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Original Article / Özgün Makale

Aortic pathologies after cardiac surgery

Kalp cerrahisi sonrası aortik patolojiler

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Background: This study aims to assess the risk factors for aortic pathologies developing following open heart surgery.

Methods: Between January 2000 and January 2009, 13,995 patients who underwent open heart surgery under extracorporeal circulation in our clinic were retrospectively analyzed. Among these patients, 50 with a previous history of cardiac surgery (39 males, 11 females; mean age 52.1±13.9 years; range 21 to 80 years) followed by an aortic pathology were enrolled. The mean time lapse between two operations was 8.5±7.4 months (range 1-31 months).

Results: The rate of total mortality was %32 (n=15). All of the five patients who underwent emergent operations died. The mean aortic diameter during the first operation was 4.1 cm, while it was 5.5 cm during the second operation. Age, aortic cross-clamping time and total perfusion time were higher in the mortality group compared to the survivors ($p<0.05$).

Conclusion: In parallel with the increasing life expectancy, it should be kept in mind that the frequency of redo operations may increase with an increasing mortality rate depending on the age. More radical surgical interventions, thus, may be used in lieu of palliative approaches during the first operation.

Key words: Aortic aneurysm; aortic dissection; aortic valve replacement; coronary artery bypass grafting; mitral valve replacement.

Amaç: Bu çalışmada açık kalp cerrahisi sonrası gelişen aortik patolojilerin risk faktörleri değerlendirildi.

Çalışma planı: Ocak 2000 - Ocak 2009 tarihleri arasında kliniğimizde vücut dışı sirkülasyon ile açık kalp cerrahisi uygulanmış 13.995 hasta retrospektif olarak incelendi. Bu hastalar içinden daha önce açık kalp cerrahisi geçirmiş olan ve sonrasında aortik patoloji tespit edilen 50 hasta (39 erkek, 11 kadın; ort. yaş 52.1±13.9 yıl; dağılım 21-80 yıl) çalışmaya dahil edildi. Her iki ameliyat arasında geçen ortalama süre 8.5±7.4) ay (dağılım 1-31 ay) idi.

Bulgular: Total mortalite oranı %32 idi (n=15). Acil olarak ameliyata alınan beş hastanın tamamı kaybedildi. İlk ameliyattaki aort çapları 4.1 cm iken, ikinci ameliyatta tespit edilen ortalama aort çapı 5.5 cm idi. Sağ kalan hastalara kıyasla, mortalite grubunda yaş, aortik kros klemp zamanı ve total perfüzyon zamanı daha yüksekti ($p<0.05$).

Sonuç: Yaşam beklentisinin artmasına paralel olarak, redo ameliyatların sıklığının artacağı ve bu ameliyatların mortalitesinin yaş ile birlikte arttığı göz önünde bulundurulmalıdır. Bu nedenle ilk ameliyatlarda palyatif yaklaşımlardan ziyade daha radikal cerrahi girişimler uygulanabilir.

Anahtar sözcükler: Aortik anevrizma; aortic diseksiyon; aort kapak replasmanı; koroner arter baypas greftleme; mitral kapak replasmanı.

Intrathoracic aortic pathologies, though they are rarely encountered after cardiac surgery, are serious problems due to their potentially lethal clinical prognosis. The underlying causes of dissections and aneurysms can include the pathology of the aortic valve, hypertension, and connective tissue diseases, or they may be secondarily attributed to the first operation and arise from suture lines, cannulation sites, cross-clamping,

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or areas of proximal anastomosis. The point at which the extent of aortic dilatation necessitates intervention differs according to the etiology. The aim of this study was to assess the risk factors involved in the development of intrathoracic aortic pathologies prior to and following open heart surgery.

PATIENTS AND METHODS

The 13,995 patients who underwent open heart surgery under extracorporeal circulation in our clinic between January 2000 and January 2009 were assessed retrospectively, and the 50 patients (39 males, 11 females; mean age 52.1±13.9 years; range 21 to 80 years old) who had undergone repeated open heart surgery for aortic pathologies were included in this study. All demographic data along with the pre- and postoperative clinical data regarding the first and second operations were collected from the patient records.

In the first operative procedure, 11 patients underwent coronary artery bypass graft (CABG) surgery, 17 had aortic valve replacement (AVR), and six had ascending aorta replacement (Table 1).

Out of the 13,995 patients who underwent open heart surgery under extracorporeal circulation, 2526 had undergone previous aortotomies. The intrathoracic aortic pathology development rate for these patients was 1.5% while the overall rate was 0.4%.

The intrathoracic aortic pathologies diagnosed after the first operation were aortic dissection for 14 patients and ascending aortic aneurysm for 26 patients (Table 2). In addition, aortic dilatation was detected in 41 patients and aortic dissection without aortic aneurysm formation was seen in five. Forty-six patients had reoperations, and four were treated medically. Of these four, two refused reoperation, one was not operated on due to advanced age and concomitant disorders, and one had small cell lung carcinoma, which precluded proceeding with the surgery.

The preoperative risk factors of the patients were as follows: 23 were smokers, 15 had chronic obstructive pulmonary disease (COPD), five were morbidly obese, five had hypercholesterolemia, and three had suffered previous cerebrovascular accidents (Table 3).

The following reoperation procedures were used to treat the intrathoracic aortic pathologies: 14 patients underwent ascending aorta replacement, 13 underwent the Bentall-De Bono procedure, eight had graft replacement of the descending aorta, six had AVR + ascending aorta replacement, and five had CABG + ascending aorta replacement (Table 4).

Statistical analyses

The Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) for Windows version 11.0 was used for the statistical analysis of data obtained from the study. Quantitative data was analyzed using statistical methods, mean, standard deviation (SD), median, and minimum and maximum values, whereas qualitative data was examined using frequencies and percentages. When comparing quantitative data between the groups, Student's t-test was used for comparing normally distributed parameters, and a non-parametric Mann-Whitney U test was used for comparing parameters which were not normally distributed. When comparing qualitative data, a chi-square test was used. When the assumptions of the chi-square test were not provided and the expected value was less than five, Fisher's exact test was used for the comparison. The statistical level of significance was accepted as $p<0.05$.

RESULTS

Forty-six of the 50 patients who had undergone previous surgery for various cardiac disorders and had developed

Table 1. Type of first operation

First operations	n	%
Aortic valve replacement	17	34
Coronary artery bypass grafting	11	22
Ascending aorta replacement	6	12
Aortic coarctation repair	3	6
Tetralogy of Fallot total correction	2	4
Aortic valve replacement + ascending aorta replacement	2	4
Bentall De Bono procedure	2	4
Aortic valve replacement + coronary artery bypass grafting	2	4
Coronary artery bypass grafting + ascending aorta replacement	2	4
Graft replacement of the descending aorta	1	2
Mitral valve replacement	1	2
Aortic valve replacement + mitral valve replacement	1	2

Table 2. Preoperative diagnoses

Operative diagnoses	n	%
Aortic dissection type 1	9	18
Aortic dissection type 2	1	2
Aortic dissection type 3	4	8
Ascending aorta aneurysm	26	52
Descending aorta aneurysm	8	16
Aortic pseudoaneurysm	2	4

Table 3. Preoperative risk factors

Preoperative risk factors	n	%
Hypertension	31	62
Smoking	23	46
Chronic obstructive pulmonary disease	15	30
Atherosclerosis	14	28
Morbid obesity	5	10
Hypercholesterolemia	5	10
Cerebrovascular accident	3	6
Chronic renal failure	3	6
Diabetes mellitus	3	6
Marfan syndrome	2	4

intrathoracic aortic pathologies were treated surgically while the remaining four patients were treated medically. Operative mortality was seen in 15 patients with a mortality rate of 32%. Surgery was performed on five patients who were experiencing emergency conditions, and all of them died.

The causes of mortality were postoperative low cardiac output syndrome for six patients, intraoperative cardiac failure for four patients, sepsis for three patients, and acute respiratory distress syndrome and multiple organ failure for two patients.

During the postoperative period, various types of infections occurred in eight of the cases, cardiac rhythm disorders were seen in six others, bleeding requiring reoperation also occurred in six cases, and cerebrovascular accidents were identified in four more.

In the second operations, ascending aortic cannulation was used for three patients, whereas the axillary artery was used in 12 others. In addition, the femoral artery was utilized in 31 cases for arterial cannulation. There were no significant differences between the cannulation sites in terms of mortality or cerebrovascular accidents ($p>0.05$). Moreover, the presence of preoperative risk factors did not significantly affect mortality ($p>0.05$).

The mean aortic diameter of the cases was 4.1 cm before the first operation and 5.5 cm before the second operation.

The mean time interval between the first and the second operations was 8.5±7.4 months (range; 1-31 months). The operative data for the second operations included a mean aortic cross-clamp (ACC) time of 88 minutes, a mean cardiopulmonary bypass (CPB) time of 136.5 minutes, and a mean hypothermia level of 26 ºC (Table 5).

The mean age of the patients was significantly higher in the mortality group (62 years) when compared with the survivors (49 years) ($p=0.01$). Aortic cross-clamp times were also divergent between the two groups ($p=0.02$). The mean ACC time was 132 minutes in the mortality group and 82 minutes for the survivors (0.02). The average CPB time of the mortality group and the survivors was 160 minutes and 121 minutes, respectively. This difference between the two groups was also statistically significant ($p=0.004$) (Table 6).

DISCUSSION

Despite the improvement in cardiac surgical procedures, the mortality rate for aortic surgery still remains high. In various series, the operative mortality rates of type A and type B aortic dissections have been reported as 4-17% and 11-15%, respectively; however, there was no difference between the two types of dissections in terms of long-term survival.[1] The operative mortality rate for patients with an aortic aneurysm has ranged between 1.7% and 17.1% in several studies.[2] Additionally, previous

Table 4. Second surgical procedures for treating intrathoracic aortic disorders

Second surgical procedure	n	%
Ascending aorta replacement	14	30
Bentall De Bono procedure	13	29
Graft replacement of the descending aorta	8	17
AVR + ascending aorta replacement	6	13
CABG + ascending aorta replacement	5	11

AVR: Aortic valve replacement; CABG: Coronary artery bypass grafting.

Table 5. Operative data regarding the second operations

Operative data	Mean±SD
Aortic diameter (second operation)	5.8±1.5
Time interval between the two operations	8.5±7.4
Aortic cross clamp time (minutes)	107.2±46.9
Cardiopulmonary bypass time (minutes)	158.3±82.0
Hypothermia level (°C)	26.1±3.2

SD: Standard deviation.

Table 6. The operative data according to mortality status

	Mortality group		Survivors		
Operative data	Mean	Min.-max.	Mean	Min.-max.	*p*
Age	62.0	39.0-71.0	49.0	21.0-75.0	0.01
Aortic cross-clamp time (minutes)	132.0	68.0-235.0	82.0	44.0-231.0	0.02
Cardiopulmonary bypass time (minutes)	160.0	79.0-366.0	121.0	68.0-275.0	0.04
Hypothermia level (°C)	25.5	18.0-30.0	28.0	18.0-32.0	0.06
Aortic diameter (first operation)	3.9	3.0-6.0	4.1	3.0-5.0	0.91
Aortic diameter (second operation)	5.4	3.4-8.7	5.3	4.0-10.0	0.56

Min.: Minimum; Max.: Maximum.

cardiac surgical procedures have been found to be a determinant of mortality after aortic surgery.[3]

The operative mortality rates for reoperative aortic procedures are dramatically high even in the best series, with rates varying from 6-22% in different series.[4] In our study, we found a 32% mortality rate, with the need for urgent surgery, aortic arch replacement, and prolonged CPB time being the factors affecting mortality. The reason for the need for a reoperative aortic procedure was appraised as an inadequate first operation in 60% of the patients in a study by Dougenis et al.[4] Usually the problem in the first operation revolves around leaving a residual aneurysmatic segment, particularly in the distal ascending aorta or arcus aorta. Some surgeons prefer to use total circulatory arrest during distal anastomosis in all of their ascending aorta replacement procedures to assess the distal ascending aorta and arcus aorta,[5] but many hesitate to do this because of the increase in neurological complication rates.[6] Although we could not show a relationship between postoperative aortic disorders and preoperative risk factors such as smoking and hypertension, it is important to know that these risk factors were present in most of our cases. Patients who control their hypertension and who stop smoking can protect themselves from aneurysm or dissection formation in the postoperative period.

Stanger et al.[7] reported that the incidence of late aortic dissection after cardiac surgery is 0.6-2.3%. Thirteen percent of these patients had an AVR procedure as the first operation. The aortic wall of these patients could also be affected by surgical manipulations or existing connective tissue disease, so it is necessary to assess them carefully. von Kodolitsch et al.[8] reported that the incidence of late dissection after cardiac surgery is 0.6%, whereas it is 9% after aortic valve surgery. They deduced that the main reason for late dissection after cardiac surgery is the fragility and thinness of the aortic wall. In our study, the rate of intrathoracic aortic pathologies that developed in all patients who had undergone open heart surgery under extracorporeal circulation was 0.4% while it was 1.5% for those who had had aortotomies.

It has been stated that the existing dilatation of the aorta enlarges in a slower fashion or almost stops after aortic valve replacement.[9] It was shown in a 30-month follow-up that for patients with a normal initial aortic diameter, the ascending aorta did not dilate after aortic valve replacement. The annual dilatation amount of the ascending aorta was stated as 0.1-0.7 cm after aortic valve replacement in patients with an initial aortic diameter larger than 4 cm. Some of the patients had a noticeable amount of dilatation; however, this group consisted of only the 9.3% of patients who had an aortic diameter larger than 4 cm. Fixing the aortic valve pathology can suppress aortic dilatation, but existing aortic wall disorders, cannulation of the ascending aorta, cross-clamping of the ascending aorta, and manipulations such as aortotomies can predispose aortic dissection.[9] Posacıoğlu et al.[10] reported a series of 12 cases of postoperative aortic dissection and found that the major cause of mortality after surgical treatment was multiorgan failure syndrome due to prolonged intubation time. In our study, it was revealed that increased age along with prolonged ACC and CPB times were the predictors of mortality in postoperative aortic disorders.

Hirose et al.[11] retrospectively assessed 108 patients who had postoperative aortic disorders requiring surgery and found a mortality rate of 5.6%. They noted that the major factor which affected mortality was bleeding, and no statistically significant differences were discovered related to mortality between the elective and urgent intervention groups. Aortic dissection was mostly seen in patients who had CABG or AVR as the first operation, and the leading complications were bleeding and infections. As shown in our study, the majority of the patients who had postoperative aortic disorders had had CABG or AVR as their first operation. In contrast to the findings of Hirose et al.,[11] our study found that

the factors which affected mortality were increased age, prolonged perfusion times, and the need for urgent surgery.

Gillinov et al.[12] reported 56 cases of late aortic dissection after cardiac surgery and noted a 14% operative mortality rate. They also emphasized that rupture rarely occurs in cases of postoperative aortic dissection.

The average aortic diameter of the patients in our study who underwent a second operation was 4.1 cm at the time of the first operation. Avoiding more than one cross-clamping of the aorta, maintaining careful postoperative hypertension control, and realizing the risk of aneurysm progression or aortic dissection formation should be taken into account with patients who have dilated aortas.

A limitation of our findings is that it is difficult to ascertain the real incidence of aortic disorders that develop after a cardiac surgical procedure. The patients may have been admitted to another clinic other than the one which performed the first operation, or some may have died without being admitted to the hospital. For similar reasons, we also encountered difficulties in finding details about the first operations.

In conclusion, if the surgeon keeps in mind that the mortality rate increases with age and that the frequency of reoperations is going to increase in parallel to increased life expectancy, then performing a complete surgical repair would be a rational choice for the first operation rather than treating the patient palliatively. On the other hand, while it is clear that ACC and CPB times may be long in the second operation, it is still unclear whether performing radical operations in the first stage should be the preferred option since high mortality rates are reported even in the most successful series.

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