

Can systemic hypothermia induced during cardiopulmonary bypass protect the brain of patients undergoing carotid endarterectomy?

Karotis endarterektomi yapılan hastalarda kardiyopulmoner baypas ile oluşturulan sistemik hipotermi serebral korumaya yardımcı olabilir mi?

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Abstract

In the cases of coronary artery disease (CAD) concomitant with carotid artery stenosis (CAS), what to manage first is still a controversial subject. Patients with CAS who will undergo coronary artery bypass grafting are considered to be under a high risk of cerebrovascular accidents. On the other hand, patients with CAD who will undergo surgery for CAS are under a high risk of having myocardial infarction during the procedure especially when they have serious coronary artery lesions. That is why it is better to treat both diseases in the same surgery. In such surgeries the cornerstone is to find the best strategy that can reduce both morbidity and mortality. Carotid endarterectomy (CEA) and coronary artery bypass grafting (CABG) were performed in the same session on 3 cases of CAD and CAS who were operated under systemic hypothermia and cardiopulmonary bypass. There were no neurological complications.

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Key words: Carotid endarterectomy, coronary bypass, cardiopulmonary bypass, systemic hypothermia.

Özet

Karotis arter stenozu (KAS) bulunan koroner arter hastalarında (KAH) öncelikle hangi hastalığın tedavi edileceği ve cerrahi girişimin ne zaman olması gerektiği konusu tartışmalıdır. Koroner baypas cerrahisi uygulanacak hastalarda karotis arter hastalığı varsa serebrovasküler olay gelişme riski yüksek kabul edilir. Karotis arter cerrahisi yapılacak hastalarda ciddi koroner lezyonlar varsa işlem sırasında miyokard enfarktüsü gelişme riski fazladır. Bu nedenlerle bu iki hastalık aynı operasyonda tedavi edilmektedir. Bu hastalarda hangi cerrahi stratejinin uygulanacağı mortalite ve morbiditeyi azaltmada esastır. Biz 3 olguda hafif sistemik hipotermi ve kardiyopulmoner baypas altında karotis endarterektomi (KEA) + koroner arter baypas (CABG) uyguladık. Herhangi bir nörolojik komplikasyonla karşılaşmadık.

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Anahtar sözcükler: Karotis endarterektomi, koroner baypas, kardiyopulmoner baypas, sistemik hipotermi.

Introduction

Atherosclerosis is a systemic disease in that coronary, carotid and peripheral arteries simultaneously lead to severe occlusion. It has been shown in many studies that in patients who underwent coronary artery bypass surgery (CABG) the incidence of critical carotid stenosis varies between (> 70%) and 3-12% (1). Approximately half of the patients with carotid artery disease also have concomitant coronary artery disease (2). Currently, carotid endarterectomy (CEA) is the best choice in

the treatment of carotid artery stenosis (CAS). The disease that should be treated first or the pathology that should be treated during operations in patients with concomitant coronary artery disease (CAD) and bilateral carotid artery stenosis (CAS) is debatable. Although some reported experiences in the last few decades are available, combining CEA with CABG remains to be elucidated. Furthermore, the risk of cerebrovascular accident (CVA), which is one of the major predictors of prognosis of CABG, has been reported to increase up to 14% in patients with internal carotid artery (ICA)

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stenosis of more than %80 (2).

Some studies have shown a mortality rate for simultaneous CEA and CABG of 0–8.9% and a stroke rate of 0–9%. Lower mean arterial pressures of cardiopulmonary bypass, systemic vasodilatory response and plaque embolism during aortic cross-clamping increase the risk of peri-operative stroke in CABG patients (3). For these reasons, in patients with a combination of CAS and CAD, the surgical option should include both brain and cardiac protection. In order to decrease the rate of complications such as stroke and MI, concurrent strategies have been recommended because the proponents of the concurrent strategies think that mortality and morbidity rates are similar with the CABG and carotid surgery alone [4].

Here, we present three cases using different strategies (32 °C systemic hypothermia and with a quarter (1/4) cardiac output under cardiopulmonary bypass) who had simultaneous surgical treatment for CAS and CAD.

Preoperative assessment

The three patients had a total occluded carotid artery on one side and stenosis > 80% on the other side associated with CAD. Carotid Doppler ultrasonography and conventional coronary and carotid angiography examinations were performed for all the patients preoperatively. Patients who had unstable cardiac problems were scheduled to have CABG and CEA in the same session.

Operative technique

All patients were examined for serious carotid artery stenosis after setting up electrocardiographic, arterial, and respiratory monitoring and central venous catheterization. A median sternotomy under general anesthesia was planned. Left internal thoracic artery and saphenous vein grafts were prepared. Heparin was administered, and cardiopulmonary bypass (CPB) with a quarter flow was initiated when a steady activated clotting time was achieved after placing an arterial cannula into the ascending aorta and a two-stage venous cannula into the right atrium. We reduced the body temperature of the patients to 32°C. The aim was to maintain a mean arterial blood pressure > 120 mmHg (3). Positive inotropic agents were used if needed. A carotid endarterectomy was performed under mild hypothermia and low CBP flow. We did not use the carotid shunt in two of our 3 cases because there was a good retrograde flow in

the ICA. Endarterectomy was performed in modified eversion technique. After the skin incision medial to the sternocleidomastoid muscle was performed, common carotid artery (CCA), external/internal carotid artery (ECA/ICA) was suspended. A longitudinal arteriotomy through CCA to ECA was done. ICA was everted and endarterectomy was performed. Arteriotomy was sutured primarily with 6/0 prolene. After cross clamping the aorta, cardiac arrest was established using antegrade infusion of isothermic hyperkalemic blood cardioplegia. After distal anastomoses were completed, rewarming began. When the patient was normothermic, the heart was defibrillated, and the cross clamp was removed. Proximal aortocoronary anastomoses were completed with a side clamp. Protamine was administered to reverse the effects of heparin, and the sternal and cervical incisions were closed. The patients were transferred to the intensive care unit.

Cases

Case 1. An 81-year-old male presented at our clinic complaining of chest pain and shortness of breath. A physical examination showed carotid bruit. Carotid artery angiography revealed 100% occlusion in the right internal carotid artery (ICA) and 95% occlusion in the left ICA, indicating bilateral carotid artery disease and 80% stenosis in the left external carotid artery (ECA). Grade 3–4 mitral regurgitation was observed on a transthoracic echocardiogram. First, we performed a left carotid endarterectomy and closed the arteriotomy. Then distal anastomoses were performed. The mitral valve was replaced with a mechanical valve via a left atriotomy. The left atriotomy was closed, and proximal aortocoronary anastomoses were completed. The patient had an uneventful postoperative term and was discharged.

Case 2. A 75-year-old male presented at our outpatient facility complaining of dizziness, fatigue, and chest pain. We detected carotid bruit upon physical examination. Upper-left extremity pulses were not palpable. Carotid artery angiography revealed 100% occlusion in the common carotid artery (CCA) and 80% stenosis in the left ICA, indicating bilateral carotid artery disease. First, we performed a left carotid endarterectomy and closed the arteriotomy. Then three-vessel CBP, left internal mammary artery (LIMA) (free graft)-LAD, aorta-saphen-diagonal, and aorta-saphen-Cx PL were performed. As the patient had left subclavian artery stenosis, we used LIMA as the free graft.

Case 3. A 67-year old male presented at our outpatient clinic complaining of chest pain and palpitation. Coronary angiography showed bilateral carotid artery disease as indicated by 100% occlusion in the right ICA, and 80% stenosis in the left ICA (Figure 1). We performed a left carotid endarterectomy and closed the arteriotomy primarily. Then LIMA (free graft)-LAD, aorta-saphen-diagonal, aorta-saphen-Cx OM2 and OM4 vessel CPB were performed. The patient had a left subclavian artery stenosis; therefore, we used LIMA as the free graft.



Figure 1. Bilateral internal carotid arterial stenotic lesions.

Discussion

Mortality and morbidity during cardiovascular surgery has decreased in the last decade, although perioperative stroke rate has remained unchanged at approximately 2% [5]. Unilateral or bilateral CAS is a risk factor for neurological events after cardiac surgery. In a review, the cerebrovascular accident (CVA) ratio was 6.3% in patients with concomitant CAD and CAS undergoing staged cardiac surgery. In that review, combined surgery was not significantly different than staged surgery in terms of perioperative death, myocardial infarction, or CVA [4]. When CAE and CABG operations are performed for a one-sided total occluded carotid artery in one session, they had lower mortality and morbidity rates compared to performance in separate sessions [6,7].

Systemic hypothermia plays an important role in cerebral protection. A 2–3°C decrease in body temperature (35–34°C) can reduce neurological harm [8,9]. Clamping of the carotid artery and the time of CPB are determinative factors for possible stroke during the perioperative period. Eren et al. [6] conducted a retrospective study of 15 patients and Yıldırım et al. conducted a prospective study on 37 patients [10]. Those

patients underwent CABG and CEA during the same session under a beating heart or CPB. They reported that systemic hypothermia is a safe and reliable treatment method. Khaitan et al. reported that neuroprotection can be performed safely with hypothermy at 25° C, one aortic cross clamp and continuous retrograde blood cardioplegy technique. Five point eight percent of mortality and five point eight percent of perioperative cerebrovascular event were reported with the CEA procedure [11].

Mild systemic hypothermia, hemodilution, systemic heparin administration, and pulsatile perfusion are commonly used for cerebral protection during combined surgery [12]. However, the most problematic issue during combined surgery is with patients who have full occlusion on one side and severe stenosis on the other side. If a patient has any additional coronary lesion requiring surgery, it may hinder precautions against CVA. It is not possible to predict if these patients can tolerate carotid clamping.

Our technical strategies (mild hypothermia with low (1/4) flow CPB), which turned CAD into an advantage, were highly effective in our cases. It seems that mild hypothermia with low flow protected our patients from hyperthermic cerebral ischemia. Starting CBP with low flow facilitated maintenance of arterial blood pressure higher and allowed the heart to maintain perfusion via the vertebrobasillary system. However, positive inotropic agents were needed in two patients, as blood pressure increased due to the hypothermia and CBP. It is also important to be cautious in patients with CHD. Although not required, carotid shunts were available during the operations. It should be noted that these shunts might be needed if the duration of surgery had been longer. The advantage of our surgical technique is that there is no need of patch plasty because ICA was not cut down. The disadvantage of this technique is the technical difficulties in the need of using the shunt. For this reason, performing CEA with modified eversion technique accompanied by CPB during CABG operations in patients with bilateral CAS is important for neuroprotection.

As a conclusion, we advise conducting a CEA procedure in cases of one-sided total occlusion of the carotid artery and when the other side has a serious stenosis under CPB at the lowest flow level (1/4 cardiac flow level), using hypothermia of sufficient duration for safe correction of the stenosed carotid artery and neurological protection.

Conflict of interest: The authors declared no conflict of interest.

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