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Research Article

Carotid Endarterctomy Surgery Results, a Yozgat Based Study

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Abstract

Objectives: We aimed to present the examination of the results of patients who underwent carotid endarterctomy due to carotid artery stenosis and to compare our experience with the literature.

Methods: Thirty five patients who underwent carotid endarterctomy at Bozok University hospital between January 2013 and March 2020 were included in the study. Etiology, concomitant diseases, anesthesia type, surgery and postoperative complications were evaluated retrospectively.

Results: The mean age of the patients was 68±4.2. Of the patients, 27 were male and eight were female respectively. Right carotid endarterectomy was performed in 19 (54.28%) patients and left carotid endarterectomy in 16 (45.71%) patients. Thirty patients underwent surgery with general anesthesia and five patients underwent regional anesthesia. No mortality was observed. The records of complications were as follows; transient ischemic attacks in four patients (11.42%), difficulty in swallowing in two patients (5.71%), wound infection that improved with medical treatment in one patient (2.85%) and hematoma in three patients (8.57%) respectively in postoperative early period.

Conclusion: Carotid endarterctomy is a surgery that can be performed with low mortality and morbidity when following the principles coming from the past and present.

Keywords: carotid artery, endarterectomy, mortality

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Stroke is one of the most important causes of morbidity and mortality worldwide. In developed countries, it ranks second or third among the most common causes of death.[1] Carotid artery stenosis is one of the most important causes of stroke and atherosclerosis plays a role in one third of all strokes.[2] It has been shown that 5-12% of the new strokes are due to carotid artery stenosis appropriate for revascularization.[3] Carotid endartectomy surgery (CEA), which was first performed in 1954 for carotid artery stenosis and revascularization, is the most common vascular surgery after coronary artery disease (CAD).[4] The effectiveness of CEA in the treatment of symptomatic carotid atherosclerosis has been proven in randomized controlled trials.[5–7] European Society for Vascular Surgery; ESVS) guide recommends absolute CEA in symptomatic cases with more than 70% of stenosis. In the study named Asymptomatic Carotid Artery Surgery Trial (ACST-1), it has been shown that in asymptomatic patients, CEA significantly reduces the risk of developing strokes over a five-year period compared to patients receiving medical treatment. CEA reduces the frequency of stroke and mortality in symptomatic and asymptomatic patients.[2,8,9]

CEA is used as a common process in the surgical treatment of carotid stenosis.[10] 35 patients who underwent carotid endarterctomy between January 2013 and March 2020 were included in the study. Etiology, operation time, postoperative complications were retrospectively examined.

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Methods

Thirty five cases who underwent carotid endarterctomy at Bozok University hospital between January 2013 and March 2020 were retrospectively researched after the ethics committee approval was obtained for our study. Of the patients, 27 were male (77.14%), eight were female (22.85%). The mean age was 68±4.2. The gender, age, symptoms, concomitant diseases and postoperative complications of the patients were examined. Doppler USG was applied to the patients above the age of 50 and preparing for cardiac or peripheral surgery as a clinical routnine and to the patients having symptoms related to carotid arterial diseases independently of age. Carotid computed tomography (CT) angiography or digital subtraction angiography (DSA) were applied to the symptomatic patients having a report of 40% or higher stenosis of carotid arteries according to the doppler USG and to the asymptomatic patients having a report of 50% or higher stenosis. In the results of angiography, cases with asymptomatic stenosis over 70% and symptomatic stenosis over 50% were included in the CEA operation plan. Possible additional comorbidities and the presence of CAD were investigated in patients, and coronary angiography (CAG) examinations were performed for patients before undergoing CEA process. The history of additional diseases of cases were as follows; hypertension in 23 (65.71%), COPD in 16 (45.71%), hyperlipidemia in 12 (34.28%), peripheral artery disease in 11 patients (31.42%) and CAD in 17 (%) 48.57) were determined. Five of the patients (14.28%) had a history of cerebro vascular event (CVE) within the preoperative three months. Our general approach in CEA timing among the patients having a recent CVE history was as follows; in case of observing an infarct area less than 2 cm in brain CT, patients without neurological deficit or having a fixed deficit, the surgery was performed 15 days after the last symptom. The patients having a larger infarct area or neurological deficit were planned to undergo CEA at least 6 weeks later.

As preoperative medical treatment we apply 1x20 mg atorvastatin and acetylsalicylic acid 100 mg to each patient before the operation, however, the dose of statin may increase according to the level of hyperlidemia. Clopidogrel 1x75 mg use is stopped 7 days before the operation and 2x1 sc 0.5 mg/kg enoxiparin is started instead and the last dose is applied 12 hours before the operation. Demographic information and additional diseases of the patients are shown in Table 1.

Table 1. Demographic information of patients and additional diseases

	Number (n)	Ratio (%)
Female	8	22.85
Male	27	77.14
Diabetes Disease	19	54.28
Smoker	14	40.00
Hypertension	23	65.71
COPD	16	45.71
Hyperlipidemia	12	34.28
Peripheral Arterial Disease	11	31.42
Coronary Artery Disease	17	48.57
Cerebro Vascular Event	5	14.28

COPD: Chronic obstructive pulmonary disease.

Surgical Technique

The patient lying on the operating table in the supin position is incisioned towards the parallel stereoclavicular compound at the front edge of the sternocleidomastoid muscle. Subsequently, carotid bifurcation, common, internal and external carotid artery is found and excavated. It is hung by vessel tapes and returned. Approximately 1-2 ml local anesthesia is applied around the carotid artery bifurcation in order to prevent vagal tonus increase. Heparinization is performed intravenously at a dose of 40-80 IU/kg. The clamping of the vessels is provided. After arterotomy, which is made from the common carotid artery to the internal carotid artery in patients who will be operated by shunt, shunt is placed and fixed by squeezing from the proximal and distal parts. Plaque is carefully removed with the help of plaque emitter in the internal carotid stenotic segment. The inner part of the artery is carefully washed several times with physiologic saline solution, and the remaining tissue fragments are removed. Arteriotomy can be fixed either primarily by menas of 6-0 prolen sturation or by patchplasty. As a patch, the autologous vein grafts, Dacron or PTFE grafts, synthetic grafts can be used (Fig. 1). Hemovac drein is placed to prevent hematoma build-up at each patient's wound site. Cases are followed by intraoperative cerebral oximetry for cerebral moniterization purposes.

Results

Of the 35 cases, 16 (45.71%) were symptomatic and 19 (54.28%) were asymptomatic. In the last three months, 4 patients with CVE were given medical treatment during the recovery period. They were operated six weeks after their last symptom.

One patient with cerebral ischemic infarction below 2 cm (0.45 cm) and critical stenosis was operated early on the 15th day as a result of the co-decision made with the neurology department, and no complication was observed. Concomittant coronary artery bypass grafting (CABG) and CEA surgeries were performed in one patient. Six patients

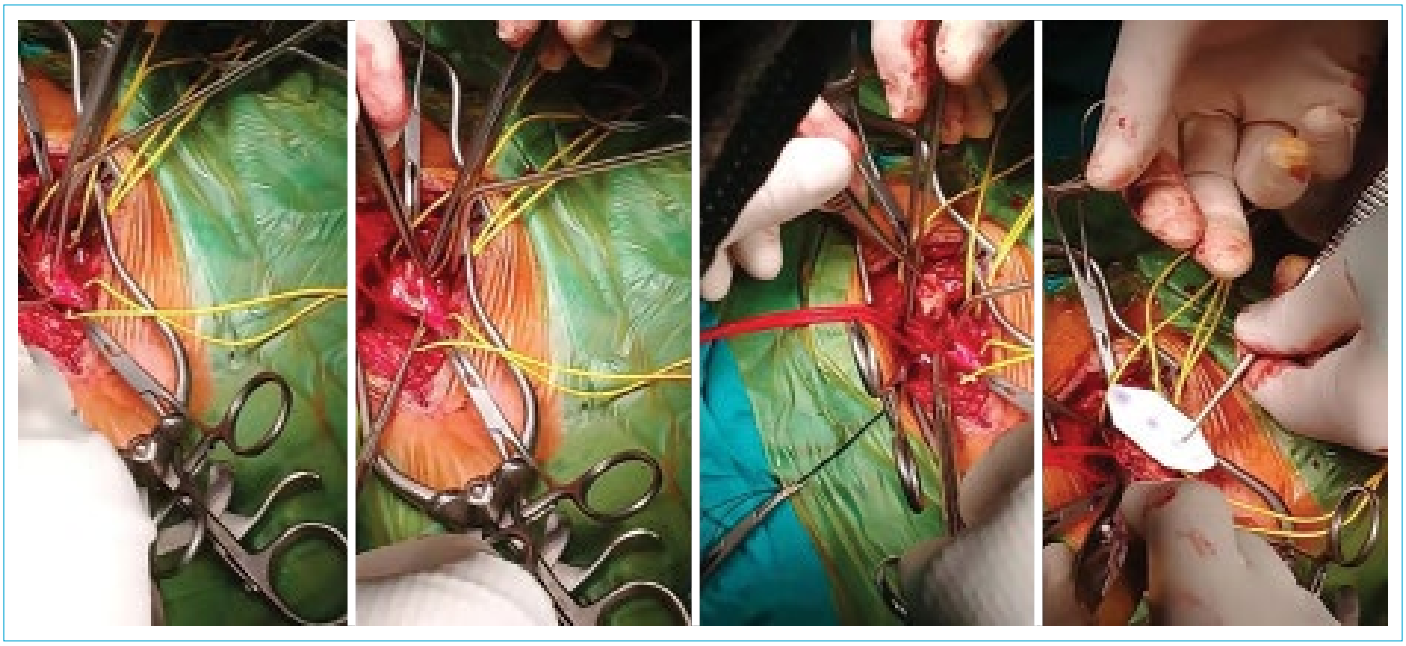

Figure 1. Carotid endarectomy surgery stages.

having unstabil angina pectoris underwent CABG surgery, 4 of whom by off-pump and two by on-pump procedure. After an average one month time, CEA was performed. According to the angiography results, 21 patients (60%) had unilateral severe carotid artery stenosis, bilateral carotid artery stenosis was observed in 14 patients (40%), ulcerated carotid plaque was observed in 3 patients (8.57%) and full-clogged carotid artery stenosis was observed in 2 patients (5.71%) (Table 2).

CEA closures made with primary closure and patch are called conventional endarterectomy in terminology. Our patients underwent surgery with conventional technique. Cervical block+local anesthesia were used in 5 patients. General anesthesia was applied in 30 patients. The average duration of carotid artery clamp was 21.7±3.1 min. The average duration of overall surgery time was 52.3±8 min. Shunts were used in 17 patients (48.57%), having bilateral critical stenosis. In 19 cases (54.28%) Dacron, in 11 cases (31.42%) PTFE, in three cases (8.57%) saphenous vein were used for patchplasty. In two cases (5.71%) primary repair were administered (Table 3).

Postoperative results were as follows; there was no mortality, transient ischemic attack was observed in four patients (11.42%), fluid swallowing difficulties was observed in 3 patients (8.57%), postoperative hypertension occurred in 8 patients (22.85%), and hypotension in 1 patient (2.85%), hematoma was observed in 3 patients (8.57%), incisional wound infection was observed in one patient (2.85%) and medically treated . In one case of combined surgery and two cases undergoing stage surgery, there were atrial fibrillation attacks that improved with medical treatment. The average length of hospitalization time was 5.02±2.2 days, the average length of duration in intensive care was 1.19±0.7 days in isolated CEA cases (Table 4).

Table 2. Stenosis ratio

Carotid Artery Stenosis	Number (n)	Ratio (%)
Unilateral stenosis ≥%70	21	60
Bilateral stenosis ≥%50-≥%70	14	40
Unilateral full-clogged carotid artery stenosis	2	5.71
Ulcerplaque	3	8.57
Other types	30	85.71

Table 3. Operative specialities

	Number (n)	Ratio (%)
Shunt usage	17	48.57
Dacron greft	19	54.28
PTFE greft	11	31.42
Safen vein patch	3	8.57
Primary repair	2	5.71

Discussion

The purpose of CEA implementation is to prevent ischemic stroke and CVE. Atherosclerosis developed in carotid arteries is commonly located in the bifurcation zone of the

Table 4. Postoperative complications

	Number (n)	Ratio (%)
Transient ischemic attack	4	11.42
Fluid swallowing difficulty	3	8.57
Postoperative hypertension	8	22.85
Postoperative hypotension	1	2.85
Hematoma	3	8.57
Wound infection	1	2.85

external carotid artery and the first two cm of internal carotid artery. The first treatment choice in cases of severe atherosclerosis in the carotid artery bifurcation zone is CEA surgery.[11] Researchs among the symptomatic and asymptomatic patients with carotid artery stenosis has shown that CEA is an effective treatment in preventing and reducing rates with stroke.[12,13] According to the American Heart Association and the American Stroke Association; CEA is strongly recommended to the patients who have had ischemic episodes (TIA), stroke in the last 6 months and having a stenosis between 50 and 99%, and the risk of perioperative stroke and mortality rate is 6%. CEA is recommended to asymptomatic patients in case of having a carotid artery stenosis between 60-99%, which is accepted to have 3% risk of stroke and mortality.[14–16] Accoring to European Society for Vascular Surgery (ESVS) CEA is recommended to the patients with a stenosis of 70% definitely and to the patientswith astenosisi 50-69% strongly (North American Symptomatic Carotid Endarterectomy Trial; NASCET), while it is emphasized that the rate of stroke/death in the surgical center should be less than 6%. In the same study, CEA is recommended in patients under 75 years of age with stenosis over 70%, and the surgical risk is less than 3%.[2,5] We included the symptomatic patients with 50% carotid artery stenosis and the asymptomatic patients with 70% or above carotid artery stenosis for CEA process.

The timing of the surgery is an important issue in the treatment of CAD. The general approach is to wait for a 6-week recovery period between the passage of CVE and the surgery. The surgery performed before six weeks is called early CEA.[14] The aim of the six-week waiting period is to ensure the improvement in cerebral vascular autoregulation and to prevent non-hemorrhagic infarction transforming to hemorrhagic infarction. However, efforts supporting the construction of CEA in a shorter time to prevent CVE that may recur during the waiting period have been proposed to be done 15 days after the last symptom of CAD.[2,15] According to our clinical approach; early CEA can be applied to hemodynamically stable patients with an infarct area less than two cm in CT or MRI, without a neurological deficit. In other cases, 6 weeks of waiting period is performed after medical follow-up.[16] Amoung our patients, one patient with a history of arecent CVE and ischemic infarct area of 0.45 cm in brain CT was operated after two weeks and other patients were operated after a period of six weeks. Patients were followed by medical treatment during preoperative period. During the six-week period, our patients had no relapsed CVE. No postoperative complication was observed in the patient who was performed early CEA.

There are different applications for anesthesia for CEA. In regional anesthesia, it is possible to evaluate the patient's consciousness status instantly. However, problems during the procedure in patients with low stress thresholds may require general anesthesia to return. In this case, intubation can lead to additional difficulties. It is the advantage of general anesthesia to provide operational comfort for the physician and patient. The fact that the patient's consciousness condition cannot be monitored instantly is the disadvantage according to local anesthesia. It is important to provide information about stress condition and procedure in the selection of patients with regional anesthesia. We applied regional anesthesia in five cases in our series. In determining the patients who were going to undergo regional anesthesia, detailed information was given by discussing them before the procedure. It was decided taking into account the demands of the patients and the conditions in which they were able to tolerate regional anesthesia and there was no problem transforming into general anesthesia. Pasin et al.[17] reported a study of 2439 cases in which they applied regional anesthesia. In seven patients regional anesthesia was ttransformed to general anesthesia. Selecting the proper patients and preoperative efficient informing play an important role in reducing the rate of transition from regional anesthesia to general anesthesia. During general anesthesia, intraoperative additional tests are used to evaluate brain functions and perfusion. Among the potential measurements of EEG and evoke, carotid stump pressure, jugular venous oxygen pressure measurement, a.cerebri media current monitoring, transcranial dops and cerebral oxillation, it is difficult to say which test is more proper and sensitive, as the given studies evaluating neurological condition of postoperative patients with regional anesthesia are not prospective and randomized.[18]

We applied cerebral oximeter to all routine patients who were performed general anesthesia to evaluate brain perfusion. We prefer cerebral oximeter as it can be applied practically and easily, as well as due to the ability of showing cerebral oxygenation level simultaneously.

The rate of concomitance of coronary and carotid artery

diseases is between 3.4% and 22%.[19] There have been different approaches over time regarding the treatment to be applied when the two diseases are together. Myocardial infarction risk is a common issue among the patients undergoing CEA before CABG procedure. On the other hand, The stroke risk is also common issue for the patients undergoing CABG before CEA. In the 185-case series of Illuminati et al; they evaluated simultaneous and gradual CABG and CEA (delayed CEA) within 3 months, and found the rate of stroke significantly higher in the group that performed at CEA in the 3-month period after CABG compared to the group of patients who performed simultaneously CEA and CABG.[20]

In our study, in 17 cases had coronary and carotid artery diseases simultaneously. However, only seven of them had CABG indication. Among six patients undergoing gradual surgery process, CABG was applied by cardiopulmunary bypass in two patients and four underwent off-pump CABG procedure. Approximately one month later, CEA was performed. In one symptomatic patient having a totally occluded carotid artery on the otherside and serious coronary arterrail disease, on-pump CABG and CEA were performed simultaneously.

The use of shunts to ensure cerebral blood flow during CEA procedureis still a controversial issue. Although there is no consensus, generally accepted situations for intraluminal shunt use are as follows; contralateral 80% or above stenosis, CVE passed on the same side, current deterioration in intraoperative cerebral moniterary, carotid stump pressure below 40 mmHg and neurological condition deterioration under regional anesthesia.[21] In our study, shunts were used in 17 patients who were considered to be at risk of achieving sufficient arterial flow during the period of carotid artery clamping.

The patchplasty procedure is another controversial point in CEA process. It is claimed that the routine patchplasty procedure has risks such as prolonging clamping time, causing double suture line, rupture, bleeding, infection and thrombosis.[22]

It has been suggested that using grafts is beneficial for those with an internal carotid artery diameter below 6 mm in order to prevent the deterioration of arterial dynamics and related complications.[23]

In case of the primary closure of an internal carotid artery with a diameter of 5 mm, the vessel diameter will be 3 mm and the area will be reduced to 76%, as the sutures on the edge of the atheriotomy will be 1 mm.[24]

In our clinical practice, we apply patchplasty to the internal carotid arteries with a diameter of 5 mm or below and apply primary suturation to the ones with a diameter of 6 mm or above with 6-0 prolene. We used a patch in 33 of the 35 patients and primary closure in two. Dacron graft was used in 19 cases, PTFE graft in 11 cases and saphenous vein graft in 3 cases. Some of the advantages of autologous veins (often saphenous veins) are as follows; low cost, infection resistance and easy access. Higher risk of rupture than synthetic grafts is a significant disadvantage.[25]

Possible complications after CEA are mortality, myocarcinal infarction (MI), stroke, TIA, nerve damage, hematoma, hyper or hypotension and infection. We didn't have mortality, stroke or MI in our case range. Detailed cardiology consultation and CAG were performed in patients before CEA procedure. The coronary revascularization of patients who needed CABG was prioritized. We believe that this approach plays an important role in preventing MI and mortality. During the postoperative period, four of our patients had TIA and three patients had difficulty in swallowing liquids and disdeviation of the tongue, which was thought to be due to N.Hypoglossus injury, and recovered with medical treatment. We believe that the injury may have been developed due to the suspension of the nerve during the operation. Three of our patients had a hematoma that didn't require revision. In a diabetic patient, an infection was observed and recovered with antibiotic therapy.

Conclusion

CEA is a surgery that can be performed with low mortality and morbidity when the principles that of past experiences from the present to the present.

Disclosures

Ethics Committee Approval: The study protocol was approved by Yozgat Bozok Universtiy Ethics Committee with 28/05/2020 dated and 2017-KAEK-189_2020.05.28_11 numbered decision.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – Z.C.E.; Design – Z.C.E.; Supervision – K.A.; Materials – F.S.Z.; Data collection &/or processing – F.S.Z.; Analysis and/or interpretation – Z.C.E.; Literature search – Z.C.E.; Writing – Z.C.E.; Critical review – K.A.

References

1. Vlasta Vuković-Cvetković. Microembolus Detection by Transcranial Doppler Sonography: Review of the Literature. Stroke Res Treat 2012;2012:382361.
2. Iiapis CD, Bell PR, Mikhailidis D, Sivenius J, Nicolaides A, Fernandes e Fernandes J, et al. ESVS guidelines. Invasive treatment for carotid stenosis:indications, techniques. Eur J Vasc Endovasc Surg 2009;37:1–19.
3. Chatzikonstantinou A, Wolf ME, Schaefer A, Hennerici MG. Asymptomatic and symptomatic carotid stenosis: an obsolete

classification? Stroke Res Treat 2012;2012:340798.
4. Eastcott HHG, Pickering GW, Robb CG. Reconstruction of internal carotid artery in a patient with intermittent attacks of hemiplegia. Lancet 1954;2:994–6.
5. Lian K, White JH, Bartlett ES, Bharatha A, Aviv RI, Fox AJ, et al. NASCET percent stenosis semi-automated versus manual measurement on CTA. Can J Neurol Sci 2012;39:343–6.
6. MRC European Carotid Surgery Trial: interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. European Carotid Surgery Trialists' Collaborative Group. Lancet 1991;337:1235–43.
7. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). Lancet 1998;351:1379–87.
8. Hıdıroğlu M, Çetin L, Kunt A, Karakişi O, Küçüker A, Şener E. Early results of carotidendarterectomy for carotid artery diseases (Karotis arter hastalıklarında ka¬rotis endarterektomi erken sonuçları). Turkish J Thorac Cardiovasc Surg 2010;18:190–5.
9. Halliday A, Mansfield A, Marro J, Peto C, Peto R, Potter J, et al. MRC Asymptomatic Carotid Surgery Trial (ACST) Collaborative Group. Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: randomised controlled trial. Lancet 2004;363:1491–502.
10. Aksun M, Yazman S, Karahan N, Coşkun MI, Çiftçi M, Özkan F, et al. Karotis Endarterektomi Operasyonlarının Retrospektif değerlendirilmesi. GKDA Derg 2016;22:93–8.
11. Maekinnon AD, Jerrard-Dunne P, Sitzer M, Buehler A, Kegler Sv, Markus HS, et al. Rates and determinants of site-specific progression of carotid artery intima-media thickness: the carotid atherosclerosis progression study. Stroke 2004;35:2150–4.
12. Barnett HJ, Taylor DW, Eliasziw M, Fox AJ, Ferguson GG, Haynes RB, et al. Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med 1998;339:1415–25.
13. Young B, Moore WS, Robertson JT, Toole JF, Ernst CB, Cohen SN, et al. An analysis of perioperative surgical mortality and morbidity in the asymptomatic Carotid atherosclerosis study. ACAS Investigators. Asymptomatic Carotid Atherosclerosis Study. Stroke 1996;27:2216–24.
14. Blaisdell WF, Clauss RH, Galbraith JG, Imparato AM, Wylie EJ. Joing study of extra cranial arterial occlusion,IV: review of surgical consideration. JAMA 1969;209:1889–95.
15. Rothwell PM, Eliasziw M, Gutnikov SA, Warlow CP, Barnett HJ. Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery. Lancet 2004;363:915–24.
16. Üstünsoy H, Kazaz H, Celkan A, Kayıran C. Strok Sonrası Karotis Endarterektomi Zamanlaması. T Klin J Cardiovascular Surgery 2002;3:57–60.
17. Pasin L, Nardelli P, Landoni G, Cornero G, Magrin S, Tshomba Y, et al. Examination of regional anesthesia for carotid endarterectomy. J Vasc Surg 2015;62:631–4.
18. Wang D, Sheng A, Gong T, Yang C, Zhai L, Wang Z, et al. Initial application of brain protection device in dilatation and stenting of carotid and vertebral artery stenosis. [Article in Chinese]. Zhonghua Wai Ke Za Zhi 2002;40:893–5.
19. Dzierwa K, Pieniazek P, Musialek P, Piątek J, Tekieli L, Podolec P, et al. Treatment strategies in severe symptomatic carotid and coronary artery disease. Med Sci Monit 2011;17:191–7.
20. Illuminati G, Ricco JB, Caliò F, Pacilè MA, Miraldi F, Frati G, et al. Short-term results of a randomized trial examining timing of Carotid endarterectomy in patients with severe asymptomatic unilateral carotid stenosis undergoing coronary artery bypass grafting. J Vasc Surg 2011;54:993–9; discussion 998–9.
21. Bayazıt M. Karotis Endarterektomi:Teknik Ayrıntılar. Türkiye Klinikleri J Surg Med Sci 2005,1:26–36.
22. Awad JA, Little JR. Patch angioplasty in carotid endarterectomy: advantages,concerns and controversies. Stroke 1989;20:417–22.
23. Golledge J, Cuming R, Davies AH, Greenhalgh RM. Outcome of selective patching following carotid endarterectomy.Eur J Vasc Endovasc Surg 1996;11:458–63.
24. Archie JP. Patching with Carotid arterektomy: When to do it and What to use.Seminars in Vasc Surg 1998;11:24–9.
25. Naylor R, Hayes PD, Payne DA, Allroggen H, et al. Randomized trial of vein versus dacron patching during carotid endarterectomy: Long-term results. J vasc Surg 2004 39:985–93.