Factors for Achieving Safe and Complete Treatment for Unruptured Saccular Aneurysm Smaller Than 10 mm by Simple Clipping or Simple Coil Embolization

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■ OBJECTIVE: **Reducing complications from unruptured aneurysms (UAs) treatment is important. We clarify the criteria for achieving safe and complete treatment for UAs ≤10 mm by clipping or coil embolization.**

■ METHODS: **This study included 59 newly treated UAs in the past 2 years. We prospectively decided on criteria to recommend active treatment. UAs ≤10 mm and in ≤75 year-olds, located at in the internal carotid artery at the paraclinoid portion and the posterior circulation aneurysms except for a vertebral artery-inferior posterior cerebellar artery aneurysm were mainly treated by coil embolization, and those in the internal carotid artery except at the paraclinoid portion, in the anterior or middle cerebral artery, and in the vertebral artery-inferior posterior cerebellar artery were treated preferably by clipping. UAs with a height/neck ratio or a dome/neck ratio ≤1.4 were treated preferentially by clipping. Specific preoperative imaging and careful manipulation were adopted for clipping.**

■ RESULTS: **Fifty-seven (96.6%) achieved modified Rankin scale (mRS) 0–1, 2 (3.4%) mRS 2–5, and 0 had mRS 6. Fifty-three UAs (89.8%) achieved complete occlusion (CO) and 7 (10.1%) had neck remnants (NR). Forty-one UAs (100%) within the criteria achieved mRS 0–1, 40 (98%) achieved CO, and 1 (2%) NR. The odds ratio of NR for those outside the criteria was 18.5 (95% confidence interval, 1.83–186.6) ($P < 0.05$). CO treated within the criteria was 39 and NR was 1. CO treated outside the criteria was 14 and NR was 5 ($P < 0.05$). The mRS 0–1 with age ≤75 years was 55 and the mRS 2–6 was 0. The mRS 0–1 with age ≥76 years was 2 and the mRS 2–6 was 2 ($P < 0.01$).**

■ CONCLUSIONS: **The treatment for UAs within the criteria, with the most recent points of concern, can lead to safe and complete results.**

INTRODUCTION

Ruptured cerebral aneurysms require treatment because they are medical emergencies. Yet it is not clear whether unruptured cerebral aneurysms (UAs) need treatment. In addition, it is not clear what kind of treatment is suitable for UAs.[1-3] The rupture rate of UAs and their complication rate are extremely important in deciding on a treatment strategy. The rupture rate has increasingly been clarified[4,5]; however, it remains unclear as to which individual aneurysms will rupture. Simple clipping and simple coil embolization are the general methods of treatment for UAs, but it is not clear which treatment is suitable for which UA. Therapeutic technology is also continually improving.[1,6] With the increasing accessibility of noninvasive imaging, physicians are faced with a dilemma regarding what to do.[7] Reducing the rate of complications with the treatment of UAs is one of the most important tasks for neurosurgeons. In the present report we clarified the criteria for achieving safe and complete treatment of unruptured saccular aneurysms ≤10 mm by simple clipping or simple coil embolization in one institute.

Key words
- Clipping
- Coil embolization
- Treatment selection
- Unruptured aneurysm

Abbreviations and Acronyms
AC: Anterior cerebral artery aneurysm
CO: Complete occlusion
D: Dome filling
D/N: Dome/neck ratio
H/N: Height/neck ratio
ICprcli: Internal carotid artery aneurysm at the paraclinoid portion
MC: Middle cerebral artery aneurysm
mRS: Modified Rankin scale
NR: Neck remnant
SSFP: Steady-state free precession
UA: Unruptured cerebral aneurysm
VABA: Posterior circulation aneurysm except VAPICA
VAPICA: Vertebral artery-inferior posterior cerebellar artery aneurysm

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METHODS

This study included 59 newly treated saccular UAs from October 2013 to September 2015 (Table 1). There were 45 women and 14 men, ranging in age from 42–82 years (60.7 ± 10.5 years). The locations of the UAs were as follows: 7 internal carotid artery aneurysms at the paraclinoid portion (ICprcli), 19 ICprcli except at the paraclinoid portion, 12 anterior cerebral artery aneurysms (ACs), 14 middle cerebral artery aneurysms (MCs), 1 vertebral artery–posterior inferior cerebellar artery aneurysm (VAPICA), and 6 posterior circulation aneurysms except VAPICA (VABA). Forty-nine of the aneurysms were detected by screening, 4 had impending rupture, 4 had subarachnoid hemorrhage from other aneurysms, and 2 were detected due to other strokes. Four aneurysms existed in different portions in a patient. UAs excluded from this investigation were as follows: UAs treated by parent artery occlusion, patients with dissecting aneurysms, UAs previously treated in certain ways, UAs treated by stent-assisted coil embolization, and UAs treated by bypass-assisted surgery. For stent-assisted coil embolization, antiplatelet agent medication is usually required,[8-12] although it has some side effects. Because the treatment for UAs is for the prevention of rupture, further treatment is undesirable. Therefore, we excluded stent-assisted coil embolization for UAs. In the present study, 182 UAs were found in our outpatient clinic. Fifty-nine of those aneurysms were treated by simple clipping or simple coil embolization. Here, we defined simple coil embolization including double microcatheter and balloon assisted embolizaiton. One 12-mm vertebral artery aneurysm was treated by parent artery occlusion and one 12-mm internal carotid artery aneurysm was treated by parent artery occlusion with an extra-intracranial bypass in this period. One hundred twenty-one aneurysms received conservative treatment. Among the conservatively followed-up UAs, 46 were ≤2.9 mm, 38 were between 3 and 3.9 mm, 25 were between 4 and 4.9 mm, and 19 were between 5 and 10 mm. In addition, 40 patients were ≥76 years old, whereas 6 patients, ≤75 years who had UAs between 5 and 10 mm, did not want to be treated. We prospectively decided on the criteria to recommend active treatment for UAs (Table 2). The background of the criteria was as follows: treatment of UAs with a maximum diameter ≥11 mm clearly have a poor outcome,[13,14] the recanalization rate of coil embolization for UAs with a diameter ≥11 mm is high.[14,15] and the clipping of large aneurysms sometimes have poor results.[16] Therefore, we considered aneurysms ≥11 mm to be in a different category. The rate of rupture of UAs with a maximum diameter <5 mm is low.[5] UAs in those ≥76 years old were not indicated according to the Japanese stroke guidelines,[17] because the life expectancy of a 76-year-old person is <10 years. UAs located at ICprcli and VABA, except VAPICA, were principally treated by simple coil embolization and UAs in the internal carotid artery except for ICprcli, AC, MC, and VAPICA were preferably treated by simple clipping.[18-20] Round UAs and UAs with both a height/neck ratio (H/N)—defined as the length from the neck to the top of the dome divided by the length of the neck (Figure 1)—and a dome/neck ratio (D/N)[21] of ≥1.5 were preferentially treated by coil embolization because the safety and accuracy of coil embolization for those aneurysms had been guaranteed.[6] Specific magnetic resonance imaging (i.e., thin-slice T1 weighted image and steady-state free precession [SSFP] imaging to investigate the adhesion of the UA in the brain)[22] and arteriovenous phase imaging by 3-dimensional digital subtraction angiography[23] were introduced before all surgeries for the safe dissection of the aneurysm and vein.[24] Careful manipulation of the brain was strictly adopted, whereby the retractor was loosened every 10 minutes and the veins were preserved as much as possible. When a patient wanted treatment for a UA that did not meet the criteria, we treated such UAs carefully. All UAs were treated in 1 institute under the management of 4 neurosurgeons who could treat UAs by either clipping or coil embolization.

We investigated the outcome of the treated UAs. Clinical status was evaluated using the modified Rankin Scale (mRS) for 3 months after surgery. An mRS score of 0 or 1 indicated that the clinical results were sufficient. The degree of aneurysm occlusion was evaluated using the Raymond classification[25]—as complete occlusion (CO), neck remnant (NR), or dome filling (D)—by conventional angiography, 3-dimensional computed tomographic angiography, or magnetic resonance angiography[26,27] for 3 months after surgery. When CO was achieved, the morphologic result was evaluated as sufficient. Rupture and additional surgery during follow-up in an outpatient clinic were also investigated. No additional drugs were administered during the follow-up period. The factors associated with the achievement of sufficient results were analyzed using multivariable logistic regression models. We also used the χ^2 test to analyze specific variables as follows: the difference of location between clipping and coil embolization, the difference in shape of the UAs between clipping and coil embolization, and the difference of outcome by criteria and age. The difference in shape of the UAs was defined by H/N and D/N. The location was classified into 2 categories: ICprcli and VABA except VAPICA and ICprcli except at the paraclinoid portion, AC, MC, and VAPICA. The review committee in this hospital approved the study and the subjects gave informed consent.

RESULTS

Overall Clinical and Morphologic Results

Fifty-seven patients (96.6%) achieved an mRS score of 0–1, 2 (3.4%) had a score of 2–4, and 0 had an mRS score of 6. Fifty-three UAs (89.8%) achieved CO, 7 (10.1%) had NR, and 0 had D. No aneurysm developed rupture and no additional surgery was performed during the follow-up period (14.8 ± 7.1 months). Regarding the 41 UAs within the criteria, all (100%) treatment resulted in mRS 0–1, 40 (98%) of these UAs achieved CO, and 1 UA (2%) had NR.

The Basic Characteristic Difference Between Simple Clipping and Simple Coil Embolization

The average age at treatment by clipping was 62.1 ± 10.8 years, and by coil embolization it was 57.1 ± 9.3 years (P = not significant) (Table 3). The average diameter of UAs treated by clipping was 5.75 ± 2.48 mm; for coil embolization it was 5.08 ± 1.78 mm (P = not significant).

The number of ICprcli and VABA except VAPICA treated by clipping was 1, and the number of IC except ICprcli, AC, MC, and VAPICA was 41. The number of ICprcli and VABA except VAPICA treated by coil embolization was 12; for IC except ICprcli, AC, MC, and VAPICA, it was 5 ($P < 0.05$).