Onion skin technique for open surgical replacement of aortic arch following primary endoprothetic thoracic aorta treatment

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Abstract

Endovascular aortic replacement (EVAR) techniques have become the first choice option for many aortic diseases in patients in whom standard open surgery was contraindicated or with high surgical risk. A secondary open surgical treatment, following a primary EVAR procedure, could, however, be challenging depending on the type, the extension and the position of primary endoprosthesis. Here, we describe an original and easy technique capable of simplifying a secondary aortic arch replacement following EVAR treatment of the descending thoracic aorta. The basic concept of such techniques is similar to that of the conventional ‘elephant trunk’ technique and is based on an inverted straight tube graft inserted into the endoprosthesis and anastomized using a multi-layer double suture with external strip felt of Dacron.

Keywords: Aortic arch • Endoprosthesis • Redo surgery

INTRODUCTION

Endovascular aortic replacement (EVAR) techniques began in 1991 when Parodi et al. [1] reported the first series of endovascular implant of custom-made endoprosthesis in patients suffering from aneurysm of abdominal aorta. The EVAR techniques were soon extended to the thoracic descending aorta [2] and gained worldwide popularity, especially for scheduled treatment of high-risk patients or in emergency settings, such as acute type B aortic dissection [3], which were previously treated conservatively. Due to the potential complications of EVAR [4] and/or the progression of the disease towards the proximal aorta, a secondary standard surgical procedure addressing the aortic arch has become, however, a potentially frequent scenario [5]. Such secondary surgical procedures could become, in some situations, quite challenging especially because of the presence of the hooks of EN. Here, we describe an original technique which we have called ‘onion skin’ that could be adopted in such conditions and could simplify the distal anastomosis improving the accuracy and reducing postoperative bleeding.

SURGICAL TECHNIQUE

The usual approach includes a midline sternotomy plus a subclavian incision for right axillary artery cannulation. We used either an 8 mm Dacron graft interposition [6] or a direct axillary artery cannulation [7]; however, alternative options (such as innominate artery cannulation) can also be used.

Epiaortic vessels and the ascending aorta are encircled with a vessel loop and cardiopulmonary bypass is started following axillary artery and right atrium cannulation (using a two-stage cannula). The patient is cooled to moderate (25°C bladder temperature) hypothermia. The left ventricle is also vented through the right superior pulmonary vein.

Once the target systemic hypothermia is achieved, the right brachiocephalic trunk is clamped at the origin and the aorta is opened. The left carotid artery is selectively cannulated using a perfusion catheter (Baxter Health Corporation, Irvine, CA, USA) and, if the retrograde flow from the left subclavian artery (LSA) is excessive, the LSA is also selectively cannulated or clamped. Selective bilateral cerebral perfusion (usually at rate of 10 ml/kg/min) is then started. The proximal end of endoprosthesis is identified and the wall of the native aorta is trimmed. An inverted Dacron graft (IDC) is then gently inserted into the endoprosthesis leaving inside it a limited (1–2 cm) trunk. A strip of felt is gently positioned all around the native aortic wall (NAW). Four concentric layers can be visualized at this stage by the surgeon, leaving the impression of an onion (‘Onion Skin Technique’). As shown in Fig. 1, the four layers include, from the outside inwards, respectively:

• The strip of Teflon;
• The external NAW;
• The endoprosthesis;
• The double layer of the IDC prosthesis.

The four layers are then packed together using two haemostatic 4–0 polypropylene sutures: the first one is a mattress suture, while the second one is a running suture involving the top of the endoprosthesis wall. At the end of such a double suture, the Dacron graft is pulled back and the anastomosis is further fixed with glue.
We use this technique both with endoprosthesis with a covered fixation system (Zenith II, Cook Medical, Inc., Bloomington, IN, USA) and with that with uncovered hooks (Talent, Medtronic, Inc., MN, USA). In case of a prosthesis with uncovered hooks, we did not cut the hook to avoid leaving sharp and dangerous fragments of the hook at the end of reconstruction (Fig. 2). Our technique indeed, once the Dacron graft is pulled back, allows the smooth uncovered proximal end of endoprosthesis to remain outside the Dacron graft as clearly shown in the postoperative CT scan in Fig. 2. We have applied this technique also in different clinical scenarios such as a case of acute type A dissection following primary thoracic EVAR for type B acute dissection or a case of third-redo open procedure (following aortic valve replacement and Bentall operation) addressing a chronic aortic arch aneurysm in a patient also with two previous EVAR treatments.

Epiaortic vessel reimplantation is then performed using either a single anastomosis technique (with a button of the aortic wall including all epiaortic vessels) or separate reimplantation with additional Dacron graft smaller size prosthesis, depending on the anatomy and the origin of epiaortic vessels. The Dacron graft is clamped just proximal to the right brachiocephalic artery, the full flow is restored and the systemic rewarming is started. The procedure is then completed according to the patient’s needs with a single proximal anastomosis of the Dacron graft on the ascending aorta or with a Bentall/David procedure with a second Dacron graft if the aortic root is also diseased.

**DISCUSSION**

Although the introduction of the frozen elephant trunk technique [8] could reduce the incidence of a secondary surgery following thoracic aortic endoprosthesis in the future, at present such a scenario could be frequent and occasionally still challenging. The technique we have proposed here seems to be safe and effective and in our opinion is easily reproducible in any clinical condition and can be adopted with any kind of endoprosthesis. The ‘onion skin’ double-suture technique should enable a better haemostasis and for a reduced risk of suture dehiscence and/or pseudoaneurysm.

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**REFERENCES**