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Repair of Acute Ascending Aorta–Arch Dissection with Continuous Body Perfusion: A Case Report

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ABSTRACT

An approach for the replacement of the distal ascending aorta–proximal arch and acute dissection is described. During the operation, the patient's entire body was continuously perfused, the aortic arch was excluded from the arterial circulation, and the aorta was not clamped at any time. To achieve continuous body perfusion, we independently cannulated the right axillary and the left femoral arteries. The right atrium was cannulated for systemic venous return, and the right radial artery was used for arterial blood pressure monitoring. The myocardium was protected with retrograde cardioplegia, and the body was protected with moderate hypothermia. Vascular clamps were placed to the proximal innominate, left carotid, and left subclavian arteries without discontinuing perfusion of the right axillary artery. A temporary clamp was applied to the femoral line, the aorta was transected, and a large Foley catheter was inserted through the true aortic lumen. The Foley bulb was positioned in the proximal descending thoracic aorta and distended with saline until the aortic blood return ceased. The femoral line clamp was removed from the cannula, and the entire body was perfused during the completion of the distal aortic anastomosis. At the completion of the anastomosis, the Foley bulb was slightly deflated. Once the inserted graft was filled with blood, a large vascular clamp was applied to the graft, and the previously placed clamps were removed from the arch branches. The femoral line was removed, and the body was perfused and rewarmed via the axillary cannulation. Following completion of the proximal graft–aortic anastomosis, the heart was reperfused, and all cannulas were removed in the usual fashion. Rapid recovery characterized the patient's initial postoperative course; however, multiple organ failure secondary to pump-induced inflammatory response followed. Aggressive medical management resulted in complete patient recovery. No neurologic deficits were observed, and the patient regained full cognitive function. This report describes a simple approach to facilitate repair of the aortic arch and minimize postoperative organ failure.

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INTRODUCTION

Repair of the aortic arch is technically demanding and requires the use of deep hypothermia with circulatory arrest and protection of the brain using antegrade [Ueda 2000] or retrograde blood flow [Ueda 1999, Safi 2001]. Despite the application of these techniques, the surgeon may have difficulties in visualizing the operative field, may require increased operative time, and thus may adversely influence neurologic outcomes [Okita 1999]. This operation is generally associated with multiple organ failure [Ehrlich 2000], including brain injury, which may result in devastating consequences. Recognizing the detrimental effects that may be encountered, we describe a new perfusion technique.

CASE REPORT

Clinical Presentation

An 80-year-old man presented to our emergency department after experiencing 10/10 precordial-epigastric pressure and pain. Analysis of the patient's electrocardiogram and cardiac enzyme levels yielded normal results. Traditional standard diagnostic techniques included computed tomography, magnetic resonance of the aorta, and transesophageal echocardiography. An arch aortogram confirmed the presence of a 5.7-cm aneurysm of the distal ascending aorta–arch, complicated with a localized acute dissection (Figure 1). The proximal aorta and aortic valve were found to be normal. The descending thoracic and abdominal aorta showed evidence of a mural hematoma, which may have been related to a previous thoracic injury.

The transesophageal echocardiogram confirmed an aneurysmatic dilatation and the presence of an aortic hematoma but failed to demonstrate the occurrence of the aortic dissection.

Medical therapy was initiated with esmolol hydrochloride and sodium nitroprusside. Following admission to the hospital, the patient experienced a second episode of pain. On the basis of these diagnostic findings, the patient was taken to the operating room.

Surgical Technique

The patient was placed in the supine position, was draped, and underwent general endotracheal intubation anesthesia without complication. The area of the right clavicular and both femoral arteries was left open to provide access for arterial

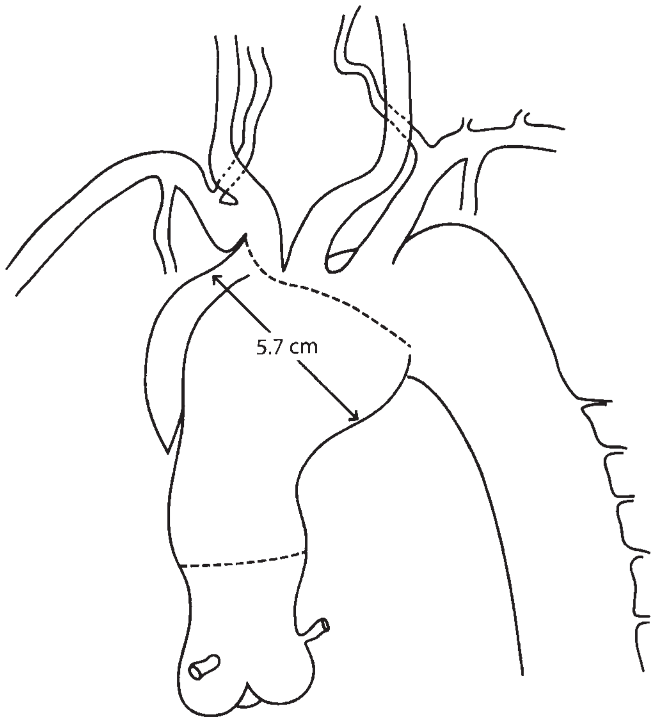

Figure 1. Composite drawing showing the extent of the aortic involvement: distal ascending aorta and proximal arch. This reconstruction is based on several aortographic views.

cannulation. The right radial artery was cannulated to monitor systemic arterial blood pressure and to discern brain perfusion pressure. Dissections of the right axillary and left femoral arteries were performed simultaneously.

A midline sternotomy and a dissection of the anterior mediastinal tissues were performed. The innominate vein was dissected, and the pericardium was incised longitudinally. Major arterial branches from the aortic arch were exposed and surrounded with Silastic tapes (Dow Corning, Midland, MI, USA). The patient was subsequently heparinized.

Arterial Line Connections

Following the placement of cardiopulmonary bypass lines, a Y connector was inserted on the arterial side. Two lines were placed, 1 cephalad toward the axillary artery and the other to the femoral area (Figure 2).

Arterial Cannulation

A 12-cm subclavicular incision was then performed. The axillary artery was dissected and subsequently exposed. Following heparin recirculation, proximal and distal control was achieved, and the artery was incised. An 8-mm Gore-Tex (W.L. Gore & Assoc, Flagstaff, AZ, USA) graft (15 cm long) was sutured in place with continuous 5-0 polypropylene sutures. After deairing of the graft, a No. 24 arterial cannula was inserted and advanced into the graft for 5 cm, secured with several No. 2-0 silk ties, and sutured to the skin.

The femoral artery was dissected, and after exposure, a No. 17 Medtronic Carmeda-coated Biomedicus arterial cannula was inserted (Medtronic, Minneapolis, MN, USA). Both axillary and femoral ends were connected proximally to the Y connector. A full dose of aprotinin was administered.

The venous return was obtained via a No. 36-46 2-stage cannula, and a retrograde set was inserted into the coronary sinus for myocardial protection. Cardiopulmonary bypass was then initiated, and the core temperature was reduced to 28°C.

Aortic Arch Management

The aortic arch dissection was extended distally to the left subclavian artery. The aorta was separated from the pulmonary artery; at this stage, systemic cooling to 28°C was achieved.

Soft vascular clamps were then applied to the brachiocephalic and left carotid arteries, and a bulldog clamp was placed across the left subclavian artery. The arterial femoral line was temporarily clamped, and the blood flow was temporarily interrupted. The flow along the axillary artery remained constant and was regulated as necessary to maintain a mean arterial (radial) pressure of 70 mm Hg.

The aorta was transected, and a No. 32 Foley catheter was introduced through the aortotomy. The 30-mL bulb was filled with normal saline and positioned at the proximal

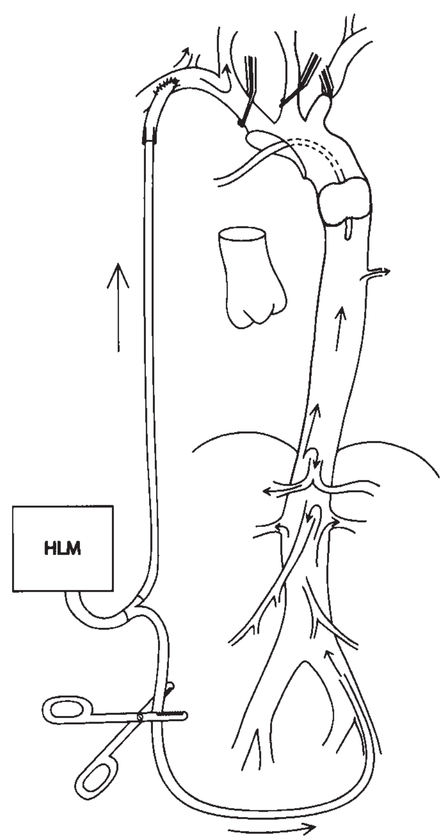

Figure 2. Arterial line placement. Both the axillary and femoral cannulations are shown. HLM indicates heart-lung machine.

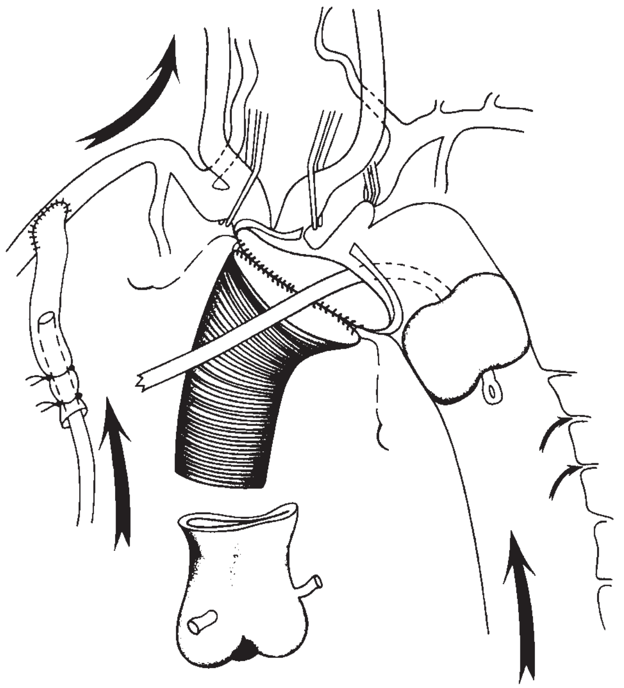

Figure 3. Distal graft–aortic anastomosis in progress. The surgical area is completely excluded from the circulation. The vascular clamps are in place, and the Foley catheter balloon is distended. Perfusion of the whole body is achieved through the axillary and femoral cannulations.

descending thoracic aorta. The arterial femoral line was then partially unclamped. At this point, no further blood was observed from the site of the Foley catheter bulb. The femoral arterial line clamp was removed, and full blood flow was resumed (Figure 3).

Surgical Procedure

Following placement of vascular clamps and endo-occlusion of the proximal thoracic aorta, the entire aortic arch became excluded from the arterial circulation while the entire body remained perfused. Retrograde intermittent blood cardioplegia was administered at 20-minute intervals.

The dilated aneurysmatic aorta including the dissection was then excised. The aortic resection extended from the mid ascending aorta to the origin of the brachiocephalic artery, with the excision extending toward the concave portion of the aorta in front of the left subclavian artery.

A 30-mm, collagen-impregnated graft was then inserted. The distal anastomosis of the graft was shaped in a bevel fashion. A long circumferential external Teflon (DuPont, Wilmington, DE, USA) pledget was used to reinforce the aortic tissue. The anastomosis was performed with No. 3-0 continuous polypropylene suture.

Following the completion of the distal anastomosis, the femoral arterial line clamp was reapplied, and the Foley balloon was deflated and removed from the aorta. Blood progressively filled the aorta and the graft, and the previously placed vascular clamps were removed from the brachiocephalic, left carotid, and left subclavian arteries. A clamp was then applied proximally to the sewn graft. The femoral line was clamped, and the femoral cannula was removed. Full circulatory support was maintained through the axillary line. Rewarming procedures were then initiated.

The aortic graft length was adjusted to the proximal anastomosis, which was performed in an end-to-end fashion. The heart was deaired, the graft clamp was removed, and the heart was reperfused. The patient was atrially paced for the spontaneous initiation of a slow sinus rhythm (Figure 4). This action converted the cardiopulmonary bypass into a standard right atrial–axillary artery cannulation, and the cardioplegic set was removed.

During cardiopulmonary bypass, the blood flow while both arterial lines remained open was 4.5 to 5.2 L/min (cardiac index, 2.28-2.64 L). While the femoral line was temporarily clamped, the axillary perfusion was reduced to 1.5 to 2.2 L/min, and a mean arterial blood pressure of 70 mm Hg was maintained through the operation. The aortic branch clamps remained in place for 42 minutes, and the total cardiopulmonary bypass time was 92 minutes.

Hemostasis was achieved after the administration of protamine, the chest underwent standard closure, and the hemodynamically stable patient was transferred to the intensive care unit.

Postoperative Course

The patient woke up with no neurologic deficits and was able to follow and comprehend verbal commands. Moreover, the patient's hemodynamics were stabilized without the use of

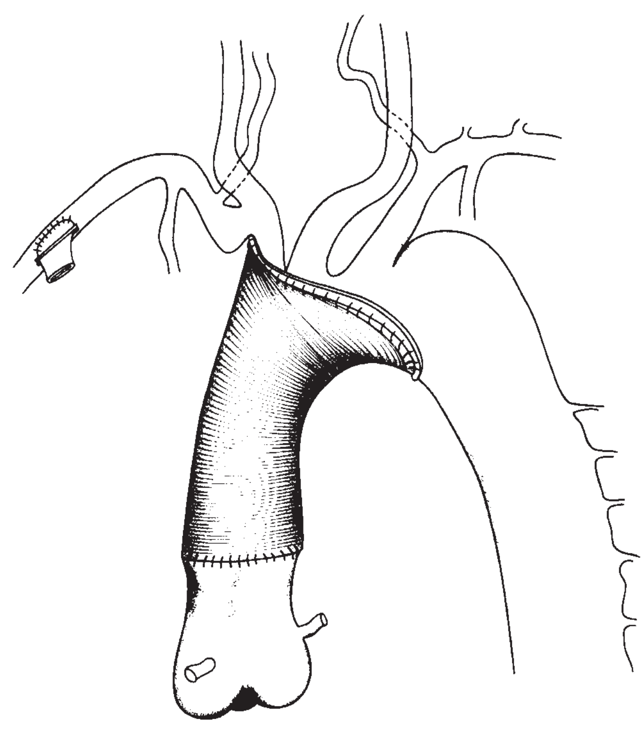

Figure 4. Completed surgical procedure.

inotropic agents. The endotracheal tube was removed on the first postoperative day. Chest drains were removed on the second postoperative day, and the patient was actively mobilized. On the third postoperative day, the patient was sitting, having oral fluids, and maintaining an intelligible conversation.

On the fifth postoperative day, the patient required reintubation for respiratory distress. Multiple complications emerged related to the systemic inflammatory response syndrome induced by the use of the heart-lung machine. The patient required a tracheostomy, acute hemodialysis, sedation, and enteral feeding. Multiple pan-cultures were performed and were found to be negative for significant infection.

All affected organs progressively recovered, and the patient had no cognitive deficits. He was transferred from the intensive care unit to a step-down unit and subsequently to a physical rehabilitation program.

DISCUSSION

Surgery of the ascending aorta–arch with graft replacement has been reported with low and high mortality and morbidity [Stowe 1998, Okita 1999, Ehrlich 2000].

When circulatory arrest is initiated for repair of the aortic arch, the blood flow to the brain is lost. The same occurs with other organs. Although antegrade and retrograde brain perfusion has been successfully used, brain protection using this approach remains suboptimal [Stowe 1998, Ehrlich 2000, Okita 2001, Safi 2001].

Historically, perfusion of the axillary artery has been used for complex aortic arch surgery [Sabik 1995, Byrne 1998] but has not been used in combination with femoral perfusion and endoaortic occlusion of the proximal descending thoracic aorta. The advantages of the described perfusion technique include allowing a complete exclusion of the aortic arch and maintaining continuous total body perfusion. By retaining blood perfusion to all organs, the surgeon theoretically should avoid the observed complications of hypothermic circulatory arrest. Furthermore, the use of aprotinin is not contraindicated, because the patient's blood remains in circulation [Sundt 1993, Gravlee 2001].

During right axillary artery perfusion, the flow to the brain is retained. A pressure of 70 mm Hg is monitored through the right radial artery that perfuses both the right internal/external carotid arteries and the right vertebral artery. The bacilar artery, which is supplied by the right vertebral artery, feeds into the posterior circuit of Willis and in conjunction with the right and left carotid arteries provides complete perfusion of the opposite side of the brain. The presence of the rich vascular anastomotic network between both external carotids allows blood flow from the right to the left external carotid. Flow from the left external carotid to the left internal carotid supplies blood to the left brain in an antegrade fashion. In the event of an incomplete circle of Willis, this carotid-carotid anastomotic network may suffice to perfuse the opposite side of the brain.

Patients presenting with an acute dissection of the aortic arch represent a high-risk group. The surgeon is challenged to create an environment that provides satisfactory visualization of and access to the surgical site; however, the safe surgical time is limited. The described procedure furnishes a simple and useful alternative and provides continuous perfusion of the brain and the entire body. The exclusion of the entire aortic arch facilitates visualization of the surgical area and theoretically should serve to reduce postoperative morbidities and enhance surgical outcomes.

REFERENCES

Byrne JG, Fitzgerald DJ, Aranki SF. 1998. Simultaneous selective cerebral perfusion and systemic circulatory arrest through the right axillary artery for aortic surgery. J Card Surg 4:236-8.

Ehrlich MP, Ergin MA, McCullough JN, et al. 2000. Predictors of adverse outcome and transient neurological dysfunction after ascending aorta/hemiarch replacement. Ann Thorac Surg 69:1755-63.

Gravlee GP. 2001. Con: aprotinin should not be used in patients undergoing circulatory arrest. J Cardiothorac Vasc Anesth 15:126-8.

Okita Y, Ando M, Minatoya K, Kitamura S, Takamoto S, Nakajima N. 1999. Predictive factors for mortality and cerebral complications in arteriosclerotic aneurysm of the aortic arch. Ann Thorac Surg 67:72-8.

Okita Y, Minatoya K, Tagusari O, Ando M, Nagatsuka K, Kitamura S. 2001. Prospective comparative study of brain protection in total aortic arch replacement: deep hypothermic circulatory arrest with retrograde cerebral perfusion or selective antegrade cerebral perfusion. Ann Thorac Surg 72:72-9.

Sabik JF, Lytle BW, McCarthy PM, Cosgrove DM. 1995. Axillary artery: an alternative site of arterial cannulation for patients with extensive aortic and peripheral vascular disease. J Thorac Cardiovasc Surg 109:885-91.

Safi HJ, Petrik PV, Miller CC III. 2001. Brain protection via cerebral retrograde perfusion during aortic arch aneurysm repair. Ann Thorac Surg 71:1062-3.

Stowe CL, Baertlein MA, Wierman MD, Rucker M, Ebra G. 1998. Surgical management of ascending and aortic arch disease: refined techniques with improved results. Ann Thorac Surg 66:388-95.

Sundt TM III, Kouchoukos NT, Saffitz JE, Murphy SF, Wareing TH, Stahl DJ. 1993. Renal dysfunction and intravascular coagulation with aprotinin and hypothermic circulatory arrest. Ann Thorac Surg 55:1418-24.

Ueda T, Shimizu H, Ito T, et al. 2000. Cerebral complications associated with selective perfusion of the arch vessels. Ann Thorac Surg 70:1472-7.

Ueda Y, Okita Y, Aomi S, Koyanagi H, Takamoto S. 1999. Retrograde cerebral perfusion for aortic arch surgery: analysis of risk factors. Ann Thorac Surg 67:1879-82.