

Surgical Management of Unruptured Cerebral Aneurysms in the Elderly: An Institution Experience

Abstract

Background and Purpose: The elderly population is increasing in the world, especially in developed countries. The gain in life expectancy is remarkable in Japan, consequently incidence of aneurysms increases in this population. The purpose of this study is to evaluate the surgical treatment and outcome of patients aged more than 75 years treated for unruptured intracranial aneurysms. **Patients and Methods:** We conducted a retrospective study for unruptured cerebral aneurysms operated between September 2014 and August 31, 2018, in Fujita Health University, Banbuntane Hotokukai Hospital, for people aged more than 75 years. A demographic study was done. We also studied aneurysm location, aneurysm size, outcome, duration of stay, and complications. **Results:** About 61 patients aged more than 75 years were operated in 4 years, comprising 12 males and 45 females. The mean age was 79.32 ± 3.29 years. Mean size of the aneurysm was 6.22 ± 3.28 . Aneurysm location ($P = 0.0037$), associated risk factors ($P = 0.006$), and association of hypertension and diabetes ($P = 0.0362$) influence outcome. Length of stay is directly correlated with outcome ($P = 0.009$). **Conclusions:** Elder patients with hypertension and diabetes or associated risk factors having a posterior circulation aneurysm have a poor diagnosis.

Keywords: Elderly, outcome, surgical treatment, unruptured cerebral aneurysms

Introduction

The remarkable gain of life expectancy in developed countries is one of the most important accomplishments in the 20th century.^[1] Most babies born since 2000 in France, Germany, Italy, the UK, the USA, Canada, and Japan will celebrate their 100th anniversary.^[1]

This is expected to change the epidemiological aspect of many diseases, including their incidences.^[2] Aneurysm incidence is high in Japan, and the management and outcome of aneurysms have improved as a consequence of the development of surgery and multimodality treatment. Unruptured intracranial aneurysms carry a risk of rupture which can lead to intracranial stroke, subarachnoid hemorrhage, coma, or death.^[3] Elder age is considered as one of the poor prognosis factors for the management of intracranial aneurysms.^[3] Management of unruptured intracranial aneurysms in the elderly remains controversial and challenging in cerebrovascular disease

because of greater rigidity and tortuosity of the arteries, concomitant disease and life expectancy.^[4] Management strategies include surgery, endovascular or conservative management with periodic imaging.^[5-7]

No consensus has been established till now for the geriatric population; the aim of this study is to show the safety of surgical treatment for Unruptured cerebral aneurysms (UCA) in the elderly.

Patients and Methods

This study constitutes a retrospective study and analysis for the outcome of patients aged more than 75 years operated for unruptured intracranial aneurysms in Fujita Health University, Banbuntane Hotokukai Hospital, between September 2014 and August 31, 2018. In all cases, the aneurysm was diagnosed by intra-arterial or computed tomography angiography.

Criteria for exclusion were when patients were 75 years old or less.

From a total of 458 patient operated in the same period, 61 patients (13%) were older than 75 years. Five patients of them presented multiple aneurysms.

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All the patients of our study underwent open surgery.

The outcome was evaluated in the postoperative period using the modified Rankin Scale (mRS).

We collected and analyzed the following variables:

- The demographic data such as sex and age. Patients were divided into three groups regarding their age (76–80, 81–85, and >85 years)
- Risk factors such as hypertension, diabetes mellitus, kidney disease, smoking, chronic cardiac disease, and kidney disease
- Aneurysm characteristics such as size and location where also studied. For a better analysis, three groups were established for aneurysms size: <7 mm, 7-9 mm, 10-25 mm.
- Complications using the mRS.

Statistical study was performed using Epi Info 7 software (Centers for Disease Control and Prevention CDC, Atlanta, Georgia, US); Continuous variables were presented as mean ± standard deviation. All variables were statistically compared with the outcome which is represented by mRS. The univariate and multivariate analysis was done using the same software.

$P < 0.05$ was considered statistically significant.

Clinical data and outcome results were provided by the senior author.

Results

Demographic study

A total of 61 patients older than 75 years operated for unruptured intracranial aneurysms were 49 females and 12 males. They were aged between 76 and 88 years. Mean age was 79.32 ± 3.29 years [Table 1].

Risk factors

Hypertension was the main risk factors in our study, it was seen in 46 cases followed by diabetes mellitus in 7 cases, and chronic cardiac disease was seen in 6 cases and kidney disease in 2 cases.

Only one patient in our current study was a smoker.

In several cases, more than one risk factor has been seen.

Out of 61 patients, 34 patients had only one risk factor (hypertension, diabetes, chronic kidney disease, cardiac disease, and smoking) [Chart 1]. Eleven patients had two risk factors and only two patients had three risk factors.

Aneurysm study

Location

Fifty-six patients (91.80%) had anterior circulation aneurysms, while 6 patients only (9.67%) presented aneurysms in the posterior circulation.

Five patients presented multiple aneurysms in anterior circulation.

Table 1: Demographic analysis of our series

| | <i>n</i> (%) |
|---------|--------------|
| Total | 61 (100) |
| Age | |
| Mean±SD | 79.32±3.29 |
| 76-80 | 44 (72.13) |
| 81-85 | 12 (19.67) |
| >85 | 5 (8.19) |
| Sex | |
| Female | 49 (80.33) |
| Male | 12 (19.67) |

SD – Standard deviation

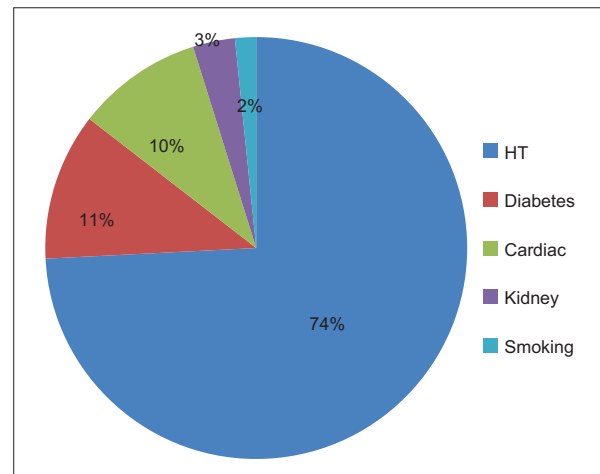


Chart 1: Risk factors of our patients

The most common site for anterior circulation aneurysms was the middle cerebral artery (MCA) (25 cases, 40.98%), followed by the internal carotid artery (IC) (22 cases, 36.06%), the anterior communicating artery (Acom) (7 cases, 11.47%), and anterior cerebral artery (6 cases, 9.83%).

Posterior circulation aneurysms were in Vertebral Artery (VA) - Posterior Inferior Cerebellar Artery (PICA) Junction (VA-PICA) in 4 cases. Two patients presented a basilar top aneurysm [Chart 2].

Size of aneurysms

Size of aneurysms ranges from 2 to 20 mm. Mean size was 6.22 ± 3.28 mm. Out of 66 aneurysms for the 61 patients, 43 aneurysms were <7 mm, 15 aneurysms had a size between 7 and 9 mm, and 8 aneurysms were more than 10 mm [Chart 3].

Multiple aneurysms

Multiple aneurysms were as follows:

- Double MCA aneurysm
- IC tip aneurysm associated with an MCA aneurysm
- An ICPCom Aneurysm was associated with an IC-anterior choroidal artery (IC-Ach) junction aneurysm

- Acom aneurysm was associated to other localization in two cases: One case of IC-Ach, and one other case of ICPC.

Management strategies

All the patients of our series underwent direct surgery. Two aneurysms were wrapped, one patient had occipital artery-posterior inferior cerebellar artery bypass. All the other aneurysms (63) were treated by microsurgical clipping.

Motor evoked potential (MEP) was used for 22 patients; only one patient had modification of wave amplitude but without any symptoms.

Outcome-modified Rankin Scale

The outcome was excellent for most of the patients. mRS at 0 in 98.36% (60 cases) signifies that there is no complication. Only one patient had a mRS at 3. This patient who was operated for a basilar artery top aneurysm presented a postoperative hydrocephalus treated by shunt.

No other patient had a complication in our series.

Length of stay

The duration of stay for the patients of our series ranges from 7 to 98 days, with a mean period of duration of 12.91 days with a standard deviation of 12.32 days.

Twenty-nine patients (47.54%) spent between 10 and 15 days after surgery, 21 patients (34.42%) <10 days, and 8 patients (13.11%) have been in the hospital for a period between 15 and 20 days after surgery.

Only 3 patients (4.91%) have been for more than 20 days in the hospital after surgery [Chart 4].

Statistical analysis [Table 2]

Analysis of various parameters with outcome was not statistically significant for each variable individually. The association of all variables influences the outcome; the study was statistically significant with a $P = 0.0377$.

Linear regression studying the location of the aneurysm with the outcome compared with other input variables was statistically significant ($P = 0.0037$).

Risk factors are not individually affecting the outcome. Associated risk factors affect the outcome. Multianalysis of variables for risk factors associated with the outcome is significant ($P = 0.006$).

The association of hypertension and diabetes mellitus influences the outcome in elderly patients ($P = 0.0362$).

Length of stay in hospital is directly correlated with the outcome ($P = 0.009$). Statistical analysis is shown in Table 2.

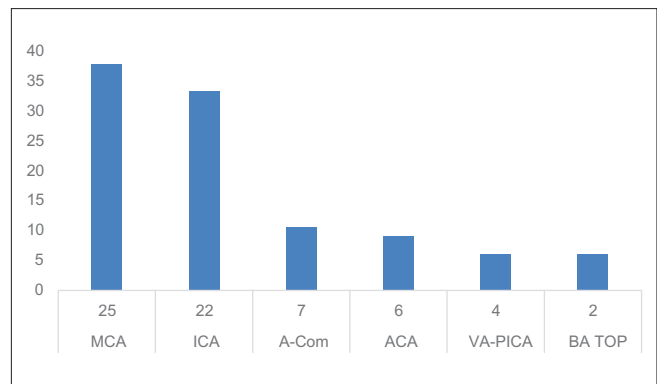


Chart 2: Location of aneurysms in our study

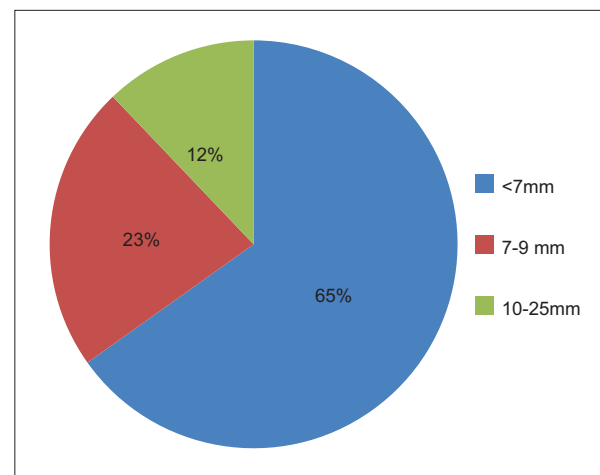


Chart 3: Size of aneurysm

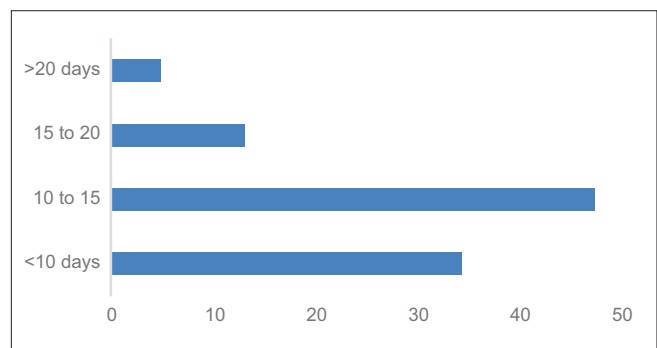


Chart 4: Length of stay (in days) after surgery

Discussion

Life expectancy is lengthening almost linearly in most developed countries, with no sign of deceleration. The probability of dying for men aged 80 years in the early 1950s was about 14%. Actually, the probability of surviving from 80 to 90 exceeds 50% for women in Japan which is the country with the best chances of survival. Large improvements in life expectancy were also reported in Spain, the USA, Italy, and Finland. The increase of the geriatric population implies the change of the epidemiologic data notably the incidence of all the pathologies.^[1,8]

Table 2: Statistical analysis of our series

| | Number | Mean | Percentage | SD | P |
|------------------------------|--------|-------|------------|-------|--------|
| Total number of patients | 61 | | 100 | | 0.0377 |
| Age | | 79.32 | | 3.29 | |
| Female | 49 | | 80.33 | | |
| Multiple aneurysm | 5 | | 8.19 | | |
| Location | | | | | 0.0037 |
| Anterior | | | 88.52 | | |
| Posterior | | | 9.83 | | |
| Risk factors | | | | | 0.006 |
| Hypertension | 46 | | | | 0.0362 |
| Diabetes mellitus | 7 | | | | |
| Cardiac disease | 6 | | | | |
| Chronic kidney Disease | 2 | | | | |
| Smoking | 1 | | | | |
| Multiple risk factors | | | | | |
| Two | 11 | | | | |
| Three | 2 | | | | |
| Duration of stay in hospital | | | | | |
| In days | | 12.91 | | 12.32 | 0.009 |
| Complication | | | | | |
| Hydrocephalus | 1 | | | | |
| Outcome m rs | | | | | |
| Good | 60 | | 98.36 | | 0.02 |
| Poor | 1 | | 1.63 | | |

SD – Standard deviation

Consequently, the incidence of cerebrovascular disease and intracranial aneurysms is increasing in elderly population which constitutes to us neurosurgeons a real challenge.

Arai *et al.* reported that of the total Japanese population, the percentage of people aged ≥ 65 years reached 25% and those aged ≥ 75 years accounted for 12.3% as of 2013, and this is expected to reach 26.9% in 2060.^[9]

The definition of the elderly population is not universal; it changes from one population to another, the reason for which we find in the literature different ages defining the elderly population. Thus, in previous publications, the elderly population was defined as aged more than 60,^[7,10] 65,^[3,4,11,12] 70^[13,14] or 75^[15] depending on the author and the country of the study.

In our current study, all patients are elder than 75 years, with a mean age of 79.32 ± 3.29 years [Table 3].

This population represents 13% from all the patients operated for intracerebral aneurysms Department of Neurosurgery, Banbutane Hotkukai Hospital, Fujita Health University, Toyoake, Nagoya, during the same period, and this percentage is similar to the literature findings; in Japan, approximately 13% of the population is older than 75 years.^[9]

The natural history of unruptured cranial aneurysms was reported in several publications,^[11,16,17] the International Study

of Unruptured Intracranial Aneurysms defined the size (7 mm or larger) and location (tip of basilar arteries and IC-posterior communicating arteries [IC-PCoM]) as significant risk factors for rupture.^[18] Unruptured cranial aneurysm study in Japan showed that the annual rate of rupture was 0.95%.^[16]

Warmer *et al.* reported that age older than 60, female gender, and Japanese or Finnish descent are important risk factors of rupture. In addition, smoking increased the risk of rupture.^[19]

Several studies compared the endovascular treatment with microsurgical clipping for elderly patients in ruptured intracranial aneurysms, but there are conflicting opinions on when there is appropriate to operate by direct surgery and endovascular surgery rather than continuing conservative management with observation for unruptured intracranial aneurysms after taking in consideration risk factors of rupture.^[19,20,12]

Nevertheless, the therapeutic attitude varies from a country to another according to the educational and economic findings. Differences in the management of cerebral aneurysms globally are significant. North Americans and Europeans show similar ratios of coiling to clipping, whereas the rest of the world shows preponderance for clipping.^[21] Patients may decrease their quality of life if knowing they are living with an unruptured aneurysm.^[22]

Bekelis *et al.*, in a cohort study which compared 8705 Medicare patients who underwent treatment for UCA for which 2585 (29.7%) underwent surgical clipping and 6120 (70.3%) underwent endovascular coiling, concluded that there was only a little difference in 1-year survival between patients undergoing elective coiling or clipping of UCA.^[12] Length of stay and cost of treatment for microsurgical management are higher than endovascular procedures.^[12]

In our actual study, length of stay was directly correlated with outcome ($P = 0.009$); the mean duration of stay was 12.91 ± 12.32 days.

Factors influencing the outcome in our series are aneurysm location and association of risk factors. Aged patients with posterior circulation aneurysm having hypertension and diabetes mellitus have a poor prognosis.

Patients with poor outcome spend more time in the rehabilitation department.^[12]

Indication for treatment of unruptured cranial aneurysms in the elderly should be taken individually with consideration of comorbidities and a good knowledge about the natural history of unruptured intracranial aneurysms.

In our series, we report a very low rate of complication which is of 1.67% (only one patient) for the whole series, with an excellent outcome for all the other patients.

Table 3: Summary of the literature review for elderly patients with unruptured cerebral aneurysms

| Study and year of publication | Country | Number of cases | Inclusion criteria - years of study | Age mean±SD | Management strategies | Aneurysm size | Location of aneurysm | Length of stay (mean) | Complications/ outcome | Factors influencing outcome (P<0.05) |
|---|---------|-----------------|---|----------------------------------|--|--|-----------------------------------|------------------------------|--|--|
| Ma <i>et al.</i> , 2018 ^[4] | China | 53 | >65 years old Ruptured aneurysm 2011-2016 | 73.4±5.6 years | Coiling | <5 mm 26.4% 5-10 mm 58.5% >10 mm 15.1% | Anter Cir 88.7% Post Cir 11.3% | - | 15.1% recurrence Outcome good 83% | Aneurysm size High-grade Hunt-Hess |
| Zheng <i>et al.</i> , 2018 ^[7] | China | 104 | >60 years old Ruptured IV and V WFNS grade 2010-2013 | - | Conservative 20.19% Coiling 47.11% Clipping 32.69% | ≤3 mm 12.5% 3-10 mm 80.76% ≥10 mm 6.36% | - | - | Death 49.03% Good 31.03% Poor 19.23% | Management strategy WFNS grade CT Fisher grade |
| Silva <i>et al.</i> , 2018 ^[3] | USA | 5635 | ≥65 years old Unruptured aneurysm 2002-2013 | 69.8±4.1 years | Coiling 64.41% Clipping 35.59% | - | - | 8 days | Death 0.9% Stroke 3.5% Hydrocephalus 1% | Age Age Management strategy |
| Zhang <i>et al.</i> , 2012 ^[10] | China | 198 | >60 years old Ruptured aneurysm 2005-2009 | - | Clipping 61.61% Coiling 38.38% | - | - | 3.2 days | Death 2.2% Stroke 10.3% Hydrocephalus 1.9% | Cardiac cplc 0.7% Death 2.2% Stroke 10.3% Hydrocephalus 1.9% |
| Bekelis <i>et al.</i> , 2017 ^[12] | USA | 8705 | ≥65 years old Ruptured and Unruptured aneurysm 2007-2012 | 70.5±4.0 years 72.7±5.5 years | Coiling 70.30% Clipping 29.69% | - | - | 7.3±6.8 days 3.7±5.5 days | Good 70% Good 88.15% | Time needed for operation Management strategy No difference in outcome |
| Horiuchi and Hongo, 2011 ^[15] | Japan | 333 | >75 years old Ruptured aneurysm 1988-2009 | 79.5 years | Clipping | <6 mm 38.7% 6-15 mm 51.1% 16-25 mm 9.9% >25 mm 0.3% | Anter Cir 98.5% Post Cir 1.5% | - | Good 51.1% Poor 48.9% | Location ACA Poor WFNS SAH grade |
| Ryttlefors <i>et al.</i> , 2008 ^[11] | USA | 278 | ≥65 years old Ruptured aneurysm | - | Clipping 50.35% Coiling 49.64% | <5 mm 54.6% 6-10 mm 37% >11 mm 8.3% | Anter Cir 98.5% Post Cir 1.5% | - | Mortality 2.15% | Location Treatment strategies (coiling or clipping) |

Contd...

Table 3: Contd...

| Study and year of publication | Country | Number of cases | Inclusion criteria - years of study | Age mean±SD | Management strategies | Aneurysm size | Location of aneurysm | Length of stay (mean) | Complications/ outcome | Factors influencing outcome (P<0.05) |
|--|---------|-----------------|--------------------------------------|------------------|-------------------------|---|------------------------------------|-----------------------|---------------------------|--|
| Hishikawa <i>et al.</i> , 2015 ^[14] | Japan | 1896 | >70 years old Unruptured aneurysm | 74.3±3.9 years | Clipping Coiling | Mean 6.2±3.9 | - | - | - | Age >80 years ICPeom location |
| Our series | Japan | 61 | >75 years old Unruptured aneurysm | 79.32±3.29 years | Conservative Surgery | Mean 6.22±3.28 <7 mm 65% 7-9 mm 23% 10-25 mm 12% | Anter Cir 91.80% Post Cir 9.70% | 12.91±12.32 days | Good 98.36% Poor 1.63% | An location Associated risk factors |

Anter – Anterior; Cir – Circulation; Post – Posterior; WFNS – World Federation of Neurosurgical Societies; Cplc – Complications; ACA – Anterior cerebral artery; SAH – Subarachnoid hemorrhage; SD – Standard deviation; CT – Computer tomography

Conclusions

Accelerating aging of the population in developed countries has a great impact on the incidence and prevalence of several pathologies. Elder age is an important risk factor for rupture of UCA. In our current study, associated risk factors, the association of hypertension and diabetes mellitus, and posterior circulation aneurysms are poor prognosis factors for surgical management in the elderly. Length of stay after microsurgical clipping is directly correlated with the outcome.

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Conflicts of interest

There are no conflicts of interest.

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