Early outcomes of cardiac reoperations: seven years of experience

Kardiyak tekrar ameliyatlarında erken dönem sonuçları: Yedi yıllık deneyimimiz

Hayrettin Tekümit, Ali Rıza Cenal, Cenk Tataroğlu, Kemal Uzun, Esat Akıncı

Department of Cardiovascular Surgery, Özel Avrupa Şafak Hospital, İstanbul

Background: The aim of this study was to present and discuss the early outcomes of our cardiac reoperation cases.

Methods: Between February 2001 and September 2008, 8645 patients underwent cardiac operations in our clinic. Medical records of 127 (1.46%) of them (76 females 51 males; mean age 51.2±13.6 years; range 11 to 75 years), who underwent cardiac reoperation, were retrospectively analyzed. The main reasons for redo cardiac surgery were progression of valvular diseases after repairs (n=43), occlusion of left internal thoracic artery or saphenous vein grafts (n=35). Preoperative clinical characteristics, perioperative data and early postoperative outcomes of the cases were presented.

Results: The interval between the first and redo cardiac operation was 7.5±8.0 (1-35) years. Four cases were operated under emergency conditions. Types of the reoperations were as follows: 35 isolated coronary artery bypass grafting surgery (27.5%), 70 isolated valve surgery (55.1%), 10 combined valvular plus coronary artery bypass grafting surgery and 12 other types of cardiac reoperation. In-hospital mortality rate was 5.5% (7 cases).

Conclusion: Reoperation itself is no longer a risk factor for poor outcome and we believe that cardiac reoperations may be done effectively and with acceptable risks when specific multidisciplinary approaches are adopted.

Key words: Aort valve replacement; arrythmia; coronary artery bypass grafting; reoperation; valve, aortic.

Amaç: Bu çalışmada, kliniğimizde gerçekleştirilen kardiyak tekrar ameliyatlara ait erken dönem sonuçları değerlendirildi.

Çalışma planı: Kliniğimizde Şubat 2001 ile Eylül 2008 tarihleri arasında gerçekleştirilen 8645 açık kalp ameliyatı içinde yer alan 127 (%1.46) kardiyak tekrar ameliyat olgusunun (76 kadın 51 erkek; ort. yaş 51.2±13.6 yıl; dağılım 11-75 yıl), tıbbi kayıtları geriye yönelik olarak incelendi. En sık rastlanan redo kardiyak ameliyat endikasyonları, daha önce tamir edilen kalp kapak lezyonlarının ilerlemesi (n=43) ve daha önce uygulanan sol internal torasik arter veya safen ven greftlerinde tıkanma olması (n=35) idi. Olguların ameliyat öncesi klinik özellikleri, ameliyat sırası bulguları ve erken dönem ameliyat sonrası seyirleri analiz edildi.

Bulgular: İlk ameliyat ile tekrar ameliyat arasında geçen ortalama süre 7.5±8.0 (1-35) yıldı. Olgulardan dördü acil koşullarda ameliyat edildi. Tekrar ameliyatların temel cerrahi girişim sınıflaması şöyleydi: 35 olgu izole koroner arter bypass ameliyatı (%27.5), 70 olgu izole kalp kapağı girişimi (%55.1), 10 olgu kombine kapak artı koroner girişimi ve 12 olgu diğer girişimler. Hastane mortalite oranı %5.5 idi (7 olgu).

Sonuç: Kardiyak tekrar ameliyatlar günümüzde kötü prognoza neden olacak bir risk faktörü değildir. Özgün multidisipliner yaklaşımlar göstererek, kardiyak tekrar ameliyatların güvenli ve kabul edilebilir risk profili çerçevesinde gerçekleştirilebileceğine inanıyoruz.

Anahtar sözcükler: Aort kapak replasmanı; aritmi; koroner arter bypass ameliyatı; tekrar ameliyat; aort kapağı.

Although recently the prevalence of redo coronary artery bypass grafting (CABG) reached a plateau,[1] the reoperation rate for CABG is still approximately 3% at five years, over 11% at 10 years, and 17% at 12 years after the initial operation. Other reports give the reoperation rates between 3% and 8.65%.[2] On the other hand, the number of patients undergoing reoperation for valvular heart disease is increasing and it will continue to increase as the general population ages.[3]

Cardiac surgery requiring a re-sternotomy (the so-called "redo" surgery) is technically difficult and carries a higher operative risk than the initial intervention. The

Received: February 13, 2009 *Accepted*: March 10, 2009

Correspondence: Hayrettin Tekümit, M.D. Özel Avrupa Şafak Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 34245 Gaziosmanpaşa, İstanbul, Turkey. Tel: 0212 - 417 00 00 e-mail: htekumit@yahoo.com

particular problems are well recognized and include a difficulty to access the heart (due to adhesions, fibrosis or calcification around the operative site) making the dissection and suture placement difficult, which in turn results in prolonged durations of operation and increased postoperative mortality and morbidity rates.[4] Thus, cardiac reoperations are specific procedures requiring additional experience both in terms of operative decision making and surgery.

The aim of this study was to present our experience on cardiac reoperations and their early outcomes.

PATIENTS AND METHODS

Study population

Between February 2001 and September 2008, 8645 patients had cardiac operations in our cardiovascular surgery clinic. A total of 127 (1.46%) patients (76 females, 51 males; mean age 51.2±13.6 years; range 11 to 75 years), who underwent cardiac reoperations were included in the present study. Hospital records of these redo patients were retrospectively analyzed. Demographical and clinical characteristics of these patients are shown in Table 1. The mean time between the initial operation and the reoperation was 7.5±8.0 years (range 1-35 years). The main reasons for redo cardiac surgery were the progression of valvular diseases after repairment (n=43), prior left internal thoracic artery or saphenous vein graft occlusion (n=35), prosthetic valve dysfunction (n=18), new onset coronary and native valve disease (n=12), presence of paravalvular leakage on implanted mechanical prosthetic valves (n=7), and other cases of failure and/or complications that developed after the first cardiac surgery (n=12). Procedures performed at the first cardiac operation are shown in Table 2.

Surgical technique

In all cases, initially the right common femoral artery and the right common femoral vein were prepared to provide a route for a possible emergency cardiopulmonary bypass. Before sawing the sternum, the epigastric fascia was opened and the inferior heart was dissected away from the chest wall. The sternal wires were cut anteriorly and bent back, but they were not removed in order to protect the underlying structures. An oscillating saw is used to divide the sternum. Once the posterior table of the sternum was divided with the saw, the wires were removed and a sharp dissection was done with scissors to separate each side of the sternum from the underlying structures. The dissection plane was close to the sternum and developed along the diaphragmatic surface, then up around the right atrium towards the aorta. Dissection on the aorta was performed slowly and diligently to avoid penetration and extension beneath the adventitia. Dissection of the left heart was completed on cardiopulmonary bypass (CPB). The heart was not dissected more than necessary to perform the planned operation safely. The patent left internal thoracic artery (LITA) was isolated and controlled either before or after the initiation of CPB. The cardiopulmonary bypass was initiated and mild systemic hypothermia (30-32 °C) was achieved. Antegrade blood cardioplegia in induction and continuous retrograde blood cardioplegia in maintenance were used for myocardial protection.

RESULTS

Except for four emergency reoperations, all reoperations were performed under elective conditions. Duration of the cross-clamp ranged between 14 minutes and 193 minutes (mean 76.9±35.4 min.). Durations of intensive care unit (ICU) stay and duration of hospitalization ranged between 0 to 48 days and 2 to 46 days, respectively. Prolonged intubation rates and prolonged ICU stay were 20.2% and 19.4%, respectively. Data regarding the operations are presented in Table 3.

The distribution of the types of the reoperations was as follows: 35 cases had isolated CABG (27.5%), 70 cases had isolated valve surgery (55.1%), 10 cases had combined valvular plus coronary surgery and 12 cases had other types of cardiac reoperation. All cases undergoing CABG had full revascularization and 44 out of 45 of them required re-revascularization of the left anterior descending artery (LAD). The mean number of distal anastomoses per patient was 1.97±1.1 (range 1-4). Off- pump redo CABG surgery was performed on 22 of the patients. The most common isolated or combined valvular intervention was mitral valve replacement (n=60), followed by aortic valve replacement (n=23), tricuspid valve reconstruction (n=11), paravalvular leak repair (n=7), tricuspid valve replacement (n=2), aortic valve repair (n=1), open mitral commissurotomy (n=1) and mitral ring annuloplasty (n=1). Surgical procedures performed in redo cardiac surgery processes are shown in Table 3.

A total of seven patients died within 30 days after operation (5.5%): two following isolated CABG reoperations, two combined coronary plus valvular reoperations and three following isolated valvular reoperations. A total of 114 patients (89.7%) were event-free during the operation and in the early postoperative period. Three patients developed major hemorrhages during the re-sternotomy procedure, but all survived. Postoperatively, one patient required permanent pacemaker implantation (at day 23) and two patients developed non-microbial sternal dehiscence (at day 15 and 24, respectively).

DISCUSSION

Cardiac reoperations represent one of the main challenges of cardiac surgery. Although recently the prevalence of redo CABGs reached a plateau,[1] the reoperation rate for CABG is approximately 3% at five years, over 11% at 10 years, and 17% at 12 years after the initial operation. Other reports give reoperation rates between 3% and 8.65%.[2] On the other hand, the number of patients undergoing reoperation for valvular heart disease is increasing and will continue to increase as the general population ages.[3]

Since February 2001, a total of 8645 open heart surgery operations were done in our clinic, among which 127 (1.46%) were reoperations. In our study, 70 cases were operated for an isolated valvular disease (55.1%). The numbers of patients operated for isolated coronary disease and combined valvular plus coronary disease were 35 (27.5%) and 10 (7.8%), respectively. This high number of valvular reoperations may be attributed to the relatively higher incidence of the rheumatic valvular heart disease in our population.

The main factor making cardiac operations different and unique is the need for a sternotomy. Cardiac surgery requiring a re-sternotomy (the so-called "redo" surgery) is technically difficult and carries a higher operative risk than the initial operation.[4] The pericardium is usually not closed after a heart surgery, and injuries to the grafts, the right atrium and ventricle, pulmonary artery, aorta and the innominate vein may occur.[5] Patients with valvular heart disease may be particularly prone to these complications, because atrial dilatation can result in significant

Table 1. Demographical and preoperative clinical characteristics of redo patients (n=127)

Parameter	n	%	Mean±SD
Age (year)			51.2±13.6
Body mass index (kg/m^2)			26.6±5.3
Male gender	51	40.2	
Peripheral artery disease	8	6.3	
Cerebrovascular disease	8	6.3	
Preoperative cerebrovascular accident	4	3.1	
Preoperative renal dysfunction	14	11.0	
Chronic obstructive pulmonary disease	35	27.6	
Previous myocardial infarction	48	37.8	
Diabetes mellitus	40	31.5	
Hypertension	44	34.6	
Smoking	42	33.1	
Interval between the first and redo operation (year)			7.5±8.0
Ejection fraction (%)			48.8±7.4
Pulmonary artery pressure (mmHg)			51.5±19.2
EuroSCORE-logistic			9.7±10.5
EuroSCORE-standard			6.8±2.6
Rythm			
Normal sinusal rhythm	81	63.8	
Atrial fibrillation	43	33.9	
Atrioventricular-block	3	2.4	
Complaints			
Palpitation	76	59.8	
Angina pectoris	46	36.2	
Canadian class II	7	15.2	
Canadian class III	36	78.2	
Canadian class IV	3	6.6	
Dyspnea	87	68.5	
NYHA class II	5	5.7	
NYHA class III	63	72.4	
NYHA class IV	15	17.2	
Emergency condition			
Emergent	4	3.1	
Elective	123	96.9	

NYHA: New York Heart Association; Canadian classification and NYHA classification was done for coronary patients (n=46) and valvular disease patients (n=87), respectively.

Table 2. Procedures performed during the first operation (n= 127)

Procedure	Number of patients
Coronary artery bypass grafting	59
Open mitral valve repair	38
MVR (with mechanical prosthesis)	6
AVR (with mechanical prosthesis)	4
AVR plus MVR (with mechanical prosthesis)	2
CABG plus mitral valve repair	5
Ventricular septal defect closure	3
MVR (with bioprosthesis)	2
AVR (with bioprosthesis)	2
AVR plus MVR (with bioprosthesis)	2
Atrial septal defect closure	1
Pulmonary stenosis repair	1
Atrioventricular canal defect repair	1
Repair of sinus valsalva aneurysm rupture	1

AVR: Aortic valve replacement; MVR: Mitral valve replacement; CABG: coronary artery bypass graft.

cardiomegaly, atrial thinning and adherence of the heart to the posterior sternum. The incidence of hemorrhage following a re-sternotomy is between 2% and 6%.[6-8]

Ellman et al.[9] reported the results of 612 re-sternotomy cases in which 56 (9.1%) had an injury during the re-sternotomy and the initial dissection. Injury to grafts was the most common (46.4%) event, with mammary arteries comprising 21% and the vein grafts comprising 25% of the total. The right ventricle was the second most commonly injured structure (21.4%). Injuries occurring during the reoperation have caused mortality rates as high as 37%, and the mortality rates of those with an injury to a patent internal thoracic artery (ITA) was between 9% and 50%.[10]

In three (2.3%) of our cases, hemorrhage occurred following the re-sternotomy: in one case, the hemorrhage originated from the right ventricle; in another, from the ascending aorta; and in the last case, from an accidentally injured LITA graft. None of our cases died due to this re-sternotomy bleeding, which may be attributed to the precautious preparation of right (rarely left) common femoral artery and common femoral vein at the beginning of the operation, so that an emergency cardiopulmonary bypass could be started without delay.

Consideration should be given to the fact that the adhesions become less inflammatory and less vascularized over time: therefore, the longer the interval between the operations is, the better the results are. Reoperation following a period between three weeks and six months after the last operation is the most difficult choice.[10] In our study, the mean time from the first operation to the reoperation was 7.5±8.0 years (range 1-35 years).

The redo coronary bypass surgery is known to be a high-risk surgery. Early mortality of redo CABG

Table 3. Operative and early postoperative data for reoperations (n= 127)

Parameter	n	%	Mean±SD
Duration of CPB (minutes)			103.96±48.9
Duraton of X-clamp (minutes)			76.9±35.4
Duration of intubation (hours)			14.5±14.3
Postoperative ICU stay (hours)			2.7±5.0
Duration of hospitalization (days)			10.5±7.7
Number of distal anastomosis			1.97±1.1
Off- pump redo CABG	22	17.3	
Prolonged mechanical ventilation	25	20.2	
Prolonged ICU stay	24	19.4	
Postoperative CVA	4	3.2	
Postoperative renal dysfunction	18	14.6	
Perioperative MI	–	–	
Low cardiac output	14	11.0	
Multi-organ failure	9	7.1	
Postoperative inotropic agent use	80	63.0	
Intra-aortic balloon pump	15	11.8	
Postoperative pulmonary complications	58	47.2	
Chest re-exploration	8	6.5	
Readmision to ICU	23	18.9	
Re-intubation	12	9.8	
Mortality	7	5.5	

CPB: Cardiopulmonary bypass; ICU: Intensive care unit; CABG: Coronary artery bypass surgery; CVA: Cerebrovascular accident; MI: Myocardial infarction.

ranges between 1.8% and 16.7%. The ten-year survival and angina-free survival rates after redo-CABG have been reported as 66.5% and 30%, respectively.[1] In the present study, the overall mortality rate was 5.5% (7 patients). Of these, two underwent isolated redo CABGs, two underwent redo combined valvular plus coronary operations, and three underwent isolated redo valvular surgeries.

The cause of perioperative death was cardiovascular in 85% of cases in the most recent cohort of patients undergoing reoperation. Furthermore, in the reoperation series, in-hospital mortality was associated with new perioperative myocardial infarction in 67% of the cases.[11] On the other hand, the early mortality rate of the patients undergoing off-pump surgery was lower than the rate of those undergoing conventional reoperations (3.3% vs. 5.5%).[12]

In our study, there were no postoperative myocardial infarctions among isolated CABG reoperation cases which may be attributed to the following factors: *(i)* 22 out of the 35 isolated CABG operations were done on the beating heart (62.8%); *(ii)* number of distal anastomoses per patient was low (1.97±1.1); *(iii)* the LITA anastomosis was injured during cardiac exploration in only one case; and *(iv)* continuous retrograde blood cardioplegia was routinely used in all redo CABG cases operated under CPB.

In patients with coronary reoperations, hospital mortality is reported to be influenced by the presence of a peripheral vascular disease, myocardial infarction between the initial operation and the redo operation, occluded ITA grafts, operative status (emergency vs. elective), CPB time longer than 120 min., antegrade delivery of cardioplegia, development of perioperative myocardial infarction,[13] diabetes mellitus and chronic obstructive pulmonary disease,[14] as well as low ejection fraction, age, female gender, a history of arrhythmia,[10] mammary artery grafting at the initial operation,[15] and renal insufficiency.[16]

In case of valvular reoperations, significant predictors of mortality were the time since the initial operation, age, indication, concomitant coronary artery bypass grafting and the replacement with a mechanical valve rather than a tissue valve.[17] Impaired functional capacity, low ejection fraction, emergent or urgent presentation, impaired renal function and involvement of the tricuspid valve were also reported as predictors of mortality after redo valve surgery.[18] Overall mortality for those patients undergoing the first heart valve reoperation was approximately 8.6%.[17]

The majority of deaths in the recent study series are due to cardiac causes, especially myocardial failure, which reflects the severely compromised hemodynamic conditions of the patients undergoing heart valve reoperations.[18]

Most of our cases consisted of valvular reoperations (70 cases, 55.1%). Our mortality rate following isolated valvular operations was observed as 4.2% (3 cases). One of these cases has had a mitral valve replacement (MVR) performed at the initial cardiac operation and was reoperated for mechanical valve dysfunction associated with a cardiogenic shock. In the second case, a dysfunction of both the aortic and mitral biological prosthetic valves was present. In the third case, the mechanical aortic and mitral prosthetic valves were again replaced by mechanical valves. The high number of valvular reoperation cases in our study can be explained by the following factors: *(i)* the prevalance of rheumatismal heart diseases is still high in our population and *(ii)* the initial intervention of most valvular reoperation cases was repair rather than replacement (68.5%).

Emergency redo surgeries may be required in patients with conditions such as endocarditis, unstable angina

Table 4. Procedures performed during the redo operation (n=127)

Procedure	Number of patients
Isolated CABG	35
Off- pump	22
On- pump	13
Isolated valve surgery	70
MVR*	42
AVR plus MVR**	9
AVR	10
TVR	2
Paravalvular leakage repair	7
Combined valvular and coronary surgery	10
CABG plus MVR	6
CABG plus MVR plus AVR	2
CABG plus mitral ring annuloplasty	1
CABG plus AVR	1
Other types of cardiac reoperations	12
Isolated graft interposition of ascending aorta	3
Ventricular septal defect closure	3
Atrial septal defect closure	1
Bentall operation plus MVR	1
Left atrial myxoma extirpation plus mitral ring annuloplasty	1
Atrioventricular canal defect repair	1
Repair of sinus valsalva aneurysm rupture	1
Dilatation of right ventricular outflow tract	1

*: Eight patients had additional Tricuspit De Vega annuloplasty; **: Three patients had additional Tricuspit De Vega annuloplasty; CABG; Coronary artery bypass grafting; MVR: Mitral valve replacement; AVR: Aortic valve replacement; TVR: Tricuspid valve replacement.

pectoris and acute aortic dissection. The mortality rate of those series is 43%, with half of the deaths occurring during the operation. The most important cause of morbidity in survivors is stroke (9%). The above-mentioned conditions may be associated with a mortality rate that may approach 100% without surgical intervention.[9] In our study, we had four cases of emergency reoperations (3.1%): two of them was in cardiogenic shock due to mechanical mitral valve dysfunction, one of them had an acute Stanford type A aortic dissection eight months after the CABG, and acute mitral insufficiency due to chordae rupture was present in the last patient who had undergone a four-vessel CABG two years ago. None of these patients died. These cases were directly transported from echocardiography or catheterization laboratory to the operating theatre. All cases had been intubated before being admitted to the operating room.

The prevalence of the coronary artery disease is gradually increasing and the rheumatismal valve disease will continue to be a health problem for the next few decades in the developing countries. In addition to this, the initial cardiac operations have begun to be performed at an earlier age, and the life expectancy is increasing due to this. All of these factors will contribute to a higher frequency of redo operations in the future. However, the reoperation itself is no longer a risk factor for a poor outcome[19] and we believe that cardiac reoperations may be done effectively and with acceptable risks when specific multidisciplinary approaches are adopted.

REFERENCES

1. Di Mauro M, Iacò AL, Contini M, Teodori G, Vitolla G, Pano M, et al. Reoperative coronary artery bypass grafting: analysis of early and late outcomes. Ann Thorac Surg 2005;79:81-7.
2. He GW, Acuff TE, Ryan WH, He YH, Mack MJ. Determinants of operative mortality in reoperative coronary artery bypass grafting. J Thorac Cardiovasc Surg 1995;110:971-8.
3. Fremes SE, Goldman BS, Ivanov J, Weisel RD, David TE, Salerno T. Valvular surgery in the elderly. Circulation 1989;80:I77-90.
4. Goodwin AT, Ooi A, Kitcat J, Nashef SA. Outcomes in emergency redo cardiac surgery: cost, benefit and risk assessment. Interact Cardiovasc Thorac Surg 2003;2:227-30.
5. Shanmugam G. Aortic valve replacement following previous coronary surgery. Eur J Cardiothorac Surg 2005;28:731-5.
6. English TA, Milstein BB. Repeat open intracardiac operation. Analysis of fifty operations. J Thorac Cardiovasc Surg 1978;76:56-60.
7. Macmanus Q, Okies JE, Phillips SJ, Starr A. Surgical considerations in patients undergoing repeat median sternotomy. J Thorac Cardiovasc Surg 1975;69:138-43.
8. Wideman FE, Blackstone EH, Kirklin JW, Karp RB, Kouchoukos NT, Pacifico AD. Hospital mortality of re-replacement of the aortic valve. Incremental risk factors. J Thorac Cardiovasc Surg 1981;82:692-8.
9. Ellman PI, Smith RL, Girotti ME, Thompson PW, Peeler BB, Kern JA, et al. Cardiac injury during resternotomy does not affect perioperative mortality. J Am Coll Surg 2008;206:993-7.
10. Roselli EE, Pettersson GB, Blackstone EH, Brizzio ME, Houghtaling PL, Hauck R, et al. Adverse events during reoperative cardiac surgery: frequency, characterization, and rescue. J Thorac Cardiovasc Surg 2008;135:316-23.
11. Gonzalez-Stawinski G Vi, Lytle B Wi. Coronary artery reoperations. In: Cohn Lh, editor. Cardiac surgery in the adult. 3rd ed. New York: McGraw-Hill; 2008. p. 711-32.
12. Mishra YK, Collison SP, Malhotra R, Kohli V, Mehta Y, Trehan N. Ten-year experience with single-vessel and multivessel reoperative off-pump coronary artery bypass grafting. J Thorac Cardiovasc Surg 2008;135:527-32.
13. van Eck FM, Noyez L, Verheugt FW, Brouwer RM. Analysis of mortality within the first six months after coronary reoperation. Ann Thorac Surg 2002;74:2106-12.
14. van Eck FM, Noyez L, Verheugt FW, Brouwer RM. Preoperative prediction of early mortality in redocoronary artery surgery. Eur J Cardiothorac Surg 2002;21:1031-6.
15. Akins CW, Buckley MJ, Daggett WM, Hilgenberg AD, Vlahakes GJ, Torchiana DF, et al. Reoperative coronary grafting: changing patient profiles, operative indications, techniques, and results. Ann Thorac Surg 1994;58:359-64.
16. Akins CW, Buckley MJ, Daggett WM, Hilgenberg AD, Vlahakes GJ, Torchiana DF, et al. Risk of reoperative valve replacement for failed mitral and aortic bioprostheses. Ann Thorac Surg 1998;65:1545-51.
17. Jones JM, O'kane H, Gladstone DJ, Sarsam MA, Campalani G, MacGowan SW, et al. Repeat heart valve surgery: risk factors for operative mortality. J Thorac Cardiovasc Surg 2001;122:913-8.
18. Luciani N, Nasso G, Anselmi A, Glieca F, Gaudino M, Girola F, et al. Repeat valvular operations: bench optimization of conventional surgery. Ann Thorac Surg 2006;81:1279-83.
19. Sabik JF 3rd, Blackstone EH, Houghtaling PL, Walts PA, Lytle BW. Is reoperation still a risk factor in coronary artery bypass surgery? Ann Thorac Surg 2005;80:1719-27.