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The Implication of Anterior Communicating Complex Rotation and 3-Dimensional Computerized Tomography Angiography Findings in Surgical Approach to Anterior Communicating Artery Aneurysms

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■ BACKGROUND: **To investigate the usefulness of 3-dimensional computerized tomography angiography (3D-CTA) in the microsurgical management of anterior communicating artery (AcomA) aneurysms.**

■ METHODS: **Twenty-six consecutive patients with AcomA aneurysms (22 ruptured) underwent microsurgical clipping. Detailed angioanatomic assessment of the AcomA complex and operative approach was based on the 3D-CTA.**

■ RESULTS: **The 3D-CTA showed a dominant proximal anterior cerebral artery (A1) segment in 61% and symmetric A1s in 39% of aneurysms. Dominant A1 segments presented with rotation of the AcomA complex toward the contralateral side in 63%, toward the ipsilateral side in 25%, and without rotation in 12%. With symmetric A1s, the AcomA was parallel to the coronal plane in 90% and a right-sided approach was carried out in these patients. In rotated AcomA complexes, the virtual 3D views were compared to determine the side of the approach. For superior projecting aneurysms, we determined that the approach from the side in which the A1-distal anterior cerebral artery (posterior communicating) angle was posterior was more favorable. For posterior projecting aneurysms, the approach from the side where the A1-distal anterior cerebral artery (posterior communicating) angle was more anterior was more favorable. For anteroinferior projecting aneurysms, an approach from the dominant A1 side was chosen regardless of AcomA complex rotation. Postoperative 3D-CTA showed complete exclusion of 24 aneurysms (>92%) and 2 small remnants (<2 mm). Outcome was excellent or good (modified Rankin score 0–2) in 88% of patients.**

■ CONCLUSIONS: **Rotation of the AcomA complex and dome projection are important angioanatomic elements in determining the surgical exposure and side of the approach. This study illustrates the role of 3D-CTA in the management of these difficult lesions by individualizing the surgical approach.**

INTRODUCTION

The anterior communicating artery (AcomA) is one of the most common site of intracranial aneurysms and the single most frequent site for aneurysm rupture, accounting for approximately 40% of aneurysmal subarachnoid hemorrhage.[1-3] Due to the recent advances in endovascular devices and occlusion techniques, endovascular treatment of AcomA has become a safe and effective option for certain patients.[4-6] However, there are some challenges to endovascular treatment of AcomA aneurysms. An unfavorable dome to neck ratio, broad base and dysplasia of the AcomA, irregular and multilobes feature of the aneurysms, and those with smaller size pose significant challenges for endovascular treatment, especially in the setting of a subarachnoid

Key words
- 3D-CTA
- Acom complex rotation
- Aneurysm clipping
- Aneurysm surgery
- Anterior communicating artery
- Computerized tomography angiography

Abbreviations and Acronyms
3D: 3-dimensional
A1: Proximal anterior cerebral artery
A2: Distal anterior cerebral artery (posterior communicating)
AcomA: Anterior communicating artery
CT: Computerized tomography
CTA: Computerized tomography angiography
DSA: Digital subtraction angiography
mRS: Modified Rankin score
WFNS: World Federation of Neurosurgical Societies

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hemorrhage.[4,5,7] Therefore, in certain situations, microsurgical clipping is the safer and more appropriate treatment modality.

To treat AcomA aneurysm with surgical clipping and avoid complications, one has to fully appreciate the frequently encountered anatomic variants, vital perforating arteries, and close proximity of the olfactory and optic nerves. There is evidence that microsurgical clipping of AcomA aneurysm has a higher risk of postoperative complications compared with other aneurysms in the anterior circulation.[8-11] Injury to the perforators of the AcomA, the recurrent artery of Heubner, the frontopolar and orbitofrontal arteries, brain retraction during the surgery, and the initial subarachnoid hemorrhage are responsible for these deficits. In these patients, neuropsychologic deficits account for a significant portion of the morbidity.[1,2,11-16] The difficulty of the surgical exploration varies greatly depending on the orientation and the rotation of the aneurysm in relation to the coronal plane of the AcomA complex.

Although digital subtraction angiography (DSA) is still considered the gold standard in the diagnosis and preoperative evaluation of cerebral aneurysms, 3-dimensional computed tomography angiography (3D-CTA) has been widely used as a diagnostic study[17-23] and is frequently used as the sole diagnostic study before treatment.[24-26] The efficacy of 3D-CTA in the preoperative and postoperative evaluation of clipped aneurysms has previously been demonstrated.[18,27,28] Although surgical approaches to the Acom complex have been thoroughly evaluated and studied before, the effort to further improve the surgical outcomes should continue. This study focuses on microsurgical clipping of AcomA aneurysms based on the AcomA complex rotation and the projection of the aneurysm dome using 3D-CTA. Our aim is to show that the information from 3D-CTA can be used, not only to simulate the surgical view of the aneurysm, but also to decide the sidedness of the craniotomy.

METHODS

This study was based on a series of 32 consecutive patients with AcomA aneurysms admitted to our institution during a 2-year period. The initial diagnostic imaging was obtained by computerized tomography (CT) and CTA. A 128-row CT unit was used. The CT protocol consisted of a baseline unenhanced cerebral CT with approximately 30 transverse sections 5-mm thick acquired at 120 kVp and 200 mA, immediately followed by multislice CTA. A timed test injection was used to determine the optimal duration of multislice CTA data acquisition. The data consisted of 20 identical 10-mm-thick slices (80kVp/100 mA), which were obtained from the level of the top of the frontal sinuses in a cine mode at a rate of 1 image per second during intravenous administration of 20 mL of iodinated contrast material (300 mg/mL iodine). In the test injection, the contrast material was administered at a rate of 5 mL/sec intravenously by using a power injector. There was a 10-second delay between this injection and the onset of data acquisition. The CTA data acquisition was performed according to the following parameters: spiral mode, 0.5-second rotations; 64 row collimation, 0.625 mm; pitch, 1.375l slice thickness; 0.625 mm; reconstruction interval, 0.5 mm; and acquisition parameters, 120 kVp/280 mA. A caudocranial scanning direction was selected, covering the volume extending from a point situated 1 cm below the foramen magnum up to the roof of the lateral ventricles. The injected volume was 50 mL with an injection rate of 5 mL/sec. The CTA data were then segmented by a specifically dedicated workstation into a 3-dimensional model, allowing interactive and animated displays of the intracranial vascular structures.

The virtual intraoperative views from the right-sided and the left-sided pterional approach were then reconstructed, with simulation of the patient's head rotated 60 degrees to the contralateral side and with a 20-degree extension.[29] The images were rotated according to the surgical exposure and evaluated with a small field of view. The dominancy of the proximal anterior cerebral artery (A1) segment, the size and projection of the aneurysm, the position of the AComA in the coronal plane, and both distal anterior cerebral artery (posterior communicating) (A2) segments were evaluated. The ease of surgical exposure of the region, the control of vessels, and the ease of aneurysm clipping were compared between the right-sided and left-sided surgical route by considering the basic rules of aneurysm surgery: obtaining early control of the proximal segments of the parent vessels, identifying first the neck of the aneurysm, and assuring a good visualization of the surrounding vessels, especially the hypothalamic perforators, both A2s, and the recurrent arteries of Heubner.

The following parameters were evaluated: the position of the AcomA with regard to the coronal plane (parallel or rotated away or toward the dominant A1), the ease of surgical visualization of the neck of the aneurysm, the back wall of the AcomA (hypothalamic perforators), and the origin of both A2 segments (A1-A2 angle). The craniotomy was decided based on the side offering better exposure and control on the 3D-CTA studies.

Detailed evaluation of the anatomy of the aneurysm on 3D-CTA showed favorable endovascular conditions in 6 patients in whom coiling was performed, leaving a total of 26 patients who underwent surgical clip application. Twenty-two of the 26 patients presented with a ruptured aneurysm. The surgical strategy and especially the side of the approach were individualized, as described previously. The outcome was evaluated according to the degree of the aneurysm occlusion (complete or incomplete) and the modified Rankin score (mRS) at 3 months.

RESULTS

Patient's clinical grade at presentation according to the WFNS grade is shown in **Table 1**. The aneurysms characteristics are summarized in **Table 2**. In 14 patients, the AcomA was incorporated into the base of the aneurysm, and in 12 cases the aneurysm was located at the junction of the AcomA and A2 branch. The mean size of the aneurysms in this series was 8.46 mm (range, 4—23 mm). The projection of the aneurysmal dome was superior in 17 (66%), anteroinferior in 7 (27%), and posterior in the 2 remaining patients (7%).

3D-CTA showed a dominant left A1 segment in 11 patients (42%), a dominant right A1 segment in 5 (19%), and symmetric A1s in 10 patients (39%). In 10 of 16 patients (63%) where there was a dominant A1 segment, the AcomA was rotated toward the contralateral side (i.e., the A1-A2 angle of the dominant side shifted anteriorly). In 4 cases (25%), there was a rotation toward the dominant side (i.e., the A1-A2 angle of the dominant side shifted posteriorly), and in 2 cases (12%) the AcomA was parallel to the coronal plane. With symmetric A1 segments, the AcomA was nearly always parallel to the coronal plane (90%).