Coronary Endarterectomy: Postoperative Angiographic Results

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ABSTRACT

Objective: To compare the postoperative graft patency rates of patients who had undergone coronary endarterectomies (CE) during coronary bypass surgery to those of patients who had not had CE, based on postoperative coronary angiography.

Study Design: Comparative descriptive study.

Place and Duration of Study: Coronary Angiography Unit, Tınaztepe University Faculty of Medicine, Turkey, from November 2010 through June 2021.

Methodology: Patients who had undergone CE during coronary bypass surgery were included. Postoperative morbidity results and the patency rates of the vessels with and without endarterectomy were evaluated via coronary angiographies that had been performed.

Results: The patency rate in vessels that underwent coronary endarterectomy was determined to be 73.4% according to coronary angiographies performed after an average of 47.7 months. The patency rate in vessels without endarterectomy was 63.7%. The highest patency rate was found in the left anterior descending artery (LAD) in both CE and conventional bypass coronary arteries and the lowest patency rate was found in the diagonal artery (D) in both CE and conventional bypass coronary arteries. In the comparison of vessels with and without CE, the patency rate was found to be 66.6% in patients with CE on the right coronary artery (RCA) and 45.7% in patients without CE on the right coronary artery and the difference was statistically significant ($p<0.037$).

Conclusion: Coronary endarterectomy should be used when it is believed that a simple anastomosis would not provide adequate patency during coronary bypass surgery because the primary goal should be to achieve full revascularization and a long-term patency rate.

Key Words: *Coronary angiography, Coronary bypass grafting, Endarterectomy, Patency rate.*

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INTRODUCTION

Because of the rapid advancements that are currently taking place in coronary angioplasty procedures, more complex patients are being referred for surgery, and performing decent coronary anastomoses during surgery in these cases is more difficult.[1,2] Since 1957, when Charles P. Bailey performed the first operation to solve this problem, coronary endarterectomy (CE), which is particularly favoured in occluded coronary arteries, has been used as an alternative surgical approach.[3] Although there were unfavourable studies on CE in the early years, it is now preferred when the aim is to achieve full revascularization, particularly in patients with diffuse coronary artery involvement.[4,5]

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Since CE is performed in patients with extensive calcific coronary artery structures, coronary angiography is usually required in the postoperative period. Thus, the aim of this study was to compare the graft patency rates in patients who had undergone CE during coronary bypass surgery to those of patients who had histories of having coronary angiographies in the postoperative period but had not had CE.

METHODOLOGY

Patients, who had undergone coronary bypass surgeries from November 2010 through June 2021, were screened retrospectively. Patients, who had additional CE during coronary bypass surgery and who underwent angiography for any reason after surgery, were included in the study. The patients, who underwent accompanying surgery procedures such as aneurysmectomy or valve replacement, carotis surgery, were excluded. The demographic characteristics, data about the operations, early postoperative results, and angiographic results of the patients were statistically evaluated.

Coronary bypass was performed on a beating heart in two cases and with standard cardiopulmonary support (cannulation of the ascending aorta and right atrium with moderate hypothermia at 32°C) in 108 cases. Hypothermic cardiac arrest was achieved by administering ante-grade intermittent blood cardioplegia *via* the aortic root. CE was performed on coronary arteries that did not have lumens to anastomose and whose outer lumen diameters were at least 1.5 mm thick. The traction technique was frequently used during endarterectomy. A tapering image in a cone shape in the atherosclerotic plaque that was removed by endarterectomy was accepted as an effective endarterectomy. Care was taken to ensure that no residual plaque remained distally after the endarterectomy. In cases where the plaque could not be completely removed, the residual plaque was removed by lengthening the arteriotomy. If the patient had no bleeding problem in the early postoperative period, 75 mg clopidogrel+100 mg acetylsalicylic acid was started in the early postoperative period. Dual antiplatelet therapy was routinely continued for six months, followed by single antiplatelet therapy.

A total of 440 coronary anastomoses, 128 of which were with CEs, were performed on the patients. The CEs were performed on the left anterior descending artery (LAD) in 23 patients, the circumflex artery (CX) in 21 patients, the diagonal artery (D) in nine patients, and the right coronary artery (RCA) in 75 patients. The patency ratios of the vessels with and without endarterectomy, after coronary angiography had been performed following an average of postoperative 47.7 months, were evaluated statistically.

The SPSS 25.0 program was used for statistical analysis. Pearson's Chi-squared test and the Fisher's Exact and Fisher-Freeman-Halton tests were used with the Monte Carlo simulation technique to compare categorical variables to each other, and the column ratios were compared to each other as well and expressed according to the results for the Benjamini-Hochberg corrected p-value. While quantitative variables were expressed as mean (standard deviation), median (minimum/-maximum), and median (percentile 25/percentile 75) in the tables, categorical variables were presented as n (%). Variables were analysed at a 95% confidence level, and a p-value of less than 0.05 was considered significant. The normality of continuous variables was examined With the Shapiro-Wilk test.

RESULTS

The mean age of the patients was 61.7±9.2; 91 (82.7%) of the patients were males, and 19 (17.2%) were females. The mean angiography interval after coronary bypass surgery was 47.7±24.04 months. In the preoperative demographics, the most common predisposing factors were hypertension in 78 patients (79.9%), diabetes mellitus (DM) in 53 patients (48.6%), hyperlipidemia in 55 patients (50%), and a history of smoking in 49 patients (44.5%) (Table I). Internal thoracic arteries (ITA) were used in 106 cases, and the saphenous vein was used in LAD bypasses in four cases. The median length of the patients' stays in the intensive care unit was 26 (22-32) hours, and the median hospital stay was 7 (7-9) days (Table I). Low cardiac output syndrome developed after CPB in 12 cases. An intra-aortic balloon pump (IABP) was inserted in seven of these patients, and the other five patients were taken to the intensive care unit with high-dose inotropic support. Atrial fibrillation was observed to be the most common complication, with 19% in postoperative hospital follow-ups. Neurological deficit developed in two patients and renal failure that required haemodialysis occurred in five patients. Four patients underwent surgical exploration due to bleeding in the early postoperative period.

Table I: Preoperative and postoperative patient data.

	Mean + SD or median (percentile 25-percentile 75)	(%)
Age (year)	61.7±9.2	-
Male patients	91	%82.7
Female patients	19	%17.2
Preoperative LVEF	45 (35-50)	-
Poor EF	10	% 9.1
Hypertension	78	%70.09
Diabetes mellitus (n=109)	53	%48.6
Hyperlipidemia	55	%50
Smoking history	49	%44.5
COPD	16	%14.5
Peripheral vascular disease	21	%19.1
Renal failure	4	%3.6
Surgery-angiography interval (months)	47.7±23.96	-
Totaly endartectomy	128	-
Endarterectomy site		
Left anterior descending artery	23	%17.9
Circumflex artery	21	%16.4
Diagonal artery	9	%7.0
Right coronary artery	75	%58.5
Use of ITA	106	%96.3
CPB time	75 (68-85)	-
X-clamp time	45 (40-55)	-
Entubation time	7 (6-9)	-
Low cardiac output syndrome	12	%10.9
Use of IABP	7	%6.3
Intensive care unit stay time	26 (22-32)	-
Reexploration for bleeding	4	%3.6
Respiratuvar failing	3	%2.7
Postoperative atrial fibrilation	21	%19
Postoperative temporaray hemodialysis	5	%4.5
Postoperative stroke	2	%1.8
Postoperative ejection fraction	45 (40-55)	-
Hospital stay time	7 (7-9)	-

LVEF: Left ventricular ejection fraction; COPB: Chronic obstructive pulmonary disease; CPB: Cardiopulmonary bypass; X-clamp: Cross clamp; ITA: Internal thoracic artery; IABP: Intra-aortic balloon pump.

The patency ratios of the vessels with and without CE were compared with the angiographic controls. While the average patency rate was 73.4% (94 patent vs. 34 occluded) in vessels with CE, the patency rate in vessels without CE was 63.7% (199 patent vs. 113 occluded). After CE, the best patency rate was found in the LAD, with 91.3% (21 patent vs. 2 occluded), while the lowest patency rate was found in the D, with 55.5% (5 patent vs. 4 occluded). The patency rates were 85.7% (18 patent/3 occluded) in the CX and 66.6% (50 patent vs. 25 occluded) in the RCA. The rates were similar in patients who underwent conventional bypass without CE, with the highest patency rate being 87.4% (76 patent vs. 11 occluded) in the LAD and the lowest patency rate being 42.6% (43 patent vs. 58 occluded) in the D (Table II). In the comparisons of the vessels with and without CE, the patency rate was 66.6% in patients with CE on the RCA and 45.7% in the patients without CE, and the difference was statistically significant ($p<0.037$).

Table II: Postoperative angiographic results of grafts.

	Bypass with coronary endarterectomy				Bypass without coronary endarterectomy				p
	N	Patent	Occluded	Patency rate	N	Patent	Occluded	Patency rate	
LAD	23	21	2	%91.3	87	76	11	%87.4	0.999 [f]
CX	21	18	3	%85.7	89	64	25	%71.9	0.268 [c]
D	9	5	4	%55.5	101	43	58	%42.6	0.500 [f]
RCA	75	50	25	%66.6	35	16	19	%45.7	0.037 [c]
Totaly	128	94	34	%73.4	312	199	113	%63.7	0.059 [c]

LAD: Left anterior descending artery; RCA: Right coronary artery; D: Diagonal artery; CX: circumflex artery. [c] Pearson chi-square (monte carlo), [f] Fisher's Exact test (monte carlo).

DISCUSSION

The presence of multiple comorbid factors such as hypertension, hyperlipidaemia, diabetes, smoking, and previous angioplasty in patients undergoing coronary bypass surgeries has resulted in more complicated coronary anatomies during surgery in recent years.[1,5] In these patients, it is sometimes impossible to find a disease-free segment to anastomose because of the severely calcified and completely occluded coronary artery anatomies.[2] Simple anastomosis on the calcific plaque during bypass surgeries may cause both poor quality of anastomosis and risk of distal embolisation due to plaque ruptures.[6] Again, in these patients bypasses without CE are ineffective due to the closure of the lateral branches, which can cause postoperative residual angina.[6,7] All these factors often result in the need to perform CE during bypasses in these patient groups.

Decisions to favour coronary endarterectomy in the early years, when the mortality rates were 3-12%, were controversial.[1,2,6,8,9] However, the lower mortalities and the satisfactory patency rates that have been reported in subsequent studies have increased its feasibility.[4,5,10,11] It has been emphasized that when evaluating mortality rates after CE in studies, there are many factors that might affect mortality. While some studies have reported that CE to the LAD will be high-risk, some studies have also reported high mortality rates in multiple CE cases.[6,9,12] In a study comparing the groups with and without CE, Brenowitz *et al*. reported that CE to the LAD with more than two risk factors brings higher mortality.[9] However, Marzban *et al*. found higher mortality rates resulting from high postoperative myocardial infarction (MI) in patients who had had CEs to RCAs with LADs or to RCAs with Ds and suggested that caution is necessary when performing the second CE in patients who will undergo CE to LAD or RCAs.[12] In some studies, it has been suggested that CE to the RCA should be avoided because of high mortality and morbidity (especially arrhythmia).[13] This study is consistent with the literature since we found higher morbidity (56.7% *vs.* 29.1%) and mortality (13.3% *vs.* 4.5%) rates in the patients who underwent CE to LAD during surgeries performed in the clinic. The study also compared the patients who had previous CE performed on the LAD and those with CE performed to other vessels.[14]

Studies have also been published that report low mortality and morbidity after CE.[1,15,16] In one study involving 290 patients, Zhu *et al*. found no significant difference between the patient groups in terms of early mortality and morbidity after CEs had been performed on different coronary arteries (LAD: 60, RCA: 217 and CX: 42).[15] The results of a comparative study conducted by Shapira *et al*. were similar with a low mortality rate of 2% in the CE group, and Okur *et al*. also found a low mortality rate of 1.5% in a group that had CE.[1,16]

In addition, patency rates vary as post-CE mortality rates. Patency rates are seen in the literature to be from 56% to 98%.[17] The varying rates of patency have encouraged some authors to opt for CE while others choose to abstain.[2,4,5,18] Ferraris *et al*., in their study comparing two patient groups with and without CE, found the patency rates to be lower in the group that underwent endarterectomy (58% *vs.* 40%).[18] However, in this study, the authors state that in spite of the negative results in the discussion part of the article, it may be beneficial to operate on a totally occluded vessel rather than to decide not to bypass it at all. Nemati *et al*., in a study that compared groups with and without CE, reported lower patency rates (66.7% *vs.* 95%) in both the graft and the native coronary arteries in the CE group.[5]

However, satisfactory patency rates have also been reported. Okur *et al*. found in their study, which compared a CE group and a conventional bypass group, that patency rates in a CE group were 92.3% in the early period and 82.6% in the late period.[1] Takanashi *et al*. also reported an early patency rate of 91.2% in their study, in which they performed patch anastomosis after open and long endarterectomies for the LAD.[7]

In studies with low patency rates, hypotheses supporting the results often focus on the higher number of total occluded vessels and the poor distal run-off caused in these patients.[5,18] For this reason, it is suggested that the patient group that underwent CE already had end-stage coronary artery disease, and the results should then be interpreted from this perspective.[5,18] These causes affect long-term surveillance in addition to mortality and patency rates, because the reasons for diffuse coronary artery tumours, such as among patients with DM, can lead to low left ventricular functions, residual angina, and new MI in the future among those undergoing CE.[5,9,18] Therefore when evaluating mortality, patency rates and long-term surveillance in patients who have undergone CEs, the results should not be associated only with the CE.

When reviewing the articles about patency rates after CE, it is important to examine many factors, such as the techniques of application, the vessels to which the CE was applied, the use of ITAs, the diameters of the coronary arteries and any postoperative antiaggregant treatment that might have affected the patency rates.[4,10,16,19] Shapira *et al*. emphasised that the diameter of the coronary artery is an essential factor that affects patency rates after CE and reported that endarterectomy for vessels with outer diameters of less than 1.5 mm would cause early occlusion.[16] Many studies have shown that CE to the LAD is associated with higher patency rates.[2,4] Binsalamah *et al*. found a 100% patency rate for the LAD after CE.[4] In addition, Nishigava *et al*. reported successful patency rates of 96.6% at the end of one year in 188 patients who had CE to LAD on a beating heart.[2]

In cases involving CE, CE to the RCA is performed at a higher rate, and studies on CE to the RCA show different patency rates. Erdil *et al*., in a study comparing two groups with and without CE for the RCA, did not detect a significant difference between the groups in terms of mortality and found that all grafts had excellent distal runoffs among 42 patients who underwent CE in the early postoperative period.[20] However, Brooks *et al*., in a study of patients with and without CE to the RCA, found that the patency rates in the CE group were lower than those in patients who were directly bypassed to the RCA or the posterior descending artery (PDA).[21] The authors emphasised that an essential factor affecting patency rates and recurrent angina in patients who had CE to the RCA was the diameter of the PDA. They reported that a PDA <1 mm is an important factor that negatively affects patency rates and recurrent angina after CE for the RCA.[21] Gol *et al*. reported that postoperative inotropic support, postoperative arrhythmia (atrial fibrillation), atrioventricular (AV) blocks and postoperative MI risks were higher in patients who underwent CEs for the RCA than for the other arteries.[13] In this study, patency rates after CE had been performed to the RCA were not as high as those after CEs were performed to the left system. There was a high patency in the LADs (91.3%) and CXs (85.7%) in comparison to patency in the RCAs (66.6%). However, the patency rates in patients who underwent CE to the RCAs were statistically significantly higher than among patients who did not undergo the CE.

Some studies emphasise the importance of using the ITAs after CE, and it has been reported that their use after endarterectomy to the LAD is vital in terms of high patency rates.[1,19] This is because, even if the distal runoff is poor in ITA use, the patency rate is higher because of factors such as prostacyclin being released from the endothelium, nitric oxide, vasomotor capacity, and resistance to atherosclerosis.[1,19]

Some studies have also emphasised that patency rates are related to the technique used for the CE.[9,17] CE is performed either closed or open.[2,6] In the closed technique, a coronary arteriotomy is performed, and the plaque is removed by traction. Cone-like thinning of the removed plate in this technique is crucial for effective endarterectomy. In the open technique, the plaques are removed by making an arteriotomy along the atherosclerotic plaque. This method often requires a longer anastomosis or a bypass after a saphenous patch has been used, once the procedure is completed. The open technique is generally preferred, particularly in LAD, because during CE performed in RCA it is easier to remove the plaque in one piece with a single and short arteriotomy than it is with LAD.[9] In LADs, complete removal of the plaque is more difficult because of the septal and diagonal branches, and residual plaque is more likely to remain.[9] A study that was conducted by Nishi *et al*. into CE+long anastomosis groups, comparing an open and long CE+on-lay patch left internal mammary artery anastomosis group to a closed CE group, reported higher patency rates of 89.1% with the former and 81.0% with the latter.[17] The authors suggested that making CE this way would be advantageous in removing the residual atheroma plaques that remain in the septal and diagonal branches.[17]

Postoperative antiaggregants and anticoagulants are other factors that affect patency rates. Although there is no consensus on this issue, while dual antiaggregant (clopidogrel+acetylsalicylic acid) is frequently preferred in the early period, the use of anticoagulants is also recommended in some cases.[4,6,10] In addition to these treatments, heparin infusions and dextran use have been suggested in the early postoperative period, and continuing dual antiplatelet therapy for three months to one year is essential for graft patency.[2,7] The presently reported patients continued with single antiplatelet therapy following six months of dual antiplatelet therapy.

When comparing the patency rates between the coronary arteries with CE and those with simple anastomosis, this study found that the patency rates were higher in all four coronary arteries with CE. We found a cumulative patency rate of 73.4% in patients with CE, compared to 63.7% in patients without CE. After CE, the highest patency rate in coronary arteries was found in the LAD, and the lowest patency rate was found in the D (Table II). Among patients who underwent conventional bypass, the highest patency rate was also found in the LAD, and the lowest patency rate in the D. The difference between the patency rates was not statistically significant, except for the RCA. It was found the patency rate to be 66.6% in patients who underwent CE to the RCA and 45.7% in patients who did not ($p=0.037$). In accordance with the hypothesis stated above, this result regarding the RCA are such because the RCA are such branched than the left system (especially to the LAD) and that the calcific plaque can be removed entirely during CE. The low patency rate was found in D will not provide significant data for interpreting the results of CE, since it is a non--dominant and thin vessel.

The small number of patients, the absence of a control group, and the retrospective nature of our study are some of its limitations. Moreover, not all patients who had these surgeries in our clinic were included in the study; only patients who survived and were able to undergo angiographies were included.

CONCLUSION

CE is a salvage surgical option in cases where we believe that simple anastomosis will not be satisfactory in terms of patency during coronary bypass surgery. It would be better to have a completely occluded vessel with no blood flow than to do a bypass. Given that full revascularization and long-term patency should be the primary goals of coronary bypass surgery, CE is a surgical method that should be favoured.

ETHICAL APPROVAL:
Ethics Committee approval was received from the Ethics Committee of Izmir Tinaztepe University Faculty of Medicine (No. 0013/2020, September 4, 2020).

PATIENTS' CONSENT:
Written consent was given from patients and their families before surgical and angiographic procedures.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
EE: Design of the research, drafted the manuscript, carried out the analysis and interpretation of data, and acquisition of data.
HR: Statistical analysis, acquisition of data, manuscript writing, and critical revision.
All authors approved the final version of the manuscript to be published.

REFERENCES

1. Okur FF, Uyar İS, Evrengül H, Şahin V, Akpınar B, Abacılar F, *et al*. Results of coronary artery bypass grafting eith coronary. *Endartrectomy* 2012; **20**:1-7.
2. Nishigawa K, Fukui T, Yamazaki M, Takanashi S. Ten-year experience of coronary endarterectomy for the diffusely diseased left anterior descending artery. *Ann Thorac Surg* 2017; **103(3)**:710-6. doi: 10.1016/j.athoracsur.2016.11.028.
3. Bailey CP, May A, Lemmon WM. Survival after coronary endarterektomy in man. *JAMA* 1957; **164(6)**:641-6. doi: 10.1001/jama.1957.02980060017005.
4. Binsalamah ZM, Al-Sarraf N, Chaturvedi RK, Alam A, Thalib L, Belley G. Mid-term outcome and angiographic follow-up of endarterectomy of the left anterior descending artery in patients undergoing coronary artery bypass surgery. *J Card Surg* 2014; **29(1)**:1-7. doi: 10.1111/jocs.12230.
5. Nemati MH, Astaneh B, Khosropanah S .Outcome and graft patency in coronary artery bypass grafting with coronary endarterectomy. *Korean J Thorac Cardiovasc Surg* 2015; **48(1)**:13-24. doi: 10.5090/kjtcs.2015.48.1.13.
6. Papakonstantinou NA, Baikoussis NG, Apostolakis E. Coronary endarterectomy: New flavors from old recipes. *J Cardiol* 2014; **63(6)**:397-401. doi: 10.1016/j.jjcc.2014.02.005.
7. Takanashi S, Fukui T, Miyamoto Y. Coronary endarterectomy in the left anterio descending artery. *J Cardiol* 2008; **52(3)**:261-8. doi: 10.1016/j.jjcc.2008.09.006.
8. Taşdemir O, Kiziltepe U, Karagoz HY, Yamak B, Korkmaz S, Bayazit K. Long-term results of reconstructions of the left anterior descending coronary artery in diffuse atherosclerotic lesions. *J Thorac Cardiovasc Surg* 1996; **112(3)**: 745-54. doi: 10.1016/S0022-5223(96)70061-2.
9. Brenowitz JB, Kayser KL, Johnson WD. Results of coronary artery endarterectomy and reconstruction. *J Thorac Cardıovasc Surg* 1988; **95**:1-10.
10. Chi LQ, Zhang JQ, Kong QY, Xiao W, Liang L, Chen XL. Early results of coronary endarterectomy combined with coronary artery bypass grafting in patients with diffused coronary artery disease. *Chin Med J (Engl)* 2015; **128(11)**:1460-4. doi: 10.4103/0366-6999.157652.
11. Schwann TA, Zacharias A, Riordan CJ, Durham SJ, Shah AS, Habib RH. Survival and graft patency after coronary artery bypass grafting with coronary endarterectomy: Role of arterial versus vein conduits. *Ann Thorac Surg* 2007; **84(1)**:25-31. doi: 10.1016/j.athoracsur.2007.02.053.
12. Marzban M, Karimi K, Ahmadi H, Davoodi S, Abbasi K, Movahedi N, *et al*. Early outcomes of double-vessel coronary endarterectomy in comparison with single-vessel coronary endarterectomy. *Tex Heart Inst J* 2008; **35(2)**:119-24.
13. Gol MK, Yilmazkaya B, Goksel S, Sener E, Mavitas B, Taşdemir O, *et al*. Results of right coronary artery endarterectomy with or without patchplasty. *J Card Surg* 1999; **14(2)**:75-81. doi: 10.1111/j.1540-8191.1999.tb00954.x.
14. Reyhanoglu H, Ozcan K. Does coronary endarterectomy in the left anterior descending artery ıncrease surgical morbidity and mortality? *J Surg Res* 2020; **3(3)**:253-61.
15. Zhu P, Ye X, Chen A, Liu J, Wang Z, Zhou M, *et al*. Does the site of coronary endarterectomy have an impact on the clinical outcomes and graft patency? *Interact Cardiovasc Thorac Surg* 2019; **29(3)**:402-8. doi: 10.1093/icvts/ivz099.
16. Shapira OM, Akopian G, Hussain A, Adelstein M, Lazar HL, Aldea GS, Shemin RJ. Improved clinical outcomes in patients undergoing coronary artery bypass grafting with coronary endarterectomy. *Ann Thorac Surg* 1999; **68(6)**:2273-8. doi: 10.1016/s0003-4975(99)01050-4.
17. Nishi H, Miyamoto S, Takanashi S, Minamimura H, Ishikawa T, Kato Y, *et al*. Optimal method of coronary endarterectomy for diffusely diseased coronary arteries. *Ann Thorac Surg* 2005; **79(3)**:846-52. doi: 10.1016/j.athoracsur.2004.06.070.
18. Ferraris VA, Harrah JD, Moritz DM, Striz M, Striz D, Ferraris SP. Long-term angiographic results of coronary endarterectomy. *Ann Thorac Surg* 2000; **69(6)**:1737-43. doi: 10.1016/s0003-4975(00)01293-5.
19. Gill IS, Beanlands DS, Boyd WD, Finlay S, Keon WJ. Left anterior descending endarterectomy and internal thoracic artery bypass for diffuse coronary disease. *Ann Thorac Surg* 1998;

65(3):659-62. doi: 10.1016/s0003-4975(97)01301-5.

20. Erdil N, Cetin L, Kucuker S, Demirkilic U, Sener E,Tatar H. Closed endarterectomy for diffuse right coronary artery disease: Early results with angiographic controls. *J Card Surg* 2002; **17(4)**:267-6. doi: 10.1111/j.1540-8191.2001.tb01137.x.
21. Kay PH, Brooks N, Magee P, Sturrıdge MF, Walesby RK, Wrıght JEC. Bypass grafting to the right coronary artery with and without endarterectomy: Patency at one year. *Br Heart J* 1985; **54(5)**:489-94. doi: 10.1136/hrt.54.5.489.