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Angiographic Angular Adjustment: Matching Angiographic Views and Surgical Findings to Estimate the Actual Arterial Anatomy in Surgery for Intracranial Aneurysm - Technical Note

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ABSTRACT

AIM: To describe a simple technique of angular adjustment of cerebral angiographic views that makes them similar to the surgical field under the operation microscope.

MATERIAL and METHODS: The technique of angular adjustment consists of three steps: 1. Upside-down 180-degree rotation of the standard angiographic anterior-posterior view, 2. Adjustment of the course of the angiographic internal carotid artery according to the actual internal carotid artery seen in surgery under the operating microscope, and 3. A final and more accurate angular adjustment by rotating the angiographic view in its final position, as soon as parent arteries to aneurysm, such as the internal carotid, anterior cerebral, and middle cerebral arteries, are seen in surgery.

RESULTS: The use of the technique provided a fair approximation of a rotated angiographic view and the actual surgical point of view. The technique is simple, and no sophisticated technology is needed.

CONCLUSION: The angiographic data adjusted angularly to the surgeon's point of view at surgery, very similar to the actual directions of arteries and the fundus of the aneurysm, is likely helpful to the microneurosurgeon for safely exploring aneurysms in conjunction with proximal and distal arteries.

KEYWORDS: Cerebral angiography, Aneurysm, Anterior communicating artery, Middle cerebral artery, Internal cerebral artery

ABBREVIATIONS: AP: Anterior-posterior, **ICA:** Internal carotid artery, **A1:** Proximal segment of anterior cerebral artery, **A2:** Distal segment of anterior cerebral artery, **DSA:** Digital subtraction angiography, **CTA:** Computed tomography angiography, **3D-CTA:** Three-dimensional computed tomography angiography, **MRA:** Magnetic resonance angiography, **3D-MRA:** Three-dimensional magnetic resonance angiography.

INTRODUCTION

In conventional cerebral angiography, as well as in computer-based angiographic techniques, the standard anterior-posterior (AP), lateral, and oblique views made with an upright head position still remain the main angiographic point of view. Yasargil has shown that in the pterional approach for intracranial aneurysm surgery, the actual orientation of intracranial aneurysm and arteries differ from those of standard angiographic images (19). Therefore, the surgeon needs to know with much as accuracy as possible the actual orientations of arteries and the direction of the aneurysm

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similar to that which one may encounter in exploration under the operating microscope. A simple technique of angular adjustment according to the actual anatomy of the surgical field is presented.

■ TECHNIQUE

The angiographic angular adjustment technique consists of three steps. In the first step, the surgeon rotates the standard angiographic anterior-posterior view physically at 180 degrees from an upside-down position. In the second step, an angular adjustment of the course of the angiographic internal carotid artery is made according to the actual internal carotid artery course the way it is first directly seen in the surgical field under an operating microscope. In the third step, once the parent arteries to aneurysms, such as the internal carotid artery, anterior cerebral artery (A1 segment), and middle cerebral artery (M1 segment), are seen, a final angular adjustment is made by rotating the angiographic view in its final position in order to match the angiographic data to those of surgical findings in a pterional craniotomy and the opening of the Sylvian fissure (Figure 1).

■ DISCUSSION

Cerebral angiography techniques such as digital subtraction angiography (DSA), two- and three-dimensional computed tomography angiography (2D-CTA and 3D-CTA), and three-dimensional magnetic resonance angiography (3D-MRA) are used in the diagnosis, evaluation and surgical planning of intracranial aneurysms (2,4,5,11,14-17). Cerebral angiography techniques such as digital subtraction angiography and 3D-CTA are done using standard anterior-posterior (AP), lateral, and oblique views (19). The printed and on-screen views are also given in the abovementioned conventional directions.

The pterional approach with the head of the patient turned 30 to 45 degrees to the contralateral side and extended until the malar eminence becomes the uppermost point is the standard surgical approach for most common aneurysms (18, 20). Therefore, in the pterional approach, the surgeon's point of view is totally different from that of any of the conventional AP angiographic views (18,19).

It is important for the surgeon to know the three dimensional orientation of the fundus of the aneurysm and its relationship with parent and/or contiguous vessels. A more accurate actual determination, spatial, and vector orientation is obviously essential for efficacy and safety of clipping.

The work of Yaşargil is the first example of the adjustment of the fundus direction of an aneurysm, and to our knowledge, there has been no study in the literature so far specifically addressing the need to make precise the actual orientation of the aneurysms in surgery and parent arteries from the neurosurgeon's point of view in surgery (19).

The described technique is based upon the work of Yaşargil, who noted that vascular structures described as projecting anteriorly by the neuroradiologist are actually found to be superior in surgery, and inferior structures are revealed to be anterior because the neurosurgeon is planning an intracranial procedure in the usual supine position with the head inclined 90 degrees from the vertical (19).

Based upon this particular head position, and Yaşargil's pioneering work, we described a modified technique that we use in surgery for anterior circulation aneurysms, more specifically aneurysms of the anterior communicating artery (Figure 2), the middle cerebral artery bifurcation (Figure 3), and the posterior communicating artery (Figure 4).

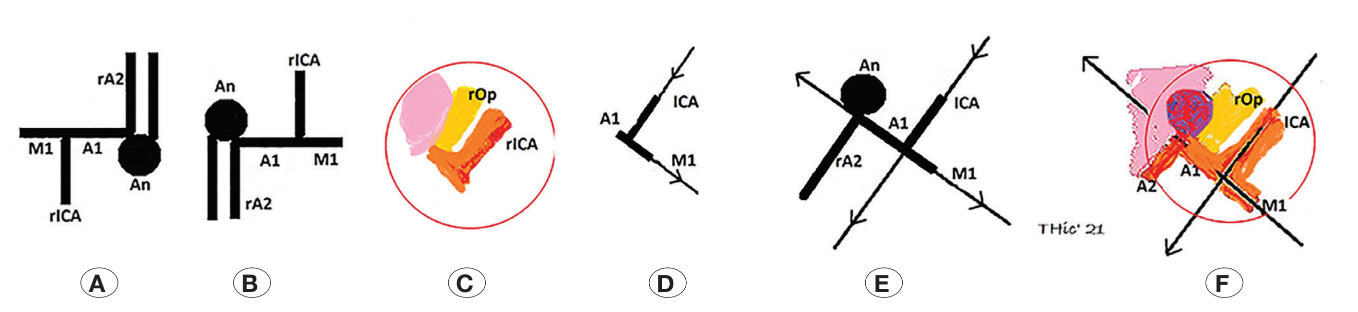

Figure 1: Schematic diagram showing the angiographic angular adjustment technique. **A)** Standard anterior-posterior view of a right carotid angiography showing an *inferiorly*-directed anterior communicating artery aneurysm. **B)** 180-degree upside-down physical rotation of the standard right carotid angiography showing a now *superiorly*-directed aneurysm fundus. **C)** The surgical point of view under the operating microscope. Note the directions of the right optic nerve and internal carotid artery. **D)** The angiographic view is rotated according to the anatomical directions of the optic nerve and internal carotid artery seen under the microscope. An angular adjustment is made with an approximately 45-degree clockwise rotation of the 180-degree-rotated view according to the angles of arteries found in the actual surgical field. The actual aneurysm direction is now *superior-anterior.* **E)** The angular adjusted view helps the surgeon to estimate the precise location and direction of the aneurysm fundus, thus allowing a safer microsurgical exploration along ICA, A1, and A2. **F)** Final representation of the surgical field under the operating microscope according to the point of view of the surgeon. Note the position and direction of the fundus of the anterior-superior-directed anterior communicating artery aneurysm. (**ICA:** Internal carotid artery; **A1:** Proximal segment of anterior cerebral artery; **A2:** Distal segment of anterior cerebral artery, **M1:** Middle cerebral artery, **An:** Aneurysm, **Op:** right optic nerve).

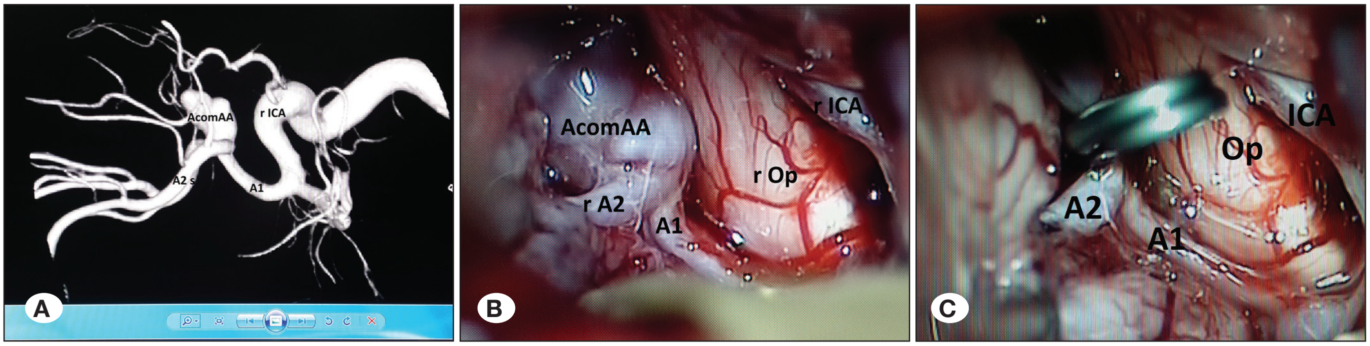

Figure 2: Right carotid three-dimensional CT angiography screen view of a patient with an anterior communicating artery aneurysm. **A)** The screen view is rotated 180 degrees, and then about 30 degrees of clockwise rotation was done using Microsoft Office Picture Manager® after the right ICA and the optic nerve were seen under an operating microscope. **B)** The actual surgical view under the operating microscope showing ICA, the right optic nerve, A1 segment, Acom aneurysm, and the right A2 segment similar to the estimated anatomy of the three dimensional arterial structure. **C)** The clipping of the Acom aneurysm. It is hoped that, in this particular configuration, the predetermination and estimation of arterial and aneurysmal vector orientations allow the surgeon able to perform a safer and more confident clip application. (**ICA:** Internal carotid artery, **A1:** Proximal segment of anterior cerebral artery, **A2s:** Distal segments of anterior cerebral artery, **A2:** Distal segment of anterior cerebral artery, **M1:** Middle cerebral artery, **AcomAA:** Anterior communicating artery aneurysm, **Op:** Optic nerve; **r:** right).

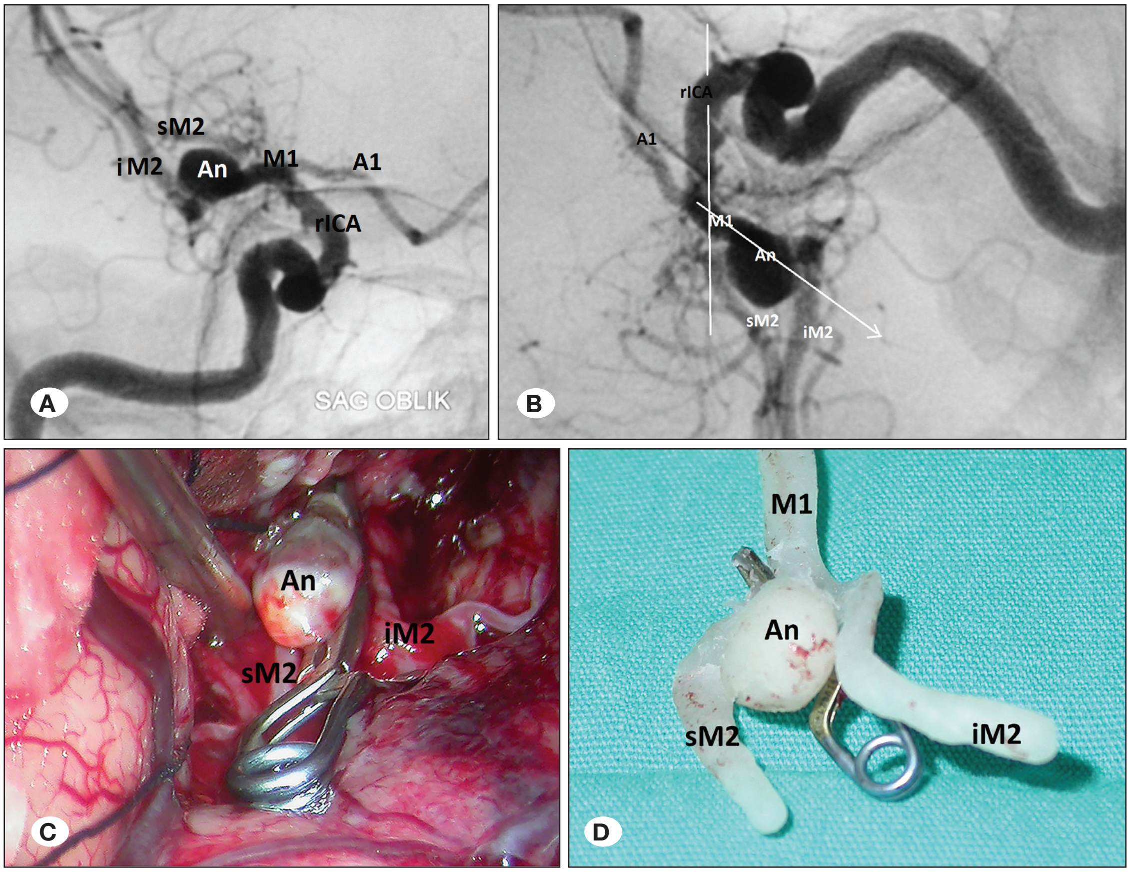

Figure 3: A) Oblique view of right carotid digital subtraction angiography (DSA) view of a patient with MCA bifurcation aneurysm. **B)** Angular adjustment is made according to the alignment of the middle cerebral artery M1 segment and both distal M2 segments, the superior and inferior trunks, beyond the bifurcation at the site of the aneurysm. This adjusted angiography likely shows the actual configuration of the aneurysm in conjunction with the two surrounding distal artery trunks. **C)** Snapshot of the surgical site shows the clipped aneurysm and distal MCA trunks quite similar to the estimated arterial configuration. **D)** Three-dimensional reconstruction of the case made by the senior author using bone-wax material shows the clipped MCA bifurcation aneurysm in relationship with the M1 segment and distal M2 trunks. (**DSA:** Digital subtraction angiography, **MCA:** Middle cerebral artery, **M1:** Middle cerebral artery proximal segment; **sM2:** Superior trunk of middle cerebral artery, **iM2:** Inferior trunk of middle cerebral artery, **An:** MCA bifurcation aneurysm).

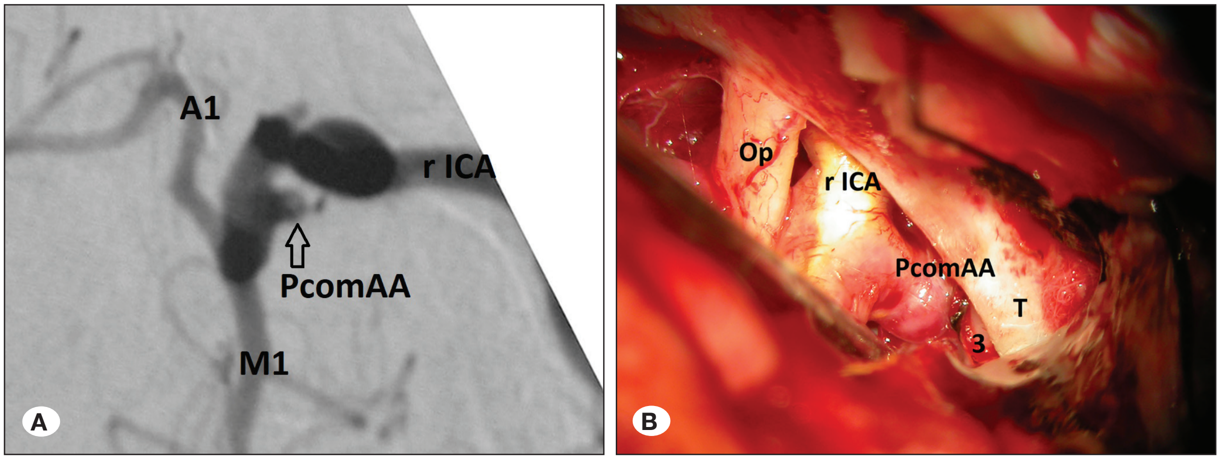

Figure 4: Angularly adjusted right carotid oblique digital subtraction angiography (DSA) view in a case of a right posterior communicating artery aneurysm (PcomAA). **A)** Adjusted picture according to the orientation of the proximal internal carotid artery in the surgical field showing the actual orientation of the Pcom aneurysm. **B)** A safer and more confident exploration of the aneurysm can now be undertaken based upon the adjusted angiographic findings. (**ICA:** Internal carotid artery, **Op:** Optic nerve, **r:** Right, **T:** Tentorium, **3:** Oculomotor nerve, **PcomAA:** Posterior communicating artery aneurysm).

With the development of three-dimensional imaging techniques, specifically 3D-CTA, and the widespread use of new computer technologies and development of computer software for creating three dimensional views (e.g., OsiriX®), reports on the use of three dimensional angiographic views simulating the surgical view of arteries and aneurysms have been reported in the neurosurgical literature (3,6,9,10,12,15,17). In 2004, Futami et al. reported the first example of a simulated aneurysm clipping based on the 3D-CTA data (3). In 2005, Siabilis et al. reported a reproduction of the surgical field with the use of 3D-CTA, an important case of simulating the surgical field (15). From 2010 on, reports on the use of the 3D-CTA data to evaluate the surgery of intracranial aneurysms have been published in the literature. The commonality in these pioneering works is the widespread use of 3D-CTA and the development of new computer software to assess the accuracy of 3D-CTA techniques (6,8,9,10,13,16,17).

For a better and more effective use of angiographic views in surgery for intracranial aneurysms, we set out to test a very simple adjustment technique. We define a rotation of angiographic images in order to angularly adjust the vessel courses as encountered in the beginning of surgery, thus obtaining rotated images that match the surgical field, very comparable to the use of microscope-integrated near-infrared indocyanine green videoangiography during surgery (1,7).

We propose a technique for more optimal use of the imaging data from any angiographic technique. The proposed technique is straightforward and does not require sophisticated technology. If the surgeon has only radiological hard copies of angiographic views, he or she can easily rotate images, or, in the case of on-screen computerized angiographic views, simple image programs that allow angular rotation (e.g. Microsoft Office Picture Manager®) can be used in computers in operating rooms (Figure 3A).

There are limitations to this technique. Due to the two-dimensional evaluation of the three-dimensional vascular structure, minor angular inaccuracies and limitations in adjustment are likely to occur. However, these are most often negligible in terms of surgical practice.

CONCLUSION

In conclusion, the angular adjustment technique, done manually and/or using common on-screen image software, is good enough to match the angiographic data with the surgical field under the operating microscope from the point of view of the surgeon. The technique shows actual vector directions of the fundus of the aneurysm in conjunction with proximal and distal arteries, and consequently enables the neurosurgeon to expose the aneurysm and arteries with more confidence and safety.

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AUTHORSHIP CONTRIBUTION

Study conception and design: TH

Data collection: TH, EA

Analysis and interpretation of results: TH, EA, BCK

Draft manuscript preparation: TH, BCK

Critical revision of the article: TH, EA, BCK

All authors (TH, EA, BCK) reviewed the results and approved the final version of the manuscript.

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