Original Article

Surgical Treatment of Aortic Arch Aneurysm Combined with Coronary Artery Stenosis

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Objective: We present operative results of aortic arch aneurysm associated with coronary artery stenosis, and evaluate the operative risk of graft replacement of the aortic arch and concomitant coronary artery bypass grafting (CABG).

Patients and Methods: From January 1991 to December 2001, we treated 16 patients with aortic arch aneurysm and coronary artery stenosis. The patients, 3 women and 13 men (study group) ranged from 58 to 79 years of age, average 68.1±5.3 years. With the aid of deep hypothermic cardiopulmonary bypass, we performed graft replacement of the aortic arch aneurysm and concomitant CABG. We bypassed 31 coronary arteries. The bypass grafts included saphenous vein (n=16), left internal thoracic artery (n=4), right internal thoracic artery (n=1), right gastroepiploic artery (n=5) and inferior epigastric artery (n=2). The number of bypassed coronary arteries per patient ranged from 1 to 3, average 2.1±0.8/patient. A comparative study was performed between the study group and a control group of patients (n=39) who had undergone only graft replacement of the aortic arch.

Results: There was no significant difference between the two groups regarding: operation time, cardiopulmonary bypass time, cardiac arrest time, intraoperative bleeding volume, and early mortality rate. However, in the patients (n=4) of the study group who had undergone total arch graft replacement with three vessel CABG, the cardiopulmonary bypass time was significantly longer than that of the patients in the control group who underwent total arch graft replacement (n=19, P<0.05). Two of the 16 study group patients died in the early postoperative period, resulting in 12.5% early mortality rate. In the control group, four of 39 patients (10.3%) died in the early postoperative period.

Conclusions: CABG combined with graft replacement of the aortic arch does not increase operative risk when the number of bypassed vessels is within two vessels, but may increase risk when three or more vessels are bypassed. (Ann Thorac Cardiovasc Surg 2002; 8: 369–73)

Key words: aortic arch aneurysm, coronary artery disease, concomitant operation

Introduction

As the number of elderly people in the population has increased, so too has the number of patients with thoracic aortic aneurysm combined with ischemic heart disease because both diseases have the same etiology: atherosclerosis. The incidence of this combination of disease ranges from 16 to 30%.[1-3] However, there are a few reports of systematic investigation of the operative results of surgical treatment for aneurysm of the aortic arch combined with coronary artery disease.[4] There is no doubt that one stage operation combining graft replacement of the aortic arch with coronary artery bypass grafting (CABG) is inevitable. However, the operative results of this procedure are still not satisfactory due to the greater surgical risk of the concomitant procedures and the car-

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diac dysfunction that can be caused by the coronary artery disease (CAD). It is important to evaluate the operative risk of this combined disease for improving operative results.

Patients

Although the operative indications for aortic arch aneurysm with CAD are essentially the same as those without CAD, the operative indication for the treatment of coronary artery stenosis in these patients is controversial. There is no doubt that one stage operation is better for these patients with multi-vessel CAD. We have performed CABG simultaneously with aortic arch aneurysm repair even in the patients with single-vessel CAD because the long-term graft patency rate with surgical intervention is better than that with percutaneus transluminal coronary angioplasty.

From January 1991 to December 2001, we treated 55 elective surgical patients with nondissecting or chronic dissecting aneurysms who underwent preoperative coronary angiography (CAG). Sixteen (29.1%) of 55 patients had significant coronary stenosis, and CABG was performed in association with aortic arch graft replacement (study group). Patients with an acute dissecting aneurysm who could not undergo preoperative CAG and who underwent CABG following intraoperative findings of CAD were excluded from this study. The aortic arch aneurysms consisted of atherosclerotic aneurysms (n=15) and DeBakey type I chronic dissecting aneurysm (n=1). Patients ranged in age from 58 to 79 years, average 68.1±5.3 years. There were 13 men and 3 women. Total aortic arch graft replacement (n=11) or proximal arch graft replacement (n=5) were performed with CABG concomitantly.

Operative Procedure

In this concomitant operation, graft replacement of the aortic arch was the main procedure rather than CABG. In the study patients, the mean cooling time to targeted lowest rectal temperature (17.7±2.7°C) was 27.5±9.5 minutes. During core cooling, we completed as many of the planned graft-coronary artery anastomosis as possible. However, left internal thoracic artery (LITA) to native coronary artery anastomosis was done after completion of the distal aortic anastomosis because of the disruption to the operative field caused during the distal aortic anastomosis. A firm and safe anastomosis of the posterior half of distal aortic anastomotic circumference is key in graft replacement of the aortic arch because of the difficulty in achieving hemostasis at this site after completion of aortic arch graft replacement. Therefore, the distal aortic anastomosis was reinforced with a Dacron felt strip, and six or seven 3-0 polypropylene interrupted mattress sutures and 2-0 polypropylene running sutures were used at this site.[5] After completion of the distal aortic anastomosis and reconstruction of the left subclavian artery, antegrade perfusion was resumed from the fourth branch of the arch graft. The order of the reconstruction of the arch vessels and coronary anastomosis was based on the degree of preoperative damage to the brain or heart of the patient. In the patients with a history of brain infarction, reconstruction of the arch vessels was carried out prior to coronary anastomosis to shorten selective cerebral perfusion (SCP) time. In the patients with poor left ventricle contraction by myocardial infarction, coronary anastomosis was carried out prior to reconstruction of the arch vessels to shorten cardiac arrest time.

The number of reconstructed arch vessels was three in 11 patients, two in two patients, and one in three patients. The mean cardiopulmonary bypass (CPB) time was 161.9±58.2 minutes (range, 107 to 291 minutes), the mean cardiac arrest time (aortic clamp time) was 97.6±26.9 minutes (range, 68 to 153 minutes), the mean circulatory arrest time for distal aortic anastomosis was 36.4±15.9 minutes (range, 32 to 49 minutes), and the mean lowest rectal temperature was 17.7±2.7°C (range, 12 to 20.1°C). Cardioplegic solution was infused intermittently either antegradely or ante- and retrogradely at 20 to 30 minutes intervals. Two independent roller pumps maintained SCP during circulatory arrest. One pump perfused the right side of the brain via the right axillary or right subclavian artery, and the other pump perfused the left side of the brain via both the left common carotid artery and the left subclavian artery. Under monitoring of the right superficial temporal arterial pressure and left-sided SCP cannula pressure, the SCP flow rate was regulated to maintain the arterial pressure before starting SCP.[6-8] The mean right-sided SCP time was 84.9±24.7 minutes (range, 27 to 134 minutes), and the mean left-sided SCP time was 65.8±23.7 minutes (range 25, to 104 minutes). The mean operation time was 7.87±1.48 hours (range, 5.2 to 10.4 hours), and the mean intraoperative bleeding volume was 2,616±1,890 ml (range, 750 to 6,850 ml).

To evaluate the increase in operative risk from the one stage operation combining graft replacement of the aortic arch with CABG, we compared operative mortality rate, operation time, total CPB time, cardiac arrest time,

Table 1. Comparison of two groups of patients, who underwent arch graft replacement associated with and without CABG

	(Ascend.) Arch graft replacement+CABG	(Ascend.) Arch graft replacement	P value
No. of patients	16	39	
No. of bypassed coronary arteries	2.1±0.8	0	
Age (years)	68.1±5.3 (58-79)	62.9±10.6 (39-77)	ns
Gender	M/F=13/3	M/F=26/13	ns
Operative mortality	12.5% (2/16)	10.3% (4/39)	ns
Operation time (hours)	7.87±1.48	7.15±1.28	ns
Total CPB time (min)	161.9±58.2	150.3±34.7	ns
Cardiac arrest time (min)	97.6±26.9	98.6±38.4	ns
Circulatory arrest time (min)	36.4±15.9	34.2±13.1	ns
rt SCP (min)	84.9±24.7	76.1±32.0	ns
lt SCP (min)	65.8±23.7	60.1±26.4	ns
Lowest rectal temperature (degrees C)	17.7±2.7	18.1±2.0	ns
Intraoperative bleeding volume (ml)	2,616±1,890	3,239±1,446	ns

Ascend.: ascending, CPB: cardiopulmonary bypass, SCP: selective cerebral perfusion
CABG: coronary artery bypass grafting, rt: right, lt: left

Table 2. Comparison of two groups of patients, who underwent total arch graft replacement with and without 3 vessel CABG

	Total arch graft replacement+ CABG (3 vessel bypass)	Total arch graft replacement	P value
No. of patients	4	19	
Operation time (hours)	9.07±1.17	7.26±1.35	ns
Total CPB time (min)	220.0±66.2	159.3±35.3	<0.05
Cardiac arrest time (min)	117.3±35.0	104.3±25.2	ns

CPB: cardiopulmonary bypass
CABG: coronary artery bypass grafting

circulatory arrest time, SCP time, lowest rectal temperature and intraoperative bleeding volume in the 16 study patients with 39 patients who underwent graft replacement of the aortic arch without CABG.

Statistical analysis

The data in this study are expressed as mean±standard deviations (SD). The differences of variables between the two groups were determined by the unpaired t-test. A p value less than 0.05 was considered statistically significant. All computations were performed using Stat View 5.0 (SAS Institute, Cary, NC) statistical software packages.

Results

The mean number of anastomosed coronary arteries was 2.1±0.8 vessels (range 1 to 3 vessels) per patient. We used 16 saphenous vein grafts (SVG) and 12 arterial grafts as follows: 4 LITA to 4 left anterior descending arteries, 1 right internal thoracic artery to 1 left anterior descending artery, 5 right gastroepiploic arteries to 4 right coronary arteries and 1 left circumflex artery, and 2 inferior epigastric arteries to 1 right coronary artery and 1 first diagonal artery, respectively. Satisfactory patency was confirmed in 20 bypass grafts (including the arterial grafts) in the 10 patients who underwent postoperative CAG.

Age, gender, mortality rate, operation time, CPB time, cardiac arrest time, circulatory arrest time, right sided SCP time, left sided SCP time, lowest rectal temperature and intraoperative bleeding volume for both groups of patients are shown in Table 1. There was no significant difference between the two groups in any of these factors. Concomitant CABG with aortic arch graft replacement did not appear to increase operative risk. However, in the patients with total arch graft replacement and three-vessel CABG (n=4), total CPB time was significantly longer than that of the patients in the control group who underwent total arch graft replacement (n=19, P<0.05) (Table 2).

Two of the 16 patients in the study group died from cerebral infarction and pneumonia, respectively, in the early postoperative period (within 30 days of surgery),

resulting in a 12.5% early mortality rate. In the control group, four of the 39 patients (10.3%) who underwent graft replacement of the aortic arch only, died in the early postoperative period. Two of these four died from cerebral infarction.

Discussion

In the literature, the incidence of graft replacement of the aortic arch associated with CABG has been reported from 17 to 33%.[9-11] These reports discuss mainly postoperative cerebral complications, which is one of the major risk factors in the surgical treatment of aortic arch aneurysm. In this study, three (50%) out of six who died in the early postoperative period in both group died from postoperative cerebral infarction. Prevention of postoperative cerebral infarction is found to be essential to improve operative results in graft replacement of the aortic arch combined with CABG as well as aortic arch replacement alone.

A few reports discuss whether concomitantly performed CABG can also be a risk factor. None of them discuss the intraoperative timing of coronary anastomosis and selection of graft materials of CABG in such a combined operation. Some authors state that myocardial infarction is one of the main causes of early postoperative death after surgical treatment of aortic arch aneurysm and that it is necessary to address concomitant surgical intervention for coronary stenosis for postoperative mortality.[10,12] They emphasize the importance of having a well-thought-out operative plan to shorten CPB and cardiac ischemic time and of aggressively performing concomitant CABG to further improve operative results, especially in older or high-risk patients who have multiple organ dysfunction. Svensson et al.[10] reviewed 656 patients who had undergone graft replacement of their aortic arch aneurysm; and 111 (16.9%) of the 656 had also undergone concomitant CABG. Overall early mortality in his series was 10%. In their report, the early mortality in patients with concomitant CABG was 12.6% and was higher than that in patients without CABG (9.5%). However, concomitant CABG was not found to be a statistically significant risk factor of early postoperative death in the surgical treatment of aortic arch aneurysm. Other investigators[4,9,13] have also concluded that CABG is not a risk factor for early operative mortality. In our study, we found no significant difference in operative risk factors between patients undergoing aortic arch graft replacement with concomitant CABG and patients undergoing aortic arch graft replacement alone. However, in the patients with concomitantly performed three vessel CABG and total aortic arch graft, CPB time was significantly longer than that of the control patients. Therefore, surgical risk may increase in patients undergoing total aortic arch replacement and CABG when three or more vessels are bypassed.

Although there is no disagreement regarding the use of arterial grafts as the first choice in CABG only, their use is controversial in combined graft replacement of the aortic arch and CABG surgery. In reports of this concomitant surgery, SVG were used because their use shortens operation time and benefits myocardial protection via the direct infusion of cardioplegic solution through the anastomosed saphenous veins.[14] In 1993, we reported a case of three-vessel CABG and concomitant aortic arch repair, which included the anastomosis of the LITA to the LAD.[15] Although we have aggressively used various types of arterial grafts since then, it is important to select the grafts based on the individual patient. The mean age of the patients with arterial grafts was 65±4.1 years, while that in the patients with vein grafts was 70±4.8 years. We tended to use SVG in the patients older than 70 years in this study. Some authors believe that it is unwise to use the internal thoracic artery for bypass grafting because stenosis or obstruction of the reconstructed arch branches can lead to graft failure. In our series, all patients in this study in whom arterial grafts were used experienced no problems in weaning from CPB, and satisfactory patency was confirmed in other bypass grafts in the 10 patients, in whom postoperative CAG could be performed. Bachet et al.[12] and Pressler et al.[16] reported that myocardial infarction is one of the main causes of late postoperative death after surgical treatment of aortic arch aneurysm and that CABG is important to further improve late operative results of this surgery. We believe that satisfactory long-term results can be obtained when an arterial graft is used in the key grafting of coronary artery, particularly in younger patients.

Conclusions

CABG concomitantly performed with graft replacement of the aortic arch does not increase operative risk when the number of bypassed vessels is within two, however, operative risk may increase due to the prolongation of pump time when three or more vessels are bypassed.

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