www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Neurovascular

Editor
Kazuhiro Hongo, MD
Shinshu University, Matsumoto, Japan

SNI Open Access

ScientificScholar® Knowledge is power
Publisher of Scientific Journals

Case Report

Percutaneous transluminal angioplasty for vertebral artery origin stenosis under the flow-reversal protection using Mo.MA™ Ultra: A technical case report

Fukutaro Ohgaki[1], Nagatsuki Tomura[2], Takashi Shuto[1]

Departments of [1]Neurosurgery and [2]Neuroendovascular Therapy, Yokohama Rosai Hospital, Yokohama, Japan.

E-mail: *Fukutaro Ohgaki - e103017f@yokohama-cu.ac.jp; Nagatsuki Tomura - tnagatuki@gmail.com; Takashi Shuto - shuto@yokohamah.johas.go.jp

***Corresponding author:**
Fukutaro Ohgaki,
Department of Neurosurgery,
Yokohama Rosai Hospital,
Yokohama, Japan.

e103017f@yokohama-cu.ac.jp

Received: 07 September 2023
Accepted: 01 November 2023
Published: 24 November 2023

DOI
10.25259/SNI_746_2023

Quick Response Code:

ABSTRACT

Background: Vertebral artery origin stenosis (VAOS) is a major cause of ischemic stroke of the posterior circulation. Aggressive medical treatment using dual antiplatelet therapy is the most common treatment approach to symptomatic VAOS; however, the effectiveness of endovascular treatment (EVT) for VAOS has recently been reported. Here, we report a case of VAOS treated with percutaneous transluminal angioplasty (PTA) under flow reversal protection using Mo.MA™ Ultra.

Case Description: The patient was a 78-year-old man. He underwent mechanical thrombectomy for acute right posterior cerebral artery occlusion, and recanalization was achieved. Subsequently, artery-to-artery (A-to-A) embolism caused by the right VAOS was revealed as the etiology. PTA under the flow-reversal protection using Mo.MA™ Ultra was performed electively, and the VAOS and antegrade flow of the right vertebral artery (VA) improved.

Conclusion: In EVT for symptomatic VAOS, lesion cross for distal protection device placement is considered to create a high risk of distal embolism due to the anatomic and clinicopathological characteristics of VAOS lesions, especially in A-to-A embolism cases. The flow-reversal protection using Mo.MA™ Ultra can be performed with EVT to prevent distal embolism with lesion cross by retrograde flow of the VA. This method is feasible, especially for cases in which antegrade flow to the basilar artery through the developed contralateral VA is anticipated during the Mo.MA™ Ultra protection.

Keywords: Embolic protection device, Flow-reversal protection, Mo.MA™ Ultra, Percutaneous transluminal angioplasty, Vertebral artery origin stenosis

INTRODUCTION

Vertebral artery origin stenosis (VAOS) is one of the most common causes of posterior circulation ischemic stroke, with a rate of approximately 15–20%.[5,6,9,12] VAOS results in vertebrobasilar and posterior cerebral ischemic stroke caused by hypoperfusion and artery-to-artery (A-to-A) embolism.[4-6,9,12] Moreover, VAOS is associated with a high risk of stroke recurrence during the first few weeks after the onset;[4] therefore, early treatment is required to prevent recurrence.

Aggressive medical management using dual antiplatelet therapy (DAPT) and endovascular treatment (EVT) have been reported for VAOS treatment; however, no evidence has revealed their superiority.[1,2] Nonetheless, the safety and efficacy of EVT for VAOS have been reported by several studies.[3,7,8,10,11,13] In addition to this, although an embolic protection device (EPD) (Spider FX™, Medtronic, Dublin, Ireland) was used in a study,[10] it has rarely been used among those studies. To date, an established method of using an EPD in EVT for VAOS has not been reported.

We report a case of VAOS in a patient who underwent percutaneous transluminal angioplasty (PTA) under flow-reversal protection using Mo.MA™ Ultra.

CASE DESCRIPTION

The patient was a 78-year-old man; he was well regarding activities of daily living (pretreatment modified Rankin Scale: 0). He had a medical history of high blood pressure. He presented with ambulation difficulty and consciousness disorder on waking and was transferred to our hospital. On admission, his Glasgow Coma Scale was 9 (E2V2M5), and he presented with left hemiparesis and hemispatial neglect with the National Institutes of Health Stroke Scale of 16. Magnetic resonance imaging (MRI) and computed

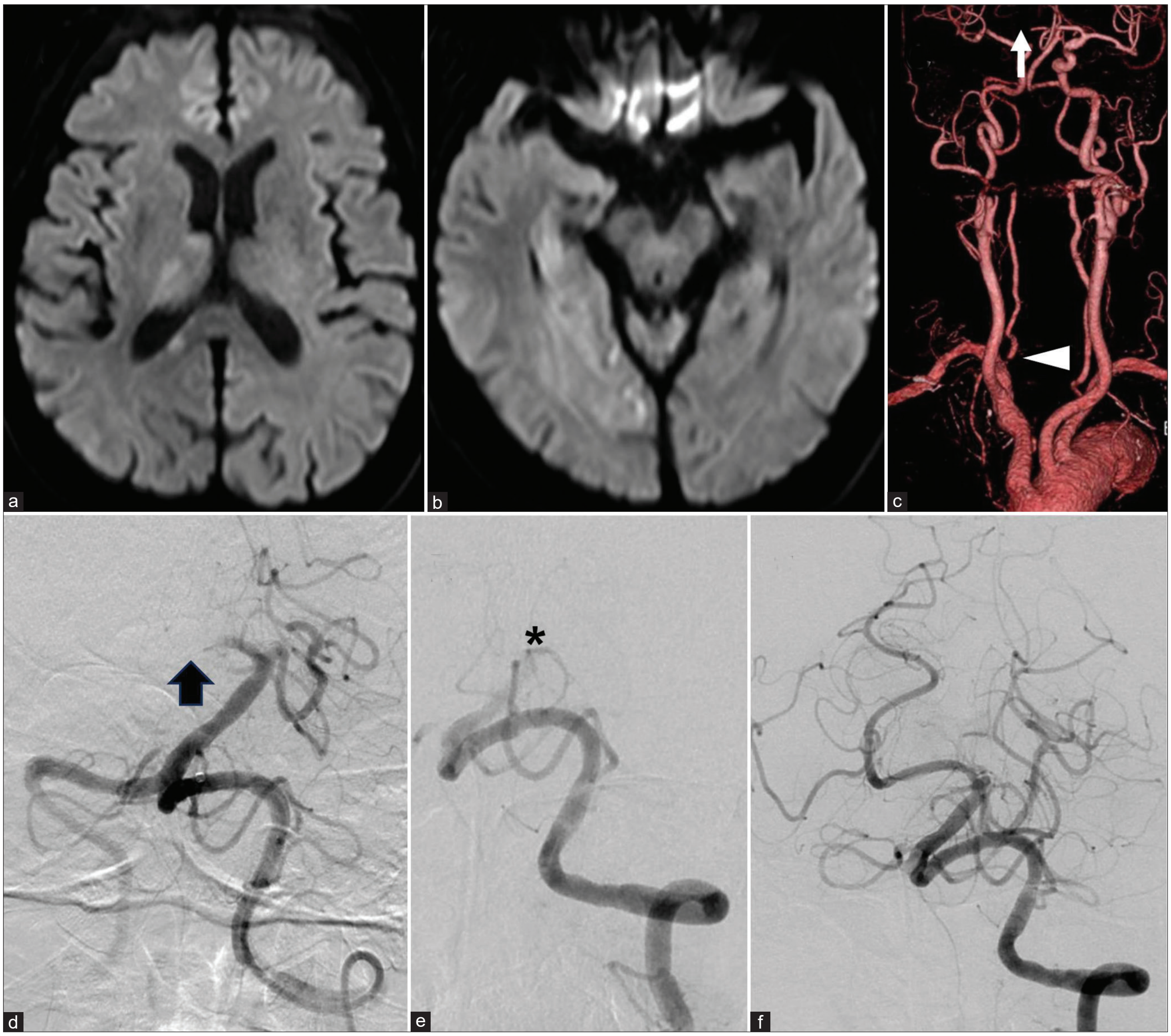

Figure 1: (a-c) Magnetic resonance imaging on admission revealed acute cerebral infarction in the PCA territory. A mismatch was detected between the high-intensity area of the diffusion-weighted image and the right P1 segment occlusion (c, arrow) with the right vertebral artery origin stenosis (c, arrowhead) shown by computed tomographic angiography. (d-f) MT was performed for the P1 segment of the right PCA occlusion (d, arrow). During MT, recanalization of PCA was accomplished once, but basilar artery occlusion occurred (e, asterisk). Recanalization of the thrombolysis index cerebral infarction score 2b was obtained (f).PCA: posterior cerebral artery, MT: Mechanical thrombectomy.

tomographic angiography (CTA) revealed acute cerebral infarction caused by occlusion of the P1 segment of the right posterior cerebral artery (PCA) with a suspicious finding of the right VAOS [Figures 1a-c]. Mechanical thrombectomy (MT) was performed through the left vertebral artery (VA) to create a clear path on the unaffected side considering the difficulty of system placement due to aorta arch type III and further A-to-A embolism with lesion cross of the right VAOS [Figure 1c]. In addition to this, because the fastest recanalization of the right PCA was pursued as far as possible, treatment of the right VAOS was considered elective [Figure 1d]. Recanalization of the right PCA was achieved once, but basilar artery occlusion (BAO) occurred during MT [Figure 1e]. Finally, effective recanalization was achieved (thrombolysis index cerebral infarction score; 2b) [Figure 1f]. Subsequently, A-to-A embolism caused by the right VAOS was revealed as the etiology of the PCA occlusion [Figure 1c].

DAPT was used to prevent the recurrence of the A-to-A embolism, and PTA for VAOS was performed electively at 20 days after onset. Anterograde flow persisted, and distal embolism was a concern. In addition, this was a symptomatic lesion that had developed A-to-A embolism once, and recurrence of A-to-A embolism with the lesion cross was concerned. Therefore, we decided to perform flow-reversal protection using the Mo.MA™ Ultra (Medtronic, Dublin, Ireland). Pretreatment CTA showed type III aortic arch and prominent tortuosity of the right brachiocephalic artery (BRCA), which was selected as the approach route; therefore, we presumed that it would be difficult to place Mo.MA™ Ultra. Consequently, we used the snare traction technique [Figures 2a-c].

First, we punctured the left common femoral artery and placed a 9Fr super sheath (Terumo, Tokyo, Japan). Using a 4Fr SIM2 120 cm (Medikit, Tokyo, Japan)/Guidewire surf

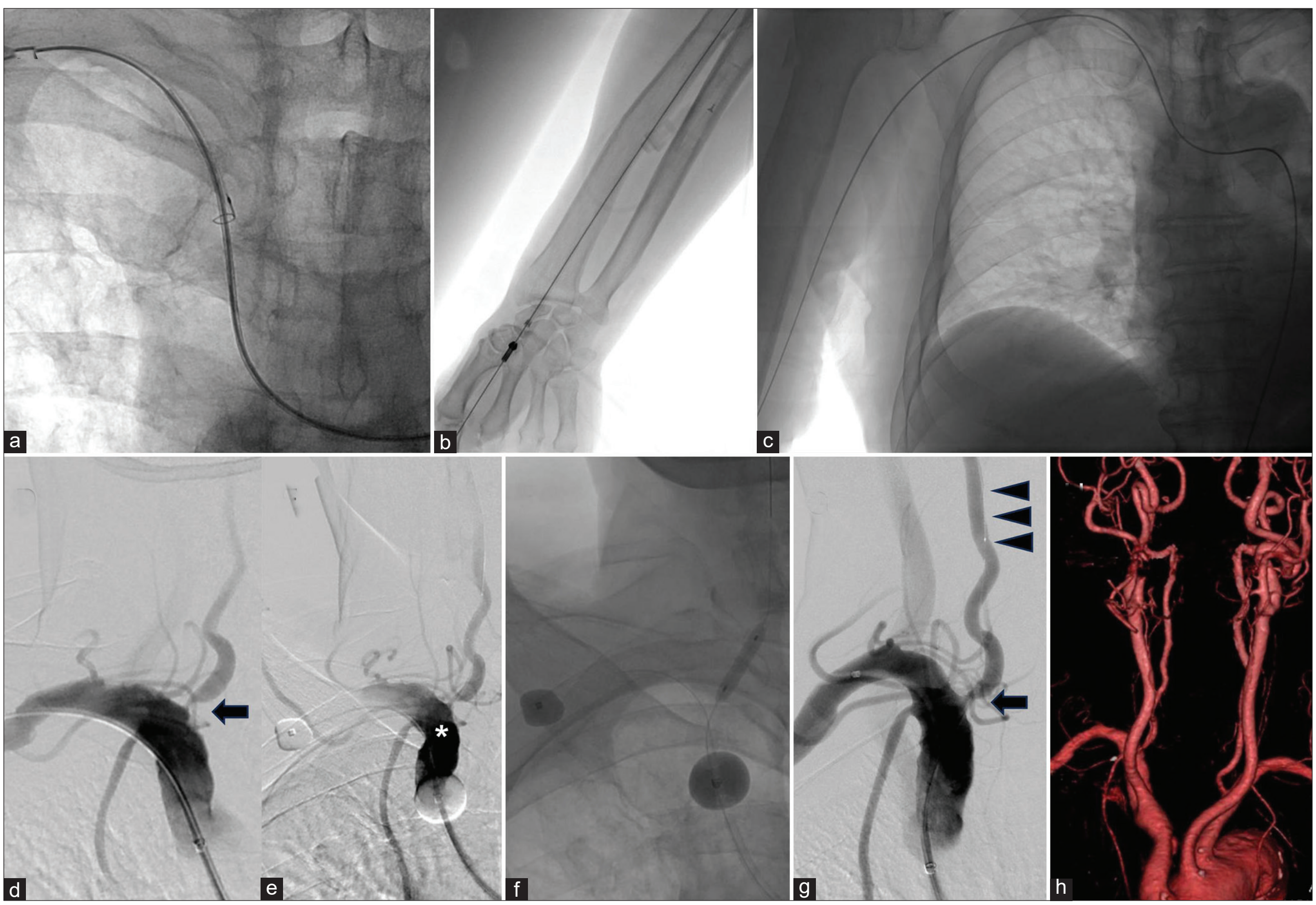

Figure 2: (a-c) For the Mo.MA™ Ultra placement, the traction route of Radifocus® stiff wire, was made using Amplatz Goose Neck™ Microsnare because its tortuosity was prominent. In digital subtraction angiography, (d) VAOS was evident (arrow) and considered the cause of the A-to-A embolism. (e) Under the flow-reversal protection, contrast agent pooled (asterisk) by retrograde flow from the right VA. (f and g) Percutaneous transluminal angioplasty was performed, leading to an improvement of VAOS (g, arrow) and antegrade flow of the right VA (g, arrowhead). (h) The patency of VAOS in the right VA was confirmed by follow-up computed tomographic angiography. A-to-A: Artery to artery, VA: Vertebral artery, VAOS: Vertebral artery origin stenosis.

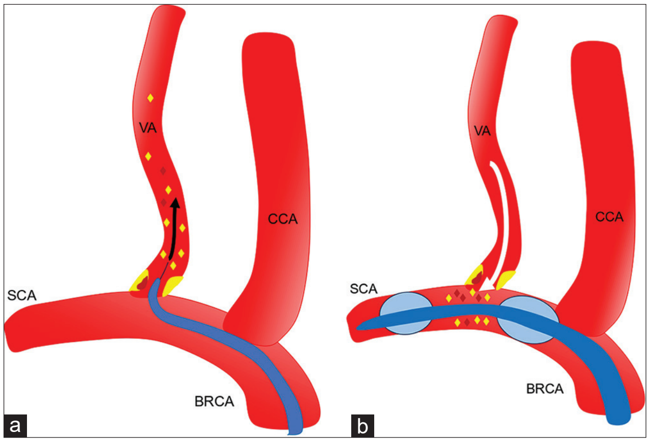

Figure 3: (a) Schema of distal embolism (yellow rhombus: Plaque debris; wine-red rhombus: Thrombus; black arrow: scattering with antegrade flow) with the VAOS lesion cross by distal protection device. (b) Schema of flow-reversal protection using Mo.MA™ Ultra. Antegrade flow from the right BRCA and retrograde flow from the right SCA were obstructed by balloon inflation. Prevention of a distal embolism (yellow rhombus: Plaque debris, wine-red rhombus: Thrombus) in VA lesion cross is possible by retrograde flow from the right VA through the union (arrow). BRCA: Brachiocephalic artery, CCA: Common carotid artery, SCA: Subclavian artery, VA: Vertebral artery, VAOS: Vertebral artery origin stenosis.

0.035 180 cm (Piolax, Kanagawa, Japan), we selected the right BRCA. Then, we punctured the right radial artery (RA) and placed a 5Fr short sheath (Terumo, Tokyo, Japan). Using the right RA route, we placed a SIM 2 in the right brachial artery using an Amplatz Goose Neck™ Microsnare (Medtronic, Dublin, Ireland) [Figure 2a]. To create the traction route of the Mo.MA™ Ultra, we placed a Radifocus® stiff 0.035 300 cm (Terumo, Tokyo, Japan) through the SIM 2 and a 5Fr short sheath in the right RA using an Amplatz Goose Neck™ Microsnare [Figures 2b and c]. We punctured the right common femoral vein, placed a 4Fr short sheath for flow reversal, and placed the Mo.MA™ Ultra to the right BRCA through this route. Activated clotting time had been maintained over 250 s by heparinization during the procedure using Mo.MA™ Ultra. After inflating the distal and proximal balloons, we confirmed the appropriate placement of the Mo.MA™ Ultra and flow-reversal protection [Figures 2d and e]. We used SL-10 150 cm (Stryker, Michigan, US)/CHIKAI 0.014 200 cm (Asahi intecc, Aichi, Japan) to perform a lesion cross and placed the CHIKAI into the V2–V3 portion of the right VA. We connected the CHIKAI extension to CHIKAI, induced Gateway 3.5 × 15 mm, and performed PTA (10 atm, nominal pressure 6 atm, 30 s) [Figure 2f]. After PTA, the right BRCA angiography showed improvement in the VAOS and VA flow [Figure 2g]. The VAOS and VA flow improvements were confirmed to persist for 15 min after BRCA angiography.

No evidence of treatment-related infarction was detected on the follow-up MRI, and the improvement in the patency of the right VAOS was maintained [Figure 2h]. The patient was discharged and transferred to a rehabilitation facility 42 days after the onset, 28 days after PTA.

DISCUSSION

Recently, several studies have reported the efficacy of EVT for VAOS.[3,7,8,10,11,13] However, because the evidence is insufficient, it is not currently an established treatment. In Japan, no stents have been approved for clinical use for VAOS, except for emergent cases of dissection; therefore, we selected PTA for the treatment of VAOS. In this case, A-to-A embolism occurred once, and BAO occurred during the MT by A-to-A embolism recurred in a short time. Thrombus remaining in the lesion or distal portion of the lesion, easiness of thrombus formation, and rich plaque in the lesion were presumed; therefore, we were concerned about A-to-A embolism recurrence due to the association of thrombus with the VAOS and distal embolism caused by plaque debris following ruptured plaque resulting from lesion cross during the placement of the distal protection device [Figure 3a]. Actually, distal protection devices were rarely used in the previous studies.[3,7,8,10,11,13] In addition to this, it has been reported that thrombosis recurrence in VAOS lesions is common.[4,14] Therefore, we avoided using a distal protection device and, instead, performed the flow-reversal protection using Mo.MA™ Ultra.

Furthermore, this patient's aortic arch was type III, Mo.Ma™ Ultra was considered suitable for a stable catheter placement [Figure 3b]. However, EVT for VAOS under the flow-reversal protection using Mo.MA™ Ultra has been rarely reported; in this case, no evidence of infarction related to the treatment was detected on follow-up MRI. Therefore, EVT for VAOS under the flow-reversal protection using Mo.MA™ Ultra can be considered feasible.

However, as a limitation of this method, the flow-reversal protection is confined in cases of well-developed contralateral VA because complete obstruction of antegrade flow is required with Mo.MA™ Ultra. Therefore, cases with poor contralateral VA development or both sides of lesions are inappropriate for this method. In addition to this, when the distance between the origin of the VA and the common carotid artery is insufficient, flow-reversal protection using the Mo.MA™ Ultra is difficult [Figure 3b].

CONCLUSION

PTA effectively prevents stroke recurrence with symptomatic VAOS. In addition to this, the flow-reversal protection using Mo.MA™ Ultra can be performed with EVT to prevent distal embolism with lesion cross by retrograde flow of the VA. This method is feasible, especially for cases where antegrade flow through the developed contralateral VA is anticipated during the Mo.MA™ Ultra protection.

Ethical approval

Not applicable.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

REFERENCES

1. Chaturvedi S. Vertebral artery stenting: Lifting the therapeutic fog. Lancet Neurol 2019;18:620-1.
2. Compter A, van der Worp HB, Schonewille WJ, Vos JA, Boiten J, Nederkoorn PJ, *et al*. Stenting versus medical treatment in patients with symptomatic vertebral artery stenosis: A randomised open-label phase 2 trial. Lancet Neurol 2015;14:606-14.
3. Gruber P, Berberat J, Kahles T, Anon J, Diepers M, Nedeltchev K, *et al.* Angioplasty using drug-coated balloons in ostial vertebral artery stenosis. Ann Vasc Surg 2020;64:157-62.
4. Gulli G, Marquardt L, Rothwell PM, Markus HS. Stroke risk after posterior circulation stroke/transient ischemic attack and its relationship to site of vertebrobasilar stenosis: Pooled data analysis from prospective studies. Stroke 2013;44:598-604.
5. Haghighi AB, Edgell RC, Cruz-Flores S, Zaidat OO. Vertebral artery origin stenosis and its treatment. J Stroke Cerebrovasc Dis 2011;20:369-76.
6. Kim YJ, Lee JH, Choi JW, Roh HG, Chun YI, Lee JS, *et al.* Long-term outcome of vertebral artery origin stenosis in patients with acute ischemic stroke. BMC Neurol 2013;13:171.
7. Li L, Wang X, Yang B, Wang Y, Gao P, Chen Y, *et al*. Validation and comparison of drug eluting stent to bare metal stent for restenosis rates following vertebral artery ostium stenting: A single-center real-world study. Interv Neuroradiol 2020;26:629-36.
8. Shao JX, Ling YA, Du HP, Zhai GJ, Xu Y, Cao YJ. Comparison of hemodynamic changes and prognosis between stenting and standardized medical treatment in patients with symptomatic moderate to severe vertebral artery origin stenosis. Medicine (Baltimore) 2019;98:e14899.
9. Thompson MC, Issa MA, Lazzaro MA, Zaidat OO. The natural history of vertebral artery origin stenosis. J Stroke Cerebrovasc Dis 2014;23:e1-4.
10. Wang MY, Wang F, Liu YS, Yu LJ. Comparison of drug-coated balloons to bare metal stents in the treatment of symptomatic vertebral artery-origin stenosis: A prospective randomized trial. World Neurosurg 2021;154:e689-97.
11. Wang Z, Ling Y, Zhao H, Mao Y, Dong Q, Cao W. A comparison of different endovascular treatment for vertebral artery origin stenosis. World Neurosurg 2022;164:e1290-7.
12. Wityk RJ, Chang HM, Rosengart A, Han WC, DeWitt LD, Pessin MS, *et al*. Proximal extracranial vertebral artery disease in the New England medical center posterior circulation registry. Arch Neurol 1998;55:470-8.
13. Wu S, Yin Y, Li Z, Li N, Ma W, Zhang L. Using drug-coated balloons for symptomatic vertebral artery origin stenosis: A systematic review and meta-analysis. J Clin Neurosci 2023;107:98-105.
14. Zhou Z, Yin Q, Xu G, Yue X, Zhang R, Zhu W, *et al.* Influence of vessel size and tortuosity on in-stent restenosis after stent implantation in the vertebral artery ostium. Cardiovasc Intervent Radiol 2011;34:481-7.

How to cite this article: Ohgaki F, Tomura N, Shuto T. Percutaneous transluminal angioplasty for vertebral artery origin stenosis under the flow-reversal protection using Mo.MA™ Ultra: A technical case report. Surg Neurol Int. 2023;14:406. doi: 10.25259/SNI_746_2023