



Prevalence of Unruptured Intracranial Aneurysms: A Single Center Experience Using 3T Brain MR Angiography

Jae Ho Kim, MD¹, Kyung-Yul Lee, MD, PhD², Sang Woo Ha, MD³, Sang Hyun Suh, MD, PhD⁴

¹Department of Neurosurgery, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

²Department of Neurology, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

³Department of Neurosurgery, Chosun University Hospital, Chosun University College of Medicine, Gwangju, Korea

⁴Department of Radiology, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

Purpose: The purpose of this study was to evaluate the prevalence and risk factors of unruptured intracranial aneurysms (UIAs), which can help establish guidelines of treatment for asymptomatic Korean adults using 3T magnetic resonance angiography (MRA).

Materials and Methods: Our Institutional Review Board approved this retrospective study, and informed consent was waived. All patients consisted of healthy individuals who underwent brain MRA using 3T magnetic resonance imaging between January 2011 and December 2012 as part of a routine health examination. Patient data and follow-up results were obtained from medical records.

Results: A total of 2,118 individuals (mean age=53.9±9.6 years, male:female=1,188:930) who had undergone brain MRA were enrolled in the study. UIAs were found in 80 patients with 105 UIAs (3.77%). Female predominance (55% in UIA vs. 43.47% in non-UIA, P=0.0416) and hypertension were more common in the UIA group (43.75% vs. 28.8%, P=0.004, respectively). The mean size of the aneurysms was 3.10±1.62 mm, and they were all saccular in shape and asymptomatic. The UIAs were most common in the internal carotid artery (59.1%), internal carotid-posterior communicating artery (15.2%), middle cerebral artery (9.5%), anterior communicating artery (8.6%), anterior cerebral artery (4.8%), and vertebral artery (2.9%). Twenty-eight of 80 patients (35%) had multiple aneurysms. The incidence of UIAs increased significantly with age (P=0.014).

Conclusion: In single center experience, we demonstrated the characteristics and prevalence of UIAs in asymptomatic adults, which may help establish guidelines or therapeutic standards for UIAs.

Key Words: Intracranial aneurysm; Magnetic resonance angiography; Cross-sectional study; Prevalence

Correspondence to:

Sang Hyun Suh, MD, PhD

Department of Radiology, Gangnam Severance Hospital, Yonsei University College of Medicine, 211 Eonju-ro, Gangnam-gu, Seoul 06273, Korea

Tel: +82-2-2019-3510

Fax: +82-2-3462-5472

E-mail: suhsh11@yuhs.ac

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INTRODUCTION

Unruptured intracranial aneurysms (UIAs) are found in approximately 3.2% of the adult population without comorbidity¹ and there has been an increasing tendency to detect UIAs due to widespread use of high-resolution magnetic resonance imaging (MRI). After the international subarachnoid aneurysm trial (ISAT) trial, the relative safety and efficacy of coiling and surgical clipping were demonstrated in preventing hemorrhage from the treated aneurysm.²⁻⁴ Moreover, advances in devices and increased experience in aneurysm treatment continue to result in improvements in clinical outcomes and safety. However, the major concern when a UIA is detected is still whether to treat it or to manage it conservatively. In the real world, there is a lack of evidence on the treatment of UIAs, except for two prospective studies.^{5,6}

Regarding the treatment strategy for UIAs, it is important to understand their natural history. Especially, the prevalence of UIAs shows a big discrepancy among several studies according to the populations studied, method of case confirmation, imaging modalities, and study design, such as prospective or retrospective. In a previous meta-analysis, the incidence of UIAs ranged from 0% to 41.8%.¹ In Korea, some authors suggested a UIA prevalence from 1.5% to 5% in adults where 1.5 T MRI was used.^{7,8}

The purpose of this study was to evaluate the prevalence and associated risk factors of UIAs, which can help to establish guidelines of treatment in healthy Korean adults when 3T MRI is used.

MATERIALS AND METHODS

Patient selection

Our Institutional Review Board approved this retrospective study, and informed consent was waived. All patients consisted of healthy individuals who underwent brain MR angiography (MRA) between January 2011 and December 2012 as part of a routine health in Gangnam Severance Checkup Center. They paid at their own expense for their brain imaging. Patient data including age, sex, comorbidities (hypertension, diabetes, hyperlipidemia, previous stroke history, and smoking), family history of cerebrovascular disease (intracerebral hemorrhage, subarachnoid hemorrhage, or cerebral infarction), and follow-up results were obtained from medical records. Patients were excluded if they had fusiform,

traumatic, or mycotic aneurysms, which have different etiologies, or aneurysms in an extradural location.

Image acquisition and interpretation

All 3-dimensional time-of-flight MRA was performed by using 1 of 2 3.0T MRI systems at our institution (Discovery MR750; GE Medical Systems, Milwaukee, WI, USA/Achieva; Philips Medical Systems, Best, The Netherlands). MRA was performed with the following parameters for the Discovery MR750 instrument: repetition time/echo time, 23/2.5 ms; flip angle, 20 degrees; field of view, 210×185 mm; 4 slabs (176 slices); slice thickness, 1.4 mm; matrix, 416×224; and acquisition time, 5 minutes and 9 seconds. MRA was performed with the following parameters for the Achieva instrument: repetition time/echo time, 25/3.5 ms; flip angle, 20 degrees; field of view, 250×198 mm; 1 slab (170 slices); slice thickness, 1.4 mm; matrix, 832×414; and acquisition time, 6 minutes and 52 seconds.

UIA was defined as abnormal focal outpouchings of the cerebral artery.⁶ All radiologic reports from both instruments were reviewed, and 2 experienced neurologists (KY Lee and SH Suh) independently reviewed the MRA images of patients with UIA and possible UIA according to those reports. In cases of discrepancy, a consensus interpretation was made. Patients with known UIAs before the MRA were also included regardless of treatment.

Aneurysm size was measured by the largest diagonal measurement. Aneurysm locations were classified as internal carotid artery (ICA), anterior cerebral artery, anterior communicating artery, middle cerebral artery (MCA), posterior communicating artery, and vertebrobasilar artery (including vertebral artery, basilar artery, posterior cerebral artery, and anterior and posterior cerebellar arteries). In addition, multiple aneurysms and the presence of daughter sacs were analyzed.

The enrolled patients were divided into 2 groups, a UIA group and a non-UIA group, which were compared according to the above criteria.

Statistical analysis

Continuous variables were described as mean±standard deviation, and categorical variables as frequencies in percentages. Differences between the 2 groups were evaluated using an Independent 2-sample t-test for continuous variables and the chi-square test (or Fisher's exact test) for categorical variables. The Mantel-Haenszel chi-square test was used to

Table 1. Demographics of all patients

Characteristics	Total (n=2,118)	Aneurysm - (n=2,038)	Aneurysm + (n=80)	P-value
Age (y)	53.87±9.59	53.75±9.61	57.05±8.77	0.0025
Female	930 (43.91)	886 (43.47)	44 (55.00)	0.0416
Hypertension	622 (29.37)	587 (28.80)	35 (43.75)	0.004
Diabetes	241 (11.38)	227 (11.14)	14 (17.50)	0.0788
Hyperlipidemia	189 (8.92)	177 (8.68)	12 (15.00)	0.052
Previous stroke	20 (0.94)	20 (0.98)	0 (0.00)	-
Smokers	711 (33.57)	689 (33.81)	22 (27.50)	0.2412

Values are presented as mean±standard deviation or number (%).

Table 2. Characteristics of unruptured intracranial aneurysms

Characteristic	Yes (n=105)
Location	
MCA	10 (9.5)
ACOM	9 (8.6)
ICA	62 (59.1)
IC-PCOM	16 (15.2)
BA	0 (0.0)
VA	3 (2.9)
ACA	5 (4.8)
Mean size	3.10±1.62
Groups by aneurysm size (mm)	
<3	64 (60.95)
3≤size<7	35 (33.33)
≥7	6 (5.71)
Multiplicity*	28 (35)
Daughter sac	2 (1.90)
Angiography	73 (69.52)
Previous aneurysm treatment	4 (3.81)

Values are presented as number (%) or mean±standard deviation. MCA, middle cerebral artery; ACOM, anterior communicating artery; ICA, internal carotid artery; IC-PCOM, internal carotid-posterior communicating artery; BA, basilar artery; VA, vertebral artery; ACA, anterior cerebral artery.

*Multiple aneurysms were seen in 28 of 80 patients.

compare trends between groups according to age. All P-values were considered statistically significant if they were 0.05 or less. Analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Table 3. Incidence of unruptured intracranial aneurysms according to age group

Age group	Aneurysm			P-value
	Total (n=2,118)	No (n=2,038)	Yes (n=80)	
Age (y)				
<40	150	148 (98.67)	2 (1.33)	0.0144
40≤age<50	503	488 (97.02)	15 (2.98)	
50≤age<60	912	876 (96.05)	36 (3.95)	
60≤age<70	433	414 (95.61)	19 (4.39)	
≥70	120	112 (93.33)	8 (6.67)	

Values are presented as number (%).

RESULTS

Patient characteristics

A total of 2,118 individuals (mean age=53.87±9.59 years, male:female=1,188:930) who had undergone brain MRAs for personal health check-ups were enrolled in the study. In Table 1, the mean age of the UIA group was significantly higher than that of the non-UIA group (57.05±8.77 years vs. 53.75±9.61 years, P=0.0025, respectively). Female predominance (55% in UIA vs. 43.47% in non-UIA, P=0.0416) and hypertension were more common in the UIA group (43.75% vs. 28.8%, P=0.004, respectively).

Prevalence and characteristics of UIA

In total, 80 patients had 105 UIAs (3.77%). The mean size of the aneurysms was 3.10±1.62 mm, and they were all saccular in shape and asymptomatic (Table 2). The locations of UIAs were as follows: ICA (62/105, 59.1%), internal carotid-posterior communicating artery (16/105, 15.2%), MCA (10/105, 9.5%), anterior communicating artery (Acom, 9/105, 8.6%), anterior

cerebral artery (5/105, 4.8%) and vertebral artery (3/105, 2.9%). Multiple aneurysms were seen in 28 of 80 patients (35%); 2 UIAs in 14, 3 UIAs in 1, and 4 UIAs in 3. Although more than 60% of UIAs were less than 3 mm in size, 6 were more than 7 mm in size (5.71%). Diagnostic angiography was performed for confirmation in 73 patients, and 4 patients were treated previously with unruptured aneurysms.

Incidence of UIAs according to aging

The incidence of UIAs increased significantly with aging ($P=0.0144$), which was 1.33% in less than 40 years, 2.98% in the 40s, 3.95% in the 50s, 4.39% in the 60s, and 6.67% in the 70s (Table 3). Especially compared to the overall prevalence of UIAs in this study, the incidence of UIAs was higher in patients aged more than 50 years, and patients aged more than 70 years showed approximately double the overall incidence.

DISCUSSION

This study demonstrated that the prevalence of UIAs was 3.77% in asymptomatic adults, which was similar to a recent meta-analysis of UIAs. In autopsy cases,⁹ an incidence of 4.6% was suggested in UIAs, and Ujiie et al.¹⁰ showed 2.7% using conventional angiography. Jeon et al.⁷ described a higher incidence of 5% in 3,049 healthy individuals using 1.5T MRI. In the era of 3T MRI, Li et al.¹¹ found a prevalence of 7.0% in 4,813 Chinese adults aged 35 to 75 years, and Imaizumi et al.¹² showed a prevalence of 4.32% in 4,032 Japanese healthy adults. Moreover, 60.95% (64/105) of UIAs were less than 3 mm in this study, which may be possible to detect by using 3T MRI. Although Vlák et al.¹ presented an incidence of 3.2% (95% confidence interval 1.9–5.2), differences among the prevalence of UIAs according to ethnic group, imaging method/device, or gender ratio should be taken into consideration.

The distribution of UIAs in this study was not much different from previous publications. The most common location of UIAs was ICA with an incidence of 74.3% in our study, which was comparable to other studies.^{1,7,10,13} In total, 8.6% of UIAs were found in the Acom, which had the highest tendency of rupture compared to others in the Unruptured Cerebral Aneurysm Study of Japan (UCAS Japan).⁶ The incidence of MCA aneurysms was 9.5% in this study, which was lower than in previous studies, and MCA aneurysms had a

lower rupture risk than other aneurysm locations.⁶ UIAs in posterior circulation showed a low incidence in general, and our study revealed only 2.9% in the vertebral artery. Although some retrospective studies^{14,15} showed posterior circulation aneurysms have a high risk of rupture, other prospective studies^{6,16} did not demonstrate a high rupture risk due to the small sample size of posterior circulation aneurysms.

Our study showed an incidence of multiple aneurysms to be quite higher than in previous publications.^{7,11–13} Iwamoto et al.⁹ reported an incidence of 21.3% for multiple UIAs, and 2 prospective Japanese studies for UIAs showed an incidence of multiple aneurysms to be 26.4% in the UCAS Japan⁶ and 33.2% in the Small Unruptured Intracranial Aneurysm Verification (SUAVE) study,¹⁶ which showed a similar result with ours. Although this result may have some bias due to its retrospective nature, it is important to contemplate multiple UIAs as a major factor for aneurysm growth and rupture.^{14,17}

In this study, there were some limitations to interpret the results for UIAs due to the ethnic bias of the Korean adult population, and UIAs were determined using MRA, which has some disadvantages for the detection of small UIAs. Although our study has the strength of a large number of asymptomatic participants and the application of 3T MRA, further longitudinal studies will need to evaluate the life of UIAs.

CONCLUSION

In this single center experience, we demonstrated the characteristics and prevalence of UIAs in asymptomatic adults, which may help establish guidelines or therapeutic standards for UIAs.

Fund

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Ethics Statement

Our Institutional Review Board approved this retrospective study, and informed consent was waived.

Conflicts of Interest

The authors have no conflicts to disclose.

Author Contributions

Concept and design: SHS. Analysis and interpretation: SHS and KYL. Data collection: SHS and KYL. Writing the article: SHS and JHK. Critical revision of the article: SWH, SHS and KYL. Final approval of the article: SHS. Statistical analysis: JHK and SWH. Obtained funding: KSIN research grant 2020. Overall responsibility: SHS.

ORCID

Jae Ho Kim: <https://orcid.org/0000-0002-6292-5223>

Kyung-Yul Lee: <https://orcid.org/0000-0001-5585-7739>

Sang Woo Ha: <https://orcid.org/0000-0002-0409-2737>

Sang Hyun Suh: <https://orcid.org/0000-0002-7098-4901>

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