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ORIGINAL ARTICLE **ÖZGÜN ARAŞTIRMA**

DESCRIPTION OF THE EFFECT OF ACA-A1 SEGMENT HYPOPLASIA ON ANEURYSM FORMATION IN ACOM ANEURYSMS WITH DSA

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ABSTRACT

NTRODUCTION: It is known that local vascular anatomy and related hemodynamic factors are effective in aneurysm formation. The Willis polygon that forms the cerebral artery network is asymmetric in upto 54% of population. However, this is not the only determinant of aneurysm formation. It is suggested that A1 segment hypoplasia/aplasia and hemodynamic changes in the anterior communicating artery have an effect on the formation of anterior communicating artery aneurysm. The aim of this study is to investigate any possible effect of anterior cerebral artery-A1 segment hypoplasia on the formation of anterior communicating artery aneurysm.
METHODS: In this study, digital subtraction angiography images of 535 patients, performed in our clinic, were evaluated. The patients were divided into in three groups as those having anterior communicating artery aneurysm (Group-1, 100 patients), patients with aneurysm in the anterior circulation without accompanying anterior communicating artery aneurysm (Group-2, 166 patients), and those who underwent digital subtraction angiography (DSA) due to subarachnoid hemorrhage but no aneurysm was detected (Group-3, 269 patients).
RESULTS: The frequency of hypoplasia/aplasia observed in Group-1 (45.0%) is significantly higher than Group-2 (13.3%) and Group-3 (16.4%) ($p<0.001$).
DISCUSSION AND CONCLUSION: This result suggests that A1 segment hypoplasia/aplasia can play a role in the formation of anterior communicating artery aneurysm.
Keywords: A1 segment hypoplasia, aneurysm, subarachnoid hemorrhage, anterior communicating artery.

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ANTERİOR KOMİNİKAN ARTER ANEVRİZMALARINDA ANTERİOR SEREBRAL ARTER-A1 SEGMENT HİPOPLAZİSİNİN ANEVRİZMA OLUŞUMUNA ETKİSİNİN DSA İLE GÖSTERİLMESİ

ÖZ

GİRİŞ ve AMAÇ: Anevrizma oluşumunda lokal damar anatomisi ve buna bağlı oluşan hemodinamik faktörlerin etkili olduğu bilinmektedir.Serebral arter ağını oluşturan Willis poligonu popülasyonun %54'ünde asimetriktir. Ancak anevrizma oluşumu için bu tek başına belirleyici değildir. Anterior komminikan arter anevrizması oluşumunda A1 segment hipoplazi/aplazi ve anterior komünikan arterdeki hemodinamik değişikliklerin etkisi olduğu düşünülmektedir. Bunların içerisinde en sık görülen A1 segment hipoplazisidir. Bu çalışmanın amacı anterior komünikan arter anevrizması oluşumunda, anterior serebral arter-A1 segment hipoplazisinin etkisi göstermektir.

YÖNTEM ve GEREÇLER: Kliniğimizde yapılan 535 hastanın dijital subtraction anjiografi görüntülemeleri incelenmiştir. Çalışmamızda hastalar üç gruba aytılmış olup bu gruplar anterior komünikan arter anevrizması olan 100 hasta (Grup-1), anterior komünikan arter anevrizması olmayan ancak anterior dolaşımda anevrizması bulunan 166 hasta (Grup-2) ve subaraknoid kanama nedeniyle dijital subtraksiyon anjiografi (DSA) yapılan ancak anevrizma saptanmayan 269 hasta (Grup-3) şeklindedir.

BULGULAR: Grup-1'de hipoplazi/aplazi gözlenme oranı (%45,0), Grup-2 (%13,3) ve Grup-3 (%16,4) 'ten istatistiksel olarak anlamlı düzeyde yüksektir ($p<0,001$).

TARTIŞMA ve SONUÇ: Elde edilen bu sonuç A1 segment hipoplazi/aplazisinin anterior komünikan arter anevrizması oluşumunda rol oynayabileceğini düşündürmektedir.

Anahtar Sözcükler: A1 segment hipoplazisi, anevrizma, subarakanoid kanama, anterior komünikan arter.

INTRODUCTION

The first description of a cranial aneurysm in the history of medicine were by Biumi and Morgagni in the 18th century. The incidence of intracranial aneurysm rupture varies between populations, but is approximately 2%. The incidence of incidental unruptured aneurysm is much higher (1). Incidentally detected aneurysm is increasing day by day due to the widespread use of noninvasive vascular imaging technologies and developments. The fate of the incidental aneurysms varies with their localization, morphology, and size (2). The International Study of Unruptured Intracranial Aneurysms showed that the size and localization of the aneurysm are the most important parameters for treatment decision (3). Despite appropriate surgical and/or interventional treatment, the mortality rate of subarachnoid hemorrhage due to the aneurysm is approximately 40% (4). Anterior communicating artery aneurysms are the most common aneurysm. The anterior communicating artery is the most important anastomotic formation that connects the two anterior cerebral arteries (ACA) and provides collateral circulation in the polygon of Willis, and its variations are common. Willis polygon has 54% asymmetric structure (5). A1 segment hypoplasia is a very common anatomical variant (6).

Local vascular anatomy has an impact on aneurysm formation and rupture (7). The flow in the anterior communicating artery (AComA), which acts as a bridge between the two anterior cerebral arteries (ACA), is affected by the blood flow from the bilateral internal carotid arteries (ICA) and the pressure between them. The asymmetry in the anterior cerebral artery-A1 segments and the resulting pressure gradient affect the flow in the anterior communicating artery (AComA) and consequently increase the possibility of aneurysm. (8). Anterior communicating artery aneurysm is more likely to occur on the side where the A1 segment is wider (9). The mechanism of aneurysm formation cannot be fully explained. The mechanism of formation has been tried to be explained by hemodynamic changes in the cerebral artery network (10) . The association of A1 segment hypoplasia is known in the formation of anterior cerebral artery aneurysm (11-17). We present the importance of A1 segment hypoplasia in the formation of anterior cerebral artery aneurysm with digital subtraction angiography that we performed on 535 patients in our clinic. As a result of a better understanding of the hemodynamics of intracranial vascular structures, more information can be obtained about aneurysm formation.

METHODS

Study Population: This study was conducted with the approval of Our University Faculty of Medicine, Non-Invasive Clinical Research Ethics Committee, numbered E-53043469-050.01.04-2100005331 and dated 17.01.2021. Our study was conducted in accordance with the Ethical Standards of the Declaration of Helsinki. Since it was a retrospective study, signed consent was waived. Angiograpy images of patients, treated with the diagnosis of subarachnoid hemorrhage (SAH) in the Neurosurgery Clinic of Our University Research Hospital between January 2016 and December 2020, were retrospectively collected.

Patient Selection: In the first group (Group-1), 100 patients with AComA aneurysm were evaluated; In the second group (Group-2), 166 patients with other arteries (ICA, ACA, MCA) aneurysms of the anterior circulation, and 269 patients in the third group were followed and treated for SAH but no aneurysm was detected in DSA were evaluated (Group-3). As a result, a total of 535 patients were included in the study. Patients with complications during the procedure, posterior cieculation aneurysm, intracranial mass, or vascular pathologies such as AVM, and venous angioma were not included in the study. Since the control images belonged to the same patient, control images were not included in the study in order to avoid statistical errors caused by repetition.

Hypoplasia and aplasia were differentiated from vasospasm by comparing the initial DSA scans of the patients with the control DSA scans. Hypoplasia that was seen in the first angiography after bleeding and could not be shown to be present in subsequent imaging was diagnosed as vasospasm. Anteroposterior, oblique, and lateral images of the anterior cerebral artery-A1 segment; Diameter measurements were made at the thinnest and thickest points of the artery, and the average of these measurements was taken as the average diameter of the segment. Right or left ACA-A1 segment diameter less than 50% of the other was considered as hypoplasia. A1 segment diameter less than 0.5 mm was considered as aplasia. The presence of ACA-A1 segment hypoplasia was investigated in all patients included in the study by scanning the data obtained. It was investigated whether there is a difference in the incidence of A1 hypoplasia between patients with anterior communicating artery aneurysms, patients with other artery aneurysms of the anterior circulation (ICA, ACA, MCA) and patients without aneurysm, and whether this difference contributes to the formation of anterior communicating artery aneurysm (Figure 1).

Figure 1. Left anterior cerebral artery hypoplasia of the patient with dsa image is seen in Figure 1.

Digital Subtraction Angiography: The Philips FD20 Allura clarity 30x40 image detector device and standard techniques were used for digital subtraction angiography (DSA).

Statistical Analysis: Descriptive statistics for the variables are expressed as mean and standard deviation for quantitative variables, and frequency (%) for qualitative variables. One-way analysis of variance was used for independent group comparisons. Relationships between categorical variables were examined with Pearson's chi-square analysis. Statistical significance level was accepted as $p<0.05$. SPSS v.25 package program was used for statistical analysis.

RESULTS

We included a total of 535 patients in our study. The groups have a homogeneous structure in terms of age and gender. The average age of the patients was 54.4±12.2 in group-1, 55.4±15.5 in group-2 and 52.8±16.6 in group-3;, and there was no statistically significant difference (Table 1).

The rate of hypoplasia/aplasia observed in group 1 (45.0%) is statistically significantly higher than group 2 (13.3%) and group 3 (16.4%) ($p<0.001$) (Table 2).

Table 1. Comparison results in terms of age and gender distribution of the group.

	Group 1 (n=100)	Group 2 (n=166)	Group 3 (n=269)	P
Age (year)	54.4±12.2	55.4±15.5	52.8±16.6	0.233
Male Gender; n(%)	59 (59.0)	76 (45.8)	142 (52.8)	0.101

Table 2. Comparison results of the groups in terms of the frequency of hypoplasia/aplasia observed.

	Group 1 (n=100)	Group 2 (n=166)	Group 3 (n=269)	p
Hypoplasia/Aplasia				
Present	45 (45.0)a	22 (13.3)b	44 (16.4)b	<0.00
Absent	55 (55.0)a	144 (86.7)b	225 (83.6)b	1

(Descriptive statistics are expressed as mean±standard deviation or frequency (%).Similar letters on the same line indicate statistical similarity, while different letters indicate difference).

DISCUSSION AND CONCLUSION

Aneurysm formation and the possibility of rupture have been tried to be explained by different mechanisms. The localization, size, and morphology of the aneurysm modify the probability of rupture. Anterior communicating artery aneurysm rupture are known to show a high rate of vasospasm, permanent neurological deficit, and poor prognosis. (18). The Unruptured Cerebral Aneurysm Study of Japan has shown that anterior communicating artery aneurysms are more prone to rupture than others. (2). With or without an aneurysm, the angle between the A2 and anterior communicating artery deteriorates with age. It is suggested that changes in the diameter and angle of the artery of the arterial bifurcation are among the factors associated with aneurysm formation. (19) (Figure 2).

In case of A1 segment hypoplasia or aplasia, the contrlateral A1 segment must be dominant. Previous studies have shown that increased wall stress due to unilateral increased flow coincides with aneurysm formation (8,12). Although the formation of AComA aneurysm with A1 segment hypoplasia is supported by many studies, different results have been obtained regarding its effect on morphology and rupture risk (20,21) (Figure 3).

A1 segment hypoplasia is a common anatomic variant. It has been seen between %2 and %22 in different series (12,22,23). In our study, A1 segment hypoplasia was found in %13.3 (Group-2) and %16.4 (Group-3) of patients without anterior communicating artery aneurysm. These figures were found to be compatible with the range accepted as normal anatomical variant

Figure 2. 3D angiography image of our patient with giant anterior communicating artery aneurysm.

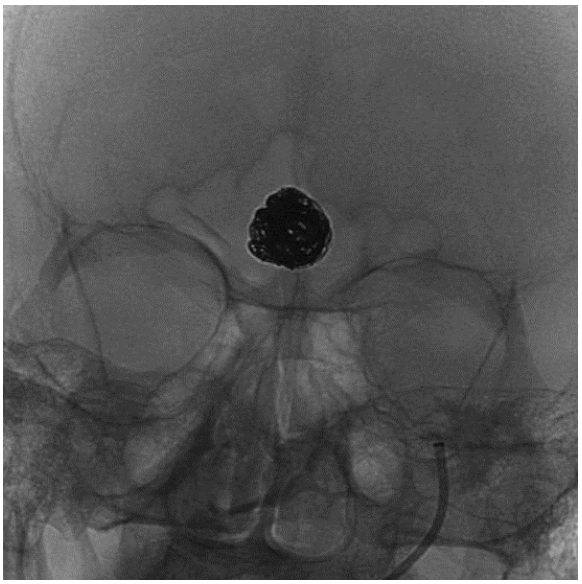

Figure 3. Our patient mentioned in Figure 5 filled the aneurysm completely with endovascular coil procedure.

in the literature (%2-22). Considering that the patients in group 2 had non-anterior communicating artery aneurysms, this result suggests that there is no relationship between other system aneurysms and the occurrence of A1 segment hypoplasia.

In case of A1 segment hypoplasia, anterior communicating artery aneurysm was documented between 41% and 85% (13). In two studies conducted on the Turkish population before our

study, the incidence rates of anterior communicating artery and A1 segment hypoplasia were found to be 50% and 41.33%, and the fact that it was close to the lower limit of the literature was thought to be related to ethnicity (11,14). In our study, this rate was found to be 45%. The similarity of the results of these three studies conducted on the Turkish population supports the idea that it is related to ethnicity.

There are a limited number of studies in the literature showing the relationship between cerebral circulation changes caused by A1 segment hypoplasia and the development of anterior communicating artery aneurysm. This study makes a significant contribution to the literature by addressing this relationship more comprehensively.

This study has some limitations. Because our study had a retrospective design and a small sample, the generalizability of our results may be limited. Conducting prospective studies with larger samples on this subject will be important to confirm and generalize our findings.

The mechanism of aneurysm formation is not fully understood. However, it is a subject that is constantly trying to be explained. The rate of hypoplasia in our patients with anterior communicating artery aneurysms was found to be higher than in patients with other system aneurysms and patients without aneurysms ($p<0.001$). This result supports the hypothesis that A1 segment hypoplasia has an effect on anterior communicating artery aneurysm formation. However, more studies are needed on this subject.

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Ethics

Ethics Committee Approval: The study was approved by Aydın Adnan Menderes University Ethical Committee of Non-Interventional Clinical Research (Date: 17.01.2021, No: E-53043469-050.01.04-2100005331).

Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective analysis.

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