Proposal for bail-out procedures - Vascular thoracic

Hypothermic circulatory arrest through a left thoracotomy in a 12-year-old child with aortic coarctation

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Abstract

Surgical correction of adult complex aortic coarctation using hypothermic circulatory arrest often requires central cannulation to secure cerebral perfusion. It is not easy to place the cannula in the ascending aorta, however, especially in children undergoing surgery through a left thoracotomy. In a 12-year-old male with hypoplastic distal aortic arch, we placed an arterial cannula in the ascending aorta using the Seldinger puncture technique through the stenotic segment of the distal aortic arch. Replacement of the stenotic segment with a 20 mm-size Dacron graft was then routine. The ascending aorta was exposed only for the proximal anastomosis. The left subclavian artery was also reconstructed. This central cannulation technique is simple and is useful in repairing complex aortic coarctation.

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1. Introduction

Surgical correction of aortic coarctation in older children presents particular problems that include recoarctation, especially when the aortic arch is hypoplastic [1]. In adult patients the stenotic segment has been replaced with a full-size graft using hypothermic circulatory arrest (HCA) [2–5]. In patients with significant aortic coarctation, a central cannulation technique has been preferred to secure cerebral perfusion during cooling [2–4]. The arterial cannula was directly inserted in the ascending aorta, either through a median sternotomy or through a left thoracotomy. This technique usually involves full exposure of the ascending aorta [4].

A 12-year-old male with aortic coarctation and hypoplastic distal aortic arch was referred to us for surgical correction. Ultrasonic Doppler diagnostics revealed a pressure gradient exceeding 60 mmHg across the stenotic aortic segment. Preoperative imaging studies revealed that the diameter of the aorta just distal to the origin of the left common carotid artery was not more than 15 mm (Fig. 1). The proximal anastomosis must be extended into the ascending aorta in order to implant a prosthetic graft of size sufficient for the patient’s future growth.

2. Technique

Following endotracheal intubation with a blocker balloon for ventilation of one lung, the patient was placed in a right decubitus position. The left pleural space was entered via the fourth intercostal thoracotomy. The left superior vena cava was mobilized to the anterior direction. A small longitudinal incision (6 cm) was made in the left side of the pericardium, to facilitate cannulation in the main pulmonary artery. The ascending aorta was exposed minimally for proximal anastomosis. The arterial line of the cardiopulmonary bypass circuit was bifurcated; one branch was for the femoral artery, and the other was for central cannulation.

A full dose of heparin was administered, and the left femoral artery was cannulated with a 16F-cannula. A long venous cannula was advanced into the right atrium through the left femoral vein, and a right-angle venous cannula was...
placed in the main pulmonary artery. Partial cardiopulmonary bypass was established between the two venous cannulae and the femoral artery. A 4-0 polypropylene mattress suture buttressed with pledgets was placed in the hypoplastic transverse aorta between the left common carotid artery and the left subclavian artery. Using the Seldinger technique, the second arterial cannula (14F Fem II, Edwards Lifesciences, Irvine, CA) was then inserted through the mattress suture into the ascending aorta. The cannula was secured by a tourniquet. Total cardiopulmonary bypass was achieved and core cooling was initiated. During this period of cooling, the 20-mm Dacron graft was prepared, with the 8-mm branch graft.

Circulatory arrest was established at a nasopharyngeal temperature below 20 °C. The distal aorta was cross-clamped and the proximal arterial cannula was removed. The proximal aorta was transected just distal to the origin of the left common carotid artery. The incision was extended towards the ascending aorta. Proximal anastomosis was made with 4-0 polypropylene continuous suture. The proximal aorta was de-aired by increasing the central venous pressure. Cardiopulmonary bypass was reinstituted using both the branch graft for the proximal arterial line and the femoral artery for the distal arterial line. The HCA time was 18 min. Rewarming was then started. The distal anastomosis was made with 4-0 polypropylene continuous suture in a beveled fashion. After the distal anastomosis was complete, the cross-clamps of the distal aorta were removed. Weaning from the bypass was uneventful. The left subclavian artery was reattached to the branch graft using 5-0 polypropylene continuous suture. The stenotic aortic segment with the vagal nerve was left in-situ behind the implanted graft.

The patient was conscious soon after leaving the operating room, and was extubated next morning. No blood transfusion was necessary. He is able to take full exercise, and no pressure gradient has been detected across the graft by ultrasonic Doppler techniques six months after the operation (Fig. 2).

3. Discussion

When the aortic arch is hypoplastic in older children with aortic coarctation, as here, in-situ replacement of the stenotic segment using a sufficiently large prosthetic graft is technically challenging [6]. The larger the diameter of the implanted graft is the better the prognosis. We thought, in our patient, that cross-clamping the aorta between the brachiocephalic artery and the left common carotid artery would disturb the proximal anastomosis. Open anastomosis was therefore the method of choice to provide sufficient length of the proximal aortic incision. For safe cardiopulmonary bypass during cooling, a second arterial line is reportedly necessary in the ascending aorta as well as the femoral artery, which is usually small in patients with aortic coarctation [2–4]. It is often not easy to place the arterial cannula in the ascending aorta through a left thoracotomy. Our technique requires only minimal exposure of the transverse aorta for central cannulation. With a partial cardiopulmonary bypass the proximal aortic pressure can be reduced. Thus, the Seldinger technique permits safe and easy advancement of the arterial cannula through the stenotic segment into the ascending aorta.

The patients with aortic coarctation, like here, can be operated upon through a median sternotomy [7]. However, from the experience of the senior author (TU), there may not be enough space to manipulate a large-size graft in children. Also, this may cause recurrent nerve palsy, which did not occur in our patient. The nerve was left in-situ with the stenotic aortic segment.

However, there may be some anatomical limitations in using this technique. Cannulation may be difficult in cases where the aortic segment just distal to the left common carotid artery is very narrow and short. And the cannula itself may disturb the flow to this artery. Our technique for central cannulation is a useful adjunct in selected cases of older children with hypoplastic aortic arch undergoing surgical correction.

References