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The Role and Reliability of Unruptured Intracranial Aneurysm Treatment Score in Decision-making in Surgical Indications for Unruptured Intracranial Aneurysms Based on the Results at a Japanese Single Center

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Abstract

To clarify the role and reliability of unruptured intracranial aneurysm treatment score in the treatment indications of unruptured intracranial aneurysm for Japanese patients, we performed a retrospective comparative analysis of our actual decision-making and unruptured intracranial aneurysm treatment score judgment. The unruptured intracranial aneurysm treatment score was applied to each of 208 Japanese patients with diagnosis of unruptured intracranial aneurysm for a year. The patients included were classified into 4 groups by integrating actual decisions with the scoring of unruptured intracranial aneurysm treatment score. Of 94 patients treated, unruptured intracranial aneurysm treatment score recommended repair for 64 (68.1%, "appropriately treated") and observation for 5 (5.3%, "possible over-treated"). Among 114 patients under observation, unruptured intracranial aneurysm treatment score recommended repair for 19 (16.7%, "possible under-treated") and observation for 29 (25.4%, "appropriately conservative"). In the remaining 91 patients judged as "not definitive" by the unruptured intracranial aneurysm treatment score, 66 (72.5%) were determined as conservative follow-up. From the perspective of the unruptured intracranial aneurysm treatment score, its sensitivity and specificity were 85.3% and 88.6%, respectively. Our findings suggest that in Japanese patients with unruptured intracranial aneurysm, unruptured intracranial aneurysm treatment score is a reliable tool for guiding treatment decisions for unexpertized clinicians; however, the final judgment should be made by a trained neurosurgeon, especially in cases categorized as not definitive.

Keywords: unruptured intracranial aneurysm, UIATS, risk of rupture, surgical indication

Introduction

Unruptured intracranial aneurysms (UIAs) affect approximately 3% of the global population, with similar incidence reported in Japan at 3.2%.[1)] However, the risk of subarachnoid hemorrhage (SAH) from a UIA is notably higher among Japanese and Finnish populations than in those in Western countries.[2-4)] SAH is a devastating event, with mortality rates reaching 43% and 67% for severe morbidity. Although management of UIA is of interest in Japanese patients with UIA owing to fear of rupture, it remains controversial, with a great challenge in balancing the risk

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of rupture and postoperative complications. The natural history of UIA has been elucidated in some large-scale prospective observational studies from North America, Europe, Finland, and Japan.[5-7] On the basis of these studies, several risk factors associated with aneurysm rupture have been identified, such as race and hypertension, and aneurysm size, location, and irregularity.

Considering and balancing these risk factors and difficulty in treatment, neurosurgeons have attempted to clarify the surgical indication for UIA to avoid the devastating consequences of SAH. The scoring tools for visualizing the degree of rupture risk are currently used for that purpose.[4,7,8]

Developed in 2015, the UIA treatment score (UIATS) helps clinicians assess treatment options on the basis of an aggregation of factors related to aneurysm rupture risk and treatment difficulty.[9] The aim of UIATS is to provide unexpertized clinicians with a tool to guide their decision-making (repair versus conservative) when dealing with patients harboring UIA. Ultimately, the main goal of the management of UIA is to minimize the number of patients experiencing SAH and those in whom general or neurological deficits associated with the treatment develop. Therefore, patients harboring UIA in whom the risk of rupture overwhelms the treatment risk should be selected for treatment. The purpose of the scoring systems for UIA is to identify such patients. However, whether UIATS makes the right decision that suits the clinical situation for UIA treatment in Japanese patients remains controversial. To confirm whether our treatment indication for UIA aligned with the idea of UIATS, we retrospectively applied UIATS in each patient, whereby we decided how to treat or manage their UIA. We attempted to investigate agreements or discrepancies by comparing our decision-making with the judgment by UIATS.

Materials and Methods

We conducted a retrospective analysis in patients diagnosed with UIA from January to December 2020. An interdisciplinary team of neurosurgeons including neuroendovascular specialists, neurologists, and neuroradiologists ultimately decided on UIA treatment based on Japanese stroke treatment guidelines.[3] Size, irregular shape, or increase of aneurysms was carefully checked by 3-dimensional computed tomography. The PHASES risk scores and The Unruptured Cerebral Aneurysm Study (UCAS) scores were also referenced.[4,8] We prioritized microsurgical clipping through conventional craniotomy for aneurysm obliteration in the study period. After the treatment, follow-up imaging and cognitive function were carefully checked at 7 days and at 3 and 12 months, and patients were observed for survival up to 3 years.

We retrospectively applied the UIATS in each patient, and individual management recommendation was defined as aneurysm repair, conservative, or "not definitive".[9] Integrating our actual decision with the judgment of UIATS, we classified the study patients into 4 groups (the group names are in parentheses): those who decided to undergo treatment and UIATS judgment-recommended repair (appropriately treated), those in whom UIATS recommended observation (possible overtreated), the patients with real observational following in whom UIATS recommended repair (possible undertreated), and those in whom UIATS recommended conservative observation (appropriately conservative).[10] The inconclusive cases for which UIATS scored less than 2 points difference between repair and conservative were labeled not definitive.

With regards to surgical complications, we gathered data for adverse events associated with UIA treatment within 30 days postoperatively.

To investigate predicted factors associated with our surgical indication, pretreatment variables were analyzed using a univariate analysis using Mann-Whitney test and Fisher's exact test with $p < 0.05$ being statistically significant. To evaluate consistency of the UIATS with actual clinical practice, we calculated the sensitivity, specificity, and rate of matched and opposite decisions. We focused on the cases presenting an opposite decision, whether adverse events such as aneurysm rupture or surgical complications occurred.

This is a retrospective observational study that was approved by the Ethics Committee of Saiseikai Kumamoto Hospital (approval number: 868). Informed consent has been obtained from all patients and relevant persons included in this study.

Results

A total of 208 Japanese patients were included in the study. Mean age was 61.8 years. Table 1 lists the characteristics of the patients, who were divided into treatment groups (94 patients, 45.2%) and conservative groups (114 patients, 54.8%). The univariate analysis indicated that age, familial history of SAH, and reduced quality of life in the patient-related risk factors and all aneurysm characteristics and growth in the aneurysm-related risk factors were significantly associated with our treatment indication.

Of the 94 patients treated, 88 underwent surgical treatment, with 84 receiving microsurgical clipping and 4 receiving endovascular coiling. Six patients refused surgical intervention and choose observation. Because the aim of the study was to evaluate our consideration of surgical indication for UIA, we defined 94 patients as the treatment group and 114 as the conservative group in the actual decision.

We applied UIATS evaluation in all patients in the study, which recommended aneurysm repair in 83 patients (39.9%) and conservative observation in 34 patients (16.3%). The UIATS judged a decision not definitive in the

Table 1 Patient characteristics in accordance with UIATS risk factors

		Actual Decision				*p*
		Treatment	(%)	Conservative	%	
No.of patients		94		114		
Mean age		59.5 ± 11.5		63.8 ± 11.9		0.013
Female		69	(73.4)	85	(74.6)	0.875
Risk factor incidence						
	Previous SAH from different aneurysm	6	(6.4)	4	(3.5)	0.353
	Family history of SAH	21	(22.3)	8	(7.0)	0.002
	Current smoker	36	(38.3)	38	(33.3)	0.471
	Hypertension	36	(38.3)	43	(37.7)	1.000
	Polycystic kidney	1	(1.1)	0	(0)	0.452
	Alcohol use	1	(1.1)	2	(1.8)	1.000
Clinical symptoms related to UIA						
	Cranial nerve deficit	4	(4.3)	1	(0.9)	0.178
	Clinical or radiological mass effect	0	(0)	1	(0.9)	1.000
Other						
	Reduced QOL	8	(8.5)	2	(1.8)	0.045
	Aneurysm multiplicity	26	(27.7)	20	(17.5)	0.094
Life expectancy due to chronic and/or malignant diseases						
	≤ 10 years	0	(0)	1	(0.9)	1.000
Comorbid diseases						
	Neurocognitive disorder	0	(0)	1	(0.9)	1.000
	Coagulopathies/thrombophilic disease	1	(1.1)	1	(0.9)	1.000
Aneurysm morphology						
	Mean aneurysm diameter (mm)	5.7 ± 2.7		4.3 ± 5.0		< 0.001
	Multilobulated shape	63	(67.0)	21	(18.4)	< 0.001
	Size ratio > 3 or aspect ratio >1.6	15	(16.0)	4	(3.5)	0.002
	Aneurysm > 7 mm	22	(23.4)	8	(7.0)	0.001
Location						
	VA or BA	7	(7.4)	5	(4.4)	0.384
	AcomA or PcomA	30	(31.9)	27	(23.6)	0.213
Other						
	Aneurym growth on serial imaging	16	(17.0)	4	(3.5)	0.001
	De novo formation on serial imaging	2	(2.0)	2	(1.8)	1.000
	High aneurysm complexity	19	(20.2)	19	(16.7)	0.590
Rupture risk scores						
	MeanPHASES (mean)	7.0 ± 2.7		6.0 ± 2.9		0.002
	Mean UCAS (mean)	4.4 ± 2.2		3.3 ± 2.4		< 0.001

remaining 91 patients (43.8%). Of 94 patients treated, UIATS recommended repair for 64 (68.1%, appropriately treated) and observation for 5 (5.3%, possible overtreated). Among 114 patients under observation, UIATS recommended repair for 19 (16.7%, possible undertreated) and observation for 29 (25.4%, appropriately conservative). In all 91 patients grouped as not definitive, 66 patients (72.5%) continued conservative follow-up in accordance with the judgment of trained neurosurgeons. From these results, the sensitivity and specificity of UIATS were calculated as 77.1% and 85.3%, respectively. The rate of matched and opposite decisions in the UIATS and our judgments

Table 2 Concordance between actual decision and UIATS

		Actual decision		
		Treatment	Conservative	
Number of patients		94	114	208
UIATS	Repair	64 (A)	19 (C)	83
	Conservative	5 (B)	29 (D)	34
	Not definitive	25	66	91

A: appropriately treated
B: possible over-treated
C: possible under-treated
D: appropriately conservative
UIATS
Sensitivity = 77.1%
Specificity = 85.3%
The rate of matched decisions between our judgment and UIATS = 44.7%
The rate of opposite decisions between our judgment and UIATS = 11.5%

Table 3 Age and morphology of aneurysms in the patients with opposite decision

	Possible over-treated	Possible under-treated
No.of patients	5	19
Mean age (median)	68.4 (73)	55.6 (55)
Aneurysm morphology		
Mean aneurysm diameter (median) mm	8.9 (9.9)	2.9 (2.7)
Multilobulated shape (%)	2 (40.0)	4 (21.1)
Size ratio > 3 or aspect ratio >1.6 (%)	2 (40.0)	1 (5.2)
Aneurysm > 7 mm (%)	4 (80.0)	0 (0.0)
Rupture risk scores		
Mean PHASES (median)	9.8 (11)	6.4 (7)
Mean UCAS (median)	6.2 (6)	3.3 (3)

was 79.5% and 20.5%, respectively (Table 2).

Focusing on the opposite decision cases, in the 5 patients in the possible overtreated group, 4 were older than 71 years and had aneurysms larger than 7 mm. Conversely, younger patients bearing aneurysm diameter less than 5 mm were included in the possible undertreated group (Table 3).

Postoperative complications were observed in 8 of 88 treated patients (9%). There were 2 major ischemic events; 1 patient with the left paraclinoid aneurysm exhibited right hemiparesis and motor aphasia due to venous return failure, and in another, transient hemiparesis developed owing to hemorrhagic infarction, which might have been influenced by perioperative discontinuation of rivaroxaban. There were 2 cases of epidural hematomas; 1 required reoperative evacuation. Minor complications included asymptomatic cerebellar ischemia, transient hemiparesis, and frontal muscle paralysis. In a 72-year-old man with myelodysplastic syndrome, who belonged to the possible overtreated group, postoperative hyponatremia, liver dysfunction, and chronic subdural hematoma that did not require evacuation occurred, causing a long hospital-stay. The other 4 patients in the possible overtreated group did not show any surgery-related complications. All aneurysms of 19 patients in the possible undertreated group were stable for 3 years from the study period.

Discussion

For more than 20 years in Japan, many patients with UIA have undergone surgical treatment. Before the introduction of scoring systems such as PHASE, UCAS, and UIATS, surgical indications were empirically determined by individual institutions on the basis of patient backgrounds and aneurysm characteristics. By comparing surgical indications in real-world practice with those determined by UIATS, we were able to assess the validity of our indications and examine the utility of UIATS. In our practice, 94

Table 4 Representative reports comparing their own institution's decisions with UIATS recommendations

Authors	Ravindra *et al.*	Hernández-Durán *et al.*	Smedley *et al.*	Yamashiro *et al.*
Year	2018	2018	2018	(present study)
Nation	USA	Germany	UK	Japan
Number of patients	221	93	296	208
Number of aneurysm	-	147	398	-
Actual decision (% = proportion against total number of patients)				
Treatment (%)	69 (31.2)	118 (80.3)	171 (43.0)	94 (45.2)
Conservative (%)	152 (68.8)	29 (19.7)	227 (57.0)	114 (54.8)
UIATS reccomendation (% = proportion against total number of patients)				
Repair (%)	45 (20.4)	79 (53.7)	174 (43.7)	83 (39.9)
Conservative (%)	117 (52.9)	45 (30.6)	224 (56.3)	34 (16.3)
Not definitive (%)	59 (26.7)	23 (15.6)	-	91 (43.8)
Verification of UIATS and actual decision				
Sensitivity (%)	48.9	88.6	64.4	77.1
Specificity (%)	80.3	33.3	68.3	85.3
Matched decision (%)	52.5	57.8	66.6	44.7
Opposite decision (%)	20.8	26.5	33.4	11.5

of 208 patients (45%) received surgical treatment, whereas the remaining 114 patients (55%) were managed conservatively. UIATS, in comparison, recommended surgery for 83 patients (40%) and conservative observation for 34 (16%), whereas it was inconclusive in 91 cases (44%). When integrating these results, UIATS showed a sensitivity of 77.1% and a specificity of 85.3%, both relatively high values. This suggests that when UIATS provides a definitive recommendation for either repair or conservative treatment, it is likely to agree with our surgical indications. This finding aligns with the purpose of UIATS, which is to assist inexperienced physicians in deciding whether to consult a neurosurgeon.[9]

In our study, the agreement rate between clinical decisions and UIATS was low at 44.7%. This was largely due to 43% of the patients receiving a not definitive recommendation. These patients still required consultation with a neurosurgeon to determine surgical eligibility. In practice, we determined that 73% of patients should undergo observation. Why did our study yield a high number of not definitive recommendations? One possibility is that simply being Japanese adds 2 points favoring UIA repair.[9] UIAs deemed suitable for observation in Western countries may be elevated to not definitive in Japanese patients.

The rate of completely opposite judgments between UIATS and clinical practice was 11.5%. Among the 19 patients in this group, 5 were possible overtreated, comprising older patients with irregular aneurysms or aneurysms larger than 7 mm. Currently, older individuals aged more than 70 years remain active and in good overall condition, and we believe they can be treated similarly to younger patients. In contrast, 14 younger patients in the possible undertreated group had small aneurysms less than 5 mm and no SAH after 3 years of follow-up, indicating that observation may be the appropriate decision. Ravindra et al.[11] have pointed out a similar tendency, stating that UIATS may lean slightly toward over-treatment. Careful consideration is required when applying UIATS in patients older than 70 years and younger patients with UIAs.

Table 4 summarizes studies comparing surgical indications in UIATS and clinical practice. Institutions with more aggressive surgical criteria tend to have higher sensitivity, whereas those favoring observation indicate higher specificity.[10-12] Because our study showed high values for both, our surgical indications appear relatively well aligned with UIATS. Medical systems and approaches to UIA differ by country, and thus, the compatibility of real-world surgical indications with UIATS varies across regions and institutions, making these findings intriguing. In our study, the large number of cases deemed not definitive caused UIATS to achieve high sensitivity and specificity.

The results of previous studies about the natural history of UIA discovered many rupture-risk factors related to patient, aneurysm, and treatment: aneurysm size greater than 10 mm, hypertension, history of SAH,[5,6] aneurysm size greater than 7 mm, presence of a daughter sac,[7] cigarette smoking,[6] autosomal dominant polycystic kidney disease,[13] or aspect ratio.[14] The UIATS offers a comprehensive scoring system that attempts to weight patient-related, aneurysm-related, and treatment-related risks including the previously mentioned factors in aneurysm rupture. The UIATS should be considered as "advice" from a multidisciplinary group, rather than a mathematical model to predict UIA rupture such as PHASES and UCAS score.[9] At present, it should allow a more reliable application of the risk factors for aneurysm rupture and aneurysm treatment,

and therefore facilitates an objective consultation in patients with UIA independent of the specialty of the treating physician.

This study includes some limitations. Data presented represent only a single-center practice and were recorded retrospectively. As with any evaluation of treatment decisions, patient and physician interpretations of the available information play a role and may be subject to bias. Treatment decisions may be biased given no uniform algorithm is used, although a multidisciplinary decision team performed the judgment. In addition, our surgical indication was considered on the basis of microsurgical clipping, which is more invasive than endovascular treatment and applied to the indication for aneurysm of the anterior circulation, whereas coil embolization was more common for posterior circulation aneurysm. Therefore, our decisions were subject to some selection bias.

Conclusions

UIATS serves as a useful tool for risk assessment and decision-making in Japanese patients with UIAs. However, there may be mismatches, particularly in older patients with aneurysms at high risk of rupture and young patients with aneurysms at low rupture risk. Careful evaluation of aneurysm-related factors is essential to determine treatment suitability. Given its limitations, particularly in cases in which recommendations are not definitive, a thorough neurosurgical evaluation remains essential.

Conflicts of Interest Disclosure

All authors have no conflict of interest.

References

1) Harada K, Fukuyama K, Shirouzu T, et al. Prevalence of unruptured intracranial aneurysms in healthy asymptomatic Japanese adults: differences in gender and age. Acta Neurochir (Wien). 2013;155(11):2037-43. doi: 10.1007/s00701-013-1841-7
2) Vlak MH, Algra A, Brandenburg R, et al. Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. Lancet Neurol. 2011;10(7):626-36. doi: 10.1016/S1474-4422(11)70109-0
3) Japan Stroke Society Guideline 2021 for the Treatment of Stroke (revised version 2023). Tokyo; 2023. p. 197-200.
4) Greving JP, Wermer MJ, Brown RD Jr, et al. Development of the PHASES score for prediction of risk of rupture of intracranial aneurysms: a pooled analysis of six prospective cohort studies. Lancet Neurol. 2014;13(1):59-66. doi: 10.1016/S1474-4422(13)70263-1
5) International Study of Unruptured Intracranial Aneurysms Investigators. Unruptured intracranial aneurysms--risk of rupture and risks of surgical intervention [published correction appears in N Engl J Med. 1999;340(9):744]. N Engl J Med. 1998;339(24):1725-33. doi: 10.1056/NEJM199812103392401
6) Juvela S, Porras M, Poussa K. Natural history of unruptured intracranial aneurysms: probability of and risk factors for aneurysm rupture. J Neurosurg. 2000;93(3):379-87. doi: 10.3171/jns.2000.93.3.0379
7) UCAS Japan Investigators, Morita A, Kirino T, et al. The natural course of unruptured cerebral aneurysms in a Japanese cohort. N Engl J Med. 2012;366(26):2474-82. doi: 10.1056/NEJMoa1113260
8) Hishikawa T, Date I. Unruptured cerebral aneurysms in elderly patients. Neurol Med Chir (Tokyo). 2017;57(6):247-52. doi: 10.2176/nmc.ra.2016-0286
9) Etminan N, Brown RD Jr, Beseoglu K, et al. The unruptured intracranial aneurysm treatment score: a multidisciplinary consensus. Neurology. 2015;85(10):881-9. doi: 10.1212/WNL.0000000000001891
10) Smedley A, Yusupov N, Almousa A, et al. Management of incidental aneurysms: comparison of single Centre multi-disciplinary team decision making with the unruptured incidental aneurysm treatment score. Br J Neurosurg. 2018;32(5):536-40. doi: 10.1080/02688697.2018.1468019
11) Ravindra VM, de Havenon A, Gooldy TC, et al. Validation of the unruptured intracranial aneurysm treatment score: comparison with real-world cerebrovascular practice. J Neurosurg. 2018;129(1):100-6. doi: 10.3171/2017.4.JNS17548
12) Hernández-Durán S, Mielke D, Rohde V, et al. The application of the unruptured intracranial aneurysm treatment score: a retrospective, single-center study. Neurosurg Rev. 2018;41(4):1021-8. doi: 10.1007/s10143-018-0944-2
13) Cagnazzo F, Gambacciani C, Morganti R, et al. Intracranial aneurysms in patients with autosomal dominant polycystic kidney disease: prevalence, risk of rupture, and management. A systematic review. Acta Neurochir (Wien). 2017;159(5):811-21. doi: 10.1007/s00701-017-3142-z
14) Ujiie H, Tachibana H, Hiramatsu O, et al. Effects of size and shape (aspect ratio) on the hemodynamics of saccular aneurysms: a possible index for surgical treatment of intracranial aneurysms. Neurosurgery. 1999;45(1):119-29; discussion 129. doi: 10.1097/00006123-199907000-00028

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