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Angiographic and preoperative assessment: number of perforating arteries in patients with anterior communicating artery segment aneurysms

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ABSTRACT

Background: This study focuses on comparing and predicting the number of perforating arteries (PA) of the anterior communicating artery (AcoA) preoperatively by using cerebral angiographic studies and perioperative surgical observations.

Materials and methods: From April 2010 - March 2012, 13 patients with subarachnoidal haemorrhages undergoing surgery to repair an AcoA aneurysm were evaluated with digital subtraction angiography (DSA) and perioperative surgical observations available for the study. Each patient's number of PA arising from AcoA was investigated based on DSA imaging. DSA examinations were retrospectively evaluated by three neuroradiologists. The perioperative surgical observations were evaluated together by two neurosurgeons who performed surgical procedures.

Results: The number of PA of AcoA was classified into four groups. Group 1: No PA; Group 2: PA 1 to 3; Group 3: PA 4 to 6; Group 4: PA> 6. In our study, in 6 of 13 patients (46.1%) three radiological evaluations were in accordance with each other; in 8 (61.5%) cases the number of PA found in surgical observation was higher than the number obtained from at least two radiologic examinations. In all radiological examinations, PA numbers were most commonly (%61.5) classified as Group 2 (PA numbers between 1-3); in 76.9% of cases, the number of PA found in surgical observation was equal or more than those of radiological evaluations. Additionally, in 5 (38.4%) cases, the number of PA found in surgical observation was higher than the number of those radiologic examinations. **Conclusion:** We found that the number of perforating arteries of AcoA segment obtained from the surgical observation is slightly higher than the number obtained from the preoperative DSA assessment.

Keywords
angiographic, preoperative assessment, arteries, artery segment aneurysms

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Introduction

Anterior Cerebral Artery (ACA) and the Perforating artery (PA) of the Anterior Communicating Artery (AcoA) segment carry significant importance in clinical and surgical interventions. Personality changes, decreased spontaneous activity, memory defects similar to Korsakoff's syndrome and mineral imbalance have been described due to impairment of the perforating arteries of the AcoA (1, 3, 11-14, 16). Preoperative diagnostic angiographic assessment is a notable tool for defining regional vascular pathologies, especially the saccular aneurysms and endovascular treatments. It is essential to identify perforating arteries during surgical and endovascular treatments of saccular aneurysms. Precise assessement of the perforating arteries and being aware of the possible vascular anomalies are key factors in preoperative evaluations specifically for AcoA aneurysms. High variety and small diameters of the perforating Arteries of the Anterior Comunicating Artery (AcoA) segment cause difficulties in angiographic imaging (6, 13).

Different numbers and distributions of AcoA perforators can be seen during the surgeries. Literature review reveals insufficient information about cadaveric dissection studies on perforating arteries (5, 7, 8, 10, 12-14). We compared the perioperative observations and intraoperative microscope records with the cerebral digital subtraction angiography (DSA) of the AcoA perforators from AcoA aneurysm surgeries performed in our department.

In our knowledge, this is the first study comparing DSA evaluation of AcoA perforators with surgical observation. The purpose of our study is to determine the preoperative DSA imaging precision and reliability on numbers of perforating arteries of the Anterior Communicating Artery (AcoA) evaluated by Neuroradiologists, which could change the surgical approach and management of the case.

Materials and methods

Our study was conducted on thirteen patients who were admitted to the neurosurgical clinic of the Dr. Lütfi Kırdar Kartal Teaching and Research Hospital between April 2010 – March 2012 with spontaneous subarachnoid hemorrhages (SAH), undergone a 4-way digital subtraction angiography (DSA) (both carotid and vertebral arteries) which revealed anterior communicating artery aneurysms (AcoAA). Patients were preoperatively evaluated for SAH by using Fisher Grading and WFNS grading systems.

Only sufficiently valuable images, obtained intraoperatively through the occular of the microscope of the AcoAA cases were included in the study. Cases not fitting this criteria were excluded.

The angiographic images, containing both carotid and vertebral arteries, were obtained using a 4-way digital subtraction angiography (DSA) in a different hospital. Perforating arteries of the anterior comunicating artery segment were evaluated by DSA for every participating patient. Perioperative images were taken with Nikon Coolpix 4500 Japan photo camera.

Retrospective assesement of DSA imaging was conducted by skilled radiology operators and were evaluated by three Neuroradiologist. The intraoperatively collected recordings and perioperative observations were evaluated by two Neurosurgeons, who were experienced in vascular surgery.

The number of perforating arteries (PA) of AcoA was classified into four groups. Those are, Group 1: No PA; Group 2: PA 1 to 3; Group 3: PA 4 to 6; Group 4: PA> 6.

Results

For our study, we included 13 patients, ages varied from 28-70, 4 patients were female while the remaining 9 were male. 11 patients were classified as Fisher grade 2; 1 patient as Grade 3 and 1 patient as Grade 4. 8 patients were classified as WFNS grade 1, 4 patients as grade 2 and 1 patient as grade 3.

Radiologic assessment

The DSA results were retrospectively evaluated by three specialized radiologists. The assessment was done retrospectively at different radiology institutions. Double-blinded assessments of the obtained DSA images were conducted by neurologically specialized radiologists not familiar with the cases. 6 patient had dominant inflow from the left anterior cerebral artery (3 female, 3 male), 7 patient had dominant inflow from the right anterior cerebral artery (1 female, 6 male) (Table 1).

First Neuroradiologist (NR-1) evaluations of DSA revealed; no perforating artery of AcoA seen in 2 patients (Group 1); 1-3 perforating arteries of AcoA

seen in 7 patients (Group 2); 4-6 perforating arteries of AcoA seen in 4 patients (Group 3) (Table 2).

Second Neuroradiologist (NR-2) evaluations of DSA revealed; no perforating artery of AcoA seen in 2 patients (Group 1); 1-3 perforating arteries of AcoA seen in 11 patients (Group 2). No patient was evaluated as Group 3 (Table 2).

Third Neuroradiologist (NR-3) evaluations of DSA revealed; no perforating artery of AcoA seen in 2 patients (Group 1); 1-3 perforating arteries of AcoA seen in 6 patients (Group 2); 4-6 perforating arteries of AcoA seen in 5 patients (Group 3)(Table 2).

In our study, it was seen that all three radiological assessments overlap with each other in 6 cases (46.1%) (Case No. 5, 6, 7, 8, 10, 12). On all radiological examinations, PA was found to be the most common (61.5%) between 1 and 3 (Group 2).

Table 1. Display of cases according to age, gender, aneurysm filling direction, Fisher Grade, WFNS Grade.

Case No	Age	Gender	Fisher Grade	WFNS Grade	Aneurysm filling direction
01	30	Female	2	3	Left
02	50	Male	2	1	Right
03	38	Female	2	2	Left
04	65	Male	4	2	Right
05	70	Female	2	1	Right
06	63	Male	2	1	Right
07	62	Male	2	1	Left
08	65	Male	2	1	Right
09	40	Male	2	1	Left
10	63	Male	3	2	Right
11	69	Female	2	1	Left
12	44	Male	2	1	Right
13	28	Male	2	2	Left

Table 2. Comparison of radiologic data and number of intraoperative perforating arteries.Group 1: 0 (no PA seen); Group 2: PA numbers 1-3; Group 3: PA numbers 4-6 ; Group 4 : PA numbers more than 6.

Case No	Neuroradiologist-1	Neuroradiologist-2	Neuroradiologist-3	Surgical assessment
01	0	1 - 3	4 - 6	4 - 6
02	4 - 6	1 - 3	4 - 6	4 - 6
03	1 - 3	0	0	1 - 3
04	1 - 3	1 - 3	4 - 6	> 6
05	1 - 3	1 - 3	1 - 3	1 - 3
06	1 - 3	1 - 3	1 - 3	4 - 6
07	1 - 3	1 - 3	1 - 3	4 - 6
08	1 - 3	1 - 3	1 - 3	1 - 3
09	4 - 6	1 - 3	4 - 6	> 6
10	1 - 3	1 - 3	1 - 3	1 - 3
11	4 - 6	1 - 3	4 - 6	4 - 6
12	0	0	0	1 - 3
13	4 - 6	1 - 3	1 - 3	4 - 6

Surgical assessment

Results collected from the exact digital images obtained from intraoperative microscope and from the intraoperative records of two neurosurgeons specialized in vascular surgery; all patients revealed perforating arteries of AcoA, 1-3 perforating arteries of AcoA seen in 5 patients (Group 2), 4-6 perforating arteries of AcoA seen in 6 patients (Group 3), more than 6 perforating arteries of AcoA seen in 2 patients (Group 4) (Table 2).

Result of surgical assessment revealed that 38,4% (5/13) of all cases had 1-3 perforating arteries (Group 2).

Comparison of assessments

Radiologic and surgical assessments were compared to evaluate preoperative DSA's predictivity and reliability on PA.

Equal or more numbers of perforating arteries (PA); 10/13 (76,9 %) were obtained from surgical evaluation compared to radiological assessment (Case No. 1,2,3,4,6,7,9,11,12,13). Eight (61,5%) cases revealed high PA numbers from surgical assessment compared to two radiological assessments.

In 8 cases (61,5%) at least one of the three radiological evaluation classified perforating artery group (PA) same as surgical assessment. In 5 cases (38,5%) sugical assessments showed more PA numbers than in all radiological assessments.

In one case (Case No. 1) eventhough all radiological evaluations revealed no PA, surgical assessment classified case as Group 2 (1-3 perforating arteries of AcoA).

Discussion

Cerebral Angiography gives the best possible insight into the cerebral vascular anatomy and pathology of a patient's cerebral saccular aneurysms, hence being the most trusted and used method when encountering these patients in the neurosurgical clinic. Cerebral angiography is gained utilizing several different techniques such as 4-way Digital subtraction angiography (DSA), magnetic resonance angiography (MRA), and computed tomography angiography. DSA is still the gold standard imaging technique in most centers (2, 3).

Our clinic uses the 4-way DSA in our daily practice, leading us to use the said method again in our study to define PA number concentration. The anatomical research conducted by Türe and Serizawa on the numbers of perforating artery (PA) of the anterior communicating artery has immense importance in our study (12, 13). Türe et al. presented results showing 1-6 perforating arteries (average 2,5) with 0,15-2,1 mm diameter on AcoA segment as well as dividing the perforating arteries into three subgroups according to their orientations; hypothalamic, subcallosal, and median callosal (13).

Results obtained from the study of Serizawa et al. was conducted on 30 human cadavers and revealed 2-8 perforating arteries (average 4,1) with 0,1-0,8 mm diameter on the AcoA segment. They also divided the perforating arteries into three subgroups according to their orientation; hypothalamic, subcallosal, chiasmatic (12).

Our study aimed to determine the number of perforating arteries of the AcoA segment parallel to these two studies, which are seen in the sources and constitute the primary reference in this regard.

Our study differs from the previously mentioned two papers, as they describe the results of definitive anatomical research collected from cadavers. Our study, however, focused on the results gathered from the evaluation of DSA images and intraoperatively obtained images from the surgical microscope, giving live-pictures, hence our paper is not an anatomy paper as every patients DSA, AcoA perforators number was tried to be determined.

The existence of the Heubner artery within the arterial system was questioned during surgical interventions. Evaluating the diameter of perforating arteries was another contrasting factor of our study.

All data collected from radiologic evaluations were compared with the acquired intraoperative PA numbers from surgical procedures done by two neurosurgery specialists.

As far as our research has shown, no other PA studies are utilizing intraoperative AcoA images. We believe that our study, being the first of its kind in this field, will help create a database and lead as an example for further research.

According to our literature review, there are three major studies about perforating artery numbers. A study on 20 human cadavers conducted by Türe et al. revealed 1-6 PA (average 2,5), a study on 30 human cadavers conducted by Serizava et al. showed 2-8 PA (average 4,1), and study of Marinkovic et al. revealed only 1-5 PA (average 2) respectively. (8, 12, 13). The most common PA number, according to our radiologic assessment, is between 1-3 PA. Although our results fail to measure-up to Serizawa, they are compatible with the findings of Türe et al. and Marinkovic et al. According to surgical observation results, half of the cases were categorized as Group 3. This result is not different from the average results at the sources and appears to be in the upper and lower limits. Four main perforating artery groups of AcoA were defined in the following manner: Group 1 no perforating artery, Group 2 perforating artery number between 1 and 3, Group 3 perforating artery numbers between 4 to 6, Group 4 perforating artery number more than 6. This classification has never been defined before, yet we need a more extensive database to prove PA numbers' radiological and surgical validity between 1-6.

Our study showed that all three radiological assessments overlap with each other in 6 cases (46.1%). In all radiological examinations, PA numbers were most commonly (%61.5) classified as Group 2.

According to the results of the surgical assessment, the rate of having 1-3 PA (group 2) is only 38,4% (5/13), which shows the superiority of DSA, yet during the surgical intervention, the occurrence of PA resulted in being higher when compared to the numbers revealed by the DSA. Perforating artery numbers obtained from the surgical assessment were almost equal to or higher than the radiological assessment results (76,9%). According to surgical evaluations, 61,5% of cases have higher PA numbers than two radiological assessments, which supports the possibility of having higher numbers of PA during surgical observation than results collected from DSA imaging. Furthermore, the surgical observation revealed an even higher PA occurrence (in 38,4% cases) when looking at the previous radiological evaluations.

The numbers of perforators are a highly essential value for preoperative preparations and evaluations for aneurysms surgeries. Especially AcoA aneurysm dome projection changes both surgical approaches and relations between perforators (3, 4). Protecting these perforators is important for favorable postoperative outcomes. Preservation of perforators is necessary for hypothalamic and fornicial blood

supply to preserve memory and endocrine functions (4, 9, 15).

Our observations lead us to believe that perioperative PA encounter was higher than preoperatively taken DSA revealed.

However, to speak of a significant result for either method, a more extensive database and further studies need to be conducted to give meaningful outcome possibilities before going into surgery. Nevertheless, our study showed surgeons need to be aware of the DSA information can be less than the reality. So preoperative evaluations and surgical approach plannings need to be done by considering this.

Conclusion

Perforating artery segments of the anterior communicating artery of the anterior cerebral artery are essential structures to recognize during surgical interventions. Preoperative evaluation of perforating arteries and other vascular anomalies can cause notable differences in the outcome of AcoA aneurysm surgeries. Perforating arteries of AcoA were evaluated according to the criteria defined in previous studies. We aimed to determine the accuracy and reliability of cerebral angiographic evaluation of the AcoA segment's perforating arteries before the surgical procedure.

The DSA results were retrospectively evaluated by 3 different specialized radiologists. The intraoperatively collected recordings and images were evaluated by two neurosurgeons, experineced in vascular surgery. Our observations lead us to believe that perioperative PA encounter was higher than DSA images taken preoperatively. Surgeons should not exclude the possibility that there might be more perforating arteries than detected in DSA to avoid misleading the number of PA seen in the preoperative radiologic assessment.

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