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Unruptured Intracranial Aneurysms: Surgery Still Safe as a Treatment Option

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
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Abstract

Background. Despite a number of studies on the treatment of unruptured intracranial aneurysms (UIA), the optimal method still remains unclear.

Objectives. The aim of the study was to demonstrate that UIA clipping is a safe procedure and can be a good alternative for patients not qualified for endovascular procedures and who have refused conservative management.

Material and Methods. Results were gathered from a sample of 104 patients with UIA treated in our facility over a 9-year period starting January 2005. The data from a medical database was collected, followed by a long-term assessment of the functional outcomes using the modified Rankin Scale (mRS) and of quality of life (QoL) using a SF-36 questionnaire and comparing it to a Polish population reference.

Results. Overall postoperative morbidity was 5.7% and the mortality rate was 0%. The mean follow-up period was 6.5 years. A favorable outcome (mRS 0–2) was achieved in all the patients. Ninety-eight patients achieved an mRS score of 0, 2 patients an mRS score of 1, and 4 patients an mRS score of 2. All patients lived at home. Sixty-nine point two percent were fully employed, 27.0% were retired because of age, and only 3.8% relied on government help due to postoperative disability. The QoL index was similar to that of the standard Polish population.

Conclusions. In unruptured cerebral aneurysms, clipping is a safe procedure that provides good outcomes and an unaffected quality of life. It remains a good option especially for patients with MCA aneurysms that are not appropriate for endovascular management (*Adv Clin Exp Med* 2016, 25, 5, 911–916).

Key words: unruptured intracranial aneurysm, clipping, functional outcome, quality of life.

Since the publication of the results of the International Study of Unruptured Intracranial Aneurysms (ISUIA), the recommended management of patients with unruptured intracranial aneurysm (UIA) continues to be discussed [1]. According to American Heart Association guidelines, for incidental small (less than 10 mm) aneurysms in patients without previous subarachnoid hemorrhage (SAH), treatment rather than observation cannot be generally advocated [2]. However, many authors disagree with this recommendation and emphasize that the majority of intracranial aneurysms, which rupture with considerable frequency, are indeed those of small and medium size [3–5]. In the USA, more than 15,000 patients annually suffer SAH from aneurysms with a maximum diameter less than 7 mm, which result in severe mor-

bidity and mortality [6, 7]. Bryce K. A. Weir estimated that the average size of the aneurysm is less than 10 mm. He explained the quantitative difference between the group of small-to-medium sized and large-to-giant sized aneurysms by the fact that small and medium sized aneurysms rupture before reaching large or giant size [8]. Furthermore, the patient's awareness of harboring an unprotected intracranial aneurysm, which is a potentially life threatening complaint, reduces quality of life [9]. The choice of treatment method has also been challenged after the introduction of non-invasive endovascular treatment in 1990. Since the ISUIA and ISAT (International Subarachnoid Aneurysm Trial), the application of endovascular coiling has increased considerably, especially for unruptured aneurysms, shifting treatment para-

digms and carrying a risk that surgical clipping will become a historical method [1, 10].

The aim of our study was to demonstrate that aneurysm clipping is safe and remains a good option for patients with UIA disqualified from endovascular procedures and who have refused conservative management. We conducted a long-term follow-up of patients with UIA who underwent surgical treatment, assessed the functional outcomes and quality of life (QoL) and compared it to a reference population.

Material and Methods

Patients and Procedures

This study was approved by the Ethics Committee of Wrocław Medical University. It was conducted in the Department of Neurosurgery, which is a high-volume center, according to AHA (American Heart Association) guidelines, which treats more than 30 aneurysms per year [11–13]. Patients, admitted to the Department of Neurosurgery between January 2005 and December 2013 with the diagnosis of UIA, were identified from a clinical database. All patients with the diagnosis of UIA and treated surgically by experienced consultant neurosurgeons, who were included in the study, had no SAH history, were not qualified for the endovascular procedure by an interventional radiologist for various reasons (aneurysm location, size, morphology, generalized arteriosclerosis) and refused conservative management.

The patients were invited by a telephone call or a letter to participate in the study. If the patient was unable to come, we conducted a telephone interview.

Out of 104 patients, 82 responded to the invitation and 18 were interviewed by telephone. Four patients did not participate in the study: one patient died (4 years after the operation, due to a heart attack), two could not be contacted, and one refused to participate in the study.

Instruments

The outcomes were assessed using the modified Rankin Scale, which measures the degree of disability or dependence in daily activities, in which 0 = no symptoms at all, 1 = no significant disability despite symptoms; able to carry out all usual duties and activities, 2 = slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance, 3 = moderate disability; requiring some help, but able to walk without assistance, 4 = moderately severe dis-

ability; unable to walk without assistance and unable to attend to own bodily needs without assistance, 5 = severe disability; bedridden, incontinent and requiring constant nursing care and attention, 6 = dead. Outcome 0 to 2 was considered to be good, 3 to 6 was considered to be poor.

Quality of life was evaluated using the Polish version of the Short Form – 36 Health Survey Questionnaire, v. 2 (SF-36v2) which consists of 36 items [14]. It measures eight health-related domains: physical function – PF (10 items), physical role (role limitations because of physical health problems) – PR (4 items), physical pain – PP (2 items), general health perception – GH (5 items), vitality – VT (4 items), social function – SF (2 items), emotional role (role limitations because of emotional problems) – ER (3 items) and general mental health – MH (5 items). The direct score in the different domains is based on a scale that ranges from 0 (maximum reduction in QoL) to 100 (no reduction in QoL).

Data Collection and Analysis

We collected the data from the medical records of patients treated surgically for UIA in our facility. The patients were then asked questions related to their clinical history, physical and mental health, daily life activities, and adjustment problems after surgery and their social, professional and economic status, either face-to-face or by telephone interview. The patient's condition was assessed using the Glasgow Outcome Scale (GOS). Next, the SF-36 was administered in order to assess the QoL, using the Polish population data as a reference [31]. A decline in QoL was determined if the direct score was one standard deviation below the mean.

Results

Baseline Characteristics of Patients

The study group consisted of 104 patients with UIA, including 90 women. The mean age at the time of treatment was 54.4 (range 39 to 68) years. The baseline characteristics of the patients are presented in Table 1. One hundred and four patients underwent surgeries with a total of 112 craniotomies and clipping of 116 aneurysms. In 4 craniotomies, more than one aneurysm (multiple, one-sided MCA aneurysms) was clipped. Eight patients were treated for more than one UIA from separate craniotomies (all of them with MCA mirror

Table 1. Baseline patient characteristics

Characteristics	n = 104	%
Age, median (years)	54.4 ± 11.57	
Female sex	90	86.5
Chronic co-morbidities hypertension	78 56	75 53.8
Aneurysm location		
MCA	88	84.6
ACoA	8	7.7
ICA	6	5.8
pericallosal artery	2	1.9
Multiple aneurysms	38	36.5
MCA mirror aneurysms	26	25.0
Aneurysm's size		
mean (mm)	8.9 ± 6.1	
small (0–5 mm)	20	19.2
medium (6–10 mm)	68	65.4
large (11–24 mm)	10	9.6
giant (≥ 25 mm)	6	5.8
Diagnostic cause		
headaches	82	79.0
paresis n. III	2	1.9
epilepsy	8	7.7
neurofibromatosis II	2	1.9
head trauma	2	1.9
loss of consciousness	4	3.8
vertigo	4	3.8

aneurysms) in the study period, but only the outcome of the last procedure was taken into account. In the study group, there was a predominance of MCA aneurysm (84.6%), as well as aneurysms of small and medium size (84.6%). The most frequent reason for starting diagnostic procedures was persistent, debilitating headaches (79%).

Treatment Results, Complications

Ninety four patients (90.3%) had uneventful postoperative course. Ten patients had complications postoperatively. Six of them developed focal cerebral infarction, confirmed by computed tomography scans, resulting in hemiparesis and aphasia in four patients and aphasia in two patients. Those neurological deficits were resolved partially during hospitalization. Two patients developed an intracranial hematoma requiring surgical removal, and two patients had superficial wound infection. Those four patients were in perfect neurological condition at discharge, despite the recovery complications. We defined morbidity as an occur-

rence of any neurological deficits or disability at discharge. The overall morbidity was 5.7% and none of the patients died. The mean postoperative hospitalization time was 8.2 days. On discharge, 90 patients achieved an mRS score of 0, 8 patients achieved an mRS score of 1 due to postoperative headache, and 6 patients an mRS score of 2.

Long-term Functional Outcome, Quality of Life

The mean follow-up period was 6.5 years. Table 2 shows the results of the long-term follow-up. A good outcome (mRS score 0–2) was achieved in all the patients: 98 patients had a score of 0, 2 had a score of 1, and 4 had a score of 2. All patients lived at home. When patients were asked to define their main current health complaints: 72 had none, 4 reported a new health problem which was not related to the surgery, and 28 reported symptoms of chronic preexisting conditions.

Regarding employment, 28 patients (27.0%) had retired because of their age, 4 (3.8%) were receiving a social security benefit provided by the government, and 72 (69.2%) were fully employed. Only 2 patients could not work because of postoperative disability.

We noted the decline in QoL assessed by Short Form-36 in 4 patients, mainly in the domains related to physical activity (PF, PR). In the remaining 100 patients (96.1%), QoL was similar to that

Table 2. Results of long-term follow-up

Long-term follow up	n = 104	%
Functional outcome (mRS)		
mRS 0	98	94.2
mRS 1	2	1.9
mRS 2	4	3.8
Type of residence		
home	104	100
Employment status		
working	72	69.2
retired	28	27.0
government assistance	4	3.8
Health-related quality of life (SF-36), mean		
PF (physical function)	64.1 ± 24.7	
PR (physical role)	50.0 ± 25.6	
PP (physical pain)	47.1 ± 21.4	
GH (general health)	38.2 ± 13.5	
VT (vitality)	50.8 ± 8.8	
SF (social function)	62.5 ± 10.2	
ER (emotional role)	61.1 ± 18.1	
MH (mental health)	54.6 ± 10.7

Fig. 1. SF-36 item scores for normal Polish population [11] and study group

of the general Polish population. Figure 1 shows the mean scores of the eight domains of SF-36 in our study group. For reference, the scores from the general Polish population are shown with standard deviations. The mean quality-of-life scores in our study population are similar to the Polish reference population. There was a slight decline in the mean values in two domains, that is PP and GH. The mean values in other domains are even higher than those for the reference population, especially for SF.

Discussion

The most frequently cited study on unruptured aneurysms, the ISUIA, estimated the risk of rupture as 0.05% per year for aneurysms smaller than 10 mm, making their treatment unjustified [15]. Those results differ significantly from previous studies and more recent studies such as UCAS or HUNT, but they initiated a worldwide discussion on conservative management of patients with small, asymptomatic, unruptured intracranial aneurysms and no history of subarachnoid hemorrhage [16–18]. Despite this debate, we believe that the ultimate decision should belong to the patient [7, 19]. The awareness of the presence of intracranial aneurysm, which is potentially disabling or life threatening, could be a source of considerable anxiety that reduces quality of daily life and prevents normal functioning [9]. We strongly agree with R. Leblanc's statement that "it is desirable to identify unruptured aneurysms and treat them before they rupture" [20]. A number of studies have shown that the results of surgical man-

agement are good with relatively low morbidity and mortality [21, 22]. Since the introduction of the endovascular method in 1990, clinical studies comparing the mortality and clinical outcomes of patients with UIA treated with either the surgical or endovascular technique have been conducted and have supported coiling as an equal or better alternative [1, 23, 24]. According to ISUIA investigators, overall mortality and morbidity after 1 year for UIA patients treated surgically was 12.6% and endovascularly – 9.8%. In fact, the optimal method still remains unclear and the decision on the type of treatment should be multi-dimensional, taking into account the patient's and the aneurysm's characteristics and also the center's expertise in the available forms of treatment.

Nevertheless, endovascular coiling has become a preferential treatment and nowadays the majority of UIA in the USA are treated using this method, although there is substantial regional variation among different states [25, 26]. In Europe, the situation is somewhat different. Bradac et al. investigated aneurysm treatment in Europe in 2010 and stated that only in cases of vertebro-basilar aneurysm, endovascular coiling was widely accepted. For aneurysms located in the supratentorial region, Eastern European countries, compared to the rest of Europe, strongly favor surgical clipping. The authors attribute this to economic reasons but also to the shortage of experienced coilers in Eastern Europe [27]. However, there is no shortage of well-trained and experienced neurosurgeons in these countries. According to Chayette et al., the surgeon's experience is one of the predictors of a functional outcome after UIA surgery [28]. Barker et al. stated that surgery performed at high-vol-

ume facilities or by high-volume neurosurgeons was associated with significantly lower morbidity and modestly lower mortality [29]. Similarly, Andaluz et al. found that the large academic centers achieve better results, particularly for surgical clip placement [30]. Our hypothesis was that experienced neurosurgeons can significantly reduce the risk of surgical treatment to a level equal or even lower than for the endovascular method. Indeed, we achieved an extremely low morbidity of 5.7% and survival rate of 100%. Quality of life of our patients in the long-term follow-up was similar to that of the reference Polish population, with the mean values of psychosocial domain scores even slightly higher, which could be explained by improved well-being after reducing a risk for disability or even death. Although there are reports on a decline in QoL after treatment of patients with UIA, they are attributed to fear of recurrence, which is significantly higher after endovascular coiling procedures [31, 32]. Moreover, economic cost-benefit analyses from different countries have revealed that, despite a shorter length of patients' stay, the endovascular method was associated with higher hospital costs in patients with both unruptured and ruptured aneurysms. The cost of endovascular coils is much greater than surgical clips, which is another factor limiting the widespread use of the endovascular method especially in developing countries [33, 34]. Because of these economic factors, neurosurgery is likely to remain the only

option for many patients with cerebral aneurysms for decades.

The review of the literature on aneurysm treatment over the last decades shows that after a time of controversy and uncertainty regarding the best treatment options, there is a place now for both invasive and noninvasive treatment and also expectant management for patients who choose no intervention. The data from the Nationwide Inpatient Sample in the USA revealed that, although endovascular techniques were increasingly used between 1993 and 2003, the use of surgical clipping procedures remained stable [30]. Bradac et al. suggest that surgery remains the gold standard of MCA aneurysm treatment [27]. According to some authors, both clipping and coiling of UIA is safe and can be used equally, based on the patient's age and aneurysm location [35]. There was no significant difference in quality of life of patients successfully treated using the endovascular technique and patients who underwent craniotomy and clipping [36, 37]. It should be mentioned that the parallel use of these two methods resulted in better overall outcomes in the treatment of cerebral aneurysms, both ruptured and unruptured [30].

Unruptured cerebral aneurysm clipping is a safe procedure that provides good outcomes and unaffected quality of life. It remains a good option for patients, especially with MCA aneurysms, who are not appropriate for endovascular management.

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Conflict of interest: None declared

Received: 28.10.2015

Revised: 23.11.2015

Accepted: 16.02.2016