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Koroner Bypass Sonrası Hastalarda Greft Açıklığı, Hastalık İlerlemesi ve Tekrar Girişim Oranının Orta Dönem Anjiyografik Değerlendirilmesi

MID-TERM ANGIOGRAPHIC EVALUATION OF GRAFT PATENCY, DISEASE PROGRESSION AND RE-INTERVENTION RATE IN PATIENTS AFTER CABG

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Özet

Amaç: Bu retrospektif çalışmanın amacı pompalı ve pompasız koroner arter bypass cerrahisi (KABG) uygulanmış 619 hasta da orta-dönem anjiyografik sonuçları, hastalık ilerlemesi ve tekrar girişim oranının belirlenmesiydi.
Materyal ve Metod: Haziran 1992 ile Aralık 2001 yılları arasında KABG uygulanmış 619 hastada (Pompalı KABG n: 509, pompasız KABG n: 110) ortalama 52.3 ± 15.8 ay sonra kontrol koroner anjiyografik muayene yapıldı. Toplam 1689 bypass değerlendirildi. Greftlerin açıklık oranları, yeni gelişmiş damar lezyonları ve re-intervasyonlar incelendi.
Bulgular: Ortalama hasta yaşı pompalı grupta 55.2 ± 9.3, pompasız grupta 52.9 ± 10.1 yıl idi. Pompalı grupta hastaların %12.9 kadın iken pompasız grupta bu oran %21.8 idi. Operasyon ile anjiyografik değerlendirme arasında ki süre pompalı grupta 55.4 ± 17.6 ay, pompasız grupta ise 49.1 ± 12.8 aydı. Sol internal mammariyan arter ve safen ven greftleri'nin açıklık oranları pompalı grupta %93, %75.4, pompasız grupta %91 ve %66 idi. Pompalı grupta 131 olguda (%25.7) toplam 144 hemodinamik olarak anlamlı yeni damar lezyonu, 112 olguda (%22) toplam 126 tekrar girişim, pompasız grupta ise 29 olguda (%26.3) toplam 33 yeni damar lezyonu ve 23 olgu da (%20.9) toplam 23 tekrar girişim yapıldığı saptandı.
Sonuç: Bu çalışmanın pompalı ve pompasız CABG uygulanan hastalarda orta-dönem anjiyografik sonuçlarının değerlendirilmesi açısından bir fikir verdiğine inanmaktayız. Daha fazla sayıda olgu içeren çağdaş yöntemlerle yapılacak tamamlayıcı çalışmalar gereklidir.
Anahtar kelimeler: KABG, koroner anjiyografi

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Summary

Background: The aim of this retrospective study was; determination of mid-term angiographic results, the rate of disease progression and re-intervention of the 619 patients who had been operated with the techniques of on- pump and off-pump coronary artery bypass grafting (CABG).
Methods: During the period from June 1992 until December 2001, control angiographic examinations were performed in 619 (On-Pump: 509, Off-Pump: 110) patients at an average of 52.3 ± 15.8 months after CABG. A total of 1689 anastomoses on 619 patients were evaluated. Patency rate of the grafts, newly developed vessel lesions, and re-interventions were noted.
Results: Mean age was 55.2 ± 9.3 year in on-pump group and 52.9 ± 10.1 year in off-pump group respectively. The percentage of female patients was 12.9% in the on-pump group and 21.8% in the off-pump group. The mean interval from operation to angiographic examination was 55.4 ± 17.6 months and 49.1 ± 12.8 months respectively. The patency rate of the left internal mammary artery and saphenous vein graft was 93%, 75.4% in the on-pump group and 91%, 66% in the off-pump group. There were a total of 144 clinically significant newly developed lesions in 131 (25.7%) patients and a total of 126 reinterventions in 112 (22%) patients in the on-pump group and 33 clinically significant newly developed lesions in 29 (26.3%) patients and 23 reinterventions in 23 (20.9%) patients in the off-pump group.
Conclusion: We believe our study may give an aspect for overall evaluations of the mid-term outcomes of CABG either on-pump or off-pump fashion. Further complementary studies with higher number of patients in contemporary methods are warranted.
Keywords: CABG, coronary angiography

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Introduction

Conventional coronary artery bypass grafting (CABG) has been one of the most common cardiac operations in open-heart surgery all over the world for more than two decades. CABG with cardiopulmonary bypass (CPB) is a routine and safe procedure in selected low-risk patients [1]. The beneficial clinical effects of complete revascularization were shown in the early 1980s and confirmed by others later on [2,3]. It is widely accepted that complete revascularization with the use of CPB remains the surgical gold standard [4]. However, in an attempt to avoid the deleterious effects of CBP, off-pump CABG has recently been rediscovered and refined since 1990s. In the early period of 1990s, off-pump CABG gained increasing acceptance for selected patients with single-vessel disease. Introduction of stabilizers made complete revascularization feasible even in multi-vessel disease [5].

The aim of this retrospective study was; determination of mid-term angiographic results, the rate of disease progression and the rate of reintervention of the 619 patients who had been performed on- pump and off-pump CABG.

Materials and Methods

Patients

During the period from June 1992 until December 2001 a total of 619, control angiographic examinations were performed in (On-Pump: 509, Off-Pump: 110) patients at an average of 52.3 ± 15.8 months after CABG. The reasons leading angiographic assessment were angina pectoris, myocardial infarction (MI), no symptoms but positive treadmill and /or myocardial perfusion scintigraphy and also preoperative evaluation before a major surgical procedure such as; abdominal, vascular, and neurological. Mean age was 55.2 ± 9.3 years and 86.9% of the patients was male. Preoperative patient's characteristics, risk factors, left ventricular function parameters and extension of coronary artery disease were presented in (Table 1).

Definitions

Individual risk factors were as follows: diabetes mellitus = insulin-dependent or non-insulin dependent; hypercholesterolemia = cholesterol level greater than 220 mg/dL; hypertension= diastolic blood pressure of 95 mm Hg or greater; smoking = use of cigarette more than one pack per day; positive family history = atherosclerotic coronary artery disease in a first-degree relative.

Ventricular performance score (VPS) as seen in Table 1 is a scoring system of left ventricular function due to wall motion of the seven segments (antero-basal, antero-lateral, apical, inferior, postero-basal, postero-lateral and septal segments) of the heart at left and right oblique ventriculography, and defined as; normal: 1, hypokinesia: 2, akinesia: 3, dyskinesia: 4, aneursym: 5.

Newly developed vessel lesion: Stenosis more than 50% of vessel when compared the baseline angiogram.

Re-intervention: The patients which underwent percutaneous transluminal coronary angioplasty (PTCA) with either stent insertion or not to newly developed vessel lesions and/or recurrent stenosis in graft or anastomotic site, after CABG.

Operative technique

The complete revascularization was the goal in all operations. All operations were performed with standard midline sternotomy. Under CPB cardiac arrest was performed by initial crystalloid cardioplegia (Plegisol, 4°C, 15cc/kg) and myocardial preservation was supported with 400 cc cold blood cardioplegia in every 20 minutes and topical cooling. A hot shot was performed just before removal of the cross clamp. In situ left internal mammarian artery (LIMA) was used as a graft to left anterior descending artery (LAD) whereas saphenous vein graft (SVG)'s were used to remaining vessels. All distal anastomosis were performed using a double armed 7-0 polypropylene suture with a continuous suturing technique whereas the proximal anastomosis were performed using 6-0 polypropylene suture on a partial aortic clamp. The distal anastomoses on the beating heart were performed without using any mechanical stabilization. Quality assessment of the each anastomosed native coronary artery had been defined during the operation according to the diameter and plaque formation of the vessel. The plaque formation was evaluated both visual and palpation of the vessel and the diameter was assessed using 1, 1.5 and 2 mm metal-tipped coronary probes. The findings were noted as follows; Grade 1: normal distal run-off below the stenosis and vessel diameter > 1.5 mm, Grade 2: wall thickness and minimally plaque formation, vessel diameter ≥1.5 mm, Grade 3: multiple plaque formation and vessel diameter ≤1.5 mm, Grade 4: performing endarterectomy. Operative data including quality of the vessels, use of LIMA, SVG's and bypassed vessels were presented in (Table 2).

Angiographic examination

A total of 1689 anastomoses on 619 patients were evaluated. All angiograms were assessed day by day in an institutional advisory board including staff surgeons and cardiologists. Patency rate of each graft and newly developed vessel lesion were noted as follows: patent: no stenosis; occluded: non-opacified graft; partially patent: hemodynamically significant (>50%) stenosis; newly developed vessel lesion: stenosis more than 50% of vessel when compared the baseline angiogram. Angiographic results were presented in Table 3 and rate of newly developed lesions and re-interventions were presented in (Table 4).

Statistical analysis

All statistics were performed using SPSS statistical software (release 9.0, SPSS Inc., Chicago, IL). Means ± standard deviation is presented. The unpaired t-test and the x - test were used in statistical analysis and a P value equal to or smaller than 0.05 was considered statistically significant. Freedom from development of new lesions and reintervention - reoperation plots showed the estimated survival probability by the Kaplan-Meier method, with log-transformed 95% point-wise confidence intervals.

Results

Patients

Six hundred and nineteen (509 in the on-pump group and 110 in the off-pump group) patients were evaluated angiographically. Mean age was 55.2 ± 9.3 year in the on-pump

Table 1. Preoperative characteristics, risk factors and left ventricular function parameters of the patient's.

	On-Pump (N: 509)	**Off-Pump (N: 110)**
Mean age (year)	55.2 ± 9.3	52.9 ± 10.1
Gender (male%)	86.9	78.2
Diabetes (%)	22.7	9.1
Smoking (%)		
Preoperative	59.8	57.3
Postoperative	9.3	9.0
Hypertension (%)	39.7	38.2
Hypercholesterolemia (%)		
Properative	46.1	42.7
Postoperative	33.5	30
Total cholesterol level mg/dl(mean)		
Preoperative	228 ± 49	221 ± 45
Postoperative	207 ± 43	206 ± 40
Family history (%)	32.8	32.7
Ejection Fraction %	57.7 ± 10.7	58.4 ± 10.5
VPS (mean)	8.9 ± 2.1	9.0 ± 2.0

VPS = Ventricular performance score

Table 2. Operative data's.

	On-Pump	**Off-Pump**
Vessel qulaity (mean)		
(Grade 1-4)		
LAD system	1.7 ± 0.7	1.3 ± 04
Cx system	1.6 ± 0.6	-
RCA	1.9 ± 0.7	1.7 ± 0.8
RPD	1.7 ± 0.7	-
Use of LIMA (n)		
Individual	497 (97.6%)	108 (98.2%)
Use of SVG (n)	1034	50
Saphenous vein bypasses (n)		
LAD	12	2
Diagonal	180	20
Intermediate	58	1
CxOM1	184	-
CxOM2	173	-
CxOM3	41	-
CxPL	36	-
RCA	139	26
RPD	170	1
RPL	41	-
Total	1034	50

LAD = left anterior dessenden artery; Cx = circumflex artery; RCA = right coronary artery; RPD = right posterior descending artery; LIMA = left internal mammarian artery; SVG = saphenous vein graft; CxOM1 = circumflex obtuse marginal 1 branch; CxOM2 = circumflex obtuse marginal 2 branch; CxOM3 = circumflex obtuse marginal 3 branch; CXPL = circumflex postero-lateral branch; RPL = right coronary artery postero-lateral branch

group and 52.9 ± 10.1 year in the off-pump group respectively. The percentage of female patients was 12.9% in the on-pump group and 21.8% in the off-pump group respectively. Preoperative mean ejection fraction and VPS was 58.4 ± 10.5%, 8.9 ± 2.1 in the on-pump group and 57.7 ± 10.7%, 9.0 ± 2.0 in the off-pump group. The other characteristics and risk factors were presented in (Table 1).

Operative data

A total of 1689 bypasses were performed in 619 patients where 1531 was in the on-pump group (3.0 ± 1.1), 158 was in the off-pump group (1.4 ± 0.5). Left internal mammary artery was used as a graft in 497 patients (97.6%) in the on-pump group and 108 patients (98.1%) in the off-pump group. The remaining saphenous bypasses included 1034 in the on-pump group and 50 in the off-pump group respectively. The quality of the vessel disease and the each bypassed vessel was presented in (Table 2).

Angiographical findings

The mean interval from operation to angiographic examination was 55.4 ± 17.6 months in on-pump group and 49.1 ± 12.8 months in the off-pump group, respectively.

Graft patency

Four hundred sixty two (93%) of the LIMA-LAD anastomoses in the on-pump group and 98 (91%) in the off-pump group were patent. Anastomotic site stenosis occured in 12 (2.4%) patients in the on-pumpgroup and in 4 (3.7%) patients in the off-pump group. The patency rates for SVG were 75.4% in the on-pumpgroup where 66% in the off-pump group.

Ventricular function

There was an improvement in the value of LVF parameters (EF%, VPS) in both groups, but the results did not differ statistically when compared with the preoperative values (Table 3).

Development of new lesions

There were a total of 144 clinically significant newly developed lesions in 131 (25.7%) patients where 74 were in non-grafted vessels and 70 were in grafted vessels in the on-pumpgroup and 33 in 29 (26.3%) patients where 24 were in non-grafted vessels and 9 were in grafted vessels in the off-pump group. As seen in Table 3; right coronary artery, circumflex artery and distal LAD artery were the mostly diseased vessels in either groups. Freedom from development of new lesions was 74.2% in a main period of 100.5 months (95% CI 92.8-108.3 months) in the on-pumpgroup and was 74.5% in a mean period of 65.9 months (95% CI 60.8-71.0 months) in the off-pump group, respectively (Figure 1).

Reoperation-Reintervention

There were a total of 126 reinterventions in 112 (22%) patients in the on-pumpgroup. Ninety four of them were for newly developed lesions and 20 for recurrent stenosis in SVG, 6 for SVG anastomotic stenosis, 5 for stenosis in LIMA-LAD anastomosis and 1 for left mean coronary artery stenosis. In the off-pump group there were a total of 23 reintervention in 23 (20.9%) patients where 19 of them for newly developed lesion and 4 for stenosis in LIMA-LAD anastomosis. Three patients (12, 18 and 23 months after the first operation, 0.5%) in the on-pump group and 1 patient (60 months after the first operation,

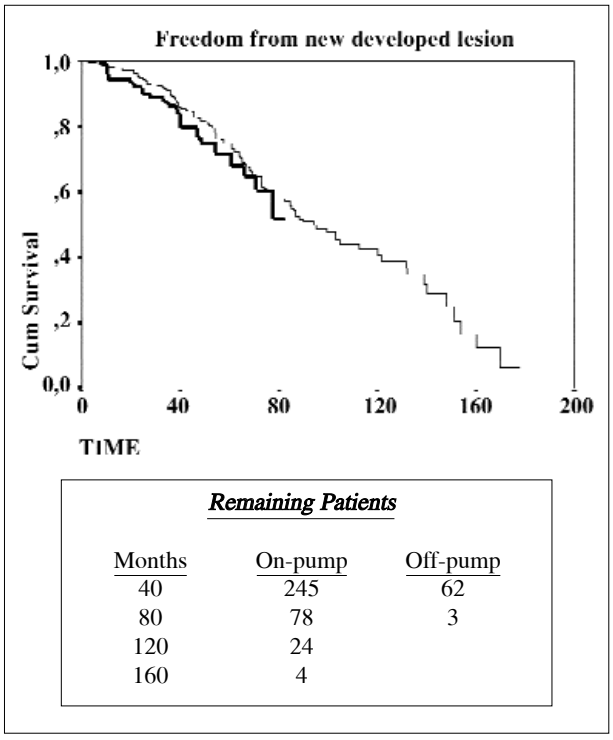

Figure 1. Freedom from new developed lesion.

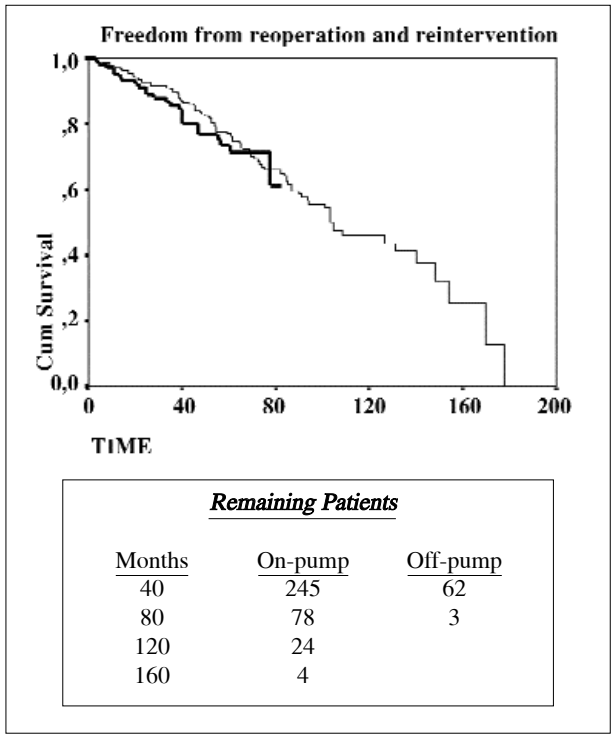

Figure 2. Freedom from reoperation and re-intervention.

Table 3. Angiographical findings.

	On-Pump			Off-Pump		
Mean Period (month)		55.4 ± 17.6			49.1 ± 12.8	
Graft Patency	Patent	Occluded	Partially patent	Patent	Occluded	Partially patent
LIMA	462 (93)	23 (4.6)	12 (2.4)	98 (90.7)	6 (5,5)	4 (3.7)
SVGs						
LAD	11 (91.6)	1 (8.3)		2 (100)		
Diagonal	147 (81.6)	31 (17.2)	2 (1.1)	12 (60)	8 (40)	
Intermediate	40 (68.9)	15 (28.8)	3 (5.1)	1 (100)		
CxOM1	143 (77.7)	35 (19)	6 (3.2)	-	-	
CxOM2	133 (76.8)	38 (22)	2 (1.1)	-	-	
CxOM3	35 (85.3)	4 (9.7)	2 (4.8)	-	-	
CxPL	31 (86.1)	5 (13.9)	-	-	-	
RCA	90 (64.7)	40 (28.7)	9 (6.4)	17 (65.3)	9 (34.6)	
RPD	122 (71.7)	40 (23.5)	8 (4.7)	1 (100)		
RPL	28 (68.2)	9 (21.9)	4 (9.7)	-	-	
Total	**780 (75.4)**	**218 (21.0)**	**36 (3.4)**	**33 (66)**	**17 (34)**	
Mean EF %						
Preoperative		57.7 ±1 0.7			58.4 ± 10.5	
Postoperative		58.0 ± 12.6			59.4 ± 10.7	
Mean VPS						
Preoperative		8.9 ± 2.1			9.0 ± 2.0	
Postoperative		8.7 ± 1.9			8.8 ± 2.1	

LIMA = left internal mammarian artery; SVG = saphenous vein graft; LAD = left anterior descending artery; CxOM!-2-3 = circumflex artery obtuse marginal 1-2-3 branch; CxPL = circumflex artery postero-lateral branch; RCA = right coronary artery; RPD = right coronary posterior descending artery; RPL = right coronary artery postero-lateral branch; EF = ejection fraction; VPS = ventricular performance score. Unless otherwise indicated, numbers in parenthesis are percentages

Table 4. Preoperative characteristics, risk factors and left ventricular function parameters of the patient's.

	On-Pump		Off-Pump	
	New lesion	Reintervention	New lesion	Reintervention
LAD	22	8	5	5
Diagonal	4	4	-	-
Cx	52	35	18	9
RCA	58	44	7	5
RPD	8	3	3	-
LMCA		1		-
LIMA anast.		5		4
SVG		20a		-
SVG anast.		6b		-

LAD = left anterior descending artery; Cx = circumflex artery; RCA = right coronary artery; RPD = right posterior descending artery; LMCA = left main coronary artery; SVG = saphenous vein graft; a = reintervention for recurrent stenosis in SVG; b = reintervention for SVG anastomotic stenosis

0.9%) underwent reoperation because of the occlusion of LIMA. Reintervention- reoperation free survival was 77.2% in a mean period of 108.7 months (95% CI 99.7-117.6 months) in the on-pumpgroup and 78.1% in a mean period of 67.8 months (95% CI 62.8-72.8 months) in the off-pump group respectively (Figure 2).

Discussion

The long-term patency rate of grafts is one of the major factors in determining the late results of CABG. Because of the excellent early, mid-term and also long-term patency rate, LIMA has been the most popular graft in LAD anastomosis. In the study of Fitzgibbon and associates early – intermediate – long-term patency rates of LIMA were documented as 95% - 91% - 80% respectively in-patients who underwent

conventional CABG [6]. In this study the patency rate of LIMA was 93% in the on-pump group where 90.7% in the off-pump group, respectively. These results were also comparable with the other reports [7,8]. Even though the long- term patency of SVG has been known to be lower than that of internal mammary artery [6,7] the SVG is still the most widely used graft because of its accessibility and availability. Occlusion rate of SVG is around 12-20% in the first year and 2-4% annually for the next 4 or 5 years. Subsequently, this rate doubles, so that in 10 years, approximately 50% of grafts became occluded due to the graft atherosclerosis [9]. In this study the overall patency rate of SVG was 75.4% in the on-pump group where 66% in the off-pump group respectively. It has been well known that the fate of grafts depends on many factors, including size and the quality of the distal run-off of the native coronary artery, technical faults in harvesting, handling and fashioning the conduits; thrombosis; myointimal hyperplasia; fibrosis; and a rapidly progressing variety of atherosclerosis [10]. Among the SVG grafts patency rate of RCA bypass was lowest where LAD was highest in the on-pump group and the patency rate of diagonal branch was lowest where LAD was highest in the off-pump group (Table 3). As we mentioned before quality of the distal run-off is one of the major factor affecting graft patency. In the on-pump group the quality scoring of the RCA was found higher than the other coronary arteries.

Although off-pump CABG gained increasing acceptance, there have been concerns about accuracy and patency rate of the grafts. Gundry and colleagues compared two methods and demonstrated lower patency rates and more frequent re-interventions in the off-pump group [11]. Also Ömeroğlu and associates documented 47.1% patency rate for SVG's in patients underwent CABG without CPB [12]. However, the use of cardiac stabilizer provides excellent stabilization of the target area and enables the anastomoses to be performed in better quality and with higher rate of graft patency [13].

Long-term follow-up evaluation of patients with CABG has revealed a greater incidence of disease progression either in grafted and non-grafted arteries [14]. In the study of Manninen and associates the progression of vessel lesion was reported 20.2% in non-grafted segment and 12% in distal to the anastomosis of patients two years after CABG [7]. In this study the development of new lesion including either bypassed and non-bypassed vessel was 25.7% in the on-pump group and 26.3% in the off-pump group, respectively. In the on-pump group stenosis beyond the anastomosis was detected mostly in LAD and circumflex artery where in RCA and LAD in the off-pump group. Re-interventions were performed mostly to circumflex artery in both groups.

In conclusion; this study aims at presenting mid-term angiographic results of the patients whom underwent CABG with and without CPB. Groups were not compared statistically because of the differences in the number and distribution of the bypassed grafts.

We believe our study may give an aspect for overall evaluations of the mid-term outcomes of CABG via either CPB or off-pump fashion. Further complementary studies with higher number of patients in contemporary methods are warranted.

References

1. Shennib H, Allan GL, Akin J. Safe and effective method of stabilization of coronary artery bypass grafting on the beating heart. Ann Thorac Surg 1997;63:998-2.
2. Bell MR, Gersh BJ, Schaff HV, et al. Effect of completeness of revascularization on long-term outcome of patients with three-vessel disease undergoing coronary artery bypass surgery. A report from coronary artery surgery study (CASS) registry. Circulation 1992;86:446-57.
3. Vural K, ½ener E, Taşdemir O. Long-term patency of sequential and individual saphenous vein coronary bypass grafts. Eur J Cardiothorac Surg 2001;19:140-4.
4. Jones EL, Weintraub WS. The importance of completeness of revascularization during long-term follow-up after coronary artery operations. J Thorac Cardiovasc Surg 1996;112:227-37.
5. Cartier R, Brann S, Dagenais F, Martineau R, Couturier A. Systemic off-pump coronary artery revascularization in multivessel disease: experience of three hundred cases. J Thorac Cardiovasc Surg 2000;119:221-9.
6. Fitzgibbon GM, Kafka HP, Leach AJ, et al. Coronary bypass graft fate and patient outcome: angiographic follow-up of 5,065 grafts related to survival and reoperation in 1,388 patients during 25 years. J Am Coll Cardiol 1996;28:616-26.
7. Manninen HI, Jaakkola P, Suhonen M, Rehnberg S, Vuorenniemi R, Matsi PJ. Angiographic predictors of graft patency and disease progression after coronary artery bypass grafting with arteriel and venous grafts. Ann Thorac Surg 1998;66:1289-94.
8. Kim KB, Cheong L, Cheul L, Chae IH, et al. Off-pump coronary artery bypass may decrease the patency of saphenous vein grafts. Ann Thorac Surg 2001;72:S1033-7.
9. Alderman EL. Angiographic correlates of graft patency and relationship to clinical outcomes. Ann thorac Surg 1996;62:22-5.
10. Nwasokwa ON. Coronary artery bypass graft disease. Ann Intern Med 1995;123:528-45.
11. Gundry SR, Romano MA, Shattuck OH, Razzaouk AJ, Bailey LL. Seven-year follow-up of coronary artery bypasses performed with and without cardiopulmonary bypass. J Thorac Cardiovasc Surg 1998;115:1273-8.
12. Ömeroğlu SN, Kırali K, Güler M, et al. Midterm angiographic assessment of coronary artery bypass grafting without cardiopulmonary bypass. Ann Thorac Surg 2000;70:844-50.
13. Subramanian VA. Less invasive arterial CABG on a beating heart. Ann thorac Surg 1997;63:68-71.
14. Kroncke GM, Kosolcharon P, Clayman JA, Peduzzi PN, Detre K, Takaro T. Five-year changes in coronary arteries of medical and surgical patients of the Veterans Administration randomized study of bypass surgery. Circulation 1988;78:144-50.