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Cannulation of the Ascending Aorta in Left Thoracotomy for Thoracic Aortic Aneurysms

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ABSTRACT

In patients with aneurysms of the thoracic aorta, the risks of cerebral embolism and malperfusion are increased if retrograde aortic perfusion via the femoral artery is used during repair. We describe a surgical technique used for 6 aneurysms of the thoracic descending aorta that were operated on via thoracotomy with cannulation of the ascending aorta and deep hypothermic circulatory arrest.

INTRODUCTION

A number of techniques have been used to repair aneurysms of the descending aorta. However, in cases where it is difficult to clamp the aorta because of proximal or distal extension of aneurysms, deep hypothermic circulatory arrest (DHCA) offers a technical advantage.

In aortic aneurysm surgeries that are carried out via thoracotomy and using DHCA, the femoral artery is the vessel most often used for arterial cannulation [Kouchoukos 2001]. In addition, the left subclavian artery, the left common carotid artery, the right axillary artery, the ascending aorta (accessed by extending the thoracotomy and transverse sternotomy), or transapical aortic cannulation are used as alternative sites for arterial cannulation for cardiopulmonary bypass (CPB) [Westaby 1998; Katoh 2000; Moriyama 2001; Neri 2002]. In patients with aneurysms of the thoracic aorta, the risks of cerebral embolism and malperfusion are increased if retrograde aortic perfusion is done via the femoral artery [Westaby 1999]. In this report, we describe the surgical technique we used for 6 aneurysms of the thoracic descending aorta that were operated via thoracotomy with cannulation of the ascending aorta and DHCA.

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SURGICAL TECHNIQUE

The patient was anesthetized and intubated using a double-lumen endotracheal tube. He or she was then rolled to a right lateral decubitus position, with the shoulders placed at an 80° to 90° angle to the operating table and the pelvis tilted approximately 30° anteriorly to allow access to the femoral vessels. The left femoral artery was exposed for arterial cannulation (dlp Femoral Cannulae; Medtronic, Minneapolis, MN, USA). Then a long venous drainage cannula was inserted into the right atrium via the left femoral vein (Carpentier Bi-caval Femoral Venous Cannulae; Medtronic). A posterolateral thoracotomy was performed, and the chest was entered through the fourth intercostal space. A longitudinal incision was made in the pericardium 2 cm anterior to the left phrenic nerve. Several pericardial sutures were placed to expose the pulmonary artery and the ascending aorta (Figure 1). Low-flow perfusion (less than 1.5 L/min) of CPB via the femoral artery was started gradually to avoid retrograde flow into the aortic arch. After starting CPB, a right-angled venous cannula was inserted into the main pulmonary artery, through the pulmonary valve, and into the right ventricle to provide venous return to the right ventricle. The main pulmonary artery collapsed as venous return began via this cannula. After this vessel collapsed, cannulation of the ascending aorta made it easy to achieve better exposure of the medial and anterior parts of the ascending aorta, thus avoiding the need for transverse sternotomy (Figure 2). After the ascending aorta was cannulated, the cannula was connected to a second arterial perfusion line, and the arterial line to the femoral artery was clamped. CPB was continued with full flow rate, providing rapid cooling. When the heart began to fibrillate, a vent catheter was inserted through the apex of the left ventricle to allow decompression. As cooling proceeded, the proximal segment of the aneurysm was exposed by appropriate dissection through the fourth intercostal space. A second thoracotomy was performed at the seventh or eighth intercostal space via the original skin incision. With the exposure provided by both thoracotomies, the proximal and distal aspects of the aneurysm were both surgically accessible. Before discontinuing the anterograde perfusion via the ascending aorta, 60 mEq of potassium chloride was injected into the CPB

Figure 1. Exposure of the pulmonary artery after placement of pericardial sutures via the left thoracotomy. P indicates pulmonary artery.

pump to induce asystolic arrest. When rectal temperature reached 16°C and jugular oxygen saturation was above 95%, the patient was tilted head down and anterograde perfusion from the ascending aorta was discontinued.

Once circulatory arrest was established, the distal half of the aneurysm was clamped or an aortic occlusion balloon catheter (LeMaitre Vascular, Burlington, MA, USA) was inserted directly into the aortic lumen. Perfusion to the lower body via the femoral artery was started at a rate of roughly 1 to 1.5 L/min. The proximal portion of the aneurysm was opened, and the most appropriate site for proximal anastomosis was selected (aortic arch or proximal thoracic descending aorta). After the proximal graft-aorta anastomosis was completed (Hemashield Woven Double Velour Vascular Graft; Medox Medicals, Oakland, NJ, USA), perfusion of the lower body via the femoral artery was discontinued and perfusion was restarted via the cannula in the ascending aorta at a rate of 500 mL/min. This was done to flush all air from the brachiocephalic vessels, aortic arch, and aortic graft. The graft was then clamped immediately distal to the proximal anastomosis, and anterograde perfusion of the upper aorta via the cannula in the ascending aorta was started. The distal graft-aorta anastomosis was achieved by beveling the distal opening of the descending thoracic aorta to include the patent intercostal arteries below T8. Rewarming was initiated after the distal anastomosis was completed.

DISCUSSION

The advantages of DHCA for descending and thoracoabdominal aorta procedures have been well defined by Kouchoukos and coworkers [2001]. They include minimal aortic dissection, elimination of the need for proximal and sequential aortic clamping, access to the proximal aortic arch, a bloodless field, return of the majority of the shed blood into the perfusion circuit, and protection of the central nervous system, the heart, and the abdominal organs by hypothermia. However, in patients with atheromatous or chronically dissected thoracoabdominal aorta, retrograde arterial flow from the femoral artery carries a high risk of cerebral embolism and malperfusion [Westaby 1999]. In most patients with complex aneurysms of the descending aorta, extended thoracotomy and transverse sternotomy are required to cannulate the ascending aorta. Although extended thoracotomy with a transverse sternotomy affords excellent exposure of the ascending aorta for anterograde perfusion, the sacrifice of both internal thoracic arteries with this method is an important disadvantage and has raised questions concerning wound healing. The other major disadvantage of transverse sternotomy is the high rate of sternal disruption at the transverse sternotomy site. This complication occurs in 20% to 40% of cases, and can lead to significant pain and deformity, slow the postoperative recovery, and increase the risk of sternal infection [Brown 1996].

We have used the described surgical technique to treat 6 aneurysms of the thoracic descending aorta (5 patients with chronic type B dissection and 1 with an atherosclerotic aneurysm). In all cases, the descending aorta was completely replaced, and distal arch replacement with reconstruction of the left subclavian artery was performed in 1 patient. One patient died after developing secondary paraplegia and subsequent multiple organ failure. In this patient, re-exploration was required for a bleeding thoracic artery. None of the other 5 patients developed complications, and these individuals were discharged home at a mean of 10 ± 2.9 days after the procedure. None of the 6 patients had complications related to the cannulation procedure.

In summary, this method for patients with complex aneurysms of the thoracic descending aorta who are operated on under conditions of deep hypothermia and circulatory arrest is valuable for several reasons. To avoid retrograde aortic perfusion after femoral artery and vein cannulation, the circulation can be supported initially by low-flow perfusion, and then easy cannulation of the pulmonary artery and the ascending aorta can be performed. Antegrade aortic perfusion

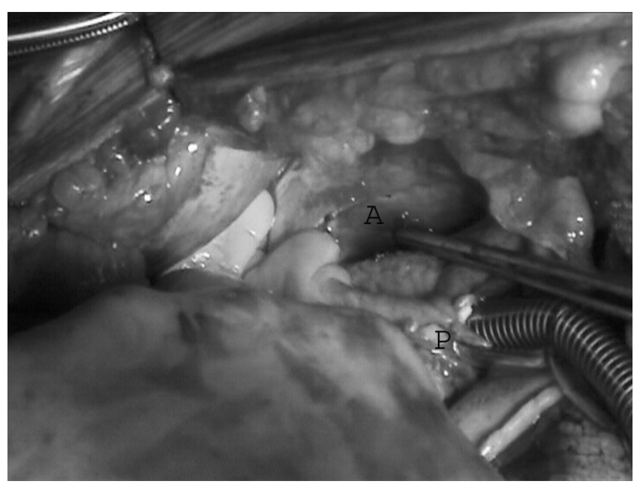

Figure 2. Exposure of the ascending aorta after collapse of the main pulmonary artery via the left thoracotomy. A indicates ascending aorta; P, pulmonary artery.

facilitates the easy evacuation of air from the ascending aorta and the aortic arch after completion of the proximal anastomosis. This method also eliminates the need for an extended thoracotomy with transverse sternotomy.

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