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Clinical and Radiological Characteristics of Patients with Symptomatic Internal Carotid Artery Stenosis and Early and Late Outcomes of Carotid Artery Stenting

Semptomatik İnternal Karotis Arter Stenozu Olan Hastaların Klinik ve Radyolojik Özellikleri ve Karotis Arter Stentlemesinin Erken ve Geç Dönem Sonuçları

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Öz

Amaç: Karotis arter stentleme (KAS) serebrovasküler hastalıklarda karotis endarterektomiye alternatif olarak kullanılan bir yöntemdir. Serebral koruma cihazlarının geliştirilmesi ile bu işlemin uygulanabilirliği artmıştır. Bu çalışmada, KAS uygulanan hastaların klinik ve radyolojik özellikleri ile erken ve geç dönem sonuçları araştırıldı.
Hastalar ve Yöntem: 2008 ile 2014 yılları arasında üniversite hastanesine başvuran ve internal karotis arter (İKA) darlığı saptanıp KAS uygulanan 76 hastanın (54 erkek, 22 kadın) klinik ve radyolojik özellikleri, stentleme sonrası erken ve geç dönem sonuçları geriye dönük olarak incelendi.
Bulgular: Başvuruları sırasında tüm hastalar semptomatikti ve yapılan tetkikler sonrasında İKA darlığı tespit edildi. 62 hastada tek taraflı (sağ İKA, %34,2 sol İKA %47,4) 14 hastada bilateral (%18,4) darlık saptandı. Ortalama darlık derecesi 82,1 (Standart sapma: 11,36, Aralık:60-99%) idi. Tüm hastalar İKA darlığı için stentleme ile tedavi edildi (teknik başarı oranı: %100). İşlemler esnasında herhangi bir komplikasyon gelişmedi. 1 yıllık takip süresince hiçbir hastada tekrarlayan iskemik atak olmadı. Karotis arter hastalığı; hipertansiyon, hiperlipidemi, diyabetes mellitus, koroner arter hastalığı, geçirilmiş serebrovasküler olay ve geçici iskemik atak öyküsü ile yüksek oranlarda ilişkiliydi.
Sonuçlar: Karotis arter hastalıkları, eşlik eden hastalıklar ve geçirilmiş serebral vasküler olaylar ile birlikte son derece önem arz etmektedir. KAS uygulaması, iyi seçilmiş ve risk analizlerinin medikal tedaviler ile birlikte yapıldığı olgularda ciddi komplikasyon oranının düşük olması nedeniyle güvenle kullanılabilecek bir yöntemdir.

Anahtar Kelimeler: Ateroskleroz, karotis arter, endovasküler tedavi, klinik sonuçlar

Abstract

Aim: Carotid artery stenting (CAS) is an alternative approach to carotid endarterectomy in cerebrovascular diseases. The applicability of this procedure has increased as a result of development of cerebral protection devices. In the trial, the clinical and radiological characteristics and early and late outcomes of patients who received CAS were investigated.
Patients and Methods: The study had a retrospective design. The clinical and radiological characteristics and early and late outcomes after CAS of 76 patients (54 male, 22 female) who were admitted to a university hospital between 2008 and 2014 due to a diagnosis of internal carotid artery stenosis (ICA) were retrospectively reviewed.
Results: All patients were symptomatic during their admissions, and after their workups were completed, ICA stenosis was determined. Unilateral (Right ICA 34.2%, left ICA 47.4%) stenosis in 62 patients and bilateral stenosis (18.4%) in 14 patients were determined. The mean degree of stenosis was 82.1 (SD:11.36, range: 60-99%). All patients were treated with stenting for ICA stenosis (technical success rate: 100%). No complications occurred during these procedures. During the one-year follow-up, no recurrent ischemic attack occurred in any patients. Carotid artery disease is highly associated with hypertension, hyperlipidemia, diabetes mellitus, coronary artery disease, a history of cerebrovascular accidents and transient ischemic attack.
Conclusions: Carotid artery disease is a critical factor with co-morbidities and history of cerebrovascular incidents. The carotid artery stenting (CAS) procedure is a method that can be used safely because its serious complication rate is low in cases that are well-selected and have had risk analyses performed regarding medical treatments.

Key words: Atherosclerosis, carotid artery, endovascular treatment, clinical outcomes

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INTRODUCTION

Morbidity and mortality due to stroke constitute a major health problem. The most common cause of all strokes is atherosclerotic disease of the carotid arteries. ICA stenosis is one of the major causes of ischemic stroke. While the frequency of ICA stenosis for people in their sixties is 0.5%, it reaches 10% for people over the age of 80 (1,2). It was reported in the literature that, in asymptomatic patients who have 50% carotid artery stenosis, the risk of ipsilateral stroke in a five-year period is 4%, with it is 8% in patients with 70% stenosis (3). In the literature, the ipsilateral stroke or mortality rate of cases with asymptomatic carotid artery stenosis was found as 10.9% in their 5-year optimal medical treatment and follow-up (4). On the other hand, in cases with symptomatic carotid artery stenosis, the 2-year mortality or stroke rate was found very high as 26% (5, 6). Especially case groups with multiple risk factors and advanced stenosis are considered to be a riskier group for secondary stroke. Being at or over the age of 65, being male and having a history of coronary artery disease and hypertension are at the top of significant clinical risk factors (7).

The North American Symptomatic Carotid Endarterectomy Trial (NASCET), the European Carotid Surgery Trial and many clinical trials conducted in recent years have shown the benefits of carotid revascularization by using carotid artery stenting (CAS) or carotid endarterectomy (CEA) in patients with symptomatic carotid stenosis (8-13). It is thought that arterial revascularization by endarterectomy or stenting has positive contributions to the clinic of stroke at the early and late stages of stroke (14). Since significant studies published in 1990s, CEA has become prominent as a first-step treatment for symptomatic patients with carotid stenosis between 50% and 99% (15,16). Today, especially with newly developed devices and methods, CAS has started to become an acceptable treatment method alternative to standard CEA (17,18). In the last decade, the use of CAS has increased, and it constitutes approximately 17% of all carotid revascularization procedures in the USA (19,20).

So far, there has been 20 RCTs investigating the effectiveness and safety of stenting for endarterectomy and carotid stenosis (21,22). Despite different study designs, these RCTs and their meta-analyses provided similar results: CEA has a lower risk of periprocedural stroke; in CAS, there is a lower risk of periprocedural myocardial infarction (MI), cranial nerve damage and operation region hematoma. After excluding periprocedural strokes (strokes occurring within 30 days of the intervention), neither CAS nor CEA presented results that showed their superiority over the other in the long run in terms of reducing the risk of ipsilateral stroke in patients with symptomatic occlusive carotid diseases (23). Beyond the periprocedural period, carotid stenting is as effective in preventing recurrent stroke as endarterectomy (24).

In particular, CAS is indicated as an alternative to CEA in the presence of factors that increase the risk of open surgery, such as contralateral carotid occlusion, high carotid bifurcation, carotid dissection, contralateral vocal cord paralysis, prior neck irradiation, tracheostomy and those who cannot medically tolerate anesthesia. Moreover, CAS may be considered for those with standard surgical risk and symptomatic carotid stenosis if there are factors that decrease the risk of endovascular intervention such as age less than 70 years, last symptomatic episode more than 2 weeks prior, low burden of age-related white matter changes, experienced interventionalist team, a single short noncalcified plaque without intraluminal thrombus or favorable aortic arch anatomy without significant atheromatous burden (25).

With newly developed endovascular intervention methods, reductions in the rates of the aforementioned complications and long-term positive outcomes regarding patient comfort and new methods that emerged with these techniques have continuously broadened the indication area of CAS. The increasingly abundant data accumulation in this field will lead to a clearer assessment of outcomes. In the light of the information above, this study aimed to contribute to the literature on revascularization with clinical results that may expand the assessment area of the existing literature by investigating the clinical and radiological characteristics of patients receiving carotid artery stenting, applicability and safety of stenting in groups with multiple risk factors and its long-term clinical outcomes.

PATIENTS AND METHODS

Data collection

The study had a retrospective design and included 76 patients who received the CAS procedure due to atherosclerotic ICA stenosis at Necmettin Erbakan University in the Meram Faculty of Medicine in Konya, Turkey between 2008 and 2014. Symptomatic patients, that is, patients who experienced a cerebrovascular accident (CVA), a transient ischemic attack (TIA) or

an attack accompanied by focal neurological signs, in whom carotid artery stenosis was evaluated according to the NASCET criteria (26) and with an ICA stenosis more than 50% were selected for the trial. The eligibility criteria for the patients included stenosis of 50% or more of the diameter of the artery in angiography, 70% or more in ultrasonography or 70% or more in computed tomographic angiography or magnetic resonance angiography if the stenosis in ultrasonography was 50 to 69%. Data regarding age, sex, hypertension (HT), diabetes mellitus (DM), hyperlipidemia (HL), coronary artery disease (CAD), congestive heart failure (CHF), atrial fibrillation (AF) (from patients' ECGs), coronary artery bypass graft operation (CABGO), chronic renal failure (CRF), use of antiaggregants and anticoagulants, history of CVA and/or TIA, history of CVA in family, clinical characteristics of carotid artery disease and clinical follow-ups after stenting including 30-day follow-ups and first year follow-ups were collected from patient files and hospital records. The trial was performed in accordance with the Declaration of Helsinki and approved by the local ethics committee of the Necmettin Erbakan University, Meram Medical Faculty.

Carotid angioplasty and stenting procedure, stent controls

Endovascular treatment was carried out by an interventional neuroradiologist who had conducted at least 5000 extracranial-intracranial operations (carotid stenting, cerebral aneurysm-AVM, intracranial balloon angioplasty-stenting). For all patients, the procedure was performed under IV sedation. In two of the patients, brachial artery access was applied, and in 74 of the patients, femoral artery access was applied. After placing 5F short sheath, arcus aortography was obtained. As soon as placing the sheath, 100 iu/kg heparin bolus was given. The common carotid artery where the lesion was catheterized with a suitable catheter (5F VERTEBRAL or SIMMONS 2). Afterwards, angiographies were obtained in projections that showed the stenosis region best. Preoperative cerebral angiography images were also taken. An exchange length guidewire was placed with the tip in the distal common carotid artery (CCA) or in the external carotid artery, except for the stenotic area. After this, a long vascular sheath (6f 90 cm) was positioned at CCA. As the long vascular sheath, shuttle (COOK MEDICAL INC.) or destination (TERUMO) was used. In all stenting procedures, the embolic protection devices Spider (EV3) and Emboshield (ABBOTT) were used. Self-opening tapered or non-tapered nitinol stents [Protoge (EV3) and Xact (ABBOTT)] were used. When needed, pre- and post-dilation balloon angioplasties (ABBOTT) were performed. To discard major embolism, postoperative cerebral angiography was ensured in all cases. The stenting procedure was performed with only one physician with the same angiography device (GE, Advantix). After the endovascular procedure, the patients were followed up for 48 hours with visits of 12-hour intervals by a clinician and with vital sign monitoring at the neurovascular unit.

Statistical analysis

Statistical analyses were performed with SPSS 16.0 for Windows (Statistical Package for the Social Sciences, Chicago, IL). Mean, median, frequency, percentages and standard deviation (SD) were used among the descriptive statistics of the data. The significance of the difference between the means of the groups was compared with One-Way ANOVA test. Chi-squared test was used in the analysis of the qualitative independent data. All significance levels were two-tailed and set on the level of 0.05.

RESULTS

The mean age of the sample (n=76) was 64.61±8.81 (range: 46-80) years. 22 (28.9%) of the patients were female, and 54 (71.1%) of them were male. 26 (34.2%) of them had a right-sided ICA stenosis, 36 (47.5%) of them had a left-sided ICA stenosis, and in 14 (18.4%) of them had a bilateral ICA stenosis. The angiographic lesion degree was reported with a ratio of 60-69% in seven (9.2%) of them, 70-79% in 21 (27.6%), 80-89% in four (5.3%) and 90-99% in 44 (57.9%) (Table 1). There were no significant differences between the patient groups in terms of sociodemographic characteristics in the side and degree of carotid artery stenosis.

There was a history of hypertension in 54 (71.1%) of the patients, hyperlipidemia in 35 (46.1%), diabetes mellitus in 33 (43.4%) and coronary artery disease in 24 (31.6%). A left-sided ICA stenosis was reported as the most frequent type, occurring in 26 (48.1%) of the hypertensive patient group, 17 (48.6%) of the hyperlipidemic patient group, 19 (57.6%) of the diabetic patient group and 13 (54.2%) of the patient group of CAD (Table 1). It was determined that, before stenting, 62 (81.6%) of the patients were on antiaggregant therapy, and eight (10.5%) were on oral anticoagulant therapy. A left-sided ICA stenosis was diagnosed as the most frequent, occurring in 28

Table 1. Clinical and radiological characteristics of the patients

		Right ICA Stenosis n:26	Left ICA Stenosis n:36	Bilateral ICA Stenosis n:14	p
Sociodemographic data					
Age	(mean±SD)	66.58±8.24	62.97±12.83	61.57±10.81	0.310
Sex, Male	n (%)	18 (33.3)	24 (44.4)	12 (22.2)	0.398[a]
Sex, Female	n (%)	8 (36.4)	12 (54.5)	2 (9.1)	
Medical History					
DM	n (%)	10 (30.3)	19 (57.6)	4 (12,1)	0.247[b]
H	n (%)	11 (31.4)	17 (8.6)	7 (20)	0.881
HT	n (%)	19 (35.2)	26 (48.1)	9 (16.7)	0.824
CAD	n (%)	6 (25)	13 (54.2)	5 (20.8)	0.516
CHF	n (%)	0 (0)	1 (50)	1 (50)	0.403
AF	n (%)	0 (0)	1 (50)	1 (50)	0.403
CABGO	n (%)	3 (27.3)	8 (72.7)	0 (0)	0.117
CRF	n (%)	2 (40)	2 (40)	1 (20)	0.941
Antiaggregant use	n (%)	20 (32.3)	28 (45.2)	14 (22.6)	0.144
Anticoagulant use	n (%)	1 (12.5)	5 (62.5)	2 (25)	0.392
History of CVA	n (%)	13 (33.3)	18 (46.2)	8 (20.5)	0.890
History of TİA	n (%)	13 (39.4)	16 (48.5)	4 (12.1)	0.421
Family history of CVA	n (%)	2 (40)	2 (40)	1 (20)	0.941
Stenosis degree					
60-69%	n (%)	4 (15.4)	2 (5.6)	1 (7.1)	
70-79%	n (%)	6 (23.1)	10 (27.8)	5 (35.7)	
80-89%	n (%)	0 (0)	3 (8.3)	1 (7.1)	
90-99%	n (%)	16 (61.5)	21 (58.3)	7 (50)	

ICA: Internal Carotid Artery **DM:** Diabetes Mellitus; **HL:** Hyperlipidemia; **HT:** Hypertension; **CAD:** Coronary Artery Disease; **CHF:** Chronic Heart Failure; **AF:** Atrial Fibrillation; **CABGO:** Coronary Artery Bypass Graft Operation; **CRF:** Chronic Renal Failure; **CVA:** Cerebrovascular Accident; **TİA:** Trans İschemic Attack.
a: One-Way ANOVA test **b:** Chi-square test

(45.2%) of the patients using antiaggregants and in five (62.5%) using anticoagulants. 39 (51.3%) of the patients experienced CVA, 33 (43.4%) experienced TIA, and in five (6.6%) of them, a family history of CVA was detected. Left-sided ICA stenosis was diagnosed in 18 (46.2%) of the patients who experienced CVA and 16 (48.5%) of the patients who experienced TIA (Table 1). There was no significant difference between the patient groups in terms of medical histories, previous illnesses, antiaggregant/anticoagulant drug use and the side effects of carotid artery stenosis.

An angiographic procedure success rate of 100% was determined for all patients. The patients with bilateral stenosis were treated with two procedures. There were no complications during the procedures. In three of the patients (3%), minor strokes occurred following the procedure. These patients had completely returned to their normal clinical neurological statuses within a month. During the 30-day follow-ups of all patients, no complication or death due to the procedure occurred. During the one-year follow-up, there was no recurrent stroke or TIA. Within the first month of the radiological follow-up of one patient (n:1, 1.4%), asymptomatic restenosis was detected. In-stent restenosis was not detected in serial Doppler ultra-sonographies performed in the first, third, sixth and twelfth months following the procedure, and the flow types and velocities were in normal ranges.

DISCUSSION

In this study, endovascular stenting method, one of the treatment options for carotid artery stenosis, was investigated. The mean age of the sample was 64.61±8.81 years. There was a history of hypertension in 71.1% of the patients, hyperlipidemia in 46.1%, diabetes mellitus in 43.4% and coronary artery disease in 31.6%. Unilateral (Right ICA 34.2%, left ICA 47.4%) stenosis in 62 patients and bilateral (18.4%) stenosis in 14 patients were determined. The mean degree of stenosis was 82.1%. No complications occurred during these procedures. During the one-year follow-up, no recurrent ischemic attack occurred in any patients.

Carotid artery stenosis is responsible for 30% of ischemic brain stroke cases (1). Atherosclerosis begins at an early age but only becomes symptomatic

at an older age. With advancing age, not only the prevalence but also the severity of the disease begin to increase. In our study, the female to male ratio of the patient group was approximately one to three, and the mean age was 64. It is stated in the literature that, in patients under the age of 70, CAS and CEA have similar risks (5.8% and 5.7%), and for younger individuals, CAS intervention is as safe as CEA (27,28). Furthermore, in the Carotid Revascularization Endarterectomy and Stenting Trial (CREST), while patients under the age of 70 benefited from CAS, for patients over the age of 70, CEA was found to be beneficial.

Treatment of carotid artery stenosis mainly comprises three methods: medical, surgical and endovascular. Additionally, for patient groups with severe stenosis along with multiple risk factors and those who are at high risk for stroke, treatment of even 50%-60% stenosis is clinically significant. Being aged 65 or older, male and having hypertension and cardiac disease are clinically significant risk factors (6,29,30). Medical treatment includes primary prophylaxis (rehabilitation and treatment of risk factors such as hypertension, diabetes, hyperlipidemia, smoking and sedentary lifestyle) and secondary prophylaxis (acetylsalicylic acid, dipyridamole, ticlopidine, clopidogrel or combinations). In our patient group, high rates of HT (71.1%), HL (46.1%), DM (43.4%) and CAD (31.6%) were found in accordance with the literature (7). The risk of having a stroke depends on the severity of the stenosis, previous neurological symptomatology and the medical treatment applied so far. In our study, approximately 91% of the patients were under medical treatment (antiaggregant or anticoagulant) before endovascular treatment: 51.3% had experienced CVA, and 48.7% had experienced TIA.

It has been suggested that, in cases where carotid stenosis is over 50%, medical treatment alone is not sufficient. If further examinations are delayed, and endovascular treatments are not evaluated, the patient is considered at a high risk for stroke and its associated risks (31). In the 1991 NASCET and ECTS trials, it was suggested that, while antiaggregant treatment had been applied prophylactically for many years, CEA decreases the risk of ischemic stroke in symptomatic cases in comparison to medical treatment. From this date forward, CEA has commonly been used (26,32). CAS had arisen as an alternative treatment method because its ischemic stroke and death rate is high intra- and post-operatively with conditions such as advanced age, contralateral severe stenosis or occlusion, additional stenosis in ICA, CHF, restenosis due to CEA and stenosis secondary to radiotherapy (27,33,34). CAS, which was originally used only for high-risk groups, has begun to be used in all patient groups along with the more common use of stents in general. Application of medical treatment methods before and after invasive treatment methods creates the basics of sufficient treatment and lessens the risk factors (31,35). In asymptomatic patients with carotid stenosis of >60%, the incidence of stroke under medical treatment is reported as below 2.5% (36). The recurrence rate for stroke within the first two years in patients that experienced stroke due to symptomatic carotid artery stenosis under medical treatment is as high as 26% (6,15,27). Approximately 90.8% of our patient group was composed of high-rated (stenosis of 70% and above) patients, and approximately 58% of these patients had severe stenosis of 90% and above.

While the incidence of having stroke is 5.5% in symptomatic cases with stenosis of above 75%, this rate in symptomatic cases with less severe stenosis is about 2%. If TIAs accompany severe carotid stenosis, this rate, which is 10% for a one-year period, increases to 30% for a five-year period (37). In a CREST trial, in the stenting group, by the end of four years, this rate was calculated as 7.2% in terms of primary endpoints (stroke + death + 30-day MI and concurrent stroke). For all cases, the four-year stroke/death rates were 6.4% for CAS: 8% for symptomatic patients and 4.5%. for asymptomatic patients. Considering that the recurrence rate of stroke under medical treatment in the first two years reaches as high as 26% in patients who experienced stroke due to carotid artery stenosis (6,38), the fact that none of the patients in our patient group experienced recurrent stroke and transient ischemic attack during the one year follow-up period reveals an important result which should be taken into account while considering appropriate medical treatments. CAS may bring substantially positive clinical results. In patient groups indicated by evaluation of the severity of stenosis, clinical history and ongoing medical treatment to whom CAS is applied, it is clear that the mortality and morbidity rates will decrease following CAS. Medical and economical burdens resulting from poor clinical outcomes are also issues that need to be highlighted.

In geriatric patients who have carotid artery stenosis, the frequency of co-morbidities increases the perception of complication risk for the decision-

making physicians in evaluation of endovascular treatments. The groups considered to have high complication risk factors are over the age of 80, and have malignant hypertension, severe congestive heart failure, pulmonary failure, renal failure or contralateral carotid occlusion. Developed endovascular technology and increased interventional operation experiences of clinicians lead to high rates of success for endovascular treatment (25). In our study, an angiographic procedure success rate of 100% was determined for all patients. The patients with bilateral stenosis were treated with two procedures. There were no complications during the procedures. In three of the patients (3%), minor strokes occurred following the procedure. These patients had completely returned to their normal clinical neurological statuses within a month. Various technical developments have improved the safety profile of CAS. Usage of embolic protection devices that have been shown to reduce embolism risk during stenting is not a prevalent practice. Through the use of embolism-blocking filters, the frequency of embolus related to stenting has been decreased. Embolism-blocking filters make it possible to place a stent in a patient without stopping blood flow, and they even make the treatment of cases in which contralateral ICA is occluded possible. Protective devices were associated with a 38% decrease in relative periprocedural stroke risk in a systematic review of 134 studies covering more than 23,000 patients (39,40). In all cases in our trial, we believe that endovascular treatment with the use of embolism-blocking filters prevents the risk of embolus during the procedure. Likewise, in our study, during the 30-day follow-ups of all patients, no complication or death due to the procedure occurred. During the one-year follow-up, there was no recurrent stroke or TIA.

Stent complications are related to procedures (intimal dissection, etc.), hemodynamic incidents (hemorrhage etc.) and restenosis. In our study, we determined that there was no periprocedural operation complication. One of the obstacles encountered in stenting is in-stent restenosis. In the most involved case where stenting was performed, the rate for restenosis was reported as 6% (41). In our study, within the first month of the radiological follow-up of one patient (n:1, 1.4%), asymptomatic restenosis was detected. In-stent restenosis was not detected in serial Doppler ultra-sonographies performed in the first, third, sixth, and twelfth months following the procedure, and the flow types and velocities were in normal ranges. For prevention of long-term permanent neurological disorders following endovascular treatment, application of advanced procedural techniques, tight stent control and alleviation of risk factors via medical treatment play a role (42). Antiaggregant and anticoagulant treatments following endovascular treatment play a vital role in keeping the stent open. Although there are various ideas regarding medical treatment, the protocol we applied (acetylsalicylic acid and clopidogrel treatment) is among the protocols reported in the literature (43). Close monitoring of the stent openings of our patients after the procedure and arrangement and regular follow up of their pharmacological and non-pharmacological treatments regarding risk factors affected our long-term results. Furthermore, death or major stroke (ischemic or hemorrhagic) occurred in none of our cases, and in the long-term follow-ups of our patients, permanent neurological disorder was not reported. In our study, the success rate of the outcomes of the endovascular treatment procedures was high; however, it should be noted that precautions were taken against all risk factors mentioned above. Appropriate selection of patients also played an important role.

There were some limitations in our research. It was a retrospective study, the patients were from only one center, and the sample size was small.

CONCLUSION

We are of the opinion that the factors that increased our operational success and reduced complication rates included careful patient selection for endovascular procedures by complying with strict rules reported in the literature, maximum care in the preprocedural operations of the patients, close monitoring and regulation of situations increasing comorbidity, in addition to close monitoring of vital signs, using an experienced and careful neurovascular team during the periprocedural operation, periprocedural precautions taken by this team, and that the patients were followed-up by a clinician at the neurovascular unit in the postprocedural period for 48 hours including visits with 12-hour intervals and monitoring of vital signs. Along with new pharmacological and technological developments, the field of carotid artery stenting has been growing. Development of better and more easily used equipment and improvement of embolism-blocking drugs and adjuvant pharmacological treatments make carotid artery stenting more attractive. Randomized

and prospective studies regarding CAS application results, comorbidities and internal, neurological and medical treatments before, during and after the procedure will reveal the role of CAS in improved treatment of occlusive carotid artery disease.

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