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Clinical Study

Management of recurrent aneurysms following endovascular therapy

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ABSTRACT

The aim of the current study is to describe the complication rates and clinical outcomes in patients who either underwent repeat intervention or conservative management with radiographic surveillance when presenting with aneurysmal recurrence after endovascular treatment. Since publication of the international subarachnoid aneurysm trial (ISAT), an increasing number of patients are treated with endovascular therapy. However, recurrence after endovascular therapy continues to pose a challenge, and there is minimal evidence to guide its management. We performed a retrospective review of all patients who underwent endovascular treatment of an intracranial aneurysm from January 2005 to February 2013. The patients who had an aneurysmal recurrence following the initial endovascular treatment were identified and divided into two groups: those followed with conservative management (n = 24), and those who underwent reintervention (n = 65). The groups were compared for complications and clinical outcomes. When a reintervention was undertaken, microsurgical clip ligation was associated with a higher rate of occlusion than additional endovascular therapy ($p < 0.001$). When comparing conservative treatment and reintervention, there was no statistically significant difference in complications or clinical outcomes. Reintervention was more common in patients who were younger, had presented with subarachnoid hemorrhage, or had a greater degree of recurrence. We conclude that clinical outcomes and repeat subarachnoid hemorrhage are similar in patients who underwent retreatment *versus* those who had conservative management for their recurrent cerebral aneurysms.

1. Introduction

Since the international subarachnoid aneurysm trial (ISAT) [1], an increasing number of aneurysms are treated with endovascular therapy. However, a debate continues regarding the long term outcomes of endovascular therapy compared to traditional surgical clipping. Specifically, the durability of endovascular therapy is questioned, as reported recurrence rates range from 20–42% [2–5]. Recurrent aneurysms pose risks to the patient in the form of repeat subarachnoid hemorrhage (SAH), along with the procedural complications that are associated with repeat interventions [6,7]. While several reports in the literature favor retreatment, minimal evidence exists to guide the management of asymptomatic aneurysmal recurrence [8–10]. We sought to evaluate the complications and clinical outcomes related to reintervention in patients who had recurrences of previously coiled aneurysms, and to compare the results to those who were treated conservatively for their recurrences.

2. Methods

2.1. Study design

This retrospective cohort study was approved by the local Institutional Review Board. A local database comprised of all patients who underwent endovascular therapy at our institution (n = 670) was searched for patients with aneurysmal recurrences. From January 2005 to February 2013, 88 patients harboring 89 (13.3%) recurrent aneurysms were identified. These patients were divided into two groups: patients with recurrent aneurysms who were followed conservatively (n = 24), and patients with recurrent aneurysms who underwent reintervention (n = 65). Medical records were reviewed for clinical data. The clinical decision to follow an aneurysm recurrence with conservative treatment or to pursue repeat intervention, was at the discretion of the treating physician, as well as according to the faculty consensus for patients

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who were presented at an interdisciplinary neurovascular conference.

2.2. Variables and outcomes of interest

The variables that were abstracted from the medical records included the age at intervention, sex, presence of diabetes mellitus, hypertension, tobacco history, family history, Hunt–Hess grade, World Federation of Neurosurgical Societies grade, and Fisher grade. A positive family history was if one or more first degree relatives were known to have had an intracranial aneurysm. All relevant neuroimaging was reviewed, including CT scans, CT angiography, MRI angiography, and digital subtraction angiography. Recurrences were classified based on the Raymond–Roy classification scale: Class I with no aneurysm filling, Class II with filling of the neck, and Class III with filling of the aneurysm neck and dome [11]. We also classified recurrences into four groups based on maximal recurrence at any angiographic follow-up: Group 1 with 0% recurrence, Group 2 with 1–10%, Group 3 with 11–30%, and Group 4 with >30%. This was based on previous work, which showed that greater than 10% recurrence after coiling led to a higher risk of SAH [4].

The preoperative aneurysm morphology was analyzed for a correlation with subsequent treatment decisions. Aneurysms were analyzed by location (parent vessel and bifurcation or sidewall), and geometry was measured in terms of the aspect ratio, dome to neck ratio, size ratio, and inclination angle, as previously described [12].

The procedural complications included any adverse events that were attributable to the procedure and occurred during the hospital stay or within a 30 day postprocedure period. Any morbidity that was attributable to the initial SAH was excluded. The major complications were those resulting in death or permanent disability, and minor complications were transient and/or did not affect the clinical outcome. The follow-up time for conservatively managed patients was calculated from the date of the first endovascular intervention to the most recent radiographic follow-up, as well as the most recent clinic or inpatient encounter (clinical evaluation). The follow-up time for repeat intervention patients was calculated from the date of the initial intervention to the most recent endovascular intervention, as well as the most recent clinic or inpatient encounter.

The Glasgow outcome score (GOS) [13] was used to stratify the clinical outcomes at 3 months, 6 months, 1 year, and 2 years postintervention. This score has been used previously and describes the functional outcome from independent function (GOS 5) to death (GOS 1) [14–16]. The patients who were lost to follow-up were omitted from subsequent GOS analysis, but deaths were still factored into the GOS analysis at the subsequent time points. The GOS were divided into favorable outcomes (GOS 4–5) and poor outcomes (GOS 1–3), and analyzed as categorical data.

2.3. Statistical analyses

Categorical data were analyzed using a chi-squared test or Fisher's exact test, as appropriate. Continuous data were analyzed using Student's *t*-test. For all statistical analyses, $p < 0.05$ was considered significant.

3. Results

3.1. Patient and aneurysm characteristics

A total of 670 aneurysms were treated by endovascular techniques, of which, 89 (13.3%) recurred on follow-up angiography. Table 1 compares the demographics for the patients who were subsequently followed by observation alone (n = 24) *versus* those who underwent reintervention (n = 65). Between the groups, there were no significant differences in sex ($p = 0.06$), medical comorbidities (diabetes mellitus, $p = 0.33$; hypertension, $p = 0.76$; smoking history, $p = 0.68$), or family history ($p = 0.99$).

Table 1
Demographic data for patients with aneurysm recurrence after endovascular therapy

Demographics	Reintervention, n (%)	Conservative, n (%)	*p* value
Patients, n	64	24	
Age, mean years ± SD	54.4 ± 10.2	59.5 ± 10.8	0.04
Female	52 (81.3)	15 (62.5)	0.06
Diabetes mellitus	8 (12.5)	5 (20.8)	0.33
Hypertension	27 (42.2)	11 (45.8)	0.76
Smoking	43 (67.2)	15 (62.5)	0.68
Family history	16 (25.0)	6 (25.0)	0.99
Rupture on presentation	40 (62.5)*	9 (37.5)	0.04
Hunt–Hess Grade			
1	2 (5.1)	0 (0%)	–
2	15 (38.5)	3 (33.3)	–
3	16 (41.0)	3 (33.3)	–
4	3 (7.7)	2 (22.2)	–
5	3 (7.7)	1 (11.1)	–
World Federation of Neurosurgical Societies Grade			
1	17 (43.6)	3 (33.3)	–
2	10 (25.6)	3 (33.3)	–
3	3 (7.7)	0 (0)	–
4	6 (15.4)	3 (33.3)	–
5	3 (7.7)	0 (0)	–
Fisher Grade			
1	0 (0)	0 (0)	–
2	2 (5.1)	1 (11.1)	–
3	7 (17.9)	2 (22.2)	–

* One patient presented with subarachnoid haemorrhage in the reintervened group with no data on clinical presentation or the initial treatment.
– = not reported, SD = standard deviation.

Table 2
Recurrence prior to repeat treatment (reintervention group) *versus* recurrence at the most recent radiographic follow-up (conservative group) with respect to the degree of initial aneurysm occlusion

	Reintervention	Conservative
Total patients, n	64	24
100% initial occlusion, n	20	7
Follow-up recurrence, n (%)		
>30%	8 (40.0)	0 (0)
11–30%	9 (45.0)	2 (28.6)
1–10%	3 (15.0)	3 (42.9)
0%	0 (0.0)	2 (28.6)
90–99% initial occlusion, n	36	13
Follow-up recurrence, n (%)		
>30%	15 (41.7)	1 (7.7)
11–30%	12 (33.3)	4 (30.8)
1–10%	9 (25.0)	6 (46.2)
0%	0 (0.0)	0 (0.0)
Unknown	0 (0.0)	2 (15.4)
70–89% initial occlusion, n	4	3
Follow-up recurrence, n (%)		
>30%	3 (75.0)	1 (33.3)
11–30%	1 (25.0)	1 (33.3)
1–10%	0 (0.0)	0 (0.0)
0%	0 (0.0)	0 (0.0)
Unknown	0 (0.0)	1 (33.3)
<70% initial occlusion, n	4	1
Follow-up recurrence, n (%)		
>30%	4 (100.0)	0 (0.0)
11–30%	0 (0.0)	1 (100.0)
1–10%	0 (0.0)	0 (0.0)
0%	0 (0.0)	0 (0.0)