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Size and location correlations with higher rupture risk of intracranial aneurysms

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Aim: The purpose of this study was to investigate the impact of size and location of the intracranial aneurysm on rupture probability.

Material and methods: 265 patients with diagnosis of intracranial aneurysms were admitted to the department from January 2012 to December 2013. The characteristic of aneurysm, such as median size, location, single and multiple aneurysms and presentation were retrospectively reviewed using cerebral angiography reports.

Results: There were 265 patients admitted with the diagnosis of intracranial aneurysms, 193 with single and 72 with multiple aneurysms. Among them there were 197 women (74,3%) and 68 men (25,7%). The total number of aneurysms harbored by the patients with multiple aneurysms were 184. Among all patients 96 had ruptured aneurysm, most of them located at the AComA and the minority of ruptured aneurysms were located at the ICA and MCA, In most cases the size of ruptured aneurysm was smaller than 10 mm.

Conclusion: The location of an aneurysm is an important factor allowing to predict the rupture probability and to plan proper treatment. The size of the aneurysm is also very useful predictor especially correlated with the location but the impact on rupture probability still needs further examination.

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1. Introduction

Rupture of intracranial aneurysms resulting in subarachnoid hemorrhage (SAH) is associated with high risk of devastating event within 30 days and mortality rate as high as 45% with half of survivors sustaining irreversible neurological deficits [7,18,19,20]. Aneurysmal SAH occurs in 6–8 cases per 100,000 population [21]. Poor outcomes led to preventive intervention prior to aneurysm rupture. Neurosurgical procedures that occlude aneurysm before rupture and prevent bleeding may have both risks and benefits [22]. For effective treatment, prognostic criteria for the risk of rupture are needed. Multiplicity, size and location are reported to be crucial factors [17].

Large Multicentric retrospective international study of unruptured intracranial aneurysms (ISUIA) estimated risk of rupture for aneurysm smaller than 10 mm in diameter as 0.05% per year in asymptomatic patient with no previous history of SAH. Patients with previous history of bleeding have ten times higher risk. Risk of rupture for aneurysms over 10 mm in diameter was approximately 1% per year [23]. Prospective ISUIA calculated the risk of rupture for diameters 7–12 mm as 0.52% per year (anterior circulation) and 2.9% per year for aneurysms located in the posterior circulation. The 5 year cumulative rupture rate among patients with aneurysms smaller than 7 mm was 0% (group of patients without prior SAH history). Aneurysms smaller than 7 mm are benign – the authors concluded [24].

However, several investigators have challenged these studies reporting a higher percentage of small aneurysms among their case series of ruptured intracranial aneurysms. They concluded that small aneurysms (<5 mm) are a common cause of aneurysmal SAH and considered them as a lesion with a potential for rupture [3,7,18,22,25].

The aim of the study was to review our patient population with intracranial aneurysms to determine the most common size of ruptured aneurysms. Multiplicity, and location have been also taken under consideration.

2. Material and methods

Epidemiological retrospective review of the medical charts of all patients admitted with the diagnosis of intracranial aneurysms to

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the Department of Neurosurgery and Pediatric Neurosurgery in Lublin from January 2012 till December 2013 has been done. The size of each aneurysm was measured in the Department of Interventional Radiology and Neuroradiology in Lublin on DSA images using OsiriX program or computed tomography angiography (CTA). The largest diameter was measured using the long axis of the aneurysm. In patients with multiple aneurysm, the ruptured aneurysm was identified by blood distribution visible on computer tomography. Patients with ruptured aneurysms presented subarachnoid haemorrhage (SAH), intracerebral hematoma or both of them were diagnosed using computer tomography performed within 3 days of symptoms onset.

The patients were divided into two groups, those with single aneurysm (single group) and multiple aneurysms (multiple group). Patients were categorized according to their state of aneurysms: patients with ruptured and unruptured aneurysms. Aneurysm sizes were assigned to three categories: smaller than 5 mm in diameter, between 5 and 10 mm and larger than 10 mm in diameter.

The aneurysm locations were classified as follow: single group – anterior communicating artery (AComA), internal carotid artery (ICA), middle cerebral artery (MCA), basilar artery (BA), anterior cerebral artery (ACA), posterior inferior cerebellar artery (PICA), posterior cerebral artery (PCA), posterior communicating artery (PComA), vertebral artery (VE), callosomarginal artery (CMA) and multiple group – the same as the single group, excluding PCA, PComA, VE, and CMA.

To assess the correlation between aneurysm location and rupture risk Chi-Square Person test was used. The test was used to assess correlation between three categories of aneurysm size and risk of rupture. The distribution of aneurysm size was not normal (Shapiro-Wilk test $p < ,05$). To compare median size of ruptured and unruptured aneurysm U Mann-Whitney test was used.

$P < ,05$ was considered to indicate significant difference.

3. Results

In the group of 265 patients admitted with the diagnosis of intracranial aneurysms, 193 had single and 72 multiple aneurysms. There were 197 women (74,3%), aged 55,1 ± 12,1 and 68 men (25,7%), aged 49,7 ± 13,4. The total number of aneurysms in patients with multiple aneurysms were 184. There were 70 ruptured aneurysms in the single aneurysm group and 26 in the multiple aneurysm group.

In the single group, out of the 70 patients, who presented ruptured aneurysm, 21 patients (30%) had aneurysm located at the AComA, and out of the 39 aneurysms located at the AComA 53,8% were ruptured. On the other hand, out of the 123 patients with unruptured aneurysm, 53 patients (43,1%) had aneurysms located at ICA, 27,7% aneurysms were located at the MCA, and there were only 18 patients (14,6%) with aneurysm at the AComA. Additionally, 74,6% of all aneurysms located at ICA, and 70,8% of aneurysms at MCA were not ruptured (Table 1).

In the examined population there were significant differences between the size of ruptured and unruptured aneurysms. Among patients with single aneurysm the total number of ruptured ones had median size of 5 mm and unruptured aneurysms had median size of 8 mm.

In the single group most of ruptured aneurysms were located at the AComA and the minority of ruptured aneurysms were located at the ICA and MCA, which was statistically significant ($p = ,023$).

Median size of ruptured aneurysms was significantly smaller than median size of unruptured aneurysms ($p < ,02$).

Among patients with multiple aneurysms 46 patients had two aneurysms, 19 patients had three aneurysms and 7 of them had more than three aneurysms. Ruptured aneurysms were observed only among patients with two and three aneurysms and out of 46 patients with two aneurysms, 20 (43,5%) were ruptured, and 19 patients with three aneurysms had 6 ruptured aneurysms (31,6%), but this difference was not statistically significant ($p > ,05$) (Table 2). In multiple group 64% of the whole group harboured two aneurysms.

In the multiple aneurysm group out of 26 patients with ruptured aneurysms, 5 patients (19,2%) had aneurysms located at the AComA, and out of the 18 aneurysms located at the AComA 27,8% of them were ruptured. On the other hand, out of the 158 patients with multiple unruptured aneurysm, 54 patients (34,2%) had aneurysms located at the MCA, 48 aneurysm (30,4%) from 158 unruptured aneurysms were located at the ICA, and there were only 13 patients (8,2%) with aneurysms at the AComA. Additionally, 85,7% of aneurysms located at MCA, and 84,2% aneurysms at ICA were unruptured (Table 3).

Among patients with multiple aneurysms a total number of ruptured aneurysms had median size of 8,6 mm but unruptured aneurysms had median size equal to 4,3 mm (Table 3).

In the multiple group most of ruptured aneurysms were located at the AComA, but this difference was not statistically significant ($p > ,05$). Median size of unruptured aneurysms – 4 mm was significantly smaller than median size of ruptured aneurysms – 6 mm ($p < ,02$).

In the group of 132 aneurysms between 5 and 10 mm, 47 of them (35,6%) presented as ruptured aneurysms and out of 156 aneurysms smaller than 5 mm, 34 (21,8%) were ruptured. Out of 96 ruptured aneurysms, 81 (84,4%) were smaller than 10 mm in diameter. On the other hand in a total number of 89 aneurysms larger than 10 mm, 74 (83,1%) were presented as unruptured and in

Table 1
Presentation of the patients in the single group according to aneurysm location, median size and rupture ratio compared to aneurysm location.

	No Ruptured aneurysm (No %)	Median size ruptured (mm)	Unruptured (%)	Median size unruptured (mm)	No. (%)	Rupture ratio/No.%
AComA	21 (30)	5,25	18 (14,6)	6,5	39 (20)	53,8
ICA	18 (25,7)	4,25	53 (43,1)	8	71 (36,8)	25,4
MCA	14 (20)	6	34 (27,7)	5,4	48 (24,9)	29,2
BA	5 (7,1)	7	8 (6,5)	10	13 (6,7)	38,5
ACA	3 (4,3)	11,5	2 (1,6)	6	5 (2,6)	60
PICA	3 (4,3)	3	2 (1,6)	3,8	5 (2,6)	60
PCA	2 (2,9)	6,25	1 (0,8)	8	3 (1,6)	66,7
PComA	2 (2,9)	5,5	–	–	2 (1)	100
VE	1 (1,4)	4	2 (1,6)	7,8	3 (1,6)	33,3
CMA	1 (1,4)	11	–	–	1 (0,6)	100
Other	–	–	3 (2,5)	4	3 (1,6)	0
Total	70 (100)	5	123 (100)	8	193 (100)	36,3

Anterior communicating artery (AComA), internal carotid artery (ICA), middle cerebral artery (MCA), basilar artery (BA), anterior cerebral artery (ACA), posterior inferior cerebellar artery (PICA), Posterior celebral artery (PCA), posterior communicating artery (PComA), vertebral artery (VE), Callosomarginal artery (CMA).

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