details of the protocol are presented in Appendix 4.

6.2.1.3 Clinical

The CEAP grade and VCSS were recorded by a clinician on the morning of treatment.

6.2.1.4 Functional/ Quality of Life

Prior to procedures all patients were asked to complete the AVVQ (Garratt et al. 1993), the SQOR-V (Guex et al. 2007) and the generic short form 12 (SF12) questionnaire (Quality Metric TM). Further details of the questionnaires can be found in chapter 1.4 and copies of the questionnaires in Appendices 6, 7 and 11.
All questionnaires were scored with reference to the recommendations from the authors. The SF12 was scored with software from Quality Metric™.

6.2.2 Follow up

All patients were invited for follow up at 6 weeks post-procedure, when they were invited to complete the questionnaires again. In addition clinical assessments of disease severity and venous refill times were recorded by the reviewing clinician. Duplex scanning was not performed unless patients presented with symptoms suspicious of deep venous thrombosis.

6.2.3 Statistical Analysis

All statistical analyses were performed using SPSS version 17.0 (SPSS, Inc, Chicago, Illinois). Correlations between outcomes were assessed using Spearman’s correlation for non-parametric data. Groups were compared using Mann Whitney U and Kruskal Wallace tests for non-parametric data as appropriate. The responsiveness of outcome measures was assessed using the standardized response mean (SRM), calculated by dividing the mean change in score by the standard deviation of the change. The higher the SRM, the more sensitive the tool to clinical change, with SRMs of 0.2, 0.5 and 0.8 representing small, moderate or large changes respectively (Garratt et al. 1996). To avoid potential errors introduced by multiple testing, p values of 0.01 or less were considered significant.
6.3 Results

6.3.1 Study Population and Demographics

Over a period of 18 months between January 2008 and July 2009 pre-operative data were collected from 317 adult patients (female n=227 male n= 90), of mean (S.D) age  48.87 (14.49) years (minimum age 18 years, maximum age 87 years). The recruitment and follow up of patients in the study is summarised in (Figure 44).

A total of 252 patients had primary varicose veins and 65 had recurrent varicose veins. Colour duplex scanning confirmed that 191 patients had unilateral disease, 126 had bilateral disease and 45 also had deep venous incompetence. Of the 443 legs studied 322 (73%) had GSV incompetence alone, 31 (7%) had SSV incompetence alone, and 90 (20%) had more than 1 refluxing vein (either GSV+SSV or GSV + ATV or ATV+ SSV).
Baseline CEAP clinical scores for the group are illustrated in Figure 45 and ranged from C2 to C6, there were no patients classified as C0 or C1.

No significant differences were observed in any baseline scores between patients with primary and recurrent disease [AVVQ (p=0.163) SQOR-V (p=0.171) SF12PCS (p=0.08), SF12 MCS (p=0.373), VCSS (p=0.038), VSDS (p=0.386) and VRT (p=0.435) Mann Whitney U test].

![Figure 45. Distribution of clinical CEAP scores in the study cohort](image)

*Values in parentheses are raw data*

6.3.2  Relationship Between Pre-Operative AVVQ, SQOR-V and SF12

The AVVQ showed a strong positive correlation with the SQOR-V disease specific questionnaire (Figure 46), and a weak, but significant correlation with the physical component of the generic SF12 questionnaire. Correlation with the mental component score was very weak and of borderline significance (Figure 47).
Figure 46. Relationship between the AVVQ and SQOR-V

Spearman coefficient 0.702, p<0.001

Figure 47. Correlation between the AVVQ and the SF12 PCS and MCS

Spearman coefficient -0.308, p<0.001
Spearman coefficient -0.162, p=0.007
The physical component of the SQOR-V (SQOR-V PCS) correlated with the SF12 PCS, however the mental component of the SQOR-V (SQOR-V MCS) did not correlate with the SF12 MCS (Figure 48).

6.3.3 Relationship Between Baseline Clinical CEAP and AVVQ, SQOR-V, VCSS and VRTs

The AVVQ correlated with increasing CEAP grade (p<0.001 ANOVA) (Figure 49), patients with C5/6 disease had significantly higher AVVQ scores [median (IQR)] [36.75 (18.42-45.15) than those with C3/4 disease, [17.68 (13.15-25.82)] (p<0.001 Mann Whitney U) who had significantly higher scores than those with C2 disease [15.20 (11.08, 22.59)] (p<0.001 Mann Whitney U).
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Interestingly SQOR-V scores did not correlate with CEAP scores as patients with C4 disease had lower scores than those with C3 disease (*P*=.093 ANOVA) (Figure 50).

**Figure 49. Relationship between AVVQ and clinical CEAP**

**Figure 50. Relationship between SQOR-V with clinical CEAP**
Higher CEAP scores were also associated with significantly higher VCSS scores ($p= <0.001$ ANOVA) (Figure 51).

Figure 51. Relationship between VCSS and clinical CEAP

VRTs appeared shorter in patients with higher CEAP scores although variability in measurements was high and the trend was not significant (Figure 52).

Figure 52. Relationship between VRTs and clinical CEAP
### 6.3.4 Relationship Between VCSS and Quality of Life

The VCSS correlated positively with AVVQ scores and weakly but significantly with SQOR-V scores (Figure 53). However, correlations were not as strong as those observed between disease specific quality of life tools.

![Graph showing correlation between VCSS and AVVQ](image1)

**Figure 53. Correlation between the VCSS and the AVVQ and SQOR-V**

The VCSS correlated with the physical (Spearman correlation -0.206, p=0.001) but not the mental component score (Spearman correlation -0.0492, p=0.483) of the SF12.

### 6.3.5 Relationship Between Anatomical Reflux and Quality of Life

The AVVQ showed a weak correlation with VSDS scores when scores for both legs were added (Spearman Coefficient 0.230 P<.001), but did not correlate with AVVQ scores when patients with unilateral disease alone were evaluated (p=0.328). The SQOR-V did not correlate with VSDS scores when scores for both legs were added in patients with bilateral disease (Spearman Coefficient 0.124, p=0.036), or when patients with unilateral disease alone were analysed (Spearman Coefficient 0.014, p=0.856), nor did the VSDS correlate with the SF12 (p=0.983).
Patients with deep venous incompetence appeared to have a worse quality of life according to the AVVQ (p=0.042 Mann Whitney U), however, this was not reflected in the SF12 PCS or SQOR-V questionnaires (p=0.064 and p=0.640 respectively Mann Whitney U).

6.3.6 Relationship of Anatomical Reflux to VCSS

The VCSS showed a weak correlation with the VSDS which was of borderline significance (Spearman Coefficient 0.147, p=0.012)

6.3.7 Relationship of VRT to Anatomical Reflux

Patients with multiple refluxing veins did not have significantly lower VRTs than those with GSV reflux. Those with SSV reflux did have worse VRTs compared with those with GSV reflux alone, but this was not significant (p=0.263 Kruscal-Wallis). The average refill times according to patterns of venous reflux are summarised in Table 12.

<table>
<thead>
<tr>
<th></th>
<th>GSV</th>
<th>SSV</th>
<th>2 Refluxing veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRT median(IQR)</td>
<td>19.50 (11.50-29.58)</td>
<td>24.50 (13.50-34.50)</td>
<td>18.67 (13.50-27.00)</td>
</tr>
<tr>
<td>In seconds</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12. Venous refill times according to the pattern of truncal reflux

A weak correlation was observed between VSDS scores and pre-operative VRTs (Spearman Coefficient -0.257 p<0.001).

6.3.8 Relationship of VRTs to Functional Outcomes

Venous refill times (worst leg) did not correlate with the functional outcome measures of AVVQ (p=1.09); SQOR (p=0.575); SF12 PCS(p=0.779); SF12MCS(p=0.209) or VCSS (p=0.11).
6.3.9 Assessment of Relationship Between Outcome Measures Following Intervention

At 6 weeks data from 225/317 (71%) patients was available. Quality of life questionnaires were complete for 214 (68%) patients. No significant difference in disease severity or pattern of reflux was observed in patients who did not attend follow up compared with those who did, evaluated using the baseline VCSS (P=.591) and VSDS (p=.137) Mann Whitney U test. Overall patient’s quality of life, clinical and haemodynamic scores improved at 6 weeks in comparison with baseline scores. Improvements in scores are shown in Table 13.

<table>
<thead>
<tr>
<th></th>
<th>AVVQ</th>
<th>SQOR-V</th>
<th>SF12 PCS</th>
<th>SF12 MCS</th>
<th>VCSS</th>
<th>VRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>17.01 (12.14-24.64)</td>
<td>45.60 (36.54-57.17)</td>
<td>49.64 (42.48-55.24)</td>
<td>50.97 (41.60-56.47)</td>
<td>4 (4-6)</td>
<td>19.33 (11.00-25.50)</td>
</tr>
<tr>
<td>6 week</td>
<td>9.69 (5.50-16.68)</td>
<td>33.53 (25.64-42.11)</td>
<td>53.73 (46.70-56.93)</td>
<td>53.81 (645.90-57.16)</td>
<td>1 (0-2)</td>
<td>25.73 (17.00-33.00)</td>
</tr>
</tbody>
</table>

*p value* p<0.001 p<0.001 p=0.004 p<0.001 p<0.001

*Values are given as median (IQR)  * Wilcoxon Rank test

Table 13. Pre and post-intervention AVVQ, SQOR-V, SF12 and VCSS Scores

6.3.10 Relationship Between the Changes in AVVQ, SQOR-V and SF12

The relationship between improvements in quality of life post-procedure was evaluated as the percentage change in the post-procedure scores in comparison with those at baseline. AVVQ scores post-procedure showed a positive correlation with percentage change in post-procedural SQOR-V scores at 6 weeks (Figure 54).

Patients who experienced large improvements in AVVQ scores generally experienced similar improvements in SQOR-V scores, while those who experienced a worsening of AVVQ scores reported worse SQOR-V scores. However, a small number of patients had worse AVVQ scores with improvements in the SQOR-V and vice versa.

Very weak were correlations observed between changes in AVVQ scores and changes in the SF12 MCS scores at 6 weeks were of borderline significance (0.196, p=0.008), but no correlation was seen
between the PCS and the AVVQ (Spearman Coefficients 0.159 p=.032) or between the SQOR-V and the SF12 (Spearman Coefficient 0.079, p=0.296).

![Spearman Coefficient 0.492, p<0.001](image)

**Figure S4.** Relationship between changes in the AVVQ and SQOR-V

### 6.3.11 Relationship Between Changes in AVVQ, SQOR-V, and VCSS

Percentage changes in the AVVQ showed a weak correlation with the percentage changes in the VCSS (Spearman Coefficient 0.299, p<0.001), however, no correlation was observed between the percentage changes in the SQOR-V and the VCSS. (Spearman Coefficient 0.062, p=0.401).

### 6.3.12 Relationship Between the Changes in VRT and AVVQ, SQOR-V, SF12 and VCSS

Changes in venous refill times at 6 weeks did not correspond to changes in the AVVQ or the SQOR-V overall (Spearman Coefficient -0.021, p=0.826 and Spearman Coefficient 0.073, p=0.567
respectively) or in patients with unilateral disease only (Spearman Coefficient -0.067, p=0.587 and Spearman Coefficient-0.069 p=0.574 for the AVVQ and SQOR-V respectively). Percentage changes in the VRTs did not correlate with changes in the SF12 PCS (p=0.996) or MCS (p=0.790).

Patients with higher CEAP scores had lower VRTs at baseline and post-procedure (Table 14), however, post-procedure VRTs did not correlate with post-procedure VCSS scores (Spearman coefficient=-0.041, p=0.636).

<table>
<thead>
<tr>
<th></th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRT Baseline (seconds)</td>
<td>23.5</td>
<td>21.00</td>
<td>16.00</td>
<td>3.33</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td>(13.66-34.52)</td>
<td>(12.25-31.00)</td>
<td>(10.12-25.63)</td>
<td>(10.50-23.00)</td>
<td>(6.63-13.30)</td>
</tr>
<tr>
<td>VRT Post Procedure (seconds)</td>
<td>27.67</td>
<td>27.75</td>
<td>27.50</td>
<td>17.00</td>
<td>8.50</td>
</tr>
<tr>
<td></td>
<td>(19.50-32.50)</td>
<td>(19.37-36.00)</td>
<td>(18.33-34.00)</td>
<td>(10.63-26.38)</td>
<td>(6.50-14.25)</td>
</tr>
</tbody>
</table>

Figures are presented as median (IQR)

Table 14. Venous refill times according to clinical CEAP pre and post-procedure

### 6.3.13 Relationship of Outcome Measures in Patients with Deep Venous Incompetence

Pre-operatively, the adjustment for the presence of deep venous incompetence did not affect the significance of the correlations reported. Post-procedure correlations between outcomes when all patients were included in the analysis were similar to those in patients with superficial incompetence alone. However, no correlation was observed between the percentage change in AVVQ scores with changes in the SOQR-V (p=.502), VCSS (p=.010) or VRT (p=.580) when patients with deep and superficial venous incompetence were analysed separately (Spearman Rank test), although post-procedural data from only 27 patients were available for analysis.

### 6.3.14 Responsiveness of the AVVQ and SQOR-V Questionnaires

AVVQ scores pre and post-intervention correlated with pre-operative CEAP scores (p<0.001 ANOVA) and patients across all degrees of clinical severity appeared to gain significant improvement in their scores (P<.001 for C2/3/4 patients and p=0.002 C5/6 patients Wilcoxon Rank). However, percentage
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c changes in AVVQ did not correlate with pre-operative CEAP as improvements were similar in all classes (p=0.965 ANOVA). Results show that the SQOR-V questionnaire also appears to show significant improvements in scores after intervention for all degrees of severity (p=0.001 C2/3/4 and p=0.004 C5/6 Wilcoxon Rank). However, pre-operative SQOR-V scores did not correlate with C4-C6 CEAP scores (p=0.093 AVOVA) or the percentage of improvement post-intervention (p=0.602 ANOVA). The responsiveness of the AVVQ and SQOR-V questionnaires has been evaluated using the standardized response mean. SRMs confirmed the AVVQ and the SQOR-V were highly responsive to changes at 6 weeks (SRMs 0.897 and 0.870 for the AVVQ and SQOR-V respectively). SRMs have been calculated for patients according to baseline clinical CEAP for the AVVQ (Figure 55) and SQOR-V (Figure 56). When evaluating the degree of change post-procedure, both questionnaires appear to show similar degrees of improvement according to the SRM. We were not able to demonstrate an increased sensitivity for the SQOR-V in patients with C2 and C3 disease, although data for patients with C1 disease was not available in this cohort.

![Figure 55. Responsiveness of the AVVQ](image)

<table>
<thead>
<tr>
<th>AVVQ</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in score*</td>
<td>6.706 (8.536)</td>
<td>7.802 (8.730)</td>
<td>8.523 (8.225)</td>
<td>12.027 (11.866)</td>
<td>17.574 (12.691)</td>
</tr>
<tr>
<td>SRM</td>
<td>0.712</td>
<td>0.894</td>
<td>1.036</td>
<td>1.014</td>
<td>1.385</td>
</tr>
</tbody>
</table>

*Values are mean (S.D) SRM- standardised response mean= change in score divided by the change in S.D
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

**Table 15**

<table>
<thead>
<tr>
<th>SQOR-V</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>46.496 (13.319)</td>
<td>50.270 (16.048)</td>
<td>45.934 (13.334)</td>
<td>42.789 (12.822)</td>
<td>55.014 (12.116)</td>
</tr>
<tr>
<td>6 week</td>
<td>35.821 (12.128)</td>
<td>39.191 (15.994)</td>
<td>34.180 (13.017)</td>
<td>34.027 (8.336)</td>
<td>39.247 (8.631)</td>
</tr>
<tr>
<td>SRM</td>
<td>0.869</td>
<td>0.722</td>
<td>1.019</td>
<td>1.079</td>
<td>3.283</td>
</tr>
</tbody>
</table>

*Values are mean (S.D) SRM: standardised response mean = change in score divided by the change in S.D

**Figure 56.** Responsiveness of the SQOR-V

### 6.3.15 Responsiveness of Outcome Measures

Standardised response means for the questionnaires overall, confirmed that both the AVVQ and SQOR-V and VCSS are highly responsive at detecting change following intervention, however, the SF12 showed only small changes (Table 15).
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th></th>
<th>AVVQ</th>
<th>SQOR-V</th>
<th>VCSS</th>
<th>SF12 PCS</th>
<th>SF12 MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRM</td>
<td>0.897</td>
<td>0.870</td>
<td>1.756</td>
<td>0.234</td>
<td>0.225</td>
</tr>
</tbody>
</table>

Table 15. Standardised response means for outcome measures

6.3.16 Predictive Value of the AVVQ

It has been suggested that from baseline AVVQ scores it may be possible to predict patients likely to achieve better outcomes post-procedure, and if so, could be used as a rationing tool. Although baseline CEAP scores correlated with AVVQ scores, they were not predictive of changes in AVVQ scores (p=0.956 ANOVA). Baseline AVVQ scores did not correlate with changes in AVVQ scores post-intervention (Figure 57).

![Spearman Coefficient 0.074 p=0.303](image)

Figure 57. Predictive value of the AVVQ based on percentage change in scores

Patients were divided into quartiles based on baseline AVVQ point score, (quartile 1 from 0-12, quartile 2 from 12.1-17.0, quartile 3 for 17.1-25 and quartile 4 >25.1). All patient groups gained
significant improvements in the post-procedural scores at 6 weeks. No cut off point for baseline AVVQ scores was found to be predictive of treatment success and, therefore, no evidence for the use of the AVVQ as a pre-operative screening tool was found (Figure 58).

![Wilcoxon Rank test](image)

**Figure 58. Predictive value of the AVVQ**

### 6.4 Discussion

This study demonstrated that there is poor correlation between disease specific quality of life and other outcome measures used to evaluate varicose veins. As demonstrated previously, AVVQ scores did correlate with clinical CEAP scores (Mackenzie et al. 2002; MacKenzie et al. 2004), but only weak correlations were observed between AVVQ and pre-operative generic quality of life (SF12) or VCSS scores. Correlations between the SF12, CEAP and VCSS were very weak and of borderline significance only both pre and post-operatively, and no correlations were observed between the SF12 and VRTs. Results observed with the AVVQ and VCSS scores in this study were similar to those reported in other series and in recent randomized clinical trials assessing endovenous thermal ablation modalities, with improvements in scores comparable with other studies (Rasmussen et al. 2007; Darwood et al. 2008). No correlations were observed between AVVQ scores and venous refill.
times, either pre-operatively or following intervention. Although some smaller studies have shown correlations between VRTs and pre-operative quality of life, they have found no correlation between changes in VRT and either generic or disease specific quality of life following intervention (Darvall et al. 2010a), suggesting that haemodynamic measurement is a poor outcome assessment tool in patients with uncomplicated venous disease. Weak correlations were seen between AVVQ scores and anatomical reflux according to VSDS scores, further supporting the theory that the presence of anatomical reflux does not necessarily correlate with functional impairment or clinical disease (Bradbury et al. 1999; Theivacumar et al. 2008b). These findings suggest that anatomical reflux should not be relied upon in isolation as an outcome measure in routine practice. In addition studies validating the venous severity scoring system found that the VSDS did not correlate with the CEAP classification. However, a weak association was found pre-operatively between the VSDS and the VCSS, with patients with increasing numbers of refluxing segments reporting higher symptomatic scores. No association was found between the VSDS and post-operative score changes following traditional surgery in a small group of patients (Kakkos et al. 2003). Similarly haemodynamic success has been shown to be useful in the prediction of venous ulcer recurrence in patients with venous ulceration (Gohel et al. 2005a), although its application is of questionable use in patients with uncomplicated disease.

The explanation for the correlations observed may, in part, be due to the relatively small number of patients studied, and also, that some haemodynamic factors were beyond the scope of this study and not assessed. Indeed previous studies have suggested that higher venous reflux velocities are associated with a worse clinical outcome following saphenous vein ablation (Marston et al. 2008), which were not recorded in this study. They may also represent patients in whom symptoms reported were unrelated to an underlying venous cause. However, due to the difficulties in correlating venous reflux with symptomatology (Bradbury et al. 1999; Campbell et al. 2007), this is extremely difficult to assess.
6.4.1 Comparison of the AVVQ and SQOR-V

A strong correlation was observed between the two disease specific quality of life questionnaires evaluated, which was stronger than those observed between the AVVQ or SQOR-V the SF12, supporting the use of the SQOR-V as a valid and responsive disease specific questionnaire. The results of the use of the SQOR-V questionnaire in this patient group showed strong similarities to those of the original authors. Average scores for C2 and C3 patients were 43.83 and 48.84 in our patient group in comparison to 42.24 and 48.71 reported in the original publication (Guex et al. 2009).

Interestingly, in the majority of patients, changes in post-procedure AVVQ scores correlated with the SQOR-V, but a number of patients experienced improvement in one score, with worsening of the other. It is possible that this may reflect different sensitivities of the questionnaires applied to different patient groups, or represent random errors in question responses. Because of the very small number of cases this applied to, the authors were unable to evaluate this further. The SQOR-V questionnaire was specifically designed to allow more sensitive evaluation of the functional impact of venous disease in patients in CEAP classes C1-C3. The results from this study were able to support the use of the SQOR-V in this patient group, although were unable to demonstrate any superiority over the AVVQ. However, the study did not make a full assessment of the effectiveness of the SQOR-V questionnaire due the absence of patients with C1 disease alone, for whom referrals to secondary care are restricted by the UK state healthcare system.

In patients with skin changes and ulceration (C4-C6) the SQOR-V questionnaire did not correlate with clinical CEAP scores, a trend also reported in the original publication (Guex et al. 2007). Differences in scores are likely to be due to the differences in the design of the questionnaires. The SQOR-V is based on patient reported symptoms and not clinical signs, where as the AVVQ attributes a heavier weighting to the presence of skin changes and ulceration. Despite this the SQOR-V remained highly responsive in all patient groups, with responsiveness scores similar to the AVVQ. Both disease specific questionnaires were highly responsive to changes following intervention with standardised response means of >0.8 (Garratt et al. 1996). Consequently no superiority of either questionnaire over the other was demonstrated.

The VCSS was also highly responsive to changes following intervention. However, as described in other studies, generic quality of life was far less responsive to change following intervention than disease specific tools (Garratt et al. 1996).
6.4.2 Predicting Treatment Outcomes

Data from this study were unable to support the use of baseline AVVQ scores as a predictor of treatment outcomes. Improvement in post-intervention scores were significant for patients in all categories of disease severity and no cut off point could be established, below which intervention was unlikely to result in significant improvements. Baseline SQOR-V scores did not correlate with clinical CEAP scores and, therefore, its use as a predictive tool was not evaluated as baseline scores in isolation are not predictive of disease severity.

The choice of outcome measure in venous disease is difficult and has been of great interest in recent years (Guex 2008). The VCSS is undoubtedly easy and quick to use and provides a good assessment of disease severity, but offers no evaluation of the impact of the disease state on the quality of life of the patient, which is of paramount importance. Quality of life questionnaires provide a more complete assessment of the disease state, and Patient Reported Outcome Measures (PROMs) have recently been introduced in the United Kingdom for the assessment of outcomes following a number of elective procedures, including varicose veins. However, questionnaires are time consuming and costly to use and a number of patients are reluctant to complete them for a variety of reasons including difficulties with language, reading, comprehension and lack time or motivation to complete lengthy questionnaires.

Current recommended reporting standards advise the use of both generic, disease specific and clinical evaluation tools for a comprehensive assessment (Kundu et al. 2009). Duplex ultrasonography has been an important tool in establishing the efficacy of endovenous ablation techniques, although not all patients underwent duplex scanning post-operatively in this study. The weak correlations observed between anatomical and functional outcomes suggest that residual anatomical reflux in the absence of symptoms is unlikely to justify intervention, and consequently, routine duplex scanning is of questionable value and may not be a cost effective use of scarce healthcare resources. The use of PROMs could potentially negate the need for post-operative haemodynamic and anatomical evaluation in routine practice.

This study comprised of a combination of randomised and non-randomised patients and, therefore, differences in treatment allocation. However, no significant differences in outcomes were observed between the treatment groups at 6 weeks. As the aim of the study was to evaluate the relationship between outcome assessment tools and not the comparison of outcomes, this should not have affected the results. This study was also unable to evaluate disease specific quality of life questionnaires in patients who did not undergo intervention, as these patients are usually managed
in primary care. The follow up rate of 68% of patients at 6 weeks despite reminder letters and telephone calls was disappointing, and a larger dropout rate was seen in the non-randomised patients.

In this study the evaluation of digital photoplethysmography as an outcome measure was difficult to correlate with quality of life. However, patients with bilateral disease were excluded from the analysis, which may have affected the results. Overall, this is an important assessment of the reliability and use of different outcome measures in the assessment of venous disease, although in order to recommend specific tools in preference to others, larger studies will undoubtedly be required.
Chapter 7. General Discussion and Conclusions
In the introduction, the development of endovenous thermal ablation treatments, the measurement of venous disease severity and treatment outcomes were discussed and further questions regarding the role of endovenous thermal ablation were proposed.

Despite the fact that endovenous thermal ablation therapies were developed over 10 years ago, evidence from the questionnaire survey conducted (Chapter 2) confirmed that their prevalence still remain low in the United Kingdom and traditional surgery still appeared to be the most frequently performed procedure. Results suggested that high initial costs and rationing by NHS healthcare providers were likely to be the commonest reasons behind the apparent slow uptake of these new procedures. However, data from previously conducted surveys of varicose veins treatments amongst vascular surgeons, and from venous registries confirmed that thermal ablation devices are becoming increasingly popular (Lindsey et al. 2006; Winterborn et al. 2008; Edwards et al. 2009). Another factor contributing to the lack of uptake of endovenous thermal ablation is perhaps the limited knowledge of their existence by the majority of the general public. When patient preferences regarding the nature of treatment provision for varicose veins were explored (Chapter 3), the majority would prefer a minimally invasive treatment performed in a single sitting. Patient preferences were similar to those reported in previous surveys with the majority expressing willingness to undergo a more invasive treatment if they felt that it would provide more durable results (Campbell et al. 1998). Based on the patient’s opinions expressed, endovenous ablation therapies are likely to be preferable treatment modalities based on their low complication rates, minimal discomfort and excellent medium term success rates in comparison with other therapies (Van den Bos et al. 2009a). However, the majority of patients are unaware of their existence and reported that they would be most likely to make a decision based on the opinion of the surgeon they visit.

Few studies have evaluated differences between laser and radiofrequency ablation. Data from earlier studies focused primarily on the efficacy of the techniques at eliminating truncal reflux, but occlusion rates are likely to be similar between the two techniques. Patient preferences explored in Chapter 3 suggest that post-procedural discomfort and recovery times were of high importance and further evaluation of early treatment outcomes may aid clinicians in making evidence based recommendations to patients. The pilot study conducted provided valuable post-procedural discomfort scores, in order to allow accurate sample size calculation for the randomised trial, although it was unable to identify any predictive factors of post-procedural pain.
Recruitment to the randomised study was more successful than expected, with 77% of those eligible agreeing to participate. Follow up for the primary end point of the study was also better than expected with 97% at 3 days and 88% at 6 weeks, which enabled recruitment to be completed on time. The number of patients recruited to the trial highlighted a disadvantage of RCTs, as only 45% of patients screened were eligible for inclusion, and, therefore, a large proportion of the presenting population were not investigated. Although generally considered the “gold standard” in clinical research, RCTs are only applicable to the population studied, meaning that the results of treatment in patients not included are often poorly understood. Results from this RCT were applicable only to patients with primary superficial GSV reflux as patients with recurrent varicose veins, SSV and non truncal reflux were not included. Addressing these issues is difficult, although encouraging surgeons to enter patient data into registries may allow the investigation of uncommon disease processes and the evaluation of the results of treatments performed in complicated patients, frequently excluded from randomised trials. Unfortunately, data from registries are often of poor quality (www.e-dendrite.com. 2009) which may be due to the fact that data entry is very time consuming, with minimal benefit to the individual clinician. Similarly, results of the nationally collected PROM data are initially disappointing (http://www.hesonline.nhs.uk). These problems will need to be addressed if useful data are to be collected. Ensuring the data entered are of use to individual centres, clinicians and patients may help to improve the quality of the data.

Results from the pilot study and the randomised trial confirmed that radiofrequency ablation with VNUS® ClosureFAST™ was significantly less painful than laser ablation with the 980nm bare laser fibre, but no significant differences in return to work or normal activities were observed. Improvements in quality of life and clinical severity measures with the AVVQ, SF12 and VCSS were highly significant at 6 weeks and 6 months, with no significant differences between the groups. The study was sufficiently powered to investigate post-procedural pain, but did not have adequate numbers to compare anatomical success rates at 6 months, which would have required a much larger study. Despite the fact that there were more anatomical treatment successes in the EVLA group, this was not significant, and both treatments yielded good success rates at 6 months, in keeping with the published literature (Van den Bos et al. 2009a). Decisions regarding the choice of endovenous treatment modality are likely to be more complex than the evaluation of post-procedural discomfort alone. In the light of NHS restrictions and rationing of varicose vein treatments (Lindsey et al. 2006; Nasr et al. 2008) the cost effectiveness of these procedures is likely to be scrutinised. In order to allow objective comparison between treatment modalities, the evaluation of treatment success must be carefully considered. Outcome measures following
superficial venous surgery have been highlighted as being crucial to the investigation of endovenous therapies. Consensus supports the movement away from surrogate outcome measures, towards patient reported outcome measures of success, in the hope that this will allow improvement of the patient’s experience and the quality of healthcare provided (Black et al. 2009; http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_092647 2010).

Patient preferences are likely to become increasingly important factors in treatment provision and larger studies of patient preference are undoubtedly required. Importantly patient reported outcomes allow calculation of the cost effectiveness of an intervention, related to the relative improvement in quality of life experienced in QALYs, and are used in the allocation of healthcare resources. At present, calculations of cost effectiveness of therapies are based on generic assessment tools, in order to allow a comparison between different treatments and the relative importance of different disease processes. However, system specific tools are undoubtedly more responsive following interventions (Garratt et al. 1996). The increase in popularity of PROMs in research and routine practice may allow for the evaluation of more subtle differences and highlight advantages or disadvantages of a particular endovenous therapy. However, difficulties in comparing results of studies arise due to the numerous different outcome measures available. Investigation of the relationship between these outcome measures suggested that they correlate weakly, and, therefore, greater consensus regarding which to use would facilitate comparisons between studies. The cost effectiveness of the treatment of venous disease is difficult to calculate, as evidence of the rate of progression from uncomplicated disease to venous ulceration is scarce. The use of PROMs to calculate the disease burden to society may provide justification for the allocation of resources. It has been suggested that PROMs may be predictive of treatment success and that baseline scores could be used to ration resources. Evidence from this study suggests that patients with mild, moderate and severe disease benefit significantly from intervention, and unless this can be translated into justification of cost effectiveness, PROMs appear to be an inappropriate rationing tool at present.

Due to the rapidly developing technology, endovenous therapies are under constant evaluation and improvement with the introduction of new laser fibres and different wavelengths. In addition, alternative endothermal ablation devices using steam are also being introduced. In order to investigate subtle differences in outcomes, well designed large randomised trials are required. However, these are time consuming and extremely costly to conduct, and the speed at which the
technology is evolving frequently means that the device under investigation has been superseded by a superior device before the results of the study can be published. For this reason, funding for clinical trials is difficult to obtain. It is likely that in the absence of large randomised studies, data combined from smaller studies and venous registries will be important. However, if data from smaller studies is to be collated in order to draw any meaningful conclusions, consensus regarding the use of outcome measures will have to be reached.

Conclusions

Endovenous thermal ablation therapies have become increasingly popular over the last decade, however, they are not the “gold standard” treatment of varicose veins in the UK at the present time. Endovenous ablation is likely to be preferable to patients due to minimal post-procedural discomfort local anaesthetic treatment options and superior cosmetic results, although patients are generally poorly informed about the treatment options currently available.

Treatment with RFA is significantly less painful than treatment with the 980nm bare fibre laser, but does not necessarily allow more rapid return to work. No differences were observed in clinical and functional outcomes at 6 weeks and functional and anatomical outcomes were also similar at 6 months. Current laser devices are likely to be replaced with newer devices with longer wavelengths and coated or radial fibres. However, the evaluation of these newer devices and novel technologies such as steam was beyond the scope of this thesis.

Evaluation of the severity of venous disease and the optimal outcome measure remains controversial. Adequate assessment of outcomes is essential in order to establish optimal treatment provision, which at present is highly variable. A combination of clinical and patient reported outcomes is likely to be effective, and may replace surrogate outcome measures in the future. International consensus on the most appropriate questionnaire to use for a particular patient group would aid comparison between clinical studies, although at present no such consensus exists.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

References


Braithwaite, B. D. (2010). "Updates in truncal venous ablation " Vascular and Endovascular Challenges Update (BIBA Publishing, A Division of BIBA Medial Ltd. Roger M Greenhalgh (Eds)).


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Kabnick, L. S. (2009). "980nm laser vs. radiofrequency for endothermal venous ablation of the GSV: are the recovery results similar? Abstract presented at the American College of Phlebology 23rd Annual Congress, Palm Dessert, California. November ".


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www.survey.bis.ac.uk "Bristol Online Surveys (BOS)." (last accessed 31/08/2010).


Chapter 9. Appendices
9.1 Appendix 1. Web-based Questionnaire Sent to Surgeons
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Online Surveys
Develop, launch and analyse Web-based surveys

1. Which of the following procedures do you routinely perform for the treatment of varicose veins? (select all that apply)

- Surgery
- Endovenous laser ablation
- Radiofrequency ablation
- Sclerotherapy

2. If a patient is suitable for all 4 treatment modalities please rank them in order of preference (1 being most popular, 4 being least popular)

<table>
<thead>
<tr>
<th>a. Surgery</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Endovenous laser ablation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. Radiofrequency ablation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. Sclerotherapy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

3. Do you routinely perform venous duplex after the following procedures?

<table>
<thead>
<tr>
<th>a. Surgery</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Endovenous laser ablation</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>c. Radiofrequency ablation</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>d. Sclerotherapy</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

4. If you perform follow up venous duplex, please indicate the reasons for this (please tick all that apply)

<table>
<thead>
<tr>
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<th>Quality control</th>
<th>Anticipation of further treatment</th>
<th>Other (please specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Endovenous laser ablation</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>c. Radiofrequency ablation</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

**5.** Would you routinely intervene if you discovered truncal incompetence on duplex scanning in the absence of clinical recurrence after the following procedures?

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Endovenous laser ablation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Radiofrequency ablation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Sclerotherapy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**6.** If you routinely perform Endovenous laser ablation or Radiofrequency ablation, please indicate which is your usual location?

- [ ] N/A
- [ ] Operating theatre
- [ ] Adapted clinic room
- [ ] Other *(please specify)*:

   a. If you perform Endovenous laser ablation or Radiofrequency ablation, which anaesthesia do you routinely use?
      - [ ] General anaesthesia
      - [ ] Regional anaesthesia
      - [ ] Local/ Tumescent anaesthesia only

   b. What is your usual treatment plan?
      - [ ] Treatment completed in a single visit
      - [ ] Potential multiple visits
      - [ ] Mixture of both of the above

**7.** Which of the following factors influence your decision regarding treatment options? *(please rank: 1 = most influential and 4 = least influential)*

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Your perception of patient preference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Availability of space to perform the</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>procedure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Time taken to perform the procedure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 8. What is your routine method of treatment for the majority of patients with primary long saphenous vein incompetence and significant varicose veins?

- SFJ disconnection and LSV stripping with avulsions
- Endovenous laser ablation and avulsions
- Endovenous laser ablation and sclerotherapy
- Radiofrequency ablation and avulsions
- Radiofrequency ablation and sclerotherapy
- Sclerotherapy alone
- Other *(please specify)*: 

### 9. What is your routine method of treatment for the majority of patients with short saphenous vein incompetence and significant varicosities?

- SPJ Ligation (without stripping) and avulsions
- Stripping of the SSV with avulsions
- Endovenous laser ablation and avulsions
- Endovenous laser ablation and sclerotherapy
- Radiofrequency ablation and avulsions
- Radiofrequency ablation and sclerotherapy
- Sclerotherapy alone
- Other *(please specify)*: 

### 10. After treatment, what compression treatment do you routinely offer to patients?

- None
- Crepe bandage
- TEDS
- Compression stockings Grade 1
- Compression stockings Grade 2
- Other *(please specify)*: 

### 11. For how long do you advise patients to use compression after treatment?

- N/A
- <1 week
- 1 week
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

12. Do you routinely use the CEAP classification

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

13. What is your routine DVT prophylaxis regimen?

*(select all that apply)*

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>TEDS</th>
<th>Subcut heparin</th>
<th>Other (please specify):</th>
</tr>
</thead>
</table>

14. For how long do you routinely use DVT prophylaxis?

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Single dose</th>
<th>The duration of in patient stay</th>
<th>1 week</th>
<th>1-2 weeks</th>
<th>&gt;2 weeks</th>
<th>Other (please specify):</th>
</tr>
</thead>
</table>

15. Do you have any local restrictions dictating which treatments you are able to offer? Please give brief reasons.

<table>
<thead>
<tr>
<th></th>
<th>a. Surgery</th>
<th>b. Endovenous laser Ablation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

16. Do you offer different treatments in the private sector where you are not restricted by NHS criteria?

☐ Yes  ☐ No

If yes please indicate which treatments you are able to offer patients privately that you do not offer to those under the NHS (select all that apply)

☐ Traditional surgery
☐ Endovenous laser ablation
☐ Radiofrequency ablation
☐ Sclerotherapy
☐ Other (please specify):

Traditional surgery
Endovenous laser ablation
Radiofrequency ablation
Sclerotherapy
Other (please specify):
9.2 Appendix 2. Patient Perspective Questionnaire
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

1) Please state your age and sex
   Male Female
   Under 30 ☐ ☐
   30-40 ☐ ☐
   40-50 ☐ ☐
   50-60 ☐ ☐
   60-70 ☐ ☐
   70-80 ☐ ☐
   Over 80 ☐ ☐

2) Please state your occupation

3) Do you work full time or part time?
   Full time ☐
   Part time ☐
   N/A ☐

4) Please indicate how much you are affected by the following symptoms.
   (please circle one option per row)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not affected</th>
<th>Slightly affected</th>
<th>Moderately affected</th>
<th>Severely affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain/ache/ physical discomfort</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Appearance</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Limitation to activities</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The risk of complications associated with varicose veins</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
5) When considering treatment for your varicose veins which of the following concerns you?  
(please circle one option per row)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not concerning</th>
<th>Slightly concerning</th>
<th>Moderately concerning</th>
<th>Extremely concerning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking time off work</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Discomfort after treatment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Having a single treatment rather than multiple visits</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The risk of the problem re-occuring</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

6) Bearing in mind your current symptoms, how much time off work would you be prepared to take for varicose vein treatment?  
(please choose one option)

- 1-3 days
- Up to 1 week
- 1-2 weeks
- >2 weeks
- The amount of time is not important to me

7) Which outcome following treatment is most important to you  
(please rank: 1 =most important 3 = least important)

- Resolution of physical symptoms e.g. pain, aching etc
- Improved cosmetic appearance
- Reduced risk of complications related to varicose veins

If this document is found please return to Amanda Shepherd, 4 North, Charing Cross Hospital
8) Which of the treatments listed below for varicose veins are you aware of?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endovenous Laser ablation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiofrequency ablation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sclerotherapy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other (please state)---------------------------------------------------------------

9) Which would be your preferred treatment option? (you may indicate more than one choice if you have no preference)

<table>
<thead>
<tr>
<th>Treatment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td></td>
</tr>
<tr>
<td>Endovenous Laser ablation</td>
<td></td>
</tr>
<tr>
<td>Radiofrequency ablation</td>
<td></td>
</tr>
<tr>
<td>Sclerotherapy</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

OR

Do not know enough to make a decision

Please give brief reasons

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

10) Where would you prefer your treatment to be carried out? (please choose one option)

<table>
<thead>
<tr>
<th>Location</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In an operating theatre</td>
<td></td>
</tr>
<tr>
<td>In a specially adapted clinic room</td>
<td></td>
</tr>
<tr>
<td>I have no preference to the location</td>
<td></td>
</tr>
</tbody>
</table>

If this document is found please return to Amanda Shepherd, 4 North, Charing Cross Hospital
9.3 Appendix 3. Visual Analogue Pain Score and Diary Card
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Pain Score Diary
Each day please indicate how much pain you are experiencing following treatment of your varicose veins.
(Please post this in the stamped addressed envelope provided or bring it to your follow up appointment)

<table>
<thead>
<tr>
<th>Day</th>
<th>Pain Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day of surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>First day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Second day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Third day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Fourth day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Fifth day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Sixth day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Seventh day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Eighth day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
<tr>
<td>Ninth day after Surgery</td>
<td>No pain</td>
<td>Worst pain imaginable</td>
</tr>
</tbody>
</table>

Overall how satisfied are you with your surgery?

- Not at all satisfied
  - Very satisfied

Please mark a vertical line on the horizontal line to indicate how satisfied you are with your treatment for your varicose veins.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Symptom Diary

Each day for 10 days please fill in this diary of which pain killers you took and how many. If you are taking more than one type of pain killer please write them all down and indicate how many of each type you took.

<table>
<thead>
<tr>
<th>Day</th>
<th>name of painkiller</th>
<th>number of tablets taken in 24 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sixth day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seventh day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eighth day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ninth day after surgery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Diary Card version 1.0 10th March 2008

Please indicate at what stage you were able to return to work and your normal daily activities. (The activities you were able to do prior to your treatment)

<table>
<thead>
<tr>
<th></th>
<th>Day I was able to resume my normal activities (please tick one box)</th>
<th>Day I returned to work (please tick one box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 days after surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;10 days after surgery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9.4 Appendix 4. Protocol for Digital Photoplethysmography
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Measurement of venous function can be made based on the haemodynamics of blood flow in the leg, and has been shown to correlate with the severity of venous disease. This can be measured using digital photoplethysmography, which uses light rheography to measure the venous refill time.

1) The patient is seated at rest with hips and knees at an angle of 90°.
2) The probe is placed on the patient’s leg 10 cm above the medial malleolus and not over any varicosities.
3) The machine is calibrated whilst the patient remains still.
4) The patient performs 8 ankle dorsi flexions keeping the heel on the floor.
5) The patient remains still with the foot flat on the floor whilst the measurement of venous refill time is taken.
6) Steps 1 - 5 are repeated. If the values are not within 10% of each other, a third reading is taken and the mean of the 3 calculated.

The inflation of a tourniquet to 80 mmHg below the knee can simulate the effects of superficial venous surgery and can be used to predict which patients will benefit from treatment.

7) A tourniquet is placed just below the patients’ knee and inflated to 80 mmHg.
8) Steps 1 - 6 are repeated.

In this study venous refill time will be assessed using digital photoplethysmography pre-operatively with and without a tourniquet to mimic the effect of surgery, and at 6 weeks, 6 months and 12 months. 2 consecutive readings with a coefficient of variation below 10% will be used in the study, with an additional reading taken if required. The mean will be calculated.
9.5 Appendix 5. Aberdeen Varicose Vein Questionnaire and Scoring Algorithm
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Your Varicose Veins

1. Please draw in your varicose veins in the diagram(s) below:

   Legs viewed from front
   
   Legs viewed from back

2. In the last two weeks, for how many days did your varicose veins cause you pain or ache?
   (Please tick one box for each leg)

<table>
<thead>
<tr>
<th>R Leg</th>
<th>L Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>None at all</td>
<td></td>
</tr>
<tr>
<td>Between 1 and 5 days</td>
<td></td>
</tr>
<tr>
<td>Between 6 and 10 days</td>
<td></td>
</tr>
<tr>
<td>For more than 10 days</td>
<td></td>
</tr>
</tbody>
</table>

3. During the last two weeks, on how many days did you take painkilling tablets for your varicose veins?
   (Please tick one box)

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None at all</td>
</tr>
<tr>
<td>Between 1 and 5 days</td>
</tr>
<tr>
<td>Between 6 and 10 days</td>
</tr>
<tr>
<td>For more than 10 days</td>
</tr>
</tbody>
</table>
4. **In the last two weeks, how much ankle swelling have you had?**

   *(Please tick one box)*
   - None at all
   - Slight ankle swelling
   - Moderate ankle swelling (eg. causing you to sit with your feet up whenever possible)
   - Severe ankle swelling (eg. causing you difficulty putting on your shoes)

5. **In the last two weeks, have you worn support stockings or tights?**

   *(Please tick one box for each leg)*
   - R Leg
   - L Leg
   - No
   - Yes, those I bought myself without a doctor’s prescription
   - Yes, those my doctor prescribed for me which I wear occasionally
   - Yes, those my doctor prescribed for me which I wear every day

6. **In the last two weeks, have you had any itching in association with your varicose veins?**

   *(Please tick one box for each leg)*
   - R Leg
   - L Leg
   - No
   - Yes, but only above the knee
   - Yes, but only below the knee
   - Both above and below the knee

7. **Do you have purple discoulouration caused by tiny blood vessels in the skin, in association with your varicose veins?**

   *(Please tick one box for each leg)*
   - R Leg
   - L Leg
   - No
   - Yes

8. **Do you have a rash or eczema in the area of your ankle?**

   *(Please tick one box for each leg)*
   - R Leg
   - L Leg
   - No
   - Yes, but it does not require any treatment from a doctor or district nurse
   - Yes, and it requires treatment from my doctor or district nurse
9. Do you have a skin ulcer associated with your varicose veins? (Please tick one box for each leg)

<table>
<thead>
<tr>
<th>R Leg</th>
<th>L Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

10. Does the appearance of your varicose veins cause you concern? (Please tick one box)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, their appearance causes me slight concern</td>
<td></td>
</tr>
<tr>
<td>Yes, their appearance causes me moderate concern</td>
<td></td>
</tr>
<tr>
<td>Yes, their appearance causes me a great deal of concern</td>
<td></td>
</tr>
</tbody>
</table>

11. Does the appearance of your varicose veins influence your choice of clothing including tights? (Please tick one box)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Occasionally</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td></td>
</tr>
</tbody>
</table>

12. During the last two weeks, have your varicose veins interfered with your work/housework or other daily activities? (Please tick one box)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I have been able to work but my work has suffered to a slight extent</td>
<td></td>
</tr>
<tr>
<td>I have been able to work but my work has suffered to a moderate extent</td>
<td></td>
</tr>
<tr>
<td>My veins have prevented me from working one day or more</td>
<td></td>
</tr>
</tbody>
</table>

13. During the last two weeks, have your varicose veins interfered with your leisure activities (including sport, hobbies and social life)? (Please tick one box)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, my enjoyment has suffered to a slight extent</td>
<td></td>
</tr>
<tr>
<td>Yes, my enjoyment has suffered to a moderate extent</td>
<td></td>
</tr>
<tr>
<td>Yes, my veins have prevented me taking part in any leisure activities</td>
<td></td>
</tr>
</tbody>
</table>
Scoring Grid AVVQ Question 1
### Recoding the Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Left Leg</th>
<th>Right Leg</th>
<th>Maximum score per question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Score per box</td>
<td>0.172</td>
<td>0.172</td>
<td>22.016</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3.624</td>
</tr>
<tr>
<td></td>
<td>0.500</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.812</td>
<td>1.812</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2.437</td>
</tr>
<tr>
<td></td>
<td>0.812</td>
<td>0.812</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.625</td>
<td>1.625</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.437</td>
<td>2.437</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2.437</td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>1.000</td>
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</tr>
<tr>
<td></td>
<td>3.998</td>
<td>3.998</td>
<td></td>
</tr>
</tbody>
</table>

*Due to rounding errors the maximum possible score does not reach 100. The final score is calculated by summing scores for individual questions, dividing by the maximum possible and multiplying by 100.
9.6 Appendix 6. Short Form 12 Questionnaire
Your Health and Well-Being

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this survey!

For each of the following questions, please tick the one box that best describes your answer.

1. In general, would you say your health is:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
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<tr>
<td>[ ] 1</td>
<td>[ ] 2</td>
<td>[ ] 3</td>
<td>[ ] 4</td>
<td>[ ] 5</td>
</tr>
</tbody>
</table>

2. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

   a. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
      [ ] 1 .......... [ ] 2 .......... [ ] 3

   b. Climbing several flights of stairs
      [ ] 1 .......... [ ] 2 .......... [ ] 3

SF-12® Health Survey © 1992-2002 by Health Assessment Lab, Medical Outcomes Trust and QualityMetric Incorporated. All rights reserved.
SF-12® is a registered trademark of Medical Outcomes Trust.
(IQOLA SF-12v2 Standard, English (United Kingdom) 8/02)
3. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accomplished less</td>
<td>▲</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>would like</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Were limited in the</td>
<td>▲</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>kind of work or</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>other activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accomplished less</td>
<td>▲</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>would like</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Did work or other</td>
<td>▲</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>activities less</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>carefully than usual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▲</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
6. **These questions are about how you feel and how things have been with you during the past 4 weeks.** For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
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<td><img src="triangle.png" alt="Triangle" /></td>
<td><img src="triangle.png" alt="Triangle" /></td>
</tr>
</tbody>
</table>


5. Did you have a lot of energy? ................................................................. □ 1 .......... □ 2 .......... □ 3 .......... □ 4 .......... □ 5


7. **During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc)?**

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="triangle.png" alt="Triangle" /></td>
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</tr>
<tr>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 4</td>
<td>□ 5</td>
</tr>
</tbody>
</table>

Thank you for completing these questions!
9.7 Appendix 7. Patient Information Leaflet for VALVV Trial
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Patient Information

VNUS Closure Fast™ Ablation versus Laser for Varicose Veins (VALVV): A Randomised Clinical Trial.

Introduction
We are currently undertaking a study in which we are investigating the treatment of varicose veins. As you have been offered treatment for your varicose veins we would like to invite you to take part in this study. We would be grateful if you could read the following information explaining why the research is being done and what your participation would involve before you make a decision. If there is any thing you are not clear about please feel free to ask any of the doctors.

Varicose Veins
Varicose veins are enlarged and swollen veins under the skin of the legs. They are a common problem affecting approximately 25% of the population. They are thought to occur because of leaky valves in the veins under the skin. Failure of the valves leads to blood flow down the veins which can lead to the characteristic appearance of varicose veins.

We still do not know exactly why some people get varicose veins and others do not. They are more common in pregnancy and people who have family members who have varicose veins may have a tendency to develop them. People who are very overweight may also have a higher chance of developing them, although this is not always the case. Varicose veins are not a dangerous problem and a large number of people experience no symptoms at all, however, for some people they can cause a great deal of concern and may lead to leg swelling, changes in the colour of the skin and discomfort such as aching and itching. In severe cases this can cause leg ulcers.

What treatments are currently available?
For many years we have been able to treat varicose veins with an operation which involves removing the vein. In the last few years new treatments which burn away the vein have been developed. These include Endovenous Laser therapy and Radiofrequency ablation.

What are Laser therapy and Radiofrequency ablation?
Laser therapy and Radiofrequency ablation have been available in the UK since 2001 and have been approved by the National Institute of Clinical Excellence as safe and effective treatments for Varicose Veins. They are available on the NHS to people who have symptoms from their varicose veins and are frequently performed as a day case procedure (you will not normally need to stay in hospital overnight). Both treatments burn away the vein with a laser or radiofrequency probe and can avoid the need for a cut in the groin. You will be provided with additional information regarding these treatments and what will happen afterwards.

The purpose of the study
Research has shown that both laser therapy and radiofrequency ablation treatments are safe and effective, maybe even more so than surgery. Because, it is not known whether there are any major differences between laser therapy and radiofrequency ablation, further research is needed. If you agree to take part in this study you will be randomised to either the laser or radiofrequency treatment group by a computer program, to ensure that the groups are the same. This means you will have an equal chance (50:50) of having either lasers, or radiofrequency treatment for your veins. You have been invited to participate in this study as we feel that either treatment is suitable for you.
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Your involvement

If you agree to participate in the study you will have either laser therapy or radiofrequency therapy for the treatment of your veins. Prior to your treatment we would like you to fill out a short questionnaire asking you about your thoughts and feelings about your vein problems. This usually takes between 5 and 10 minutes to answer. In addition, we would like to take some measurements of the blood flow in your legs (a painless test which takes about 5 minutes) and we will ask you to keep a record of pain killers that you took and the amount of discomfort you experienced after your treatment.

You will be offered an appointment 6 weeks after your operation to make sure that your wounds have healed. At this time we will perform the same measurements and ask you to complete another short questionnaire. We will invite you to attend appointments in 6 and 12 months time for a scan, and to make sure you are still happy with the treatment you have received.

In the future we may wish to contact you for additional follow up depending on the results of this study; again your participation in this will be entirely voluntary.

If you agree to participate in this study we would usually send a letter to your GP to inform them, if you do not wish this to happen please let us know. We cannot promise this study will help you but it will help to improve the treatment of varicose veins in the future.

Taking part in this trial will cause no unnecessary risk to your health, however it is possible that the follow up care you receive, including any scans, may bring a light a problem that you were not aware of. If this does occur you will be offered appropriate treatment.

What will happen to the information?

All the data collected about you will be stored confidentially and will only be available to the researchers involved in the study. The results from the study may be presented at medical meetings or in scientific journals. Your identity will not be disclosed. If you do decide to participate and would like to be informed of the results this will be arranged for you.

Do I have to take part?

Your participation in the study is entirely voluntary. We will explain to you in detail what is involved and you will be given some written information to take home. If you agree to take part we will ask you to sign a consent form. You are free to withdraw from the study at any time without giving a reason and this will not affect any treatment you receive.

What is something goes wrong?

Imperial College London holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation without having to prove that Imperial College is at fault. This does not affect your legal rights to seek compensation.

If you are harmed due to someone’s negligence, then you may have grounds for a legal action. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been treated during the course of this study then you should immediately inform the Investigator (Dr Amanda Shepherd, see contact details below).

Ethics

All NHS research is reviewed by an independent group of people called a Research Ethics Committee, to ensure that your rights and safety are protected. This study has been approved by Charing Cross Research Ethics Committee.

Thank you very much for reading this leaflet. If you have any questions about the study please feel free to contact us

Contact details

Dr. A. Shepherd - Clinical Research Fellow
02088467335
Mr. A. H. Davies - Consultant Vascular Surgeon and Chief Investigator
02088467320
4 North Department of Vascular Surgery
Charing Cross Hospital, Fulham Palace Road, W6 8RF
Email: amanda.shepherd@imperial.ac.uk

For more advice about clinical trials you may contact the Patient Advice and Liaison Service (PALS)-
02083830088 or 02083833322

The UK’s first Academic Health Science Centre incorporating St Mary’s and Hammersmith Hospitals in partnership with Imperial College London
9.8 Appendix 8. Operation Note Proforma used for Operative Data Collection
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Vein</th>
<th>Site</th>
<th>Side</th>
<th>Diameter (mm)</th>
<th>Cycles (RFA), joules (EVLA)</th>
<th>Watts</th>
<th>Length of Vein (mm)</th>
<th>Time (secs)</th>
<th>Tumescence (mls)</th>
<th>Number of Avulsions AK</th>
<th>Number of Avulsions BK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<td></td>
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</tbody>
</table>
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

All interventions were carried out under general anaesthesia in an operating theatre by one of 3 surgeons experienced in both techniques. For both techniques the GSV was cannulated at (or as near as possible to) the most distal point of venous reflux and the catheter tip was positioned 2 cm from the saphenofemoral junction under ultrasound guidance. Standardised tumescent anaesthesia (50ml 1% lidocaine + 1:200,000 adrenaline in 1000mls of normal saline) was infiltrated along the length of the vein under ultrasound guidance. In patients treated with segmental RFA, the first segment was treated with 2 RFA cycles as per manufacturer’s instructions and the remainder of the vein was treated with one RFA cycle per 7cm segment. Extrinsic pressure was applied over the vein during treatment cycles. In patients receiving EVLA, the laser was continually withdrawn with the aim of delivering >60 j/cm energy to the vein wall, with a power setting of 11W. Patients with additional small saphenous or anterior thigh vein incompetence were treated with the allocated treatment modality at the same sitting. Patients with varicosities were treated with concomitant phlebectomies using a standard technique with an Oesch hook and all phlebectomy sites were sutured with 6,0 prolene. Tumescent anaesthesia was not used for phlebectomy incisions. The patency of the deep veins was checked in all patients using ultrasound in the operating theatre immediately after the procedure by the operating surgeon. Following treatment a crepe bandage was applied for at least 2 hours, which was replaced with a thrombo-embolic deterrent (TED) stocking prior to discharge. Patients were instructed to wear the TED stocking continuously for 1 week. On induction of anaesthesia, all patients received thromboprophylaxis consisting of 5000 units of subcutaneous heparin and a prophylactic antibiotic regimen of amoxicillin 1g and flucloxacillin 1g. All patients were discharged with a supply of paracetamol (1g up to 4 times a day) and ibuprofen (400mg up to 3 times a day) and instructed to take them only if required. All patients were also provided with a written information sheet advising them to mobilise as much as possible following the procedure and to return to work and normal activities as soon as they felt able.
9.10 Appendix 10. Raw Data of Baseline and Post-Procedure AVVQ, VCSS, SF12 Scores
### Results for Analysis of Covariance (ANCOVA) of change in AVVQ score between randomised groups

<table>
<thead>
<tr>
<th></th>
<th>AVVQ Mean (SD)</th>
<th>RFA group N=67</th>
<th>EVLA group N=64</th>
<th>Crude difference * [95% CI] P-value</th>
<th>Adjusted difference # [95% CI] P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td>20.6 (9.4)</td>
<td>18.9 (9.8)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>6 weeks</strong></td>
<td></td>
<td>10.9 (9.2)</td>
<td>10.8 (8.9)</td>
<td>-0.26 [-3.11 to +2.58] 0.854</td>
<td>+0.33 [-2.70 to +3.37] 0.828</td>
</tr>
<tr>
<td><strong>6 months</strong></td>
<td></td>
<td>10.2 (9.4)</td>
<td>10.9 (8.7)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Change in Score at 6 weeks</strong></td>
<td></td>
<td>-9.9 (9.4)</td>
<td>-9.3 (8.7)</td>
<td>-1.55 [-4.43 to +1.32] 0.286</td>
<td>-1.56 [-4.59 to +1.46] 0.308</td>
</tr>
<tr>
<td><strong>Change in Score at 6 months</strong></td>
<td></td>
<td>-10.9 (9.2)</td>
<td>-8.5 (8.1)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Values are mean(S.D) unless indicated otherwise; values in parentheses are 95 per cent confidence intervals.

†Adjusted for baseline value. ‡Adjusted for baseline value as well as age, sex, body mass index of 30 kg/m² or above, Venous Clinical Severity Score (VCSS) in the randomized leg (as a measure of severity of varicose vein disease), pattern of disease (great saphenous vein (GSV) versus GSV and small saphenous vein; great saphenous vein (GSV) versus GSV and small saphenous vein), length of vein ablated, number of phlebectomies (above or below knee), presence of deep vein disease and unilateral versus bilateral disease. RFA, radiofrequency ablation; EVLA, endovenous laser ablation; AVVQ, Aberdeen Varicose Vein Questionnaire.
# Results for Analysis of Covariance (ANCOVA) of change in SF-12 physical summary score

<table>
<thead>
<tr>
<th>SF-12 PSS Mean (SD)</th>
<th>RFA group N=67</th>
<th>EVLA group N=64</th>
<th>Crude difference * [95% CI]</th>
<th>Adjusted difference # [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 weeks</td>
<td>48.9 (9.5)</td>
<td>48.1 (10.1)</td>
<td>-0.16 [-3.34 to +3.02]</td>
<td>-0.93 [-4.26 to +2.40]</td>
</tr>
<tr>
<td>6 months</td>
<td>50.7 (8.7)</td>
<td>53.1 (7.3)</td>
<td>0.19</td>
<td>0.580</td>
</tr>
<tr>
<td></td>
<td>51.7 (9.3)</td>
<td>51.4 (9.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Score at 6 weeks</td>
<td>+2.9 (8.7)</td>
<td>+3.4 (7.9)</td>
<td>+0.29 [-3.32 to +3.89]</td>
<td>+1.60 [-2.01 to +5.21]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.875</td>
<td>0.380</td>
</tr>
<tr>
<td>Change in Score at 6 months</td>
<td>+3.4 (13.2)</td>
<td>+3.3 (14.4)</td>
<td>-0.16 [-3.33 to +3.02]</td>
<td>-0.93 [-4.26 to +2.40]</td>
</tr>
</tbody>
</table>

*Values are mean(S.D) unless indicated otherwise; values in parentheses are 95 per cent confidence intervals.

†Adjusted for baseline value.
‡Adjusted for baseline value as well as age, sex, body mass index of 30 kg/m² or above, Venous Clinical Severity Score (VCSS) in the randomized leg (as a measure of severity of varicose vein disease), pattern of disease (great saphenous vein (GSV) versus GSV and small saphenous vein), length of vein ablated, number of phlebectomies (above or below knee), presence of deep vein disease and unilateral versus bilateral disease. RFA, radiofrequency ablation; EVLA, endovenous laser ablation; SF-12® Short Form 12; PCS, physical component score; MCS, mental component score.

# Results for Analysis of Covariance (ANCOVA) of change in SF-12 mental summary score

<table>
<thead>
<tr>
<th>SF-12 MSS Mean (SD)</th>
<th>RFA group N=67</th>
<th>EVLA group N=64</th>
<th>Crude difference * [95% CI]</th>
<th>Adjusted difference # [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 weeks</td>
<td>47.1 (11.0)</td>
<td>48.0 (13.1)</td>
<td>+2.35 [-2.27 to +6.97]</td>
<td>+1.84 [-3.27 to +6.95]</td>
</tr>
<tr>
<td>6 months</td>
<td>50.4 (9.5)</td>
<td>51.3 (9.9)</td>
<td>0.316</td>
<td>0.476</td>
</tr>
<tr>
<td></td>
<td>49.0 (10.8)</td>
<td>52.4 (8.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Score at 6 weeks</td>
<td>+4.2 (13.3)</td>
<td>+2.5 (10.1)</td>
<td>-3.41 [-7.25 to +0.42]</td>
<td>-3.78 [-8.03 to +0.46]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.081</td>
<td>0.080</td>
</tr>
<tr>
<td>Change in Score at 6 months</td>
<td>+0.9 (14.2)</td>
<td>+4.7 (14.6)</td>
<td>-3.41 [-7.25 to +0.42]</td>
<td>-3.78 [-8.03 to +0.46]</td>
</tr>
</tbody>
</table>

*Values are mean(S.D) unless indicated otherwise; values in parentheses are 95 per cent confidence intervals.

†Adjusted for baseline value. Adjusted for baseline value as well as age, sex, body mass index of 30 kg/m² or above, Venous Clinical Severity Score (VCSS) in the randomized leg (as a measure of severity of varicose vein disease), pattern of disease (great saphenous vein (GSV) versus GSV and small saphenous vein), length of vein ablated, number of phlebectomies (above or below knee), presence of deep vein disease and unilateral versus bilateral disease. RFA, radiofrequency ablation; EVLA, endovenous laser ablation; SF-12® Short Form 12; PCS, physical component score; MCS, mental component score.
9.11 Appendix 11. SQOR-V Questionnaire and Scoring Algorithm
Dear Patient,

We would like to learn more about the effects your leg problems are having on your personal and professional life. Below you will find a number of situations, symptoms, sensations, and discomforts that you may or may not experience, and that may make your daily life more or less difficult. Please answer the question related to each stated situation, symptom, sensation, or discomfort. For each question, there are five possible answers. Please answer as spontaneously as possible.

Gender: ☐ male  ☐ female  Year of birth:  ☐ ☐ ☐ ☐

Are you employed:  ☐ yes  ☐ no
If yes, does your job require prolonged standing  ☐ yes  ☐ no

Please rate the 5 following items concerning your leg problems from most concerning (1) to least concerning (5):

- Discomfort / pain
- Appearance / Attractiveness
- Risk / threat to your health
- Restriction of movement/activities
- Emotional distress

Please evaluate the intensity of each symptom for both of your legs:

1. if you do not experience this symptom  5. if the symptom is severe
2. if the symptom is mild  4. if the symptom is extreme
3. if the symptom is moderate

<table>
<thead>
<tr>
<th>left leg</th>
<th>symptom to be evaluated</th>
<th>right leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
<td>Overall discomfort</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Pain</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Heaviness</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Itching</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Night cramps</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Swelling</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Warm or burning sensation</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Tingling</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Stinging or stabbing sensation</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Restless legs</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>Worse with heat (Improvement with</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Do your vein problems affect the overall appearance of both of your legs?

<table>
<thead>
<tr>
<th>Left leg</th>
<th>Right leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 no</td>
<td>no</td>
</tr>
<tr>
<td>2 yes, slightly</td>
<td>yes, slightly</td>
</tr>
<tr>
<td>3 yes, moderately</td>
<td>yes, moderately</td>
</tr>
<tr>
<td>4 yes, severely</td>
<td>yes, severely</td>
</tr>
<tr>
<td>5 yes, extremely</td>
<td>yes, extremely</td>
</tr>
</tbody>
</table>

Do you choose your clothing based on your vein problems?

| 1 never         | 2 rarely | 3 often | 4 usually | 5 always |

Do you choose your activities based on your vein problems?

| 1 never         | 2 rarely | 3 often | 4 usually | 5 always |

To what extent do your vein problems affect your activities?

If any of these activities are not applicable to you, simply check the "does not apply to me" box.

<table>
<thead>
<tr>
<th>Does not apply to</th>
<th>No</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>... Overall</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>... at work</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... at home</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... sport or leisure activities</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... prolonged</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... prolonged sitting</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... when walking</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... when using stairs</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... during sleep</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... social activities</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>... intimate or sexual relations</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

When do you experience the most discomfort or pain in your legs?

<table>
<thead>
<tr>
<th>No</th>
<th>Yes,</th>
<th>Yes,</th>
<th>Yes, severe</th>
<th>Yes, extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day and night</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Morning</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Middle of the</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Evening</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>At bedtime</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Have your leg problems changed in either of your legs since last year?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left leg</strong></td>
</tr>
<tr>
<td>① severe worsening</td>
</tr>
<tr>
<td>② moderate worsening</td>
</tr>
<tr>
<td>③ no change</td>
</tr>
<tr>
<td>④ moderate improvement</td>
</tr>
<tr>
<td>⑤ major improvement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluate the emotional consequences caused by your vein problems:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No</strong></td>
</tr>
<tr>
<td>Overall emotional consequences</td>
</tr>
<tr>
<td>&quot;Because of my vein problems, I am on edge.&quot;</td>
</tr>
<tr>
<td>&quot;Because of my vein problems, I am irritable&quot;</td>
</tr>
<tr>
<td>&quot;Because of my vein problems, I feel like I am a burden to&quot;</td>
</tr>
</tbody>
</table>

Overall, do your vein problems worry you?
① no  ② yes, slightly  ③ yes, somewhat  ④ yes, a lot  ⑤ yes, a great deal

Does the possible worsening of your vein disease worry you?
① no  ② yes, slightly  ③ yes, somewhat  ④ yes, a lot  ⑤ yes, a great deal

Does the possibility of your condition causing complications worry you?
① no  ② yes, slightly  ③ yes, somewhat  ④ yes, a lot  ⑤ yes, a great deal

Does it worry you that someone related to you suffers from vein disease?
① no  ② yes, slightly  ③ yes, somewhat  ④ yes, a lot  ⑤ yes, a great deal
### The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

<table>
<thead>
<tr>
<th>Item number</th>
<th>Items</th>
<th>Dimension</th>
<th>Value</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overall discomfort (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>2</td>
<td>Pain (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>3</td>
<td>Heaviness (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>4</td>
<td>Itching (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>5</td>
<td>Night cramps (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>6</td>
<td>Swelling (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>7</td>
<td>Warm or burning sensation (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>8</td>
<td>Tingling (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>9</td>
<td>Stinging or stabbing sensation (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>10</td>
<td>Restless legs (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>11</td>
<td>Worse with heat (left leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>12</td>
<td>Overall discomfort (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>13</td>
<td>Pain (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>14</td>
<td>Heaviness (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>15</td>
<td>Itching (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>16</td>
<td>Night cramps (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>17</td>
<td>Swelling (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>18</td>
<td>Warm or burning sensation (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>19</td>
<td>Tingling (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>20</td>
<td>Stinging or stabbing sensation (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>21</td>
<td>Restless legs (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>22</td>
<td>Worse with heat (right leg)</td>
<td>Discomfort</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>23</td>
<td>Overall appearance of your right leg affected by vein problems</td>
<td>Appearance</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>24</td>
<td>Overall appearance of your left leg affected by vein problems</td>
<td>Appearance</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>25</td>
<td>Vein problems impacting clothing choice</td>
<td>Appearance</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>26</td>
<td>Vein problems impacting activities choice</td>
<td>Restriction in movements</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>27</td>
<td>Overall restriction</td>
<td>Restriction in movements</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>28</td>
<td>At work</td>
<td>Restriction in movements</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>29</td>
<td>At home</td>
<td>Restriction in movements</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Impact</td>
<td>Level</td>
<td>Area</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>30</td>
<td>Sport or leisure activities</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>31</td>
<td>Prolonged standing</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>32</td>
<td>Prolonged sitting</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>33</td>
<td>When walking</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>34</td>
<td>When using stairs</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>35</td>
<td>During sleep</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>36</td>
<td>Social activities</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>37</td>
<td>Intimate or sexual relations</td>
<td>Movement</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>38</td>
<td>Overall, do your vein problems worry you?</td>
<td>Risk</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>39</td>
<td>Does the possible worsening of your vein disease worry you?</td>
<td>Risk</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>40</td>
<td>Does the possibility of your condition causing complications worry you?</td>
<td>Risk</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>41</td>
<td>Does it worry you that someone related to you suffers from vein disease?</td>
<td>Risk</td>
<td>1-5</td>
<td>Physical</td>
</tr>
<tr>
<td>42</td>
<td>Overall emotional consequences</td>
<td>Emotional problems</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>43</td>
<td>Because of my vein problems, I am on edge</td>
<td>Emotional problems</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>44</td>
<td>Because of my vein problems, I am irritable</td>
<td>Emotional problems</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
<tr>
<td>45</td>
<td>Because of my vein problems, I feel like I am a burden to others</td>
<td>Emotional problems</td>
<td>1-5</td>
<td>Psychosomatic</td>
</tr>
</tbody>
</table>
The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

Thesis related Prizes, Publications and Presentations

Prizes and Awards

International


National

1. Royal Society of Medicine Venous Forum 2010 “Randomised Trial comparing VNUS® ClosureFAST™ and Endovenous Laser Ablation: Duplex and Quality of Life Out comes at 6 months. First Prize


Publications


Oral Presentations

International Conference Presentations


The Role of Endovenous Thermal Ablation in the Treatment of Varicose Veins

National


Poster Presentation

Abstract

Objectives: A variety of endovenous therapies for the treatment of superficial venous incompetence are currently available. The aim of this study was to evaluate the prevalence of endovenous techniques used by consultant vascular surgeons in the United Kingdom.

Methods: An anonymous online survey of 16 multiple choice questions relating to the nature and provision of treatment for varicose veins was devised. Consultant members of the Vascular Society of Great Britain and Ireland were invited to participate by email.

Results: A total of 108/352 (31%) surgeons completed the survey. The majority offered surgery as the first-line treatment for primary great saphenous vein (GSV) and small saphenous vein (SSV) incompetence (69% and 74%, respectively). Endovenous procedures were offered as first-line treatment by 32/108 (29.6%) for GSV reflux, 36/51 (70.6%) surgeons performed these under local anaesthetic and 21/51 (41.2%) were performed as an outpatient procedure. The most important factor influencing treatment decisions was considered to be patient preference by 77/108 (71.3%) surgeons, although 48/61 (78.7%) respondents were restricted by primary care trusts with regard to endovenous treatments, and 33/108 (30.6%) offered different treatments to private patients.

Conclusion: Traditional surgery remains the most commonly offered treatment for patients with varicose veins. The provision of endovenous therapies varies greatly, and there are significant differences in local availability regarding these treatments.

Keywords: varicose veins; endovenous ablation; traditional surgery; survey

Introduction

Varicose veins are a common clinical problem affecting approximately 30% of the UK population. Patients seek treatment for a number of reasons ranging from cosmetic concerns to chronic venous ulceration. Traditionally, surgical treatment consists of saphenofemoral disconnection and stripping of the great saphenous vein (GSV). This is known to be effective, but may be associated with wound complications, high recurrence rates and subsequently a degree of patient dissatisfaction. In recent years, minimally invasive endovenous techniques have become increasingly popular in the United Kingdom as an alternative to traditional surgery. Previous postal surveys conducted in 2005 showed that endovenous treatments, including laser and radiofrequency ablation, were used by less than 30% of surgeons in the UK. Interestingly, over 50% of surgeons reported local referral guidelines restricting the treatment of varicose veins in 2005, and in the majority of cases the use of endovenous techniques was restricted to private practice. Foam sclerotherapy was reported to have been used by 20–42% of surgeons in postal surveys conducted in 2006 and 2007.

The aim of this study was to evaluate the prevalence of endovenous techniques used by consultant vascular surgeons in the United Kingdom.

Methods

A questionnaire consisting of 16 multiple choice questions was designed by members of Imperial
Vascular Unit at Charing Cross Hospital and an online survey was created using an academic online survey website. Consultant members of the Vascular Society of Great Britain and Ireland (VSGBI) with published email addresses were invited to participate by email. The questions related to the following: routine treatments offered to patients with varicose veins; use of venous duplex scanning; indications for re-intervention; anaesthesia and the location in which the treatment was performed; factors influencing the decision regarding treatment; the use of postoperative compression and thromboprophylaxis; restrictions imposed by primary care trusts regarding treatment of varicose veins and the nature of treatments offered in the private sector (see Appendix). All responses were anonymous. Where responses were incomplete, the number of responses received for that particular question was given as the denominator.

**Results**

A total of 352 consultant members of the VSGBI were contacted by email and invited to complete the survey; there were 108 responses, of which 80 were complete.

**Current use of endovenous treatments**

The majority of surgeons, 99/108 (91.6%), regularly performed traditional surgery for varicose veins, whereas sclerotherapy was routinely performed by 66/108 (61.1%) and endothermal procedures were frequently performed by 48/101 (48%) surgeons (endovenous laser therapy [EVLT] by 43 and radiofrequency ablation [RFA] by 11 respondents); 23/101 (23%) respondents did not offer any endovenous procedures. Traditional surgery was the most frequently performed treatment for GSV and small saphenous vein reflux (see Figure 1). Of the surgeons offering endovenous treatment, half performed concomitant phlebectomy for varicosities and half performed subsequent sclerotherapy for varicosities, if required. In patients deemed suitable for all treatment modalities, 60/108 (55.6%) surgeons performed traditional surgery, whereas 24/108 (22.2%) preferred EVLA. Radiofrequency ablation (6/108) and foam sclerotherapy (11/108) were used relatively less frequently (5.5% and 10.2%, respectively).

A total of 77/108 (71.3%) surgeons stated that patient preference was the most important factor when deciding which treatment to offer. The time taken for the procedure, cost or space considerations were considered relatively unimportant.

**Anaesthesia and location of treatment provision**

Endothermal treatments were performed in an operating theatre by 30/51 (58.8%) surgeons, with the remainder performed in an adapted outpatient clinic or outpatient theatre. Local anaesthesia was used by 36/51 (70.6%) surgeons performing endothermal treatments, whereas one surgeon used regional anaesthesia and the remaining 14/51 (27.5%) preferred general anaesthesia. Almost half the endothermal treatments (25/51, 49.0%) were performed with concomitant phlebectomy, with the intention of completing treatment in a single hospital visit.

**Thromboprophylaxis**

In total, 66/98 (67.3%) prescribed subcutaneous heparin or low molecular weight heparin and 42/98 (42.9%) advised TED stockings. Of those prescribing subcutaneous heparin, 42/66 (63.6%) would use a single dose only, 18/66 (27.3%) would prescribe it for the duration of their inpatient stay and two surgeons would routinely advise it for one week. Two surgeons prescribed subcutaneous heparin for bilateral or recurrent varicose veins only and many commented that they may alter thromboprophylaxis based on the individual risk of the patient. Four surgeons stated that they would not use pharmacoprophylaxis for patients undergoing foam sclerotherapy; however they would do so for endovenous or traditional surgery. A total of 16/98 (16.3%) did not routinely prescribe any form of thromboprophylaxis; of these 6/16 were performing surgery and foam sclerotherapy only, 6/16 were performing all treatments, 1/16 was performing EVLA and foam sclerotherapy, and 3/16 were performing surgery only.

**Postoperative management**

Postoperative compression was most frequently recommended for 7–14 days (Figure 2). Over half of the surgeons, 54/101 (53.4%), applied compression bandaging immediately following the procedure, which was replaced with TED stockings (<18 mmHg) prior to discharge (usually within 24 hours) whereas 6/101 (5.9%) replaced the bandaging with TED stockings after 24 hours. Grade I (14–17 mmHg) and grade II (18–24 mmHg) graduated compression stockings were used by 8/101 (7.9%) and 16/101 (15.8%) surgeons, respectively. Some surgeons, 14/101 (13.8%), did not use elastic compression hosiery and preferred bandaging, usually crepe, Pannelast® (Vernon Carus, Preston, UK) or Coban® (3MTM, Berkshire, UK).
There was considerable variation in regimes and duration of compression.

Following traditional surgery, only 2/108 (1.9%) surgeons would routinely perform colour duplex, whereas 30/48 (62.5%) would investigate patients with colour duplex after EVLT or RFA and 33/71 (46.5%) would do so following foam sclerotherapy. The commonest stated reason for postoperative duplex was to ensure successful ablation of the treated vein (29/38 [76.3%] following EVLA, 17/21 [81.0%] following RFA and 29/44 [65.9%] following foam sclerotherapy). Of the surgeons who performed colour duplex following treatment, 10/51 (19.6%) would re-intervene following endothermal treatments and 14/68 (20.6%) following sclerotherapy, if a patient still had truncal incompetence even in the absence of clinical symptoms. No surgeons reported that they would offer additional intervention in the absence of clinical symptoms following traditional surgery.

**Local rationing of varicose vein treatments**

Local restrictions to the provision of varicose vein treatment were reported by 48/108 (44.4%) respondents. Restrictions were imposed on 28/108 (25.9%) surgeons offering open surgery and 23/80 (28.8%) of those offering foam sclerotherapy; however, 48/80 (60.0%) and 48/61 (78.7%) surgeons reported restrictions regarding the use of EVLT and RFA, respectively. The lack of funding for endovenous equipment was given by many surgeons (28/80 35%) as the reason for not performing endovenous procedures, although the lack of theatre time, space due to pressure from other departments, the lack of a laser approved room and the fact that traditional surgery was cheaper than laser or radiofrequency were also given as reasons. When asked about the treatment of private patients, 33/108 (30.6%) surgeons stated that they would advise venous treatments that they were unable to offer in their National Health Service (NHS) practice.

**Discussion**

This online survey of consultant vascular surgeons in the UK conducted in 2008 showed that traditional surgery is still the most widely offered treatment for varicose veins, despite the apparent increasing popularity of endovenous procedures. These findings mirror the results from a recent postal survey of consultants and vascular trainees published in 2008, which reported that the majority (96%) of surgeons were performing conventional surgery, 27% were offering foam sclerotherapy, 19% were offering EVLT and 3% were offering RFA to NHS patients. However, these data appear to show a small increase in the use of endovenous therapies, compared with previous surveys, suggesting a slow movement towards newer techniques. Many surgeons who were performing endovenous treatments were favouring procedures performed under local anaesthetic and a significant number performed treatments on an
outpatient basis. Although this survey asked which treatments surgeons were able to offer and why, it did not investigate the patients’ perspectives. Research has shown that patients generally have little knowledge of treatment options prior to their consultation and so are likely to rely strongly on the opinion of the physician at their initial consultation, which will undoubtedly be influenced by the treatments they are able to offer. The lack of uptake of endovenous procedures may be due to the high initial costs of endovenous equipment and training, at a time when varicose vein surgery is subject to increasing scrutiny and significant funding restrictions by a large number of healthcare providers. At present, both laser and radiofrequency equipment are readily available; however, the cost of the generator and catheters varies significantly between the two. Undoubtedly, the cost-effectiveness of new therapies will be under great scrutiny prior to widespread use.

Despite reminder emails, the response rate in this survey was disappointing low. Response rates from postal surveys in the UK are extremely variable; recent postal surveys sent to both consultants and vascular trainees had significantly higher response rates, but other postal surveys have achieved similarly poor responses. Our response may be due to inaccurate or unavailable email addresses, but may also reflect a reluctance on the part of consultant vascular surgeons to engage with online surveys. Indeed, responses to previous email surveys appear to have had a poorer response rate compared with postal surveys among vascular surgeons. Research into the response rates comparing postal surveys with email/web surveys sent to medical professionals confirms that the response rate is frequently lower from electronic surveys; however, electronic surveys have been shown to result in a more rapid response at lower cost compared with postal surveys. We acknowledge that these limitations may mean that our findings are not truly representative of the entire UK practice, with enthusiastic advocates for endovenous therapies or more computer-literate surgeons potentially being more likely to respond.

At present there is no consensus regarding the nature and duration of postoperative compression that should be applied following surgical or endothermal procedures. Evidence suggests that TED stockings are adequate following foam sclerotherapy, however, compression following endothermal treatments varies widely throughout the country. This study highlighted the wide variations in practices in terms of thromboprophylaxis, postoperative compression and use of duplex imaging. Interestingly, postoperative duplex use and treatment of residual truncal reflux varied between traditional and endovenous treatments. As the prevalence of varicose veins is high, it is likely that patient demand for treatment will remain high for years to come. Each treatment modality has advantages and disadvantages, but long-term outcomes are unclear. This confusion is demonstrated by the huge variability in treatment modality, type of anaesthetic, location of therapy and postoperative management in this survey. With patient choice regarding treatment becoming ever more important, further evaluation of patient preferences regarding treatment strategy is required. Despite the introduction of minimally invasive treatments for varicose veins, traditional surgery remains the most frequently performed treatment for varicose veins in the United Kingdom and in Europe. Of the surgeons performing endovenous treatments, periproductive management varies greatly. It is clear that further clinical trials are needed to clarify some of these issues and guide clinical practice.

**Acknowledgements**

The authors would like to thank the members of the Vascular Society of Great Britain and Ireland who completed this survey.

**References**

8. Bristol Online Surveys (BOS). See www.survey.bris.ac.uk (last accessed 22 May 2009)


12 Jones TH, Hanney S, Buxton MJ. The journals of importance to UK clinicians: a questionnaire survey of surgeons. *BMC Med Inform Decis Mak* 2006;6:24


15 Beebe TJ, Locke GR III, Barnes SA, Davern ME, Anderson KJ. Mixing web and mail methods in a survey of physicians. *Health Serv Res* 2007;42(3 Pt 1):1219–34


### Appendix

<table>
<thead>
<tr>
<th>Question</th>
<th>Response options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Which of the following procedures do you routinely perform for the treatment of varicose veins? (select all that apply).</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy</td>
</tr>
<tr>
<td>2 If a patient is suitable for all four treatment modalities please rank them in order of preference (1 being most popular, 4 being least popular).</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy</td>
</tr>
<tr>
<td>3 Do you routinely perform venous duplex after the following procedures?</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy</td>
</tr>
<tr>
<td>4 If you perform follow-up venous duplex, please indicate the reasons for this (please tick all that apply).</td>
<td>Quality control, Anticipation of further treatment, Other</td>
</tr>
<tr>
<td>5 Would you routinely intervene if you discovered truncal incompetence on duplex scanning in the absence of clinical recurrence after the following procedures?</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy</td>
</tr>
<tr>
<td>6 If you routinely perform endovenous laser ablation or radiofrequency ablation, please indicate which is your usual location?</td>
<td>Not applicable, operating theatre, adapted clinic room, other</td>
</tr>
<tr>
<td>6a If you perform endovenous laser ablation or radiofrequency ablation, which anaesthesia do you routinely use?</td>
<td>General anaesthesia, regional anaesthesia, local/tumescent anaesthesia only</td>
</tr>
<tr>
<td>6b What is your usual treatment plan?</td>
<td>Treatment completed in a single visit, potential multiple visits, mixture of both of the above</td>
</tr>
<tr>
<td>7 Which of the following factors influence your decision regarding treatment options? (Please rank: 1 = most influential and 4 = least influential).</td>
<td>Your perception of patient preference, availability of space to perform the procedure, time taken to perform the procedure, cost</td>
</tr>
<tr>
<td>8 What is your routine method of treatment for the majority of patients with primary long saphenous vein incompetence and significant varicose veins?</td>
<td>SFJ disconnection and LSV stripping with avulsions, endovenous laser ablation and avulsions, endovenous laser ablation and sclerotherapy, radiofrequency ablation and avulsions, radiofrequency ablation and sclerotherapy, sclerotherapy alone and other (please specify)</td>
</tr>
<tr>
<td>9 What is your routine method of treatment for the majority of patients with short saphenous vein incompetence and significant varicosities?</td>
<td>SFJ ligation (without stripping) and avulsions, stripping of the SSV with avulsions, endovenous laser ablation and avulsions, endovenous laser ablation and sclerotherapy, radiofrequency ablation and avulsions, radiofrequency ablation and sclerotherapy, sclerotherapy alone and other (please specify)</td>
</tr>
</tbody>
</table>
## Appendix

<table>
<thead>
<tr>
<th>Question</th>
<th>Response options</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 After treatment, what compression treatment do you routinely offer to patients?</td>
<td>None, crepe bandage, TED stockings, compression stockings Grade 1, compression stockings Grade 2, and other (please specify)</td>
</tr>
<tr>
<td>11 For how long do you advise patients to use compression after treatment?</td>
<td>N/A, &lt;1 week, 1 week, 1–2 weeks, 2–4 weeks, up to 6 weeks and other (please specify).</td>
</tr>
<tr>
<td>12 Do you routinely use the CEAP classification?</td>
<td>Yes, No.</td>
</tr>
<tr>
<td>13 What is your routine DVT prophylaxis regimen? (select all that apply)</td>
<td>None, TED stockings, subcut heparin and other (please specify).</td>
</tr>
<tr>
<td>14 For how long do you routinely use DVT prophylaxis?</td>
<td>None, single dose, the duration of inpatient stay, 1 week, 1–2 weeks, &gt;2 weeks and other (please specify).</td>
</tr>
<tr>
<td>15 Do you have any local restrictions dictating which treatments you are able to offer? Please give brief reasons.</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy</td>
</tr>
<tr>
<td>16 Do you offer different treatments in the private sector where you are not restricted by NHS criteria? If yes please indicate which treatments you are able to offer patients privately that you do not offer to those under the NHS (select all that apply).</td>
<td>Surgery, endovenous laser ablation, radiofrequency ablation, sclerotherapy, other (please specify)</td>
</tr>
</tbody>
</table>

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EVT, endovenous laser therapy; RFA, radiofrequency ablation; LSV, long saphenous vein; SFJ, saphenofemoral junction; SPJ, saphenopopliteal junction; SSV, small saphenous vein; CEAP, clinical, aetiological, anatomical and pathological elements; DVT, deep vein thrombosis; NHS, National Health Service
The treatment of varicose veins: an investigation of patient preferences and expectations

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Imperial Vascular Unit, Imperial College, London

Abstract

Objectives: A number of modalities are now available for the treatment of varicose veins. The aim of the study was to investigate the factors considered important by patients when contemplating treatment of their varicose veins.

Methods: Consecutive new patients referred to a vascular surgery service were invited to complete a short anonymous questionnaire prior to their consultation. The questionnaire consisted of 13 multiple choice questions relating to symptoms, potential varicose vein treatments and patient knowledge of existing therapies.

Results: Of 111 patients, there were 83 complete responses (75%). Symptoms of pain or aching were reported as moderate or severe by 77/103 (75%) of patients and significantly limited the activities of 47/101 (47%). Although the majority (89/103 [86%]) of patients were aware of surgery, only 52/103 (51%) knew of the existence of endothermal ablation (either laser or radiofrequency) and only 23/103 (22%) were aware of foam sclerotherapy. Some 58/92 (63%) were in favour of local anaesthetic treatment. Most patients (74/103, 72%) felt inadequately informed to express a preference regarding treatment type prior to their consultation, although 24/103 (23%) expressed a preference for endovenous treatment. Interestingly, 74/92 (80%) stated that the opinion of their vascular surgeon would be likely to or definitely influence their treatment decision and the majority of patients stated that what they had read in magazines (54/80, 64%) or on the Internet (51/85, 60%) would have no influence on their decision regarding treatment, respectively.

Conclusion: Only a minority of patients referred with varicose veins were aware of endovenous treatments or felt adequately informed to express a treatment preference prior to consultation. Over half of patients expressed a preference for local anaesthetic therapy and a preference for a single visit treatment, although most would be strongly influenced by the opinion of their vascular surgeon and not influenced by media advertising.

Keywords: patient perspective; varicose veins; endovenous ablation; questionnaire study

Introduction

Varicose veins are thought to affect up to 40% of the UK population and become increasingly common with age.1 Patients may seek treatment for a number of reasons. Some have purely cosmetic complaints, but most report a wide variety of commonly experienced physical symptoms, although proving a causal relationship between symptoms and varicose veins remains difficult.1,2

Approximately 90,000 procedures are performed annually in the UK for varicose veins,3 with the majority of patients treated with traditional surgery.4–6 However, traditional surgery may be associated with significant complications, high recurrence rates7 and considerable patient dissatisfaction.8,9 The clinical benefits and cost-effectiveness of treating both complicated and uncomplicated varicose veins have been well documented.10–12 However, recent surveys have suggested that over 50% of surgeons have...
restrictions limiting who they are able to treat and the treatments they can provide.\textsuperscript{4,6,13} Differences in the referral guidelines in primary care trusts consequently means that the management of varicose veins varies widely throughout the country.\textsuperscript{13,14}

The introduction of minimally invasive endovenous techniques offers the prospect of treatment under local anaesthetic, potentially performed as an office-based procedure in order to allow quicker treatment times and rapid return to normal activities. Endovenous therapies are associated with significant consumable costs, although these may be outweighed by the perceived advantages of quicker treatment and rapid return to work. It has been suggested that endovenous treatments may be no more expensive than traditional superficial venous surgery if treatment times and recovery periods are taken into account,\textsuperscript{15} although studies of cost-effectiveness are scarce. Early outcomes following endovenous ablation are promising, meaning that choosing between different treatment modalities has become increasingly difficult. Consideration of patient preferences may help decide which treatments are best for individual patients.\textsuperscript{16} Indeed, it has been shown that most patients want to have an active role in their care and that patient involvement is important in order to ensure sustainable, effective and efficient health care.\textsuperscript{17}

The aim of the study was to evaluate patient knowledge of varicose vein treatments and assess the factors that patients considered to be important when contemplating therapy.

**Methods**

The study was set within a vascular surgical clinic in a teaching hospital (Charing Cross Hospital, London). General practitioner referral letters were scrutinized to identify patients who would be considered for treatment of their varicose veins. Consecutive patients referred to one consultant surgeon with symptomatic varicose veins were invited to complete an anonymous questionnaire prior to their consultation with the vascular surgeon. Questions related to occupation, physical symptoms and impact of the varicose veins, patient knowledge of existing treatments, concerns about complications and recurrence, preferred treatment options and factors that might influence decisions regarding treatment (Appendix 1). No information was given to patients prior to completing the survey. Where questions were not completed by every participant, the number of complete responses for that question is shown as the denominator.

**Results**

Over a six-month period, 111 patients were invited to complete the questionnaire. A total of 83 (75%) complete and 28 partially complete responses were received. The number of patients who completed each question is given as the denominator, and therefore varies for each question. A total of 80/109 (73%) of patients were female, two patients did not state their gender, 43/108 (40%) were full-time employees, 19/108 (17%) were part-time employees and 46/108 (43%) were not employed. Ages ranged between 18 and 83, with the majority of patients 79/111 (72%) aged between 18 and 60 years. Reported co-morbidities included hypertension 18/111 (16%); previous deep vein thrombosis 8/111 (7%); asthma 5/111 (5%); diabetes 4/111 (4%); epilepsy 2/111 (2%); chronic obstructive pulmonary disease 2/111 (2%); ischaemic heart disease 2/111 (2%) and transient ischemic attacks 1/111 (1%). The remaining 61% reported no co-morbidities.

**Reasons for seeking treatment and time of treatment**

Moderate or severe symptoms of pain or discomfort were reported by 77/103 (75%) (Figure 1). The appearance of varicosities moderately or severely affected 75/97 (77%) patients and was the outcome of most concern in 19/95 (20%) patients (Figure 2). There was no apparent trend in the symptoms reported and employment status (Figure 3). The majority of patients 54/96 (56%) were not concerned about taking time off work for treatment. Of these, 35/54 (65%) were not employed, 11/54 (20%) were employed full time and 8/54 (15%) were employed part-time. However, discomfort after treatment and recurrence of varicose veins were greater concerns for patients (Figure 4).

**Location and anaesthesia**

Although 23/102 (22%) of patients expressed a preference for office-based/outpatient treatment, 65/102 (64%) had no location preference. In response to the statements ‘I would prefer my treatment to be carried out in a single visit rather than several separate visits’ and ‘I would prefer my treatment to be carried out under local anaesthetic rather than general anaesthetic’, the majority expressed a...
preference for a single visit and for local anaesthetic (Table 1). Of these, 30/90 (33%) stated that the type of anaesthetic would have no influence on their choice of treatment.

**Awareness of treatments and patient preferences**

The majority of patients were aware of surgery (89/103, 89%), although far fewer were aware of endovenous techniques (Figure 5a). Most patients stated that they did not know enough about the treatments to express a preference (74/103, 72%). However, 24/103 (23%) expressed a preference for endovenous treatments over surgery (either endovenous laser ablation, radiofrequency ablation or sclerotherapy) and of the endovenous treatments, laser was the most popular (Figure 5b). There were no apparent trends in treatment preference according to occupational status; however, 10/43 (23%) of patients employed full time, 4/18 (22%) of those employed part-time and 10/41 (24%) of those not employed expressed a preference for endovenous treatments, respectively.

**Factors influencing patient decisions**

Some 74/92 (80%) stated that their treatment decision would be influenced by the opinion of their vascular surgeon. Regarding the number of visits required for treatment, 30/88 (34%) of patients stated that it would have no effect on their choice of treatment, 29/88 (33%) said that it may influence their choice of treatment and only 9/88 (10%) said it would definitely affect their choice of treatment. Similarly 30/90 (33%) patients stated that the type of anaesthesia would have no effect on their choice of treatment, with only 13/90 (14%) stating that it would definitely affect their choice of treatment.

Although some patients expressed preferences about anaesthesia and the number of visits required, these were far less likely to influence decisions about treatments. Interestingly, previous experience of
varicose vein treatment was reported to have no influence on decisions regarding future therapy by nearly half of patients 38/83 (46%). Furthermore, most patients stated that what they had read in magazines or the Internet would have no influence on their treatment decision (Figure 6).

**Discussion**

This study demonstrated that most patients referred with varicose veins have little knowledge of the available treatment options. Most were aware of surgery, but far fewer were aware of minimally invasive procedures. The findings in this study indicate that the majority of patients rely strongly on advice and opinions given by the vascular surgeon at the initial consultation. Interestingly, the majority of patients stated that information in magazines, Internet or in the media would have no influence on their decision regarding treatment. Most respondents expressed some preference towards having treatment under local anaesthetic, but also would prefer treatment to be completed in a single visit, which is often impossible, particularly for patients with bilateral disease or large numbers of varicosities. Patients appeared to be divided as to which factors were more important to them. Some patients do have specific treatment preferences, which may be related to their occupation, concerns regarding cosmesis or previous experience; however, the prospect of minimal discomfort and rapid return to normal activities is understandably attractive to all patients.

As the majority of patients in this study had little or no knowledge of varicose vein treatments, the importance of providing suitable verbal and non-verbal information at the initial consultation is clear, in order that informed consent be gained for
procedures. Despite this, a survey of ordinary members of the vascular society conducted in 2006 suggested that 70% of surgeons would give verbal information about potential treatment options for varicose veins to patients at an outpatient consultation and only 53% would also give some form of written information. Of the written information given, only 62% and 65% gave specific treatment details or details about complications, respectively, and less than 10% of patients would be referred to online information resources.13 A recent investigation of the information available to patients with varicose veins on the Internet found that less than 50% of websites discussed all treatment options and many failed to warn of potential complications.18 Ideally, patients should be provided with information about all potential treatment options, including the advantages and disadvantages, even if they are not available at that particular hospital, and should be allowed to express a preference as to where they are treated.

Recommendations published by NICE in 2001 stated that varicose vein surgery should not be provided solely for cosmetic reasons.19 However, in 2006, 20% of surgeons reported that they were still permitted by their primary care trust to offer treatment for cosmetic varicose veins.13 In terms of treating varicose veins, the most cost-effective procedure is likely to be foam sclerotherapy.20 However, with recurrence of varicosities stated as being one of the most concerning issues for many patients, in addition to cosmetic concerns, and with many

<table>
<thead>
<tr>
<th>Patients preferring a single visit for treatment (n = 93)</th>
<th>Agree strongly (%)</th>
<th>Agree moderately (%)</th>
<th>I do not mind (%)</th>
<th>Disagree moderately (%)</th>
<th>Disagree strongly (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients preferring treatment under local anaesthetic (n = 92)</td>
<td>37</td>
<td>26</td>
<td>31</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 1 Patient preferences regarding anaesthesia and number of visits

![Figure 5](a) Patients’ awareness of different treatment modalities; (b) Preferred treatment modalities of surveyed patients
preferring a single visit for treatment, foam sclerotherapy is unlikely to be the patients’ preferred treatment modality. A third of patients receiving foam sclerotherapy are likely to require more than one treatment in the first three months and cosmetic results and recurrence rates at present are often thought to be poorer than those achieved with traditional stripping or endovenous ablation.

This small non-validated questionnaire study provides interesting information about patient opinion regarding varicose veins in West London. However, in our group of patients, more than a quarter were over the age of 60 years, suggesting that the study population may not be representative of the rest of the United Kingdom population. Moreover, we recognize that more detailed questionnaires of larger populations may provide more robust information on preferences than this small study.

The patients perspective is becoming increasingly important and health-care professionals are encouraged to involve patients in their treatment decisions in order to improve health care. Varicose veins procedures are recognized as a highly litigious medical field and therefore adequate assessment of the patients concerns, preferences and expectations, along with adequate verbal and written information, is extremely important in order that patients have realistic expectations from their treatment. Further studies investigating the patients’ preference regarding the treatment of varicose veins are likely to be helpful in order to plan for future service provision.

This study investigated the knowledge and opinions of patients prior to consultation before they had been provided with any formal information – an area that is rarely studied. The findings suggest the majority of patients with varicose veins are unaware of potential treatment options, highlighting the need for clear communication and the provision of sufficient information for patients prior to varicose vein treatment in order to ensure informed consent. With so many potential modalities currently available for the treatment of varicose veins, patients’ concerns and preferences are clearly extremely important. Clinicians should attempt to evaluate preferences and expectations from all patients in order to ensure that the most appropriate treatment option, delivered in the correct manner, can be offered.

References


16 The Bristol Royal Infirmary Enquiry. The inquiry into the management of care of children receiving complex heart surgery at the Bristol Royal Infirmary. The Bristol Royal Infirmary Inquiry, 2001

17 Coulter A. *Engaging Patients in their Healthcare: How is the UK Doing Relative to Other Countries?* Picker Institute Europe, 2006


19 National Institute for Health and Clinical Excellence. See http://www.nice.org.uk


Appendix 1

1) Please state you age and sex

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Male</th>
<th>Female</th>
</tr>
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<tbody>
<tr>
<td>Under 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30–40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–50</td>
<td></td>
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<tr>
<td>50–60</td>
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<tr>
<td>60–70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70–80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2) Please state your occupation

3) Do you work full time or part time?

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4) Please indicate how much you are affected by the following symptoms. (please circle one option per row)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not affected</th>
<th>Slightly affected</th>
<th>Moderately affected</th>
<th>Severely affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain/ache/physical discomfort</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Appearance</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Limitation to activities</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The risk of complications</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>associated with varicose veins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5) When considering treatment for your varicose veins which of the following concerns you?
(please circle one option per row)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not concerning</th>
<th>Slightly concerning</th>
<th>Moderately concerning</th>
<th>Extremely concerning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking time off work</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Discomfort after treatment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Having a single treatment rather than multiple visits</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The risk of the problem reoccurring</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

6) Bearing in mind your current symptoms, how much time off work would you be prepared to take for varicose vein treatment?
(please choose one option)
- 1–3 days
- Up to 1 week
- 1–2 weeks
- >2 weeks
- The amount of time is not important to me

7) Which outcome following treatment is most important to you
(please rank: 1 = most important 3 = least important)
- Resolution of physical symptoms e.g. pain, aching etc
- Improved cosmetic appearance
- Reduced risk of complications related to varicose veins
8) Which of the treatments listed below for varicose veins are you aware of?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Endovenous Laser ablation</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Radiofrequency ablation</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sclerotherapy</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Other (please state)---------------------------------------------------------------

9) Which would be your preferred treatment option?
(you may indicate more than one choice if you have no preference)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>Endovenous Laser ablation</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>Radiofrequency ablation</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>Sclerotherapy</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

OR
Do not know enough to make a decision ☐

Please give brief reasons


10) Where would you prefer your treatment to be carried out?
(please choose one option)

<table>
<thead>
<tr>
<th>Location</th>
<th>Yes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In an operating theatre</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>In a specially adapted clinic room</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>I have no preference to the location</td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>
11) Please state how much you agree or disagree with the two statements below (please tick one box)

<table>
<thead>
<tr>
<th>Agree Strongly</th>
<th>Agree Moderately</th>
<th>I don’t mind</th>
<th>Disagree Moderately</th>
<th>Disagree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘I would prefer my treatment to be carried out in a single visit rather than several separate visits’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘I would prefer my treatment to be carried out under local anaesthetic, rather than general anaesthetic’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12) Do you suffer from any of the conditions below? Yes No

- Diabetes
- Previous heart attack/heart failure/angina
- Chronic breathing problems
- Asthma
- Epilepsy
- High blood pressure
- Previous blood clots in the leg or lung
- Previous stroke or mini stroke
13) Which things would influence your decision about your choice of treatment? (please circle one option per row)

<table>
<thead>
<tr>
<th>Recommendation of GP</th>
<th>No influence on my decision</th>
<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommendation of a Vascular Surgeon</th>
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<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
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</thead>
<tbody>
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<td>2</td>
<td>3</td>
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<table>
<thead>
<tr>
<th>Previous personal experience</th>
<th>No influence on my decision</th>
<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>1</td>
<td>2</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Experience of friends or relatives</th>
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<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
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<tbody>
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<td>2</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Recovery time off work</th>
<th>No influence on my decision</th>
<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of anaesthetic</th>
<th>No influence on my decision</th>
<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of visits required</th>
<th>No influence on my decision</th>
<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
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<tr>
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<td>2</td>
<td>3</td>
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</table>

<table>
<thead>
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<th>What you have read in a magazine</th>
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<th>May influence my decision</th>
<th>Likely to influence my decision</th>
<th>Would definitely influence my decision</th>
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<td>3</td>
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</tbody>
</table>

<table>
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<th>Would definitely influence my decision</th>
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<tr>
<td></td>
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</tbody>
</table>

Comments

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Pain Following 980-nm Endovenous Laser Ablation and Segmental Radiofrequency Ablation for Varicose Veins: A Prospective Observational Study

Amanda C. Shepherd, MRCS, Manj S. Gohel, MD, FRCS, Chung S. Lim, MRCS, Maher Hamish, FRCS, and Alun H. Davies, MA, DM, FRCS

Abstract
Objectives: The aim of this study was to evaluate postoperative pain following endovenous laser ablation (EVLA) and radiofrequency ablation (RFA) and identify risk factors for increased pain. Methods: Patients undergoing either segmental RFA (VNUS Closure Fast®) or EVLA (980 nm) for varicose veins completed a prospective disease-specific quality-of-life questionnaire (Aberdeen Varicose Vein Questionnaire [AVVQ]) and a diary card recording postoperative pain, return to normal activities, and return to work. Median 3- and 10-day pain scores were calculated. Results: In all, 81 patients returned diary cards (RFA = 45, EVLA = 36). Patients receiving RFA reported less postoperative pain than those receiving EVLA at 3 days (14.5 vs 25.8 mm, P = .053, Mann-Whitney U test) and 10 days (13 vs 23.3 mm, P = .014, Mann-Whitney U test) and returned to work earlier than those receiving EVLA (median 5 vs 9 days, P = .022). Conclusions: Patients treated with segmental RFA had less postoperative pain and returned to work quicker than those treated with EVLA.

Keywords
varicose veins, endovenous ablation, radiofrequency, laser, VNUS

Introduction
The introduction of novel, minimally invasive treatment modalities has revolutionized the management of superficial venous reflux over the last decade. Specifically, endothermal treatments including endovenous laser ablation (EVLA) and radiofrequency ablation (RFA) have been shown to be highly effective techniques to close refluxing venous channels. One-year occlusion rates over 90% have been consistently reported in prospective clinical studies. Other potential advantages include minimal postoperative discomfort, rapid return to work and normal activities, and potentially reduced neovascularization and varicose vein recurrence. Endovenous ablation using either EVLA or RFA may be performed using only local anesthetic (tumescence) in an outpatient or "office-based" setting, resulting in potential cost savings to health care providers and patients.

These proven benefits have contributed to a surge in popularity for endovenous treatments. Laser wavelengths of 810, 980, and 1470 nm are in common use, and the most popular RFA system is the ClosureFast segmental ablation catheter produced by VNUS Medical Technologies Inc (San Jose, California). Recent surveys of vascular surgeons have demonstrated that endovenous interventions are increasing in popularity, although the range of treatment strategies being offered is huge. As direct comparative studies of RFA and EVLA are scarce, choosing between interventions is extremely difficult, leading to huge inconsistencies in patient care between centers and clinicians. These inconsistencies are further exacerbated by the regular introduction of new-generation laser and radiofrequency generators and catheters. As anatomical measures of treatment success are excellent with both RFA and EVLA, other factors such as patient acceptance and postoperative pain may be important factors to help decide between treatments. To date, few studies have evaluated these issues.

The aim of this study was to evaluate postoperative pain in patients treated with endovenous laser and radiofrequency ablation and also to identify predictors of postoperative pain.

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Email: a.h.davies@imperial.ac.uk
Methods
Patients and Setting

Patients treated with segmental RFA or EVLA between January 1 and July 31, 2008, within the setting of a central London teaching hospital (Charing Cross Hospital) vascular surgery department were prospectively studied. All patients were invited to complete the Aberdeen Varicose Vein Questionnaire (AVVQ)\textsuperscript{12} prior to surgery, and their Clinical, Biometrical, Anatomical, Pathophysiological (CEAP)\textsuperscript{13} grade and Venous Clinical Severity Score (VCSS)\textsuperscript{14} were recorded by a clinician on the morning of their planned procedure. Demographic information and operative details were recorded prospectively.

Interventions

Patients with primary or recurrent great (GSV) or small (SSV) saphenous vein reflux confirmed on color venous duplex scanning were included. Segmental RFA was performed using the VNUS ClosureFast\textsuperscript{Fast} catheter, and EVLA was performed using a 980-nm laser generator (Biolitec EL-Ves, CeramOptec GmbH, Bonn, Germany). The specific procedure performed was dictated by the availability of the equipment and the preference of the patient. Patients requiring bilateral treatment were offered the same treatment to both legs at the same sitting. All procedures were performed by surgeons with endovascular experience of at least 100 procedures, and both RFA and EVLA were performed under general anesthesia with concomitant phlebectomies.

In brief, the technique involved cannulation of the refluxing truncal vein under ultrasound guidance at the distal extent of the refluxing vein or as close to this site as possible. The laser or radiofrequency catheter was then passed into the vein to be ablated and positioned 2 cm from the saphenofemoral or saphenopopliteal junctions. With the patient in the Trendelenburg position, tumescent anesthesia was then infiltrated around the vein (under ultrasound guidance) prior to ablation. Tumescent composition and regime were standardized for all patients. Segmental RFA involved double treatment of the most proximal venous segment to be ablated, followed by single treatments of the remaining venous segments per the manufacturer’s guidance. All procedures were performed as day case surgery. Concomitant phlebectomies were performed in all patients, using a standard technique with an Otech hook. Patients were discharged with Thrombo-embolic deterrent stockings (TED) stockings and advised to wear them for 24 hours for 1 week.

Assessment of Pain

Following treatment, patients were asked to complete a diary card for 10 days to record the level of pain (using a 100-mm visual analogue scale\textsuperscript{2}; Appendix). They were also asked to specify the day on which they were able to return to normal activities and recommence work duties. They were given stamped addressed envelopes to return completed diary cards.

Statistical Analysis

Average pain scores over 3 and 10 days were calculated and compared between treatment groups using the Mann-Whitney U test. Demographic and anatomical factors were compared between the 2 treatment groups using Chi-squared and Mann-Whitney U and \( \chi^2 \) test. To identify independent risk factors for postoperative pain after EVLA and RFA, the relevant factors were tested using a multivariate linear regression model. Specific correlations were tested using Spearman rank correlation for nonparametric data. All statistical tests were performed using Statistical Package for the Social Sciences (SPSS) v16.0 (SPSS Inc, Chicago, Illinois), and \( P \) values <.05 were considered significant.

Results

Study Population

Over the study period, 81 patients completed pain score assessments, of which 46 (57%) of 81 underwent segmental RFA and 35 (43%) of 81 were treated with EVLA. The majority of patients were female (62 of 81), the median age was 47 years (range 24-77), and 31 (38%) of 81 patients underwent bilateral procedures. Clinical, Biometrical, Anatomical, Pathophysiological scores were C3 (n = 19), C3 (n = 12), C4 (n = 13), C5 (n = 1), and C6 (n = 1) in the RFA group and C2 (n = 17), C3 (n = 13), C4 (n = 1), C5 (n = 3), and C6 (n = 1) in the EVLA group. Patient age, sex, AVVQ score, VCSS, and a number of bilateral procedures were comparable between the groups treated with RFA and EVLA (Table 1). However, the overall length of vein ablated was greater in the group treated with RFA (\( P = .005 \), Mann-Whitney U test Table 1). All patients were discharged from hospital on the same day of surgery and no immediate complications or incidences of DVT were encountered.

Pain Scores

Average reported postprocedure pain scores were highest for the first 3 days in both treatment groups (Figure 1). Median pain scores at 3 days were 14.5 mm (range 1-81) following RFA compared to 25.8 mm (range 0-88) after EVLA (\( P = .033 \), Mann-Whitney U test; Figure 2). Over 10 days, average pain scores were significantly lower after RFA (median 13 mm, range 0-68) in comparison to EVLA (median 23.3 mm, range 0-85; \( P = .014 \), Mann-Whitney U test; Figure 1). The time to return to normal activities was similar after RFA (median 3 days, range 0-11) and EVLA (median 5 days, range 0-11; \( P = .358 \), Mann-Whitney U test). However, patients in employment (n = 56) returned to work sooner after RFA (median 3, range 1-11 days) than EVLA (median 9, range 1-11 days; \( P = .02 \), Mann-Whitney U test).

Use of Analgesia

Information regarding analgesia use was available for 73 of 81 patients. Patients were prescribed paracetamol and
Table 1. Comparison of Assessed Risk Factors Between Studied Groups

<table>
<thead>
<tr>
<th>Factor Assessed</th>
<th>RFA (n = 40)</th>
<th>EVLA (n = 35)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age (years)</td>
<td>46 (26-74)</td>
<td>47 (24-77)</td>
<td>.614a</td>
</tr>
<tr>
<td>Sex (F/M)</td>
<td>11:33</td>
<td>12:27</td>
<td>1.000b</td>
</tr>
<tr>
<td>Initial AVVQ score</td>
<td>15.2 (2.5-71.5)</td>
<td>19.3 (2.7-42.3)</td>
<td>.062c</td>
</tr>
<tr>
<td>VCSS</td>
<td>4 (1-8)</td>
<td>5 (2-13)</td>
<td></td>
</tr>
<tr>
<td>Bilateral surgery</td>
<td>18/46</td>
<td>12/35</td>
<td>1.000a</td>
</tr>
<tr>
<td>Length of vein ablated (cm)</td>
<td>37 (14-133)</td>
<td>31 (10-75)</td>
<td>.003b</td>
</tr>
</tbody>
</table>

**NOTES:** AVVQ = Aberdeen Varicoce Veh Questionnaire; EVLA = endovenous laser ablation; F = female; M = male; RFA = radiofrequency ablation; VCSS = Vascular Clinical Severity Score.

* Results presented as median (range) unless stated otherwise.

a Mann-Whitney U test.
b Chi-square test.

c Chi-square test.

Figure 1. Average reported pain scores for endovenous laser ablation (EVLA: A) and radiofrequency ablation (RFA: B) over 10 days.

Ibuprofen and instructed to take them only if required. Sixteen patients (n = 11 in EVLA group, n = 5 in RFA group) chose to take their own analgesia including codeine phosphate 30 mg or tramadol 50 mg. Analgesia use was greatest over the first 3 days. Median (range) total tablets taken over 3 days were 6 (0-21) in the EVLA group compared to 5 (0-26) in the RFA group (P = .903, Mann-Whitney U test). Total median (range) number of pain killers taken over 10 days was 11 (0-28) in the EVLA group and 8 (0-59) in the RFA group (P = .474, Mann-Whitney U test). After 10 days, patients in the RFA group were also more likely to have stopped using any analgesia (66% no analgesia vs. 53% no analgesia in the EVLA group).

**Predictors of Postprocedure Pain**

A multivariate linear regression model was used to test the predictive value of the independent variables listed in Table 1. However, for both 3- and 10-day average pain scores, the regression model was found to be non-significant (P = .402, R² = .123 and P = .197, R² = .163, respectively). The total length of vein ablated did not correlate with average 3- or 10-day pain scores following RFA (Spearman coefficient - .006, P = .97 and Spearman coefficient .086, P = .572, respectively) or EVLA (Spearman coefficient .234, P = .183 and Spearman coefficient .103, P = .562, respectively).

**Energy Delivered for EVLA**

The mean (SD) energy delivered was 75.0 (10.3) J/cm of vein, with only 1 vein receiving less than 60 J/cm (54.3) and 7 veins receiving >80 J/cm. No correlation was observed between the energy delivered per centimeter and the postprocedural pain (Spearman coefficient .038, P = .837 and Spearman coefficient -.004, P = .987, at days 3 and 10, respectively).

**Discussion**

This prospective observational study demonstrated that segmental RFA is likely to be less painful than EVLA in the early postprocedure period in this cohort of symptomatic patients. A quicker return to work was also seen in employed patients treated with RFA, although the time to return to normal
activities was similar when considering the entire population. Interestingly, a wide range of pain scores were seen in both treatment groups, although no significant risk predictors of postprocedure pain were identified in this cohort. With similar anatomical success rates between the 2 techniques, differences in postprocedure pain and return to work may help clinicians to choose between these endovenous interventions.

The pain scores seen in this study mirror those obtained from previous studies using similar visual analogue pain diaries, where 3-day average pain scores of 7 ± 16 mm after RFA and 7-day average scores of 11 mm (range 4-31) after EVLA have been reported. Observed differences in postprocedure pain scores may be explained by differences in mechanism of action. Segmental RFA using the VNUS ClosureFast catheter causes venous closure by venous wall denaturing at 120°C, whereas laser ablation causes coagulative necrosis with temperatures of 1200°C to 1400°C recorded at the tip of the fiber. Endovenous laser ablation is thought to be associated with more vein wall perforations and therefore more pain and bruising. It would therefore seem logical that the length of vein ablated would correlate with postoperative pain, particularly after EVLA, although this was not supported by the results of this study. The relatively small sample sizes in this study may partly explain these findings.

Interestingly, despite no significant difference in time to return to normal activities, employed patients undergoing RFA did appear to return to work earlier than those undergoing EVLA. The potential implications are significant in terms of patient and societal costs, but it should be noted that the incidence of self-employment or nonphysical occupations was not recorded and may have contributed to these findings. We recognize that other factors may have contributed significantly to postprocedure pain, which were not assessed in this study. These include the number and location of phlebectomies, volume of tumescent anesthesia used, depth of the vein from skin, and other factors. Indeed, the low R² values in the multivariate regression models suggest that the factors assessed in this study may only contribute a small amount to postprocedure pain in these patients. These limitations should be considered when drawing conclusions from these results.

At a time when many efficacious endovenous interventions are available and patients are becoming increasingly involved in decisions about their health care, comparative studies are urgently needed. Occlusion rates alone are likely to be insufficient to distinguish between treatment modalities, as many studies have reported excellent anatomical results following traditional and endovenous therapies. Assessments of patient acceptance and early outcomes are likely to be more discerning. Cost-effectiveness must also be assessed, as few studies have evaluated the health economic considerations of endovenous therapies. Endovenous laser ablation and RFA are associated with significant capital and consumable costs, although they may prove more cost-effective, particularly if performed under local anesthetic in an “office based” setting and if time off work is taken into account.

In conclusion, this prospective study demonstrated that pain scores were low following both EVLA and segmental RFA. However, the results strongly suggest that segmental RFA using the VNUS ClosureFast catheter is associated with significantly less postoperative pain and may be associated with a quicker return to work. These results highlight the need for high-quality randomized clinical trials comparing endovenous procedures. Evaluation of patient acceptance, early benefits, long-term outcomes, and cost-effectiveness is essential to differentiate between endovenous treatment modalities and offer the optimal treatment strategy to individual patients.

Declaration of Conflict of Interests
The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding
The authors received no financial support for the research and/or authorship of this article.
Appendix

Pain Score Diary Used in This Study

Pain Score Diary

Each day please indicate how much pain you are experiencing following treatment of your varicose veins. (Please post this in the stamped addressed envelope provided or bring it to your follow-up appointment)

<table>
<thead>
<tr>
<th>Day</th>
<th>Day of surgery</th>
<th>First day after surgery</th>
<th>Second day after surgery</th>
<th>Third day after surgery</th>
<th>Fourth day after surgery</th>
<th>Fifth day after surgery</th>
<th>Sixth day after surgery</th>
<th>Seventh day after surgery</th>
<th>Eighth day after surgery</th>
<th>Ninth day after surgery</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<td></td>
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</tr>
</tbody>
</table>

Each night before going to bed please put a vertical line on the scale below to indicate how much pain you had on average during that day. If you have little or no pain mark to the left. If you have moderate or severe pain put a mark further to the right. If you had no pain please circle "No pain"


Please mark a vertical line on the horizontal line to indicate how satisfied you are with your treatment for your varicose veins.

Overall how satisfied are you with your surgery? No. 0. 10. Worst pain. Imaginator.

References

Randomized clinical trial of VNUS® ClosureFAST™ radiofrequency ablation versus laser for varicose veins


Imperial Vascular Unit, Department of Surgery, Division of Surgery and Cancer, Imperial College, Charing Cross Hospital, London, UK

Correspondence to: Professor A. H. Davies, 4 East Department of Vascular Surgery, Charing Cross Hospital, Fulham Palace Road, London W6 8RF, UK (e-mail: a.h.davies@imperial.ac.uk)

Background: Endovenous laser ablation (EVLA) and radiofrequency ablation (RFA) are both associated with excellent technical, clinical and patient-reported outcomes for the treatment of varicose veins. The aim of this study was to compare the techniques in a randomized clinical trial.

Methods: Consecutive patients with primary great saphenous vein reflux were randomized to EVLA (980 nm) or RFA (VNUS® ClosureFAST™) at a single centre. The primary outcome measure was postprocedural pain after 3 days. Secondary outcome measures were quality of life at 6 weeks, determined by the Aberdeen Varicose Vein Questionnaire (AVVQ) and Short Form 12 (SF-12®), and clinical improvement assessed by the Venous Clinical Severity Score (VCSS). Analyses were performed on the basis of intention to treat using multivariable linear regression.

Results: Some 131 patients were randomized to EVLA (64 patients) or RFA (67). Mean(s.d.) pain scores over 3 days were 26·4(22·1) mm for RFA and 36·8(22·5) mm for EVLA (P = 0·010). Over 10 days, mean(s.d.) pain scores were 22·0(19·8) mm versus 34·3(21·1) mm for RFA and EVLA respectively (P = 0·001). The mean(s.d.) number of analgesic tablets used was lower for RFA than for EVLA over 3 days (8·8(9·5) versus 14·2(10·7); P = 0·003) and 10 days (20·4(22·6) versus 35·9(29·4) respectively; P = 0·001). Changes in AVVQ, SF-12® and VCSS scores at 6 weeks were similar in the two groups: AVVQ (P = 0·887), VCSS (P = 0·993), SF-12® physical component score (P = 0·276) and mental component score (P = 0·449).

Conclusion: RFA using VNUS® ClosureFAST™ was associated with less postprocedural pain than EVLA. However, clinical and quality-of-life improvements were similar after 6 weeks for the two treatments. Registration number: ISRCTN66818013 (http://www.controlled-trials.com).

Introduction

In the past decade the introduction of minimally invasive endovenous ablation therapy has revolutionized the treatment of varicose veins. In 2001, endovenous laser ablation (EVLA) and radiofrequency ablation (RFA) were approved for use by the National Institute for Health and Clinical Excellence in the UK. Since then surveys and venous registries have shown that their use has been increasing steadily1–5. Perceived advantages over traditional surgery include fewer complications, minimal postprocedural pain6–8 and faster recovery times9,10.

Theoretically, the reduced incidence of neovascularization in the groin may also result in lower recurrence rates in years to come11. The majority of patients with primary varicose veins have great saphenous vein (GSV) incompetence that is amenable to endovenous thermal ablation12. With evidence to suggest that patients are concerned about recovery times and recurrence rates13, the appeal of endovenous interventions is understandable.

A wide range of endovenous laser wavelengths and fibres are now available, although the 980-nm wavelength and bare fibre are used most widely in the UK at present8. The most popular RFA system is the VNUS® ClosureFAST™
(VNUS Medical Technologies, San Jose, California, USA) segmental ablation catheter, which has superseded earlier continuous-withdrawal catheters. Although a number of studies have compared RFA or EVLA with traditional superficial venous surgery, studies comparing EVLA with RFA are scarce and findings have been inconclusive. To date, only one small randomized trial comparing VNUS® ClosureFAST™ and EVLA has been published. The aim of the present study was to compare early outcomes following EVLA 980 nm and segmental RFA in a randomized study.

Methods

Consecutive adults presenting to one vascular specialist were screened for suitability for the trial. All patients underwent Colour duplex ultrasonography (Philips iU22, Andover, Massachusetts, USA) and patients over 18 years of age with primary GSV incompetence were invited to participate. All scans were performed by an accredited vascular scientist and reflux was defined as retrograde flow of more than 0.5 s after calf compression. Patients with current deep vein thrombosis (DVT), significant arterial disease (ankle:brachial pressure index below 0.5) or who were unsuitable for general anaesthesia were excluded.

Treatment allocation

Consenting patients were randomized to either VNUS® ClosureFAST™ (RFA) or 980-nm laser (EVLA) using a bare fibre, using an internet randomization service. In patients with bilateral GSV incompetence, the leg that was more symptomatic according to the patient was randomized and the same treatment was performed on both legs. All patients were blinded to treatment allocation; however, for practical reasons, assessors were not blinded. Ethical approval for the study was granted by Charing Cross Research Ethics Committee (reference 08/H0711/19) and the trial was registered with Current Controlled Trials (ISRCTN66818013).

Interventions

All interventions were carried out under general anaesthesia in an operating theatre by one of three surgeons experienced in both techniques. For both techniques, the GSV was cannulated at, or as near as possible to, the most distal point of venous reflux, and the catheter tip was positioned 2 cm from the saphenofemoral junction under ultrasonographic guidance. Standard tumescent local anaesthesia (50 ml 1 per cent lidocaine with 1:200 000 adrenaline (epinephrine) in 1000 ml normal saline) was infiltrated along the length of the vein under ultrasonographic guidance. In patients treated with segmental RFA, the first segment was treated with two RFA cycles according to the manufacturer’s instructions, and the remainder of the vein was treated with one RFA cycle per 7-cm segment. Extrinsic pressure was applied over the vein during treatment cycles. In patients who had EVLA, the laser was continually withdrawn with the aim of delivering energy greater than 60 J/cm to the vein wall, with a power setting of 11 W. Patients with additional small saphenous or anterior thigh vein incompetence were treated with the allocated treatment modality at the same sitting. Patients with varicosities were treated with concomitant phlebectomy using a standard technique with an Oesch hook and all phlebotomy sites were sutured with 6/0 polypropylene. Tumescent anaesthesia was not used for phlebotomy incisions.

In all patients the patency of the deep veins was checked by the operating surgeon using duplex ultrasonography in the operating theatre immediately after the procedure. After treatment, a crepe bandage was applied for at least 2 h, and was replaced with a thromboembolic deterrent (TED) stocking before discharge. Patients were instructed to wear the TED stocking continuously for 1 week. On induction of anaesthesia, all patients received thromboprophylaxis consisting of 5000 units subcutaneous unfractionated heparin sodium and prophylactic antibiotics: amoxicillin 1 g and flucloxacillin 1 g. All patients were discharged with heparin sodium and prophylactic antibiotics: amoxicillin 1 g and flucloxacillin 1 g. All patients were provided with a written information sheet advising them to mobilize as much as possible after the procedure, and to return to work and normal activities as soon as they felt able.

Outcomes assessed and follow-up protocol

All patients were asked to complete the Aberdeen Varicose Vein Questionnaire (AVVQ), a validated disease-specific quality-of-life questionnaire for varicose veins, and the Short Form 12 (SF-12®; Medical Outcomes Trust, Waltham, Massachusetts, USA) to assess generic quality of life before the procedure, and the Clinical Etiologic Anatomic Pathophysiologic (CEAP) class and Venous Clinical Severity Score (VCSS) were recorded by a clinician. Patients were assessed at 10 days and 6 weeks. Patients were given a diary card with a 100-mm visual analogue scale to record postprocedural pain each day for 10 days. They were also asked to record any analgesic drugs taken, and the time taken to return to normal activities and
work, if applicable. The primary outcome measure was mean postprocedural pain over the first 3 days. Patients were invited to attend follow-up after 6 weeks, when quality of life was assessed using the AVVQ and SF-12. The VCSS was also assessed and any complications at 1 and 6 weeks were recorded. Assessment of vein occlusion rates 6 months after the intervention will be undertaken and reported separately. Duplex imaging was not otherwise performed unless a patient presented with symptoms suspicious of DVT.

Sample size calculation

Power calculation was based on the primary outcome measure of postprocedural pain after 3 days using data from a published departmental cohort study and the published literature. The calculation was based on detection of a 20-mm difference in pain scores over the first 3 days with a standard deviation of pain score of 20 mm. To attain 90 per cent power at the 5 per cent significance level, a minimum target sample size of 47 legs per group was required. This number allowed for 10 per cent non-compliance in the randomized group and 20 per cent dropout at 6 weeks.

**Statistical analysis**

All analyses were performed according to a predefined analysis plan using Stata® software version 10.0 (StataCorp, College Station, Texas, USA) on the basis of intention to treat. As the trial was relatively small, Student’s t and χ² tests were used to compare baseline characteristics between groups in order to check whether any differences had occurred by chance. The distribution of continuous

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**Fig. 1** CONSORT diagram for the trial
Radiofrequency ablation versus laser for varicose veins

Table 1 Comparison of baseline patient characteristics in a trial comparing two treatments for varicose veins

<table>
<thead>
<tr>
<th></th>
<th>RFA (n = 67)</th>
<th>EVLA (n = 64)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex ratio (F : M)</td>
<td>47 : 20</td>
<td>42 : 22</td>
<td>0.579‡</td>
</tr>
<tr>
<td>Age (years)*</td>
<td>49(15)</td>
<td>48(16)</td>
<td>0.540†</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>&lt; 30</td>
<td>61 (91)</td>
<td>0.334‡</td>
</tr>
<tr>
<td></td>
<td>≥ 30</td>
<td>6 (9)</td>
<td></td>
</tr>
<tr>
<td>VCSS*</td>
<td>5.1(2.1)</td>
<td>4.7(2.1)</td>
<td>0.278†</td>
</tr>
<tr>
<td>AVVQ*</td>
<td>20(4-9)</td>
<td>19(9-5)</td>
<td>0.412†</td>
</tr>
<tr>
<td>CEAP class</td>
<td>C1–C2</td>
<td>23 (34)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C3–C4</td>
<td>36 (56)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C5–C6</td>
<td>5 (7)</td>
<td></td>
</tr>
<tr>
<td>Deep vein disease</td>
<td>Yes</td>
<td>13 (19)</td>
<td>0.178‡</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>54 (81)</td>
<td></td>
</tr>
<tr>
<td>Pattern of disease</td>
<td>GSV</td>
<td>54 (81)</td>
<td>0.727‡</td>
</tr>
<tr>
<td></td>
<td>GSV and small saphenous vein</td>
<td>50 (78)</td>
<td></td>
</tr>
<tr>
<td>Unilateral or bilateral disease</td>
<td>Unilateral</td>
<td>13 (19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bilateral</td>
<td>36 (54)</td>
<td>0.433‡</td>
</tr>
<tr>
<td>Procedural parameters</td>
<td>Length ablated (cm)*</td>
<td>49(16)</td>
<td>0.177†</td>
</tr>
<tr>
<td></td>
<td>Total no. of phlebectomies above or below knee*</td>
<td>6.2(4.0)</td>
<td>0.945†</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages unless indicated otherwise; *values are mean(s.d.). RFA, radiofrequency ablation; EVLA, endovenous laser ablation; VCSS, Venous Clinical Severity Score; AVVQ, Aberdeen Varicose Vein Questionnaire; CEAP, Clinical Etiologic Anatomic Pathophysiologic; GSV, great saphenous vein. ‡Student’s t test; †χ² test.

variables was checked using normal plots, with transformation of any skewed variables. Postprocedural pain scores were analysed using linear regression with two levels of adjustment. Primary adjustment was made for age, sex, body mass index, clinical disease severity, number of truncal veins ablated on the trial leg, total length of vein ablated on the trial leg and number of phlebectomies on the trial leg as primary adjustment. Secondary adjustment was made for all co-variables in the primary analysis as well as for the use of analgesia.

Secondary outcomes including quality of life and clinical improvements were analysed using analysis of co-variance (ANCOVA), which adjusted changes in outcome for baseline values. In addition, primary adjustment was made using the same variables as those used for the pain score analysis, and also for presence of bilateral disease and presence of deep venous incompetence.

Results

Over 12 months from July 2008 to July 2009, 313 patients were screened for inclusion in the study. A total of 171 met the eligibility criteria and were invited to participate; 131 patients consented to randomization. Of the 40 patients who declined inclusion, six expressed a preference for a particular treatment (RFA, 2; EVLA, 4). Some 128 patients were treated within 24 h of randomization; overall, patients were treated a median of 0 (range 0–48) days after randomization. One operation was cancelled owing to problems with theatre equipment, and therefore 130 patients were treated as part of this study (Fig. 1). One patient who was randomized to RFA received EVLA, owing to non-availability of RFA equipment. For patients treated with EVLA, the mean(s.d.) energy density delivered to the GSV was 71.71(12.98) J/cm.

The patients included 89 women and 42 men with a mean(s.d) age of 49(16) years. Baseline characteristics were comparable between the randomized groups (Table 1).

Primary outcome measure: pain scores

Diary cards were available for 127 patients; postprocedural pain scores after EVLA (61 patients) and RFA (66) are shown in Fig. 2. Two patients included in the analysis did not require concomitant phlebectomy, although analyses were adjusted for the number of phlebectomy incisions. Patients receiving RFA reported less pain over the first 3 days, with a mean(s.d.) pain score of 26.4(22.1) for RFA and 36.8(22.5) for EVLA (primary adjusted difference = −10.2; P = 0.012) (Table 2).
Postprocedural pain and analgesia use

Patients in the RFA group also reported less pain over the first 10 days, with mean(s.d.) scores of 22.0(19.8) for RFA and 34.3(21.1) for EVLA (primary adjusted difference = −12.8;  P = 0.001) (Table 2). Patients in the RFA group took fewer analgesic tablets than those in the EVLA group: mean(s.d.) over 3 days 8.8(9.5) tablets after RFA versus 14.2(10.7) tablets after EVLA (P = 0.003) and over 10 days 20.4(22.6) versus 35.9(29.4) tablets respectively (P = 0.001) (Fig. 3). When pain scores were adjusted for the number of analgesic tablets taken, differences between the groups were reduced and of only borderline significance (Table 2).

Secondary outcome measures

Quality of life and Venous Clinical Severity Score

Quality of life was assessed a median of 48 (interquartile range 43–54) days after intervention; data were available for 115 patients (RFA, 60; EVLA, 55). Improvements in quality of life were seen in both groups, although there were no significant differences between the two groups in AVVQ, VCSS or SF-12 in either the physical component or mental component score (Table 3).

Return to normal activities and work

Data regarding return to normal activities were available for 62 patients after RFA and for 50 after EVLA. The majority of patients returned to normal activities within 3 days: EVLA, 25 (50 per cent) of 50 patients; RFA, 37 (60 per cent) of 62. About three-quarters of patients resumed normal activities within 7 days: EVLA, 37 (74 per cent) of 50; RFA, 48 (77 per cent) of 62. Regarding return to work, data were available for 41 patients in the RFA group and 34 in the EVLA group. Results were similar, with 15 (37 per cent) and 14 (41 per cent) patients returning to work within 3 days, and 29 (71 per cent) and 24 (71 per cent) returning to work within 7 days in RFA and EVLA groups respectively.
Radiofrequency ablation versus laser for varicose veins

Fig. 3 Number of analgesic tablets used each day after endovenous treatment for varicose veins with radiofrequency ablation (RFA) or endovenous laser ablation (EVLA)

Table 3 Analysis of co-variance for secondary outcomes after radiofrequency or endovenous laser ablation for varicose veins

<table>
<thead>
<tr>
<th></th>
<th>RFA (n = 60)</th>
<th>EVLA group (n = 55)</th>
<th>Crude difference*†</th>
<th>P</th>
<th>Adjusted difference*‡</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVVQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>20.6(9.4)</td>
<td>18.9(9.8)</td>
<td>−0.3 (−3.1, 2.6)</td>
<td>0.854</td>
<td>0.2 (−2.8, 3.2)</td>
<td>0.887</td>
</tr>
<tr>
<td>6 weeks</td>
<td>10.9(9.2)</td>
<td>10.8(8.9)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>VCSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>5.1(2.1)</td>
<td>4.7(2.1)</td>
<td>−0.1 (−0.7, 0.5)</td>
<td>0.777</td>
<td>0.0 (−0.6, 0.6)</td>
<td>0.993</td>
</tr>
<tr>
<td>6 weeks</td>
<td>1.7(1.7)</td>
<td>1.5(1.8)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>SF-12® PCS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>48.9(9.5)</td>
<td>48.1(10.1)</td>
<td>−2.6 (−0.6, 0.5)</td>
<td>0.101</td>
<td>−1.8 (−5.2, 1.5)</td>
<td>0.276</td>
</tr>
<tr>
<td>6 weeks</td>
<td>50.7(8.7)</td>
<td>53.1(7.3)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>SF-12® MCS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>47.1(11.0)</td>
<td>48.0(13.1)</td>
<td>−0.7 (−4.4, 3.0)</td>
<td>0.704</td>
<td>−1.5 (−5.4, 2.4)</td>
<td>0.449</td>
</tr>
<tr>
<td>6 weeks</td>
<td>50.4(9.5)</td>
<td>51.3(9.9)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

Values are mean(s.d.) unless indicated otherwise; †values in parentheses are 95 per cent confidence intervals. ‡Adjusted for baseline value. ††Adjusted for baseline value as well as age, sex, body mass index of 30 kg/m² or above, Venous Clinical Severity Score (VCSS) in the randomized leg (as a measure of severity of varicose vein disease), pattern of disease (great saphenous vein (GSV) versus GSV and small saphenous vein), length of vein ablated, number of phlebectomies (above or below knee), presence of deep vein disease and unilateral versus bilateral disease. RFA, radiofrequency ablation; EVLA, endovenous laser ablation; AVVQ, Aberdeen Varicose Vein Questionnaire, SF-12®, Short Form 12; PCS, physical component score; MCS, mental component score.

Complications

During the study, two major complications were observed. One patient randomized to RFA suffered a pulmonary embolus 2 weeks after intervention (the patient was treated with warfarin, although no evidence of DVT or clot extension in the leg veins was found on duplex imaging). One patient in the EVLA group developed a lymphatic leak from the cannulation site, and lymphoscintigraphy confirmed increased lymphatic collateral flow consistent with trauma at the site.

Table 4 Reported complications after radiofrequency or endovenous laser ablation

<table>
<thead>
<tr>
<th></th>
<th>RFA (n = 67)</th>
<th>EVLA (n = 64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td>4 (6)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Haematoma</td>
<td>0 (0)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Thrombophlebitis</td>
<td>5 (7)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Paraesthesia</td>
<td>8 (12)</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Staining to skin</td>
<td>6 (9)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Seroma</td>
<td>2 (3)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>1 (1)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages.
Minor complications included wound infection (4-6 per cent), haematoma (1-5 per cent), thrombophlebitis (6-1 per cent), saphenous nerve paraesthesia (9-9 per cent) and skin staining (6-1 per cent) (Table 4). Two patients in the EVLA group reported an increase in spider veins and, despite the intention to perform procedures as a day case, four patients (3-1 per cent) required overnight admission after the procedure because of nausea (RFA, 1; EVLA, 1), hypotension secondary to general anaesthesia (RFA, 1) or pain requiring opioid analgesia (RFA, 1).

Discussion

This study demonstrated that VNUS® ClosureFAST™ resulted in significantly less pain than 980-nm EVLA for varicose veins. However, reported pain and analgesia use was very variable in both groups and, interestingly, reductions in pain did not translate into faster recovery times. At 6 weeks there was no significant difference in clinical disease severity or quality-of-life scores, and the degree of improvement in the AVVQ and VCSS was similar to that reported in other randomized trials. The results of the present study support the findings of other studies that have shown less postprocedural pain after RFA16,18, but failed to show differences in outcomes after 1 month18. Discrepancies between studies may be explained by variations in procedure technique and follow-up times. In contrast to the RECOVERY trial18, minor complications including paraesthesia, thrombophlebitis and skin infections were not more prevalent in the EVLA group at any time point. One patient in the RFA group had a pulmonary embolus 10 days after the procedure. This was diagnosed and treated at a different hospital and no DVT was found in the leg veins on duplex imaging. The cause of this pulmonary embolus remains unknown; the patient had no known risk factors for thromboembolic disease at the time of surgery and remained on warfarin.

One possible explanation for the reduced pain scores following RFA may be that the controlled heating and segmental ablation technique of VNUS® ClosureFAST™ reduces the number of vein wall perforations and the extravasation of blood into the tissues; this has been shown to occur after use of the 980-nm laser in animal models and in humans. Recent research has suggested a rapid increase in the popularity of endovenous thermal ablation and this trend appears likely to continue. Patients seeking superficial venous interventions are frequently concerned about postprocedural discomfort, recovery times and recurrence. It is therefore important to provide sufficient information about all the available procedures, so that patients and physicians can reach evidence-based decisions about treatment options.

This study was sufficiently powered to evaluate postprocedural pain and both procedures were performed under identical conditions. The authors decided not to evaluate postprocedural bruising owing to difficulties in accurate quantification, and because previous studies have shown that it does not necessarily correlate with postprocedural pain or time taken to resume normal activities. Patients were blinded to treatment allocation, significantly reducing the potential for bias and allowing a direct comparison of the outcomes of the two procedures. Although the assessors were not blinded, the primary outcomes were patient reported and therefore unlikely to have been affected by the assessors. Patients also underwent concomitant phlebectomies if necessary, with the aim of completing all treatment in a single visit. This approach has been shown to be preferable for many patients, associated with improvements in clinical and quality-of-life outcomes and a reduced need for further procedures.

Limitations of the study included the fact that all procedures were performed under general anaesthesia, so that an assessment of the adequacy of the tumescence during the procedure was not possible. However, the technique of tumescent anaesthesia infiltration under ultrasonographic guidance was standardized for both procedures. Elsewhere, a significant proportion of endovenous thermal ablation procedures are performed as outpatient procedures, and even performing concomitant phlebectomy is feasible as an office-based procedure. However, this may be difficult in patients with bilateral disease or those with large numbers of varicosities. As the aim was to complete all treatments in one sitting, patients were therefore offered general anaesthesia. Moreover, the groups in this randomized study were well matched in terms of disease pattern, and analyses were adjusted for numerous variables including number of phlebectomies performed to ensure that detected differences were truly due to the ablation technique.

To date, the majority of studies have provided data supporting the short-term efficacy of EVLA and RFA, and long-term data are scarce. EVLA would appear to have better occlusion rates, of around 95 per cent, in comparison with 80 per cent for the early RFA catheters at 5 years. However, results from VNUS® ClosureFAST™ appear promising and may be superior to the original RFA in the longer term. Long-term studies of venous occlusion and recurrence are clearly required to support the durability of endovenous thermal ablation procedures.
painful than 980-nm EVLA. However, to reduce the post-procedural discomfort associated with EVLA, newer radial fibres, longer wavelengths and jacketed laser fibres have been developed. These newer techniques have been shown to be associated with low postintervention pain scores\(^ {33–36}\) and are likely to replace the 980-nm bare-tip laser fibre. Data from randomized trials supporting the use of these newer devices are awaited.

**Acknowledgements**

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**References**

23. Shepherd AC, Gohel MS, Lim CS, Hamish M, Davies AH. Pain following 980-nm endovenous laser ablation and segmental radiofrequency ablation for varicose veins: a
prospective observational study. *Vasc Endovascular Surg* 2010; [Epub ahead of print].
34 Kabnick LS. 980 nm laser versus radiofrequency for endothermal venous ablation of the GSV: are the recovery results similar? The American College of Phlebology 23rd Annual Congress, Palm Desert, California, USA. *Phlebology* 2009; (in press) (Abstract).

**Commentary**

**Randomized clinical trial of VNUS® ClosureFAST™ radiofrequency ablation versus laser for varicose veins (Br J Surg 2010; 97: 810–818)**

This was a well constructed prospective randomized trial comparing the early outcomes of radiofrequency ablation and endovenous laser ablation of the great saphenous vein. The primary outcome measure of postprocedural pain was clearly stated and the study was adequately powered with additional numbers built in for non-compliance and dropout. The findings were similar to those of the RECOVERY trial. Both studies showed that radiofrequency ablation using the VNUS® ClosureFAST™ technique caused less postoperative pain as determined by a visual analogue scale. The additional comparison of analgesic use strengthens the results; however, pain is subjective and the study would have been improved by comparing some objective features such as bruising, and by ensuring that clinicians performing the follow-up were blinded. Unlike the RECOVERY study, which compared quality of life at 2, 7, 14 and 30 days, quality of life in this study was reassessed only at 6 weeks postprocedure, and showed no difference between the groups. Unfortunately, a considerable proportion (12 per cent) of the patients were lost to follow-up at 6 weeks and, although this was built into the power calculation, one has to consider why these patients did not attend.

All patients undergoing treatment for varicose veins should receive information and advice regarding analgesia requirements and return to normal activity. Although there is no evidence that changing patient information alters patients’ choices, it is important to standardize the information given to patients in a study of this kind in order to remove bias.

This study suggests that radiofrequency ablation using the VNUS® ClosureFAST™ technique is better for patients in the short term. The longer-term clinical results are awaited eagerly.
References


2 Darwood RJ, Walker N, Bracey M, Cowan AR, Thompson JF, Campbell WB. Return to work, driving and other activities after varicose vein surgery is very variable and is influenced little by advice from specialists. Eur J Vasc Endovasc Surg 2009; 38: 213–219.