Masters of Cardiothoracic Surgery

Intercostal artery reattachment for prevention of spinal cord ischaemia

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Clinical vignette

Herein, we illustrate different techniques for intercostal artery (ICA) reimplantation during thoracoabdominal aortic (TAA) surgery (1).

Case 1 (loop graft): 23-year-old female with Marfan syndrome who presented with a type B aortic dissection during pregnancy, managed conservatively. On surveillance, the proximal descending diameters expanded significantly, and an extent II TAA repair from distal to left subclavian artery (LSA) to infrarenal aorta was planned. The proximal clamp was placed proximal to the LSA, which was snugged, in order to resect the dissection flap that originated within the arch.

Case 2 (island patch): 37-year-old male with Marfan syndrome who presented with a type B aortic dissection two years prior, initially managed conservatively until the proximal thoracic diameters began expanding. He was planned for an extent II TAA replacement from the distal to LSA to individual iliacs.

Case 3 (end graft): 65-year-old male with degenerative extent IV TAA aneurysm. Planned extent IV TAA replacement from lower to iliac bifurcation. Motor-evoked potential (MEP) signal decreased intraoperatively during opening of the visceral segment and a single large lumbar artery was reimplanted to the main graft using an end graft technique.

Surgical technique

Neuromonitoring systems include near infra-red spectrometry (NIRS) probes in the forehead, paraspinal muscles and bilateral calves and MEP electrodes in the skull and four limbs (1,2).

Patients are positioned in right lateral decubitus position with 30° hip-tilt and 90° left arm flexion. Surgery is performed via thoracophrenolaparotomy through the 6th intercostal space. Following systemic heparinization, targeting an activated clotting time of 300–350 s, left heart bypass (LHB) is established by cannulation of the left inferior pulmonary vein and the distal aorta/left femoral artery. LHB flows are adjusted to maintain femoral mean arterial pressures of >60 mmHg. Temperature drifts to 34 ℃. Surgery is conducted with sequential clamping to minimise ischemia. We describe the proximal to distal sequence of the operation; this can be inverted to adapt to aortas with excessive intramural thrombus load in the proximal segments. A proximal clamp is applied distal to the LSA and in the mid DTA, minimising the spinal ischemia as the lower thoracic ICAs are perfused by the LHB. Patent ICAs are overrun with 2/0 silk sutures to prevent steal syndrome due to excessive back bleeding. Following completion of the proximal anastomosis, the clamp is reapplied above the diaphragm. The aortotomy is extended, and the lower ICAs (T8–T12) are identified and temporarily occluded with 8F umbilical catheters to avoid steal syndrome. We advocate for routine reimplantation of the two pairs of lower ICAs, regardless of the MEP results.

Different techniques can be used for ICA reimplantation (1-5):

(I) The island patch (inclusion technique): the selected ICAs are isolated as an island and anastomosed side-to-side to the appropriate part of the main aortic graft previously cut with electrocautery with a continuous 4/0 polypropylene suture;

(II) End graft: the selected ICAs are anastomosed end-

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to-side to a 10 mm Dacron graft using a continuous 4/0 polypropylene suture;

(III) Loop graft: the mid part of a 10 mm graft is anastomosed end-to-side around the ICAs using a continuous 4/0 polypropylene suture.

Irrespective of the reimplantation technique used, it is paramount to communicate the true and false lumens at this level in dissection patients, as well as to include the adventitia layer in the suture. otherwise, extensive bleeding and pressurisation of the false lumen will occur (1-3). The clamp is then moved to the infrarenal aorta, and the visceral segment exposed. The celiac trunk and superior mesenteric artery are cannulated with 12-F balloon-tipped catheters and are perfused with 200 mL/min of isothermic blood. The renal arteries are cannulated with 9-F balloon-tipped catheters and are perfused with Custodiol solution (1 L at 4 ℃ + 500 mL/30 min if required) (1). The distal anastomosis is performed to an appropriately sized Coselli graft. The LHB can be discontinued followed by individual anastomosis for each of the visceral arteries to the corresponding branches on the aortic graft. Following LHB weaning and decannulation, heparin is reversed with protamine. Haemostasis is achieved, and routine closure performed (1).

Comments

The different techniques of ICA reimplantation have their own advantages and disadvantages (3-5). The island patch has better patency, as the size and orientation of the anastomosis ensures a good run-off without any kinks; however, aneurysmal dilation of the remaining aorta has been described in up to 7% of patients, predominantly in those with connective tissue disorders (CTDs) (5). We reserve the island patch for patients >60 years and no CTD, as they allow reimplantation and restoring pulsatile flow to ICAs at early stages of surgery. Both end and loop grafts can accommodate one pair of ICAs at a time, minimising the amount of native aorta preserved and hence reducing the rate of late aneurysms. As they are not incorporated into the main aortic graft directly, anastomosis is usually easier due to less tension, and any potential bleeding can be repaired easily. The morphology of the graft allows for perfusion of the ICAs immediately by delivery of blood from the LHB. However, the cons are the lower patency rates (5), attributed to a lower run-off compared to the island due to the smaller size of the anastomosis, and potential kinks by pressure of the adjacent main aortic graft; this is more evident for the end grafts as there is only run-off from one arm as opposed to two arms on the loop graft. We tend to use the loop graft for patients of a young age and/or those with CTD, while we reserve the end grafts to cases where an additional ICA is reimplanted at the end due to unstable/decreased MEPs.

Irrespective of the technique used for reimplantation, key interventions to minimise spinal cord injury (SCI) include spinal fluid drainage, intraoperative neuromonitoring (NIRS and MEPs), LHB with sequential clamping, and maintenance of distal MAP of >60 mmHg, along with restoration of the pulsatile flow to the pelvic circulation as soon as possible. Reimplantation of T8–L1 ICAs, regardless of intraoperative changes on MEPs, have drastically reduced the rate of SCI and paraplegia (1-3).

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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