Turkish Neurosurgery 2009, Vol: 19, No: 1, 21-28

Carotid Endarterectomy with Regional Anesthesia: An Audit of 71 Cases

Bölgesel Anestezi ile Karotis Endarterektomisi: 71 Vakanın Dökümü

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ABSTRACT

AIM: The aim of carotid endarterectomy (CEA) is the successful removal of the atherosclerotic plaque and meticulous anatomical and physiological reconstruction of the carotid artery without any perioperative complications. Endarterectomy can also be carried out with regional anesthesia, which allows monitoring of the neurological status. This study reviews patients who underwent CEA with regional anesthesia.

MATERIAL and METHODS: A total of 71 consecutive patients were planned to undergo carotid endarterectomy under regional anesthesia between 2000 and 2006. All of these patients, assessed by our neurovascular team, were recruited prospectively and the data was analyzed retrospectively.

RESULTS: The study group consisted of 23 women and 48 men with a mean age of 62 (range 37-79). 67 patients (94,4%) had symptomatic, and 4 (5,6%) had asymptomatic (5.6%) carotid stenosis. Six patients (8.45%) were intolerant to carotid clamping (8,45%). The stroke morbidity rate was 1.4% and the mortality rate was 1.4%. The mean hospitalization time was 2.07 (range 1-10) days.

CONCLUSION: Carotid endarterectomy performed under regional anesthesia can be a safe method which may lead to better neurological outcome. This method offers several advantages including monitorization of the cerebral ischemia during surgery, usage of selective shunting, decreased need for intensive care and shorter hospitalization time.

KEYWORDS: Carotid endarterectomy, Regional anesthesia, Carotid stenosis

ÖZ

AMAÇ: Karotis endarterektomide amaç, herhangi bir komplikasyon olmadan aterosklerotik plağın dikkatlice çıkarılarak patent arter karotisin yeniden tamiridir. Bölgesel anestezi nörolojik monitorizasyona olanak sağlaması nedeniyle tercih edilen yöntemlerden birisidir. Bu çalışmanın amacı, bölgesel anestezi ile karotis endarterektomi uygulanan olgularımızın retrospektif olarak gözden geçirilerek klinik sonuçlarımızın incelenmesidir.

YÖNTEM ve GEREÇ: 2000 – 2006 tarihleri arasında 71 olgu bölgesel anestezi ile karotis endarterektomi operasyonuna alınmıştır. Hastaların bilgileri prospektif olarak kaydedilmiştir. Tüm olgular nörovasküler ekip tarafından ameliyat öncesinde ve sonrasında takip edilmiştir. Bütün prospektif data retrospektif olarak analiz edilmiştir.

BULGULAR: Olgularımızın 23'ü kadın, 48'i erkekti ve ortalama yaşları 62 (37-79) bulundu. 67 hasta semptomatik (%94,4), 4 hasta asemptomatikdi (%5.6). Altı (%8,45) hasta karotis kapatılmasını tolere etmedi. Mortalite %1,4 morbidite %1,4 olarak belirlendi. Hastanede kalma süreleri ortalama 2,07 (1-10) gündü.

SONUÇ: Uyanık hastada bölgesel anestezi ile karotis endarterektomisi güvenli bir yöntemdir. Ameliyat sırasında oluşabilecek serebral iskeminin monitorizasyonu, seçici şant uygulanabilmesi, yoğun bakım ihtiyacının olmaması ve hastanede kalış sürelerinin kısa olması da bu tekniğe ayrı avantajlar sağlamaktadır.

ANAHTAR SÖZCÜKLER: Karotis endarterektomisi, Bölgesel anestezi, Karotis stenozu

Received : 11.11.2008
Accepted : 23.01.2009

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INTRODUCTION

Carotid endartectomy (CEA) is an effective surgical method, with acceptable mortality and morbidity ratios, which can reduce the incidence of stroke in vulnerable patients. Although the results of carotid artery stenting have improved especially with the use of cerebral protection devices (9,11,38), CEA is still the gold standard to prevent ischemic stroke with the long-term results (10,22,33). The goal of carotid endarterectomy is the successful removal of the atherosclerotic plaque and reconstruction of the carotid artery without perioperative complications (20). Ischemia and emboli are the main causes of mortality and morbidity in these patients. Several techniques and devices including electroencephalography (EEG), somatosensory evoked potentials (SEP), transcranial doppler ultrasound monitoring, selective or routine intracarotid shunting, use of barbiturate neuronal protection, patch grafting, and carotid artery stump pressure monitorization (20, 22) have been developed in order to avoid these complications. Performing CEA under regional anesthesia (RA) in an awake patient is another recommended method. Regional anesthesia allows communication with the patient and gives the surgeon the opportunity to closely monitor the neurological status during the operation providing immediate intervention if necessary. This approach also offers the advantage of avoiding the possible cardiovascular and pulmonary complications due to general anesthesia (GA) and the duration of hospitalization is reduced (4,17,20, 21,29).

Patients who underwent CEA under regional anesthesia were prospectively documented and the results retrospectively examined in this study.

MATERIAL and METHOD

A total of 71 consecutive patients were planned to undergo carotid endarterectomy under regional anesthesia at the Bakirkoy Hospital for Psychiatric and Neurological Diseases between 2000 and 2006. All of these patients were documented prospectively and the data was analyzed retrospectively.

All patients were assessed by our neurovascular team consisting of a neurologist, a neurosurgeon and a neuroradiologist before the operation in collaboration with the neurology, neurosurgery and radiology departments of Istanbul University, Istanbul Medical School, in order to determine indications for CEA. Carotid duplex ultrasonography, magnetic resonance angiography (MRA), carotid tomography angiography (CTA) and digital subtraction angiography (DSA) were used to determine the degree of carotid stenosis. Carotid duplex ultrasonography and magnetic resonance scanning were performed in all patients. Some of the patients also underwent MRA, CTA or DSA or both. In our series, CEA indication was present in ≥60% carotid stenosis for the symptomatic and ≥70% for the asymptomatic cases. Patients with Rankin scores below 2 were not operated on.

The surgical procedure was explained in detail to all patients.

All patients were given 300mg of acetylsalicylic acid before the operation and it was continued if no complications occurred. The patients were fully monitored and the team were ready to switch to general anesthesia if necessary. The blood pressure was continuously monitored both by a transducer from the radial intra-arterial line and an intravenous line. A five-channel electrocardiography (ECG) was used throughout the operation.

Regional Anesthesia Technique

A superficial and deep cervical plexus block was applied routinely by the anesthetist as described. With the head in a neutral position, the C4 nerve root lies deep in the line drawn from the tip of the mastoid process to Chassaignac's tubercle of the sixth cervical vertebra, at the level of the lower border of the mandible. The C3 and C2 roots are located on the same line at one and two thirds of the distance from the C4 to the mastoid tip respectively. In order to achieve a deep cervical plexus block, 5ml of 1% lidocaine with epinephrine was injected into all three points with a 22-gauge needle inserted medially and slightly caudally. An additional 5-10ml of lidocaine was injected subcutaneously along the posterior border of sternocleidomastoid muscle at about halfway for a superficial cervical plexus block.

Surgical Technique

In order to continuously monitor the neurological status, the patient was kept awake and cooperative. Intravenous midalozame was only administered for sedation when really necessary. All patients were administered with 5000 u. iv. heparin before clamping. Controlled hypertension was maintained throughout the carotid artery clamping by the anesthetist. Consciousness was tested verbally. In

order to test motor function, the patient was given a plastic toy in the contralateral hand, which made a noise when squeezed and was asked to squeeze it periodically. The carotid was clamped for 5 minutes and the operation carried out if no neurological changes were detected. The operation was discontinued if a neurological deficit occurred within the first 5-minute period. However, a shunt was inserted if a deficit occurred after the carotid was dissected.

A standard surgical technique was used: removal of the atherosclerotic plaque and carotis reconstruction was carried out under the microscope (Figure 1,2). Tacking sutures were used. Perioperative microsurgery doppler (Mizuho, Japan) was used to monitor the blood flow of the internal carotid and other branches of the carotid artery. The patients were observed in the intensive care unit for 4 hours and taken to the ward in the absence of complications. The duration of the operation, carotid closure time, duration of hospitalization scores before and after the operation and all complications within 30 days were recorded. The neurologist and the neurosurgeon undertook follow-up examinations at 6 weeks and 3 months. A control carotid doppler examination was carried out at the post-operative third month.

Figure 1. *Operation site*

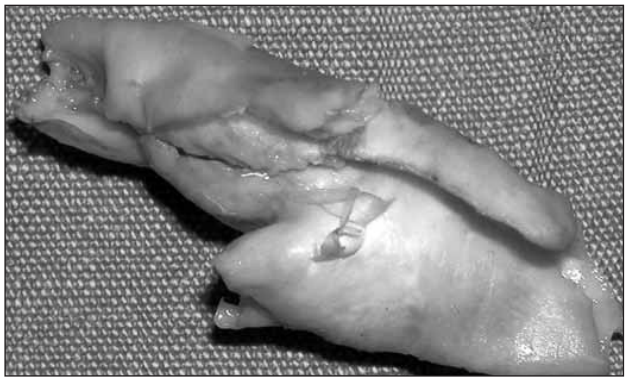

Figure 2. *Removed carotid plaque*

RESULTS

Seventy-one patients were taken into operation for carotid endarterectomy under regional anesthesia between 2000 and 2006. Of these patients, 48 were men (67.6%), 23 were women (32.4%) and the mean age was 62 years (ranging between 37-79 yrs). Nineteen patients (26.8%) were older than 70 years of age; 13 (18.3%) 70-75, and 6 (8.5%) 75-80 years of age. Twenty-six (36.6%) patients had right and 45 (63.4%) had left carotid stenosis. A total of 67 (94.4%) had symptomatic, and the remaining 4 (5.6%) had asymptomatic carotid stenosis. In addition to carotid duplex ultrasonography, 7 patients underwent CTA, 36 patients had DSA, and 35 had both DSA and MRA to determine the degree of stenosis. Nineteen patients (26.8%) also had contralateral stenosis and 2 had total occlusion. All asymptomatic patients had a stenosis of ≥70%. The demographic and clinical characteristics of all patients are shown in Table I.

The most common comorbidity was hypertension, found in 37 patients (52.1%) and smoking was present in 27 (38%) patients. The other comorbidities are listed in Table II.

The mean operation time was 120±17 minutes (60-150 mins), and the mean carotid closure time was 37±10 minutes (27-50 mins). The mean intensive care unit stay was 10 hours (range 4 hours-7 days) and the mean hospitalization time for these patients was 2.7 days (range 1-10 days). These are presented in Table III. Intraoperative neurological symptoms

Table I: The demographic and clinical characteristics of the patients

Clinical features	**N (%)**
Mean age	62 yrs (37-79 yrs)
Female/male	23/48
Right/left	26/45
Contralateral stenosis	19 (2 total occlusion)
Patients over 70 yrs old	19 (26.8%)
70-75 yrs old	13 (18.3%)
75-80 yrs old	6 (8.5%)

Table II: Comorbidity in CEA patients

Comorbidity	Number of patients n (%)
Hypertension	37 (52.1%)
ASCVD	6 (8.5%)
MI	1 (1.4%)
Smoking	27 (38%)
Hyperlipidemia	7 (9.9%)
Diabetes Mellitus	12 (16.9%)
Alcohol	8 (11.3%)

ASCVD: atherosclerotic cardiovascular disease,
MI: myocardial infarction

Table III: Perioperative features

Perioperative features	Duration
Mean operation time	120±17 mins (60-150 mins)
Mean carotid closure time	37±10 mins (27-50 mins)
Mean intensive care unit stay	10 hours (4 hours-7 day)
Mean hospitalization time	2.7 days (1-10 days)

were detected in 6 patients (8.45%), all were smoking males with hypertension and symptomatic stenosis and 2 had contralateral occlusion. Four patients had hemiparesis within seconds following clamping and their operation was discontinued. An endovascular stent was placed in two of these patients. The other two refused any surgical intervention and continued to take their antiaggregant medication. Neurological symptoms occurred after 10 minutes in two patients and the operation was completed by shunting with no shunt complications. There was no morbidity and mortality in the 6 patients with intraoperative neurological symptoms.

Primary vessel closure was performed in 69 patients and patch angioplasty was preferred in two patients.

One patient with severe symptomatic ulcerative left carotid stenosis (90%) developed blurring of consciousness, transient aphasia and right hemiplegia immediately after CEA. Emergency cranial angiography revealed occlusion of the left carotid artery from the bifurcation. He died at the 8th postoperative day due to stroke. Another patient had acute thrombosis of the operated carotid after the operation. Urgent DSA revealed thrombosis of the left carotid artery. Intraarterial injection with a microcatheter without any thrombolitic agent prompted recanalization of the thrombosis. She had only mild right hemiparesis. Four patients had haematoma at the operative site after CEA and only one required surgery. One patient had lymphorrhage on the first postoperative day and wound drainage was applied. Another patient had a wound infection and received antibiotic therapy. Both of them recovered successfully. Only 4 patients encountered a decrease in their Rankin score. We encountered 1 case of inadvertent injection into the vertebral artery during regional anesthesia. The surgery was carried out using regional anesthesia without any problem.

The total stroke morbidity and mortality rate was 2.8% and the complications are listed in Table IV. At the sixth week of follow up there were no additional complications and neurological deficits. Restenosis was detected in 3 patients at the third month by carotid duplex ultrasonography.

Table IV: Complications after CEA

Complications	Number of patients n (%)
Reversible non-fatal stroke	1 (1.4%)
Cardiopulmonary	3 (4.2%)
Reversible 12th cranial nerve palsy	2 (2.8%)
Hematoma	4 (5.6%)
Restenosis	3 (4.2%)
Lymphorrhage	1 (1.4%)
Wound infection	1 (1.4%)
Death	1 (1.4%)

DISCUSSION

Carotid endarterectomy is a prophylactic procedure proven to be more effective than medical therapy for stroke prevention in cases with carotid artery stenosis (3,10,32,33). This study examined the clinical outcomes of 71 cases that underwent CEA with regional anesthesia.

The indications for CEA were recently reviewed by the American Academy of Neurology (7). There are two groups of patients to consider: One group is the symptomatic patients who have an active plaque giving rise to emboli causing transient ischaemic attacks (TIAs) and reversible ischaemic neurological deficits. The other group is the asymptomatic patients who have demonstrable disease at the

carotid bifurcation but no history of a recent neurological event attributable to the lesion. There is clear evidence in favor of CEA in symptomatic patients with 70% carotid stenosis. This is based particularly on two large studies, the North American Symptomatic Endarterectomy Trial (NASCET) and the European Carotid Surgery Trial (ECST), both of which showed that surgery was superior to the best medical treatment (10, 33). There are also data to support CEA in asymptomatic patients but these are less robust than in symptomatic patients (3,32). The benefits were mainly seen in younger patients and the outcome for patients older than 75 yr was uncertain (32).

Two large trials involving asymptomatic patients have presented evidence that there is modest benefit favoring CEA in subjects with asymptomatic stenosis, provided that highly skilled surgeons are involved and that complication rates are below 3%. Even with this low operative complication rate, the number needed to treat to prevent 1 stroke in 2 years is 83 cases (2).

In the 2 large trials involving a total of nearly 4500 patients, the annual stroke and death rate after CEA was 1%, versus 2% among those without CEA. What we do not know is whether this 2% could be reduced by a strictly supervised regimen of best medical care, including the control of blood pressure, diabetes mellitus, lipids and cigarette smoking, along with appropriate ASA therapy. A trial of CEA versus tightly controlled (as opposed to standard) medical care is one of the last remaining major trials still required to complete our knowledge of the role of CEA in stroke prevention in asymptomatic patients (1).

In our series, 67 patients (94.4%) had symptomatic, and the remaining 4 (5.6%) had asymptomatic carotid stenosis. Due to the controversies of CEA for asymptomatic cases, our number of asymptomatic cases is low. Our observations support the fact that reducing the risk factors would be sufficient for the majority of asymptomatic cases (2).

Carotid endarterectomy can be performed under either general or regional anesthesia.

Results from several studies have shown that CEA under regional anaestesia is associated with better circulatory stability and lower morbidity and mortality rates (12,30,36,37). It allows the monitoring of cerebral perfusion in an awake patient by neurological examination and the safe usage of selective shunting (4). Because of its advantages, regional anesthesia has been adopted by many centers (12,13,17,20,28), however the robustness of the statistical data has been questioned in some studies (16,34).

The two most-feared major perioperative complications of CEA are cerebrovascular accident and myocardial infarction. The pooled data from the NASCET, ESCT, and the Veterans Administration Trial provide an insight into the incidence of cerebrovascular accident after CEA (35). Data are presented on 3248 patients who underwent surgery. Of the 35 recorded deaths (1.1%) within 30 days of surgery, 20 were due to operative strokes. Two hundred and twenty-nine patients suffered the combined outcome of stroke or death within 30 days of surgery. The data from the Cochrane Collaboration meta-analysis of regional versus general anesthesia for CEA also provides valuable information on the overall incidence of adverse events. The combined outcome of any stroke or death within 30 days of surgery was 4.5% and a myocardial infarction rate of 2.2% was also reported (34). Although the randomized trials were too small for reliable conclusions, regional anesthesia was associated with a significant reduction in local hemorrhage. Meta analysis of the non-randomized trials showed that local anesthesia was associated with a 37% reduction in the relative odds of stroke and death, 47% reduction in the relative odds of early myocardial infarction, and a reduction in the length of hospital stay (34).

Another recent study showed that there is a significantly better neurological outcome in favour of regional anesthesia (27). Although the combined death and stroke rate were not significantly different between regional and general anesthesia (4.1% vs 3.2%), cerebral complications were more common in the GA group (27). More strokes (3.5% vs. 2.3%) and transient ischemic attacks (3.4% vs. 1.0%), were seen in the GA group. Regression analysis shows that preoperative neurological events, operation time and type of anesthesia have a significant impact on postoperative neurological events. Cardiopulmonary rates less than 1% were reported in both the RA and GA groups (27). A retrospective study by Watts et al. reported no difference between LA and GA with regards to neurological complications among 582 patients (39).

In our series, the total stroke morbidity and death rate was 2.8%, similar to the rates reported in the literature for RA. The incidence of cardiovascular complications was 4.2%. None of our patients had myocardial infarction. Our results also showed that cardiopulmonary complications were especially decreased. Carotid endarterectomy is most often indicated in patients who have precariously balanced homeostatic mechanisms. Several risk factors have been identified for atherosclerosis including atherosclerotic coronary disease, hypertension, smoking habits, diabetes and pulmonary disease (5,8,33). These patients are already on complicated medication and the surgical procedure should therefore be as minimally disruptive as possible. Regional anesthesia is a good option to achieve this goal.

Operating on an awake patient becomes more difficult when the patient is restless or in cases of sudden neurological deficit requiring immediate shunting. Shunt use and monitoring methods are currently debated. Several methods such as electroencephalogram (EEG), stump pressure measurement, intraoperative transcranial doppler, and somatosensory evoked potentials (SEP) have been used to monitor cerebral ischemia but none have shown to be effective (15,18,19,23,25). Nevertheless they may provide the advantage of accurate selection of the patients requiring shunts which may explain the lower incidence of cerebrovascular complications. Potential perioperative complications of shunting such as arterial dissection or thromboembolism can also be avoided this way [18]. Shunt use is thought to be reduced under RA (6,31). Differences in carotid shunting have also been reported by Watts et al (39) and shunt use was significantly more common in the GA group (83% vs. 9%) in their study. There was no difference in shunt use in the Lutz et al. study (16% vs. 14%), explained by the use of SSEP monitoring in the GA group and very selective shunting (27).

The shunting rates in CEA under regional anesthesia are usually around 10-20% (4, 28), however some studies have reported lower rates of around 5% (20,24). This rate was even lower in our study at 2.8%. Routine shunting is naturally an option, but there may be advantages in choosing selective shunting, such as fewer embolic events due to minimised manipulation of the artery. It has been postulated that more shunt use means longer clamping and operating times (39).

Gabelman et al. have confirmed the benefits of performing CEA in awake patients by demonstrating less operative time and intensive care unit stay compared to those operated on under GA (14). In our study, the hospitalization time of 2,7 days was quite short in comparison to similar CEA series under RA. Most of the patients did not require intensive care and were discharged on the second day after the operation.

Cranial nerve complications mainly arise due to dissection or ecartation. Nerve damage of the hypoglossal (<1%), phrenic, recurrent laryrngeal nevre (1%) and mandibular branch of the facial nerve may be seen (26). Minor reversible neurological complications might also be seen during anesthetic, injection because this region is in close contact with the cranial nerves and the sympathetic structure. In our series, no serious complications associated with regional anesthesia were encountered.

As in the Cochrane review, hematomas requiring surgery are more common in GA cases (6.4% vs 3.0%) (27).Our hematoma rate at the operation site was 5.6%. This is slightly higher than the rates reported for CEA under RA, however only one of our cases required surgery.

As CEA is a preventive procedure, its success is determined by the minimization of perioperative complications, stroke and mortality. Kılıç et al described several details of surgical technique to minimize these complications (26).

The disadvantages of RA are the movement of the target operation site with actions like coughing, swallowing etc., difficulty of surgical exposure in high bifurcation and problems with the provision of surgical training. Contralateral phrenic nerve palsy is a contraindication. General anesthesia may be preferred in situations such as deafness and anxiety which may interfere with neurological monitoring.

We used prospective data collection but our study has some obvious limitations. This study suffers from the limitations of a retrospective cohort study. A large multi-centre prospective randomized study (Level 1b) would be necessary to confirm the conclusions of our study.

CONCLUSION

Carotid endarterectomy under local anesthesia can be performed safely and may lead to a better neurological outcome. It offers several advantages,

including monitoring of the cerebral ischemia during surgery, usage of selective shunting, decreased need for intensive care and shorter hospitalization time.

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