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How to Do It: Proximal Elephant Trunk Insertion Technique for Preventing Stroke during Replacement of the Descending Aorta through a Left Thoracotomy

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ABSTRACT

To reduce the risk of stroke during open surgery for the treatment of descending thoracic or thoracoabdominal aortic diseases, we attempted to insert a proximal elephant trunk to stabilize the atherosclerosis at the site of the proximal anastomosis. Although the patients had dense atherosclerotic lesions, they recovered well without neurologic complications. This technique is simple and may be effective for preventing stroke when replacing the descending thoracic or thoracoabdominal aorta through a left thoracotomy.

INTRODUCTION

Although thoracic endovascular aortic repair has become widely accepted as an effective technique for the treatment of descending thoracic aortic aneurysms, conventional open surgery continues to play an important role. As for open surgery for the treatment of diseases of the descending aorta, avoiding stroke and paraplegia is important for improving the patient's postoperative course. To prevent stroke, we have developed the proximal elephant trunk insertion technique (PETIT) to stabilize the atherosclerosis at the site of the proximal anastomosis, and we have applied the technique clinically. The patients recovered well without neurologic complications. This technique is simple and may be effective for preventing stroke during the replacement of the descending aorta.

PATIENTS AND METHODS

Three patients with a descending thoracic or thoracoabdominal aortic aneurysm underwent emergency graft replacement via PETIT. The ages of the patients were 84, 76, and 65 years. Two of the patients were cases of ruptured aneurysms and were in shock. One patient had a 64-mm thoracoabdominal aortic aneurysm with back pain and received a diagnosis of an impending rupture. A preoperative computed tomography scan showed that all 3 patients had severe atherosclerotic lesions in the descending aorta (Figure 1A). The patients were placed under general anesthesia and then in a right semilateral position. The left femoral artery and vein were exposed and cannulated to establish a cardiopulmonary bypass. A left anterolateral thoracotomy was performed through the fourth or sixth intercostal space. When the patient's core temperature reached 20°C, we administered 40 mEq of potassium chloride to the cardiotomy reservoir to obtain cardiac arrest, and cardiopulmonary bypass was halted. The aneurysm was then opened, and the presence of continuous, severe atherosclerotic lesion was confirmed directly (Figure 1C). After exposing and trimming

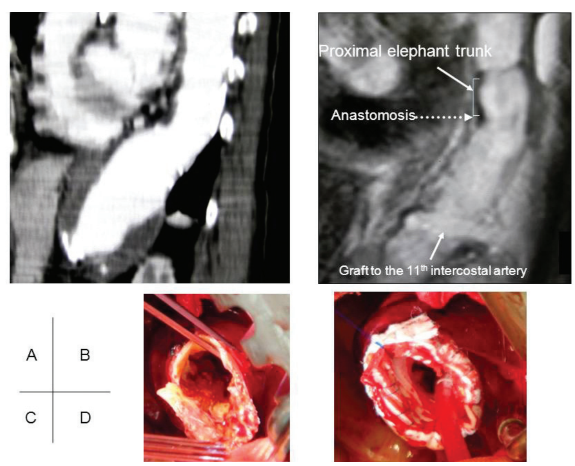

Figure 1. A, Preoperative computed tomography scan of a thoracoabdominal aortic aneurysm. A dense thrombus is present in the aneurysm. At the proximal anastomosis site, a long atheromatous lesion continues to the aneurysm. B, Postoperative magnetic resonance imaging of the thoracoabdominal aortic replacement. A proximal elephant trunk was firmly attached to the aortic wall without eversion. Stabilized atherosclerosis and a newly formed thrombus were detected between the aortic wall and the graft. C, Direct view of the inside of the aorta prior to the elephant trunk procedure. Dense, continuous atheromatous lesion can be seen. D, Proximal elephant trunk insertion technique. The softly inserted and fixed elephant trunk can be seen inside the aorta. The outside was also reinforced with a Teflon felt strip, and a stabilized proximal anastomosis site was made.

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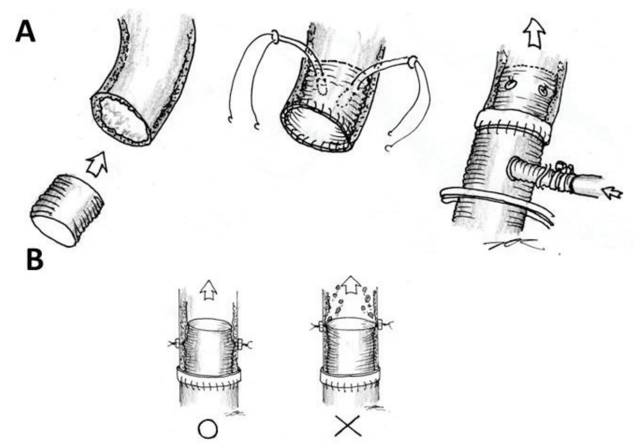

Figure 2. A, Proximal elephant trunk insertion. An elephant trunk is folded and inserted into the aorta. Great care should be taken not to injure the atheromatous lesion. A graft of the same size as the inner diameter of the aorta is used as the proximal elephant trunk. The length of the elephant trunk is 30 mm. Three or four U sutures of 4-0 polypropylene were placed 10 mm away from the proximal edge of the elephant trunk. These sutures were passed from the inside of the graft through the aortic wall to the outside and tied loosely. B, Mechanism of the proximal elephant trunk. When the sutures are placed at the proximal end of the graft, particles will be pushed out and freed by the suture (×). When the fixing sutures are placed 10 mm away from the edge of the graft (○), the atheroma is unlikely to become an embolic particle, even if it is deformed and becomes unstable, because it is covered by the sleeve of the graft.

the proximal anastomosis site of the aorta, we carefully inserted a folded elephant trunk (30 mm in length and 22 or 24 mm in diameter) into the aorta so as not to scratch the atheroma. The trunk was then opened gently with forceps. The size of the elephant trunk was chosen so as to match the size of the inner diameter of the native aorta. Three or four 4-0 polypropylene mattress fixing sutures were placed from inside the proximal elephant trunk to the outside of the aorta and then tied softly. These fixation sutures were placed not at the edge of the graft, but 10 mm away from the proximal edge. The distal edge of the graft was fixed to the aortic wall with a 4-0 polypropylene running suture with an outside reinforcement of the felt strip (Figure 1D). Then, the graft was replaced in the usual fashion. A graft with a branch was anastomosed. The graft was clamped, the inflow root was changed from the left femoral artery to the branch of the graft, and cardiopulmonary bypass was reinitiated (Figure 2A). Finally, the distal anastomosis was performed. Two of the patients underwent replacement of the upper half of the descending aorta, and the third patient underwent thoracoabdominal aortic replacement with reconstruction of the 11th intercostal artery and celiac trunk.

RESULTS

No transient or permanent neurologic complications occurred. No postoperative visceral organ or limb ischemia occurred. The postoperative magnetic resonance images revealed a well-attached elephant trunk (Figure 1B).

COMMENT

The potential for postoperative stroke is significant after surgery on the thoracic aorta. The risk of stroke is approximately 7%. Stroke is often lethal (28.3% of cases), accounting for one quarter of all deaths from thoracic aortic surgery [Coselli 2008]. Cardiopulmonary bypass with profound hypothermic circulatory arrest is well established as an adjunct for the protection of the central nervous system during the treatment of complex pathologies involving the thoracic descending or thoracoabdominal aorta [Coselli 2008; Ji 2008]. Although many arterial cannulation sites have been reported, especially in emergency cases, simple cannulation and rapid establishment of cardiopulmonary bypass are important for rescuing the patient [Goldstein 2001]. Therefore, we readily use cannulation of the left femoral artery in such situations. During rewarming in our presented procedure, the time from cardiac arrest until beating of the heart for up to 1 hour is the most "dangerous" period, because the blood flow to the brain is retrogradely perfused from a side branch. We often are faced with a dense, continuous atheromatous lesion. For such a lesion, we can never avoid atheromatous plaque. If we debride the plaque, only the weak adventitia and the unstable plaque produced by the debridement will remain. Considering that the majority of strokes are technically related to embolic ones, we hypothesized that reducing emboli technically detached from the proximal anastomosis may reduce the incidence of stroke [Neri 2002].

In our technique, the aim of using 3 or 4 fixing sutures is to prevent the graft from everting. When the fixing sutures are placed at the proximal end of the graft, the atheroma will be pushed out when the suture is tied, possibly causing a stroke. When they are placed 10 mm away from the edge of the graft, the atheroma is unlikely to form an embolic particle, even if it is deformed and becomes unstable, because it is covered by the sleeve of the graft (Figure 2B). Furthermore, the proximal stabilization may reduce the risk of paraplegia caused by the extensive resection of the aorta to search for a "best" anastomosis site that may be unclear.

Theoretically, this technique may also be applicable to the distal anastomosis for preventing a "distal" embolism. The elephant trunk method is usually a good means for making a scaffold of the proximal or distal anastomosis site for a planned staged surgery. Recently, it has also been used to make a landing zone for performing consecutive thoracic endovascular aortic repairs. Our presented technique may add a third application for the elephant trunk.

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