Dissecting Spontaneous Vertebral Artery Aneurysms (V4). Endovascular reconstructive techniques with FD Stents. Case series

ABSTRACT

Background: Spontaneous vertebral artery dissection (SVAD) is rare and occurs in young patients with subarachnoid hemorrhage (HSA) or stroke (3 to 5%). Only 11% occur in the V4 segment of VA. Its treatment changed in parallel with the progress of endovascular technology. Material and Methods: Six consecutive cases of dissecting vertebral artery aneurysms V4 are reported. All males with mean age 35 years. Clinical presentation with headache and neckache in all cases, ischemic stroke and SAH one case each. All patients underwent reconstructive endovascular treatment with FD stent, with or without microcoils. Results: All patients were under dual antiplatelet therapy before EVT (Aspirin 200mg and clopidogrel 75mg or ticagrelor 180mg/day). Reconstructive technique was performed with FD stent in two cases, associated of microcoils and "jailing technique" in two cases or multiple telescoping stents in three cases. Occlusion of the aneurysm and arterial permeability were found in long term follow up in 5 cases. In a case of fusiform aneurysm, there was late thrombosis of the telescoped stents and arterial occlusion without clinical repercussion. Conclusion: Due to the high rate of surgical morbidity, endovascular treatment became the first line for this kind of aneurysm. The reconstruction using a flow bypass and device reconstructive technique is an attractive alternative, showing long-term favorable clinical and angiographic outcomes with the ability to maintain patency of the parental and lateral branch arteries.

Keywords: Dissecting spontaneous vertebral aneurysms; Endovascular treatment; Flow diverter stent

RESUMO

Introdução: A dissecção espontânea da artéria vertebral (DAV) é rara e ocorre em pacientes jovens com hemorragia subaracnoidea (HSA) ou stroke (3 a 5%). Apenas 11% ocorrem no segmento V4 da VA. O tratamento mudou paralelamente ao progresso da tecnologia endovascular. Metodologia: Seis casos consecutivos de aneurismas dissecantes da artéria vertebral V4, todos do sexo masculino e idade média de 35 anos. Apresentação clínica com cefaleia e nucalgia, stroke e apenas um caso com HSA. Todos foram submetidos a tratamento endovascular reconstrutivo com uso de stents FD com ou sem micromolas. Resultados: Todos os pacientes sob dupla antiagregação antes do TEV (aspirina 200mg e clopidogrel 75mg ou ticagrelor 180mg). Realizada técnica reconstrutiva com implante de stent FD, micromolas e “jailing technique” em 2 casos ou múltiplos stents telescopados em 3 casos. Oclusão do aneurisma e permeabilidade arterial em seguimento tardio ocorreu em 5 casos. Em um caso de aneurisma fusiforme houve trombose tardia dos stents telescopados e oclusão arterial, sem repercussão clínica. Conclusão: Devido ao alto índice de morbidade cirúrgica, o tratamento endovascular tornou-se a primeira linha para esse tipo de aneurisma. A reconstrução utilizando um dispositivo de desvio de fluxo é uma alternativa atrativa, mostrando desfechos clínicos e angiográficos favoráveis em longo prazo com a capacidade de manter a patência da artéria parental e do ramo lateral.

Palavras-chave: Dissecção espontânea da artéria vertebral; Tratamento endovascular; Dispositivo de desvio de fluxo
INTRODUCTION

Vertebral artery (VA) V4 segment and posteroinferior cerebellar artery (PICA) aneurysms are rare (less than 3% of all aneurysms) but represents one fifth of all those originated in the posterior fossa\(^1,2\). Most common presented as saccular aneurysms, it can also be present as fusiform or dissecting, with the VA being the most common site of the last type\(^3\). Dissecting aneurysms can yet be classified as traumatic and spontaneous. The last one commonly is present in relatively young patients with subarachnoid hemorrhage (SAH) or ischemic symptoms (3-5% of patients with SAH) and only 11% of cases take place in the V4 segment\(^4\).

There are several treatment options to use in this kind of aneurysms from clip placement or endovascular treatments (EVTs) to occlude the proximal vertebral artery and trapping it surgically or by EVT, in aneurysm wrapping and EVT using regular or flow-diverter (FD) stents with or without coils\(^1\).

With the advance of endovascular techniques such as embolization and remodeling, the treatment of posterior circulation aneurysms became safer, decreasing the morbimortality rates\(^5\) and showed better outcomes compared to surgical treatment\(^6\).

The purpose of this study is to show the efficacy of using EVT and reconstructive techniques to treat this type of aneurysms, evaluating the clinical and angiographic outcomes of the patients submitted to the procedures.

MATERIALS AND METHODS

In this study we reported six consecutive cases of dissecting spontaneous aneurysms in the V4 segment and PICA. The cases were classified by Mizutani's nonatherosclerotic dissecting vertebral artery aneurysms classification, type 1 to type 4. Most of aneurysms were type 2 Mizutani. All patients were male (mean age 35 years), presenting with ischemia (2 cases), headache and neckache without SAH (3 patients) or headache with SAH (1 case). They were all treated with endovascular and reconstructive techniques using FD stents with or without microcoils. Patient's information as well as clinical presentation, treatment option, complications and outcome are in Table 1.

| Case | Sex | Age | Mizutani Classification | Clinical Presentation | EVT | Complication | Follow-up |
|------|-----|-----|-------------------------|-----------------------|-----|--------------|-----------|
| 1    | M   | 40  | Type 4                  | SAH                   | Stent FD(SILK*) | No          | GR        |
| 2    | M   | 41  | Type 1                  | Stroke                | Stent FD(SILK) | Stent thrombosis | GR        |
| 3    | M   | 17  | Type 3                  | Stroke                | Stent FD + contralateral Vertebral occlusion coils (LEO**+SILK) | No          | GR        |
| 4    | M   | 28  | Type 2                  | Headache/neck ache    | Stent FD + coils(FRED*** | No          | GR        |
| 5    | M   | 49  | Type 2                  | Headache/neck ache    | Stent FD + coils(FRED) | No          | GR        |
| 6    | M   | 36  | Type 2                  | Headache/neck ache    | Stent FD(FRED)  | No          | GR        |

Observation: FD: flow diverter; GR: good recovery; *SILK flow diversion device; ** LEO auto expandable intracranial stent; ***FRED flow redirection endoluminal device.

Table 1. Demographic, clinical presentations, treatments, complications, and clinical outcome in the series cases.
**Case 1**

Male patient, 40 years old, presented sudden holocranial severe headache. Computerized tomography (CT) evidenced Fisher 1 SAH (Figure 1A). A 3D angiotomography and angiography showed small aneurysm-like fusiform dilation of the left posterior inferior cerebellar artery (PICA) (Figure 1B and 1C). It was opted for arterial reconstructive technique with FD device after the acute phase of subarachnoid hemorrhage and vasospasm within the 15 days after bleeding.

Patient with dual antiplatelet therapy, initiated 3 days before the procedure (clopidogrel 75mg and aspirin 200mg/day). General anesthesia. Settled the IVA sheath 6F (Balt, Montmonrency, France) in the left V2 vertebral artery. Fargo Max 6F (Balt, Montmonrency, France) catheter settled in the left V4 vertebral artery. Vasco 10 microcatheter (Balt, Montmonrency, France) with the help of Traxcess 14 micro guide (Microinvention, CA, USA) set distally in the left PICA. Deployment of SILK Stent 2.5x25mm (Balt, Montmonrency, France) recovering all aneurysm extension, being observed a stagnation within the aneurysmal sac at angiographic control at the end of the procedure (Figures 1D and 1E). The patient evolved without any complication.

**Case 2**

Male patient, 42 years old, presented headache and neckache after arterial hypertension, evolving with dizziness. After 1 week of symptoms persistence, patient searched neurological care. MRI was performed. Diffusion sequence showed ischemia in the left cerebellar hemisphere (Figure 2A) and T2 sequence showed image suggestive of left VA dissection by presence of intraparietal thrombus (Figure 2B). Cerebral angiography with 3D reconstruction showed left vertebral artery dissection, with a fusiform aneurysm, but without PICA involvement (Figure 2C e 2D). It was opted for EVT with reconstructive technique and use of telescoped stent (stent Leo+ e Silk+).

Patient with dual antiplatelet therapy, initiated 3 days before the procedure (clopidogrel 75mg and aspirin 200mg/day). General anesthesia. IVA 6F long sheath (Balt, Montmonrency, France) in the left V2 vertebral artery and Fargo Max 6F guider catheter (Balt, Montmonrency, France) in the left V4 vertebral artery were set. Vasco 21 microcatheter (Balt, Montmonrency, France) with Hybrid 12/14 micro guide wire (Balt, Montmonrency, France) was inserted first to deployment of auto expandable stent Leo+ 3,5x50mm (Balt, Montmonrency, France) (Figure 2E), to serve as a bridge for anchoring the seconding telescopic stent silk FD 3.5x35mm (Balt, Montmonrency, France) (Figure 2F) due to fusiform anatomy of the aneurysm. The final angiographic control in late phase showed good retention within the aneurysm (Figure 2G). Patient recovered without neurologic symptoms, keeping dual antiplatelet therapy for 6 months. After 6 months the angiographic follow up showed an asymptomatic left VA occlusion due to stent thrombosis (Figure 2H).

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**Figure 1.** Case 1. A. CT scan SAH Fisher I; B. DSA lateral view: dissecting left PICA aneurysm; C. 3D Angio CT Scan aneurism view; D. FD Stent silk 2.5x25mm view; E. DSA control after endovascular treatment.
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Souza JVA, Andrade GC, Lesczysnki A, Alves HFP - Dissecting Spontaneous Vertebral Artery anteroinferior cerebellar arteries (AICA) (Figures 3B and 3C).

Angiography and 3D angiography gave evidence of a partially thrombosed, large, and complex circumferential fusiform aneurysm of the low basilar artery, with involvement of both vertebral arteries, as well as the anteroinferior cerebellar arteries (AICA) (Figures 3B and 3C).

Symptoms receded as days went by. Magnetic resonance imaging (MRI) showed a partially thrombosed aneurysm of the low basilar artery, with a hypersignal of acute ischemia of the brainstem (Figure 3A). Angiography and 3D angiography showed left V4 segment, above the PICA. The microcatheterization of the left VA was performed with Echelon 14 microcatheter (Covidien Ev3, Irvine, CA, USA) and Traxcess 14 micro guidewire (Microinvention, Tustin, CA, USA), and final occlusion of the left vertebral artery was done with platinum microcoils (Figure 3D). The angiographic control showed left VA with maintenance of flow through the PICA artery (Figure 3D).

**First surgical time**

The patient was started on dual antiplatelet therapy 3 days before the procedure (clopidogrel 75mg and aspirin 200mg/day). Patient under general anesthesia. A 6F IVA long sheath (Balt, Montmorency, France) was set in V2 segment of the right vertebral artery and a Fargo Max 6F guide catheter (Balt, Montmorency, France) in V4 segment of the right vertebral artery. Vasco 21 microcatheter (Balt, Montmorency, France) was inserted distally in the left posterior cerebral artery with Traxces 14 micro guidewire (Microinvention, Tustin, CA).

Deployment of the first stent, LEO+ of 3.5 mm 30 mm (Balt, Montmorency, France), and then the second telescoped stent, LEO+ of 3.5 mm 25 mm (Balt, Montmorency, France) to cover the whole aneurysm length. A 6F IVA long sheath (Balt, Montmorency, France) was set in V2 segment of the left vertebral artery and a Fargo Max 6F guide catheter (Balt, Montmorency, France) in V4 segment of the left vertebral artery. A detachable gold balloon B1 (Balt, Montmorency, France) was deployed in the left V4 segment, above the PICA. The microcatheterization of the left VA was performed with Echelon 14 microcatheter (Covidien Ev3, Irvine, CA, USA) and Traxcess 14 micro guidewire (Microinvention, Tustin, CA, USA), and final occlusion of the left vertebral artery was done with platinum microcoils (Figure 3D). The angiographic control showed left VA with maintenance of flow through the PICA artery (Figure 3D).

**Second surgical procedure**

After 3 months, second surgical procedure was performed keeping dual antiplatelet therapy. General anesthesia, a 6F IVA long sheath (Balt, Montmorency, France) and Fargo Max 6F guide catheter (Balt, Montmorency, France) were set in the right vertebral artery. A Vasco 21 microcatheter (Balt, Montmorency, France) and Traxcess 14 micro guidewire (Microinvention, Tustin, CA, USA) were positioned distally on left posterior cerebral artery. Deployed silk stent 3.5x30 mm (Balt, Montmorency, France) overlapping the two LEO+ stents (Balt, Montmorency, France) (Figure 3E). On 12 months follow up the angiographic control showed basilar artery reconstruction and full elimination of the aneurysm (Figure 3F). The patient recovered without any neurological complications.
Male patient, 28 years old, with spontaneous intense headache and neckache, had a partial improvement of symptoms. CT scan and MRI were performed after more than 60 days, with images suggestive of partially thrombosed aneurysmatic lesion in the left vertebral artery territory (Figures 4 A and B). 3D angiography showed partially thrombosed aneurysmatic lesion with parietal irregularities in V4 (Figures 4C and D).

Patient initiated dual antiplatelet therapy 3 days before the procedure (ticagrelor 180mg and aspirin 100mg/day). General anesthesia was used. Neuron Max 6F long sheath (Penumbra, CA, USA) and Sofía 6F guide catheter (Microinvention, CA, USA) were inserted in the left vertebral artery, followed by supra selective double microcatheterizing settling Headway 27 microcatheter (Microinvention, CA, USA) and Traxcess 14 micro guidewire (Microinvention, CA, USA) in the left V4 vertebral artery, distally to the aneurysm. Also, a microcatheterization of aneurysm sac with Headway Duo microcatheter (Microinvention, CA, USA) was done. It was opted for jailing technique with deployment of FRED FD stent 3.5x15mm and occlusion of aneurysm sac with platinum microcoils (Figure 4E). Angiographic follow up with six months showed aneurysm occlusion and flow preservation of left vertebral artery (Figure 4F).

Case 4

Male patient, 28 years old, with spontaneous intense headache and neckache, had a partial improvement of symptoms. CT scan and MRI were performed after more than 60 days, with images suggestive of partially thrombosed aneurysmatic lesion in the left vertebral artery territory (Figures 4 A and B). 3D angiography showed partially thrombosed aneurysmatic lesion with parietal irregularities in V4 (Figures 4C and D).
Case 5
Male patient, 49 years old, searched neurological care complaining of headache with sudden severe left neckache. CT showed regular hyper-uptake spot within the brainstem. MRI (T2) showed expansive vascular lesion with internal thrombus in left VA topography, suggesting partially thrombosed dissecting aneurysm of the left V4 (Figure 5A). Angiography and 3D angio (Figures 5B and 5C) showed large circumferential dissecting aneurysm of left V4 vertebral artery. Opted for arterial reconstruction technique with use of FD device. Some microcoils were associated combining jailing technique due to the presence of intra-saccular thrombus, to reduce the risk of late rupture of the aneurysm.

Patient with dual antiplatelet therapy, initiated 3 days before the procedure (ticagrelor 180mg and aspirin 100mg/day). General anesthesia was used. Neuron Max 6F long sheath (Penumbra, CA, USA) was set in left V2 VA. Sofia 6F (Microinvention, CA, USA) set in the left V4 VA. Supra selective dual suction Headway 27 microcatheter (Microinvention, CA, USA) was set in left V4 vertebral artery distally to the aneurysm with the help of Traxcess 14 micro guidewire (Microinvention, California, USA). Inserted Headway Duo microcatheter (Microinvention, California, USA) inside the aneurysm sac, followed by EVT with jailing technique (Figures 5D and 5E), FRED FD Stent and microcoils implantation. The six months angiographic control showed aneurysm occlusion and flow preservation of left VA (Figure 5F).

Figure 5. Case 5. A. MRI T2 partial thrombosed dissecting left vertebral aneurysm; B. DSA AP view: dissecting fusiform left vertebral aneurysm; C. 3D DSA aneurysm view; D. FD Stent FRED + coils “jailing technique” with partial occlusion; E, F. DSA at 6 months follow up, AP view with occlusion of dissecting aneurysm and reconstruction of vessel wall.

Case 6
Male patient, 36 years old, complained of headache associated with left sudden and severe neckache. CT showed hyperdense regular image within the left VA territory. MRI (T2) showed expansive vascular lesion without thrombus in the left vertebral artery topography, suggesting dissecting aneurysm of the left V4. Digital angiography with 3D reconstruction revealed a left V4 segment dissecting fusiform aneurysm (Figure 6A and 6B). Treatment option was arterial reconstructive technique with flow diverter device.
Patient with dual antiplatelet therapy, initiated 3 days before the procedure (ticagrelor 180mg and aspirin 100mg/day). General anesthesia. Neuron Max 6F sheath (Penumbra, CA, USA) settled in left V2 VA. Sofia 6F (Microinvention, CA, USA) set in the left V4 VA, followed by supra selective dual suction Headway 27 microcatheter (Microinvention, CA, USA) set in left V4 vertebral artery distally to the aneurysm with the help of Traxcess 14 micro guidewire (Microinvention, California, USA) as well as FRED FD Stent deployment (Figure 6B). Six months angiographical control showed aneurysm occlusion and flow preservation of left vertebral artery (Figure 6C and 6D).

Only one case presented initial SAH. Half of the cases was diagnosed after sudden and severe headache and neckache (50%), and in other two cases (33%) after stroke (Table 1). All cases underwent endovascular treatment with reconstructive technique and use of flow diverter (FD) stent, associated with platinum microcoils in the cases with intrasaccular thrombus in case of Type 2 of Mizutani (33%). The morbimortality rate was of 0% despite of the late occlusion of stent in one of the cases (VA occlusion without clinical repercussion in a late follow up).

DISCUSSION

Intracranial VA dissecting aneurysms are rare lesions. However, the advances in imaging modalities and brain imaging screening have increased their detection rate. When ruptured, its prognosis is extremely poor. Between 30-70% of patients with ruptured intracranial VA dissecting aneurysms will have recurrent bleeding. In most of the cases, these aneurysms have a broad neck and fragile walls, making surgical clipping or endovascular coil embolization difficult7.

Arterial dissection is characterized by the disruption of the internal elastic blade (IEB) and/or the middle layer, with or without intramural hemorrhage, causing vessel narrowing or dilation, after chronic thickening of the intimal caused by the granulation tissue and repeated intramural hemorrhage with fragile neo vessels after 14 days7.

In spontaneous VA dissections, pain is the most frequent symptom and is often characterized as unilateral headache and neckache, followed by posterior circulation ischemic manifestation8. Patients presenting intracranial hemorrhage have nearly 70% recurrent bleeding rate, mainly within 24 to 72 hours, with high mortality rates8. In vertebral dissection without intracranial hemorrhage with recurrent ischemic symptoms, significant stenosis or dissected vessels dilation (pseudoaneurysm) after the follow up, even with the best medication, the EVT is recommended3.
A variety of treatment strategies have been applied in those patients, including surgical reconstruction, surgical ligation, wrapping, surgical bypass, and endovascular treatment, but optimal treatment strategies have not yet been established. Various EVT have been used to treat VA dissecting aneurysms. Endovascular approaches to these aneurysms can be divided into reconstructive and deconstructive techniques.

Reconstructive techniques restore the normal vascular anatomy and preserve the parent artery. These techniques use single or double stent placement with or without coil embolization. The most complete treatment of a VA dissecting aneurysm is the occlusion of the parent artery. There are several limitations to this technique. For patients with hypoplastic contralateral VA, PICA-involved VA dissecting aneurysms, bilateral lesions, or lesion of the extended basilar artery, this treatment results in not only cerebellar infarctions but also medullary infarctions. The reconstructive technique is useful in the treatment of ruptured or unruptured intracranial VA dissecting aneurysms.

Recently, the reconstructive EVT, as stent-assisted coils or flow diverter stent, has been reported as an effective treatment modality. The parenteral vessel reconstruction using FD device can be safe and effective for cerebral artery dissection, with a complete occlusion rate in dissecting aneurysms of about 67-75%. In large dissecting aneurysms and/or those with intramural thrombus in the aneurysm dilatation, the use of microcoils can bestow a higher occlusion index. In cases of SAH-associated dissecting aneurysms, the use of FD Stent in the treatment of these lesions involving the PICA has been described in literature as a reasonable option.

The treatment of posterior circulation dissecting aneurysms located between intradural vertebral artery V4 and vertebrobasilar junction, with PICA involvement remains a major challenge for neurosurgeons and neuroradiology. Due to its high recurrent bleeding rate, more immediate treatments are needed. Given the high morbimortality rate in microsurgery, the EVT became the first option for this kind of aneurysm. Our series demonstrates that arterial reconstruction with FD and/or microcoils seems to be a good option for the treatment of these lesions, even in ruptured aneurysms cases. However, there is still a concern of occlusion of lateral arterial branches and perforating arteries, just as the arterial occlusion by stent thrombosis with neurological deficit risk.

CONCLUSION

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