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Original Article

A novel approach using Neuron 6F guiding catheter for the embolization of intracranial aneurysm with coiling of the parent internal carotid artery

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Abstract: To describe our initial experience and early outcomes with distal placement of the Neuron 6F guiding catheter through coiled ICA for aneurysmal EVT. We examined the utility of the Neuron[f] 70 6F guiding catheter for the embolization procedure in such cases, fourteen cases of aneurysm with coiling of the parent ICA are presented via traditional guiding catheters. With the support of 8F ENVOY guiding catheter as a shuttle sheath, the Neuron™ 70 6F guiding catheter was successfully placed through coiled extracranial ICA, so the mirocatheter could be delivered to a more strategic position for embolization of the aneurysm. Coiling of extracranial ICA was found as parent artery on angiogram in all patients with ruptured aneurysms. Even where there were two curvatures of more than 360° in the coiled segment of the ICA, Neuron™ 70 6F guiding catheter could be placed through the coiling to a distal position and enabled EVT of intracranial aneurysms with no related neurological complications. Neuron guiding catheter is a useful device for embolization of aneurysm where there is coiling of parent ICA, easily placed through the coiling of the ICA and provided robust anatomical support via enhanced catheter-to-vessel wall engagement.

Keywords: Coiling of internal carotid artery, endovascular treatment, intracranial aneurysm, Neuron guiding catheter

Introduction

Morphological variations of the cervical internal carotid arteries (ICA) have been reported as coiling, looping, kinking, or tortuosity of the vessels [5, 10, 13]. Abnormalities of the ICA are common, although their etiology remains unknown. Extreme tortuosity, which we define here as a circular morphology of an over 360°turn in the extracranial ICA on angiogram, is a considerable clinical challenge where endovascular treatment (EVT) is necessary, particularly for intracranial aneurysm [2, 5, 8, 15]. As the ICA is the typical route for anterior circulation aneurysm embolization, a coiled segment within the ICA interferes with the placement of a conventional guiding catheter distal to it so that suitable positioning of the microcatheter is often unattainable [1, 2, 8]. Therefore, aneurysms that present with a coiled parent ICA are nearly impossible to resolve with a conventional coil embolization procedure, and patients must undergo more invasive procedures. The recent design of the Neuron guiding catheter, with a distal flexible and soft tip, presented a possible solution for negotiating coiling of the ICA and delivery of the microcatheter to a more advantageous position for the embolization procedure in these patients. In this article, we describe our initial experience and early outcomes with distal placement of the Neuron 6F guiding catheter through coiled ICA for aneurysmal EVT.

Materials and methods

From October 2010 to October 2012, fourteen patients with ruptured aneurysms, in which coiling of ICA was apparent on angiogram, underwent EVT. Of the fourteen patients, nine were women and five were men whose average age was 61 years (range 34-78 years). Tortuosity of

Table 1. Clinical data of patients

Patients	Age	Gender	Pathology	Side of lesion	Aortic Arch	Catheter position/ Tip of Neuron	Treatment	Compli-cation
1	75	F	PCoA-AN	Right	Type II	Petrous segment	Double microcatheter Em	None
2	67	F	AchA-AN	Right	Type II	Petrous segment	Stent assisted coil Em	None
3	56	M	AcoA-AN	Left	Type III	Petrous segment	Coil Em	None
4	72	M	PCoA-AN	Left	Type II	Petrous segment	Double microcatheter Em	None
5	61	F	AchA-AN	Right	Type III	Petrous segment	Stent assisted coil Em	None
6	70	F	A_1-AN	Right	Type II	Petrous segment	Double microcatheter Em	None
7	46	M	McA-AN	Left	Type II	Petrous segment	Coil Em	None
8	66	F	AcoA-AN	Right	Type III	Petrous segment	Stent assisted coil Em	None
9	34	F	PCoA-AN	Right	Type I	Petrous segment	Coil Em	None
10	51	F	PCoA-AN	Right	Type III	Petrous segment	Coil Em	None
11	78	M	PCoA-AN	Left	Type II	Petrous segment	Double microcatheter Em	None
12	71	F	MCA-AN	Right	Type III	Petrous segment	Coil Em	None
13	54	M	PCoA-AN	Right	Type II	Petrous segment	Coil Em	None
14	65	F	AcoA-AN	Right	Type III	Petrous segment	Stent assisted coil Em	None

AchA, Anterior choroidal artery; AN, Aneurysm; Em, Embolizatio; AcoA, Anterior communicating artery; PCoA, Posterior communicating artery; A, Anterior artery.

the aortic arch was also associated with coiled extracranial ICA in these patients. The femoral artery was punctured with an 8F sheath (TURMAO), and an 8F ENVOY guiding catheter (Cordis) was then used as a shuttle sheath to the proximal segment of the parent ICA bifurcation. Subsequently, a Neuron 6F 0.070 inch inner luminal diameter guiding catheter was advanced through the coiled ICA by a 0.035 angled glidewire (TURMAO). A microcatheter (Echlon-10, Covidien, or Headway, Microvention) was delivered into the aneurysm sac through the Neuron 6F inner lumen. The EVT procedure was then performed as per convention. Clinical data was obtained including sex, age, side of the coiling of the ICA, type of aortic arch, position of the guiding catheter placement, responsible aneurysm, treatment strategy, and complications. The aortic arch anomalies were classified according to Ivan P. Casserly's manual [3]. The basic features and clinical data of the patients are presented in **Table 1**.

Results

All ruptured aneurysms with coiling of the parent ICA were confirmed by neuroimaging and angiography (**Figure 1A-D**). Anomalies of the aortic arch were detected in 13/14 cases on angiogram; 7/14 cases were classified as type II and 6/14 cases as type III. For the first two cases with coiled parent ICA, we tried to advance the Neuron 6F guiding catheter along a 0.035 inch angled glidewire, but we failed as the guiding catheter buckled and folded back in the tortuous aortic arch. Therefore, an 8F ENVOY guiding catheter was used as a shuttle sheath up to the proximal bifurcation segment of the parent ICA, so that subsequently, the Neuron 6F guiding catheter would easily advance, even through the coiling of the ICA to the distal end (**Figure 2A**). This tri-axial technique as developed in the first two cases was applied to place the Neuron 6F guiding catheter for the next twelve cases. Transient ICA vasospasm occurred in two of these patients during placement of the Neuron 6F guiding catheter. After treatment of the symptoms, vasospasm of the parent ICA was relieved, and the embolization was successfully performed through the path of the Neuron 6F guiding catheter (**Figure 2B**). No significant complications, related to placement of the Neuron 6F guiding catheter through coiled segments of the ICA, occurred in any patient (**Figure 3**).

Discussion

As the routine path for EVT of a variety of intracranial vascular diseases, morphology and anomaly of the aortic arch and the carotid artery on angiogram are always a particular focus for the neuroradiologist. The etiology of specific abnormalities, such as coiling of the ICA, remains unknown and may be congenital or secondary to atherosclerotic changes. They

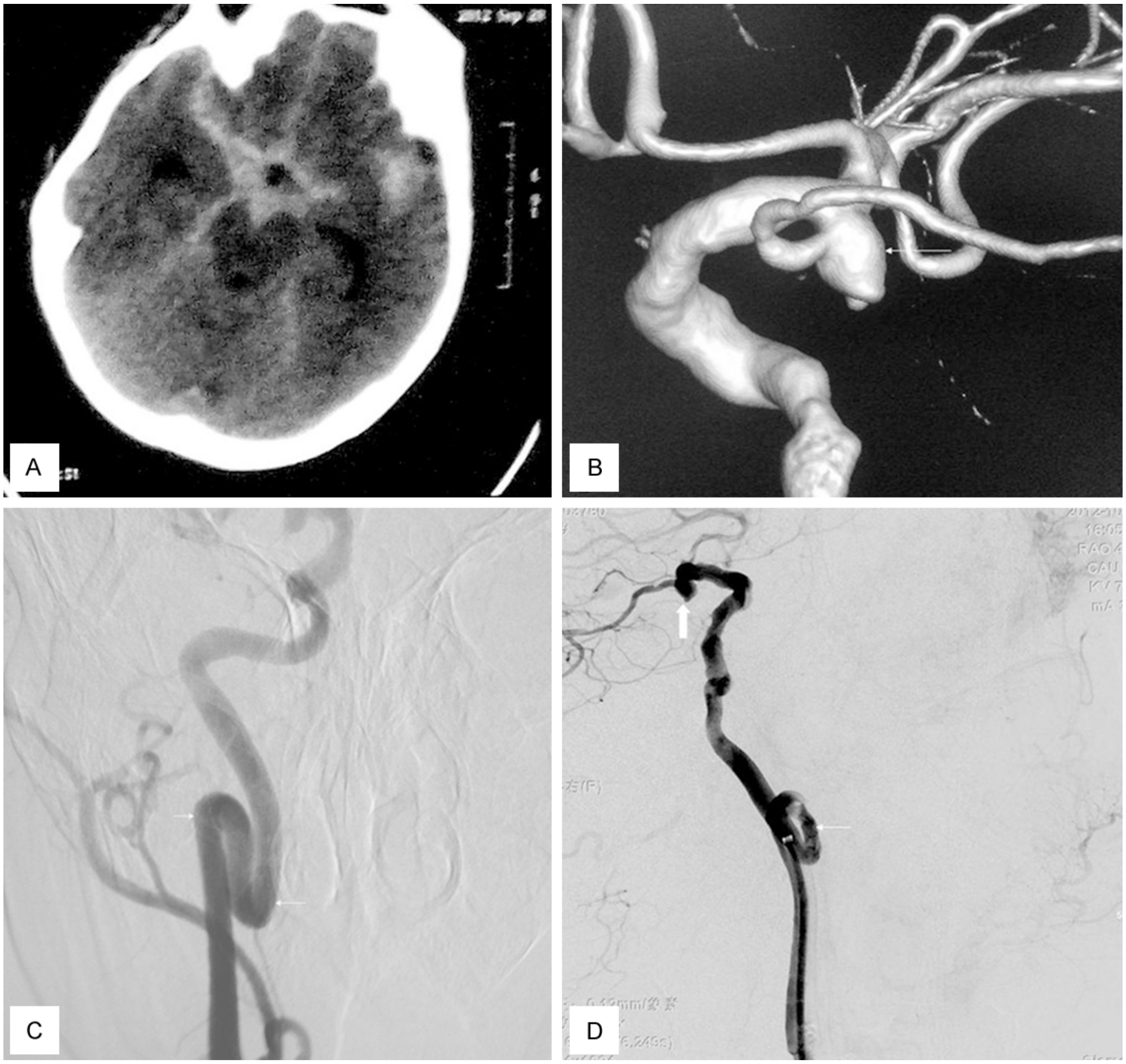

Figure 1. Preoperative CT and angiograms of aneurysms and anomalies of the ICA. A. CT scan showing the suprasellar cistern full of blood and the right Sylvian cistern with more extensive hemorrhage than the left; B. CTA showing an aneurysm located in the PcoA segment with a relatively wide neck (arrow); C. Preoperative angiography of the innominate artery revealing an "S" shaped curvature in the extracranial ICA in the A-P view (arrow); D. Preoperative angiography in a simulated working project revealing coiling of the extracranial ICA (small arrow) and a PcoA-aneurysm with a relatively wide neck just as the above CTA image (big arrow).

present specific challenges clinically that may or may not be compatible for EVT especially when combined with intracranial aneurysm [5, 13].

Some authors have already addressed the difficulty of EVT and proposed some strategies for patients with marked tortuosity of the aortic arch and/or carotid artery in conjunction with intracranial aneurysm [1, 2, 8, 12, 13, 15]. In our study, patients with ruptured aneurysms in which the parent artery presented with greater than 360° coiling of the external ICA, 13/14 cases were accompanied by an anomaly of the aortic arch of type II or type III. EVT performed on such cases was particularly challenging for several reasons [1, 15, 8]. Firstly, we had to provide the Neuron 6F guiding catheter with additional support in order to achieve sufficient stability so that it would not fold back in the tortuous aortic arch. Secondly, it was essential for successful microcatheterization that the guiding catheter completely passes through the coiling of the ICA. Finally, without a distal position for the guiding catheter across the coiling of the ICA, microcatheter manipulation was

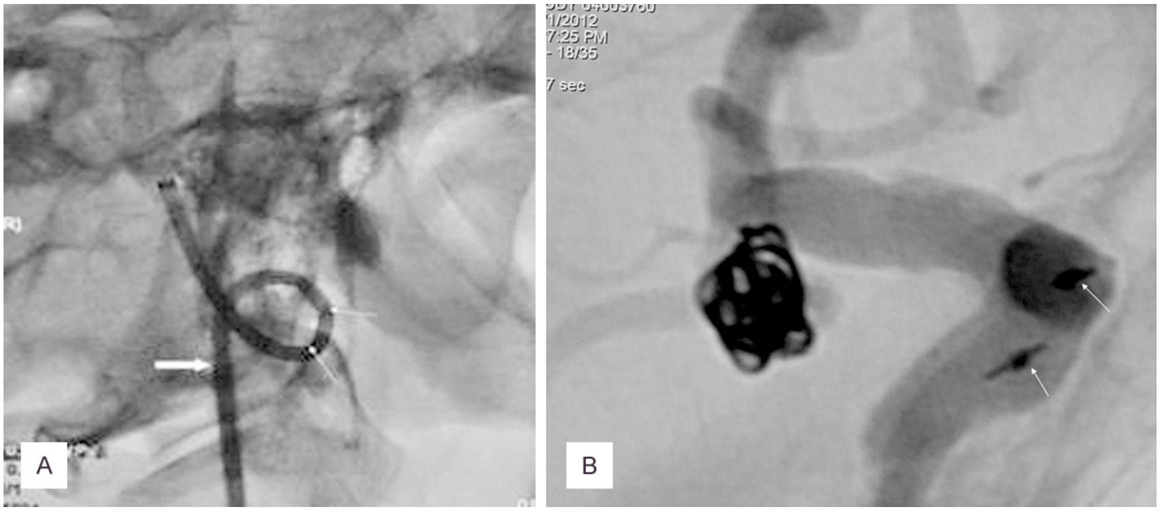

Figure 2. Fluorscopic image of Neuron 6F guiding catheter and microcatheter positioning. A. A fluoroscopic image of a working project demonstrating the Neuron 6F guiding catheter placement through the coiling of extracranial ICA up to the Petrous segment. In this case, some slight angulated distortions occurred in response to placement of the Neuron 6F guiding catheter (small arrows). The distal tip of the 8F ENVOY guiding catheter, used as a shuttle sheath, is shown proximal to the coiling (big arrow); B. Fluoroscopic image showing how the double microcatheter technique was utilized intraoperatively. The proximal marks of the double mirocatheters and the end marks of two unreleased coils are shown (small arrows).

Figure 3. Fluoroscopic image of an aneurysm after embolization. A fluoroscopic image showing that the aneurysm was successfully occluded by coils (arrow), and that the parent artery and its distal branches remained intact after withdrawal of microcatheters.

more difficult due to the added friction between the microcatheter and the wall of the ICA coiling. Unanticipated movement of the microcatheter may occur, such as a sudden lurch forward or a perforation of the aneurysm sac, which could then trigger severe sequelae [4]. Many endovascular methods have been applied to deal with the added difficulty of tortuous vessels, such as including a rigid glidewire for more support for the guiding catheter or modification of the guiding catheter itself [4, 6, 8]. Under these circumstances, the conventional guiding catheter, which was designed with a relatively stiff tip and inherent shape retention, was not compatible with EVT. These methods were almost useless when employed to resolve ruptured aneurysms where the parent ICA was coiled. Therefore, we believe that the Neuron 6F guiding catheter maybe an effective alternative. According to the manufacturer, the novel device was designed not only with a thin, soft distal tip that possesses good flexibility, but also with a stainless steel braided tip that retains the shape of the inner lumen. The Neuron 6F guiding catheter is, therefore, capable of negotiating very tortuous vascular anatomy as well as providing a good working path for subsequent microcatheter manipulation [4, 7, 11].

For a skilled neuroradiologist, negotiating a Neuron 6F guiding catheter through such coiling of the ICA is relatively straightforward. However, there were some difficulties to overcome initially because of its longer length and longer distal flexible tip, which are different from the conventional guiding catheter. In the first two patients, the Neuron 6F guiding catheter easily buckled or folded back in the tortuous aortic arch when we tried to advance it without added support. Even when we placed the guiding catheter up to the proximal segment of the coiled ICA or inserted a rigid glidewire over the coiling of the ICA, the Neuron 6F guiding catheter still failed to be advanced across the affected segment. In the end, an 8F ENVOY guiding catheter was utilized as a shuttle sheath. This tri-axial technique was then applied to smoothly advance the Neuron 6F guiding catheter across the coiling of ICA alongside the 0.035 glidewire. This approach sufficiently stabilized the Neuron 6F guiding catheter so that the coiled ICA could be effectively navigated. In fact, the tip of the guiding catheter was still in its original position, even upon completion of the embolization (**Figure 3**). Although other studies had suggested that we use the Neuron 6F guiding catheter to have more distal access to the intracranial vessels for a more unrestricted microcatheterization, their experiences were primarily based upon cases where the catheter was passed through a tortuous ICA or intracranial vessels but without coiling [7, 9, 11, 12, 14]. We found it impossible to reach a distal position over the coiling of parent ICA without an 8F ENVOY guiding catheter as a shuttle sheath as it provided support that was essential for the proper placement of Neuron 6F guiding catheter.

Although the guiding catheter seemed highly compatible with the coiling of the ICA, there were still some slightly angulated distortions that occurred after we placed the catheter across the coiling of the ICA. In one patient, the distortions induced by the catheter were thought to have narrowed or even closed the lumen, creating conditions that were insufficient for smooth advancement of the microcatheter to the distal end. However, we still utilized the double microcatheter technique or stent assistance for the EVT. Even in this patient, both microcatheters could still be advanced and smoothly withdrawn through the inner lumen of guiding catheter (**Figure 2B**). In the series of patients with aneurysms, in addition to the aged and women who accounted for most of the cases, many patients (8/14 cases) were complicated cases that required the double microcatheter technique or stent application. The advantage of the 0.070 inch inner luminal diameter Neuron guiding catheter is that a microcatheter and balloon or stent are capable of being placed within it, and we were still able to simultaneously perform intra-procedural roadmapping and real time angiography [4].

Our goal was to take advantage of the development of modern endovascular techniques and devices, in order to avoid more invasive strategies that can be used to resolve this medical dilemma. Some clinicians have directly punctured the tortuous ICA or even performed surgery of the area instead of EVT [2, 15, 16]. Direct puncture of the ICA did resolve the condition in some patients, but the approach is relatively unusual for a neuroradiologist to perform and often led to dissection, local hematoma, as well as other complications [2, 8]. In comparison, we did not find typical intra-operative or post-operative complications caused directly by the utilization of the Neuron 6F guiding catheter coupled with EVT. Similar results have been reported by other groups [4, 7, 14].

In our study we found that the Neuron 6F guiding catheter was a safe and effective device for the coil embolization of intracranial aneurysms where there is coiling of the parent ICA. Just as reported, the catheter provided us with viable alternatives to treat patients who would otherwise not be candidates for EVT [4, 7, 9, 11, 14]. Our results are, however, based on a limited number of cases, and therefore, a larger study with more cases as well as long term follow-up are essential.

Acknowledegments

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Disclosure of conflict of interest

None.

Abbreviations

ICA, internal carotid artery ICA; EVT, endovascular treatment.

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