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Early-term outcomes of simultaneous carotid endarterectomy and coronary revascularization

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ABSTRACT

Objectives: This study was designed to evaluate the early-term results of the safety and effectiveness of simultaneous applications of coronary revascularization and carotid endarterectomy.

Patients and methods: In the sectional descriptive study conducted between December 2010 and December 2014, 32 patients (22 males, 10 females; mean age: 66±1.6 years; range, 49 to 85 years) with coronary artery disease and carotid artery stenosis were evaluated. All patients underwent simultaneous carotid endarterectomy and coronary artery bypass grafting. They were followed at the median for three months. Demographic characteristics of the patients and a history of previous myocardial infarction, hypertension, diabetes mellitus, hyperlipidemia, renal disease, peripheral arterial disease, and smoking were recorded.

Results: Hospital mortality was encountered in two (6.3%) patients. One (3.1%) patient had a postoperative major stroke, whereas two patients had a transient ischemic attack. Postoperative myocardial infarction was observed in one patient.

Conclusion: Synchronous carotid endarterectomy and coronary artery bypass grafting may be safe and effective in the management of patients with concomitant carotid artery stenosis and coronary artery disease.

Keywords: Carotid artery stenosis, carotid endarterectomy, coronary artery bypass grafting, coronary artery disease.

The coexistence of coronary artery and internal carotid artery obstructive disease is quite prevalent.[1] Significant internal carotid artery stenosis is detected in 8 to 14% of patients undergoing coronary artery bypass surgery.[1] Significant internal carotid artery disease poses a high risk for stroke after coronary bypass surgery. Therefore, carotid endarterectomy (CEA) is recommended for stroke prevention before coronary artery surgery.[1,2]

Surgical options applied in the coexistence of coronary and carotid artery disease are as follows: *(i)* staged approach, where endarterectomy is initially performed, followed by coronary artery bypass grafting (CABG); *(ii)* simultaneous approach, in which both procedures are done in one session; *(iii)* reversed approach, where CABG is performed first and CAE is performed later, which has a high cerebrovascular event rate. The overall risk of death, stroke, and myocardial infarction has been reported to be 10 to 12% after staged or simultaneous CEA and coronary bypass.[3] In this study, we aimed to present our results of CEA and myocardial revascularization performed simultaneously in a single center.

PATIENTS AND METHODS

Thirty-two patients (22 males, 10 females; mean age: 66.8±1.6 years; range, 49 to 85 years) who underwent simultaneous CAE and CABG using cardiopulmonary bypass (CPB) at the Turgut Özal University Faculty of Medicine Hospital between December 2010 and December 2014 were included in the sectional descriptive study. The patients were followed up for three months after the CABG. Surgical indications for CAE were as

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follows: *(i)* ≥50% internal carotid artery stenosis in a symptomatic patient, *(ii)* ≥70% internal carotid artery stenosis in an asymptomatic patient, and *(iii)* ≥70% bilateral internal carotid artery stenosis in an asymptomatic patient. Reoperation or emergency operations, patients with preoperative inflammatory or infective lung disease, patients with a left ventricular ejection fraction <40%, patients with chronic liver disease, and those using preoperative steroids were excluded from the study. All patients were operated by the same surgical team. Preoperative carotid artery evaluation of our patients was routinely performed with carotid Doppler ultrasonography. Computed tomography was performed in six patients (18.75%) as the rate of carotid stenosis could not be determined clearly who underwent carotid Doppler ultrasonography.

Surgical technique

The carotid artery was reached by passing the medial fascia of the sternocleidomastoid muscle. After the common carotid artery, internal carotid artery, and external carotid artery were fixed with nylon tapes, heparin was applied as a standard procedure. An incision was made in the carotid artery extending from the common carotid artery to the internal carotid artery. A carotid shunt was applied to all patients, and then CEA was performed. After the procedure was completed, the incision was repaired with primary or a continuous suture technique using a carotid patch. Acetylsalicylic acid was routinely added to the treatment on the first postoperative day in all patients.

Median sternotomy was performed, the left internal mammary artery was prepared. Moderate hypothermic CPB was applied during the operation. Myocardial protection was started with cold crystalloid cardioplegia, followed by cold blood cardioplegia. The aortic clamp was removed after all distal and proximal anastomoses were completed. We believe that the anastomosis quality is better under cross-clamp.

Statistical analysis

All data were collected and analyzed using IBM SPSS version 20.0 software (IBM Corp., Armonk, NY, USA). Descriptive data are reported as median with interquartile range or frequencies as appropriate. We performed a Student t-test or Mann-Whitney U test as appropriate. Categorical variables were expressed as numbers (percentages) and compared using Pearson's chi-squared tests. Clinical data were presented as mean ± standard deviation (SD). A p value <0.05 was considered statistically significant.

Table 1
Clinical characteristics of the patients

	n	%	Mean±SD	Range
Age (year)			66.8±1.6	49-85
Sex				
Male	22	68.8		
Female	10	31.3		
Neurological history				
Asymptomatic	23	71.9		
Transient ischemic attack	4	12.5		
Stroke	5	15.6		
Cardiac history (myocardial infarction)	15	46.9		
Chronic obstructive pulmonary disease	6	18.8		
Hypertension	26	81.3		
Diabetes mellitus	18	56.3		
Chronic renal failure	4	12.5		
Smoking	13	40.6		
Hyperlipidemia	10	31.3		
Peripheral artery disease	7	21.9		

SD: Standard deviation.

Table 2
Preoperative data

	n	%	Mean±SD	Range
Aortic cross-clamp time (min)			99.7±5.7	38-193
Cardiopulmonary bypass time (min)			125.6±7.6	60-259
Number of coronary grafts			3.5±0.1	2-5
Intensive care duration (h)			24.3±2.6	14-76
Length of stay in hospital (days)			6.6±0.5	4-14
Surgical technique primary	1	3.1		
Patchplasty	31	96.9		

SD: Standard deviation.

RESULTS

Preoperative demographic data are given in Table 1. In the preoperative evaluation, most of the patients were asymptomatic (23 patients, 71.9%). Four (12.5%) patients had a transient ischemic attack, and five (15.6%) patients had a history of stroke. Two patients with a history of stroke had right lower and right upper extremity weakness, two patients had left lower and left upper extremity weakness, and one patient had a complete motor deficit on the left side.

Unilateral stenosis was detected in 25 (78.1%) patients, and bilateral stenosis was detected in seven (21.9%) patients. Fifteen (46.9%) patients had a history of coronary artery disease (myocardial infarction). Two of four (12.5%) patients with chronic kidney disease were continuing the hemodialysis program.

The preoperative data of the patients are given in Table 2. All patients were followed in the intensive care unit on the first day of operation. The carotid artery was repaired with a patch in 31 (96.9%) cases, and primary closure was preferred in only one (3.1%) patient due to the large diameter of the carotid artery.

Postoperative data of the patients are given in Table 3. Early mortality occurred in two (6.3%) patients due to cardiac events. One was deceased while hospitalized on the seventh postoperative day, and sudden death was observed in the other patient after discharge in the first postoperative month. Permanent hemiplegia developed in one patient, who was referred to physical therapy and rehabilitation after discharge. A transient ischemic attack developed in two patients. Myocardial infarction was observed in one patient after the operation.

Table 3
Postoperative data

	n	%
Early mortality	2	6.3
Neurological event persistent		
Hemiplegia	1	3.1
Transient hemiparesis	0	0
Transient ischemic attack	2	6.3
Postoperative MI	1	3.1
Atrial fibrillation	3	9.4
Heart failure	2	6.3

MI: Myocardial infarction.

DISCUSSION

One of the most common and feared complications after myocardial revascularization is a perioperative neurological event. In addition to having a significant effect on morbidity and mortality in the early and late periods, it prolongs the stay in the intensive care unit and the duration of discharge. It causes loss of workforce and reduced quality of life.[4-6]

It has not yet been clarified whether carotid artery disease causes perioperative stroke in individuals who have undergone coronary bypass operations. It has been suggested that some of the strokes may occur from residual carotid plaques during or after the operation, as well as from the harmful effects of the CPB, particularly the loss of pulsatile flow and the decrease in systemic perfusion pressure during CPB, which causes ischemia and related stroke distal to the carotid stenosis.[2,6] However, Reed et al.[7] also reported that more than 50% of strokes occur in the

postoperative period. This indicates that there are other mechanisms as well. More research is needed on this topic.[2,7]

Discussions are still ongoing about the surgical sequencing of patients with both CABG and CEA indications.[8] Surgical strategies such as staged, reverse staged, or simultaneous approaches were reported to minimize perioperative neurological and cardiac complications in these patients.[9] In patients with significant carotid artery stenosis who underwent CABG alone, the perioperative neurologic event rate was reported between 7.4 and 20.3%, and the mortality rate was between 6.9 and 13.8%.[10,11] In addition, a high morbidity rate of 7 to 8% was reported in patients requiring CABG but undergoing isolated CEA, and this is mostly the result of perioperative myocardial infarction.[11] Therefore, simultaneous operation in which both CEA and CABG are performed is recommended.[12,13] Trachiotis and Pfister[14] and Akins et al.[15] reported that combined CEA and CABG surgery were very effective in reducing neurological and myocardial complications. In addition, Takach et al.[16] stated in their study that the simultaneous approach is as safe as the staged approach even in the high-risk patient group. However, the discussion of how the simultaneous approach will be conducted has continued since Bernhard et al.[17] reported the simultaneous operation for the first time. The incidence of stroke is high (10%) in patients who initially underwent CABG and then CEA under cardiopulmonary bypass. In patients who underwent CEA and then coronary bypass operation, the incidence of perioperative myocardial infarction was found higher, and it has been reported that 25 to 30% of death rates are due to myocardial infarction.[18,19] Evagelopoulos et al.[20] performed combined surgery in 313 patients in which the carotid artery was prepared first and performed CEA after cooling to 30°C with median sternotomy, systemic heparinization, standard cannulation, and CPB. The early mortality rate with this technique was found to be 8.9% (4.2% cardiac origin). Khaitan et al.[21] reported that cerebral protection could be safely applied with 25°C hypothermia. In our series, we found that major neurological morbidity was 3.1% and mortality was 6.3% in our patients. In addition, 6.3% of our patients developed a transient ischemic attack.

Although there is no consensus on the ideal mean blood pressure for cerebral protection in CPB, Tufo et al.[22] reported that the risk of neurological events increased fourfold when the blood pressure remained below 50 mmHg for more than 10 min. In the simultaneous surgical technique used in our study, CEA is performed first, and then CABG is performed. Cerebral perfusion was maintained by the routine use of carotid shunts in all patients during CEA. In addition, we aimed to prevent cerebral hypoperfusion by keeping the perfusion pressure above 70 mmHg during CPB.

It has been reported in various publications that cardiopulmonary bypass and aortic and carotid cross-clamp time are the most important determinants of perioperative stroke development in CABG surgery. Each of these two periods is of particular importance in combined surgery. In a study of 2,211 patients undergoing coronary artery surgery, it was reported that pump time exceeding 120 min was a predictor of perioperative stroke.[23] In our series, the mean aortic cross-clamp time was 99.7±5.7 min, and the mean CPB time was found 125.6±7.6 min.

The main limitation of this study is that it included a single center. Therefore, the number of patients and the follow-up period are limited. Long-term follow-up results are needed.

In conclusion, combined CEA and CABG intervention may be recommended in the presence of severe carotid stenosis with coronary artery disease. When evaluated together with the literature, it can be said that the results of the simultaneous approach will be satisfactory.

Ethics Committee Approval: The study protocol was approved by the Turgut Özal University Ethics Committee (Date/no: 12.01.2011/03). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Chiariello L, Nardi P, Pellegrino A, Saitto G, Chiariello GA, Russo M, et al. Simultaneous carotid artery stenting and heart surgery: Expanded experience of hybrid surgical procedures. Ann Thorac Surg 2015;99:1291-7.
2. John R, Choudhri AF, Weinberg AD, Ting W, Rose EA, Smith CR, et al. Multicenter review of preoperative risk factors for stroke after coronary artery bypass grafting. Ann Thorac Surg 2000;69:30-5.
3. Naylor AR, Cuffe RL, Rothwell PM, Bell PR. A systematic review of outcomes following staged and synchronous carotid endarterectomy and coronary artery bypass. Eur J Vasc Endovasc Surg 2003;25:380-9.
4. Akins CW. Combined carotid endarterectomy and coronary revascularization operation. Ann Thorac Surg 1998;66:1483-4.
5. Berens ES, Kouchoukos NT, Murphy SF, Wareing TH. Preoperative carotid artery screening in elderly patients undergoing cardiac surgery. J Vasc Surg 1992;15:313-21.
6. Kış M, Merdanoğlu M, Balkanay M. A comparison of modified eversion endarterectomy versus classical endarterectomy in the surgical treatment of carotid artery stenosis. Cardiovasc Surg Int 2020;7:163-9.
7. Reed GL 3rd, Singer DE, Picard EH, DeSanctis RW. Stroke following coronary-artery bypass surgery. A case-control estimate of the risk from carotid bruits. N Engl J Med 1988;319:1246-50.
8. Gansera B, Angelis I, Weingartner J, Neumaier-Prauser P, Spiliopoulos K, Kemkes BM. Simultaneous carotid endarterectomy and cardiac surgery--additional risk factor or safety procedure? Thorac Cardiovasc Surg 2003;51:22-7.
9. Borger MA, Fremes SE, Weisel RD, Cohen G, Rao V, Lindsay TF, et al. Coronary bypass and carotid endarterectomy: Does a combined approach increase risk? A metaanalysis. Ann Thorac Surg 1999;68:14-20.
10. Hertzer NR, Loop FD, Taylor PC, Beven EG. Staged and combined surgical approach to simultaneous carotid and coronary vascular disease. Surgery 1978;84:803-11.
11. Reul GJ, Morris GC Jr, Howell JF, Crawford ES, Stelter WJ. Current concepts in coronary artery surgery. A critical analysis of 1,287 patients. Ann Thorac Surg 1972;14:243-59.
12. Minami K, Fukahara K, Boethig D, Bairaktaris A, Fritzsche D, Koerfer R. Long-term results of simultaneous carotid endarterectomy and myocardial revascularization with cardiopulmonary bypass used for both procedures. J Thorac Cardiovasc Surg 2000;119:764-73.
13. Hertzer NR, O'Hara PJ, Mascha EJ, Krajewski LP, Sullivan TM, Beven EG. Early outcome assessment for 2228 consecutive carotid endarterectomy procedures: The Cleveland Clinic experience from 1989 to 1995. J Vasc Surg 1997;26:1-10.
14. Trachiotis GD, Pfister AJ. Management strategy for simultaneous carotid endarterectomy and coronary revascularization. Ann Thorac Surg 1997;64:1013-8.
15. Akins CW, Moncure AC, Daggett WM, Cambria RP, Hilgenberg AD, Torchiana DF, et al. Safety and efficacy of concomitant carotid and coronary artery operations. Ann Thorac Surg 1995;60:311-7.
16. Takach TJ, Reul GJ Jr, Cooley DA, Duncan JM, Ott DA, Livesay JJ, et al. Is an integrated approach warranted for concomitant carotid and coronary artery disease? Ann Thorac Surg 1997;64:16-22.
17. Bernhard VM, Johnson WD, Peterson JJ. Carotid artery stenosis. Association with surgery for coronary artery disease. Arch Surg 1972;105:837-40.
18. Brener BJ, Brief DK, Alpert J, Goldenkranz RJ, Parsonnet V. The risk of stroke in patients with asymptomatic carotid stenosis undergoing cardiac surgery: A follow-up study. J Vasc Surg 1987;5:269-79.
19. Moore WS, Barnett HJ, Beebe HG, Bernstein EF, Brener BJ, Brott T, et al. Guidelines for carotid endarterectomy. A multidisciplinary consensus statement from the Ad Hoc Committee, American Heart Association. Circulation 1995;91:566-79.
20. Evagelopoulos N, Trenz MT, Beckmann A, Krian A. Simultaneous carotid endarterectomy and coronary artery bypass grafting in 313 patients. Cardiovasc Surg 2000;8:31-40.
21. Khaitan L, Sutter FP, Goldman SM, Chamogeorgakis T, Wertan MA, Priest BP, et al. Simultaneous carotid endarterectomy and coronary revascularization. Ann Thorac Surg 2000;69:421-4.
22. Tufo HM, Ostfeld AM, Shekelle R. Central nervous system dysfunction following open-heart surgery. JAMA 1970;212:1333-40.
23. Birdi I, Izzat MB, Bryan AJ, Angelini GD. Normothermic techniques during open heart operations. Ann Thorac Surg 1996;61:1573-80.