A vascular tube for intercostal artery reimplantation

Masashi Toyama*, Akihiko Usui, Toshiaki Akita, Yuichi Ueda

Department of Cardio-thoracic Surgery, Nagoya University Graduate School of Medicine, 65 Tsurumaicho, Showaku, Nagoya 466-8550, Japan

Received 14 October 2005; received in revised form 3 December 2005; accepted 5 December 2005

Abstract

Paraplegia and paraparesis are major concerns in descending and thoracoabdominal aortic repair. A shorter period of spinal cord ischemia is preferred for protection. We have developed a new technique in which plural intercostal arteries are reattached in a short time. The lower descending aorta is tailored using automatic sutures, and a vascular tube is made with diameter about 2.0 cm. Blood supply of intercostal arteries including the Adamkiewicz artery is resumed by perfusing the vascular tube in not more than 20 min. This technique has been applied in four patients, and there was neither paraplegia nor paraparesis.

Keywords: Vascular tube; Spinal cord protection

1. Introduction

Postoperative paraplegia and paraparesis are major concerns in descending and thoracoabdominal aortic repair. In spite of advances in anaesthetic and surgical techniques, the rate of paraplegia and paraparesis varies between 5% and 40%[1]. Reduction in the duration of spinal cord ischemia is a solution for these neurological complications. We perform a repair of the pleural intercostal arteries in a very short time using a vascular tube tailored by automatic sutures.

2. Technique

Extended descending thoracic aneurysm and thoracoabdominal aneurysm are indications for this technique. The day before the operation, a drainage tube for cerebrospinal fluid is inserted. For anaesthesia, a double lumen endotracheal tube is used. The patients are placed in a right lateral decubitus position, with the shoulder at 60° and the hips flexed to 30° from the horizontal. The descending thoracic aorta is exposed via left posterolateral thoracotomy. For thoracoabdominal aneurysm, the incision is extended along the pararectal line.

When the aneurysm does not extend to the distal aortic arch, the operation is performed in normothermic partial cardiopulmonary bypass by clamping the descending aorta. Right femoral vein drainage and right femoral artery return are applied for perfusion of the lower body. The distal anastomosis site is exposed, and a short length of segmental aortic clamping is applied just below and above the distal anastomosis site. A coated woven Dacron graft (Hemashield gold, Boston Scientific, Natick, MA, USA) is anastomosed to the distal end with 3-0 polypropylene suture with no interruption of the intercostal arteries. The aortic clamping is then removed and reapplied above the proximal anastomosis site. The aneurysm is now isolated from the blood supply and is opened longitudinally. After all intercostal arteries are identified, the free aneurysmal wall on the opposite side of the intercostal arteries is raised, and automatic sutures are applied (GIA stapling system, Tyco Healthcare, Mansfield, MA, USA). An aortic wall strip about 3 cm wide is tailored on both sides of the intercostal arteries, and a vascular tube is constructed of about 2 cm in diameter. For dissecting aneurysm, the flap is excised so that the ostia of the intercostal arteries can be opened to the tube. The distal end of the tube is closed, and its proximal end is anastomosed with a 10 mm diameter graft with 4-0 polypropylene suture in end-to-end fashion, following which blood perfusion is resumed via a side branch of an arterial cannula. Even for thoracoabdominal aortic repair, a vascular tube is used just above the celiac trunk and is made in the same fashion. The proximal end of the aorta is sutured to the main graft in end-to-side fashion. The vascular tube is reinforced with Teflon felt strips. Anastomotic sites between the aorta and the graft are wrapped with graft strips to reduce tension and to prevent a fistula formation (Fig. 1).
When the aneurysm extends to the distal aortic arch, deep hypothermic cardiopulmonary bypass is applied with right axillary artery return and right groin vein drainage to prevent retrograde arterial perfusion.

3. Results
We performed plural intercostal artery reconstruction with a vascular tube technique in four patients. Two patients had extended thoracic descending aortic aneurysm, and the other two had thoracoabdominal aortic aneurysm. Three of these were chronic dissecting aneurysm, and the fourth showed impending rupture of true aneurysm. In a patient with true aneurysm and in one case of dissecting aneurysm after aortic arch replacement, aortic repair was performed in normothermic partial bypass. The others were done under deep hypothermic circulatory arrest. The spinal cord ischemia time was 10 min and 18 min in the first two cases, and 54 min and 49 min in the last two. In all cases, the time taken to make a vascular tube was less than 20 min. The cardiopulmonary bypass time was 92 min and 126 min in the first two, and 201 min and 181 min in the last two cases. There was neither paraplegia nor paraparesis. We assessed the status of the vascular tube by enhanced computed tomography before discharge. We observed the vascular tubes clearly and identified the intercostal arteries (Fig. 2). Follow-up computed tomographic scans revealed occluded vascular tubes in two cases.

4. Comment
Svensson [2] attributed major causes of the spinal cord injury to three events: (1) the duration and degree of ischemia; (2) failure to re-establish blood flow to the spinal cord; and (3) a biochemically mediated reperfusion injury. Here, we have addressed the duration of ischemia and re-establishment of blood supply for the spinal cord. The origin of the Adamkiewicz artery varies from T7 to L4, and is generally hard to identify [3]. Minatoya et al. [4] reported that postoperative paraplegia could not always be prevented even in patients with identified and reimplanted great radicular artery. Reimplantation of the plural intercostal and lumbar arteries, including the Adamkiewicz artery, in a short time should improve neurological outcomes in thoracic and thoracoabdominal aortic repair. Using a vascular tube technique, we can reduce the spinal cord ischemic time and perform complete reconstruction of plural intercostal arteries.

In cases of acute aortic dissection and some cases of degenerative aneurysm, it is not feasible to make a vascular tube because the aortic wall is unsuitable. We experienced

Fig. 1. The aneurysm is opened and intercostal arteries are identified (A). A vascular tube is made using automatic suture (B). Perfusion to the intercostal arteries is resumed through the vascular tube (C). The vascular tube is attached to the main graft (D).

Fig. 2. Computed tomographic scan and three-dimensional computed tomographic angiography showing the vascular tube. The white arrow indicates the vascular tube. The black arrow reveals the intercostal artery arising from the vascular tube.
one case of degenerative aneurysm in which a vascular tube could not be made.

Problems that may arise in the late phase include enlargement of a vascular tube, its rupture, and thrombus formation in the tube. In two patients, the tube was totally obstructed. Though there may be small demand on the intercostal arteries in these two cases, we believe that a vascular tube will still assist in spinal cord protection. During and immediately after the operation, blood flow to the spinal cord may be reduced because of hypotension and spinal cord oedema. There may be a spasm in collateral circulation. The vascular tube should function at this stage. It is obstructed gradually, in accordance with the increase of collateral circulation of the spinal cord. No changes were observed in the size of the vascular tubes during 1 year in our series.

Descending thoracic aneurysm can be repaired using endovascular stent graft. However, chronic dissecting aneurysm in which a false lumen is patent, and extensive aneurysm, are not feasible for stent grafting. Criado et al. [5] reported a 4.3% incidence of spinal cord ischemia after endovascular stent grafting for thoracic aneurysm. Our technique can be used for both dissecting and extensive aneurysm. Long-term results of endovascular repair, however, remain unclear.

We have developed a new technique of plural intercostal artery reconstruction using a vascular tube for spinal cord protection, and have implemented it in four patients. There was neither paraplegia nor paraparesis. This technique makes possible the certain reconstruction of plural intercostal arteries with a short duration of spinal cord ischemia. It is useful for protection in spinal cord ischemia, although our patients were heterogeneous in their aetiology and in the extent of aneurysm and the surgical procedures used.

References