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Technical Note

Efficacy of the Insertion-support Guiding Catheter in Approaching Intracranial or Craniocervical Lesions in Patients with the Difficulty of Extracranial Trans-arterial Access

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Objective: We aimed to investigate the efficacy of the insertion-support guiding catheter (ISGC) for approaching target lesions during endovascular therapy in patients with severe atherosclerotic or tortuous arteries.

Case Presentations: The ISGC is an 8 Fr, JB2 shape, stiff-type, short guiding catheter. We used ISGC for 52 patients between April 2007 and March 2018, microcatheters or therapeutic devices were delivered to target lesions via ISGC in 46 (88.4%) of the 52 patients, and none of them developed associated complications. Herein, we present three representative cases.

Conclusions: An ISGC is useful for vascular intervention in patients with atherosclerotic or tortuous arteries.

Keywords ▶ insertion-support guiding catheter, endovascular therapy, atherosclerosis, tortuous vessels, thrombectomy

Introduction

Insertion of a regular guiding catheter to the target vessels for intracranial lesions is often difficult because of severe atherosclerosis or tortuous vessels. Furthermore, as anatomical factors, a steep arterial bifurcation from the aortic arch, or a gap between the origin of the brachiocephalic artery (BCA) and the top of the ascending aorta, such as in type 3 aortic arch, are also problems that cannot be ignored.

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To deliver a guiding catheter in such circumstances, we often use a different types of inner catheter, such as Simonds type or catheters with other tip shapes. The guidewire may also be changed to a stiffer type. In some cases, the turn-over technique at the aortic valve,[1)] exchange-technique with a long-type guidewire, or carotid-compression technique may be used with care.[2)] However, when the delivery of the guiding catheter fails, the approach is usually changed to via the brachial artery or common carotid artery (CCA). If this still fails, the therapy is regrettably often discontinued. Since 2007, we started to use the insertion-support guiding catheter (ISGC) (SEL-E guiding catheter; Medikit, Tokyo, Japan), prior to changing the puncture site under the conditions described above. ISGC enables introduction of an intermediate catheter to the target portion. We present the effectiveness and safety of the ISGC in patients with challenging extracranial trans-arterial access.

Case Presentations

Device Information

The features of the ISGC are as follows: 8 Fr, JB2 shape, stiff-type guiding catheter, outer diameter, 2.7 mm (8.0 Fr); inner diameter, 2.24 mm (0.088 inch); inner layer, polypropylene; outer layer, nylon; stainless steel braiding; platinum

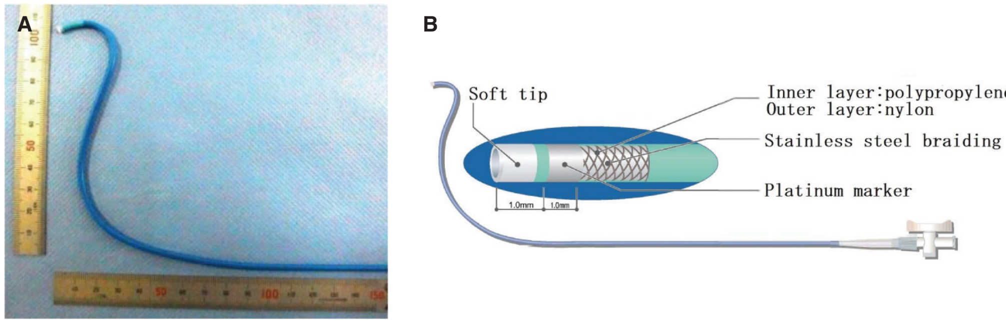

Fig. 1 (**A**) ISGC (SEL-E guiding catheter Medikit, Japan). (**B**) Illustration of the ISGC structure. ISGC: insertion-support guiding catheter

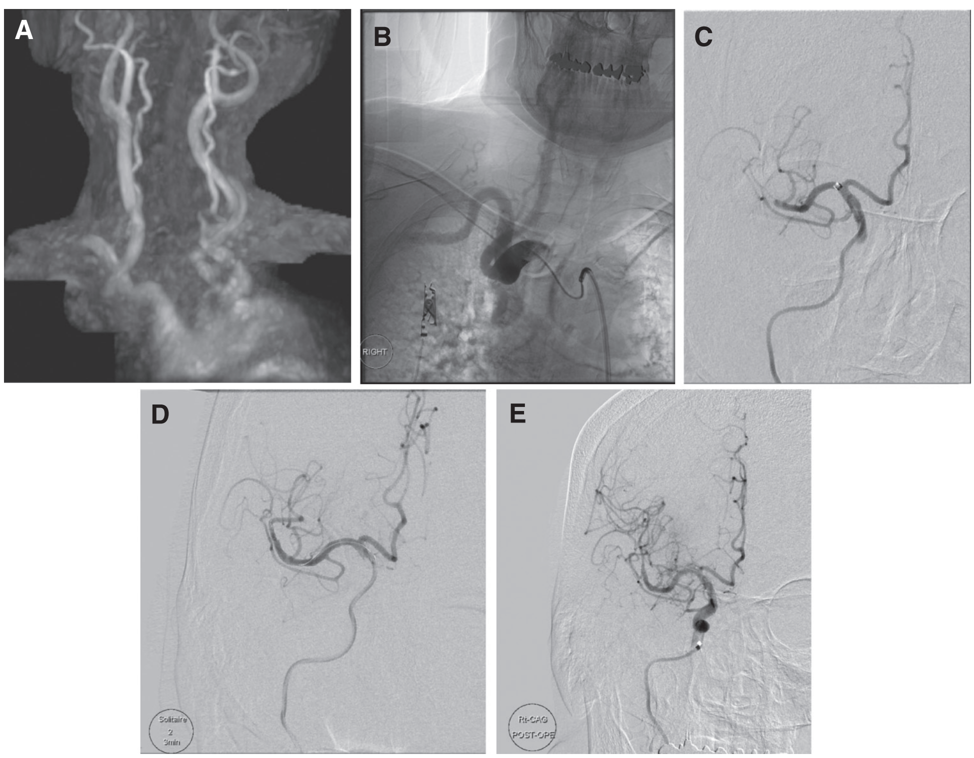

Fig. 2 (**A**) The cervical MR angiogram shows tortuous vessels and type 3 aortic arch. (**B**) The brachiocephalic angiogram shows tortuous brachiocephalic and proximal common carotid arteries. (**C**) The right internal carotid angiogram shows the right MCA inferior trunk occlusion. (**D**) After deploying a stent retriever. (**E**) The right internal carotid angiogram of the post-operation shows recanalization of the MCA. MCA: middle cerebral artery

marker; full length, 83 cm; and effective length, 75 cm (effective lengths of 70 cm and 80 cm were previously available, but now only 75 cm is available) (**Fig. 1A** and **1B**).

Case 1

An 83-year-old woman with a history of hypertension and angina presented at 4 hours after the sudden onset of dysarthria and paralysis of the left upper and lower limbs. Diffusion-weighted magnetic resonance imaging (DW-MRI) showed early ischemic changes in the right insular and frontal cortices. The right middle cerebral artery (MCA) inferior trunk was poorly visualized on MR angiograms. We initially attempted to insert a 9-Fr Optimo balloon-tipped guiding catheter (Tokai Medical Products, Aichi, Japan) with a 4-Fr JB2 diagnostic catheter and a 0.035-inch guidewire into the right internal carotid artery (ICA). However, a type 3 aortic arch, tortuous BCA, and CCA prevented insertion of the guiding catheter (**Fig. 2A** and **2B**). Switching the inner catheter to a 4-Fr Simmons type and applying the turnover technique were unsuccessful.

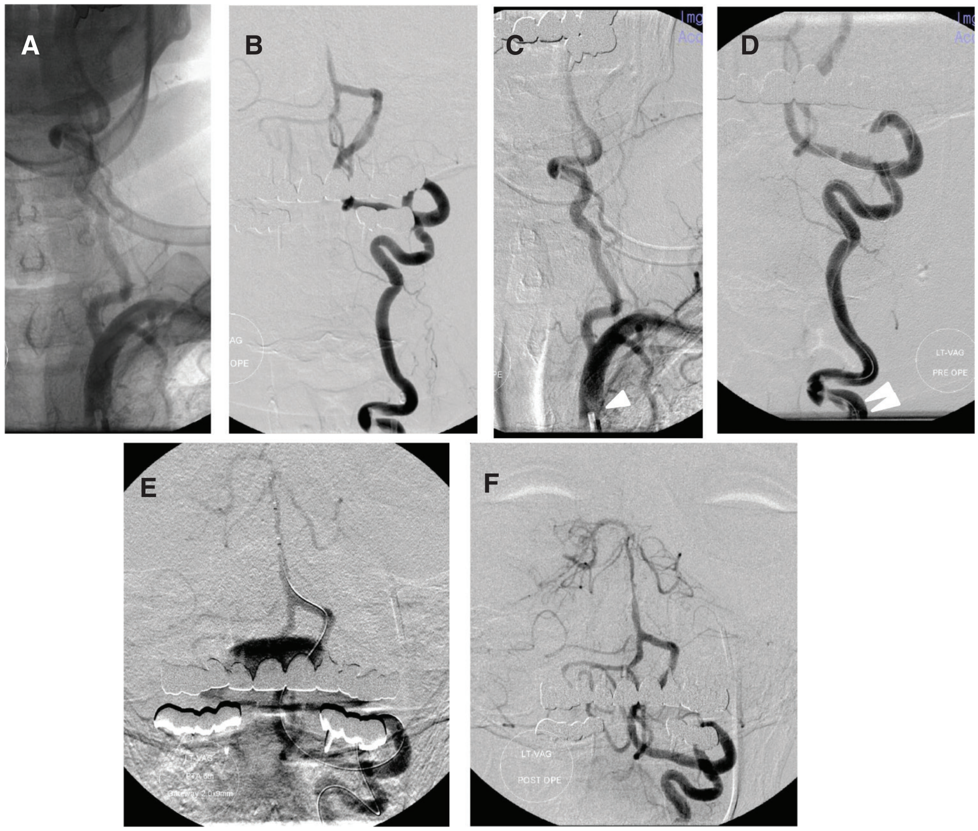

Fig. 3 (**A** and **B**) The subclavian angiogram shows highly tortuous left VA, and severe stenosis of the BA. (**C**) An ISGC is placed at the origin of the left SCA. Arrow head reveals the tip of the ISGC. (**D** and **E**) A 5Fr ENVOY guiding catheter is inserted to left VA through the ISGC. A PTA balloon catheter with a microguidewire is introduced to the lesion. Double arrow head reveals the tip of the 5Fr ENVOY guiding catheter. (**F**) The angiogram of the post-operation shows dilated BA. BA: basilar artery; ISGC: insertion-support guiding catheter; PTA: percutaneous transluminal angioplasty; SCA: subclavian artery; VA: vertebral artery

We could not even insert a guide wire. We then inserted an ISGC to the origin of the BCA with a 4-Fr JB2 catheter and a 0.035-inch guidewire. The ISGC allowed the smooth introduction of a Penumbra 5MAX ACE perfusion catheter (Penumbra, Alameda, CA, USA) as an intermediate catheter with a microcatheter and a microguidewire, into the right ICA (**Fig.2C**). Thereafter, a thrombus in the right MCA was removed using a stent retriever through the Penumbra 5MAX ACE (Solumbra technique)[3,4] (**Fig. 2D** and **2E**).

Case 2

A 62-year-old woman with a history of hypertension and brainstem infarction, presented at 5 days after the onset of gradually worsening dysarthria and a gait disturbance. DW-MRI revealed acute cerebral infarction in the right side of the pons. The basilar artery (BA) was poorly visualized on MR angiograms. Angiography revealed severe stenosis of the BA and a highly tortuous vertebral artery (VA) (**Fig. 3A** and **3B**). We initially placed a 5-Fr ENVOY (Cordis, Miami Lakes, FL, USA) guiding catheter into the left VA and attempted to reach the lesion by inserting a percutaneous transluminal angioplasty (PTA) balloon catheter with a microguidewire, but the 5-Fr ENVOY easily slipped. Therefore, we inserted an ISGC at the origin of the left subclavian artery (SCA) (**Fig. 3C**). Through the ISGC support, we inserted the 5Fr ENVOY into the left VA and manipulated the PTA balloon catheter to reach the lesion in the stenosed BA, which was subsequently dilated (**Fig. 3D–3F**).

Case 3

A 68-year-old man underwent coil embolization for an unruptured anterior communicating artery aneurysm under general anesthesia. An initial attempt to place a 4-Fr Asahi-Fubuki guiding sheath (Asahi Intecc Co. Ltd., Aichi, Japan) failed because of a type 3 aortic arch, tortuous BCA, and CCA (**Fig. 4A**). We thus inserted an ISGC at the BCA origin

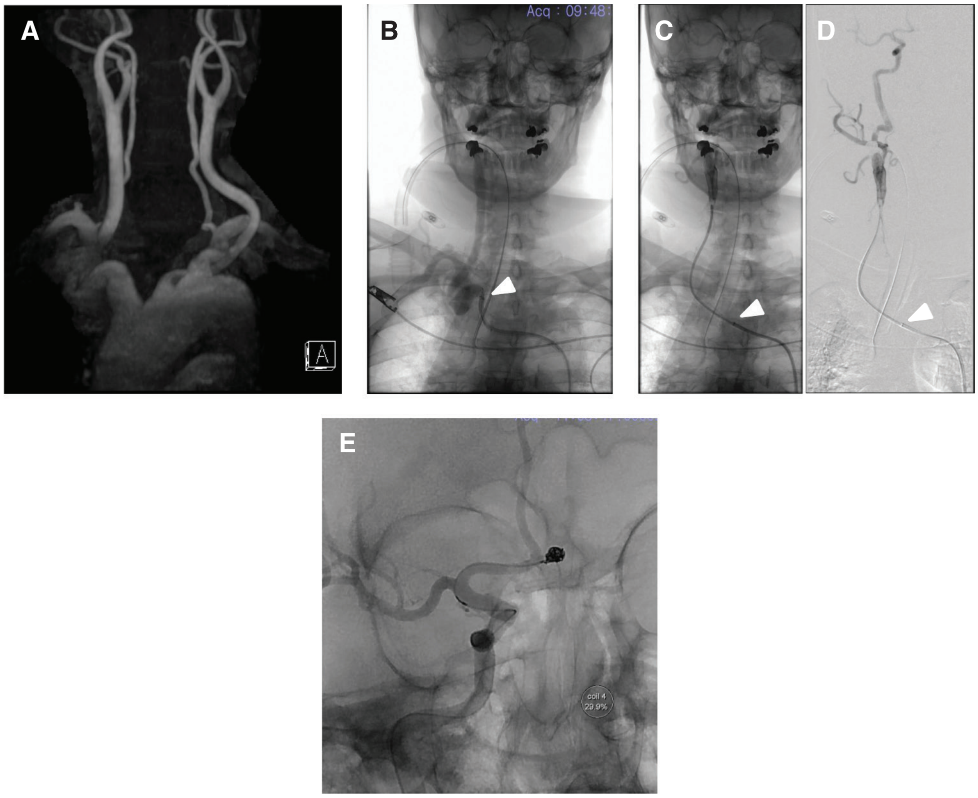

Fig. 4 (**A**) The cervical MR angiogram shows tortuous vessels and type 3 aortic arch. (**B**) The brachiocephalic angiogram shows tortuous brachiocephalic and proximal common carotid arteries. (**C** and **D**) 6-Fr Asahi-Fubuki 110-cm guiding catheter is inserted to right CCA through the ISGC. Arrow head reveals the tip of ISGC. (**E**) The aneurysm is simply embolized using a microcatheter. CCA: common carotid artery; ISGC: insertion-support guiding catheter

(**Fig. 4B**), which allowed smooth insertion of a 6-Fr Fubuki 110-cm guiding catheter into the right ICA. The aneurysm was then simply embolized using a microcatheter (**Fig. 4C–4E**).

The results of 52 cases are summarized in **Table 1** and the inner catheters we used are shown in **Table 2**.

Discussion

Recently, the development of distal access catheters (DAC) such as Penumbra has advanced. We developed a short and easy-to-operate ISGC to strongly support the induction of DAC at the bifurcation of the aortic arch. The ISGC is shaped like the JB2 to match the shape of the aortic arch. We tried a steeper tip angle, but as a result, it turned out that the current tip angle had stronger support. Introducing an ISGC is relatively simple. Using a 0.035-inch wire and a 4- to 6-Fr regular catheter as the guide, we introduce the ISGC tip at the distal side of the target vessel. The 0.035-inch wire and the 4- to 6-Fr regular catheter are then removed, and the ISGC is pulled back to the appropriate proximal portion. The ISGC is positioned at the origin of the BCA, left CCA, or left SCA. It usually takes only a few minute. Using the ISGC as a stable guiding catheter, an intermediate catheter, such as a 6-Fr catheter or Penumbra 5MAX ACE, can be smoothly inserted into a proximal vessel such as the CCA, or an ICA that is located near a target vessel, and the target lesion is approached using a microcatheter, balloon catheter for PTA, a Penumbra for the direct aspiration first pass (ADAPT) technique,[5–7] or a stent retriever. As an inner catheter, experientially, Penumbra 5MAX ACE, 6Fr Fubuki, and 4.2Fr Fubuki can be introduced smoothly. A soft type inner catheter appears to be compatible.

New devices such as stent retrievers or the Penumbra system have markedly improved outcomes from endovascular therapy of ischemic stroke.[8–10] However, we often encounter cases in which we have to discontinue endovascular therapy because the guiding catheter cannot be inserted. In such cases, the ISGC becomes a powerful option. The result of our series showed a high rate (88.5%) of reaching the final target lesion using ISGC and none of them developed associated complications. In acute reperfusion therapy,

Table 1 Patients' characteristics and clinical outcome

Type of EVT	Acute reperfusion therapy	PTA or PTAS	Coil embolization	Total
Cases, n(%)	31 (59.6)	13 (25.0)	8 (15.4)	52 (100)
Age, years, median (range)	83 (48–93)	73 (57–86)	74.5 (68–84)	79 (48–93)
Male sex, n (%)	13 (41.9)	6 (46.2)	0 (0.0)	19 (36.5)
Aortic arch, n (%)				
Type1	2 (6.5)	0 (0.0)	0 (0.0)	2 (3.8)
Type2	10 (32.3)	4 (30.8)	3 (37.5)	17 (32.7)
Type3	19 (61.5)	9 (62.2)	5 (62.5)	33 (63.5)
Bovine, n (%)	3 (9.7)	1 (7.7)	0 (0.0)	4 (7.7)
Vessel ISGC placed, n(%)				
BCA origin	16 (51.6)	6 (46.1)	7 (87.5)	29 (55.8)
Left CCA origin	7 (22.6)	5 (38.5)	1 (12.5)	13 (25.0)
Left SCA origin	8 (25.8)	2 (15.4)	–	10 (19.2)
Target lesion, n (right/left)				
CCA	1 [-/1]	1*1 [-/1]	–	2 (3.8)
ICA	6 [5/1]	1*2 [1/-]	2 [2/0]	9 (17.3)
MCA M1	7 [4/3]	4 [-/4]	2 [2/0]	13 (25.0)
MCA M2	2 [1/1]	1 [0/1]	–	3 (5.8)
Acom	–	–	3	3 (5.8)
SCA	–	1 [1/0]	–	1 (1.9)
VA	–	3 [2/1]	1 [1/-]	4 (7.7)
BA	15	1	–	16 (30.8)
BCA	–	1	–	1 (1.9)
Arrival rate to the lesion, n (%)	26 (83.9)	12 (92.3)	8 (100)	46 (88.5)
Success of procedure, n (%)	17 (54.8)*3	12 (92.3)	8 (100)	37 (71.2)
Intracranial hemorrhage, n (%)				
Symptomatic	2/26 (7.7)	–	–	2 (3.8)
Asymptomatic	6/26 (23.1)			6 (11.5)
Complications related to SEL-E, n (%)	0	0	0	0 (0.0)

Acom: anterior communicating artery; BA: basilar artery; BCA: brachiocephalic artery; CCA: common carotid artery; ICA: internal carotid artery; MCA: middle cerebral artery; SCA: subclavian artery; VA: vertebral artery *1 Left CCA origin *2 Right ICA origin
*3 TICI≥2b

Table 2 Type of intermediate catheters

Type of EVT	Acute reperfusion therapy	PTA or PTAS	Coil embolization	Total
Intermediate catheter, n				
Envoy				
5 Fr	1	1	–	2
6 Fr	3	1	2	6
Slim guide				
6 Fr (115 cm)	1	1	–	2
Launcher				
5 Fr (90 cm)	–	1	1	2
6 Fr (90 cm)	1	–	1	2
6 Fr (100 cm)	–	2	–	2
Fubuki				
4 Fr (sheathless 90 cm)	1	–	–	1
6 Fr (110 cm)	5	4	4	13
4.2 Fr (120 cm)	1	–	–	1
4.2 Fr (130 cm)	2	–	–	2
Penumbra 5Max ACE	9	–	–	9
Without intermediate catheter	2	2	–	4
Unsuccessful procedure	5	1	–	6

the therapeutic time window is limited, and this technique is effective in such conditions. Especially in cases with large-vessel occlusion in the posterior circulation, the ADAPT technique with Penumbra has been reported as effective.[11,12] ISGC has good compatibility with Penumbra. If necessary, combined utilization with the stent retriever is also possible in procedures such as the Solumbra technique. In PTA/PTAS, to approach the final lesion, support by the guiding catheter is sometimes necessary. ISGC can support other devices. Also for coil embolization, we can utilize the balloon assist technique using a 6-Fr intermediate catheter.

Using ISGC, if necessary, a guiding catheter can be replaced with another. In this situation, we insert a regular catheter such as a 4-Fr JB2 distally through the ISGC, and exchange the guiding catheter using a long stiff wire. Neuro EBU (Medtronic, Dublin, Ireland) can be used in the same way. In our limited experience, an ISGC is easier to insert and position than the Neuro EBU. However, the Neuro EBU might offer more support when a patient has a significantly larger gap between the BCA bifurcation and the top of the aortic arch.

Changing the puncture site might be effective for some patients. However, this method is more laborious, maneuvers are unfamiliar, and risk of dissection or hematoma is increased even under ultrasound guidance, particularly when a highly sclerotic CCA is punctured. In view of this, using the ISGC as the first strategy is reasonable. If an ISGC does not succeed, we consider approaches via the brachial artery using a Simmons catheter, which can be successful, depending on the structure of the blood vessels. This approach is effective for treating patients with abdominal aortic aneurysms, stenosis or occlusion of the iliac artery, and post-artificial blood vessel replacement or post-bypass surgery for such blood vessels.

A few disadvantages of the utilization of the ISGC should be described. First, we need to use a sheath no less than 8 Fr. Second, usual microcatheter or PTA balloon catheter will be short when a long inner catheter such as Penumbra is used together. A longer catheter such as Velocity (Penumbra, Alameda, CA, USA) microcatheter and Unryuu PTA balloon catheter (Kaneka, Tokyo, Japan) can resolve this problem. Lastly, ISGC as a stiff-type guiding catheter may be worried about the destruction of soft plaque at the aortic arch and increase distal emboli. However, in our experience, there is no apparent difference on the DWI-MR findings after operations between an ISGC and normal guiding catheters.

Limitations

This study was based on retrospective data, limited experience from a single center, and a relatively small cohort. In future, prospective analysis seems mandatory to confirm the safety and efficacy of this technique and this device.

Conclusion

The ISGC enables smooth insertion of an intermediate catheter and allows delivery of a microcatheter or other therapeutic device to the final target lesion with an excellent rate (88.5%), even in cases with severe atherosclerotic or tortuous extracranial arteries. This device and technique will be one of the most effective methods in patients with severe vascular conditions for access.

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Disclosure Statement

The authors declare that there is no conflict of interest.

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