Carotid Endarterectomy; Single Center, Single Surgeon Results

Karotid Endarterektomi; Tek Merkez, Tek Cerrah Sonuçlarımız

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ABSTRACT Objective: Carotid artery stenosis is one of the main causes of ischemic stroke. As the population gets older, it becomes more important. Carotid endareterectomy has proven its safety and efficacy, and it is the best treatment option. In this report, we share our results of conventional carotid endarterectomy performed by one surgeon with primary closure without using shunt except in one patient. **Material and Methods**: Between 2009 and 2012, 42 patients underwent carotid endarterectomy. The mean age, mean clamp time, co-morbidities, surgical and aneshesia procedures, perioperative and postoperative complications were studied. **Results:** The mean age of the patients was 66 ± 8.13 years. Of all patients 78.6% were males and 21.4% were females. Shunt and patchpasty was used in one patient (2.3%). Conventional endarterectomy, primary closure without using shunt was performed in other patients. Two patients (4.7%) had complications in the postoperative period, one had a transient ischemic attack and one had a neulogical sequel. **Conclusion:** Carotid endarterectomy can be performed safely in carotid artery stenosis and has different modifications. It is very important to complete the procedure with short clamp times. According to our data, we believe that, to maintain acceptable results, patient and optimal surgery type selection and primary closure without shunting are very effective.

Key Words: Carotid endarterectomy; carotid stenosis; treatment outcome

ÖZET Amaç: Karotid arter darlığı dünya çapında serebrovasküler olayların önemli bir nedenidir ve ortalama yaş arttıkça giderek önemli bir problem haline gelmektedir. Günümüzde ciddi karotid arter darlıklarının tedavisinde karotid endarterektomi güvenilirliğini defalarca ispat etmiştir. Bu operasyonun farklı modifikasyonları yapılmaktadır. Biz kliniğimizde tek cerrah tarafından şant kullanılmadan primer onarılan ve açık endarterektomi yapılan hastalarımızın sonuçlarını paylaşarak, bu tekniğin güvenilirliğini dökümente etmeyi amaçladık. **Gereç ve Yöntemler:** 2009 ve 2012 yılları arasında karotid endarterektomi yapılan 42 hasta retrospektif olarak incelendi. Ortalama yaş, ortalama klemp zamanı, operasyon yapılan karotis arter, kullanılan cerrahi ve anestezik yöntem, perioperatif ve postoperatif komplikasyon oranları araştırıldı. **Bulgular**: Ortalama yaş 66 ± 8,13 olarak bulundu. Hastaların %78,6'sı erkek, %21,4'ü kadındı. Şant ve patchplasti sadece bir hastada kullanıldı (%2,3). Diğer tüm hastalara şant kullanılmadan primer onarım ve açık endarterektomi yapıldı. Postoperatif dönemde iki hastada komplikasyon gelişti (%4,7). Bir hastada geçici iskemik atak görüldü, diğer hastada ise erken postoperatif dönemde arteriyal tromboz gelişti ve hastada nörolojik defisit görüldü (%2,3). Diğer hastalar problemsiz taburcu edildi. **Sonuç:** Karotid endarterektomi ciddi karotis arter darlığında güvenle kullanılan bir tedavidir ve değişik modifikasyonları mevcuttur. Karotis arter cerrahisinde işlemi mümkün olan en kısa klemp süresi ile tamamlamak oldukça önemlidir. Elde ettiğimiz veriler sonucunda, hastaya göre operasyon seçiminin ve şant kullanılmadan yapılan primer onarımın kabul edilebilir sonuçlar alınmasında oldukça etkili olduğunu belirtmekteyiz.

Anahtar Kelimeler: Karotid endarterektomi; karotid darlığı; tedavi sonucu

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Carotid artery stenosis (CAS) is one of the main causes of ischemic stroke. As the population gets older, it becomes a more important and common problem. Medical therapy, imaging procedures for di-

agnosis, follow up and interventions for these patients cause high healthcare costs. More than 50% stenosis of either carotid artery diameter is accepted as moderate stenosis. The prevalence of moderate to severe CAS ranges between 5 to 9% in the population older than 65 years.[1] Mortality from stroke occurs with an incidence of 10 to 30%. Patients also have high risk of recurrent ischemic events and mortality, and this risk increases by years after stroke. Atherosclerosis of the supra aortic vessels like common carotid artery is the main cause in approximately 20% of strokes.[2] Atherosclerosis is related with 13 to 68% of the strokes worldwide.[3] The superiority of the interventional carotid artery therapy compared to medical therapy was documented in many reports. The main therapy for CAS is carotid endarterectomy (CEA) and it has numerous technical modifications. Endovascular carotid artery therapy has become more popular in the last decade and is being employed widely. Regarding mortality, morbidity and long term results, there is still no marked difference between CEA and endovascular carotid artery therapy.[2] Between 1998 and 2008, 92% of all carotid interventions were CEA, the rest was endovascular carotid stenting. [4]

In this study, we aimed to document our CEA results in 42 patients operated in a single center by a single surgeon.

MATERIAL AND METHODS

Between April 2009 and December 2012, 42 patients underwent CEA operation. The patients were studied respectively. The Hospital Ethics Committee approved the study based on retrospective data retrieval, waiving for individual consent. This study complies with the Declaration of Helsinki.

Carotid artery stenosis was diagnosed first by Doppler ultrasonography and soon confirmed by computerized tomography angiography (CTA). The indication for CEA was determined based on CTA, lesions of either carotid more than %70 were selected as surgical candidates irrespective of the symptoms.

ANESTHESIA

All patients were pre-medicated with 10 mg of oral diazepam on the night prior to surgery and 0.05 mg/kg intravenous midazolam on the operation day. Electrocardiography, radial artery catheterization, central venous pressure measurement via the internal jugular vein, capnography and pulse oximeter were used for monitoring in all patients.

General anesthesia was employed in 39 cases (92.9%) Anesthesia was induced with etomidate (2 mg/kg), fentanyl (1 μg/kg), vecuronium (1 mg/kg) and maintained with isofluorane 1 MAC.

In 3 patients (7.1%) local anesthesia with dexmedetomidine and cervical block was employed. For induction, dexmedetomidine (1 μg/kg) bolus for 10 minutes was used and maintained with infusion (0.5 μg/kg/min) prilocaine 5 cc, 2% was used for superficial cervical block and 15 cc for deep cervical block.

SURGICAL PROCEDURE

Conventional carotid endarterectomy procedure followed by primary closure of the arteriotomy line (beginning proximal to bifurcation and continued till the distal part of the internal carotid artery) without additional patchplasty was performed in 41 patients. Only in one patient, patchplasty with saphenous vein graft was employed due to small (<5 mm) diameter of common and internal carotid arteries. Except for this patient, carotid shunting was not used. Atheromatous plaque was stabilized with polypropylene sutures in posterior, anterior and lateral walls in all patients.

STATISTICAL ANALYSIS

The data were analyzed using software SPSS version 17.0 (version 17.0, Statistical Package for the Social Sciences Inc, Chicago, IL, USA). Continuous variables were presented as “mean ± SD”, median (min, max) and categorical variables were presented as “numbers and percentages”.

RESULTS

The mean age of the patients was 66.64 ± 8.13 (min:46, max:82). There were 33 males (78.6%) and 9 females (21.4%). Thirty three (78.6%) pa-

TABLE 1: Preoperative characteristics of patients.

	Mean ± SD
Age	66.64 ± 8.13
LVEF (%)	55.43 ± 11.44
	n (%)
Sex	
Male	33 (78.6)
Female	9 (21.4)
Preoperative β-blocker therapy	33 (78.6)
Current/Ex-smoker	31 (73.8)
Diabetes mellitus	17 (40.5)
Hypertension	35 (83.3)
Peripheral arterial disease*	7 (16.7)
Coronary artery disease	33 (78.6)
Preceding CABG	5 (11.9)
Following CABG	23 (54.8)
Concomitant CABG	1 (2.4)
Stroke	19 (45.2)
COPD/Asthma	3 (7.14)

*History of therapeutic vascular intervention, history of claudication, angiography/non-invasive proven peripheral arterial disease

BMI: Body mass index; LVEF: left ventricular ejection fraction; CABG: Coronary artery bypass grafting; COPD: chronic obstructive pulmonary disease

TABLE 2: Intraoperative characteristics of patients.

	n (%)
General anesthesia	39 (92.9)
Dexmedetomidine + cervical block	3 (7.1)
Right sided CEA	23 (54.8)
Left sided CEA	16 (38.1)
Bilateral CEA	3 (7.1)
Shunt	1 (2.3)
Patchplasty	1 (2.3)
	Mean ± SD
Cross-clamp time (min)	12.4 ± 1.96*

*n:45 (bilateral CEA cases are also included)

CEA: Carotid endarterectomy.

tients had coronary artery disease; 23 (54.8%) were operated for coronary artery bypass grafting (CABG) following CEA and 5 (11.9%) had CABG before CEA. The demographic characteristics of the patients are summarized in Table 1. Right sided CEA was performed in 23 cases (54.8%) whereas left sided CEA was performed in 16 cases (38.1%). Bilateral CEA was performed only in 3 cases (7.1%), but at separate sessions. The mean time of carotid clamping was 12.4±1.96 (min:7, max:16) minutes. All operations were performed by a single surgeon. The operative characteristics of the patients are given in Table 2.

Two patients (4.7%) had a complication in postoperative course, one patient (2.3%) had a transient ischemic attack that resolved spontaneously in 30 minutes. In one patient (2.3%), carotid artery thrombosis developed in postoperative sixth hour confirmed by Doppler ultrasonography. This patient was reoperated for the thrombosis and had contralateral hemiplegia developed after reoperation. He was discharged with hemiparesis (3/5) on postoperative day 12. Postoperative course was uneventful in the rest of the patients.

DISCUSSION

Despite the improvements in medical therapy, CAS is still one of the most important causes of ischemic stroke. As the population gets older and atherosclerotic diseases become more frequent, CAS is becoming more important. Due to a wide range of therapeutic modalities and different preferences, conflicting results are reported. We believe that, as our study documents the results of a single technique performed by a single surgeon in a single center, the data is optimized and is reliable.

Diagnosis of the CAS is still a challenging subject. Generally, Doppler ultrasonography is preferred for the first diagnosis in patients with symptoms, but the diagnosis in asymptomatic patients is more difficult.[5] Screening population with Doppler ultrasonography was not reported to be cost-effective in previous studies.[6] Today, after detecting CAS with physical examination or Doppler ultrasonography, CTA and magnetic resonance angiography (MRA) are used for confirmation. They are both effective methods for imaging the carotid arteries as well as the aortic arch, aortic braches, cervical and intracranial circulation. Evaluation of the cerebral parenchyma and soft tissue can also be made.[7,8] In our practice, we use Doppler ultrasonography to discover CAS and operation planning was made with CTA.

Indications for treatment of CAS depend on five factors; neurological symptoms, degree of stenosis, medical co-morbidities, vascular and local anatomic features and carotid plaque morphology.[2] Carotid endarterectomy is highly beneficial in patients with 70% or more stenosis. Patients with 50-69% stenosis have marginal benefits. Carotid endarterectomy reduces ipsilateral stroke and death rates significantly when compared to medical therapy in long term follow-up of severe CAS. The European Society for Vascular Surgery (ESVS) guidelines recommend CEA to symptomatic patients with 70% or more stenosis. Patients with 50 to 69% stenosis will probably benefit from CEA. It is contraindicated for symptomatic patients with 50% or less stenosis. Carotid endarterectomy should be performed two weeks after the last symptoms. Surgery can also be recommended for the patients younger than 75 years of age with 70 to 99% of stenosis. When gender differences are explored, it is observed that women benefit less than men and CEA should be considered for only young and fit women.[2,9] In our practice, coronary artery disease patients make up the majority of our patient population and most of the patients with CAS are diagnosed prior to coronary revascularization. Therefore, we operate both symptomatic and asymptomatic patients that have 70% or more CAS to reduce complications related to cerebral hypoperfusion. We use the same criteria in men and women.

While planning the operation, cerebral perfusion must be investigated carefully. The contralateral carotid artery stenosis or occlusion, vertebral arteries, anterior and posterior communicating arteries and brain tissue must be well explored. In CAS, cerebral collateral blood flow is extremely important. One of the most important collateral blood flow source is the anterior communicating artery, and it has been considered as a dominant source of collateral blood flow. Although vertebral arteries have an important role in collateral blood flow in CAS, in cases of intact anterior communicating artery, shunt use may be unnecessary and can even complicate the procedure. Shunting has a remarkable embolism risk, can prolong clamp times and makes the endarterectomy technically difficult.[10] In our practice, when the anterior communicating artery is patent, we do not employ shunt in endarterectomy patients independent from the contralateral carotid artery stenosis rate. When there is a severe stenosis in both carotid arteries, we prefer the dominant vertebral artery side for deciding first operation side.

There is still a debate going on between patchplasty and primary closure. Important number of reports suggested the superiority of patchplasty when compared to primary closure considering stroke, arterial occlusion and restenosis rates especially in long term follow up. However, patchplasty has significant perioperative risks like surgical difficulty, prolonged clamp times, two suture lines instead of one and use of a patch material. These disadvantages may lead to early restenosis, arterial rupture, infection and pseudoaneursym formation. Complications related with patch harvesting area may occur when autogenous grafts are used.[11] Despite these reports, it was documented that use or not use of patch have the same morbidity and mortality rates.[12-14] Rerkasem and Rothwell compared patchplasty and primary closure in a large group of patients.[15] They found that patchplasty had favorable results when compared to primary closure, but suggested to make further studies with increased number of patients to have a certain decision. They also emphasized the importance of surgeon preference. The only definitive suggestion was to use patchpasty in carotid arteries smaller than 5 mm in diameter.[15] We agree with this recommendation, but in our study, all patients had more than 5 mm carotid diameter.

Clamping time may be the most important parameter of this procedure. In monkey experimental studies, the safe clamping time was reported as approximately 50 minutes for reversibility of brain ishcemia.[16] In our study, the mean clamp time was 12.4±1.90 minutes. In our opinion, reducing clamp time must be main goal during surgical method preference. Using shunts and patchplasty techniques prolong the clamp time and we believe that these two methods should be used in selected patients (small diameter of the carotid artery, inactive anterior communicating artery and poor cerebral collateral blood flow).

There is vast amount of data reported regarding eversion and conventional endarterectomy techniques. The two types of endarterectomy have similar results.[17] The method preference usually depends on surgeon's experience. However, eversion endarterectomy can be technically challenging and clamp time may be prolonged. We prefer conventional endarterectomy in all patients due to technical ease.

Anesthesia is another important topic in these patients. General and local anesthesia have been employed and both have advantages and disadvantages on each other. Recently, local anesthesia is more popular than general anesthesia, but both have similar results regarding perioperative stroke rates.[18,19] We used local anesthesia only in 3 patients while other patients had general anesthesia. The type of anesthesia employed should mainly depend on patient and experience of the surgeon. Especially in chronic obstructive pulmonary disease patients, local anesthesia should be performed.[20]

In patients with coronary artery disease, CAS is very important intraoperatively and postoperatively because stroke after coronary artery bypass grafting (CABG) has 23% mortality rate. Three to 22% of the patients undergoing CABG have severe CAS and these lesions are responsible for 30% of the strokes after CABG. Staged or concomitant procedures can be performed in these patients, but there is still no consensus in the literature that staged or concomitant CEA and CABG is superior to one another in means of mortality and morbidity. It was repeatedly reported that there was no statistically significant difference between the two procedures.[21-23] We performed staged CEA and CABG in our patients with at least two weeks of time interval between the procedures. In our study, the percentages of patients with coronary artery disease and CABG are high, since our clinic primarily deals with cardiac procedures and most of the patients are candidates of CABG.

The risk of stroke and mortality rates after CEA are between 2% and 3% in the literature.[24] In our patients 2.7% of the patients had stroke and no mortality was seen.

CONCLUSION

Carotid endarterectomy is a safe and reliable therapeutic modality for preventing stroke in CAS. Every center has experience on different types of operations and in experienced hands, all methods have remarkable results. We performed conventional CEA with primary closure and without use of shunt in all patients in order to reduce clamp times. We have comparable results with other series. We believe that this method is a safe and easy method in selected patients.

Conflict of Interest

Authors declared no conflict of interest or financial support.

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