Anterior communicating artery aneurysm surgery: Determining the most appropriate head position.

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Running head: Head position in anterior communicating artery aneurysm surgery

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Abstract

Object: Head positioning and the degree of rotation for anterior communicating artery aneurysm surgery is controversial. With this study, we aimed to give a broad description of head positioning for various aneurysm dome projections.

Methods: Using a corrosion-cast technique, a three-dimensional arterial tree was demonstrated, an anterior communicating artery region aneurysm model was prepared, and pictures were taken at various angles. Brain arteries of 3 cadaveric heads filled with colored latex were studied bilaterally. Following this procedure, a pterional surgical approach was performed. The aneurysm model was developed on cadavers for their intraoperative position and for each projection; pictures demonstrating the microscopic surgical view were taken at 15° intervals. All dissections were performed using a surgical microscope (Carl-Zeiss, NC 4-Germany), and for each dome projection, determination of the most suitable head positioning was ascertained.

Results: According to our observations, 30° of rotation was found as the most suitable position for the anterior projection. This angle was the best position for controlling the contralateral A1 and A2 parts of the anterior cerebral artery with the aneurysm neck. A1 perforators and ipsilateral A1 and A2 segments were the most important structures to be protected. In addition, all arterial branches of this region were identified and their relationships were documented. Between A1 and A2, the best view of the aneurysm neck was obtained with 15° rotation with a posterior projection, while 30° was the best angle for a superior projection. Aneurysms projecting inferiorly necessitated the greatest rotation at 45°.

Conclusions: Aiming at minimally invasive procedures, we tried to improve the surgeon’s orientation during anterior communicating artery surgeries. Detailed arterial anatomical

knowledge of each dome projection may reduce intraoperative complications and concomitant morbidity.

Key Words: Anterior communicating artery aneurysms, surgical head position, subarachnoid hemorrhage, parenchymal hematoma, ventricular hematoma

Abbreviations: A1, Proximal segment of anterior cerebral artery; A2, postcommunicating segment of anterior cerebral artery; ACoA, Anterior communicating artery; ACoAA, Anterior communicating artery aneurysm.

Introduction

The success of an operation is dependent not only on advanced microsurgical instruments, timing and correct indications but also surgical positioning.[7,17,18] Position is especially important when minimal tissue ecartation is desired. In aneurysm surgery, minimal tissue manipulation should be done in order to prevent the development of postoperative vasospasm. However, a review of the literature demonstrated a range of suggestions for anterior communicating artery aneurysm (ACoAA) surgical positioning.[3,4,10,14] In this study, we aimed to determine the most appropriate positions in aneurysm surgery on the ACoA by creating a cadaver model.

Materials and Methods

This study was performed at Ankara University Faculty of Medicine, Department of Anatomy, Surgical Neuroanatomy Laboratory and the Department of Neurosurgery operating room. First, a corrosion injection-molding technique, which was previously applied to other arteries, was used to show three-dimensional anatomy of the brain arteries. [15,16] A fresh human brain was irrigated by cannulating the internal carotid and basilar arteries. These vessels were filled with colored polyester blend. For this purpose, polyester (50 ml), pigments and catalyst (2.5 ml) were mixed in a bottle at room temperature and an accelerator (2.5 ml) was added. Then, this mixture was injected through the cannulae within a period not exceeding 7 minutes. The brains were stored in containers filled with diluted sulfuric acid for the corrosion process and debris removed with water. This method provided a three-dimensional view of the brain arteries (Fig. 1). After placing a synthetic substance for creating an aneurysm model, camera images (Fuji Finepix S7000) were obtained at different angles. The relationship between vascular structures adjacent to the ACoAA was evaluated (Fig 2). After corrosion images were taken, a cadaver model was developed. Three human cadavers were used in the study. All cadavers were male with a mean age of 60.3 (52, 61 and 68 years, respectively). Cadavers were filled with colored latex and fixed using 10% formaldehyde. All dissections were performed using surgical instruments and a three-pin head rest to place the head for skull fixation. The hair was generously shaved. The skin incision curves began at the level of the zygoma about 5 mm anterior to the tragus. The incision was continued in a straight line superiorly for 8-10 cm and then curved gently anteriorly to reach the level of the normal hairline at the midline. The scalp and temporalis muscle were lifted as a single flap and the craniotomy was performed with three burr holes. The sphenoid ridge and the bone overlying the anterior temporal lobe were then removed. The dura was opened in a curvilinear fashion and retracted over the base. The dissection proceeded under the operating microscope (Carl-Zeiss, NC-4, Germany). The sylvian fissure was opened. Both the A1 segment, the proximal portion of the A2 segment and its branches, the ACoA, the recurrent artery of Heubner, and the orbitofrontal, frontopolar and perforating arteries were dissected. Arachnoid bands were carefully cleaned of branches and perforating arteries. A small resection was performed of the ipsilateral gyrus rectus.

The falx cerebri was defined as the midline. Images were obtained for each projection of the aneurysm fundus (superior, inferior, anterior, posterior) at 15° intervals from 0° up to 45° by turning the head under the microscope. The most suitable head position for each projection of the aneurysm was then determined.

Results

Anterior Projection

The aneurysm was located superior to the ACoA and projected forward to the distal part of the anterior cerebral artery but this did not include the distal A2 segments. The aneurysm fundus was located inferior to the optic nerve and medial to the recurrent artery of Heubner. The most important anatomic structure in this projection was the contralateral A2 segment.

Zero Degree (0°): The ipsilateral recurrent artery of Heubner and the orbitofrontal and frontopolar arteries were larger than in the surgical field, and the aneurysm neck remained covered by the fundus in this view.

Fifteen Degrees (15°): In this view, the fundus of the aneurysm prevented visualization of the neck of the aneurysm. Because the fundus was located slightly more laterally, the aneurysm neck began to partially emerge but the view was still insufficient for clipping the aneurysm neck.

Thirty Degrees (30°): In this view, both A1 and A2 segments and the recurrent artery of Heubner were clearly seen. The neck of the aneurysm was in the middle of the surgical exposure. A 30° angle was found to be the most suitable head position for the anterior projection of the ACoAA (Fig 3).

Forty-five Degrees (45°): In this view, visualization of the aneurysm neck was adequate, but the contralateral A2 segment was covered by the aneurysm fundus. In addition, the ipsilateral recurrent artery of Heubner and the orbitofrontal and frontopolar arteries were too prominent in the surgical field.

Posterior Projection

The aneurysm fundus protected by the occipital lobe, and was located posterior to the A2 segment. It was covered by the contralateral orbitofrontal and frontopolar arteries. The perforating branches of the ACoA were located at the base of the aneurysm neck. The most important anatomical structures in this projection were the hypothalamic arteries.

Zero Degree (0°): In this view, the aneurysm was not clearly seen because of the perforating arteries of the ACoA and A2; only a part of the aneurysm base could be seen. There was no corridor for approaching the aneurysm.

Fifteen Degrees (15°): In this view, perforating branches of the ACoAA and fundus of the aneurysm could be more easily seen. There was a surgical corridor toward the aneurysm between the A1 and A2 segments. This was found to be the most suitable head position for anteriorly projecting ACoAA (Fig 4).

Thirty Degrees (30°): After rotating the ipsilateral A2 segment, the aneurysm could be visualized slightly better but the neck of aneurysm could not be seen sufficiently for clipping. The perforating branches of the ACoA were too prominent in the surgical area in this view.

Forty-five Degrees (45°): The aneurysm was completely covered by perforating arteries and the orbitofrontal artery. The neck of the aneurysm could not be clearly visualized.

Superior Projection

The aneurysm was located between both A2 segments and the aneurysm fundus projected in the same direction as the A2 segments. The aneurysm was covered by the contralateral A2 segment and the proximal segment of the recurrent artery of Heubner. The most important anatomic structures in this projection were the recurrent artery of Heubner and the A2 segment.

Zero Degree (0°): In this view, the recurrent artery of Heubner and the A2 segment were clearly seen. The aneurysm fundus was seen between both A2 segments but the aneurysm neck could not be clearly seen.

Fifteen Degrees (15°): Visualization of the aneurysm was slightly better but the aneurysm neck was still not clearly seen.

Thirty Degrees (30°): After 30° of rotation, the contralateral A2 segment, recurrent artery of Heubner and neck of the aneurysm were clearly seen. The most suitable head position a superiorly projecting ACoAA was found to be the 30° angle (Fig 5, 6).

Forty-five Degrees (45°): In 45° of rotation, the ipsilateral recurrent artery of Heubner was seen to emerge entirely into the surgical field. The contralateral A2 segment and recurrent artery of Heubner prevented visualization of the aneurysm.

Inferior Projection

The aneurysm fundus projected toward the skull base in this view and the most important anatomic structures seen were the hypothalamic arteries. In this projection, the recurrent artery of Heubner and the A1 and A2 segments were seen much more clearly viewed compared to the other projections.

Zero Degree (0°): In this view, the aneurysm fundus was seen but the aneurysm neck could not be clearly seen.

Fifteen Degrees (15°): In this view, the ACoA and A1 segment were located in the middle of this view. The neck of the aneurysm could not be visualized in this projection.

Thirty Degrees (30°): In this view, the aneurysm neck was seen but the perforating branches of the ACoA posed a serious obstacle.

Forty-five Degrees (45°): In this view, the aneurysm neck and perforating branches of the ACoA were visualized better. The most suitable head position for the inferior projection of the ACoAA was found to be the 45° angle (Fig 7).

Discussion

Establishment of head position is one of the most important steps in ACoAA surgery.[1,2,5,7,13] Aneurysm control should be done by clipping the aneurysm with minimal tissue manipulation and dissection in the best possible head orientation. A number of different head positions for ACoAA surgery have been described in the literature. For example, Meyer et al.[6] suggested that the head must be rotated a maximum of 30° towards the opposite side, and that this angle should not be exceeded. Yaşargil [17,18] and Roux et al.[8] emphasized the need to position the head rotated 30° and Tamargo et al.[12] stated that ACoAA surgery required an angle between 30-45°. Sekhar et al.[11] and Samson et al.[9] suggested head positions of 45° and 60°, respectively. We classified ACoAA separately according to 4 different projections, and attempted to determine the most suitable degree of head rotation for each projection.

Optimal head positions for anterior and superior projections of the ACoAA were obtained at 30°. With 30° rotation, the A1 segment, A2 segment, recurrent artery of Heubner, and aneurysm neck were clearly seen for the anterior projection. For the superior projection, the contralateral A2, recurrent artery of Heubner and aneurysm neck were also clearly seen with 30° of rotation. In the literature, Yasargil et al.[17,18] proposed 30° of rotation. Roux et al. [8] also reported that the head should be rotated 30° in order to keep the contralateral A2 out of the field.

For a posterior projection, the most suitable head position was found to be 15°. In this view, the origin of the perforating arteries and aneurysm neck could be clearly visualized. A review of the literature revealed that the nearest similar position was suggested by Meyer et al[6].

For an inferiorly projected ACoAA, the most suitable head position was found to be 45°. In this view, the aneurysm neck and perforating branches were clearly seen. Tamargo et al. [12] and Sekhar et al.[11] also suggested 45° of head rotation with such aneurysms.

Conclusion

In this study, we emphasize that each aneurysm dome projection of the ACoAA should be individually considered and the head position adjusted accordingly. The use of appropriate head positions during surgery will prevent the development of postoperative ischemic complications and will increase the success of surgery by preventing unnecessary tissue manipulation.

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Figure Legends

Figure 1: Appearance of the brain arteries after corrosion technique. ICA: internal carotid artery; MCA: middle cerebral artery; ACA: anterior cerebral artery

Figure 2: Appearance of the aneurysm model. AcoAA, anterior communicating artery aneurysm model; MCA: middle cerebral artery; DACA:distal anterior cerebral artery.

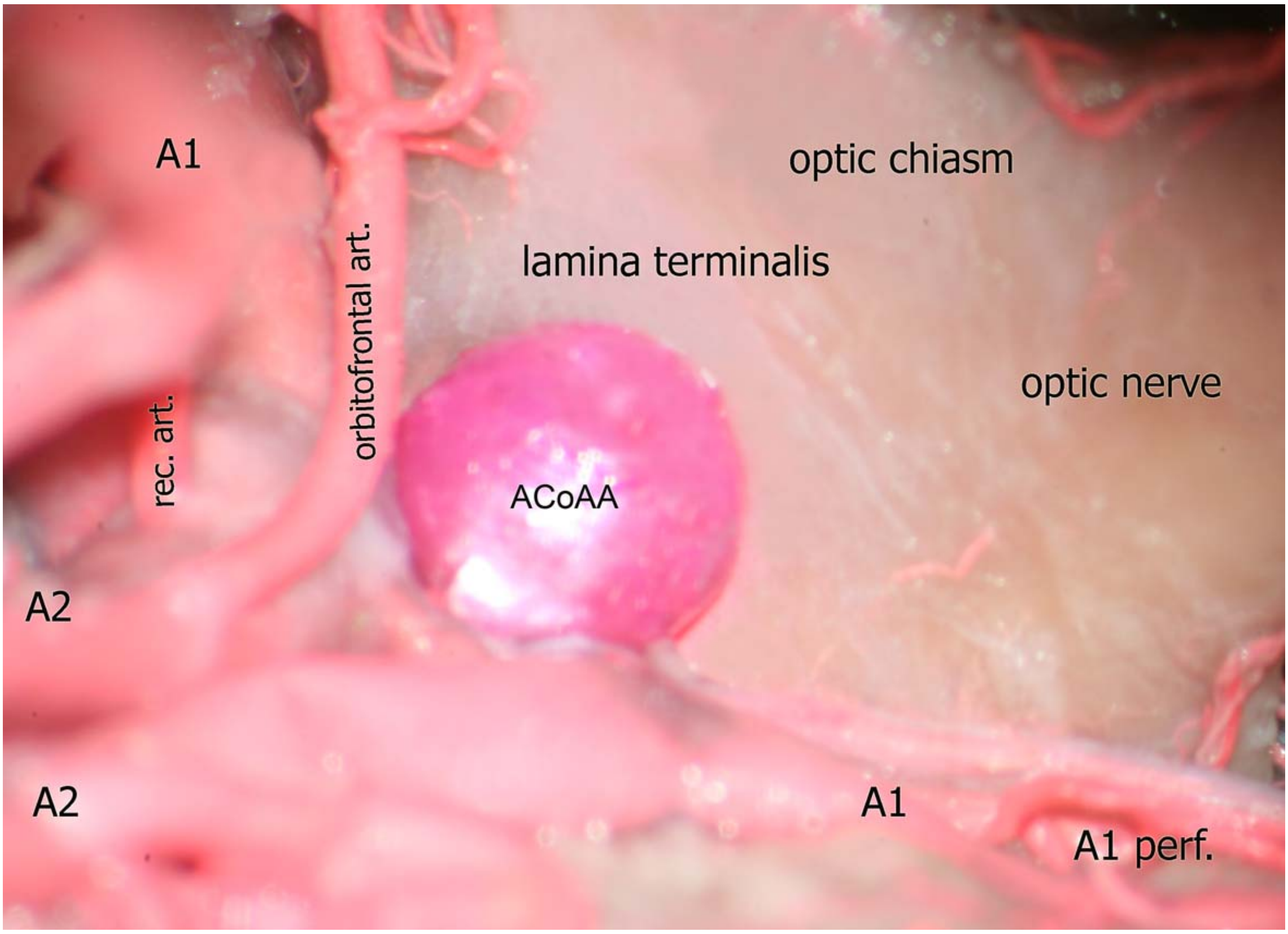
Figure 3: Anteriorly projected ACoAA and view of related vascular structures in 30° of head rotation. AcoAA: Anterior communicating artery aneurysm model; rec. art: recurrent artery of Heubner; orbitofrontal art.:orbitofrontal artery.

Figure 4: Posteriorly projected ACoAA and view of related vascular structures in 15° of head rotation. AcoAA: Anterior communicating artery aneurysm model; rec. art: recurrent artery of Heubner; orbitofrontal art.:orbitofrontal artery; perf. art. perforating arteries.

Figure 5: Superiorly projected ACoAA and view of related vascular structures in 30° of head rotation. AcoAA: Anterior communicating artery aneurysm model; rec. art: recurrent artery of Heubner; orbitofrontal art.:orbitofrontal artery.

Figure 6: Clipping view of superiorly projected ACoAA in 30° of head rotation. AcoAA: anterior communicating artery aneurysm model AcoAA: Anterior communicating artery aneurysm model; rec. art: recurrent artery of Heubner; orbitofrontal art.:orbitofrontal artery.

Figure 7: Inferiorly projected ACoAA and view of related vascular structures in 45° of head rotation. ACoAA: Anterior communicating artery aneurysm model; rec. art: recurrent artery of Heubner; orbitofrontal art.:orbitofrontal artery; A1. perf.: perforator arteries originating from the proximal segment (A1) of the anterior cerebral artery.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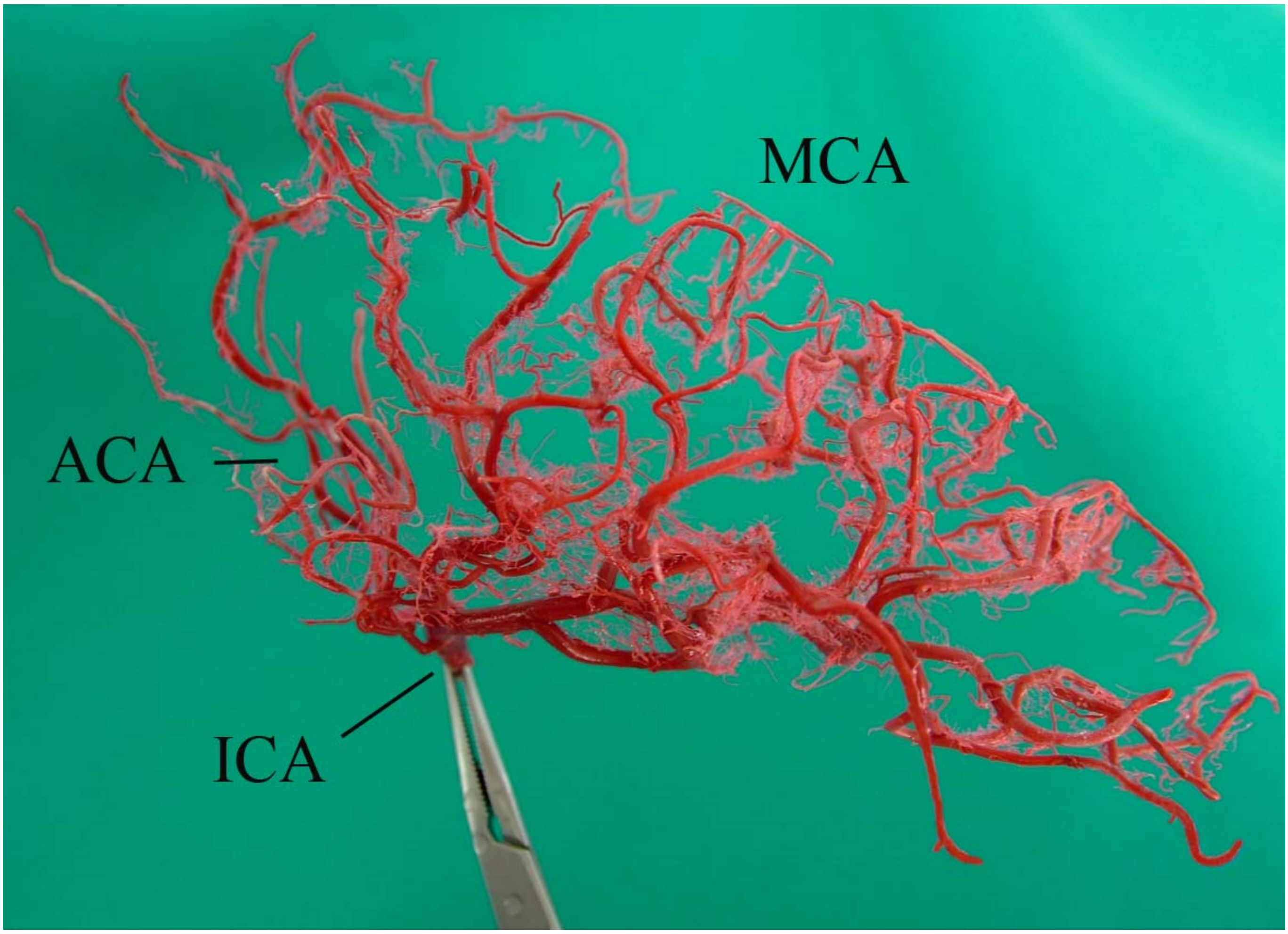
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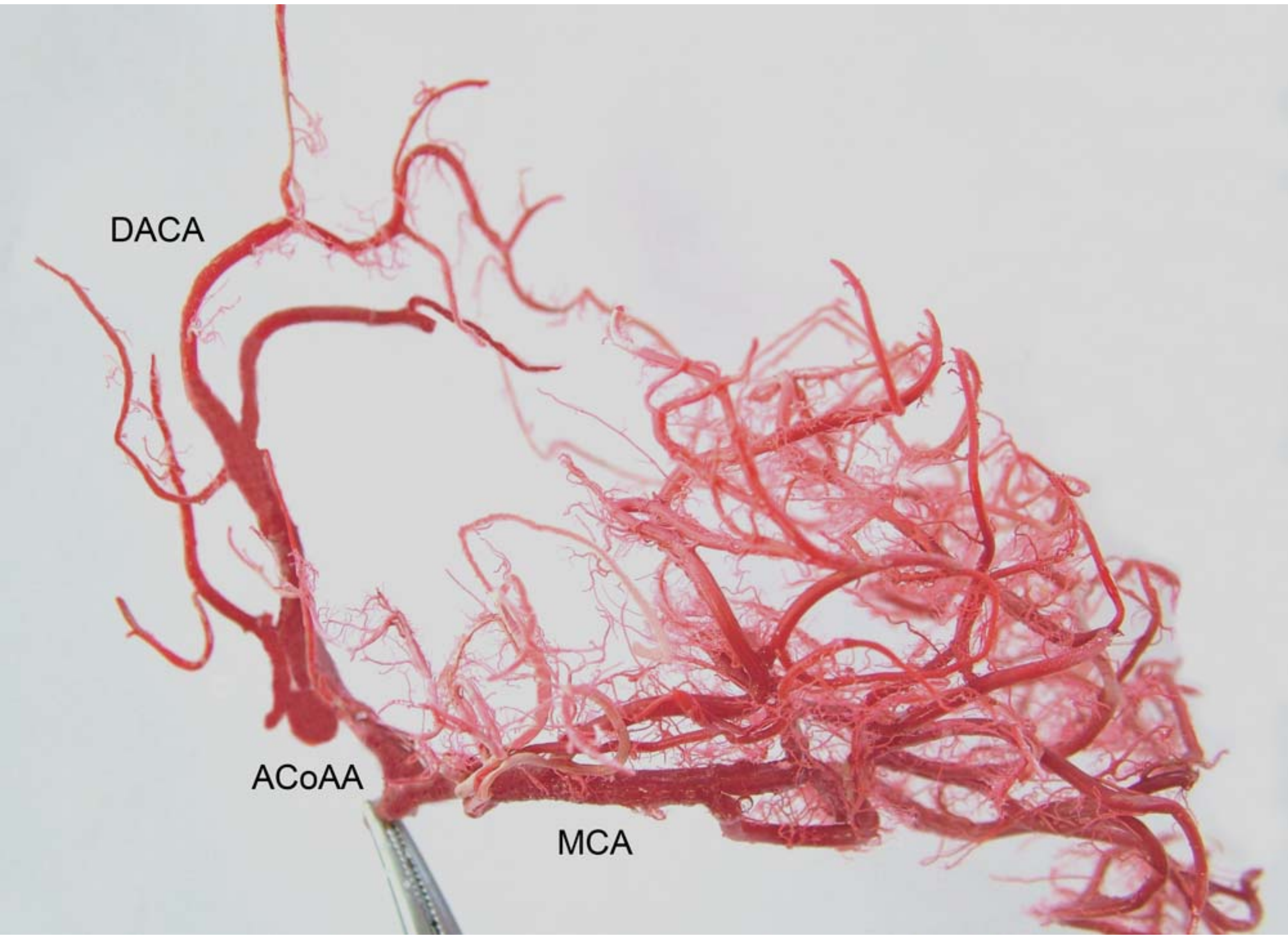
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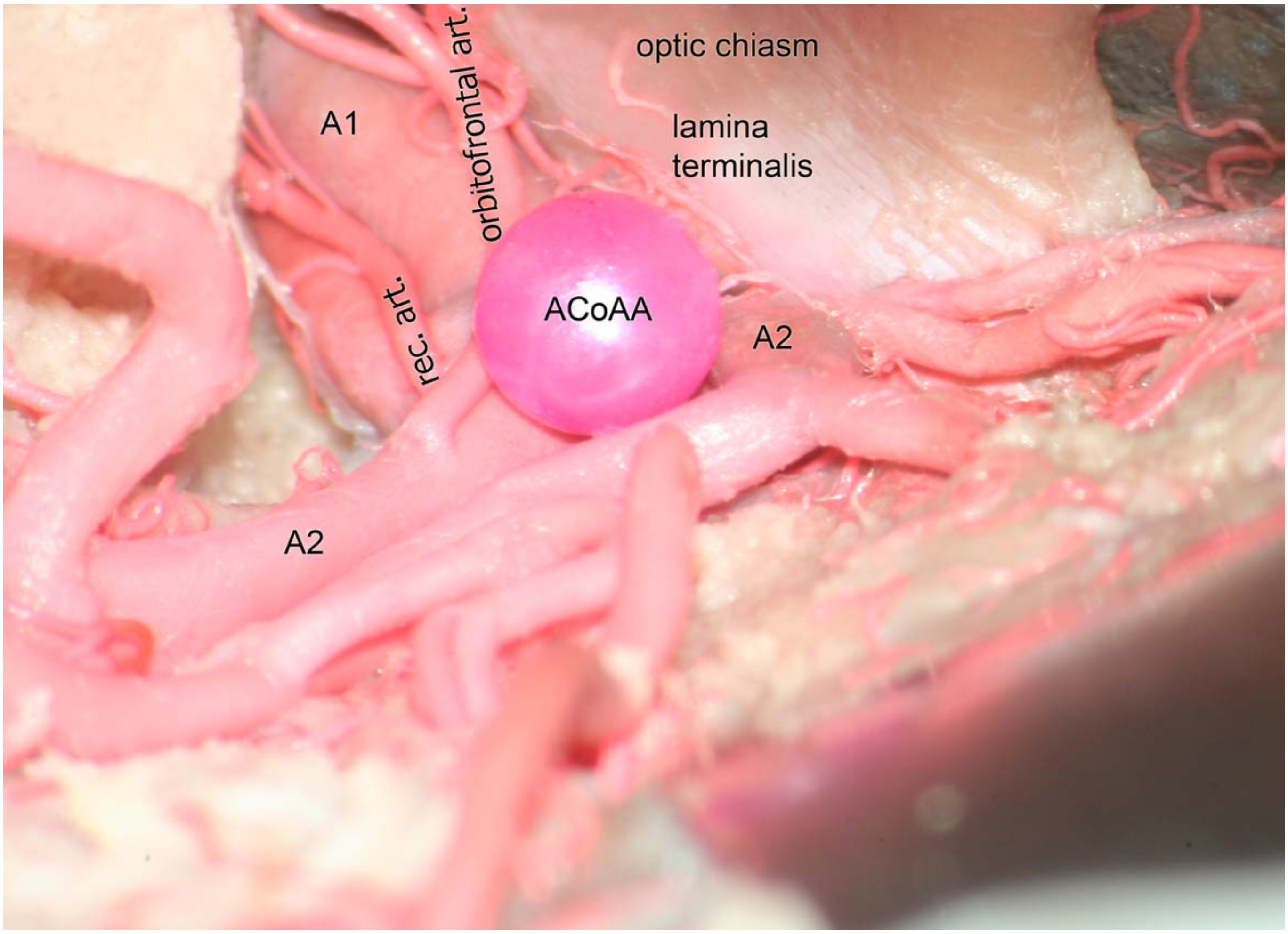
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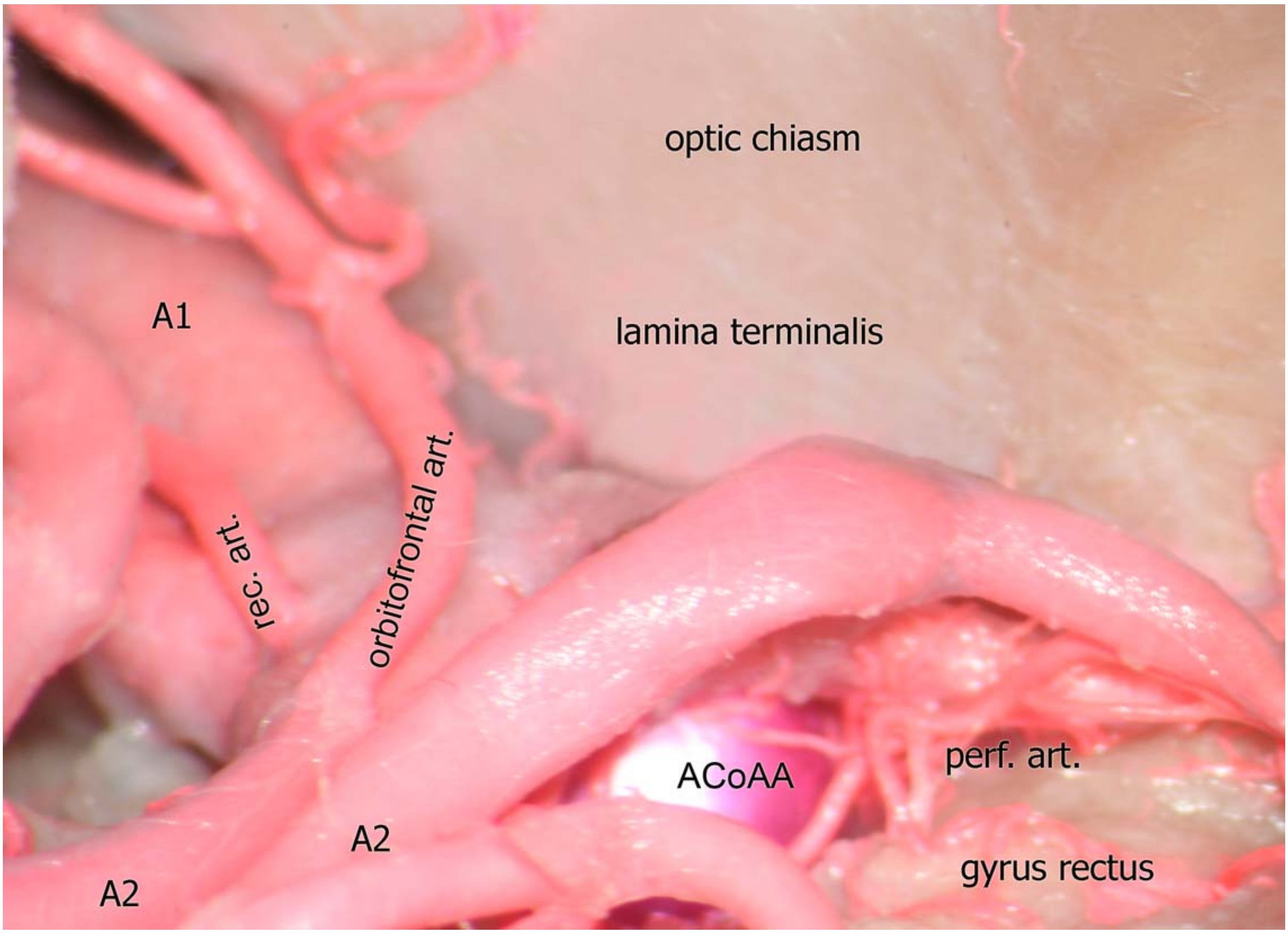
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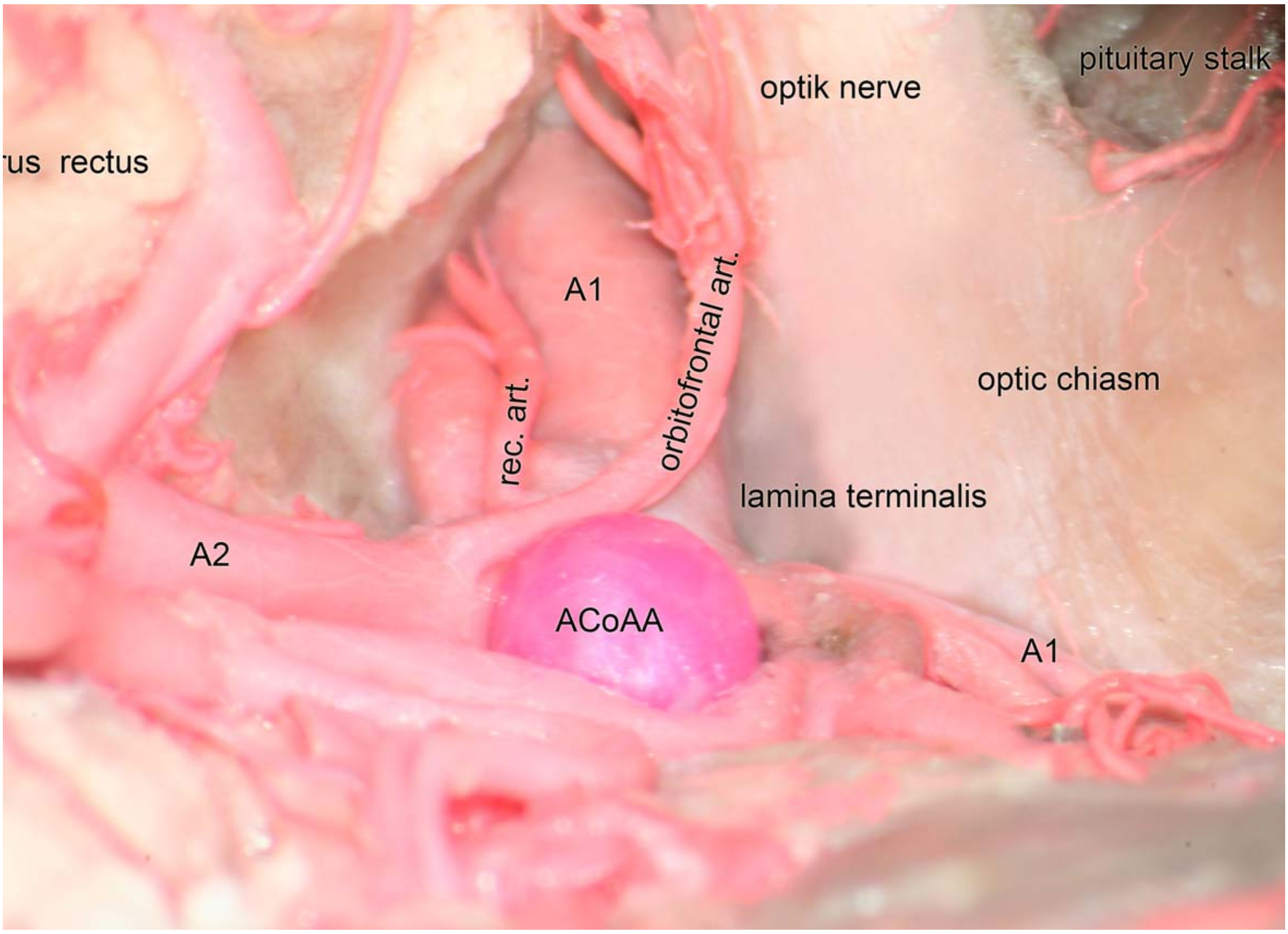
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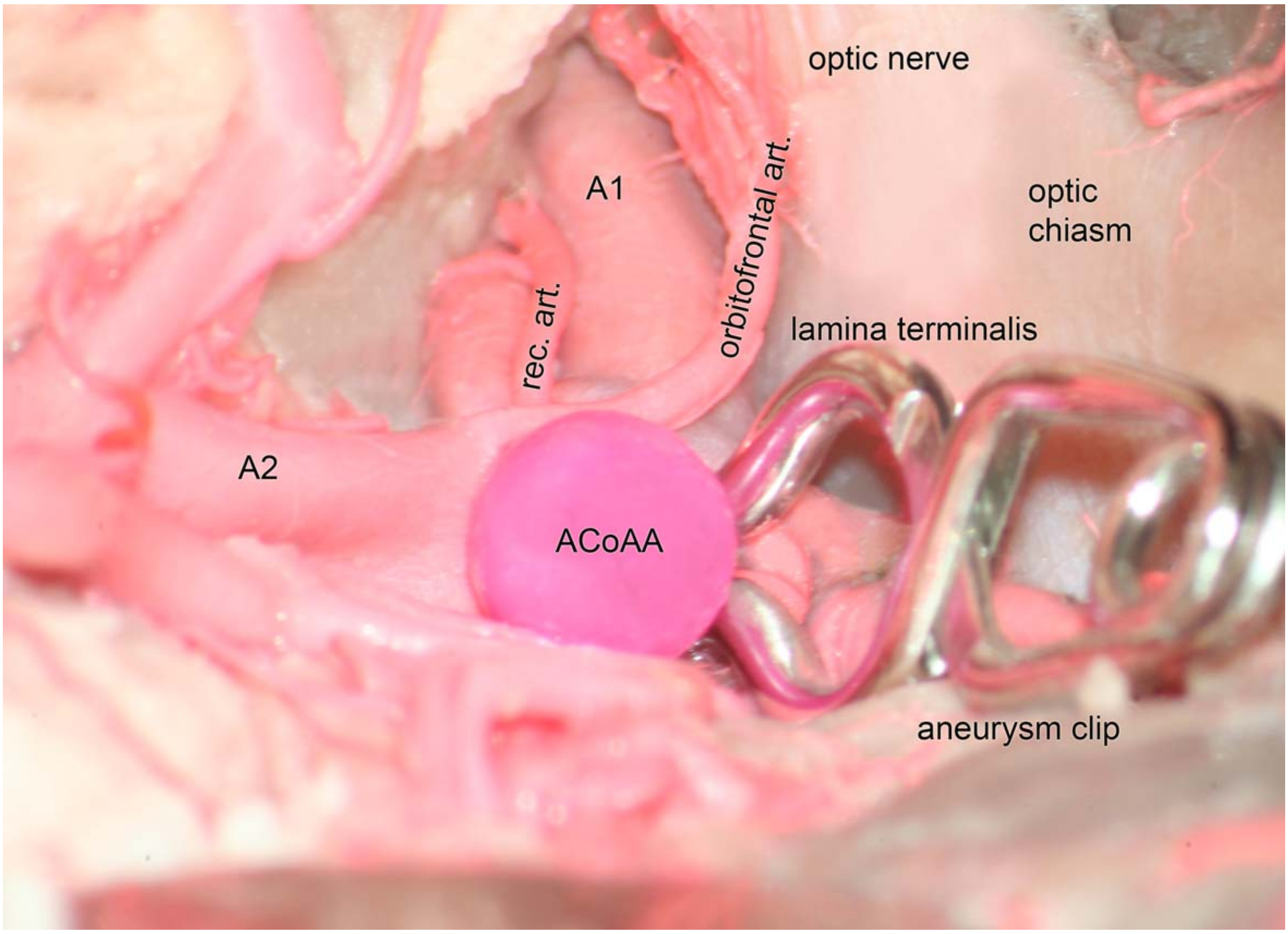
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