Aneurysmectomy of the distal aortic arch, proximal descending thoracic aorta and graft interposition using Hemashield Gold Woven Double Velour Vascular Graft under mild hypothermic extracorporeal circulation: a video presentation

Ujjwal K. Chowdhury, Niwin George, Lakshmi Kumari Sankhyan, Sukhjeet Singh, Sushama Gayatri, Abhinav Sing Chauhan, Vishwas Malik, Priyanka Chowdhury

Department of Cardiothoracic and Vascular Surgery, All India Institute of Medical Sciences, New Delhi, India

Received: 01 October 2019 / Accepted: 02 November 2019

Introduction

Most medial-degenerative aneurysms of the descending thoracic aorta and distal aortic arch are fusiform rather than sacciform in nature. Thus, they involve almost the entire circumference of the aorta and excision requires insertion of a fabric graft to restore circulatory continuity [1].

The major problems in the distal aortic arch and proximal descending thoracic aortic surgeries are the adequacy of surgical exposure, maintenance of viability and maintenance of spinal cord perfusion [2-6]. Past four decades have witnessed a number of techniques of maintenance of cerebral integrity during periods of circulatory interruption [3-6]. Various techniques of antegrade and retrograde cerebral perfusion and circulatory arrest have been tried with unpredictable results [7-14]. Because of cerebral autoregulatory physiological mechanism, there are inherent logical issues of cerebrovascular spasm, under perfusion and over perfusion into an elastic or expansile cerebral vasculature, causing cerebral edema or ecchymosis [7-13]. During hypothermia, mechanical means of cerebral blood supply aggravates the problem.

In order to analyze the risk of spinal cord neurological deficit, Svensson and associates in 1993 divided the descending thoracic aorta into three equal extents: extent A was the proximal third, extent B was the middle third and extent C was the distal extent [14]. Concern over paraplegia has existed since the earliest days of aortic surgery with surgical treatment of coarctation of the aorta in 1945 [15,16]. Although spinal cord is protected from ischemic damage in coarctation of the aorta, the collateral circulation remains insufficient for prolonged temporary occlusion required for resection of aortic aneurysm [15,16].

Several ingenious techniques have been used clinically to prevent ischemic injury to the spinal cord. These techniques are a) controlled
extracorporeal circulation as was practised by Denton A. Cooley in 1957 [17]; b) atrio-femoral bypass with an interposed mechanical pump or with an oxygenator in the circuit [18]; c) femoro-femoral bypass with an interposed oxygenator [19]; d) a Gott’s aorto-aortic heparin-coated vascular shunt [20]; and e) a Gott’s tube between left ventricular apex and lower half of body [21,22].

Although the above techniques were beneficial in preventing paraplegia and reducing strain on the left ventricle in the hands of several investigators across the world, they have all introduced additional complications and slowly have fallen into disfavor [23-26]. The Texas Heart Institute Group advocated simple aortic cross-clamping with expeditious removal of the aneurysm without any such support measures and restoration of pulsatile flow. This group and other investigators published their clinical observations that indicate that periods of 30 minutes of aortic occlusion was well tolerated with a low incidence of paraplegia [23-26]. We do not have any experience in using this technique.

We report here-in a 58-year-old hypertensive male patient presented with upper back pain, hoarseness of voice and dysphagia to solids of three years duration. There was no history of chest trauma or chest infection. Computerized tomographic angiography revealed a fusiform aneurysm arising from the distal aortic arch till the upper descending thoracic aorta, about 10 cm in length and 14 cm in diameter. The proximal aortic arch and descending thoracic aorta were normal. The arch vessels were arising normally and were normal in calibre. The patient underwent aortic aneurysmectomy, and graft interposition using Hemashield Gold Woven Double Velour Vascular Graft (Boston Scientific Medi-Tech, Wayne, NJ, USA) under mild hypothermic extracorporeal circulation.

**Surgical techniques**

**Position and surgical approach**

The chest was entered through fourth and sixth left intercostal spaces using a long oblique left posterolateral thoracotomy incision for exposure of the distal aortic arch and distal graft aortic anastomosis. A double-lumen endotracheal tube allowed the collapse of the left lung, thereby facilitating the operation. The right lung which is larger than the left provided adequate ventilation during intrathoracic dissection.

**Isolation of the vagus and left phrenic nerve**

The vagus nerve pedicle was dissected away from the distal arch aneurysm and looped. The left phrenic nerve pedicle was dissected and isolated using an umbilical tape.

**Exposure and cannulation of the femoral artery and femoral vein**

An infragluteal vertical incision was made over the right femoral artery. Both the right femoral artery and right femoral vein were dissected and looped to facilitate later cannulation. Following systemic heparinization, elective femoral arteriovenous cannulation was performed using a long femoral arterial and a venous cannula (Edwards Lifesciences, LLC, One Edwards Way, Irvine, CA, USA).

**Cannulation of the distal aortic arch**

The distal aortic arch above the aneurysm at the level of the left subclavian artery was cannulated and connected to the bypass circuit for antegrade aortic perfusion. The femoral arterial perfusion was used for distal aortic perfusion.

**Completion of the aortic dissection under controlled extracorporeal circulation**

Under normothermic controlled extracorporeal circulation, the descending thoracic aorta above and below the aneurysm was dissected for proximal and distal aortic control. Meticulous attention was exercised not to injure the intercostal arteries during the process of dissection.

**Cross-clamping of the descending thoracic aorta above and below the aneurysm**

The distal aortic arch was cross-clamped proximally at the site of origin of the left subclavian artery and distally about 5–6 cm below the aneurysm.

**Aneurysmectomy and graft interposition**

The aneurysm was incised in between stay sutures in the midline. All intra-aneurysmal clots were evacuated. A 10 cm segment of Hemashield Gold Woven Double Velour Vascular Graft was used for the restoration of aortic continuity. The graft was sutured using 4-0 polypropylene sutures (Johnson and Johnson Ltd., Ethicon, LLC, San Lorenzo, USA), reinforced with Teflon pledgets as and when
required. The graft was sutured using the inclusion technique. Care was taken not to narrow the anastomotic sites. After securing hemostasis and ensuring distal aortic perfusion, the patient was separated from cardiopulmonary bypass and successfully decannulated.

**Short- and long-term results**

The postoperative recovery was uneventful. Follow-up visit at 48th month revealed the patient in New York Heart Association functional class I with good biventricular function and no neurological deficit.

**Conclusion**

The potential benefits of this dual arterial cannulation are excellent operative exposure, maintenance of perfusion of all the vital organs including the brain, avoidance of circulatory arrest, and performance of the operative procedure under controlled conditions. Aneurysmectomy and graft interposition for the restoration of aortic continuity can be performed under optimal visualization, achieving perfect hemostasis.

**Conflict of interest**

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of the article.

**Funding**

The authors received no financial support for the research, authorship and/or publication of this article.

**References**