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Combined Surgical Approach to Carotid and Coronary Artery Disease

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A B S T R A C T

The aim of this study was to compare two different surgical approaches to patients with coexistent significant carotid and coronary artery obstruction. Patients were treated with combined operation of carotid endarterectomy and coronary artery bypass grafting (CEA/CABG). The first group of patients underwent the CABG procedure with the cardiopulmonary bypass (CPB) on arrested heart and the second group without the CPB on a beating heart – off pump. Between May 15 1998, and October 9 2003, thirty-five consecutive patients underwent the combined procedure. In both groups there were no cases of transient or permanent perioperative neurological events. Overall, early mortality was 5.6%. The incidence of a perioperative myocardial infarction was 5.5%. In the follow-up period there were no cases of late stroke. According to the presented results in this study, it was found that the combined CEA and CABG is an equally safe and effective procedure performed with or without cardiopulmonary bypass for patients with a severe coexistent carotid and coronary artery disease.

Key words: *carotid artery obstruction, carotid endarterectomy, coronary artery obstruction, coronary artery bypass grafting, stroke*

Introduction

The presence of a significant carotid artery disease in patients requiring coronary artery bypass grafting (CABG), incidentally found during a preparation for surgery, still is a matter of debate concerning the best surgical management. The incidence of more than 80% carotid artery stenosis in patients undergoing elective CABG has been reported as 8.5%[1,2]. Even a higher incidence of carotid artery stenosis has been reported with the left main coronary artery disease[3].

There is no ideal method to treat this high-risk group of patients. Options vary from a simultaneous (same anesthesia) to a staged procedure, whereby carotid endarterectomy (CEA) is performed several days prior to (staged approach) or after (reversed staged approach) coronary revascularisation. Each of these methods has its advantages and disadvantages, which can be measured by global mortality, incidence of stroke and incidence of myocardial infarction (MI).

Advocates of combined approach (simultaneous the CEA and CABG procedure) cite low incidence of stroke and MI as well as cost benefits of that procedure[4–11]. The rate of permanent neurological deficit was 1.9–9% and the mortality rate 3–8%[4,8,10–13].

In an effort to reduce the incidence of perioperative neurological complication among the high-risk patients with the coexistent critical carotid and coronary artery disease, we have approached these patients in our institution with combined procedure in which the CEA preceded the CABG during the same anesthesia.

The cardiopulmonary bypass (CPB) has been reported to be associated with a higher risk of stroke[14,15]. The off pump CABG (OPCABG) avoids the CPB as one of the contributing factors for stroke and gives additional benefits of decreased morbidity from systemic inflammatory response, in terms of blood loss, use of blood and blood products, intensive care unit stay, and hospital stay[16,17].

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The aim of this study was to compare two different surgical approaches to patients with the coexistant carotid and coronary artery obstruction, according to postoperative results, especially neurological complications. The CABG was made with the CPB on arrested heart (CPBCABG) or on a beating heart without the CPB (OPCABG). The surgical strategy and approach to each patient depended on the choice of each surgeon.

Relatively little data has been available for the long-term follow-up of combined CEA/CABG patients.

In this study, we also tried to determine the long-term results in these patients treated with the combined CEA/CABG operations, especially the late survival and freedom from late stroke.

Materials and Methods

Patients

Between May 15, 1998, and October 9, 2003, thirty-five consecutive patients underwent combined carotid and coronary artery revascularisation, representing 2% of all coronary operations performed in our institution during this period. The data was retrospectively reviewed for demographic information, clinical, angiographic and operative characteristics and results.

The distribution of important demographic and clinical characteristics of patients is shown in Table 1.

The average age of the CPBCABG group of patients was 65.35±5.65 years (range 55 to 74 years), and of the OPCABG group of patients was 63.94±6.58 years (range 50 to 76 years), (p=0.502, Table 1).

There were 15 men (88%) and 2 woman (12%) in the first group of patients, versus 14 men (77%) and 4 woman (22%) in the second group of patients.

The male-to-female ratio in two observed groups did not differ significantly (p=0.658, Table 1).

Symptoms related to coronary artery disease, as exertion angina, unstable angina and prior myocardial infarction in two observed groups did not differ significantly (p=1.000, Table 1).

The relative frequencies of asymptomatic bruit, transient ischemic attack (TIA), prior stroke and prior CEA in the neurological history in two observed groups did not differ significantly (p=0.228, Table 1).

Preoperative screening

Nearly all patients in this study were referred to hospital because of cardiac symptoms. Non-invasive carotid artery testing was performed on all patients with or without a history of neurological symptoms, a previous stroke, audible carotid bruit or evidence of multisystem vascular disease.

Extracranial carotid arteries were evaluated by color flow duplex scanning study. B-mode and color flow images of the common, external, and internal carotid arteries were obtained in longitudinal and transverse planes. The presence of plaque was noted and reduction in the cross-sectional area of the lumen was calculated. Patients who had more than or equal to 70% narrowing of common or internal carotid artery underwent a selective carotid angiography. A haemodynamically significant lesion was defined as a diameter reduction of equal or more than 70% of internal carotid artery (ICA) relative to the normal distal ICA.

The absolute indications for simultaneous procedures were symptomatic carotid artery disease (defined as either a TIA or a stroke occurring four or more weeks before the CABG), ICA stenosis of 70% or more, with or without a contralateral disease (the CEA was performed on the more severely affected side, unless stenosis of 100% – occluded) and ulcerated, unstable ICA lesion, regardless of the degree of stenosis.

Patients with the carotid stenosis of less than 70% were treated no differently from patients without stenosis.

The findings of coronary angiographic and carotid color flow duplex scanning/angiographic features in the patients' population are listed in Table 2.

A three-vessel coronary disease or a significant left main disease (more than 50% stenosis), or both, were present in 81% of the first group of patients and 77% in the second group of patients. The relative frequencies of coronary angiography findings in two observed groups did not differ significantly (p=1.000, Table 2).

The mean values of relative ICA stenosis on operated side did not differ significantly (p=0.301, Table 2). Contra lateral disease did not differ significantly (p=0.711, Table 2).

Definitions

Preoperative neurological status was categorized as asymptomatic or symptomatic (history of TIA, amaurosis fugax or complete stroke).

Perioperative neurological events were defined as TIA, reversible ischemic neurological deficit, or complete stroke.

Perioperative MI was defined as the occurrence of new Q waves, persistent ST segment changes correlated with an elevated myocardial fraction of creatinine kinaze, or new wall motion abnormality on echocardiogram.

Operative technique

All patients underwent one CEA and CABG, performed concomitantly under general anesthesia by the same operating team. All the CEAs were performed before myocardial revascularisation regardless if it was made with or without the CPB.

The CEA was made in the usual fashion, by ventral incision anterior to sternocleidomastoid muscle. Patients were heparinized by 5,000 i.u. of heparin. The decision to use a shunt or not was based on collateral circulation (back flow in the internal carotid artery). A shunt was used in all cases with occlusion of contralateral carotid artery. Arteriotomy was closed directly using a running 6–0 non-absorbable suture. The wound was closed after myocardial revascularisation with drainage.

TABLE 1
DEMOGRAPHIC PROFILE AND CLINICAL CHARACTERISTIC

Variables	Patients, N=17 CPBCABG	Patients, N=18O PCABG	p value
Age-years			
X± SD	65.35±5.65	63.94±6.58	ns
Range	55–74	50–76	
=70years	3 (18)	3 (16)	ns
Sex			
Male	15 (88)	14 (77)	ns
Female	2 (12)	4 (22)	ns
Smoking history	13 (76)	14 (77)	ns
Hypertension	12 (70)	16 (88)	ns
Diabetes mellitus	5 (29)	4 (22)	ns
Renal insufficiency	0	1 (5)	*
Chronic obstructive pulmonary disease	3 (17)	4 (22)	ns
Cardiac history			
Asymptomatic	1 (5)	0	*
Exertion angina	12 (70)	13 (72)	ns
Unstable angina	4 (23)	5 (27)	ns
Prior myocardial infarction	6 (35)	6 (33)	ns
Prior coronary artery bypass grafting	0	0	
Left ventricular ejection fraction			
X±SD	61.17±6.96	56.11±9.93	ns
Ejection fraction =35%	0	2 (11)	*
Neurologic history			
Asymptomatic bruit	12 (70)	16 (88)	ns
Transient ischemic attack	5 (29)	2 (11)	ns
Prior stroke	2 (12)	3 (16)	ns
Prior carotid endarterectomy	1 (5)	1 (5)	ns
Euroscore			
X± SD	5.35±2.57	6.05±2.01	ns

Numbers in parenthesis are percentages, *The frequencies are too low for statistical analysis, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting

The median sternotomy was performed after the CEA. The initial heparin dose (after internal mammary artery harvesting) was given depending on base line activated clotting time (ACT) obtained after completion of the CEA. The ACT was maintained longer then 480 seconds in the CPBCABG procedure or 250 seconds in the OPCABG procedure. Conversion of heparin was made by 3 mg per kg of protamin sulfate at the end of procedure. Standard CABG was performed with the CPB on 17 patients (48%) and without the CPB on 18 patients (52%).

In those patients with the CPBCABG, the mean arterial pressure was maintained at a minimum of 60 mmHg. The CPB was normothermic in all patients. The ascending aorta, aortic arch, and descending aorta were examined for presence of significant atherosclerotic disease (mobile atheroma, wall thickening, etc.) using routinely transesophageal and epiaortic echocardiography. When significant aortic disease was found, at the discretion of the operating surgeon, the aorta was not used for the creation of proximal anastomoses. In cases in which the aorta was used, great efforts were made to use a single partial aortic occlusion period with a side-biting clamp in an area of ascending aorta deemed to be free of atherosclerotic disease. In order to see the global and regional left ventricular functions in all patients, the transesophageal echocardiography was performed before, during and after the operation.

The OPCABG was performed through a midsternotomy using stabilization devices and an oxygen blower was used for providing a bloodless field.

Follow-up

A follow-up clinical information about survival and subsequent neurological and coronary events was obtained during the period of hospitalization, and 3 to 68 months postoperatively (average 10.9±16.3 months) through

TABLE 2
ANGIOGRAPHIC FINDINGS

Variables	Patients, N=17 CPBCABG	Patients, N=18 OPCABG	p value
Coronary angiography			
One vessel disease	1 (5.6)	1 (5.5)	ns
Double vessel disease	2 (11)	3 (16)	ns
Triple vessel disease	9 (52)	8 (44)	ns
Left main stenosis	5 (29)	6 (33)	ns
Left ventricular ejection fraction			
Normal (>50)	15 (88)	15 (83)	ns
Mildly depressed (41–50)	2 (11)	1 (5.5)	ns
Moderately depressed (31–40)	0	2 (11)	*
Severely depressed (<30)	0	0	
ICA % stenosis on operated side			
X±SD	80.82%±10.96%	77.5%±7.52%	ns
Range	70–99%	70–95%	
Contralateral stenosis	12 (71)	14 (77)	ns
ICA % stenosis on nonoperated side			
X±SD	72.91%±22.6%	69.3%±17.6%	ns
Range	50–100%	50–100%	
Total occlusion	4 (23)	3 (16)	ns

Numbers in parenthesis are percentages, *The frequencies are too low for statistical analysis, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting, ICA – internal carotid artery

direct communication with patients. Neurological and cardiac status was evaluated.

Statistical analysis

The interval values were expressed as mean values ± standard deviation and compared using the t-test. The categorical data were analyzed using the χ^2 test or Fischer's exact test. It was significant that the p value was lower than 0.05.

Results

The operative characteristics of the CEA and the CABG procedures are listed in Table 3 and 4.

All patients had a unilateral CEA. A right CEA was performed in 10 (58%) cases, versus 12 (66%) cases, and a left CEA was performed in 7 (41%) cases, vs. 6 (33%) cases (p=0.733, Table 3). None underwent bilateral carotid endarterectomy or had prior contralateral CEA. The carotid arteriotomy was closed directly in all patients. A shunt was used in 10 (58%), vs. 6 (33%) cases. The mean carotid occlusion time in two observed groups did not differ significantly (p=0.439, Table 3).

The CPBCABG was performed in 17 patients and the OPCABG in 18 patients. The CPB was maintained for a mean of 87.17±26.09 minutes. The average aortic cross-clamp time was 52.17±17.1 minutes.

On average, 3.7±1.04 coronary artery bypass grafts were performed in the CPBCABG group of patients (range 3 to 6 grafts) and 1.83±0.78 coronary artery bypass grafts in the OPCABG group of patients (range 1 to 4 grafts). The mean number of grafts applied was significantly greater in the CPBCABG than in the OPCABG patients (t=6.041, p=0.000, Table 4). In 14 (82%) vs. 18 (100%) cases the left internal mammary artery was used (p=0.104, Table 4).

The incidence of in-hospital and 30-day postoperative events is listed in Table 5.

Briefly, there were no cases of perioperative permanent and transient stroke or other neurological events in both groups of the patients. In the CPBCABG group there was neither a perioperative death nor MI.

The incidence of a perioperative death was 11% (2 of 18) in the OPCABG group, including one case of intraoperative MI (5.5%).

The primary cause of death in the two CEA/OPCABG patients was as follows: the first was due to an intraoperative MI, the second was due to perioperative pulmonary embolism on the fourth postoperative day. In the first case, the electrocardiogram abnormalities, the cardiac enzymes and the transesophageal echocardiography determined the MI. The second case was determined by autopsy findings.

One of the CPBCABG patients and one of the OPCABG have developed a neck haematoma, which requested reexploration and evacuation of the haematoma (p=1.000, Table 5). There was no infection at the CEA site.

TABLE 3
CAROTID ENDARTERECTOMY – INTRAOPERATIVE VARIABLES

Variables	Patients, N=17 CPBCABG	Patients, N=18 OPCABG	p value
Right carotid endarterectomy	10 (58)	12 (66)	ns
Left carotid endarterectomy	7 (41)	6 (33)	ns
Bilateral carotid endarterectomy	0	0	
Shunt used	10 (58)	6 (33)	ns
Carotid occlusion time – minutes			
X±SD	17±2.23	17.75±3.3	ns

Numbers in parenthesis are percentages, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting

TABLE 4
CORONARY ARTERY BYPASS GRAFTING – INTRAOPERATIVE VARIABLES

Variables	Patients, N=17 CPBCABG	Patients, N=18 OPCABG	p value
Number of grafts			
X±SD	3.7±1.04	1.83±0.78	<0.001
Range	3–6	1–4	
Left internal mammary artery	14 (82)	18 (100)	ns
Right internal mammary artery	0	1 (5)	*
Cross-clamp time-minutes			
X±SD	52.17±17.1		
Range	15–79		
Cardiopulmonary bypass-minutes			
X±SD	87.17±26.09		
Range	26–128		
Intraaortic balloon pump			
Preoperative	1 (5)	1 (5)	ns
Intraoperative	0	1 (5)	*
Postoperative	0	0	

Numbers in parenthesis are percentages, *The frequencies are too low for statistical analysis, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting

The average pulmonary ventilation in the first group of patients was 18.2±4.67 hours (with the range of 7 to 24 hours), versus 13.93±5.7 hours (with the range of 8 to 24 hours) in the second group of patients, and was significantly higher in the CPBCABG than in the OPCABG patients (p=0.021, Table 5).

An average postoperative intensive care unit stay was 3.81±5.92 days, with the range of 2 to 11 days, vs. 3.29± 3.8 days with the range of 1 to 16 days. The mean and up to seven days long intensive care unit stay in two observed groups did not differ significantly (p=0.758, p= 0.177, Table 5).

An average length of postoperative hospitalization was 11.75±7.78 days, with the range of 5 to 32 days, vs. 10.32±6.52 days, with the range of 5 to 58 days and did not differ significantly in two observed groups (p=0.534, Table 5).

With two cases of death in the perioperative period, 17 patients in the CEA/CPBCABG group and 16 patients in the CEA/OPCABG group were available for a long-term follow-up, listed in Table 6.

The average follow-up was 10.9±16.3 months (with the range of 3 to 68 months). During the follow-up period, there were no cases of late stroke and mortality in the CPBCABG group, or in the OPCABG group.

Discussion

The initial premise in this study was that the CEA and the CABG are the best treatment modalities for patients with a significant carotid or coronary disease[18–23]. Controversies existed in literature whether or not the CEA is protective against a stroke. However, some ran-

TABLE 5
IN-HOSPITAL AND 30-DAY POSTOPERATIVE EVENTS

Variables	Patients, N=17 CPBCABG	Patients, N=18 OPCABG	p value
Death (hospital/30-day)	0	2 (11)	*
Myocardial infarction	0	1 (5.5)	*
Pulmonary embolism	0	1 (5.5)	*
Pulmonary ventilation – hours			
X±SD	18.2±4.67	13.93±5.7	<0.05
Range	7–24	8–24	
Reexploration for neck wound bleeding	1 (5)	1 (5)	ns
Neck wound infection	0	0	
Transient ischaemic attacks	0	0	
Stroke	0	0	
Combined total stroke and death	0	0	
Intensive care unit stay – days			
X±SD	3.81±5.92	3.29±3.8	ns
Range	2–11	1–16	
<7 days	13 (76)	17 (94)	ns
Hospital stay – days			
X±SD	11.75±7.78	10.23±6.52	ns
Range	5–32	5–58	

Numbers in parenthesis are percentages, *The frequencies are too low for statistical analysis, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting

TABLE 6
FOLLOW-UP

Variables	Patients, N=17 CPBCABG	Patients, N=16 OPCABG	p value
Neurologic related events			
Transient ischemic attack	0	1 (6.6)	*
Stroke	0	0	
Cardiac related events			
Exertion angina	1 (6.6)	1 (6.6)	ns
Unstable angina	0	0	
Congestive heart failure	0	0	
Myocardial infarction	0	0	

Numbers in parenthesis are percentages, *The frequencies are too low for statistical analysis, CPBCABG – cardiopulmonary bypass coronary artery bypass grafting, OPCABG – off pump coronary artery bypass grafting

domized trials have demonstrated a significant benefit of the CEA over a continuous medical treatment for symptomatic patients with reduction of ipsilaterale stroke from 26% to 9%[24], and even for asymptomatic severe carotid artery stenosis with reduction in ipsilateral neurological events from 18% to 7%[25]. These data may be extrapolated to the patients requiring the CABG, and argue our aggressive surgical approach for this population.

The second premise that had to be addressed was whether the presence of a severe disease in one arterial system could be a significant threat to patients with the coexistent diseases if an operation addresses only the disease in the other system.

The major contribution of the coronary artery disease to the short-term risks of the CEA has been well established[26]. The CEA done in patients with a severe uncorrected coronary artery disease has been associated with perioperative MI rates as high as 17% and operative mortality rates of up to 20%, with MI accounting for as many as 60% of these deaths[7,8].

The incidence of neurological complications that occured during the performance of coronary artery surgery varies widely and has been reported between 1 and 14%[8,9,12,27]. Although the role of carotid disease in the genesis of perioperative stroke in patients undergoing isolated myocardial revascularisation remains incompletely defined, because of multifactorial etiology, several reports indicate that significant carotid artery stenosis is an important, and for some the strongest, incremental risk factor[4–6]. D'Agostino at al., estimated perioperative risk at <2% in patients with carotid stenosis <50%, 10% with stenosis 50–80%, and 11–19% with stenosis >80%[13].

A risk for the perioperative stroke after the CABG has become an issue of increasing importance to cardiac surgeons, especially as the average age of coronary bypass patients continues to rise as well as the incidence of the stroke. Tuman and colleagues reported a stroke rate of 0.9% for patients who were less than 65 years old compared with 8.9% for patients who were more than 75 years of age, with the curve of stroke incidence in their patients rising exponentially after the age of 65[28]. To put this risk in perspective, the average age of coronary bypass patients in our institution is currently 61±8.87 years (the range of 18 to 88 years), with 4.7% of patients being 75 or more years of age.

The third premise was that the combined CEA decreases the incidence of stroke, severity of stroke, or mortality at the time of the CABG compared with stage procedure.

Hertzer and colleagues compared results from combined and staged patients and found a lower stroke incidence (5.3% versus 11.4%) and stroke/death (8.4% versus 13.3%) with combined versus staged surgery[9]. This is contrary to an earlier report in which both stroke (8.7% versus 5.1%) and stroke/death (13.0% versus 6.8%) was greater with combined surgery[29].

Takach and associates compared the results of staged and combined procedure over two periods (1975 to 1985 versus 1986 to 1996). They found a similar trend of increased safety of combined procedure over those two periods (stroke: 5.4% down to 1.9%; stroke/death: 8.1% down to 5.7%)[30].

Brener and associates concluded that a superior outcome could be achieved with the combined operation[31]. The reports of other authors have also demonstrated the safety and efficacy of the simultaneous CEA and CABG[10,11,32,33].

A therapeutic and technical advances of contemporary cardiac surgery, operative myocardial protection, hemodynamic stability, patient monitoring, and medical management have been important factors contributing to the increased safety of combined coronary and carotid artery surgery[34–39].

A combined strategy of the CEA and the OPCABG performed on patients with a severe coexistent carotid and coronary artery disease, who are at a high risk for a perioperative stroke, could have several benefits. Firstly, the risk of embolism from the carotid source is potentially reduced. Secondly, by minimizing aortic manipulation it reduces the chance of atheroembolism from an aortic source. Thirdly, the OPCABG procedure may eliminate some of the potential untoward effects of nonpulsatile extracorporeal circulation (systemic inflammatory response, low-flow phenomena, etc.)[10,40,41].

The key question in this study was whether the simultaneous CEA and CABG procedure is equally safe and efficacious surgical approach if performed with and without the cardiopulmonary bypass.

In our both groups of patients there was no incidence of in-hospital ipsilateral permanent neurological sequels, nor incidence of combined total stroke and death. We believe that the simultaneous CEA and CABG procedure is safe and efficacious surgical approach performed with or without the CPB for patients with a severe coexistent carotid and coronary artery disease. Results documented in this study justify our rather aggressive approach we took on these severely diseased patients.

Long-term results found in patients who require either the CEA or the CABG have yielded good results. Civil et al. reported a 2.2% stroke rate after mean follow-up of 22 months[42]. Reported actuarial 5-year rates for freedom from stroke after the CEA have ranged from 87 to 90%[43,44]. Long-term survival after the CEA has been reported with good results. Actuarial 5-year survival after the CEA has ranged from 72 to 82%[45]. As a common cause for late deaths, MI was revealed[44].

The five and 10 year survival after the CABG was reported by Meyers and associates to be 90% and 74%[46].

In the follow-up period, there were no cases of late stroke. When comparing long-term results of our both groups of patients to the CEA patients, both groups enjoy same benefits of excellent long-term freedom from stroke and long-term survival. Therefore, we have identified patients that have benefited from operative strategies that include both, the carotid artery disease and the coronary artery disease.

The economic benefit was also reported, avoiding two separate operative procedures and hospitalization, as well as presenting substantially prolonged hospital stays of patients with perioperative cerebrovascular accidents[11].

Conclusion

Combined carotid endarterectomy and coronary artery bypass grafting is a safe and efficacious surgical approach performed with and without cardiopulmonary bypass for patients with a severe coexistent carotid and coronary artery disease. Results documented in this study justify our rather aggressive approach to patients with a severe coexistent disease. It also potentially eliminates expenses for subsequent hospitalization due to the second operation, or a stroke resulting from uncorrected carotid artery disease.

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KOMBINIRANI KIRURŠKI POSTUPAK KOD BOLESTI KAROTIDNIH I KORONARNIH ARTERIJA

SAŽETAK

Cilj ovog rada bio je usporediti dva različita kirurška postupka kod bolesnika s istovremenim značajnim suženjem karotidnih i koronarnih arterija. Pacijenti su liječeni kombinirnom operacijom endarterektomije unutarnje karotidne arterije i aortokoronarnog premoštenja. U prvoj skupini bolesnika aortokoronarno premoštenje je napravljeno uz pomoć stroja za izvantijelesni krvotok na zaustavljenom srcu, a u drugoj skupini bez uporabe stroja za izvantijelesni krvotok na kucajućem srcu. Od 15. svibnja 1998. godine do 9. listopada 2003. godine, u našoj ustanovi operirano je ukupno 35 bolesnika kombiniranim kirurškim postupkom. U ranom postoperativnom razdoblju u obje skupine bolesnika nije bilo slučajeva novonastalog prolaznog niti trajnog neurološkog poremećaja. Ukupna smrtnost bila je 5,6%, a učestalost srčanog infarkta 5,5%. Tijekom praćenja bolesnika po otpustu iz bolnice nije bilo slučajeva novonastalog neurološkog poremećaja. S obzirom na prikazane rezultate u ovom radu, utvrđeno je da kombinirana operacija karotidne endarterektomije i aortokoronarnih premoštenja je podjednako siguran i učinkovit postupak napravljen uz pomoć stroja za izvantijelesni krvotok kao i bez njegove uporabe kod navedene skupine bolesnika.