The Heart Surgery Forum #2004-1059
7 (5), 2004 [Epub September 2004]
doi:10.1532/HSF98.20041059

Online address: www.hsforum.com/vol7/issue5/2004-1059.html

Surgery Using Median Sternotomy for Diffuse Aneurysmal Disease of the Thoracic Aorta

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ABSTRACT

We present our experience using an anterior approach for the replacement of an extensive aneurysm of the thoracic aorta. In recent years we have performed surgery on 20 patients by means of a median sternotomy for aneurysms of the ascending aorta, aortic arch, or descending thoracic aorta. In all but 1 of the patients, a procedure in the ascending aorta was also performed. In some patients a small anterior left thoracotomy at the 4th intercostal space was required to allow the replacement of the aorta as for the diaphragm. Antegrade selective cerebral perfusion (ASCP) according to Kazui's technique was used as a brain protection method. All procedures were performed successfully and the aneurysm was completely resected. No neurologic complications or other major complications occurred. We believe that the anterior approach for extensive thoracic aorta replacement is feasible, allows the use of ASCP, and has shown encouraging results.

INTRODUCTION

The aneurysmal pathology of the thoracic aorta may have several degrees of extension: it may involve only a few segments or, occasionally, the entire extension of the thoracic aorta. The main causes of the diffuse aneurismal disease of thoracic aorta are type A aortic dissection, mega-aorta syndrome (often a consequence of chronic aortitis), and inheritable pathologies of the connective tissue such as Marfan syndrome.

In the complex cases, it is possible to approach the aorta in a single definitive operation or in a multistage operation including, in selected cases, a hybrid approach with endoprosthetic treatment.

We report herein our experience with a single-stage operation to treat an extended aneurysm of the thoracic aorta using median sternotomy with an associated left anterior thoracotomy. A brief video of ascending aorta, aortic arch, and descending thoracic aorta replacement using sternotomy accompanies this article.

Presented at the 10th Annual CTT Meeting 2004, Miami Beach, Florida, USA, March 10-13, 2004.

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MATERIALS AND METHODS

Patient Profile

From November 1996 to December 2003, 20 patients underwent surgical treatment of diffuse aneurysmal disease of the thoracic aorta. Thirteen patients were treated for degenerative true aneurysms, 4 patients for chronic dissection, and 3 patients for pseudoaneurysm after aortic coarctation repair and aortic arch hypoplasia. There were 14 men and 6 women aged 58.3 ± 13.2 years (mean ± SD) (range, 18-72 years). All patients underwent elective surgery. Associated diseases included hypertension in 16 patients (80%), coronary artery disease in 2 (10%), chronic renal dysfunction, defined as a serum creatinine level exceeding 2 mg/dL, in 2 (10%), and diabetes in 1 (5%). Symptomatic cerebral vascular disease (transient ischemic attack) was present in 1 patient (5%). Six patients (30%) had undergone previous surgical procedures: coarctation repair in 3 patients, ascending aorta replacement for acute type A aortic dissection in 2 patients, and aortic valve replacement in 1 patient. A preoperative evaluation of cerebral circulation was performed in all cases with echo-Doppler and/or digital angiography.

Operative Techniques

A median sternotomy was used in 13 patients (65%) and a median sternotomy plus left anterolateral thoracotomy in 7 (35%). After systemic heparinization, standard cardiopulmonary bypass (CPB) was instituted, the arterial cannula was inserted in the femoral artery, and a single 2-stage cannula was placed in the right atrium. The left side of the heart was vented through the right superior pulmonary vein. Myocardial protection was provided with cold crystalloid cardioplegia (Custodiol; Koehler Chemie, Alsbach-Haenlein, Germany).

Selective cerebral perfusion (SCP) as described by Kazui [1989] was used in all cases to prevent ischemic brain damage during aortic surgery. As the patient was cooled down to a nasopharyngeal temperature of 26°C, the systemic circulation was arrested and the ascending aorta or aortic arch wall was opened. With the patient in the Trendelenburg position, 15 F retrograde coronary sinus perfusion cannulae (Chase Medical, Richardson, Texas, USA) were inserted into the brachiocephalic and left common carotid arteries through the aortic lumen. The left subclavian artery was clamped or occluded with a tourniquet to prevent a "steal" phenomenon. A single-roller pump separated from the systemic circulation was used to initiate cerebral blood flow at 10 mL/min per kg of body

weight and adjusted to maintain a right radial pressure between 40 and 70 mm Hg. Open distal aortic anastomosis was performed [Kazui 1992]. When the anastomosis was completed, the prosthesis was clamped and CPB restarted in order to allow brief distal perfusion (5-6 minutes). With respect to the extent of replacement, a complete replacement of the thoracic aorta (ascending, arch, and descending) was performed in 8 patients (40%), a total arch and descending aorta replacement in 8 patients (40%), and an ascending aorta plus total arch and upper descending aorta replacement in 4 patients (20%). Supraaortic vessels were reimplanted using en bloc [Pearce 1969] or separated graft techniques [Spielvogel 2002, 2003].

Concomitant procedures included composite valve graft implantation (modified Bentall procedure) in 4 patients (20%), coronary artery bypass grafting in 2 patients (10%), and mitral valve repair in 1 patient (5%).

Extracorporeal Circulation Data

The mean CPB time was 228.1 ± 52.7 minutes, and the mean aortic cross-clamp time was 166.4 ± 20.4 minutes. Complete circulatory arrest time, defined as the time between the systemic circulation suspension and the beginning of SCP, was 5.9 ± 1.9 minutes. The mean SCP time was 127 ± 29.2 minutes.

RESULTS

There were no early deaths. No permanent neurologic deficit, defined as stroke, was reported.

Transient neurologic dysfunction, defined as postoperative agitation, lethargy, or confusion with complete resolution of symptoms before discharge, occurred in 2 patients (10%).

Other postoperative complications consisted of pulmonary failure requiring respiratory support for more than 48 hours postoperatively in 2 patients (10%), bleeding requiring a repeat thoracotomy in 1 patient, and renal failure in 1 patient (5%). Cardiac complications occurred in 2 patients (10%), acute myocardial infarction in 1 patient and congestive heart failure in 1 patient.

DISCUSSION

In the last decades, the technical improvement of CPB, myocardial protection, and intensive care technique have reduced mortality and morbidity during surgery of the thoracic aorta.

Neurologic injuries are the most feared complications resulting from suspension of cerebral circulation. To prevent these complications, various methods have been widely used.

Deep hypothermia with circulatory arrest (DHCA), used in our institution since 1974 during aortic arch operations [Pierangeli 1975], is a simple and valid method. This technique presents the disadvantage of a limited safe time of circulatory arrest (<40 minutes at 18°C); stroke incidence and mortality rate increase for a circulatory arrest time of longer than 45 and 60 minutes, respectively [Svensson 1993]. With this technique the incidence of cerebral complications ranged from 7% to 10% [Crawford 1989, Svensson 1993, Ergin 1994]. In our experience permanent neurologic deficit occurred in 5.4% of patients and transient neurologic dysfunction in 6.7% [Di Bartolomeo 1997]. Furthermore, prolonged CPB time, required to cool and rewarm the patients, increases the risk of coagulative deficits, pulmonary complications, and microembolisms [Loop 1976].

Retrograde cerebral perfusion associated with DHCA was introduced to prolong the safe period of circulatory arrest, and good results have been reported [Ueda 1990, Yasuura 1992, Safi 1993]. Coselli [1995], in a recent study, did not report any transient or permanent neurologic deficits in 111 patients. However, this technique does not avoid the problems associated with DHCA. We have had very limited experience with this technique and the results were similar to those obtained with DHCA.

Since November 1996, we have been using SCP as described by Kazui [1989, 1992, 1995] with very encouraging results. This technique provides moderate hypothermia (26°C), which, at the same time, reduces the problems due to deep hypothermia and prevents ischemic injuries of the abdominal viscera and the spinal cord. Cerebral perfusion is obtained by cannulating the innominate and left common carotid arteries and regulated by a single-roller pump separated from the systemic circulation [Di Bartolomeo 2001]. The blood is perfused at the rate of 10 mg/kg per minute.

SCP has considerably prolonged the safe time of circulatory arrest, allowing more complex and time-consuming aortic arch reconstruction [Di Eusanio 2003].

In our experience we have seen that it is possible to treat diffuse aneurysmal disease of the thoracic aorta (arch, ascending, and descending aorta) using only an anterior approach (median sternotomy); the opening of the left pleura allows the exposure of the descending thoracic aorta until the third distal portion. Occasionally an additional left anterior thoracotomy at the fourth intercostal space may be necessary to improve the exposure in case of a particular thorax conformation, involvement of the aorta up to the diaphragmatic iatus, or in case of reoperation with firm pleuritic adhesions.

In summary, antegrade SCP is an optimal technique of cerebral protection. It extends the safe period of circulatory arrest and obviates the problems due to deep hypothermia. The main characteristics of this kind of protection (prolonged safe cerebral protection time, moderate hypothermia, improved cerebral cooling, maintained cerebral autoregulation, and independent control of cerebral and systemic circulation) has led us to offer a single-stage correction with satisfactory results for a complex pathology such as diffuse aneurismal disease of the thoracic aorta. The anterior approach, using a median sternotomy, is safe and allows good exposure of almost the entire thoracic aorta; moreover, it significantly reduces the surgical invasivity in terms of wound extension and number of operations.

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