

Simultaneous carotid endarterectomy and myocardial revascularization by using cardiopulmonary bypass for both procedures

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SUMMARY

This study retrospectively reviewed early outcomes after the carotid endarterectomy combined with coronary artery bypass grafting (CABG). Between January 2007 and March 2011, 52 patients who underwent combined myocardial revascularization and carotid endarterectomy in a single-stage procedure. The principal indication was the need for symptomatic or asymptomatic carotid stenosis of 80% stenosis or more. The mean age was 66.4 ± 6.6 years (range 50-75). 34 patients (65.4%) were male, 18 patients (34.6%) female. Mean number of the grafts 2.7, mean ejection fraction was (EF) % 49.6 ± 8.4 . A total of 22 patients (42.3%) had a previous myocardial infarction, 7 patients (13.4%) presented with unstable angina and one patient (1.9%) had prior coronary artery bypass grafts. The average cardiopulmonary bypass time was 83.2 ± 41.7 (range 30-204) min and cross-clamping time was 31.8 ± 11.8 (range 18-67) min. Early overall mortality was 3 (5.7%), of which 2 were cardiac related (3.8%). Other cause of death was fatal stroke in one patient (1.9%). Perioperative morbidity included myocardial infarction in 1 patient (1.9%), neurologic deficit in 3 (5.7%), 2 patients (3.8%) low cardiac output syndrome. Carotid endarterectomy and myocardial revascularization in conjunction with cardiopulmonary bypass is a method safe enough to prefer its routine use with acceptable low operative risk.

Key words: Carotid endarterectomy, coronary artery bypass grafting, post-operative complications, etiology

ÖZET

Kardiyopulmoner baypas kullanılarak eş zamanlı karotis endarterektomi ve miyokardiyal revaskülarizasyon

Bu çalışmada, koroner arter bypass greftleme (KABG) ile birlikte yapılan karotis endarterektomi sonrası erken dönem sonuçları retrospektif olarak sunuldu. Ocak 2007 - Mart 2011 tarihleri arasında kliniğimizde 52 hastaya kombine miyokard revaskülarizasyon ve karotis endarterektomi operasyonu yapıldı. Temel endikasyon, % 80 ve üstü semptomatik veya asemptomatik karotis darlığı idi. Yaş ortalaması 66.4 ± 6.6 yıl (48-77), 34 hasta erkek (% 65.4), 18 hasta kadın (% 34.6) kadın olarak bulundu. Ortalama greft sayısı 2.7, ortalama ejeksiyon fraksiyonu (EF) % 49.6 ± 8.4 idi. 22 hastada geçirilmiş miyokard infarktüsü (% 42.3), 7 hastada (% 13.4) kararsız angina, bir hastada geçirilmiş koroner arter bypass greft (% 1.9) öyküsü mevcuttu. Ortalama kardiyopulmoner baypas zamanı 83.2 ± 41.7 (dağılım 30-204) dakika ve kros-klemp zamanı 31.8 ± 11.8 (dağılım 18-67) dakika idi. Erken mortalite olarak bildirilen 3 hastanın (% 5.7), ikisi kardiyak sebebiyle idi. Diğer hastada ölüm nedeni, fatal inme (% 1.9) idi. Perioperatif morbidite olarak, 1 hastada miyokard infarktüsü (% 1.9), 3 hastada nörolojik defisit (% 5.7), 2 hastada (% 3.8) düşük kardiyak debi sendromu gelişti.

Kardiyopulmoner baypas ile birlikte eşzamanlı yapılan karotis endarterektomisi ve miyokardiyal revaskülarizasyon düşük operatif riski ile rutin tercih edilebilecek güvenli bir yöntemdir.

Anahtar kelimeler: Karotis endarterektomi, koroner arter bypass greftleme, postoperatif komplikasyonlar, etiyoloji

Introduction

A postoperative cerebral stroke remains one of the most serious complications after cardiac surgery. In recent studies, the frequency of severe perioperative strokes in unselected patients undergoing coronary artery bypass grafting (CABG) has varied between 0.3% and 3.9%(1,2). The most important risk factor for postoperative neurological complication is severe stenosis of the extracranial arteries in 1.3%–16% of preoperative patients requiring cardiac surgery(3,5). The treatment strategy for patients with concomitant carotid artery stenosis and cardiac surgery has not been clarified. The surgical strategy for these patients in this department is a one-stage procedure with cardiopulmonary bypass (CBP) being instituted before carotid endarterectomy for additional cerebral protection with mild hypothermia, systemic heparinization, and controlled hemodynamics under pulsatile perfusion. This study retrospectively reviewed short outcomes after a simultaneous carotid endarterectomy and coronary artery bypass surgery.

Material and Methods

A retrospective nonrandomized chart review was performed in patients who underwent for concomitant carotid and coronary disease at the department of cardiovascular surgery in our hospital between January 2007 and March 2011. Basic demographic information, preadmission comorbidities, medication profiles, presenting neurologic symptoms, operative details, as well as the nature of any postoperative complications were recorded. A total of 52 patients underwent combined unilateral/bilateral carotid endarterectomy (CEA) /coronary artery bypass grafting (CABG) operations. There were 34 male (65.4%) and 18 female (34.6%) patients, aged 48 to 77 years (median, 66.4 ± 6.6 years). Smoking history,

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hypertension and hypercholesterolaemia were present in >50% of cases. The concomitant carotid endarterectomy was performed in 28 patients on the right side, 23 patients on the left side and one patient on the bilateral. An overview on their preoperative conditions is given in Table I.

In Table II all results from the cardiac catheterization and digital subtraction angiography of the case group summarized. Most patients (53.8%) had triple-vessel disease and 23% had double vessel disease. In 18 patients (34.6%), a bilateral carotid stenosis was found. Ulcerated plaques were seen in 4 patients. Simultaneous procedures in the case group were mainly performed as elective operations (Table III).

The severity of internal carotid artery stenosis was graded as % 70 or more duplex carotid scanning. Patients who have intermediate stenosis have undergone DSA (digital subtraction angiography). The indication for a simultaneous approach was the need for myocardial revascularization and either symptomatic or asymptomatic internal carotid stenosis with equal or > 80% diameter reduction.

All patients had unilateral/bilateral carotid endarterectomy with autologous saphenous vein patch plasty or primary repair and concomitant cardiac surgery. Both CABG and CEA were performed by the same surgical team. The carotid artery was exposed. Median sternotomy was performed, systemic heparinization (3 mg/kg body weight) and cannulation were carried out. The mean arterial pressure was maintained at 60–70 mmHg with the unloaded beating heart. A carotid endarterectomy with autologous

Table I. Demographic and clinical characteristics

<i>Characteristics</i>	<i>Case group (n=52)</i>	<i>%</i>
Age		
Range	48-77	
Mean ±standard	66.4±6.6	
Sex		
Female	18	%34.6
Male	34	%65.4
Risk factory		
Smoking history	35	%67.3
Hypertension	30	%57.7
Diabetes mellitus	13	%25
Hypercholesterolemia	33	%63.5
Peripheral vascular disease	35	%67.3
Previous myocadial infarction	22	%42.3
Unstabil angina	7	%13.4
Neurological history	5	%9.6

Table II. Cardiac catheterization and dijital substraction angiography findings

<i>Findings</i>	<i>Case</i>	<i>%</i>
Coronary artery disease	52	%100
Single vessel	10	%19.2
Double vessel	12	%23
Triple vessel	28	%53.8
Multi vessel	2	%3.8
Ejection Fraction:		
Normal (≥50)	40	% 76.9
Mildly (40-49)	10	%19.2.
Severely (≤40)	2	%3.84
Carotis stenosis:		
Unilateral	30	%57.6
Bilateral	18	%34.6
Ulceration	4	%7.69

Table III. Operative characteristics

<i>Operative characteristics</i>	<i>Case group (n=52)</i>	<i>%</i>
Operative priority		
Elective	51	%98
Emergent	1	%1.9
CABG		
Number of grafts (range)	1-5	
Mean±standard deviation		
LIMA use	45	%86.5
Cardiopulmonary bypass (min)		
Range	30-204	
Mean±standard deviation	83.25±41.7	
Cross-clamp time (min)		
Range	18-67	
Mean±standard deviation	31.8±11.85	
IABP	1	
CEA		
Unilateral	51	
Bilateral	1	
Clamping time (min)		
Range	13-43	
Mean±standard deviation	20.23±5.62	

saphenous vein patch 7.6% (4/52) or primary repair 92.3% (48/52) was performed under simple carotid arterial clamping (without using shunt tube). Then, a CABG with the intermittent aortic cross-clamp method under cardiac arrest with cold blood retrograd cardioplegic solution were performed. The neck incision was left open until the end of the cardiac procedure.

Values were expressed as mean $\pm$ standard deviation and percentage per variables. All analyses were performed with Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) 13.0 version software.

Results

The average number of grafts was estimated to be 2.7. In 45 cases LIMA had been used. The average cardiopulmonary bypass time was 83.2 ± 41.7 min and cross-clamping time was 31.8 ± 11.8 min. An intra-aortic balloon pump was necessary in 2 cases. Unilateral carotid endarterectomy was performed in 51 patients (98.1%). In one case (1.9 %) a bilateral carotid endarterectomy was necessary. Average carotid clamping time was 20.2 ± 5.6 min (13-43) (Table III). One patient (1.9%) suffered myocardial infarction and 2 patients (3.8%) developed low cardiac output syndrome postoperatively. Revision of the internal carotid artery was necessary in one patient (3.8%) because of a haematoma in the soft tissue of the neck. 2 patients (3.8%) developed arrhythmia that needed medical treatment. Overall early mortality occurred in 3 patients (5.7%) of which 2 cases (4.2%) were cardiac related. The early causes of death were myocardial infarction in one patient (1.9%), low cardiac output in one patient (1.9%). Other cause of death was fatal stroke in one patient (1.9%). Resuscitation (postoperative cardiac arrest because of arrhythmia) was necessary in one patient (1.9%).

Discussion

Although the first description of a combined carotid endarterectomy and open heart surgery approach was reported by Bernhard and coworkers in 1972(6). The coincidence of coronary and carotid artery disease (uni- or bilateral, with or without involvement of the supra-aortic branch) is still a problem with regards to surgical strategy. This patient group is known to have a high risk cardiac or neurological complications after isolated coronary artery bypass grafting or carotid endarterectomy. It is clear that the desired goal of all methods is to minimize neurologic complications and mortality. Since the opening of the Heart Centre Duisburg in 1989 the authors have favoured a simultaneous approach to lesions in both arterial systems in order to avoid myocardial infarction or stroke. Simultaneous carotid endarterectomy and myocardial revascularization can be justified as

a routine surgical management of severe lesions in both arterial systems. The risk of myocardial infarction, apoplectic stroke or mortality was not significantly different than isolated procedures(7).

Routine carotid endarterectomy or coronary revascularization in patients without concomitant carotid or coronary disease or confounding illnesses can be performed with minimal morbidity and mortality.(8) In patients with no carotid artery disease undergoing coronary revascularization, pooled data from 1985 to 1992 have demonstrated an early mortality rate of %2.7 and stroke rate of % 1.9.(8) Faggioli and colleagues demonstrated that CABG in the presence of unilateral hemodynamically significant carotid artery disease is associated with a % 15 perioperative stroke risk(9). Hertz et al reported that the incidence of permanent stroke was % 6.7 if the contralateral internal carotid artery was more than % 50 narrowed and % 11 in the presence of contralateral internal carotid artery occlusion after CABG.(8) The risk of stroke in CABG patients with bilateral hemodynamically significant carotid artery stenosis could be considerably higher. To reduce the neurologic morbidity in patients with concomitant carotid and coronary artery disease, many surgeons advocated carotid endarterectomy before or simultaneously with coronary vascularization.

The rationale for this approach is based on the concern that the potential reduction in cerebral blood flow during cardiopulmonary bypass might be the antecedent factor for postoperative strokes. Furthermore the effects of nonpulsatile flow and labile arterial pressure during cardiopulmonary bypass may also influence the incidence of neurologic events. Embolization of atheromatous material, air, fat, thrombus or thrombosis or intracerebral hemorrhage are all potential factors in the genesis of strokes(10).

The incidence of major neurological complications after CABG has been reported to be between %1-6(11). Although several factors play significant roles in causing strokes in patients undergoing isolated coronary revascularization, carotid artery stenosis is an important, incremental risk factor(12,13). D'Agostino and coworkers estimated perioperative risk according to the degree of carotid stenosis as follows: < 2% with stenosis < 50%, 10% with stenosis 50%-80%, and 11-19% with stenosis > 80%(14). On the other hand, a controversy still exists in the literature as to whether or not CEA is protective against

stroke. The North American Symptomatic Carotid Endarterectomy Trial (NASCET) study showed that in symptomatic patients with 70-99% carotid stenosis, CEA decreased the 2-year rate of ipsilateral stroke from 26% (in medically treated patients) to 9%(15). The Asymptomatic Carotid Atherosclerosis Study (ACAS) study demonstrated a reduction in total neurological events in patients with > 60% carotid stenosis from 18 to 7%, over a 5 year period.(16) These data demonstrated clearly the need for an aggressive surgical approach in patients with concomitant significant carotid and coronary artery stenosis. Gugulakis et al reported that the incidence of permanent neurologic deficit was 2.4% and the hospital mortality rate was 4.2% in 1444 patients who underwent various combined procedures(17).

The best approach to the management of concomitant severe carotid and coronary artery disease remains unanswered. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines recommend carotid endarterectomy (CEA) in asymptomatic carotid stenosis of $\geq 80\%$ either prior to or combined with coronary artery bypass surgery (CABG). Currently, there is no consensus as to which surgical approach is superior. More recently, carotid artery stenting (CAS) prior to CABG is emerging as an alternative option with promising results in asymptomatic patients considered 'high risk' for CEA. A <3% composite event rate has been set as a benchmark for isolated CAS or CEA in asymptomatic patients by the ACC/AHA; however, most CEA or CAS studies in patients requiring concomitant CABG have shown event rates ranging from 10-12%. This review examines the available data on carotid revascularisation in relation to CABG surgery to aid in the risk-benefit decision analysis in this controversial area(18).

Large clinical studies have shown excellent outcomes when shunts are placed for CEA. But, many surgeons argue that shunts are not routinely necessary, even in patients with contralateral carotid occlusion(19,20,21). This conclusion is justified by similarly large case series of CEAs that demonstrate equivalent rates of stroke with and without a shunt in CEAs in patients(22). Our results are in agreement with other series reporting that combined CEA and CABG without shunt can be performed safely(23,24,25).

Carotid endarterectomy under conditions of ECC, beating heart, mild hypothermia (30°C), haemodilu-

tion and systemic heparinization has several advantages because mild hypothermia reduces the oxygen consumption in heart and brain. Systemic heparinization reduces the risk of embolization and major stroke.

Simultaneous carotid endarterectomy and coronary artery bypass surgery is a safe and effective technique for patients with significant coronary artery and carotid artery disease. We suggest that performing concomitant coronary revascularization and carotid endarterectomy under cardiopulmonary bypass is safe, offering acceptable morbidity and mortality rates.

References

1. Ganushchak YM, Fransen EJ, Visser C, De Jong DS, Maessen JG. Neurological complications after coronary artery bypass grafting related to the performance of cardiopulmonary bypass. *Chest* 2004;125:2196-205.
2. Karimi A, Ahmadi H, Davoodi S, Movahedi N, Marzban M, Abbasi K, et al. Factors affecting postoperative morbidity and mortality in isolated coronary artery bypass graft surgery. *Surg Today* 2008;38:890-8.
3. Minami K, Fukahara K, Boethig D, Bairaktaris A, Fritzsche D, Koerfer R. Long-term result of simultaneous carotid endarterectomy and myocardial revascularization with cardiopulmonary bypass used for both procedures. *J Thorac Cardiovasc Surg* 2000;119:764-73.
4. Swain JA. Cardiac surgery and brain. *N Engl J Med* 1993;329: 1119-20.
5. Kawarada O, Yokoi Y, Morioka N, Nakata S, Higashiue S, Mori T, et al. Carotid stenosis and peripheral artery disease in Japanese patients with coronary artery disease undergoing coronary artery bypass grafting. *Circ J* 2003;67:1003-6.
6. Bernhard VM, Johnson WD, Peterson JJ. Carotid artery stenosis. Association with surgery for coronary artery disease. *Arch Surg* 1972; 105: 837-40.
7. Evagelopoulos N, Trenz MT, Beckmann A, Krian A. Simultaneous carotid endarterectomy and coronary artery bypass grafting in 313 patients. *Cardiovasc Surg* 2000 Jan;8(1):31-40.
8. N.R Hertzner, F.D.Loop, P.C. Taylor. Surgical staging for simultaneous coronary and carotid disease study including prospective randomization. *J Vasc Surg* 1989;9:455-63.
9. G.R Faggioli, G.R Curl, J.J Ricotta. The role of carotid screening before coronary artery bypass. *J Vasc Surgery* 1990;724-31.
10. Dylewski M, Canver CC, Chanda J, Darling RC 3rd, Shah DM. Coronary artery bypass combined with bilateral carotid endarterectomy. *Ann Thorac Surg* 2001 Mar;71(3):777-81.
11. Venkatachalam S, Gray BH, Mukherjee D, Shishebor MH. Contemporary management of concomi-

- tant carotid and coronary artery disease. *Heart* 2011 Feb;97(3):175-80.
12. Roach GW, Kanchuger M, Mangano CM, et al. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. *N Engl J Med* 1996; 335: 1857-63.
 13. John R, Choudhri AF, Weinberg AD, et al. Multicenter review of preoperative risk factors for stroke after coronary artery bypass grafting. *Ann Thorac Surg* 2000; 69: 30-5; discussion 35-6.
 14. D'Agostino RS, Svensson LG, Neumann DJ, Balkhy HH, Williamson WA, Shahian DM. Screening carotid ultrasonography and risk factors for stroke in coronary artery surgery patients. *Ann Thorac Surg* 1996; 62: 1714-23.
 15. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 1991; 325: 445-53.
 16. Endarterectomy for asymptomatic carotid artery stenosis. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. *JAMA* 1995; 273: 1421-8.
 17. Gugulakis A, Kalodiki E, Nicolaides AN. Combined carotid endarterectomy and coronary artery bypass grafting. A literature review. *Int Angiol* 1991; 10: 167-72.
 18. ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease. *Stroke* 2011; 42:464-540.
 19. Samson RH, Showalter DP, Yunis JP. Routine carotid endarterectomy without a shunt, even in the presence of a contralateral occlusion. *Cardiovasc Surg* 1998;6:475-84.
 20. Bydon A, Thomas AJ, Seyfried D, Malik G. Carotid endarterectomy in patients with contralateral internal carotid artery occlusion without intraoperative shunting. *Surg Neurol* 2002;57:325-30; discussion: 331-2.
 21. Dimakakos PB, Antoniou A, Papasava M, Mourikis D, Rizos D. Carotid endarterectomy without protective measures in patients with occluded and non occluded contralateral carotid artery. *J Cardiovasc Surg* 1999; 40:849-55.
 22. Cinar B, Goksel OS, Karatepe C, Kut S, Aydogan H, Filizcan U, et al. Is routine intravascular shunting necessary for carotid endarterectomy in patients with contralateral occlusion? A review of 5-year experience of carotid endarterectomy with local anaesthesia. *Eur J Vasc Endovasc Surg* 2004;28:494-9.
 23. Özatik MA, Göl MK, Fansa I, Uncu H, Küçüker SA, KüşçüKaksu S, et al. Risk factors following coronary artery bypass operations. *J Card Surg* 2005;20:52-7.
 24. Akins CW, Hilgenberg AD, Vlahakes GJ, Madsen JC, MacGillivray TE, LaMuraglia GM, et al. Late results of combined carotid and coronary surgery using actual versus actuarial methodology. *Ann Thorac Surg* 2005;80:2091-7.
 25. Kougias P, Kappa JR, Sewell DH, Feit RA, Michalik RE, Imam M, et al. Simultaneous carotid endarterectomy and coronary artery bypass grafting: results in specific patient groups. *Ann Vasc Surg* 2007;21:408-14.