



Aneurysm Clip Compression Technique in the Surgery of Aneurysms with Hard/Calcified Neck

Servet Inci, Atilla Akbay, Merdan Orunoglu

■ **OBJECTIVE:** One of the most important technical problems in surgery to repair aneurysms is the presence of a hard/calcified neck. In this situation, various techniques can be used for proper clipping. In addition to well-known techniques, we have used a different technique for more than 10 years. This technique probably also has been used by other neurosurgeons, but we could not find any publications about it in the English literature. Therefore, we would like to report the details of this technique and our own experience.

■ **METHODS:** More than 600 anterior circulation aneurysms were clipped between January 2003 and December 2014. It was necessary to apply this technique in 25 aneurysms because of a hard/calcified neck. This series was reviewed retrospectively. If the hard-calcified plaque at the neck does not allow for full closure of the clip and the known techniques are not sufficient for clipping, we carefully and slowly compress the aneurysm clip itself at the neck with a hemostatic clamp. The hard plaque usually is crushed with this technique, and full closure of the clip is immediately obtained.

■ **RESULTS:** Complete occlusion of the neck was achieved in 16 aneurysms (64%) with this technique. Technique-related complication developed as intraoperative rupture of the aneurysm in two patients (8%). However, this complication was managed with other techniques in both cases. No distal thromboembolism developed in any patient.

■ **CONCLUSIONS:** Our aneurysm clip compression technique may be a viable option in surgery of aneurysms with hard-calcified neck.

INTRODUCTION

Despite recent advances in microneurosurgery and aneurysm clips, one of the most important technical problems in aneurysm surgery is still the presence of dense calcified/atherosclerotic plaque in the aneurysm neck, especially in large and giant aneurysms (6, 11, 19, 20). This plaque can prevent full closure of the clip and cause incomplete occlusion of the neck. The neurosurgeon may have to choose an indirect method (wrapping, ligation, trapping with or without bypass surgery) in this situation; however, the best method for treatment of aneurysms, especially giant aneurysms, is still direct surgical clipping (3, 8, 13, 17, 18, 21, 28, 34). Therefore, every effort should be done for direct clipping. For this purpose; 1) a booster clip can be used for additional closing force (30), but is not always effective. 2) Various multiclipping techniques that apply a combination of straight and fenestrated clips usually solve this difficult problem (3, 8, 12, 17, 25, 33). Despite these advanced clipping techniques, however, sometimes a full closure may not be obtained. In addition, it sometimes may not be possible to apply multiclips because of lack of space or inaccessibility. 3) Microendarterectomy can be performed successfully before clipping (15, 27); however, this procedure is a risky one because of possible intimal injury of the parent artery. If a good cleavage plane between the calcified plaque and the arterial wall is not identified properly, this technical failure may cause intimal injury, which can result in dissection and finally occlusion (4, 34) or even perforation of the arterial wall.

We often use these techniques. In addition, we also use a technique with a hemostatic clamp in aneurysms with hard/calcified neck that we call the aneurysm clip compression (ACC) technique. This technique probably also has been used previously by some neurosurgeons, but we could not find any publications about this technique in English literature. Therefore, we would like to report details of this technique and our own experience.

Key words

- Aneurysm
- Clip
- Compression
- Hard-calcified
- Neck

Abbreviations and Acronyms

ACC: Aneurysm clip compression

ICA: Internal carotid artery

MCA: Middle cerebral artery

Department of Neurosurgery, School of Medicine, University of Hacettepe, Ankara, Turkey

To whom correspondence should be addressed: Servet Inci, M.D., Ph.D.

[E-mail: sinci@hacettepe.edu.tr or servet@mailcity.com]

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METHODS

From January 2003 to December 2014, more than 600 anterior circulation aneurysms were clipped by the senior author (S.I.) at Hacettepe University Hospital. In the same period of time, it was necessary to use the ACC technique in 25 aneurysms because of a hard, calcified neck. The demographic and clinical data of the patients who successfully treated with this technique are given in **Table 1**. The sizes of aneurysms in these 16 patients were as follows: 6 giant, 6 large, and 4 small. There were 10 women and 6 men ranging in age from 30 to 64 years (mean 50.2 years). According to modified Rankin Scale (7), the patients were graded as follows: grade 0 in 4 patients, grade I in 2, grade II in 3, grade III in 4, and grade IV in 3. Localizations of the aneurysms were as follows: middle cerebral artery in 12 cases, anterior communicating artery in 3, and internal carotid artery in 1. Twelve patients presented with subarachnoid hemorrhage (2 with previous subarachnoid hemorrhage), and 2 with mass effect. The aneurysm was found incidentally in 2 patients. All patients underwent routine preoperative neuroradiologic investigations (magnetic resonance imaging; 3-dimensional computed tomography angiography, digital subtraction angiography and cross-compression test, if necessary). Postoperative neurologic status of the patients was assessed by Glasgow Outcome Scale (16).

Postoperative remnant of the aneurysms was evaluated by angiography according to the classification of Sindou et al. (26).

Surgical Technique

After a relatively large pterional craniotomy, the Sylvian fissure is opened widely. The cerebrospinal fluid is sufficiently drained for a slack brain. Proximal and distal control is obtained routinely. The neck of the aneurysm is explored fully and prepared for clipping. The neck is compressed gently with a bipolar forceps to evaluate its softness and flexibility, after temporary clipping of the parent artery. If considered suitable, the neck is clipped with a proper clip or clips in the usual manner. If the neck is thick and calcified, it is possible that the clip blades will not close completely.

Despite the use of a booster clip or multiclipping techniques with straight and fenestrated clips, if the calcified plaque prevents complete occlusion of the neck, the third step is the ACC technique in our surgical algorithm before microendarterectomy. For this purpose, the parent artery is temporarily occluded, and the most appropriate clip is placed on the neck of the aneurysm. The clip should be slightly longer than the width of the aneurysm neck (about 1.5 times longer). This is important for clip compression, if necessary. A suitable vascular clamp is selected according to position of the clip at the neck of the aneurysm. We have used mostly

Table 1. Clinical Course and Outcome of 16 Patients Treated with the ACC Technique

| Patient No. | Age/ Sex | Presentation | Preoperative Grade* | Size | Location | Compressed Part of the Clip Blade | Technique-Related Complication | Remnant† | Outcome‡ |
|-------------|-------------|----------------|------------------------|-------|----------|--------------------------------------|-----------------------------------|----------|----------|
| 1 | 30/F | SAH | 3 | Giant | MCA | Tip | - | - | Moderate |
| 2 | 51/M | SAH | 4 | Large | ACoA | Bottom | - | - | Moderate |
| 3 | 52/M | Incidental | 0 | Small | MCA | Tip | - | - | Good |
| 4 | 43/M | SAH | 2 | Giant | MCA | Bottom | - | Grade I | Good |
| 5 | 53/F | Epilepsia | 1 | Giant | MCA | Tip | - | Grade I | Good |
| 6 | 46/M | SAH | 3 | Small | ACoA | Bottom | - | - | Good |
| 7 | 50/M | SAH | 2 | Large | ACoA | Tip | Intraoperative rupture | - | Good |
| 8 | 34/F | SAH, ICH | 4 | Giant | MCA | Tip + bottom | - | Grade I | Good |
| 9 | 43/M | SAH, ICH | 4 | Giant | MCA | Tip | Intraoperative rupture | - | Poor |
| 10 | 64/F | SAH | 2 | Large | MCA | Tip | - | - | Good |
| 11 | 63/F | SAH | 3 | Small | MCA | Tip | - | - | Good |
| 12 | 42/F | Loss of vision | 1 | Giant | ICA | Bottom | - | Grade I | Good |
| 13 | 60/F | SAH | 3 | Small | MCA | Tip | - | - | Good |
| 14 | 55/F | Incidental | 0 | Large | MCA | Tip | - | Grade II | Good |
| 15 | 59/F | Previous SAH | 0 | Large | MCA | Bottom | - | Grade I | Good |
| 16 | 59/F | Previous SAH | 0 | Large | MCA | Tip | - | - | Good |

ACC, aneurysm clip compression; F, female; SAH, subarachnoid hemorrhage; MCA, middle cerebral artery; M, male; ACoA, anterior communicating artery; ICH, Intracerebral hematoma; ICA, internal carotid artery.

*According to modified Rankin Scale.

†Sindou classification.

‡Glasgow Outcome Scale.

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