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Endovascular Treatment in Orificial Occlusive Lesions of Vertebral Artery

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Abstract

Objectives: Vertebral artery (VA) stenosis is found in 20% of patients with posterior fossa ischemia. Endovascular treatment has become more preferable to be used in the treatment of VA orificial occlusive lesions referring to the recent developments. In this study, we aimed to present the clinical results and to show the success of the endovascular treatment in occlusive lesions localized in VA orifice.

Materials and Methods: In our retrospective study, 28 patients undergoing endovascular intervention between 2010 and 2013 for symptomatic occlusive lesion in VA orifice were examined. The patients were diagnosed with Doppler ultrasonography, following extensive neurological examination. Consequently, stent implantation with digital subtraction angiography device was applied in interventional radiology unit. Demographical, angiographical, clinical information of subjects, as well as data regarding the stenosis before and after the procedure were recorded.

Results: Endovascular treatment was applied to 19 patients with left vertebral (67.8%), eight patients with right vertebral (28.5%), and one patient with left and right vertebral lesions (3.5%). Technical success rate was 100%. One total occlusion (3.5%), three 95% to 99% stenosis (10.5%) and one 70% stenosis were seen during follow-up. Among the patients, two with 95% to 99% stenosis were treated endovascularly again. In early (0-3 months) term, primary and secondary patency rate was 100%. For mid-(4-6 months) term, primary and secondary patency was 96.4%. At long term, primary and secondary rates were 86.9% and 91.3%, respectively.

Conclusion: Endovascular treatment, combined with optimal medical therapy, is an effective treatment method in orificial occlusive lesions of VA.

Keywords: Vertebral artery, stenosis, endovascular treatment, stent

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Introduction

Atherosclerosis is the most common cause of vascular disease in western countries and in Turkey. Vertebral artery (VA) stenosis has been observed in 20% of patients with posterior circulation ischemia. The most common site of stenosis in the VA is the proximal section. Risk of recurrent attacks in patients with vertebrobasilar ischemic attack is between 25% and 35%[1-4].

Surgical treatment is very limited in VA occlusive lesions. Surgical treatment is applied less frequently in VA stenosis due to complications such as Horner syndrome (15-28%) and laryngeal nerve injury (2%), high peri-operative mortality, and technical difficulties. Since balloon angioplasty and stent implantation eliminate surgery-related morbidity, they are more frequently preferred with combined administration of appropriate anticoagulant and antithrombotic therapy[5,6]. Stenting with endovascular procedure is the treatment option in patients with ongoing symptoms despite drug therapy[7]. Endovascular treatment of the proximal lesions of the VA is a procedure that increases cerebral and posterior current with high technical success and decreases symptoms[8,9].

In this study, we aimed to evaluate endovascular treatment and clinical outcomes in occlusive lesions localized to VA orifice.

Materials and Methods

A total of 28 patients who underwent endovascular treatment for VA orifice stenosis were evaluated prospectively. VA orifice stenosis was diagnosed by Doppler ultrasonography (US) examination and digital subtraction angiography (DSA). Rate of stenosis was calculated by taking the ratio of the stenosis level to a normal distal segment. Patients' ages and genders, clinical findings, neurological system examination information, sites and rates of stenosis, and post-operative complications were recorded. After endovascular treatment, patients were evaluated for restenosis with Doppler US at 1st, 3rd, 6th and 12th months after the treatment and once a year after then.

Patient Selection

Inclusion criteria for patient selection were being symptomatic due to VA stenosis and the presence of at least 50% stenosis at the lesion level.

Endovascular Treatment Procedure

Before the endovascular intervention, the patient and patient's relatives were informed about possible risks and complications and written informed consent was obtained. 100-300 mg/day acetyl salicylic acid (Aspirin®, Atapsin®, Babyprin®, Coraspin®, Dispril®) and 1x75 mg/day clopidogrel (Plavix®) were initiated in all patients one week before the procedure to reduce the risk of thrombosis after stent implantation and to accelerate the endogenous clearance phase of the thrombus component of the lesion. The patients were evaluated with complete blood count, coagulation tests, and biochemistry panel before the procedure.

The procedure was performed in the interventional radiology department with the Advantx DSA device (GE, USA) after patient preparation. After local anesthesia, a short vein sheath (5-7 Fr) was inserted from the femoral artery with the Seldinger method. Diagnostic DSA was performed, and the diagnostic catheter was withdrawn and replaced by a 6 or 7 Fr (80-100 cm) long vessel sheath or shuttle introducer. 6-7 Fr guiding catheters were used in some patients. Stent size and diameter were determined by angiographic images. IV heparinization was performed so that activated clotting time was approximately 2-3 times the normal (5000 IU IV bolus, and 1000 IU IV heparin per hour in patients passing the one-hour mark). Sublingual nifedipine (Nidilat®) and, when needed, nitroglycerin (Perlinganit®, Nitroglycerin®) infusion were administered in patients with hypertension. The lesion was then crossed with 0.014-inch microguide wire. After the lesion was crossed with the help of the guide wire, stent was directly applied to 27 lesions, and applied to two lesions after predilatation based on the degree of stenosis. Predilatation was performed with a 3 mm balloon. Stent lengths ranged from 9 to 40 mm and diameters from 3 to

5 mm. The stents used were balloons or self-expendable stents, stainless steel, elgiloy, nitinol or chromium-cobalt.

At the end of the procedure, diagnostic images were taken to observe the success rate of the treatment. APT values were checked if the femoral entry was not going to be closed by special closure devices, and in case of long (>200 seconds) APT values, the patients were let to wait so the APT values would decrease. APT values were not considered in case of closure with special closure devices. Angioseal (St. Jude Medical, Saint Paul, Minnesota) or Star-Close (Abbott Vascular, CA) was used for the closure.

Post-procedure Follow-up

Patients were hospitalized for at least 1 day and 10000 units/24 hours of heparin infusion was initiated. After 6 hours of immobilization, limited mobilization was achieved for 18 hours. Also, lifelong application of 100-1000 mg/day acetyl salicylic acid and 3-6 month application of 75 mg/day clopidogrel (Plavix®) were recommended. Follow up was done for 1 day and at the 1st, 3rd, 6th, and 12th months after the procedure by Doppler USG and clinical examination. DSA was performed in patients with restenosis and endovascular treatment was repeated in patients when deemed necessary.

Statistical Analysis

Data were analyzed in Microsoft Excel. Descriptive analysis was performed.

Results

Ten patients (35.7%) were female and 18 patients (74.3%) were male. The mean age was 58.3±12.3 years. Twenty-eight patients had a total of 29 lesions and the rate of stenosis was 55-99%. Patient complaints at time of admission are shown in Table 1. Endovascular treatment was successfully performed in all patients (100% technical success). No complications were observed during the procedure and within the first 24 hours (Morbimortality 0%). Endovascular treatment was applied to the left VA in 19 (67.8%) patients and right VA in eight (28.6%), and simultaneous bilateral treatment was performed in one (3.6%) patient. Ten (35.7%) patients had 95% to 99%stenosis. Nine of these patients underwent direct stent implantation and one patient underwent balloon dilatation followed by stent implantation (Figures 1a-c). Simultaneous stent implantation was performed on 6 of 9 stenotic internal carotid artery lesions, 1 of 3 stenotic main carotid artery lesions, 2 of 3 stenotic subclavian artery lesions, and 1 stenotic axillary artery lesions that were incidentally detected during the perioperative period.

The mean follow-up period was 21.3 (1-74) months. One patient died of cardiac arrest one month after the procedure. All of the 28 lesions in 27 patients were patent during the early follow-up period (0-3 months) (Primary patency=100%). There was no pathology in the mid-term (4-6 months) follow-up except for one patient with 70% stenosis (Primary patency=96.4%). No re-operation was planned as no new symptoms were observed in patient follow-up. In 22 patients with late-term follow-up (7-12 months), one of 23 lesions had total occlusion and two had 95% to 99% stenosis. Re-stenting was performed in one of these patients who developed 95% to 99% stenosis. Re-operation was not performed in the other patients as one of them did not develop any new symptoms and the symptoms of the other patient regressed (primary patency=86.9%, secondary patency=91.3%) (Table 2).

Table 1. Admission complaints of patients included in the study (n=28)

Clinical Symptoms	n (%)
Dizziness	14 (50.0)
Visual disturbances	5 (17.8)
Loss of strength	4 (12.9)
Imbalance	4 (12.9)
Nausea and vomiting	4 (12.9)
Headache	2 (6.4)

Table 2. Primary and secondary patency rates of patients during follow-up after endovascular treatment

	Primary Patency (%)	Secondary Patency (%)
Early period (0-3 months)	100.0	100.0
Mid-term (4-6 months)	96.4	96.4
Late period (7-12 months)	86.9	91.3

Symptomatic thromboembolic events were not observed in any patient during follow-up.

Discussion

While primary treatment in vascular diseases is generally surgery, interventional radiology has become a preferable method following the advancements in this field after the 1980s since it shortens the length of hospital stay in many diseases and is cost-effective compared to surgery. Balloon angioplasty and stent implantation of VA and subclavian artery, in addition to carotid artery stenosis, have been widely used over the last 20-25 years[10].

25% of infarctions are posterior system infarctions, of which 20% are VA orifice stenoses. The most common non-cardiac cause of posterior system infarctions is stenosis of the VA orifice and along its cervical course. VA stenosis reduces posterior cerebral perfusion and causes vertebrobasilar insufficiency. It is also an important embolic source for posterior circulation. 5-year recurrent stroke risk after vertebrobasilar transient ischemic attack or stroke has been reported as 22-35%[1,2,11].

The presence of multiple symptoms associated with the posterior system should primarily suggest vertebrobasilar ischemia. Among these, the most common is dizziness[12]. The most common complaint in our patients was also dizziness with 50%. In patients with no problems other than posterior system infarction, symptoms may be improved by appropriate medication. Antithrombotic and anticoagulant drugs are used in the initial treatment to reduce the risk of stroke in VA stenosis. In the study performed by "The Warfarin-Aspirin Symptomatic Intracranial Disease" study group for the medical therapy used in intracranial VA stenosis, it was observed that the rate of ischemic stroke was lower in patients receiving anticoagulant therapy even though these patients had a higher rate of basilar artery and bilateral VA stenosis compared to patients receiving antiplatelet agents. However, high rates of hemorrhagic complications were observed. This limits the effectiveness of anticoagulant therapy. Antiplatelet use has been reported to eliminate the challenges associated with anticoagulant use and its follow-up (major hemorrhage and INR tracking)[13]. Surgical or endovascular treatment is an alternative treatment option when medical treatment is insufficient.

In the 672-patient meta-analysis of Hongliang, no difference was observed in mortality rates due to vascular pathology in 30-day follow-up among patients who received only medical treatment and patients treated with endovascular therapy combined with medical treatment.

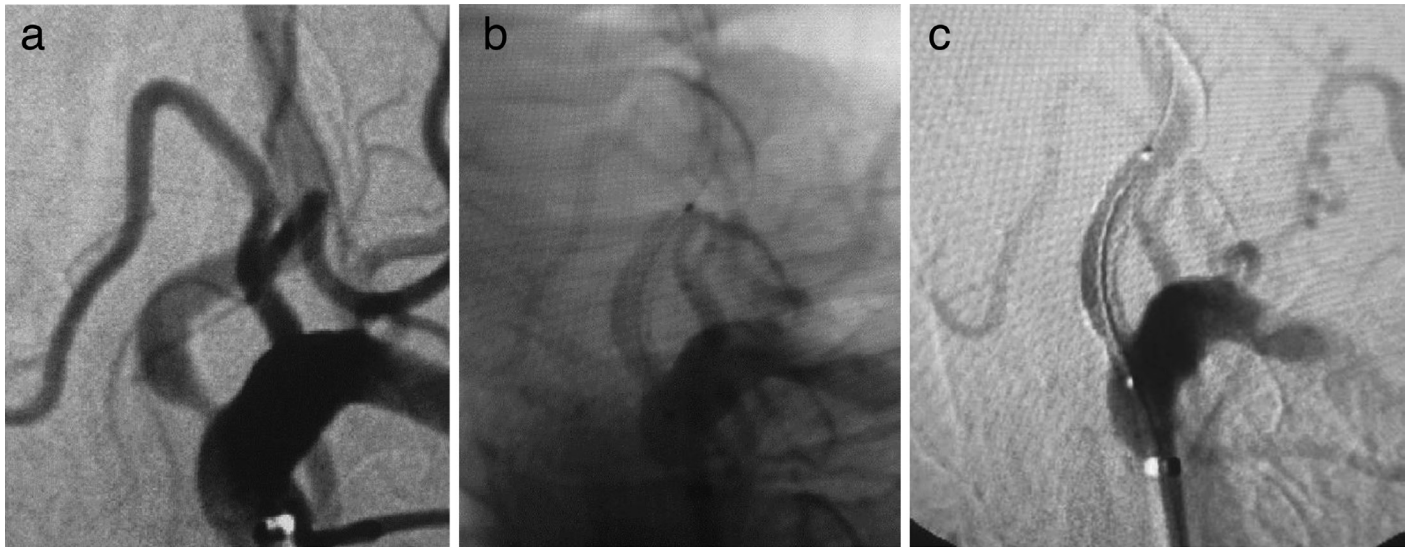

Figure 1a-c. Images of left vertebral artery before and after treatment. Patient with 95% to 99% stenosis in the left vertebral artery **(a)** was treated with stent implantation **(b)**. No residual stenosis was observed in the images taken **(c)**

In long-term follow-up, it was observed that the ratio of VA stenosis was lower in the patients treated with endovascular therapy combined with medical treatment, but there was no significant difference between the two groups in overall mortality rates[14].

A similar version of the anticoagulant and antithrombotic therapy used in carotid stenting was used in VA endovascular treatment as well. Kızılkılıç et al. applied lifelong 100-300 mg/day acetyl salicylic acid and 3-12- month 75 mg/day clopidogrel (Plavix®) treatment[10]. Piotin et al. studied endovascular treatment in seven patients with VA stenosis and applied 500 mg/day of ticlopidine for at least 3 months after the procedure[15]. In their interventional treatment study on 12 patients with extracranial VA diseases, Mukherjee et al. applied lifelong acetyl salicylic acid and 1-12 months 75 mg/day clopidogrel treatment after the procedure[16]. In endovascular treatment procedures towards the VA applied in our department, 75 mg/day clopidogrel was applied for 3-6 months and 100-300 mg/day lifetime dose of acetyl salicylic acid was applied.

Technical success varies according to the development of materials used in endovascular treatment, the degree of stenosis, vascular tortuosity, and the experience of the operating radiologist. In the primary stenting study of Kızılkılıç et al. on 14 patients with severe VA orifice lesion, technical success rate was 100%[10]. The technical success rate of stent implantation in 68 patients with advanced VA stenosis performed by Radak et al. was 93.2%[17]. In our study, endovascular treatment was successfully applied to all 29 VA orifice lesions in 28 patients (100% technical success rate).

Balloon angioplasty performed with or without stenting has an important place in the endovascular treatment of VA orifice stenosis. However, its use alone in the VA orifice is limited due to elastic recoil and dissection despite high technical success and low complication rates. The restenosis rates of balloon angioplasty are high and range from 75% to 100%. Motarjeme et al. performed the PTA procedure on 39 cases of vertebral orifice stenosis in a series of 151 lesions in 112 patients with stenosis in supra-aortic vessels[18]. The procedure was successfully performed in 36 of the 39 patients, and the procedure could not be performed in three patients as the VA could not be catheterized due to subclavian artery problems. When patients treated with stent implantation and balloon angioplasty on VA origin were compared, no treatment-related complications were observed in either of the groups. In post-operative control angiography, residual stenosis was found in 53% of balloon angioplasty patients and 40% of patients treated with stent. In the 12-month control angiography, restenosis was found in 70-75% of the patients who underwent angioplasty. On the other hand, 55% stenosis was observed in only one patient among those treated with stents. In their 11-patient study on basilar artery and intracranial VA stenoses, Barakate et al. performed only balloon angioplasty on seven lesions in five patients[19]. The mean rate of post-operative stenosis was 54% in these patients. On the other hand, the mean rate of post-operative stenosis was reported to be 11.1% in six patients who underwent stenting. In our study, direct stent implantation was applied to 27 of 29 lesions. Only one patient had 10% residual stenosis after the procedure. In the 4-month Doppler USG and control angiography, 75% restenosis was observed in one patient. One of these patients applied to the emergency room during follow-up after the treatment and MRI revealed infarction in the right posterior inferior cerebellar artery irrigation area. Control angiography revealed that there was 95% to 99% occlusion in the stent. In another patient, the 2nd-year control Doppler USG revealed 90% in-stent stenosis. Balloon dilatation was performed on this patient and then the stent was placed. There was no residual stenosis.

The use of embolic protection devices during VA endovascular treatment is controversial. In the study of Qureshi et al., endovascular treatment of VA origin stenosis was performed and distal embolic protection device was used on 12 patients[20]. In eight patients,

macroscopically visible embolic material was observed in the filter examination after the procedure. In our study, we did not use distal embolic protection device on any of the patients. Since our patients were asymptomatic after the procedure, MRI examination was not required.

There is no consensus on the use of drug-eluting stents and bare stents in VA endovascular treatment. In the retrospective study of Raghuram et al., where they performed 28 stent implantations, 13 of which were drug-eluting, in 24 patients, there was no significant difference between the two groups in terms of restenosis rates[21]. We did not use drug-eluting stents in our study.

Vajda et al. treated VA origin lesions in 12 female and 36 male patients with short drug-eluting stents, and follow-up was performed at the 6th week, 12th week, 6th month, and 12th month neurological examinations, MRI, and angiographic imaging[22]. In another study in which endovascular treatment of symptomatic VA ostium stenosis was performed, patients were followed up with a monthly neurological examination and CT or MRI was performed when a new symptom was observed. Doppler USG was performed at the 1st month and 6th month follow-ups. In our study, we performed clinical examinations and Doppler USG procedures on the postoperative day 1, and 1, 3, 6 and 12 months after endovascular treatment and annually after 12 months. In case of clinical or ultrasonographic findings, we performed angiography.

In their study, Nahser et al. performed endovascular treatment of intracranial VA stenosis, and the rate of neurovascular complications that developed was 5%[23]. In the study of Cloud et al. comparing balloon angioplasty and primary stenting procedure for occlusive diseases of the VA orifice, stent was applied to 10 of 14 patients and balloon angioplasty was applied to the remaining four patients. None of the patients had any complications related to the procedure[24]. In the 980-patient meta-analysis of Stayman et al., the rate of vertebrobasilar infarction was reported to be 1.3% at the 21st month follow-up[25]. In the meta-analysis of Antoniou et al. evaluating 1117 VA lesions in 1099 patients, transient ischemic attack and stroke rates in the early period were 1.5% and 0.5%, respectively[26]. In our patients, no symptomatic thromboembolic events were observed during follow-up.

Conclusion

Endovascular treatment combined with appropriate anticoagulant and antithrombotic therapy is a preferable treatment modality in the occlusive lesions of the VA orifice due to its minimally invasive nature, high technical success, and low in-stent restenosis rates.

Ethics

Ethics Committee Approval: Retrospective study.

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: O.G., H.B.O., H.T.B., E.A., E.H.A., Concept: O.G., E.A., Design: O.G., E.A., E.H.A., Data Collection or Processing: O.G., H.B.O., H.T.B., E.A., E.H.A., Analysis or Interpretation: O.G., H.B.O., H.T.B., E.A., E.H.A., Literature Search: O.G., E.A., E.H.A., Writing: O.G., E.A., E.H.A

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