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Original Article

Treatment outcome after coiling or clipping for elderly patients with unruptured intracranial aneurysms

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Objective: The purpose of this study was to analyze treatment outcomes according to treatment modality for elderly patients over 75 years with unruptured intracranial aneurysm.

Methods: Fifty-four elderly patients treated in a single tertiary institute between January 2010 and December 2018 were retrospectively reviewed. We compared clinical outcome, radiological results, and complications between the coiling and clipping groups.

Results: A total of 55 procedures were performed in 54 patients. Of 55 aneurysms, 44 were treated endovascularly and 11 were treated surgically. There was no significant difference in patient baseline characteristics including mean age, sex, and pre-existing co-morbidity between the two groups. Even though there was no significant difference (p=0.373), procedure-related symptomatic complication occurred only in coiling group (3 out of 44 patients, 6.6%). Mortality rate was significantly higher in clipping group (1 out of 11 patients, 9.1%) than in coiling group (0%, p=0.044). Good clinical outcome (modified Rankin Scale 0-2) at 90 days was achieved in 43 cases treated with coiling (97.7%), and 10 cases with clipping (90.9%, p=0.154).

Conclusions: Clipping is more invasive procedure and takes longer operation time, which might lead to unpredictable mortality in elderly patients. Coiling might have high procedure-related stroke rate due to tortuous vessels with atherosclerosis. Therefore, aggressive treatment of elderly patients should be carefully considered based on patient's medical condition and angiographic findings.

Keywords Elderly, Cerebral, Aneurysm, Coiling, Clipping

INTRODUCTION

The age of current population shows abruptly accelerating pace. Average human life is over 80 years old and more than 75% of population die after 75 years old in

most developed country.[11] In addition, due to recent advent of non-invasive imaging tools such as magnetic resonance angiography (MRA) or computed tomogram angiography (CTA), more and more unruptured intracranial aneurysm (UIA) have been detected in elderly patients.[10] It is still controversy that which method (surgery, endovascular treatment (EVT), or observation and follow-up) is optimal for these patients.[20] Aging process changes patient's physiologic conditions including decreased life expectancy, increased co-morbidity, increased surgical risk due to its invasiveness and longer operation time, and increased EVT risk due to vascular tortuosity and atherosclerosis.[2][6][8][14] Therefore, for almost extremely elderly patients with more than 75 years, observation and follow-up is mainly chosen for fear of procedure-related or unrelated complications.[6][20] However, in some UIA cases, treatment should be needed even in extremely elderly patients. In this study, we introduced our experience treating UIA with extremely elderly patients and compared treatment outcome between surgery and EVT.

MATERIALS AND METHODS

Study population

A total of 2,878 consecutive intracranial aneurysms were treated with EVT or surgery between January 2010 and December 2018 in a single tertiary center. Among these, patients with ruptured aneurysm and patients less than 75 years old were excluded. Finally, we included a total of 55 UIAs in 54 extremely elderly patients with more than 75 years old. The detailed patient data were retrospectively reviewed from our prospectively collected aneurysm database that included clinical information, radiological findings, outcome, and complications by two independent observers. The study protocol was approved by the institutional review board of our institution, and the requirement for written informed consent was waived.

Treatment strategy and procedure

The treatment strategy (coiling or clipping) was decided by a multidisciplinary team composed of two neurovascular neurosurgeons and a neurointerventionist. After careful review of angiographic findings and consideration of patient's medical condition, we decided the treatment modality. If we concluded that there were no definite benefits between the two options concerning clinical outcome and postprocedural complications, coiling was primarily chosen rather than clipping. In cases with 1) MCA aneurysm with incorporated branching vessel, 2) very tortuous proximal vessels, and 3) intracranial stenosis around the aneurysm, we primarily selected clipping rather than coiling. Additionally, we considered aneurysm location, configuration, endovascular accessibility to the aneurysm, patient's medical and neurological condition, predicted treatment risks, surgeon's preference, and preference of the patient and family for this decision.

All clipping was conducted by conventional pterional approach and routine microsurgical procedure under general endotracheal anesthesia (GEA). Intraoperative monitoring (IOM) system including somatosensory and motor evoked potential was routinely applied in all surgery. After neck clipping, intraoperative doppler sonography and indocyanine videoangiogram were also routinely used in all cases to confirm the patency of parent and branching vessel and rule out blood filling into the aneurysmal sac. All coiling was also performed under GEA. We did not use IOM in coiling cases. Aneurysm occlusion was confirmed by immediate postprocedural cerebral angiography. Regardless of treatment modality, all patients were routinely taken care of in the intensive care unit. If complication did not occur, the patients were transferred to general ward on postoperative day 1 and discharged within 5 hospital days.

Outcome assessment

Patients' clinical outcomes were assessed by the modified Rankin Scale (mRS) at discharge and 3 months later. Good clinical outcome was regarded as mRS ≤2. Postprocedural symptomatic complication was defined as

1) development of new neurologic deficit, or 2) decreased 2 or more of mRS score compared with initial score.

Immediate postoperative angiographic results were evaluated by digital subtraction angiography (DSA) after EVT, and indocyanine videoangiogram or DSA after surgery. The first follow-up radiologic examination was MRA in coiling and CTA in clipping. We performed MRA or CTA at three to 12 months after the operation in an outpatient clinic. An additional imaging study was conducted according to the result of first follow-up imaging study.

Statistical analysis

We used SPSS version 24 for the statistical analysis (SPSS Inc., IBM Company, Chicago, IL, USA). Student's t-test or Mann-Whitney U test for continuous variables and χ^2 or Fisher's exact test for categorical variables were used for statistical analysis.

RESULTS

Baseline patient characteristics

The details of clinical and radiological characteristics are summarized in Table 1. Fifty-five UIAs in 54 patients were treated in our institute. Of 55 UIAs, 44 were treated with coiling and 11 were treated with clipping. Forty-one out of 54 patients (74.5%) were female, and the mean age was 76.9 years old. Underlying co-morbidity was found in 45 patients (83.3%). Twenty-two patients (40.7%) had 2 or more co-morbidity. The most common co-morbidity was hypertension (40 of 54 patients, 74.1%), followed by diabetes mellitus (12 patients, 22.2%) , heart problem, previous stoke history, and pulmonary problem. UIA involving anterior communicating artery (AcomA) was most common site (17 out of 55 UIAs, 30.9%), followed by posterior communicating artery (PcomA) (13 patients, 23.6%), middle cerebral artery (MCA) (11 patients, 20.0%), posterior circulation (6 patients, 10.9%), paraclinoid (6 patients, 10.9%), anterior choroidal artery (1 patient, 1.8%), and distal anterior cerebral artery (1 patient, 1.8%). The mean aneurysm size was 8.7±4.3 mm. Seventeen out of 54 UIAs (31.5%) were more than 10 mm in size.

Table 1. Patient baseline characteristics

Variables	Value (%)
Number of patients	54
Mean age±SD (years)	76.9±2.1
Female	41 (74.5)
Co-morbidity	
Hypertension	40 (74.1)
Diabetes mellitus	12 (22.2)
Pulmonary problem	5 (9.2)
Heart problem	8 (14.8)
Previous stroke history	7 (12.9)
Location	
AcomA	17 (30.9)
PcomA	13 (23.6)
MCA	11 (20.0)
DACA	1 (1.8)
Paraclinoid	6 (10.9)
AchA	1 (1.8)
Posterior circulation	6 (10.9)
Mean size±SD (mm)	8.7±4.3
<5 mm	8
5 mm≤ <10 mm	30
10 mm≤ <15 mm	13
15 mm≤ <25 mm	3
25 mm≥	1
Treatment modality	
Endovascular treatment	44
Surgery	11

SD, standard deviation; AcomA, anterior communicating artery; PcomA, posterior communicating artery; MCA, middle cerebral artery; DACA, distal anterior cerebral artery; AchA, anterior choroidal artery

Clinical and radiological features according to treatment modalities

The comparison of clinical and radiological characteristics between coiling group and clipping group is depicted in Table 2. There was no significant difference in patient baseline characteristics including mean age, sex, body mass index (BMI), and co-morbidity between the two groups. Aneurysm location was significantly differ-

Table 2. Comparison of clinical and radiological features between coiling and clipping

Characteristics	Value		*p* value
	Coil embolization (n=44, %)	Surgical clipping (n=11, %)	
Mean age±SD (years)	76.95±2.045	76.73±2.149	0.745
Female	34 (77.3)	7 (63.6)	0.353
Co-morbidity			
Hypertension	31 (70.5)	10 (90.9)	0.164
Diabetes mellitus	9 (20.5)	3 (27.3)	0.624
Anticoagulant	0 (0.0)	1 (9.1)	0.044
Heart problem	7 (15.9)	1 (9.1)	0.566
Pulmonary problem	4 (9.1)	1 (9.1)	1.000
Previous stroke history	7 (15.9)	0 (0.0)	0.157
BMI	24.34±3.43	23.98±2.57	0.751
Location			0.007
AcomA	14 (31.8)	3 (27.3)	
PcomA	12 (27.3)	1 (9.1)	
MCA	4 (9.1)	7 (63.6)	
DACA	1 (2.3)	0 (0)	
Paraclinoid	6 (13.6)	0 (0)	
AchA	1 (2.3)	0 (0)	
Posterior circulation	6 (13.6)	0 (0)	
Mean size±SD (mm)	9.24±4.55	6.60±2.33	0.070
Aneurysm size			0.410
≤5 mm	5 (11.4)	3 (27.3)	
>5 mm and ≤10 mm	23 (52.3)	7 (63.6)	
>10 mm and ≤15 mm	12 (27.3)	1 (9.1)	
>15 mm and ≤25 mm	3 (6.8)	0 (0.0)	
25 mm>	1 (2.3)	0 (0.0)	
Anesthesia time (min)	114.36±26.80	189.54±34.27	<0.001
Immediate results			0.483
Complete occlusion (Raymond 1)	27 (61.4)	8 (72.7)	
Incomplete occlusion (Raymond 2, 3)	17 (38.6)	3 (27.3)	
Long-term radiologic results			
Mean follow-up months	26.97±21.68	19.64±19.39	0.337
Regrowing	7 out of 38 (18.4)	0 out of 9 (0)	0.163
Procedure-relate symptomatic complication	3 (6.8)	0 (0.0)	0.373
Mortality due to 2ndary medical problem	0 (0.0)	1 (9.1)	0.044
mRS at 3 months			0.154
0	39 (88.6)	10 (90.9)	
1	4 (9.1)	0 (0.0)	
2	0 (0.0)	0 (0.0)	
3	0 (0.0)	0 (0.0)	
4	1 (2.3)	0 (0.0)	
5	0 (0.0)	0 (0.0)	
6	0 (0.0)	1 (9.1)	

SD, standard deviation; BMI, body mass index; AcomA, anterior communicating artery; PcomA, posterior communicating artery; MCA, middle cerebral artery; mRS, modified Rankin Scale; DACA, distal anterior cerebral artery; AchA, anterior choroidal artery

ent between the two groups. The proportion of MCA aneurysm was significantly higher in clipping group. The mean aneurysm size was larger in coiling group (9.24±4.55 mm) compared to those in clipping group (6.60±2.33 mm), but there was no statistical difference (p=0.07). The proportion of large aneurysm did not differ between the two groups. Total anesthesia time was significant longer in clipping group (189.54±34.27 min) than in coiling group (114.36±26.80 min, p<0.001). Postoperative complete occlusion (Raymond 1) rate was 72.7% (8 out of 11 cases) in clipping group and 61.4% (27 out of 44 cases, 61.4%) in coiling group. There was no significant difference between the two groups (p=0.483). Even though there was no statistical difference (p=0.163), aneurysm regrowing occurred only in coiling group (7 out of 38 cases, 18.4%) after mean 25.6 months follow-up period. Three (6.8%) procedure-related symptomatic complications developed in coiling group, while no symptomatic complication occurred in clipping group (p=0.373). One mortality case (9.1%) due to secondary medical problem occurred in clipping group, and there was no mortality case in coiling group (p=0.044). Good clinical outcome at 3 months was achieved in 43 out of 44 cases (97.7%) in coiling group and in 10 out of 11 cases (90.9%, p=0.154) in clipping group.

DISCUSSION

In this study, we achieved good clinical outcome with acceptable complication rate in both EVT and surgery groups. Procedure-related ischemic complication occurred in 3 out of 44 cases (6.8%) in EVT group. However, only one patient remained neurologic deficit at 3 months after the procedure. There was no hemorrhagic complication in both EVT and surgery groups. In surgery group, there was no procedure-related symptomatic complication. One patient suddenly died at 3 days after surgery. She fully recovered after surgery for 3 days and thus, this was due to secondary medical problem.

Even though there was no significant difference, procedure-related symptomatic complication occurred only in EVT group in this study. These results differ from previous results that EVT showed significant low complication rate rather than surgical clipping in elderly patients. EVT is known to have benefit in the elderly patients and safer than surgical clipping because EVT is less invasive for elderly patients who has many co-morbidities and low performance status.[3-5)12)] Mahaney et al. reported that procedure-related morbidity and mortality related to poor clinical outcome was significantly higher in surgical clipping group compared with EVT group for elderly patients.[12)] Meta-analysis which analyzed treatment outcome of EVT for elderly patients with UIA showed low perioperative stoke (4%) and mortality (1%) rate.[16)] These previous studies defined the elderly patients as over 65 years old. On the other hand, we included only extremely elderly patients with more than 75 years in this study. As age increases, atherosclerotic change and tortuosity of the great and intracranial vessels are getting worse. We believe that severe atherosclerosis and vascular tortuosity affect procedure-related complication of EVT group more than surgery group in our study. Similar to our results, Yang et al. reported that there was no significant difference in symptomatic complication and clinical outcome between the two groups.[20)] Jang et al. also reported that the morbidity rate was higher in coiling group (4%) than in clipping group (1.78%).[9)]

Some previous reports revealed that surgery for elderly patients is more invasive and has significant high morbidity and mortality than coiling.[4)5)16)] There are some explanations for these results; 1) high perioperative stroke risk in surgery group[12)] and 2) secondary medical complication due to its invasiveness and related slower mobilization.[3)] In this study, there was no perioperative stroke in surgery group. We though that surgery is nowadays safer than the past as an advance of intraoperative monitoring and postoperative intensive medical care.[15)17)] The development of technology and knowledge can play an important role to reduce procedure-related complication after surgical clipping. In contrast, we had one mortality case after surgery because of worsening of underlying cardiac problem and thus, the mortality

rate (9.1%, p=0.044) was significantly higher in clipping group. Yang et al. also reported that general complications including heart dysfunction and pneumonia occurred significantly higher in surgery group (21.4%) than in EVT group (4.69%, p=0.033).[20] We thought that invasiveness of surgery and longer operation and anesthesia time might be associated to these results. In addition, the rate of good functional outcome at 3 months was lower in clipping group (90.9%) than in coiling group (97.7%) even though there was no statistical significance (p=0.154). These results may advocate that physicians can primarily consider coiling for UIA treatment in extremely elderly patients. Accordingly, we still choose coiling as a primary treatment option for extremely elderly patients if there are no definite benefits.

Previous studies revealed that age is a risk factor for aneurysm rupture, which results in poor outcomes of elderly patients.[18)20)] Therefore, aggressive treatment is sometimes needed even in elderly patients. However, age is also a risk factor for procedure-related or post-procedural morbidity and mortality.[4)19)] Elderly patients often prefer conservative management rather than aggressive treatment due to fear of occurring postoperative complications.[6)9)20)] Accordingly, the indication of aggressive treatment for elderly patients with UIA should be individualized. Various aneurysm rupture risk calculation systems including PHASES score[7)] and estimated rupture rate by unruptured cerebral aneurysm study (UCAS)[13)] or international study of unruptured intracranial aneurysms (ISUIA)[1)] can be helpful to decide whether to treat the aneurysm or not. Aneurysm factors including size and location and patient factors including previous aneurysm rupture history, underlying co-morbidity, ethnicity, and life expectancy should be carefully considered for deciding treatment.

This study was conducted retrospectively at a single tertiary center and the number of extremely elderly patients with UIA may not be large enough to draw definite conclusions about the safety and efficacy of both EVT and surgical clipping. Therefore, potential selection bias might have an influence on treatment outcomes. Further prospective randomized large population data should be investigated to exclude any limitations.

CONCLUSIONS

Clipping is more invasive procedure and takes longer operation time than coiling. Accordingly, clipping might lead to unpredictable mortality due to secondary medical complication. Coiling might have high procedure-related stroke rate due to atherosclerotic tortuous vessels in elderly patients. Therefore, aggressive treatment of elderly patients should be carefully considered based on patient's medical condition and angiographic findings.

Disclosure

The authors report no conflict of interest concerning the materials or method used in this study or the finding specified in this paper.

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