It is safe to use all inside meniscal repair devices for posteromedial meniscal 'ramp' lesions

Abstract

Purpose: Recently it has been recognized that menisco-capsular lesions of the posterior one third of the medial meniscus frequently occur during injuries causing ACL rupture, and that these lesions are easily missed at arthroscopy. Furthermore, it is clear that these lesions are biomechanically significant, adding to the deficits caused by ACL rupture, and that their repair can reverse this. The efficacy of an all-inside repair technique has been questioned by some authors and as a result they have advocated the use of an accessory posteromedial portal and a suture shuttle. We investigate the use of Ultra FastFix and FastFix 360 meniscal repair devices to repair posteromedial meniscocapsular separations as regards safe deployment and the effect of all inside repair on the mobility of the posterior joint capsule.

Methods: Twenty cadaveric fresh frozen knees were used – 10 in each of two groups. A ramp lesion was created using a Beaver knife. The lesion was then repaired with either 4 Ultra FastFix (Smith and Nephew) or 4 FastFix 360 (Smith and Nephew) meniscal repair devices. The knees were put through a standardized loading cycle consisting of 10 Lachman's tests and 10 maximum loading manual anterior drawer tests at 90 degrees of flexion. Each knee was then flexed and extended fully 10 times. The specimens were sectioned proximal to the menisci and each anchor identified and its position recorded and photographed.

Results: In the Ultra FastFix group a single anchor was found to be in an intraarticular position - a failure rate of 2.5%. In the FastFix 360 group 5 anchors failed – a 12.5% failure rate. In all cases the anchors were attached to their suture and so not truly loose within the joint.

Conclusions: This study confirms the safe deployment of an all inside repair device for these difficult lesions. All inside meniscal repair is a core skill for soft tissue knee surgeons and the authors would advocate its use. Ultra FastFix had the lower failure rate of 2.5%, which the authors believe is acceptable, and makes this device preferable to the Fast-Fix360.

Key Terms: ACL
Knee
Meniscus
Meniscal repair

Introduction

The repair of 'ramp' lesions has been advocated by multiple authors [1,2,9,11,13]. This study was designed to investigate the use of an all inside repair device for these difficult lesions. The use of all inside meniscal repair devices is a core skill for soft tissue knee surgeons unlike the use of a suture shuttle via an accessory posteromedial portal.

First described by Strobel in 1988, and Bollen in 2010 [2,16], injury to the posteromedial meniscocapsular junction ('ramp' lesion) after ACL rupture is now increasingly recognized with an incidence of up to 17% [2,9,11-13]. These lesions are often overlooked as they cannot be seen from the standard anterior to posterior view of the medial compartment of the knee. Probing whilst looking from this view is unreliable. The only way to identify the lesion with confidence is by insertion of the arthroscope into the posteromedial recess of the knee: either through a posteromedial portal or via the anterolateral portal passing the arthroscope over the ACL remnant through the intercondylar notch [12,13,15].

Li et al have advocated the use of an all-inside repair technique with suture anchors [8]. Choi et al found no difference in the healing of tears of the posterior horn of the medial meniscus with an all-inside technique or an inside-out technique [3]. However some authors have raised concerns over the efficacy of an all inside repair technique and safety: specifically implant failure and inadvertent intra-articular implant placement and the possible longer term consequences of this [5,13,14,17]. Instead the use of an accessory posteromedial portal and a suture shuttle technique has been advocated [1,7,10,13].

In a laboratory biomechanical study of the ramp lesion [15] the experimental rig used during testing precluded the use of an accessory posteromedial portal and a suture shuttle and therefore all-inside devices (FastFix 360 (Smith and Nephew, Andover, MA, USA) and Ultra FastFix (Smith and Nephew))were the only option for repair of the ramp lesion. Whilst none of the 28 Ultra Fast Fix were found within the joint, 18% of the FastFix 360 anchors were found in the joint during knee dissection at the conclusion of the study. It was not possible to determine whether the devices had not been deployed properly at the time of insertion or if

the anchors had been pulled into the knee during testing. However, the presence of some of the meniscal anchors in an intra-articular position was concerning. In the experimental setup undertaking meniscal repair on the cadaveric knees was challenging since the test rig made access to the medial compartment difficult. Furthermore, as the study focused on kinematic impact no deep MCL release, as may be performed clinically, was possible to improve access. Finally a 'learning curve' effect may also have been present since the suture anchors found in the joints were predominantly in those knees tested earliest in the study, and this factor may have influenced the success rates with the two device types, the first knees using the 360 and the later knees the Ultra anchors.

Regardless of the quality of suture device deployment, the study confirmed the biomechanical effectiveness of this technique. The current study was designed and conducted as there was a duty to investigate the technique further regarding the safe deployment of all inside meniscal repair devices in a setting that more closely replicated the *in vivo* surgical experience. The aims were therefore to determine:

1. Whether it is safe and effective to use Ultra FastFix (Smith and Nephew) and FastFix 360 (Smith and Nephew) meniscal repair devices to repair posteromedial meniscocapsular separations
2. Whether there is any effect on the mobility of the posterior capsule of the knee following a ramp lesion repair

The authors hypothesized that it was not safe to use an all inside meniscal repair device.

Materials and Methods

Twenty fresh frozen cadaveric knees (mean age = 62±14.5 years (mean ± standard

deviation), range 39-84) were obtained. Ten knees were assigned to the Ultra FastFix group (mean age 63 ± 14.7) and ten to the FastFix 360 group (mean age 61 ± 15.1).

The femur and tibia were sectioned approximately 200mm proximal and distal to the joint line. The femur was held in a clamp with the knee in 90 degrees of flexion. The knee could be fully extended freely to facilitate the repair technique. The ramp lesion was created via a posteromedial portal as described previously with a Beaver knife. The ramp lesions were then arthroscopically repaired with a standard all-inside technique. Visualization of the posteromedial recess via the intercondylar notch during the study demonstrated that in knee flexion the posterior capsular wall unfolded and dropped posteriorly and distally away from the periphery of the posterior medial meniscus, whereas in knee extension it was pulled proximally and anteriorly and held taut against the periphery of the meniscus (Figure 1+2). For this reason the ramp lesions were repaired with the knee in an extended position to facilitate passage of the meniscal anchors across the lesion and through the posterior capsule. The mobility of the posteromedial medial recess was examined pre and post ramp lesion repair and no difference was identified.

Four repair devices were used in each knee. All three surgeon authors were subspecialist soft tissue knee surgeons. Each ramp lesion was repaired with a combination of horizontal mattress and vertical mattress suture configurations. There was no specific standardized technique and each individual configuration was determined by tear morphology and access constraints. As is the case in clinical practice, in the present study, some devices were seen to have failed directly after deployment – they were then meticulously removed from the knee and a further device used in their place to reproduce a life-like situation.

The repairs were loaded using a maximal manual anterior drawer force at 90˚ and a Lachman test at 20 ˚ knee flexion; these were each applied 10 times to each specimen. The knees were then cycled through full flexion and extension range of motion 10 times to simulate loading of the repair. The knees were then transected

immediately proximal to the rims of the menisci. Each individual anchor was dissected out and its position recorded and photographed (Figures 3-6). Particular note was made of any anchors found in an intra-articular position. Also it was recorded if the suture was seen to have failed and the suture anchors were loose in the extra-articular soft tissues.

Ethics Committee Approval

This project was approved by REC Wales approval 12/WA/0196, ICHTB HTA licence 12275, application number R14136-1A.

Analysis

Four repair devices were used in each knee with 10 knees in each arm of the study. Each repair device had 2 anchors but both had to be correctly positioned for the device to be effectively deployed. Ten specimens were used in each arm of the study based on the number of anchors found within the joint in the previous study [16]; With 2 types of anchor, and 4 anchors in each knee, 20 knees gave two groups of 40 anchors for comparison.. Non parametric statistical testing was carried out, using the Mann-Whitney U Test, precluding the need for a power analysis.

Failure was defined as the presence of anchors in an intra-articular position at the time of specimen dissection. Some anchors were unsuccessfully deployed during use – if this was recognized at the time they were then removed and a further device used in their place. This was defined as unsuccessful deployment, and recorded, but no further analysis was done as this simply mirrors clinical practice with no risk to the knee as the device was removed.

Results

During surgery, unsuccessful deployments of some devices were seen: three of the Ultra FastFix devices and four of the FastFix 360 devices; these were removed and replaced, giving 40 of each device which were believed – at the time of insertion - to have deployed as intended (Tables 1 and 2).

After the knees had been transected, one out of the 80 deployed Ultra FastFix anchors was identified in an intra-articular position demonstrating failure of 1 of the 40 devices used (2.5%). In the FastFix 360 group 5 anchors were found in the joint, each from separate devices, demonstrating failure of 5 of the 40 devices (12.5%).(Tables 1 and 2). No significant difference was found between the groups (n.s).

Discussion

The most important finding of this study was that it is safe to use all inside meniscal repair devices for the repair of 'ramp' lesions. This technique has previously been found to be biomechanically efficacious [15]. The alternative method of repair suggested by others involves use of a suture shuttle passed through an accessory posteromedial portal [1,13]. Whilst there is no doubt that this method can work well many knee surgeons find it a challenging technique to complete satisfactorily. The authors hope that the reassurance that this study gives surgeons will lead to more 'ramp' lesion repair with all inside meniscal repair techniques – this is a core skill for all soft tissue knee surgeons unlike the use of a suture shuttle via a posteromedial portal.

It has become increasingly apparent that the recognition and repair of ramp lesions is important at the time of ACL reconstruction [2,6,13,15,20]. It is imperative to specifically look for these lesions by introducing the arthroscope into the posteromedial recess as described above [13,15]. As awareness of these lesions increases there would be value in identifying them on preoperative MRI.

However, it is the authors' experience, and that of others [2, 7, 10] that MRI seems unreliable in detecting this lesion. The reason may be that an MRI scan is normally undertaken with the knee in an extended position, so the lesion is reduced. Therefore, arthroscopic visualization is the key. The repair of ramp lesions not only reduces tibiofemoral joint laxity, but it could be expected to reduce load on the ACL graft, thus protecting it during the healing period [16].

The posterior capsule of the knee relaxes and falls posteriorly as the knee moves from full extension into flexion. All-inside repair techniques rely on fixation of the meniscal lesion to the capsule with the anchors deployed in an extra capsular position (Figures 4 and 5). Concerns have been expressed about the possible effect of tethering the capsule in a non-anatomic position when using an all inside technique to repair ramp lesions [13]. However, the capsule is pulled up tight to

the posterior aspect of the tibia when the knee is in full extension. Moreover the capsule is firmly attached to the supero-posterior margin of the tibia. It is therefore important that the ramp lesion is repaired with the knee as close as practically possible to full extension to avoid any tethering effect. This also reduces the distance that the repair device has to travel to cross the meniscal lesion and the capsule, thereby minimizing the risk of unsuccessful deployment of the device within the joint. This may have been a reason why some authors observed that an all-inside technique was unsatisfactory if they used a more flexed position. During this study the downward movement of the capsule was observed as the knee flexed before ramp lesion repair and then again after an all inside repair. No difference in capsular movement was seen following lesion fixation.

Each surgeon used both meniscal repair devices in their quota of knees, so the surgeon could be seen as another variable influencing the results. In clinical practice many surgeons will be using this technique and so potential surgeon variability was seen as representative of real life practice.

In proper technical usage of the Fast-fix and other all-inside devices *in vivo,* once a repair is completed, careful examination must be made for any suture anchors deployed incorrectly within the joint cavity. These must be removed carefully and another suture anchor deployed as needed. Seven devices used were identified during surgery as having deployed unsuccessfully, leaving anchors within the joint. These were easily removed as would be done in a clinical situation. It is imperative to recognize this phenomenon at surgery because loose anchors are likely to cause intra-articular damage. This is an unsuccessful deployment rate of 7 of 87 (8%). This rate compares favorably with that of Walgrave et al [19], who reported an unsuccessful deployment rate of 11.6% in a large series of patients undergoing meniscal repair and meniscal allograft transplantation but this relates to FasT-fix which predated Ultra Fastfix and Fastfix 360.

After opening the joints, our failure rate with Ultra FastFix was 1 in 40 devices (2.5%), which is thought by the authors to be acceptable. In the device that failed the intra-articular anchor was tightly applied to the undersurface of the meniscus.

Whilst any intra-articular hardware can potentially cause iatrogenic chondral damage the authors think that in this position it is less likely as there is little movement here [18].

Most of the published failures of surgical devices for meniscal repair relate to a failure of meniscal healing rather than a failure of deployment but the authors feel that this unsuccessful deployment rate is within acceptable limits.

The surgeon authors felt that the failure rate in this study was higher than that experienced in their practices, probably as a result of the limitations of the cadaveric study. The specimens were older than patients who have ramp lesion repairs, so their tissues were probably degraded. It was difficult to apply valgus opening to the isolated joints, thus reducing access. Furthermore, despite efforts to load the knees prior to dissection, as detailed above, this clearly does not replicate normal loading of the meniscal repair in vivo. In normal circumstances in clinical practice we would limit flexion to 90 degrees for 6 weeks to protect our repairs. In this study the loading cycle post repair was therefore not intended to recreate in vivo loading but simply to stress the repairs and test their robustness in a uniform reproducible way.

Conclusions

This study has demonstrated the safety of an all-inside technique in relation to intra-articular anchor retention and potential iatrogenic damage to the joint. The results show that this was a rare occurrence – particularly in the Ultra FastFix group.

Whilst there was no statistical difference between the 2 groups the practice of the surgeon authors of this study is now to routinely repair ramp lesions at the time of ACL reconstruction, after rasping of the lesion, using the longer-reach Ultra FastFix sutures.

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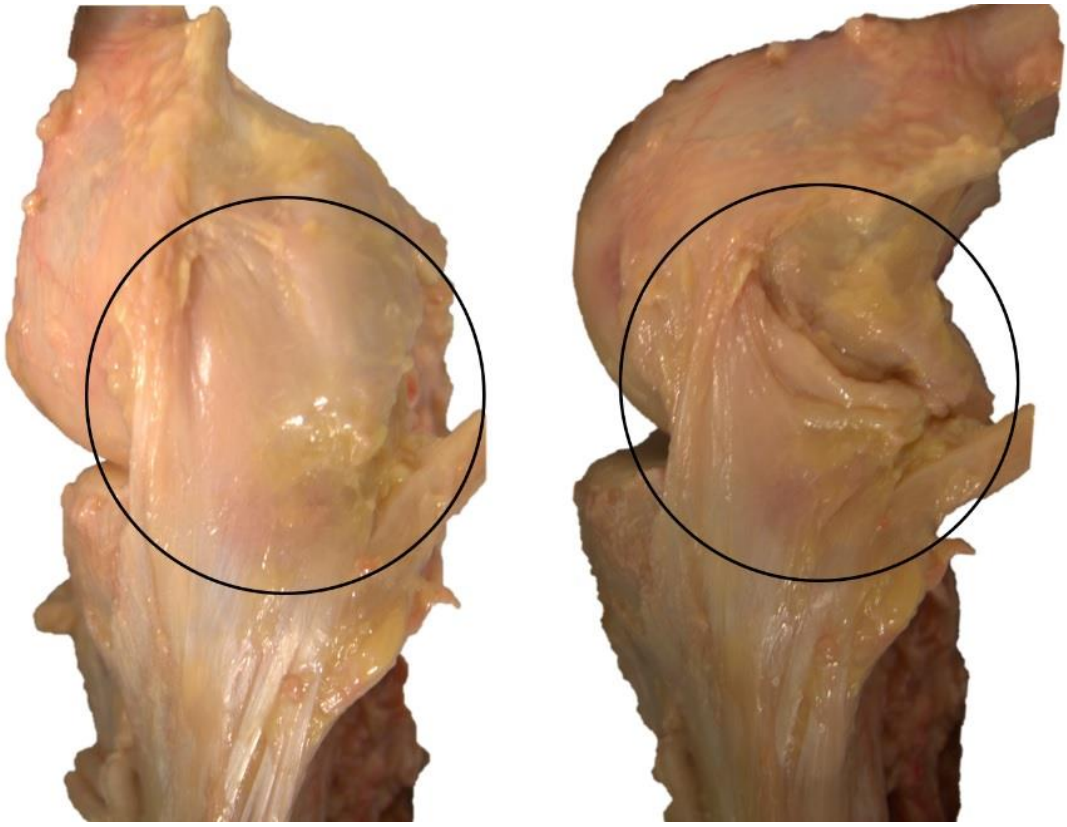
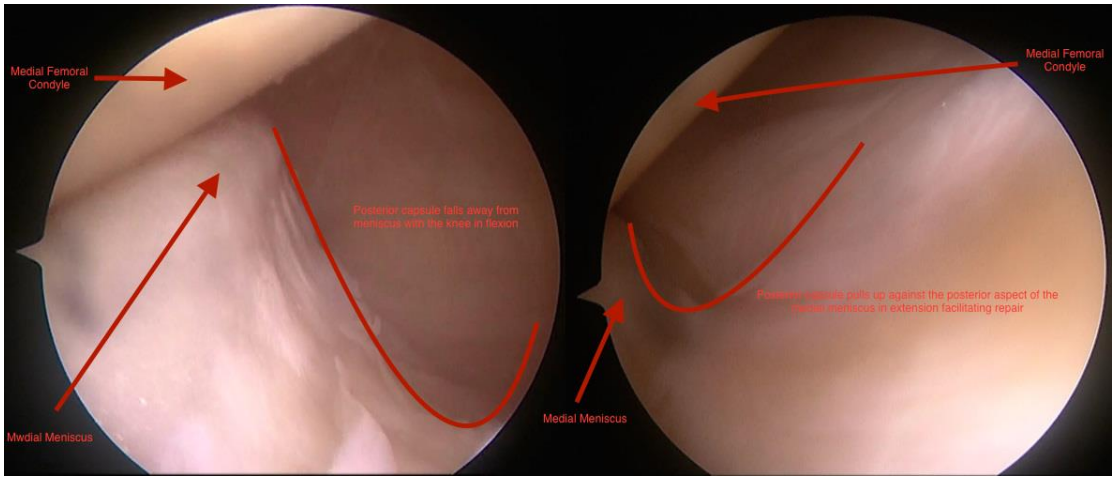


Figure 1: The medial view of a right-sided knee, left image with the knee in extension and right image with it flexed to 70˚. The posterior capsule can be seen to relax and fall away from the posterior tibia as the knee is flexed. This happens above the level of the joint line.



Video 1.mp4

Figure 2 + Video 1: Arthroscopic still and video images of the posteromedial recess via the intercondylar notch showing the capsule lax and fallen away from the medial meniscus in flexion and taut against it in extension

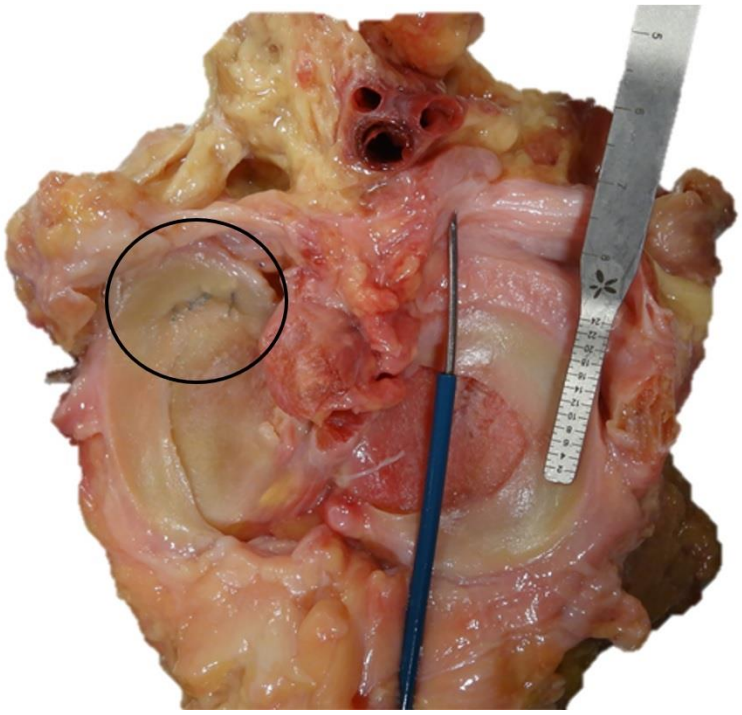


Figure 3: Left knee sectioned proximal to menisci. Repair is circled. Ruler for scale. An Ultra Fast-Fix device is placed overlying the posterior lateral meniscus showing the proximity of its penetrating tip to the neurovascular bundle illustrating why posterior horn lateral meniscus tears are not safely repaired with an all-inside device introduced via an anterolateral portal. Conversely the image shows that a device used to repair a posterior lesion of the medial meniscus, such as a ramp lesion, with an all-inside device introduced via the anteromedial portal through the meniscus has a good clearance of the neurovascular bundle.

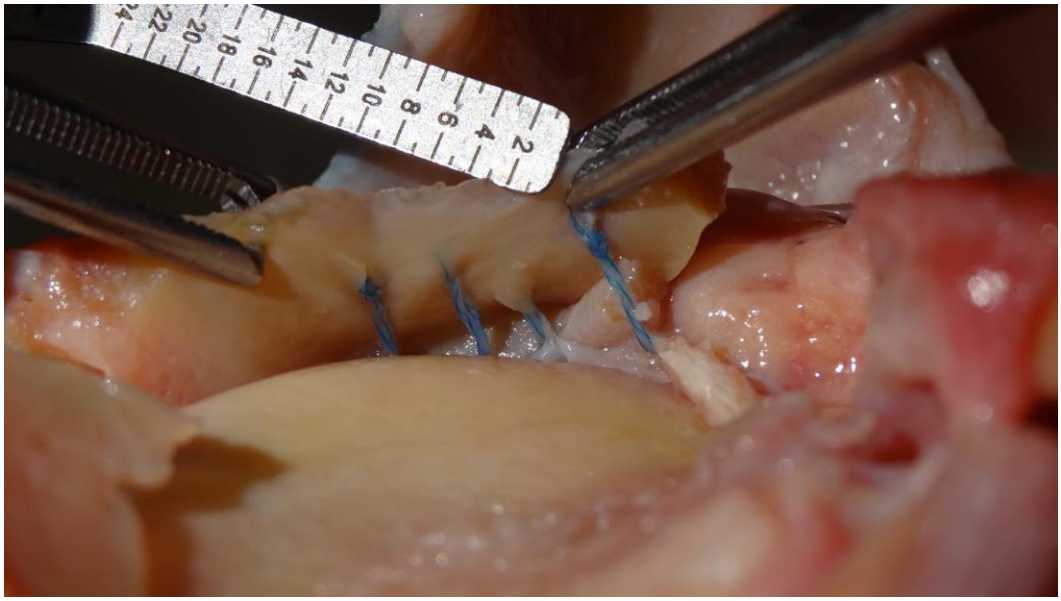


Figure 4: Repair visualized from the inferior surface of the meniscus. No intra-articular anchors were found in this specimen.

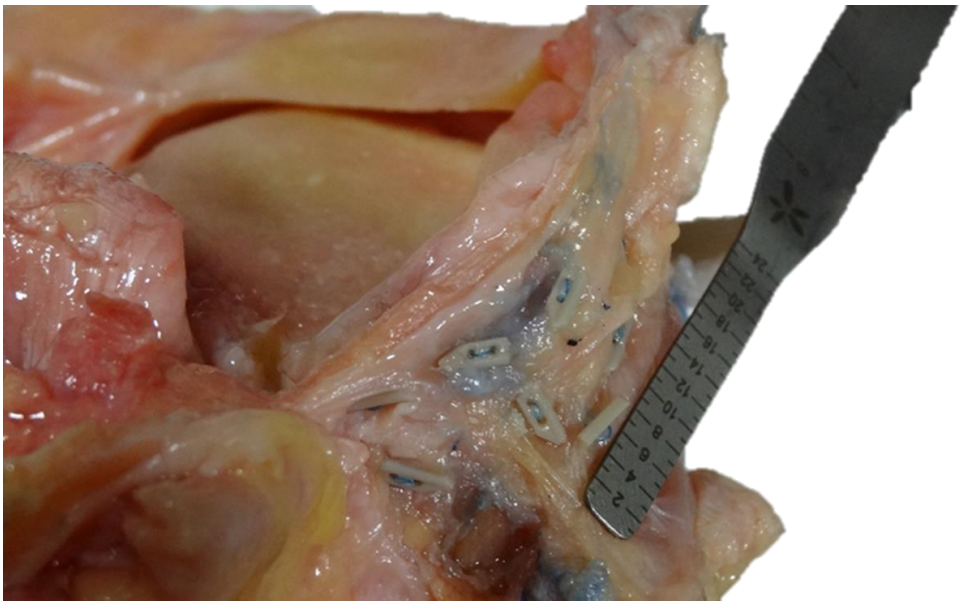


Figure 5: All 8 anchors identified in appropriate extra capsular location in extra-articular soft tissue posterior to the posterior medial meniscus following repair.

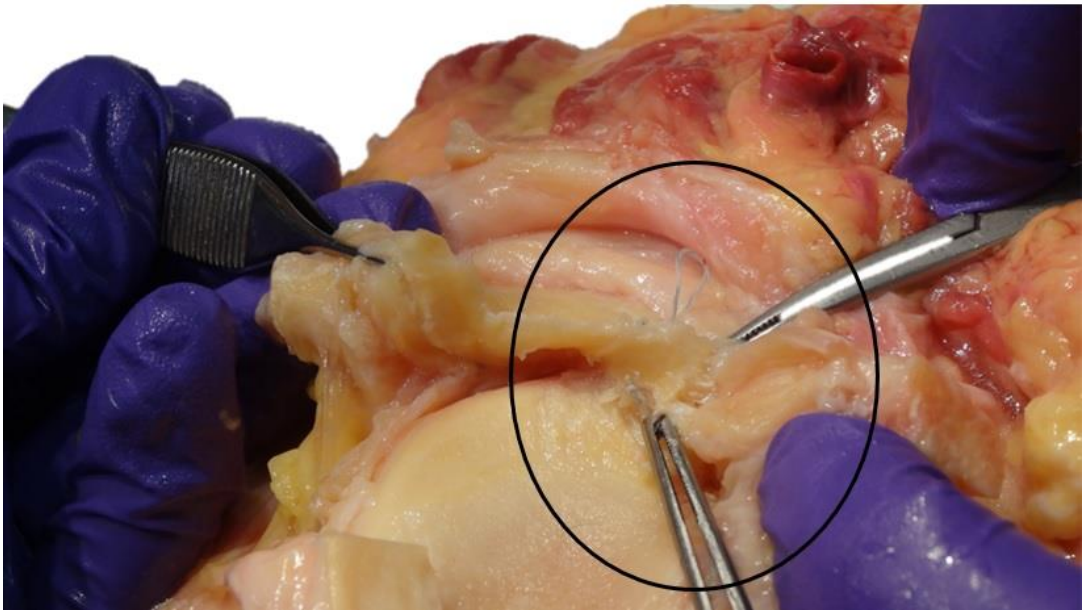


Figure 6: FastFix 360 anchor in joint firmly attached to meniscus as its suture was intact.

Age	Gender	Unsuccessful deployment and removed during procedure	Failed and In Joint at dissection
61+/-15(39-84)	5M, 5F	4	5

Table 1: Results from FastFix 360 knees

Age	Gender	Unsuccessful deployment and removed during procedure	Failed and In Joint at dissection
63+/-15(41-82)	5M, 5F	3	1

Table 2: Results from Ultra FastFix knees