A Novel Technique of Safe and Versatile Microguidewire Shaping with Neuroendovascular Therapy: Modified Pigtail Method

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Objective: A tip shape of a microguidewire that is safe and highly versatile in coil embolization of cerebral aneurysms was evaluated.

Case Presentations: Case 1: A 65-year-old woman with subarachnoid hemorrhage due to rupture of an anterior communicating artery aneurysm which was coil-embolized 7 years before. The aneurysm recanalized and regrew thereafter, and an additional embolization was performed. Angiography before treatment showed 50% stenosis at the origin of the right internal carotid artery (ICA). In addition, the A1 of the right anterior cerebral artery divided from the ICA at a relatively sharp angle. Therefore, the tip of the microguidewire was shaped to a modified pigtail. With this single tip shape, the wire and microcatheter could be safely guided to the anterior communicating artery aneurysm, and satisfactory coil embolization could be achieved. Case 2: A 68-year-old woman with right hemiplegia had a sudden onset of occlusion of the M2 superior trunk of the left middle cerebral artery and underwent thrombectomy. A microguidewire with a tip shaped into a modified pigtail could cross the lesion safely through the occluded segment with no distal view of the course of the vessel. The thrombus was retrieved using a stent retriever, and thrombolysis in cerebral infarction (TICI) 3 could be achieved.

Conclusion: This microguidewire tip shaping technique is considered to be safe and effective in various phases of endovascular treatment.

Keywords ▶ endovascular treatment, shaping, microguidewire

Introduction

There have been reports concerning shaping of the tip of the microcatheter for intracranial endovascular treatment,¹ ² ³ but we could find no reports of the evaluation of the tip shape of microguidewires. The shaping of the microguidewire, which is inserted before introduction of the microcatheter, is also considered to be important. We devised the modified pigtail method for shaping of the tip of the microguidewire to be used in the selection of cerebral vessels. Since the modified pigtail shape is advantageous as the tip shape can be adjusted according to the length exposed from the microcatheter, ensures high catheter trackability, and is considered to be relatively safe in case of its erroneous entry into aneurysmal blebs, we employ this method as the first choice for many patients. The results of evaluation of this method are reported.

Case Presentations

Case 1
A 65-year-old woman developed subarachnoid hemorrhage due to rupture of an anterior communicating artery aneurysm 7 years before. The Hunt & Kosnik grade was II, and the Fisher grade was 2. On the day of the onset, she underwent endovascular coil embolization. The postoperative course was uneventful, and the patient was followed...
was maintained at 200 sec or longer by intravenous administration of heparin. An 8F Cello (Medtronic, Minneapolis, MN, USA) was advanced to the right common carotid artery, a 4F Fubuki (Asahi Intecc, Aichi, Japan) and XT17 straight microcatheter (Stryker, Kalamazoo, MI, USA) were coaxially guided to the distal ICA using a Chikai 14 microguidewire (Asahi Intecc), the tip of which was up as an outpatient. In the present episode, an aneurysmal recanalization and regrowth was noted in the follow-up study, and endovascular retreatment was scheduled. Angiography performed before treatment showed 50% stenosis at the origin of the right internal carotid artery (ICA). An 8F short sheath was inserted via the right femoral artery under local anesthesia. The activated clotting time (ACT)
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shaped into a modified pigtail (Fig. 1). While 50% stenosis was noted at the origin of the right ICA (Fig. 2A), the microguidewire with its tip shaped into a modified pigtail could be advanced intracranially by safely passing the plaque area without being blocked by the narrow segment of the proximal ICA (Fig. 2B). The A1 of the right anterior cerebral artery divided relatively sharply from the end of the right ICA (Fig. 2C), but the microguidewire with a modified pigtailed tip could be easily advanced to A1 (Fig. 2D) and trailed directly by the microcatheter (Fig. 2E). Thereafter, the microcatheter was inserted into the aneurysm, and the complete occlusion was achieved by placing six detachable bare platinum coils. No perioperative complication was noted.

Case 2
A 68-year-old woman suddenly developed consciousness disturbance, right hemiplegia, and conjugate deviation to the left with a National Institute of Health Stroke Scale (NIHSS) of 30 points. A diagnosis of an embolic left middle cerebral artery occlusion was made on the basis of MRI findings, and thrombectomy was started 3 hours after the onset. Under local anesthesia, a 9F short sheath was inserted via the right femoral artery. The ACT was maintained at 250 sec or longer by intravenous administration of heparin. A 9F Cello (Medtronic, Minneapolis, MN, USA) was advanced to the left ICA. On the left ICA angiography, occlusion of the M2 superior trunk of the left middle cerebral artery was demonstrated (Fig. 3A). A Penumbra 5MAX ACE (Penumbra, Alameda, CA, USA) and a Marksman (eV3 Covidien, Irvine, CA, USA) were introduced to the left middle cerebral artery with guidance by a Chikai 14 microguidewire with its tip shaped into a modified pigtail. Because of the pigtail tip of the microguidewire, it could be advanced safely without erroneously entering a small vessel because of the pigtail shape of its tip. (D) A–P view of the left internal carotid arteriogram after retrieval of the thrombus with a stent retriever demonstrating a complete recanalization of the M2 superior trunk of the left middle cerebral artery could be recanalized.
Validation using a silicone tube model

The performance of the microguidewire and microcatheter at sharp bifurcations was examined using a silicone tube model. It was assumed that the aneurysm was located beyond the bifurcation and that the microguidewire could not be advanced to a position sufficiently distal to the aneurysm. A Headway 17 microcatheter (Terumo, Tokyo, Japan) with the terminal 5 mm shaped at 45° was combined with a Chikai 14 microguidewire (Asahi Intecc). When the terminal 5 mm of the microguidewire was shaped at 90°, the catheter escaped toward the parent artery at sharp bifurcations and could not trail the microguidewire (Fig. 4). However, when the tip was shaped into a modified pigtail, the pigtailed tip acted as an anchor, and the microcatheter could follow the guidewire without bending distally toward the parent artery (Fig. 5).

Discussion

In coil embolizations of cerebral aneurysms, it is extremely important to safely guide a microcatheter to an appropriate location in the aneurysm. Although there have been some reports concerning the shape of the microcatheter, those focusing on the shape of the microguidewire have been few. For the safety of the microguidewire, its tip is required to have a shape that prevents its unintended entry into perforating branches or blebs of the aneurysm or reduces the risk of their perforation if it has erroneously entered them. For the versatility of the microguidewire, high vessel selectivity is required. Therefore, for our modified pigtail method, the proximal part of the tip is shaped at 135° to allow the guidewire to adapt to all angles (Fig. 1). Thus, the modified pigtail tip of the guidewire can prevent an erroneous entry into perforating branches and blebs of the aneurysm and provide an anchoring effect and microcatheter trackability, in addition to the high vessel selectivity because of a property of double-angle shape. Because of the combination of these features, the catheter can be guided to the aneurysm with a single guidewire (Fig. 6).

A microguidewire with a modified pigtail shape is considered to have the supportability sufficient to ensure trailing of the microcatheter even into vessels that divide sharply, because the relatively rigid shaft part of the microguidewire can be applied to the vascular bifurcation by shaping the flexible tip into a pigtail. This supportability is expected to prevent mal-direction of the catheter and mitigate the ledge effect between the vascular wall and the catheter. In securing the M1 and A1, which divide sharply from the ICA, and P1 of the posterior cerebral artery, which divides sharply from the basilar artery, the proper vessel can be safely selected, and trailing of the microcatheter can be facilitated because of the pigtail tip and the 135° curve of the microguidewire. The modified pigtail method is also useful for thrombectomy in the ultra-acute period of cerebral infarction. When a stent retriever is used, it is necessary to allow the microguidewire to pass through the occluded vessel, which is not delineated by angiography, but a microguidewire with the modified pigtail shape can be safely advanced across the lesion even in blood vessels that are invisible distally to the lesion because of the pigtail shape of its tip. The selection of the vessel and safe guiding of the microcatheter to the occluded part of the vessel across the lesion are considered possible without using multiple microguidewires.
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Fig. 5  Behavior of a modified pigtail microguidewire in a silicone tube model. (A) The tip of the microguidewire selects a branch at a sharp bifurcation. (B) The microguidewire advanced when it is pushed in with a slight torque. (C) The pigtail tip is unlikely to enter a perforating branch. It also provides an anchoring effect. (D) The microcatheter can follow the microguidewire without misguiding to the antegrade direction.

Fig. 6  Schematic illustration of the modified pigtail method. (A) With a microguidewire with a tip shaped at 90°, the microcatheter advanced toward the opposite. (B) A microguidewire with a tip shaped into a modified pigtail provides an anchoring effect, at the vascular bifurcation, because the rigid part of the wire can secure the tracking of the microcatheter even through sharp curves. (C) The angle at the tip can be changed in accordance with the length of the tip outside of the microcatheter. ICA: internal carotid artery
We have also previously reported a method of intentionally rotating a microcatheter for stent placement in a large basilar artery aneurysm and re-treatment of stented carotid lesions using the modified pigtail guidewires. The modified pigtail guidewire was proved to be safe and effective in both the procedures.4,5

A limitation of this method is that some experience is necessary for shaping a modified pigtail. If the tip of the guidewire is shaped into an excessively narrow pigtail shape, an introduction of the microguidewire to the hub of the microcatheter may become difficult. In addition, while a modified pigtail can be applied to microguidewires other than Chikai, the thin shaper attached to Chikai is convenient for the shaping. The advent of preshaped products is also awaited. This shape is not necessary in all patients, and the indication of this technique should be evaluated individually in actual clinical practice.

Conclusion

Microguidewires with a pigtail tip and a 135° curve in the proximal portion were described with case reports. This shaping method is considered to be safe and effective in various phases of endovascular procedures.

Disclosure Statement

The first author and all of the coauthors have no conflicts of interest to disclose concerning this paper.

References