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Case Report

Steerable microcatheter for distal access of a giant cavernous carotid artery aneurysm during treatment with Pipeline Embolization Device: A case report and review of the literature

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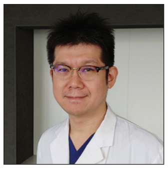

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ABSTRACT

Background: In the treatment of giant cerebral aneurysms with flow-diverting stents, access to the distal parent artery is critical but occasionally challenging. This article provides our experience with a novel steerable microcatheter in such a situation, as well as a review of the literature.

Case Description: A 73-year-old woman presented with right ptosis and external ophthalmoplegia. Magnetic resonance angiography revealed a giant right cavernous internal carotid artery aneurysm. Endovascular treatment was planned with flow diversion, but distal access was not possible using the standard technique. A 2.4-Fr steerable microcatheter, Leonis Mova Selective, was implemented, and by bending the catheter tip toward the distal parent artery, a guidewire could be guided distally. After the catheter exchange, two flow-diverting stents were deployed successfully.

Conclusion: Steerable microcatheters may provide an option in treatment with flow-diverting stents for giant cerebral aneurysms where access to the distal parent artery is compromised.

Keywords: Buddy-wire technique, Complication, Flow diverter, Intra-aneurysmal looping, Stent retriever

INTRODUCTION

In the treatment of giant cerebral aneurysms with flow-diverting stents, access to the distal parent artery is critical but occasionally challenging.[5,7,9]

Leonis Mova (Sumitomo Bakelite, Tokyo, Japan) is a novel steerable microcatheter that received approval in Japan in November 2022 for its use in the head and neck region. The angle of the tip can be changed by manipulating the handle and can be fixed at an optimal angle. In the present case, we used the Leonis Mova to access the distal parent artery of a giant cavernous internal carotid artery (ICA) aneurysm that could not be accessed using standard techniques and successfully treated it with a flow diverter.

This report describes the technical aspects of the use of a steerable microcatheter for giant cerebral aneurysms. In addition, an initial review of the literature on the clinical use of steerable

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microcatheters for intracranial vessels is presented. To the best of our knowledge, only three giant cerebral aneurysms have been treated with steerable microcatheters.

CASE PRESENTATION

A 73-year-old woman developed ptosis and external ophthalmoplegia of the right eye. Magnetic resonance angiography showed a giant right cavernous ICA aneurysm and endovascular treatment with flow diversion was planned. The patient was started on aspirin and clopidogrel one month before treatment.

Endovascular treatment

Under general anesthesia and after general heparinization, a 6-Fr guiding sheath (Fubuki Dilator Kit, 80 cm; Asahi Intecc, Aichi, Japan) was placed from the right femoral artery into the right cervical ICA. The aneurysm originated from the C4 portion of the right ICA, and the diameter of the dome was 27.6 × 25.1 mm [Figure 1a and f]. Both the distal and proximal parent arteries were incorporated into the aneurysm wall and were flattened and obstructed due to the mass effect. The distance between the inflow and outflow was 13 mm.

Using a 5-Fr Navien, 115 cm (Medtronic, Minneapolis, MN, USA) as an intermediate catheter, we attempted to guide a Phenom 27 (Medtronic) and Chikai 14, 200 cm (Asahi Intecc) into the distal parent artery using the standard technique. However, although the guidewire could be guided to the origin of the distal parent artery, it could not be guided further distally [Figure 1b and g]. Therefore, the Phenom 27 was exchanged for a Leonis Mova Selective, 150 cm [Figure 1c and h], and by bending the tip appropriately and keeping it directed toward the orifice of the distal parent artery [Figure 1d and i], the guidewire could be guided to the M2 portion of the middle cerebral artery [Figure 1e and j].

The Leonis Mova was exchanged for a Phenom 27 using a Chikai 14, 300 cm (Asahi Intecc). During this procedure, the tip of the Phenom 27 was stuck at the orifice of the distal parent artery due to the "ledge effect" and could not be guided [Figure 2a]. A Chikai 10, 200 cm (Asahi Intecc) was inserted in parallel with the Chikai 14 to resolve the snagging, and the Phenom 27 was guided distally [Figure 2b]. A 4.5 × 35 mm Pipeline Embolization Device Flex with Shield Technology (Medtronic) was deployed from the C2 to C4 segment, and a similar 4.5 × 25 mm stent was overlapped along the neck [Figure 2c]. Angioplasty was performed with a 7 × 7 mm Shouryu 2 HR (Kaneka, Osaka, Japan). Cone-beam computed tomography confirmed good apposition of the stent to the parent artery wall. Angiography showed an eclipse sign with an O'Kelly–Marotta Grading Scale score of A3. Blood flow in the distal ICA improved in comparison with before treatment.

The postoperative course was good, and the patient's ptosis began to improve on postoperative day 3. She was discharged on postoperative day 12.

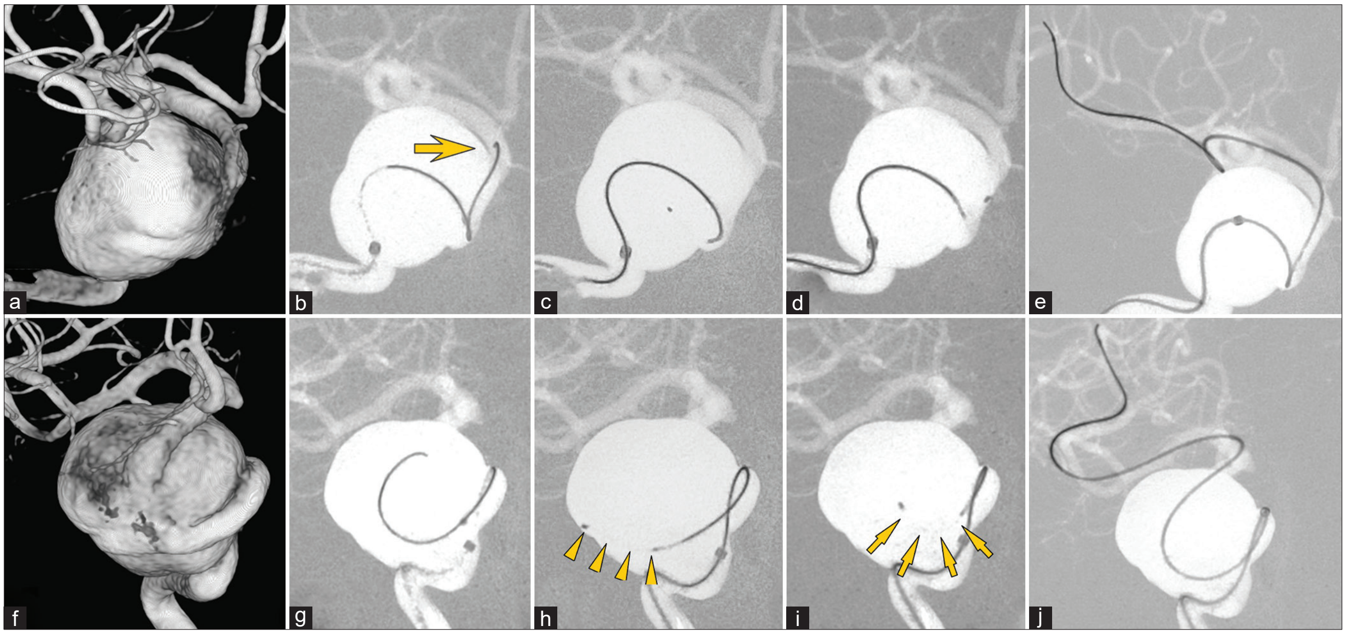

Figure 1: (a and f) Three-dimensional rotational angiography shows a giant right cavernous internal carotid artery aneurysm (27 × 26 mm). (b and g) A regular 0.017-inch microcatheter and 0.014-inch guidewire (arrow) can not be guided into the distal parent artery. (c and h) The neutral position of the Leonis Mova Selective (arrowheads). (d and i) By bending the tip of the Leonis Mova Selective toward the distal parent artery (arrows), the guidewire can be guided into the middle cerebral artery (e and j).

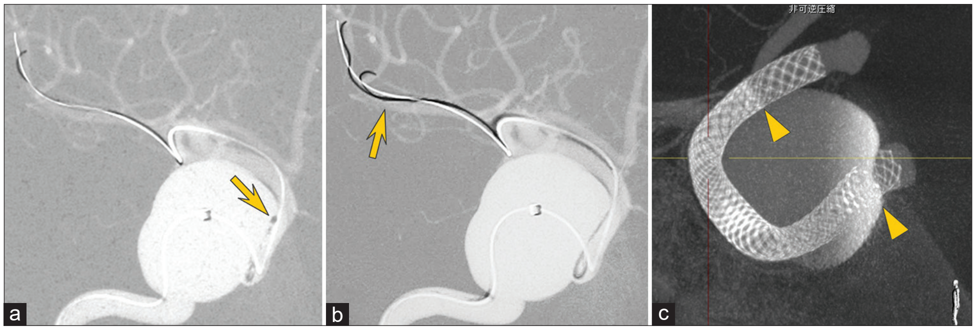

Figure 2: (a) When exchanging the Leonis Mova Selective for a 0.027-inch microcatheter using a 0.014-inch, 300-cm guidewire, the tip of the latter catheter (arrow) interferes with the orifice and cannot be advanced into the parent artery. (b) By introducing a 0.010-inch guidewire in parallel, the catheter can be guided to the distal parent artery. (c) Two flow diverters are implanted (arrowheads indicate the second stent).

DISCUSSION

Experience with Leonis Mova in giant cerebral aneurysms

In giant cerebral aneurysms, access to the distal parent artery can be difficult due to the unfavorable anatomy of the aneurysm, the acute branching angle of the parent artery, and the narrowing of the parent artery.[7] In the present case, a giant cavernous ICA aneurysm whose distal parent artery was difficult to access by standard techniques was treated with flow diversion using a novel steerable microcatheter, the Leonis Mova, to provide easy distal access. The tip of Leonis Mova can be bent 180° in both directions using two operating guidewires inside the catheter wall and can be locked at an optimal angle [Figure 3a-c]. There are three types of catheter – Selective, Standard, and High-Flow – with outer diameters of 2.0–2.4 Fr, 2.4–2.6 Fr, and 2.9–2.9 Fr, respectively, for which guidewires of up to 0.014 inch, 0.018 inch, and 0.025 inch, respectively, are compatible. In this case, the Leonis Mova Selective, with the smallest diameter, was used. Pretreatment *in vitro* simulation showed that the shape of the catheter tip was well maintained after insertion of 1–2 cm of a 0.014-inch guidewire [Figure 3d-f]. The control unit of the Leonis Mova Selective is larger than that of a regular microcatheter, and the catheter tip can be bent in both directions by rotating the dial [Figure 3g, dashed arrow]. The angle is fixed by pulling the stopper [Figure 3h, arrow]. On the other hand, the Bendit catheter can be bent at the tip by sliding the button while pressing it to unlock it.

To direct the catheter tip toward the parent artery orifice, it was necessary to rotate the Leonis Mova three-dimensionally, but the catheter did not have high torque transferability of its own. By rotating the Leonis Mova and guidewire while pulling them proximally as a single unit, the system was easily rotated. In addition, the aneurysm wall was used to limit the plane of movement of the catheter tip, making it easier to direct the tip toward the arterial orifice.

It is not recommended to bend the tip of the Leonis Mova with the guidewire in the tip; it is preferable to pull the guidewire back proximally before bending it. Except for the tip marker, the catheter tip is not highly visible. Therefore, the shape of the bent tip had to be estimated from the movement and direction of the tip marker, but this did not interfere with its actual use.

Review of previous reports on the use of steerable microcatheters for intracranial vessels

We searched PubMed using the keyword "steerable microcatheter" and found 57 reports. Among these were five reports of 42 cases using steerable microcatheters in the endovascular treatment of human intracranial vessels [Table 1].[1,2,4,6,8] There were no reports of the use of a Leonis Mova microcatheter. Killer-Oberpfalzer *et al.*[4] described three large or giant cerebral aneurysms (one basilar artery aneurysm treated with stent-assisted coil embolization and two cavernous ICA aneurysms with flow diverter implantation) and reported that the use of steerable microcatheters was useful for gaining access to the distal parent artery. Three cases of flow-diverting stent implantation for small or medium-sized aneurysms were also described.[4] In these six cases, the Bendit 21 (outer diameter 3.1 Fr, compatible with guidewires up to 0.018 inch) was used.

Access to the distal parent artery of giant cerebral aneurysms

Catheters for flow diverter deployment are relatively rigid, which limits their maneuverability. Therefore, if access to the distal parent artery is difficult, a catheter with a lower profile and higher maneuverability is first guided distally and then exchanged for a catheter designed for the flow diverter. However, catheter exchange carries the risk of vascular injury, distal wire perforation, and subarachnoid hemorrhage.[7]

Table 1: Summary of 43 reported cases in which steerable microcatheters were used for intracranial endovascular treatment.

Case	Author	Age/sex	Indication	Steerable microcatheter	Treatment
1	Devarajan *et al.*[2]	Adult/F	Left superior hypophyseal artery aneurysm	Bandit	WEB
2	Qiao *et al.*[6]	60 s/F	Left MCA aneurysm 6.6 × 5.9 mm	Bandit 21	WEB SL 5 × 3
3		60 s/F	Right ICA aneurysm 4.1 × 4.0 mm	Bandit 21	Coil embolization
4		60 s/F	Acute stroke, right M1 occlusion	Bandit 21	Aspiration, stentriever
5		80 s/F	The acute stroke left M2 occlusion	Bandit 21	Aspiration, stentriever
6		40 s/M	Acute stroke, right M2 occlusion	Bandit 21	Aspiration, stentriever
7		80 s/F	Right occipital AVM with large PCA aneurysm	Bandit 21	Flow diversion
8		40 s/M	Right subdural hematoma	Bandit 21	MMA embolization
9		80 s/M	Left ICA terminus occlusion	Bandit 21	Aspiration
10		60 s/F	Right V4 critical stenosis, symptomatic	Bandit 21	Balloon-mounted stent
11	Tokuyama *et al.*[8]	68/F	CS DAVF	Swift Ninja HF	TVE
12		70/F	TSS DAVF	Swift Ninja Standard, HF	TVE + TAE
13		76/F	TSS DAVF	Swift Ninja Standard	TVE
14		78/F	TSS DAVF	Swift Ninja Standard, HF	TVE + TAE
15		77/F	TSS DAVF	Swift Ninja Standard	TVE + TAE
16		58/F	SPS DAVF	Swift Ninja HF	TAE + TVE
17		73/F	TSS DAVF	Swift Ninja HF	TAE + TVE
18		71/M	TSS DAVF	Swift Ninja HF	TAE + TVE
19		80/F	CS DAVF	Swift Ninja HF	TVE
20		83/M	CS DAVF	Swift Ninja HF	TVE
21		49/M	TSS DAVF	Swift Ninja HF	TAE + TVE
22		60/M	TSS DAVF	Swift Ninja HF	TVE + TAE
23		70/M	TSS DAVF	Swift Ninja HF	TVE + TAE
24	Killer-Oberpfalzer *et al.*[4] (Case 24, 25: Berenstein *et al.*[1])	70s	Giant basilar aneusysm 23 × 27 mm	Bandit 21	Solitair stent, coil
25		50s	Giant cavernous ICA aneurysm 27 × 29 × 26 mm	Bandit 21	Flow diverter, coil
26		70s	Supraclinoid aneurysm 5 × 5.5 mm	Bandit 21	Silk vista 4.5 × 15 mm
27		40s	AVM	Bandit 21	Embolization with PHIL
28		60s	Aneurysm	Bandit 21	Contour 9 mm
29		70s	Carotid aneurysm 4.4 × 3.8 mm	Bandit 21	LVIS stent, Hydrosoft coil
30		40s	A1 aneurysm 5 × 7 mm	Bandit 21	Contour 9 mm
31		60s	Basilar aneurysm 5 × 5 mm	Bandit 21	Contour 7 mm
32		40s	Side-wall aneurysm 3.0 × 2.9 mm	Bandit 21	Contour 5 mm
33		50s	Ophthalmic aneurysm 2.5 × 1.5 mm	Bandit 21	Fred Flow Diverter 4.0 × 12/18 mm
34		60s	ACOM aneurysm 7 × 5 mm	Bandit 21	Coils, Contour 9 mm, 7 mm
35		70s	Cavernous aneurysm 17.1 × 22.3 mm	Bandit 21	Fred flow diverter 4.5 × 39/45 mm
36		30s	Two aneurysms: Right MCA and right ACOM	Bandit 21	Contour
37		50s	Basilar aneurysm 6.69 × 7.52 mm	Bandit 21	Silk Vista, Contour
38		60s	ACOM aneurysm 6 × 5 mm	Bandit 21	Contour
39		60s	AVM	Bandit 21	Coil Finish Barricade
40		60s	Aneurysm (6 × 4 mm) of the left cerebral artery at the temporal branch	Bandit 21	Leo Baby stent, Hydrocoil
41		70s	Aneurysm (7.6 mm)	Bandit 21	Hydrocoils
42		60s	Angioplasty	Bandit 21	Stent
43	Present case	73/F	Right giant cavernous ICA aneurysm 27 × 25 mm	Leonis Mova Selective	Pipeline 4.5 × 35 mm, 4.5 × 25 mm

ACOM: Anterior communicating artery, AVM: Cerebral arteriovenous malformation, CS: Cavernous sinus, DAVF: Dural arteriovenous fistula, HF: High flow, ICA: Internal carotid artery, LVIS: Low-profile Visualized Intraluminal Support device, MCA: Middle cerebral artery, MMA: Middle meningeal artery, PCA: Posterior cerebral artery, PHIL: Precipitating Hydrophobic Injectable Liquid, SPS: Superior petrosal sinus, TAE: Transarterial embolization, TSS: Transverse sigmoid sinus, TVE: Transvenous embolization, WEB SL: Woven EndoBridge SL

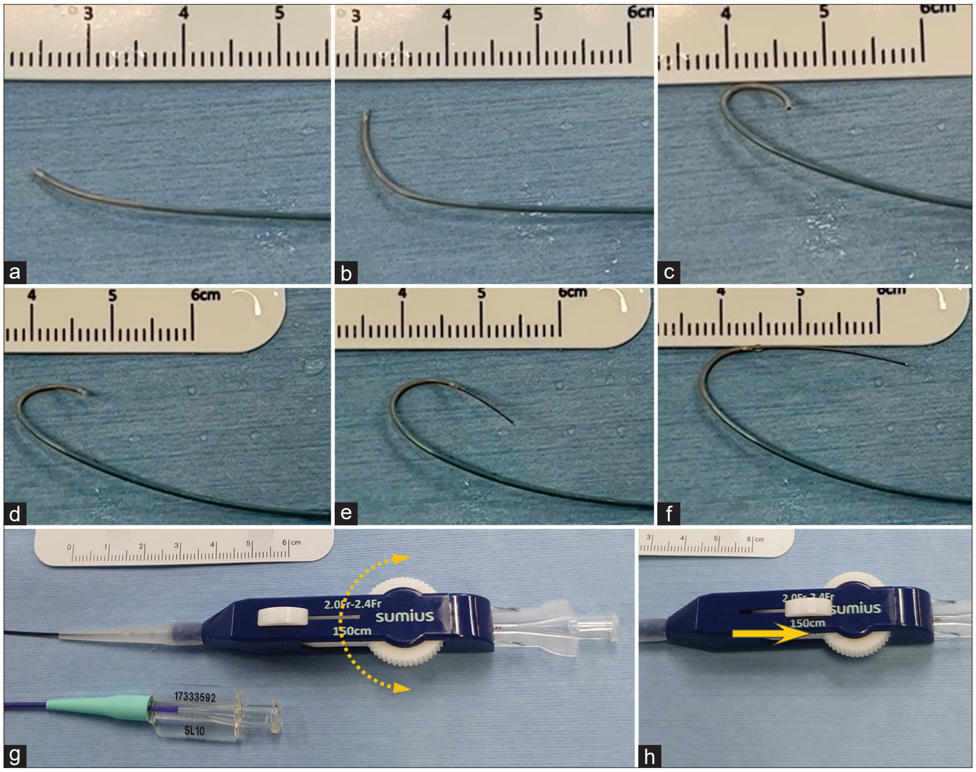

Figure 3: (a-c) The Leonis Mova Selective can be bent at the tip and locked in shape at any angle by manipulating the handle. (d-f) Compared to without a 0.014-inch guidewire, the catheter tip shape is maintained when the wire is advanced 1 cm and 2 cm. (g and h) The control unit is larger than that of a regular microcatheter. By rotating the dial, the catheter tip can be bent in both directions (dashed arrow), and it is fixed by pulling the stopper (arrow).

If access to the distal parent artery is still difficult, the guidewire and microcatheter can be looped within the aneurysm and guided to the distal parent vessel, after which the loop in the aneurysm is removed.[5,9] Several methods for anchoring the catheter tip during loop removal have been reported. Methods that do not require an additional device include rapid catheter withdrawal and manual aspiration with a syringe.[5] Some methods use assistive devices such as a balloon catheter or stent retriever to anchor the catheter tip.[5,7] However, stent retrievers are used off-label in Japan, which adds additional cost, and the length of the pushing wire is not long enough for catheter replacement, which may result in inadequate control. Moreover, there is potential for vascular injury where the stent retriever is deployed. The looping of the catheter inside the aneurysm itself may lead to complications arising from stress on the aneurysm wall.[5,9] Therefore, some clinicians recommend that a smaller-diameter catheter be looped and guided distally and that the catheter be exchanged after the loop is removed.[7,9]

In the present case, the Leonis Mova was guided directly into the distal parent artery without looping within the aneurysm and then exchanged for a catheter for the flow diverter. To reduce the risk during the catheter exchange maneuver, we attempted to introduce the intermediate catheter into the distal parent artery, but this was not possible due to the tortuosity of the proximal parent artery. Considering the stress on the aneurysm wall and distal artery, as well as maneuverability, we used the smaller-diameter Leonis Mova. Although larger-diameter devices are available, the safety of direct deployment of flow-diverting stents with the Leonis Mova has not yet been established.

Buddy-wire technique

Another problem in directing larger-diameter, stiffer catheters for flow diverter deployment is the "ledge effect," whereby the catheter tip snags at the distal parent artery orifice, preventing device navigation and potentially leading to serious complications due to unexpected device advancement. To avoid this, the "buddy-wire technique" has been reported, whereby the catheter is guided along two guidewires.[3] In the present case, a 0.010-inch guidewire was used along with a 0.014-inch guidewire during the catheter exchange to Phenom 27. A larger-diameter steerable microcatheter beforehand might allow catheter exchange with a larger-diameter guidewire. However, using two smaller-diameter guidewires may be advantageous in two ways: It is less invasive to the vessel, and the individual wires can be adjusted.

CONCLUSION

Steerable microcatheters may provide an option in the deployment of flow-diverting stents for giant cerebral aneurysms where access to the distal parent artery is compromised.

Ethical approval

The research/study approved by the Institutional Review Board at Junshin Hospital, number 2023-006, dated 2023/12/05.

Declaration of patient consent

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

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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. Berenstein A, Chapot R, Orion D, Barr JD, Cabiri O, Killer-Oberpfalzer M. Clinical and simulated experiences with the bendit articulating/steerable microcatheter in endovascular treatment: 2-dimensional operative video. Oper Neurosurg (Hagerstown) 2023;25:e36-7.
2. Devarajan A, Al-Kawaz M, Giovanni B, Tabani H, Shigematsu T, Fifi JT. Placement of an intrasaccular flow diverter in an intracranial sidewall aneurysm using the Bendit articulating microcatheter. J Neurointerv Surg 2023. Online ahead of print.
3. Dobrocky T, Lee H, Nicholson P, Agid R, Lynch J, Swaminathan SK, *et al*. When two is better than one: The buddy-wire technique in flow-diversion procedures. Clin Neuroradiol 2022;32:491-8.
4. Killer-Oberpfalzer M, Chapot R, Orion D, Barr JD, Cabiri O, Berenstein A. Clinical experience with the Bendit steerable microcatheter: A new paradigm for endovascular treatment. J Neurointerv Surg 2023;15:771-5.
5. Lagios K, Mantatzis M. Vacuum for straightening the microcatheter after intra-aneurysmal looping: The "Lagman vacuum" technique. Interv Neuroradiol 2019;25:438-41.
6. Qiao Y, Zhang YJ, Tsappidi S, Mehta TI, Hui FK. Initial clinical experience with the Bendit steerable articulating tip microcatheter for intracranial access and intervention. Interv Neuroradiol 2023. Online ahead of print.
7. Quäschling U, Kläver M, Richter C, Hamerla G, Mucha S, Scherlach C, *et al*. Flow diversion in challenging vascular anatomies: The use of low profile stent retrievers for safe and accurate positioning of the microcatheter. CVIR Endovasc 2020;3:19.
8. Tokuyama K, Kiyosue H, Hori Y, Okahara M, Nagatomi H, Asayama Y. Utility of a steerable microcatheter for the selective transvenous embolization of dural arteriovenous fistulas. J Neuroendovasc Ther 2023;17:153-8.
9. Wang CC, Lv N, Feng ZZ, Li ZF, Zhao R, Li Q, *et al*. Intra-aneurysmal microcatheter looping technique for stent-assisted embolization of complex intracranial aneurysms. Interv Neuroradiol 2015;21:580-4.

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