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Original Article

Endovascular treatment of ruptured intracranial aneurysms in patients 70 years of age and older

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Abstract

Background: An increasing number of elderly patients present with intracranial aneurysms. In addition to female gender, an older age is associated with a higher risk of developing a subarachnoid hemorrhage (SAH), and these patients often fare poorly in terms of long-term outcome. It is often thought that elderly patients would especially benefit from endovascular aneurysm treatment. We assessed the clinical outcomes in elderly patients with ruptured intracranial aneurysms (RIAs) who were treated by endovascular procedures.

Methods: We performed a retrospective review of a prospective database of elderly patients treated with coil embolization for RIAs. The clinical outcomes were assessed using the modified Glasgow Outcome Scale. The rates of procedural complications and adverse events were also recorded.

Results: During a period of 5 years, 162 patients with 183 intracranial aneurysms were treated in our hospital by means of an endovascular approach. Among them, 51 patients (31.5%) with a ruptured aneurysm were aged 70 years or older. These patients aged 70-91 years (mean age, 74 years) were treated by coil embolization for RIAs. Among them, seven had a Hunt and Hess (HH) grade of I or II, 42 had an HH grade of III or IV, and 2 had an HH grade of V. Endovascular treatment resulted in 32 complete occlusions (62.7%), 15 neck remnants (22%), and 4 body fillings (7.9%). Procedural complications occurred in five patients (9.8%). The outcomes were good or excellent in 17 patients (33.3%). Three patients (5.8%) who died had an HH grade of IV or V. Rebleeding occurred during follow-up in one patient (1.9%).

Conclusions: Coil embolization of intracranial aneurysms is safe and effective in the elderly. However, the morbidity and mortality rates are higher in patients with high HH grades. This finding suggests that the timing of treatment should be based on the patient's initial clinical status.

Key Words: Coil embolization, elderly, intracranial aneurysm, ruptured

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INTRODUCTION

With the increase in elderly population, we can expect more elderly patients to present with intracranial aneurysms. In addition to female gender, an older age is associated with a higher risk of developing a subarachnoid hemorrhage (SAH), and these patients often fare poorly in terms of ong-term outcome.[9,11] Older age, combined with a higher frequency of comorbidities, makes many of these patients poor surgical candidates. Medical complications that can occur with anesthesia and surgical treatment can lead to worse outcomes in patients harboring both ruptured and unruptured aneurysms. Endovascular coil embolization represents a generally better-tolerated alternative to surgical clipping.[17,25]

In a long-term follow-up of patients treated in the International Subarachnoid Aneurysm Trial (ISAT), younger patients (<40 years of age) treated by coil embolization, despite showing good initial results, had a greater risk for late rebleeding, compared with patients treated with clipping.[15] Additionally, many more patients required retreatment for ruptures, residual filling, or recanalization of the aneurysm after coiling.[4] Determining the effects of a less durable treatment option in this de mographic set ting and evaluating its impact on the long-term outcome is of great importance.

It seems possible that a less-invasive approach, particularly in those patients with multiple comorbidities who are poor surgical candidates, may be reasonable. The risk of rebleeding and recanalization, which are prominent in younger patients, may be less important in elderly patients. Coupled with the fact that older patients have a higher risk of adverse outcomes with surgical treatment compared with endovascular treatment,[1] coil embolization may be the preferred treatment option for elderly patients. However, there have been relatively few series that have so far assessed the outcomes of coil embolization, exclusively in an elderly population. We herein present our experience with endovascular coil embolization in a series of 51 elderly patients (>70 years of age).

MATERIALS AND METHODS

Patients

Between April 2006 and December 2010, 162 patients with 183 intracranial aneurysms were treated in our hospital by means of an endovascular approach. Among them, 51 patients (31.5%) with a ruptured aneurysm were aged 70 years or older. These included 34 females (67%) and 17 males (33%), with a mean age of 74 years (range, 70-91 years).

All patients presented with SAH and were classified according to the Hunt and Hess (HH) scale. Seven patients (14%) were assigned to grade I or II, 30 (58%) to grade III, 12 to (24%) grade IV, and 2 (4%) to grade V [Table 1]. All patients underwent conventional angiography of both carotid arteries and vertebral arteries. Table 2 shows the location and size of the aneurysms, 74% of which were in the anterior circulation and 26% were in the posterior circulation. Multiple aneurysms were seen in six patients (11.7%), and we treated both ruptured and unruptured intracranial aneurysms.

Therapeutic alternatives were discussed by the neurosurgical and neurointerventional teams. The indications for endovascular therapy in our patient group mainly concerned the anticipated surgical difficulties due to the age of the patients and/or the location of their aneurysms. In all patients, embolization was performed within 72 after initial bleeding.

Endovascular procedure

Endovascular treatment was performed under general anesthesia and with systemic heparinization. The adequacy of systemic anticoagulation was monitored by frequent measurements of the activated clotting time (ACT). A baseline ACT was obtained before a bolus administration of heparin (50 IU/kg body weight) and hourly thereafter. The bolus was followed by a continuous infusion (1000 IU/h) with the purpose of doubling the baseline ACT. In most cases, systemic heparinization was prolonged for 24 hafter the procedure. One

Table 1: Characteristics of the elderly patients with ruptured aneurysms

Age (years)	70-91, mean 74.1
Gender (M/F)	17/34
Subarachnoid hemorrhage	
Hunt and hess grade (%)	
I	2 (3.9)
II	5 (9.8)
III	30 (58.8)
IV	12 (23.5)
V	2 (3.9)

Table 2: The location and sizes of the ruptured aneurysms

Location	Size (mm)				
	<5	5-12	12-25	>25	Total
ICA	4	10	0	0	12 (27.4)
ACA	18	6	0	0	24 (47)
MCA	0	0	0	0	0 (0)
VA-BA	7	5	1	0	13 (25.6)
Total	29 (56.9)	21 (41.1)	1 (2.0)	0	51

ICA: Internal carotid artery, ACA: Anterior cerebral artery, MCA: Middle cerebral artery, VA-BA: Vertebral artery-basilar artery, Values are given as number (%)

patient demonstrated an aneurysm perforation for which heparinization was immediately reversed with protamine sulfate. All patients were treated by selective embolization with detachable coils. In six cases (12%) with an unfavorable neck-to-sac ratio, the adjunctive techniques[5,19] were used to prevent protrusion of the coil into the parent and/or branch artery [Table 3]. In two patients (3.9%), arterial tortuosity of the femoral and/or supra-aortic vessels prevented successful access; in these patients, common carotid artery puncture was performed. After endovascular treatment, the patients were transferred to the intensive care unit, where their fluid balance, neurological status, and blood pressure were carefully monitored. We administered antiplatelet agents after coil embolization for 1 month without letting the patients take them before treatment. Indication of a balloon assist technique was an aneurysm with wide neck, and indication of the double catheter technique was an aneurysm with size more than 7 mm and distorted form.

Immediate outcome

Patients underwent angiography to document aneurysm obliteration. The angiographic results were classified as complete occlusion (no contrast material filling the aneurysmal sac), neck remnant (residual contrast material filling the aneurysmal neck), and body filling (residual contrast material filling the aneurysmal body). A senior neurointerventionalist recorded the clinical course, including worsening of symptoms and death. The clinical outcome was graded according to a modified Glasgow Outcome Scale (GOS)[8] as follows: Excellent (neurological function intact), good (mild hemiparesis, cranial nerve palsy, or other deficit that did not interfere with daily functioning or work), fair (significant hemiparesis, aphasia, confusion, or other deficit that interfered with daily activities or prevented a return to work), and poor (coma or severe neurological deficit rendering the patient dependent on family or nursing staff). We defined outcome as the onset after 60 days.

RESULTS

Endovascular procedure

Selective embolization was successful in all patients and resulted in 32 (62.7%) complete occlusions, 15 (29.4%) neck remnants, and 4 (7.9%) body fillings [Table 4]. Complications related to the procedure occurred in a few patients. One patient with a ruptured basilar tip aneurysm experienced bleeding during placement of the last coil. Heparinization was immediately reversed, and the control angiogram obtained 5 min later showed no contrast agent extravasation and complete occlusion of the aneurysm. The patient woke up with moderately severe increased headaches without the neurological deficit seen at the clinical examination. We observed four thromboembolic events (7.8%) that resulted in a persistent neurological deficit in the patient.

Clinical outcome

Table 5 shows the clinical outcome based on the HH grade on admission. The modified GOS grade showed that 17 patients (33.3%) had a good or excellent outcome; these included 6 patients with a low HH grade (I, II), 9 with an HH grade of III, and 2 with an HH grade of IV or V. The clinical outcome was judged poor or fair in 31 patients (60.7%), including 29 with a high HH grade (III-IV) and 1 with a low HH grade (II). The remaining 31 patients (66.7%), including 12 (38.7%) with an HH grade of IV or V, died from comorbid medical conditions (congestive heart failure, sepsis, or pneumonia).

Table 3: The techniques used and the location of ruptured aneurysms

Location	Technique			
	Simple	Double	Balloon	Total
ICA	10	2	2	14
ACA	24	0	0	24
MCA	0	0	0	0
VA-BA	11	1	1	13
Total	45 (88.2)	3 (5.9)	3 (5.9)	51

ICA: Internal carotid artery, ACA: Anterior cerebral artery, MCA: Middle cerebral artery, VA-BA: Vertebral artery-basilar artery, values are given as number (%)

Table 4: The degree of occlusion after coil embolization

Location	The degree of occlusion			Total
	CO	NR	BF	
Total	32 (62.7)	15 (29.4)	4 (7.9)	51
ICA	4	8	2	14
ACA	21	3	0	24
MCA	0	0	0	0
VA-BA	7	4	2	13

Aneurysms were divided into three groups according to the degree of occlusion (CO: Complete occlusion, NR: Neck remnant, and BF: Body filling), ICA: Internal carotid artery, ACA: Anterior cerebral artery, MCA: Middle cerebral artery, VA-BA: Vertebral artery-basilar artery, values are given as number (%)

Table 5: Clinical outcomes in relation to the initial clinical status

GOS score	Total	Hunt and Hess grade				
		I	II	III	IV	V
GR	17 (33.3)	2	4	9	1	1
MD	16 (31.4)	0	1	13	2	0
SD	11 (21.6)	0	0	6	5	0
VS	4 (7.8)	0	0	2	2	0
D	3 (5.9)	0	0	0	2	1

GOS: Glasgow outcome scale (after 3 months), GR: Good recovery, MD: Moderate disability, SD: Severe disability, VS: Vegetative state, D: Dead, values are given as number (%)

DISCUSSION

Previous studies

For patients with SAH who underwent surgery, there were trends toward decreases in the case fatality rate and in the incidence of permanent symptomatic vasospasm. Since their introduction, endovascular technologies have evolved into one of the most important management options for intracranial aneurysms, and the techniques have been shown to be generally safe and effective.[6,7,20] Technological advances have "pushed the envelope" to make the techniques more durable and more applicable for complex types of aneurysms.[2,14,23]

The largest prospective clinical trial to date comparing coiling and surgical clipping was the ISAT.[16-18] Although the ISAT showed that the initial treatment of cerebral aneurysms with coil embolization was better tolerated than surgical clipping, the trial has been the object of scrutiny due to its methodology.[16-18] In particular, the study only randomized those patients who were deemed suitable candidates for either coiling or clipping. Additional follow-up of the patients treated in the ISAT has revealed several interesting findings. First, although coil embolization was initially better tolerated, with lower morbidity and mortality, 17.4% of patients who underwent coiling required retreatment for a rupture or residual or recurrent aneurysm filling, compared with only 3.8% treated surgically. About half of these patients were retreated early and half were re-treated late, with a mean time to retreatment of 20.7 months. Retreatments continued to be required throughout the follow-up period. After surgery, most retreatments were early (mean, 5.7 months). Based on the hazard ratio, late retreatment was 6.9 times more likely to be needed after endovascular treatment and was most common in subjects with a younger age, larger lumen size, and incomplete occlusion.

Other series of coil embolization studies in elderly patients in the literature have included 68 patients reported by Lubicz *et al.*,[13] 63 patients reported by Cai *et al.*,[3] and 52 patients reported by Sedat *et al.*[21] Although the general rates of good outcomes have varied depending on the make-up of the presenting clinical conditions (ruptured vs. unruptured, good vs. poor grade, etc.), it has generally been reported that the endovascular treatment of elderly patients is safe and effective. As we have shown in our series as well, the rate of poor outcomes is considerably worse in patients who initially present with a poor clinical grade, regardless of the treatment.

By regrading the re-rupture risk, Cai *et al.*[3] reported two aneurysms (3% of 65 coiled aneurysms) that re-ruptured after treatment. Lubicz *et al.*[13] and Sedat *et al.*[21] reported no re-ruptures. The series on the elderly from the ISAT did not comment on the re-rupture rate. Our rate of re-ruptured aneurysm (1.9% of 51 successfully embolized aneurysms) was comparable to these previously reported rates, as well as to the overall rate of 3% re-hemorrhage after endovascular treatment in the entire ISAT population.[18]

Endovascular treatment

The procedure used for the endovascular coiling of intracranial aneurysm has been described in the literature. However, specific situations may be encountered in elderly people. The tortuosity or stenosis of the femoral and/or supra-aortic vessels may limit intracranial arterial access. In our series, four patients (7.8%) could not be treated successfully via the femoral approach: The carotid and/or the femoral artery had a tortuous course that prevented safe catheterization of the aneurysm with a microcatheter. Common carotid artery punctures were performed to allow for better catheter pushability and stability. Endovascular treatment was performed with heparinization, and the common carotid artery was compressed for 15 min at the end of the puncture to prevent any local complications at the puncture site.

Procedural complications may occur during endovascular coiling of intracranial aneurysms, and are mostly of thromboembolic and hemorrhagic origin. Sedat *et al.*[21] showed that thromboembolic events during embolization of a ruptured aneurysm are more common in the elderly people than in younger patients (13% vs. 4.2%). Although our results were not compared with those of younger patients, they seem to confirm these findings. We observed four thromboembolic events (7.8%) that resulted in persistent neurological deficits in one patient. One patient with a ruptured basilar tip aneurysm experienced bleeding during placement of the last coil. The patient woke up without the neurological deficit seen at the clinical examination. The higher rate of embolic complications is probably related to the atheromatous degeneration and tortuosity of the intracranial and/or the supra-aortic vessels that may increase the difficulty of catheterization and the duration of treatment.

Clinical outcome

Sedat *et al.*[21] reported that 48% of their patients had good or excellent outcomes and 29% had a fair or poor outcome, with a mortality rate of 23%. In our series, a good or excellent clinical outcome was observed in 17 patients (33.3%) and a fair or poor outcome was observed in 31 patients (60.7%). Our mortality rate was 5.8% (3 patients). The larger number of patients with low HH grades (I-III) in our study may explain this slight difference. These results compare favorably with those of the surgical series[10,12,22,26] reporting 37-48% rates of good or excellent outcomes with mortality rates of 16-35%.

Although early embolization of patients with low HH grades (I-III) is now generally accepted, the optimal

care of those with high HH grades (IV and V) remains controversial. An endovascular series in patients of any age with HH grades of IV of V had a mortality rate of 59%.[24] The series reported by Sedat *et al.*[21] assessing this problem in the elderly people reported a significant correlation ($P < 0.05$) between a high HH grade and poor GOS, with only 16% of patients achieving a favorable outcome with a mortality rate of 42%. We confirmed these findings in our series: 10 (71.4%) of 14 patients with an HH grade of IV (12 patients) or V (2 patients) were treated within 72 h of the SAH, but ultimately died or had a poor outcome.

Endovascular treatment of ruptured intracranial aneurysms has been accepted as an alternative to surgical clipping, but information about its feasibility and long-term results in the elderly patients is limited. Coil embolization of ruptured intracranial aneurysms in patients 70 years of age or older is effective and presents rebleeding. However, the morbidity and mortality rates are higher in patients with high HH grades. This finding suggests that the timing of treatment should be based on the patient's initial clinical status.

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