A Novel Technique for Microcatheter Additional Shaping During Intracranial Aneurysmal Coil Embolization: Microcatheter Shaping Cast

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Abstract

Background: When a shaping mandrel is inserted into the tip of a preshaped microcatheter, the existing curve becomes uncertain because the tip is straightened by the inner mandrel. Therefore, we developed a way to perform microcatheter shaping by means of an external cast, which we named "microcatheter shaping cast." **Techniques:** A shaping mandrel attached to a microcatheter was used and coiled 4–5 times around a metallic introducer, which was attached using a microguidewire. Then, a stent-like handmade cast was prepared. After the microcatheter tip was inserted into the cast, it was manually bent according to the aneurysmal shape and size. The tip and cast were heated with a hot air gun. We evaluated the relationship between degrees of bending and heating time to achieve appropriate right-angled shaping memory. **Conclusions:** The presented microcatheter shaping method should be more useful than conventional internal shaping, especially in cases that require an additional microcatheter shaping or reshaping during aneurysmal coil embolization.

Keywords: *Coil embolization, intracranial aneurysms, microcatheter*

Introduction

In coil embolization of intracranial aneurysms, it is very important to guide the microcatheter to an appropriate site in the aneurysm and then stabilize it there.[1-3] Especially, in parasellar internal carotid artery aneurysms, three-dimensional complicated shaping of the microcatheter tip is often required, and various methods and techniques have been reported.[4-8] Moreover, reshaping of the microcatheter tip is occasionally required in some difficult cases. When a typical shaping mandrel is inserted into the tip of the preshaped microcatheter, the location and direction of the existing curve become unclear because the tip is turned straight by the inner mandrel. Consequently, we cannot perform the desired accurate three-dimensional shaping.

In this technical note, we present a novel approach for microcatheter shaping by means of a handmade external cast, which is named the "microcatheter shaping cast" (MCSC). We discuss the utility of our method.

Materials and Methods

In this study, we used SL-10 microcatheters (Stryker Neurovascular, Kalamazoo, MI, USA) and Headway 17 microcatheters (Terumo, Tokyo, Japan). At first, we assumed that an SL-10 preshaped 90° microcatheter required additional shaping on the proximal side after the initial attempt to guide it into the aneurysm failed. When a typical shaping mandrel was inserted into the tip of the SL-10 preshaped 90° microcatheter, the location and direction of the existing curve became unclear because the tip was turned straight by the inner mandrel [Figure 1]. Therefore, the MCSC was used. A shaping mandrel attached to a microcatheter was used and coiled 4–5 times around a metallic introducer, which was attached with a Traxcess microguidewire (Terumo) [Figure 2]. Then, the stent-like handmade cast was prepared. After the tip of the microcatheter was inserted into the cast, it was manually bent according to the aneurysmal morphology [Figure 3]. We typically use a patient-specific vascular model created using a three-dimensional printer. The microcatheter tip and cast were heated with a hot air gun (Bosch, Gerlingen, Germany). The microcatheter in the MCSC was set at 3 cm from the nozzle of the hot air gun, which had a temperature of 130°C. We then evaluated the relationship between the degrees of

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bending in the MCSC and heating time sufficient to achieve right-angled retention of the microcatheter tip.

Results

Figure 4 shows the process from the straight tip to the most favorable right-angled shape. In the MCSC, the degree of bending was approximately 135° before heating. Using the hot air gun at 130°C, the proper exposure time of the microcatheter tip was confirmed for 30 s. We determined that the appropriate degrees of bending and heating exposure time for achieving an appropriate right-angled tip were 135° and 30 s for both the SL-10 and Headway 17 straight microcatheters.

Discussion

The importance of guiding the microcatheter to the desired site and stabilizing it in an aneurysm cannot be overly emphasized.[1-3] Some authors have reported the characteristics of various microcatheters, differences in responses to steam shaping, and techniques to guide a microcatheter into the aneurysms. Especially, in parasellar internal carotid artery aneurysms, three-dimensional complicated shaping of the microcatheter tip is often required, and a variety of methods, including shaping under three-dimensional angiography, shaping using a three-dimensional printer, and *in vivo* printing methods, have recently been reported.[4-8] When the initial attempt to guide the microcatheter into the complicated aneurysm fails, reshaping of the microcatheter tip is occasionally

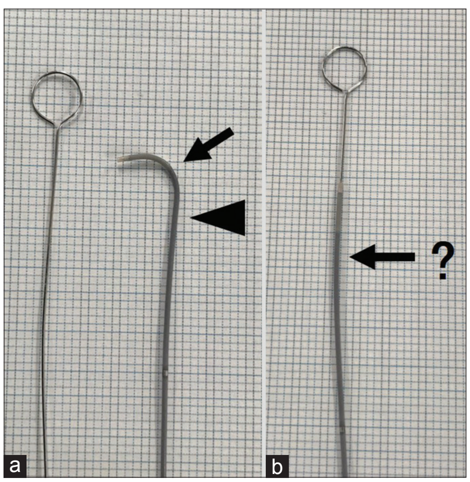

Figure 1: (a) Photograph of a preshaped microcatheter (right side) and a shaping mandrel attached to the microcatheter (left side). The black arrow indicates the preexisting angle. The black arrowhead indicates the site where we want to create a three-dimensional shape. (b) When the mandrel is inserted into the microcatheter tip, the site and direction of the preexisting memory become lost (black arrow)

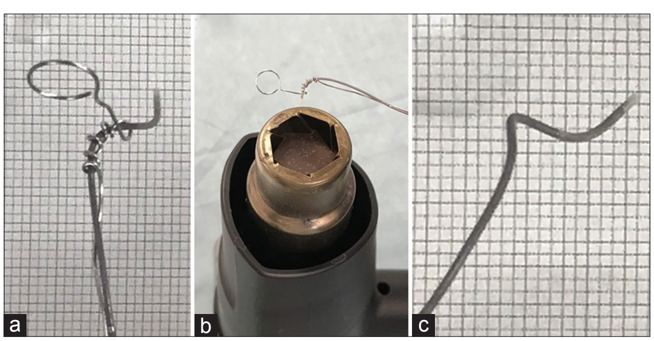

Figure 3: (a) After the tip of the preshaped microcatheter is inserted into the cast, it is manually bent according to the aneurysmal morphology. (b) The tip and cast are heated over a hot air gun. (c) The three-dimensional shaped tip is shown

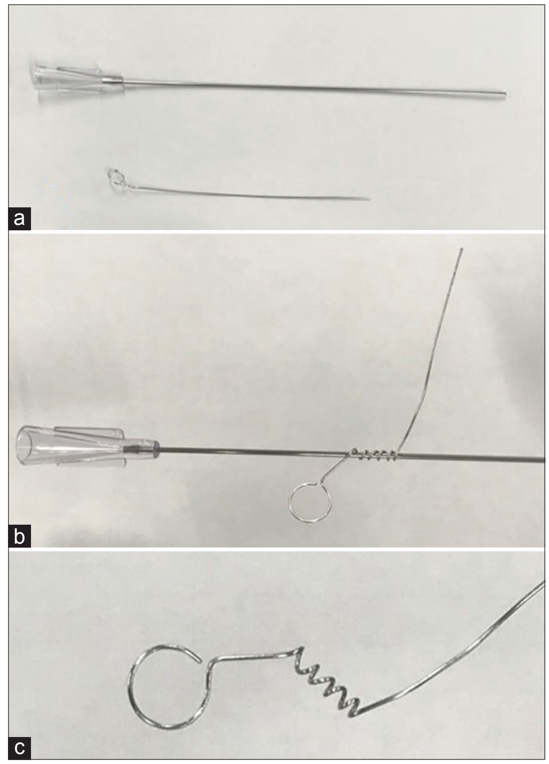

Figure 2: (a) Photograph of a wire introducer (upper side) and a shaping mandrel (lower side). (b) The mandrel is manually coiled 4–5 times around the introducer. (c) Photograph of the microcatheter shaping cast

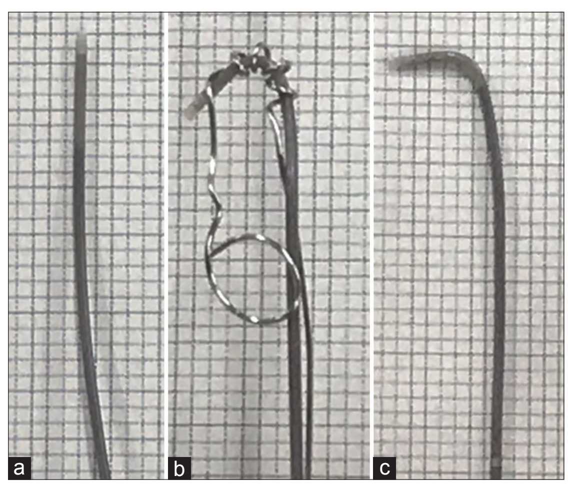

Figure 4: (a) Photograph of a straight microcatheter. (b) The microcatheter is inserted into the cast and bent at an approximately 135° angle before heating. (c) Photograph of the microcatheter after heating. The exact right-angled shape is achieved

required. In those situations, typical shaping mandrels are inadequate because of location and direction problems when they encounter the inner mandrel. And then, we cannot make an accurate three-dimensional shaping we want. To the best of our knowledge, no previous report has discussed methods to reshape microcatheters. Therefore, we sought to develop a method that can shape a microcatheter externally.

Previously, external microcatheter shaping using an *in vivo* printing method to make a small loop using the operator's fingers has been reported.[8] Although the method can create a rough shape, it is hard to make a precise shape. Moreover, the operator must be able to withstand the heat from steam or an air gun. In contrast, the MCSC provides the ability to shape fine curvatures and keep the operator's fingers away from hot air. One of the most concerning problems with the MCSC is collapse of the inner lumen. Our study proved that the inner lumens were not collapsed up to the rectal angle by the MCSC; however, when the tip required a sharp angle, the inner lumens sometimes became stuck. We recommend that a microguidewire should be inserted into the microcatheter before performing the MCSC to prevent collapsing the inner lumen. Using our heating conditions, the tip of microcatheters turned white, powdery, and bubbled when heated for >60 s. This phenomenon appeared to be caused by excessive water loss from the nylon. We confirmed that the retaining rectal angled shape was sufficient after 30 s of heating.

This study had some limitations. First, making the handmade cast requires specific skills. It is difficult to create a fine catheter shape when the pitch of the spiral is too wide or too close. Second, because only one shaping mandrel is attached to each microcatheter, repeat shaping cannot be performed. Third, the degrees of bending might be affected by room temperature and humidity. Fourth, excessive heating could damage a microcatheter and prevent subsequent use. Finally, the most difficult and critical point is how to know the appropriate catheter shape, not how to make it for experienced physicians. Almost experienced physicians can make the appropriate catheter shape from the nonreshaped microcatheter at the initial attempt. However, we believe that this technique is useful for physicians who want to make an additional microcatheter shaping or reshaping for the target aneurysm.

We presented a method to achieve microcatheter shaping by means of a handmade external cast. The method has been more useful than conventional internal shaping using an inner mandrel, especially in cases that required an additional microcatheter shaping or reshaping during aneurysmal coil embolization.

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Conflicts of interest

There are no conflicts of interest.

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