Türk Göğüs Kalp Damar Cerrahisi Dergisi

Turkish Journal of Thoracic and Cardiovascular Surgery

Simultaneous carotid endarterectomy and coronary revascularization using moderate hypothermia in patients with bilateral carotid disease and coronary artery disease

İki taraflı karotis ve koroner arter hastalığında orta derecede sistemik hipotermi uygulanarak eşzamanlı karotis arter endarterektomisi ve koroner revaskülarizasyonu

Ercan Eren, Mehmet Balkanay, Mehmet Erdem Toker, Altuğ Tuncer, Cüneyt Keleş, Berk Özkaynak, Mustafa Güler, Gökhan İpek

Department of Cardiovascular Surgery, Kartal Koşuyolu Heart and Research Hospital, İstanbul

Background: The appropriate surgical strategy for patients with combined carotid and coronary artery disease remains controversial. This study was designed to investigate the safety and effectiveness of simultaneous applications of coronary revascularization and carotid endarterectomy under systemic hypothermia.

Methods: We retrospectively evaluated 15 patients (11 males, 4 females; mean age 64 years; range 55 to 72 years) with coronary artery disease and bilateral carotid artery stenosis. Nine patients had bilateral carotid artery disease with more than or equal to 70% stenosis and contralateral occlusion, and six patients had bilateral stenosis ranging between 80% and 99%. All the patients underwent carotid endarterectomy under moderate (25 °C) systemic hypothermia. Coronary revascularization was performed during the periods of cooling and rewarming. The mean follow-up period was 26.2±8.3 months (range 12 to 41 months).

Results: No hospital mortality was seen. The mean number of grafts used was 2.7±0.7. The mean times of carotid occlusion and cross-clamping were 14.5±0.7 minutes and 104±8.2 minutes, respectively. The mean hospital stay was 7.6±0.8 days. None of the patients developed stroke or death or required contralateral carotid endarterectomy during the follow-up period.

Conclusion: Simultaneous coronary artery bypass grafting and carotid endarterectomy using moderate systemic hypothermia for cerebral protection is a safe and effective procedure for patients with coexisting coronary artery disease and significant bilateral carotid artery occlusive disease.

Key words: Combined modality therapy; coronary artery bypass/methods; endarterectomy, carotid/methods.

Amaç: Karotis ve koroner arter hastalığının bir arada bulunduğu olgularda uygun cerrahi strateji halen tartışmalıdır. Bu çalışmada, sistemik hipotermi altında eşzamanlı koroner arter revaskülarizasyonu ve karotis endarterektomisi uygulamasının güvenliği ve etkinliği araştırıldı.

Çalışma planı: Çalışmada iki taraflı karotis arter hastalığı ve koroner arter hastalığı olan 15 olgu (11 erkek, 4 kadın; ort. yaş 64; dağılım 55-72) geriye dönük olarak değerlendirildi. Dokuz hastada iki taraflı %70 ve üzerinde karotis darlığı ve karşı tarafta tıkanıklık, altı hastada ise %80-99 iki taraflı karotis arter darlığı vardı. Tüm hastalara orta derecede (25 °C) sistemik hipotermi altında karotis endarterektomisi uygulandı. Koroner arter revaskülarizasyonu soğuma ve ısınma periyodları sırasında yapıldı. Ortalama izlem süresi 26.2±8.3 ay (dağılım 12-41 ay) idi.

Bulgular: Hastane içi ölüm olmadı. Ortalama greft sayısı 2.7±0.7 idi. Ortalama karotis oklüzyon zamanı ve krosklemp zamanı sırasıyla 14.5±0.7 ve 104±8.2 dakika bulundu. Hastanede kalış süresi ortalama 7.6±0.8 gündü. Ameliyat sonrası izlem süresince hiçbir hastada inme ve ölüme rastlanmadı, karşı taraf karotis endarterektomisi gerekmedi.

Sonuç: İki taraflı karotis hastalığı ve koroner arter hastalığının bir arada bulunduğu olgularda serebral koruma için sistemik hipotermi altında eşzamanlı koroner arter revaskülarizasyonu ve karotis endarterektomisi uygulaması güvenli ve etkili bir yöntemdir.

Anahtar sözcükler: Kombine tedavi yöntemi; koroner arter bypass/yöntem; karotis endarterektomi/yöntem.

Received: September 6, 2006 *Accepted:* January 5, 2007

Correspondence: Dr. Ercan Eren. Kartal Koşuyolu Yüksek İhtisas Eğitim ve Araştırma Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 34846 Cevizli, İstanbul. Tel: 0216 - 459 40 41 e-posta: erenerus@yahoo.com

Despite a heightened of the dangers of coexistent carotid and coronary artery disease, the incidence of perioperative stroke has not changed over the past decade. Presenting carotid artery disease is associated with high incidence of stroke after a cardiac surgery.[1-3] Faggioli et al.[2] suggest that the prophylactic carotid endarterectomy (CEA) in patients with high grade or bilateral carotid artery disease may reduce the incidence of perioperative stroke. Coronary revascularization in a patient with internal carotid artery stenosis more than 50% is associated with a postoperative stroke rate of 6%, which increases significantly to more than 16% when stenosis is more than 90%.[4,5] Many surgeons advocated combined coronary artery bypass grafting (CABG) with unilateral carotid endarterectomy for obtaining reduced postoperative stroke rate. However, there are many clinical studies with the concomitant approach which has different postoperative stroke rates ranging from 2% to 20%.[6-8] There are many factors which influence the postoperative stroke rate such as patient selection criteria, variations in operative techniques, and intraoperative cerebral protective measures in the combined approach.

In the literature, most of the studies on concomitant CABG with CEA involved only one-sided (right or left) CEA because of significant unilateral carotid stenosis. There are only a few reports of undergoing combined CABG plus CEA in patients with symptomatic or asymptomatic significant bilateral carotid stenosis and coronary artery disease.[9,10] Because the postoperative stroke rate after combined CABG with bilateral CEA has been higher than concomitant CABG with unilateral CEA,[4,11,12] this obviously reveals that there is need for developing reliable clinical and operative guidelines for the management of patients with severe coronary and bilateral carotid artery stenosis. Therefore, the purpose of this study is to review our experience with combined CABG and unilateral CEA using moderate hypothermia for cerebral protection in this challenging group of patients.

PATIENTS AND METHODS

A retrospective nonrandomized chart review was performed in 15 patients (11 males, 4 females; mean age 64 years; range 55 to 72 years) who underwent concomitant CABG and unilateral CEA at Koşuyolu Heart and Research Hospital between June 2002 and October 2004. The study group consisted of stable angina patients with bilateral carotid artery stenosis, more than 70% of whom were scheduled to undergo CABG.

Perioperative risk factors were hypertension (n=11, 73.3%), obesity (n=6, 40%), diabetes (n=7, 46.6%), smoking history (n=7, 46.6%), and prior peripheral vascular disease (n=3, 20%). One patient (6.6%) presented with a history of stroke, three had (20%) transient ischemic attack, none of the patients presented with amaurosis fugax. The majority of patients (11/15, 73.3%) had asymptomatic bilateral carotid artery disease. Right carotid artery stenosis of more than 70% was present in nine patients (60%) and left carotid artery stenosis of more than 70% was present in 11 patients (73.3%) based on duplex ultrasound examination.

Patient selection criteria. All patients scheduled for CABG had a bilateral carotid artery color-flow duplex ultrasound examination whenever they had history of transient ischemic attacks, syncope or any cerebrovascular accidents, or asymptomatic bruits on physical examination. All of the patients were evaluated for carotid disease in another radiologic unit. Our review of the color-flow duplex ultrasound results comparing to operative specimens has demonstrated a high level of accuracy between duplex criteria and percentage of stenosis determined at the time of operation. Concomitant CABG and unilateral carotid artery endarterectomy operation was performed in patients who had >70% stenosis detected by duplex ultrasound, either having neurologic symptoms or not. No additional procedure such as magnetic resonant angiography or contrast angiography was performed for further investigation to confirm the validity of the ultrasound results. All patients, with or without symptomatic bilateral carotid disease who had >70% stenosis on one side while having >50% stenosis on the other side that were detected by duplex ultrasound were randomly chosen for concomitant coronary artery revascularization and CEA procedure. Patients who underwent concomitant unilateral CEA with CABG due to unilateral significant carotid and coronary artery disease were excluded from the study.

Operative technique. The same team of cardiothoracic surgeons performed the concomitant CABG with unilateral CEA procedures. Intraoperative cerebral monitoring devices were not used in any of the patients. Endarterectomy procedure was performed primarily on the side with a greater rate of stenosis.

The carotid artery was exposed through an incision anterior to the sternocleidomastoid muscle. The carotid vessels were isolated in the usual fashion. A median sternotomy was made and the conduit was harvested. Heparin administration and cannulation were then performed. Cardiopulmonary bypass was initiated and a retrograde cannula was placed in the coronary sinus and a venting cannula was placed on the ascending aorta. Cardiac arrest was achieved using retrograde warm blood cardioplegia, which was then cooled to 25 °C and given continuously for myocardial protection. As the cardioplegia was cooled down, the systemic perfusate

temperature is dropped to 25 °C. Throughout the cross-clamp period, high flow and pressure (mean 70 mmHg) were maintained with a centrifugal pump. The operation continued as if a cardiac operation alone was being performed. When an esophageal temperature of 25 °C is reached, the distal coronary anastomosis was completed, and the cardiac section of the operation was stopped. Attention was diverted to the carotid artery while aorta remained clamped and retrograde blood cardioplegia was given continuously. The carotid artery was clamped, opened, and endarterectomized without shunting. The principles of endarterectomy were strictly followed including extending the endarterectomy incision to normal internal carotid artery distally, endarterectomy of the internal and external carotid arteries, meticulous debridement of all flaps, and closure of the arteriotomy primarily or with a saphenous vein patch using a running 6-0 prolen suture. The artery was de-aired, and the clamps were released to re-establish flow into the carotid artery. We did not use the intravascular shunt in any study case. Temporary shunt is indicated for all patients with a prior history of cerebral infarction as weel as for those with a back-pressure of less than 25 mmHg. Patients undergoing operations for TIAs or asymptomatic carotid stenosis in whom the back-pressure is greater than 25 to 40 mmHg do not require a shunt. The remaining coronary grafts were completed, before the final proximal anastomosis to the ascending aorta was initiated, the patient was rewarmed to a systemic temperature of 37 °C. The operation was completed in a routine fashion with discontinuation of cardiopulmonary bypass.

The mean follow-up period was 26.2±8.3 months (range 12 to 41 months).

RESULTS

There was no mortality. Intraoperatively, cardiopulmonary bypass was maintained for a mean of 135 minutes (median duration, 130 minutes). The average aortic cross-clamp time was 104 minutes (medial time, 100 minutes). The average number of grafts was 2.7±0.7. Postoperative intensive care unit stay was 2.1±0.4 days with a mode of 2.5 days and a range of 1 to 2.5 days. No permanent or transient neurologic events including minor neurological events were observed in the early and late postoperative period. None of the patients required prolonged mechanical ventilation for more than 24 hours postoperatively.

DISCUSSION

Although the first description of a combined carotid endarterectomy and open heart surgery approach was reported by Bernhard et al.[13] in 1972, the choice of treatment for patients coexisting significant carotid artery stenosis and coronary artery disease is still a dilemma. During the past decade cardiac mortality and associated morbidity have steadily declined, but perioperative stroke rates have remained relatively constant in open heart surgery. Recently, Engleman et al.[14] reported the mean stroke rate of 2% following isolated CABG in a collective review of more than 35,000 patients. In addition, previous and more recent studies present that the presence of bilateral or unilateral carotid artery occlusive disease is a risk factor for the development of neurologic injury following cardiac operations in the early and late perioperative periods.[15,16] Patients with coexistent carotid and coronary artery disease present a major management problem because they represent a high-risk group of either surgery. Dashe et al.[17] found that stroke rate increased in a graded fashion in relation to the degree of carotid stenosis: 1.4% for the 0% to 24% stenosis subgroup, 4.1% for the 25% to 49% stenosis subgroup, 10.4% for the 50-69% stenosis subgroup, and 50% for the 70-90% stenosis group. In patients with symptomatic or asymptomatic carotid disease who underwent only CABG operation the incidence of stroke has been found to be as high as 17% in various reports.[1,16,18]

The risk of stroke in CABG with bilateral hemodynamically significant carotid artery stenosis could be considerably higher. This hypothesis was supported by a study of Nunn in which he reported a 58% stroke rate in untreated patients presenting bilateral carotid stenosis.[19] Similarly, Hertzer et al.[16] reported a significant number of patients in their series who had developed contralateral strokes in the unoperated diseased carotid artery side. In addition, Breaslau et al.[20] documented that the patients with bilateral carotid artery disease had a 23% incidence of stroke on the untreated contralateral side. To reduce the neurologic morbidity in patients with concomitant carotid and coronary disease, many surgeons advocated CEA before or simultaneously with coronary artery revascularization. Regarding CEA in this challenging group of patients, several investigators have also proposed that carotid endarterectomy should be performed on the side that contributes the majority of cerebral blood flow with or without cardiopulmonary bypass, and the contralateral side should be addressed at a later time in a reversed staged fashion.[21] However, recently, as in their interesting study, Dylewski and et al.[22] reported their successful surgical results of combined bilateral CEA with CABG in 33 patients with significant bilateral carotid occlusive and coronary artery disease. In this regard, Kouchoukos and et al.[9] suggest the use of hypothermic circulatory arrest for cerebral protection during combined CABG and CEA in patients with bilateral carotid artery disease. Although there are many methods which protect the brain during the CEA opera-

tions such as ipsilateral jugular venous oxygen tension measurement, monitoring of electroencephalographic waves and using the internal shunt depending on the back-pressure in the internal carotid vessel, we agree with Kouchoukos that hypothermia is a beneficial strategy for cerebral protection during the combined CEA and CABG. In an effort to reduce the risk of perioperative stroke for this patient population, in our institution, we have advocated moderate hypothermia during the concomitant CEA and CABG procedures using single cross-clamp in patients with significant bilateral carotid artery stenosis and coronary artery disease. We have never tried bilateral CEA because of probability of increased neurologic, respiratory, cardiac complications and uncomfortable condition either for the surgeon and the patient. In our opinion, performing a unilateral CEA while ignoring the contralateral diseased carotid artery in patients who have significant bilateral carotid artery stenosis may result in increased morbidity and mortality from the uncorrected lesion. Our rationale for using moderate hypothermia for cerebral protection in this setting has been based on historical and recent published data.[9,10,23] Khaitan et al.[23] found that hypothermia to 25 °C in patients is a good method for simultaneous repair of coronary and carotid lesions in a high-risk group of patients with concomitant disease in the study of 121 patients. Similarly, Guibaud et al.[10] recommend hypothermia to 28 °C or below degrees during the carotid clamping time for cerebral protection when ipsilateral or contralateral supply is reduced, or even absent.

This report presents the analysis of our recent experience with 15 patients who underwent simultaneous CEA and CABG under moderate hypothermic (25 °C) cardiopulmonary bypass. There was no mortality. No patient in this recent series suffered from a perioperative neurologic event. All patients who received combined CEA and CABG in our institution had carotid stenosis greater than 70% at least on one side of the carotid vessels. This represents less than 1% of our patient population undergoing CABG. Four percent of all patients undergoing cardiac procedures in our institution had carotid disease of greater than 50% stenosis. Patients with carotid stenosis of 50% to 70% are treated as routine CABG patients, and there was no perioperative stroke. Our cross-clamp and perfusion times were not significantly increased with the standard times at this institution. However, the intensive care unit stay was longer than other standard CABG patients. This prolonged stay was due to more closing follow-up of the patients for possible postoperative complications.

In conclusion, the operative technique we describe is a good one for treating the patients presenting with significant coronary artery disease associated with symptomatic or asymptomatic bilateral carotid artery occlusive disease. It entails a single period of anesthesia and hypothermia for cerebral protection. We have used this method with no mortality and morbidity and recommend its use in this high-risk group of patients.

Study limitations. The limitations of the current study include the having a small number of patients (15 pts) and lack of any comparison group to draw a statistically significant result from the hypothermia technique. As widely known, the patients with significant coronary and carotid artery disease are very rare. This selected group of patients mostly encountered during the investigation of a coronary disease. In our study, all patients were diagnosed bilateral carotid disease during the physical examination in the hospital by duplex carotid ultrasound. Regarding comparison group, we did not design a group which managed traditionally to compare the efficacy of the hypothermia technique. Under the theoretical knowledge, we believe that these kinds of patients should be operated using the combined procedure for better and safer cerebral protection other than techniques such as staged or reverse staged operations. Therefore, we operated all patients with combined significant bilateral carotid and coronary disease under the hypothermia technique.

REFERENCES

1. 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.
2. Faggioli GL, Curl GR, Ricotta JJ. The role of carotid screening before coronary artery bypass. J Vasc Surg 1990;12:724-9.
3. Mills NL, Everson CT. Atherosclerosis of the ascending aorta and coronary artery bypass. Pathology, clinical correlates, and operative management. J Thorac Cardiovasc Surg 1991;102:546-53.
4. Rizzo RJ, Whittemore AD, Couper GS, Donaldson MC, Aranki SF, Collins JJ Jr, et al. Combined carotid and coronary revascularization: the preferred approach to the severe vasculopath. Ann Thorac Surg 1992;54:1099-108.
5. Chang BB, Darling RC 3rd, Shah DM, Paty PS, Leather RP. Carotid endarterectomy can be safely performed with acceptable mortality and morbidity in patients requiring coronary artery bypass grafts. Am J Surg 1994;168:94-6.
6. Mackey WC, Khabbaz K, Bojar R, O'Donnell TF Jr. Simultaneous carotid endarterectomy and coronary bypass: perioperative risk and long-term survival. J Vasc Surg 1996; 24:58-64.
7. Trachiotis GD, Pfister AJ. Management strategy for simultaneous carotid endarterectomy and coronary revascularization. Ann Thorac Surg 1997;64:1013-8.
8. 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.
9. Kouchoukos NT, Daily BB, Wareing TH, Murphy SF.

Hypothermic circulatory arrest for cerebral protection during combined carotid and cardiac surgery in patients with bilateral carotid artery disease. Ann Surg 1994;219:699-705.
10. Guibaud JP, Roques X, Laborde N, Elia N, Roubertie F, Ewald J, et al. Extracorporeal circulation as an additional method for cerebral protection in simultaneous carotid endarterectomy and coronary artery surgical revascularization. J Card Surg 2004;19:415-9.
11. Furlan AJ, Craciun AR. Risk of stroke during coronary artery bypass graft surgery in patients with internal carotid artery disease documented by angiography. Stroke 1985; 16:797-9.
12. Vassilidze TV, Cernaianu AC, Gaprindashvili T, Gallucci JG, Cilley JH Jr, DelRossi AJ. Simultaneous coronary artery bypass and carotid endarterectomy. Determinants of outcome. Tex Heart Inst J 1994;21:119-24.
13. Bernhard VM, Johnson WD, Peterson JJ. Carotid artery stenosis. Association with surgery for coronary artery disease. Arch Surg 1972;105:837-40.
14. Engleman DT, Cohn LH, Rizo RJ. Incidence of predictors of TIAs and strokes following coronary artery bypass grafting: report and collective review. Available from: http://www.hsforum.com/stories/articleReader$709.
15. Darling RC 3rd, Paty PS, Shah DM, Chang BB, Leather RP. Eversion endarterectomy of the internal carotid artery: technique and results in 449 procedures. Surgery 1996;120:635-9.
16. Hertzer NR, Loop FD, Beven EG, O'Hara PJ, Krajewski LP. Surgical staging for simultaneous coronary and carotid disease: a study including prospective randomization. J Vasc Surg 1989;9:455-63.
17. Dashe JF, Pessin MS, Murphy RE, Payne DD. Carotid occlusive disease and stroke risk in coronary artery bypass graft surgery. Neurology 1997;49:678-86.
18. Kartchner MM, McRae LP. Carotid occlusive disease as a risk factor in major cardiovascular surgery. Arch Surg 1982; 117:1086-8.
19. Nunn DB. Carotid endarterectomy: an analysis of 234 operative cases. Ann Surg 1975;182:733-8.
20. Breslau PJ, Fell G, Ivey TD, Bailey WW, Miller DW, Strandness DE Jr. Carotid arterial disease in patients undergoing coronary artery bypass operations. J Thorac Cardiovasc Surg 1981;82:765-7.
21. Jahangiri M, Rees GM, Edmondson SJ, Lumley J, Uppal R. A surgical approach to coexistent coronary and carotid artery disease. Heart 1997;77:164-7.
22. Dylewski M, Canver CC, Chanda J, Darling RC 3rd, Shah DM. Coronary artery bypass combined with bilateral carotid endarterectomy. Ann Thorac Surg 2001;71:777-81.
23. 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.