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Clinical Study

Surgical treatment of patients with unruptured intracranial aneurysms

S.F. Chen [a], Y. Kato [b,*], R. Sinha [c], A. Kumar [d], T. Watabe [b], S. Imizu [b], J. Oda [b], D. Oguri [b], H. Sano [b], Y. Hirose [b]

[a] Department of Neurosurgery, The First Affiliated Hospital of Xiamen University, Xiamen, China
[b] Department of Neurosurgery, Fujita Health University Hospital, 1-98, Dengakugakubo, Kutsukake, Toyoake, Aichi 470-1192, Japan
[c] Department of Neurosurgery, St. Stephen's Hospital, Delhi, India
[d] Department of Neurosurgery, Nizam's Institute of Medical Science, Hyderabad, India

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ABSTRACT

We present our experience with elective microsurgical clipping of unruptured intracranial aneurysms (UIA) and analyze this management. A total of 150 patients with UIA were reviewed and data were collected with regard to age, sex, presence of symptoms, location and size of the aneurysms, surgical complications and postoperative 1 year outcomes. Aneurysm size was assessed either by three-dimensional CT angiography or digital subtraction angiogram. Glasgow Outcome Scale was used to assess clinical outcomes. One hundred and fifty patients with 165 aneurysms were treated in this series. The mean size of the UIA was 5.6 mm. Eighty aneurysms (48.5%) were less than 5 mm in size, and 73 (44.2%) were from 5 to 10 mm. Ten (6.1%) of the aneurysms were large and two (1.2%) were giant. One hundred and forty-three were asymptomatic and seven were symptomatic before surgery. The outcome was good in 147 patients (98%), and only three patients (2%) had a treatment-related unfavorable outcome. Five patients experienced transient neurological deficits and one patient experienced permanent neurological deficits. Overall 98.7% of the treated aneurysms were satisfactorily obliterated. Wound complications were seen only in three patients. In conclusion, UIA pose a significant challenge for neurosurgeons, where a delicate balance between benefits and possible risks must be weighed. If the requisite expertise is available, they can be treated surgically with low morbidity and a good outcome at specialized neurovascular centers.

1. Introduction

The management of unruptured intracranial aneurysms (UIA) remains one of the most controversial topics in neurosurgery [1–4]. The guidelines for treating UIA differ between countries, with differences in health care systems and epidemiological factors. Recent advances in noninvasive imaging, including CT angiography (CTA), and MR angiography (MRA) have increased the clinician's ability to diagnose UIA, and the use of new surgical techniques has lead to improved and safe treatment of UIA [5,6]. We present an overview of the results of surgical treatment of UIA at a specialized neurovascular center. We also review the literature regarding the risk of rupture and risk of surgical clipping in UIA and treatment recommendations or guidelines for the management of UIA, to further understand the optimal treatment strategies for an individual patient.

2. Materials and methods

A total of 205 patients with intracranial aneurysms were treated by surgical clipping at our tertiary care centre in Japan between January 2011 and December 2011. All the surgical procedures were performed by two experienced senior neurosurgeons with assistance from four other colleagues. Of these 205 patients, 55 patients with subarachnoid hemorrhage (SAH) due to ruptured aneurysms were excluded. The data reported in this study represent only those who underwent surgical obliteration of UIA. Using the clinical records, we reviewed the 150 patients with UIA and data were collected with regard to age, sex, presence of symptoms, location and size of the aneurysm, surgical complications and postoperative 1 year outcome at follow-up.

One hundred and five (70%) patients were female and 45 were male. Patient age ranged between 29 and 79 years (mean age 57.8 years). Most patients were in their sixth (65, 43.3%) or fifth (38, 25.3%) decades of life. Thirty patients (20%) were older than 70 years of age. Aneurysm size was assessed by direct interpretation of three-dimensional CT angiography (3D-CTA) or digital

* Corresponding author. Tel.: +81 56 293 9253; fax: +81 56 293 3118.
E-mail address: katoyoko@163.com (Y. Kato).

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subtraction angiography. Also, the following measurements of the cerebral aneurysms were collected from the preoperative imaging: maximum height, maximum width of the aneurysmal sac and maximum neck diameter. In this series, micro-Doppler examination was performed after clipping in all patients to assess blood flow in parent and branching vessels. Endoscopy was used to verify correct clipping. In most cases we also used microscope-integrated near-infrared indocyanine green videoangiography. Intraoperative angiography was performed in patients treated by retrograde suction decompression assisted clipping through the existing catheter to confirm obliteration of the aneurysm and patency of the parent vessels. After surgery, all patients underwent postoperative CTA or digital subtraction angiography in specific circumstances. Clinical outcome was assessed by the Glasgow Outcome Scale.

3. Results

Altogether, 150 patients with 165 aneurysms were treated in this series. One hundred and six patients had a single aneurysm and 44 (29.3%) patients had multiple aneurysms. Of the 44 patients with multiple aneurysms, 12 were treated with clipping of coexisting aneurysms in the same surgery. Most aneurysms (40%) were in middle cerebral artery (MCA) territory while 24.2% involved the anterior communicating artery complex or the distal anterior cerebral artery (ACA). In the internal carotid artery (ICA), 21.8% aneurysms were in the posterior communicating segment and 10.3% were in the ophthalmic segment. Cavernous segment ICA and basilar artery aneurysms were rare. Anatomical location of all the aneurysms is summarized in Table 1. The mean size of the UIA was 5.6 mm. Eighty aneurysms (48.5%) were less than 5 mm in size, and 73 (44.2%) were from 5 to 10 mm. Ten (6.1%) of the aneurysms were large (10–25 mm) and two (1.2%) were giant (>25 mm). Before surgery 143 aneurysms were asymptomatic and seven were symptomatic. Of the seven symptomatic patients, two presented with visual disturbance and five presented with oculomotor nerve palsy. Of the 143 asymptomatic patients, 29 were found to have UIA during examination for non-specific symptoms, including headache, vertigo or numbness; three were detected during the treatment of other ruptured aneurysms and the remaining 111 patients were found to have UIA during a routine "brain checkup".

One anterior communicating artery complex aneurysm and nine distal ACA aneurysms were treated via an interhemispheric approach. Three patients with unruptured superior hypophyseal artery aneurysms were treated via a contralateral pterional approach. Four patients with basilar artery aneurysms were treated via a fronto-temporo-zygomatic craniotomy with combined subtemporal and transylvian (half and half) approach. The remaining patients underwent fronto-temporal craniotomy with ipsilateral pterional approach. Two patients with large ophthalmic segment aneurysms were managed with intentional reconstruction of the aneurysm neck followed by endovascular coiling. Eight patients with large or giant ICA aneurysms were treated by retrograde suction decompression assisted clipping. MCA–superficial temporal artery bypass surgery was included in the treatment of one patient with a large MCA aneurysm.

After treatment, wound complications were found in three patients (surgical repair for cerebrospinal fluid leak was done in two patients while one patient with wound infection required redo surgery) (Table 2). One patient developed chronic subdural hematomas which required surgical evacuation 2 months after surgery. Frontal contusions, possibly caused by brain retraction, were detected in one patient on the postoperative CT images.

There were no deaths related to surgical treatment in this series. The postoperative 1 year outcome was good in 147 patients (98%), and only three patients (2%) had a treatment-related unfavorable outcome. Five patients experienced transient neurological deficits and one patient experienced permanent neurological deficit (Table 2). Overall, 98.7% of the treated aneurysms were satisfactorily obliterated as confirmed by the postoperative 3D-CTA and/or digital subtraction angiography.

4. Discussion

The surgical management of patients with UIA has become an area of controversy during the past 20 years, as surgery requires an accurate assessment of risk compared with the natural history of the disease [2,7]. In Japan, UIA are frequently diagnosed by the Brain Docs system (a brain screening program), which not only detects unruptured cerebral aneurysms, but also identifies other asymptomatic brain diseases. This system has gained popularity in the context of increasing use of accurate MRI/MRA [8]. With advances in neuroimaging, UIA are being diagnosed more frequently. Furthermore, the actual risk of surgical obliteration of unruptured aneurysms has probably changed in recent times, with improvement in the surgical armamentarium as well as better postoperative care [7]. The aim of this study was to present an overview of the results of surgical treatment of UIA at a specialized neurovascular center and to analyze our current management strategies.

4.1. Risk of rupture of UIA

The prevalence of UIA has been estimated to range between 1 and 6% of the population, depending on the study [3]. The annual rupture risk of all intracranial aneurysms has been reported as between 1 to 3% in retrospective studies. The first international study of unruptured intracranial aneurysms (ISUIA) was based on a retrospective analysis designed to assess the natural history of UIA [9]. They assessed the natural history of unruptured intracranial aneurysms in 1449 patients with 1937 aneurysms. In 727 patients who had no prior history of SAH, the cumulative rate of rupture for aneurysms less than 10 mm in size was less than 0.05% per year, and the rate was approximately 0.5% per year in 722 patients who had a history of SAH. The rupture rate of aneurysms that were 10 mm or more in diameter was less than 1% per year in both groups. However, it is known that the results of the ISUIA were in conflict with those of other studies. Patients of the ISUIA were collected from the time period when UIA were

Table 1
Distribution of unruptured aneurysms

Location	Number	%
Middle cerebral artery	66	40
Posterior communicating segment	36	21.8
Anterior communicating artery	31	18.9
Distal anterior cerebral artery	9	5.5
Ophthalmic segment	17	10.3
Intracavernous sinus	2	1.2
Basilar artery	4	2.4
Total	165	100

Table 2
Treatment-associated complications

	Number	%
CSF fistula	2	1.3
Wound infection	1	0.7
Chronic subdural hematoma	1	0.7
Permanent neurological deficits	1	0.7
Transient neurological deficits	5	3.3
Total complications	10	6.7

CSF = cerebrospinal fluid.