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Original Research

Our Experiences with Vertebral Artery Stents

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ABSTRACT
Objective: This study aimed to evaluate the success and clinical outcomes of endovascular stent treatment in vertebral artery (VA) occlusive lesions.
Methods: A total of 103 patients who underwent endovascular treatment due to VA constriction were included in this study. The patients were diagnosed on the basis of their clinical manifestations (vertigo, visual complaints, syncope, ataxia, drop attack, ischemic stroke, and transient ischemic attack (TIA)), neurological examinations, Doppler ultrasonography examination, and digital subtraction angiography (DSA). For angiographic evaluation, all patients underwent four vessel angiographies including the aortic arch, VA, and carotid artery. Anterior circulation, posterior circulation, and the Willis polygon were evaluated for all patients. During the procedure, the patients were not sedated, and neurological findings were continuously monitored.
Results: Thirty-six patients had stents implanted in their right vertebral arteries, 16 patients in their left vertebral arteries, and 3 patients in both vertebral arteries. During the procedure, bradycardia developed in three cases, and atropine was administered for its intervention. Hypotension developed in two cases, and dopamine along with 0.9% NaCl was administered for its intervention. One of the patients developed a speech disorder along with a complaint of imbalance 24 hours after the procedure. A magnetic resonance imaging (MRI) examination revealed an infarct on the left posterior inferior cerebellar artery (PICA) supply area. The patients' symptoms subsided with minimal sequelae. Two patients had TIAs with complaints of dizziness and weakness on the left side. Hemorrhage and hematoma developed in the femoral artery region 2 hours after the stent implantation in two cases. One unit transfusion was applied.
Conclusion: Vertebral artery stenosis is one of the correctable causes of posterior systemic stroke and can now be diagnosed with more ease with the use of modern imaging methods. Balloon angioplasty or stent-assisted endovascular treatment is an effective treatment with low morbidity and mortality for patients with a single VA or who do not respond to medical treatment due to cerebral vascular pathology.
Keywords: Vertebral artery, stenosis, stent

INTRODUCTION

In Western societies, stroke is a major cause of death and hospitalization and is the second most common cause of fatalities worldwide. Twenty-five percent of ischemic strokes are caused by the vertebrobasilar system, whereas approximately one-fifth of posterior strokes are due to vertebral artery (VA) constrictions. Unlike for anterior circulation, no definitive treatment strategies have been established for symptomatic posterior circulation stenosis yet. Drug therapy alone can reduce the risk of strokes in these patients, but there is no definitive study in this regard. Surgical treatment of VA occlusive lesions is very limited, and endovascular treatment methods and technological improvements have rendered almost all surgical treatment options (1-3) obsolete. This study aimed to evaluate the success and clinical outcomes of endovascular stent treatment in VA occlusive lesions.

METHODS

A total of 103 patients who underwent endovascular treatment between 2014 and 2017 due to VA constriction were included in this study. Gaziantep University School of Medicine Ethics Committee's approval (date:01/18//2018, decision no:2018/27) was obtained for the study. The patients were diagnosed on the basis of their clinical manifestations (vertigo, visual complaints, syncope, ataxia, drop attack, ischemic stroke, and transient ischemic attack (TIA)), neurological examinations, Doppler ultrasonography examination, and digital subtraction angiography (DSA). The patients and their relatives were informed about the risks and possible complications before undergoing the procedure and were given an informed consent form to sign. To reduce the risk of thrombosis following stent implantation and to speed up the endogenous clearance phase of the lesion's thrombus component, the patient was put on a dosage of 100–300 mg/day of acetylsalicylic acid and 1×75 mg/day of clopidogrel 1week before the procedure. A few days before the procedure, the patients were evaluated with a full blood count, coagulation tests, and a biochemical panel. The patients were told not to eat on the day of the procedure. For angiographic evaluation, all patients underwent four vessel angiographies including the aortic arch, VA, and carotid artery. Anterior circulation, posterior circulation, and the Willis polygon were evaluated for all the patients.All patients

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received 5,000–10,000 unit of heparin after arterial intervention to maintain an active clotting time (250 s). Endovascular therapy was performed for all patients under local anesthesia following insertion of a subclavian arterial 6-F 100-cm-long guide catheter (Guider Softip, Boston Scientific Target, Fremont, Boston, USA) using stents with a monorail system dilated with a balloon using a 0.014 guide wire (TransendEx 0.014 inch, Boston Scientific Target, Fremont, Boston, USA). Patients developing bradycardia (pulse rate of <40 or a decrease of ≤50% for up to 24 hours) or hypotension (systolic blood pressure of <90 mmHg or mean arterial pressure of <50 mmHg) during and after the stenting procedure were recorded. At the end of the procedure, anterior posterior and lateral cranial angiographic imaging were performed, and the procedure was ended. During the procedure, the patients were not sedated, and neurological findings were continuously monitored. Double antiplatelet therapy (aspirin and clopidogrel) was applied for at least 3 months after the procedure.

Statistical Analysis

The Statistical Package for the Social Sciences 22 (SPSS, IBM Corp;, Armonk, New York, USA) package program was used for data analysis. Descriptive statistics were given as mean values, standard deviations, and the frequency distribution in percentages. The Chi-Square Test was used for categorical data and the significance level was accepted as $p<0.05$ in statistical analysis.

RESULTS

Out of 103 patients, 71 (68.9%) were male and 32 (31.1%) were female. The mean age of the patients was 68.5. Of the103 patients, 33 had type 1 arch, 30 had type 2 arch, and 16 had type 3 arch (Table 1). The risk factors were ischemic cerebrovascular diseases in 55 (53.4%) patients, hypertension in 56 (54.4%), hyperlipidemia in 22 (21.4%), diabetes in 33 (32.0%), and atrial fibrillation in 1 (1.0%). Further, 64 patients (62.1%) had vertigo, 20 (19.4%) had visual symptoms, 5 (4.8%) had syncope, 6 (5.8%) had TIAs, and 2 (1.9%) had ischemic strokes (Table 2).

The left VA origin stenosis degree revealed that 14 (13.5%) patients had <50%, 11 (10.6%) had 50%–69%, 21 (20.3%) had 70%–99%, 4 (3.8%) had near occlusion, and 5 (4.8%) had total occlusion (Table 3). Thirty-six patients had stents implanted in their right vertebral arteries, 16 in their left vertebral arteries, and 3 in both vertebral arteries (Table 4). The mean age of patients who had stent implantations was 65.97±7.9 years. Twenty-three patients (48.9%) who had stent implantations had type 1 arch. During the procedure, bradycardia developed in three cases, and atropine was administered for its intervention. Hypotension developed in two cases and dopamine along with 0.9% NaCl was administered for its intervention. One of the patients developed a speech disorder alongwith a complaint of imbalance 24 hours after the procedure. A magnetic resonance imaging (MRI) examination revealed an infarct on the left posterior inferior cerebellar artery (PICA) supply area. The patients' symptoms subsided with minimal sequelae. Two patients had TIAs along with complaints of dizziness and weakness on the left side. Hemorrhage and hematoma developed in the femoral artery region 2 hours after the stent implantation in two cases. One unit transfusion was applied (Table 5).

Table 1. Arcus types

Arcus types	n=103	Percent
Type1	33	32.0
Type2	30	29.1
Type3	16	15.5
Type1 bovine	14	13.6
Type2 bovine	6	5.8
Type3 bovine	4	3.9
Total	103	100.0

Table 2. Patient characteristics

Patients	Total n=103(%)
Age (years)	68.5
Indication for procedure	
Vertigo	64 (62.1%)
Visual disturbance	20 (19.4%)
Syncope	5 (4.8%)
CVA/TIA	6 (5.8%)
Ataxia	4 (3.8%)
Drop attack	2 (1.9%)
Comorbidities	
History of stroke	55 (53.3)
Hypertension	56 (54.3)
Diabetes	33 (32)
Hyperlipidemia	22 (21.3)
Smoking	8 (7.7)
Heart failure	8 (7.7)
Atrial fibrillation	1 (0.9)
Coronary artery disease	29 (28.1)

Values are mean±SD or n (%). CVA: cerebrovascular accident; TIA: transient ischemic attack

DISCUSSION

Vertebral artery stenosis is among the most common causes of posterior ischemic symptoms. VA stenosis may be intra- or extracranial, but it frequently occurs at the subclavian artery exit level. VA stenosis is one of the correctable causes of posterior systemic stroke and can now be diagnosed with more ease through the use of modern imaging methods such as computerized tomography (CT), MRI angiography, and DSA.

Vertebral artery stenoses reduce posterior cerebral perfusion causing vertebrobasilar insufficiency. They are also an important embolic source for posterior circulation. The risk of recurrent stroke after 5 years of vertebrobasilar TIA or strokes is reported to

Table 3. Patients' intracranial and extracranial stenosis grades

Angiography stenosis level	Left vertebral artery origin n (%)	Left vertebral artery intracranial n (%)	Right vertebral artery origin n (%)	Right vertebral artery intracranial n (%)
No stenosis	48 (46.6)	89 (86.4)	40 (38.8)	99 (96.1)
<50%	14 (13.5)	10 (9.7)	15 (14.5)	3 (2.9)
50%–69%	11 (10.6)	2 (1.9)	8 (7.7)	1 (0.9)
70%–99%	21(20.3)	2 (1.9)	29 (28.1)	0 (0)
Near occlusion	4 (3.8)	0 (0)	7 (6.7)	0 (0)
Occlusion	5 (4.8)	0 (0)	4 (3.8)	0 (0)

Table 4. Patients implanted with stents

Stent–implanted patients	n=103	Percent
Left vertebral artery	16	15.5
Right vertebral artery	36	35.0
Both vertebral arteries	3	2.9

Table 5. Procedural complications

Procedural complications	n=103	Percent
Bradycardia	3	2.91
Hypotension	2	1.94
Stroke	1	0.97
Transient ischemic attack	2	1.94
Hematoma/bleeding requiring transfusion	3	2.91

be 22%–35% (4-7). Medical, surgical, and endovascular methods are used for treating VA stenosis.

Surgical treatment has been abandoned because of complications such as Horner's syndrome (15%–28%) and laryngeal nerve injury (2%) (5).

Endovascular treatment should be considered the first option for patients with asymptomatic bilateral carotid occlusion where VA enables the collateral circulation or in the case of posterior strokes developing despite appropriate medical treatment. Technical success varies according to the risk factors of patients, the state of the endovascular treatment materials, the degree of stenosis, the type of arch, and the experience of the interventionalist neurologist performing the procedure (8, 9).

Arcus aorta typing, determined by the distance of the point where the truncus brachiocephalicus originates from the arcus aorta to the arcus aorta peak point, is important for intravenous procedures for diagnosis and treatment of supra-aortic and cerebral vessels, which are becoming increasingly more common (10). As one goes from type 1 to type 3, catheterization of the supra-aortic vessels and the planned procedures afterwards become more complicated. For this reason, knowing the aortic arch type is important in the planning of intravenous procedures. Overall, 32% of the patients had type 1 arch, 29.1% type 2 arch, 15% type 3 arch, 13.6% type 1 bovine arch, 5.8% type 2 bovine arch, and 3.9% type 3 bovine arch.

In terms of risk factors that play an important role in technical success and prognosis, ischemic cerebrovascular diseases were found in 53.4% patients, hypertension in 54.4%, hyperlipidemia in 21.4%, diabetes in 32%, a history of smoking in 7.8%, cardiac insufficiency in 7.8%, atrial fibrillation in 1%, and coronary artery disease in 28.2% patients.

In a study by Stayman et al. (11) focusing on endovascular treatment of extracranial VA stenosis, the rate of strokes was 1.1% and that of TIAs was 0.8%. In our study, the ischemic stroke rate was 1%, and the transient ischemic stroke rate was 3.6%.

The technical success rate in a stent implantation study by Motarjeme et al. (12) for 39 patients' vertebral orifice was 92.3%. In our study, endovascular treatment was successful for 55 patients who had stent implantations, implyinga 100% technical success.

CONCLUSION

Vertebral artery stenosis is one of the correctable causes of posterior systemic stroke and can now be diagnosed with more ease through the use of modern imaging methods. Balloon angioplasty or stent-assisted endovascular treatment is an effective treatment with low morbidity and mortality for patients with a single VA or who do not respond to medical treatment due to cerebral vascular pathology.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University School of Medicine (date:01/18//2018, decision no:2018/27).

Informed Consent: Written informed consent was obtained from patient who participated in this study.

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