New angled fenestrated clips for fusiform vertebral artery aneurysms

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New angled fenestrated clips are introduced for surgery of certain difficult aneurysms. Their usefulness was proven in two cases of fusiform vertebral artery aneurysms. The aneurysms were obliterated, new parent arteries were reconstructed, and the inclusion of adjacent vital nerves and vessels in the clips was avoided. Technical problems associated with the application of these clips are discussed.

KEY WORDS fusiform aneurysm vertebral artery aneurysm clip vasa vasorum

Surgery of vertebral artery aneurysms presents two difficult problems. The first is the narrow operative field surrounded by the medulla and lower cranial nerves, and the second is the high incidence of fusiform aneurysms. Wrapping a fusiform aneurysm in this location with muscle or muslin is difficult because of the limited surgical space and the many adjacent vital structures. In many cases, only partial coating of the aneurysm or proximal ligation of the vertebral artery is achieved.1, 4 Our newly designed fenestrated clip with angled blades* makes it possible to obliterate many of these fusiform aneurysms.6 We report two cases in which these clips were used to obliterate aneurysms that could not otherwise be clipped successfully.

Case Reports

Case 1

This 58-year-old man suffered a subarachnoid hemorrhage (SAH). Preoperative angiography showed a fusiform aneurysm of the right vertebral artery, spherical in shape (Fig. 1 left). Two months after SAH, with the patient in a prone position under halothane general anesthesia, this aneurysm was clipped under controlled temporary hypotension induced by trimethaphan (Arfonad). Two clips were used in this case (Fig. 2 right); a straight fenestrated clip with the fenestrated part 5 mm in diameter and the straight blades 9 mm long, and a right-angled clip with blades 7.5 mm long forming an angle of 90° with the fenestrated portion, which was 5 mm in diameter. First, the straight fenestrated clip was inserted in between the posterior inferior cerebellar artery (PICA) and the aneurysm. During this procedure, the hypoglossal nerve was included within the fenestrated portion of the clip together with the parent artery (Fig. 2, Clip A). Then, in order to obliterate the remaining part of this aneurysm, the right-angled fenestrated clip was applied (Fig. 2, Clip B). The postoperative angiogram (Fig. 1 right) demonstrated successful obliteration of the part of the dome that was considered to have ruptured. Except for a transient hypoglossal paresis, the postoperative course was uneventful.

Case 2

This 48-year-old man complained of ipsilateral hemifacial spasm. Angiography revealed an unruptured aneurysm in the left vertebral-PICA region. The patient was operated on in the prone position via left suboccipital hemicraniectomy. Although the preoperative angiograms had suggested that clipping of the

*Fenestrated Sugita clips manufactured by Mizuho Ikakogyo Co., Ltd., Hongo 3-29-10, Bunkyo, Tokyo, Japan.
Fusiform vertebral artery aneurysm

Fusiform vertebral artery aneurysm

FIG. 1. Case 1. Lateral views of right retrograde brachial angiograms before and after surgery.

FIG. 2. Case 1. Schematic drawings of operative views. The fusiform aneurysm of the right vertebral artery was obliterated using straight (A) and angled (B) fenestrated clips.

aneurysm neck would be possible (Fig. 3 left), at surgery a fusiform aneurysm was found. The first clip was applied to the distal portion of the fusiform aneurysm to construct a new parent artery (Fig. 4, Clip A). This clip was a straight fenestrated clip having a fenestration 5 mm in diameter and straight blades 9 mm long. The second clip, which was a right-angled fenestrated type with blades 7.5 mm long and a 5 mm-diameter fenestration, was placed on the portion of the aneurysm that appeared to form the neck of the aneurysm on the preoperative angiograms (Fig. 4, Clip B). During application of the second clip, the glossopharyngeal and vagus nerves were spared from clipping by the L-shaped blades being slipped under them. The remaining proximal dome was obliterated using an oblique-angled fenestrated clip with a fenestration 5 mm in diameter and blades 5 mm long (Fig. 4, Clip C). This third clip was inserted from the side of the newly formed parent artery to override the blades of the second clip. After clipping the aneurysm, Gel-
FIG. 3. Case 2. Anteroposterior views of left vertebral angiograms before and after surgery.

FIG. 4. Case 2. Schematic drawings of operative views. One straight (A) and two angled (B and C) fenestrated clips were used.
Fusiform vertebral artery aneurysm

FIG. 5. Technical explanation of reconstruction of a parent artery from a large fusiform aneurysm. Left: X–X’: an opened distance of about 13 mm between the blades of an angled fenestrated clip is required in order to construct a parent artery 5 mm in diameter. Y–Y’: the actual maximal opening distance of the largest angled clip is only 8 mm. Right: Our recommended method. A straight fenestrated clip (A) is first applied to reduce the size of aneurysm. Then an angled fenestrated clip (B) can be applied. Covering the blades of the second clip with Silastic tubes except for the parts crossing Clip A facilitates a complete closure of the neck of the aneurysm. See text.

foam was placed between the facial-acoustic nerve complex and the anterior inferior cerebellar artery. Postoperatively, the hemifacial spasm disappeared and, except for reduced hearing on the operated side, there were no complications.

Discussion

Straight fenestrated clips were first devised by Drake for aneurysms of the basilar artery. We have designed oblique and right-angled fenestrated clips for aneurysms in difficult locations, not only in the vertebral artery but also in the anterior portions of the circle of Willis. Without these clips, the aneurysms in this report could not have been surgically treated except by proximal ligation of the vertebral artery or wrapping of the aneurysm.

Our new oblique and right-angled fenestrated clips are similar to Sundt-Kee’s clip graft or Heifetz’s clips of cylinder shape. The latter clips are more useful for the repair of an injured parent artery because they can circumferentially wrap the artery. However, they are not suitable for obliterating an aneurysm since their cylinder-shaped blades obstruct the surgeon’s vision, making it difficult to avoid inclusion of nerves and vessels around the aneurysm. It is also difficult to be certain where the clip is placed in relation to the parent artery, and postoperative stenosis of the parent artery is likely. An advantage of our newly designed oblique and right-angled fenestrated clip is that the problems associated with cylinder-shaped clips are avoided.

There are technical problems when applying angled fenestrated clips to a large fusiform aneurysm. In using either the oblique or right-angled clip, care must be taken to apply the clip blades much deeper on the dome than one would first consider necessary. Otherwise, the newly formed parent artery becomes stenotic. As illustrated in Fig. 5, the blades of an angled fenestrated clip must be fully opened to cover a length of at least 3.14 ($\pi$) times the diameter of a parent artery. For instance, a length of at least 15 mm is necessary to construct a new parent artery 5 mm in diameter from a large fusiform aneurysm. The thickness of the wall of a fusiform aneurysm must also be considered in this connection. The angled blades of a fenestrated clip do not open more than 8 mm and,
furthermore, they cannot be slipped along the aneurysm. In order to overcome this difficulty, a straight fenestrated clip, the tips of which open wider than those of an angled fenestrated clip, is used before the application of the latter in order to reduce the size of the aneurysm, as in Cases 1 and 2. The second clip with angled blades can then be applied at a suitable location.

When using more than two clips for one aneurysm, the situation could arise, in rare instances, where two clips cross. In such a situation, the second clip does not completely close because of the thickness of the blades of the underlying clip. This problem is solved by covering the blades of the second clip with Silastic tubes, 0.5 to 0.6 mm thick, except for the parts that override the first clip (Fig. 5 lower right).

In the case of a symmetrical fusiform aneurysm, the location of the vasa vasorum provides important information as to where to reconstruct a new parent artery. Although the configuration of the aneurysm and the natural flow pattern seen on the preoperative angiograms may suggest the side of the original parent artery, careful observation of the vasa vasorum on the aneurysm wall under direct vision is extremely helpful in determining the portion of the aneurysm suitable for a parent artery, because the vasa vasorum are mainly distributed on the wall of the healthy artery.

**References**


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