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Original Investigation

Endovascular Treatment of Intracranial Ophthalmic Segment Aneurysms: A Series and Literature Review

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ABSTRACT

AIM: To present the outcomes and follow-up results of endovascular coil embolization in patients with ophthalmic segment aneurysms (OSAs).

MATERIAL and METHODS: The data of 42 patients with 44 OSAs (7 ruptured and 37 unruptured), who underwent treatment using endovascular techniques between January 2007 and November 2010, were retrospectively reviewed.

RESULTS: The angiographic occlusion of the aneurysms was complete for 37 aneurysms (84.1%), near complete for 4 aneurysms (9.1%) and incomplete occlusion for 3 aneurysms (6.8%). There were 2 (4.5%) symptomatic procedure-related complications (ischemic events). One patient died of massive cerebral infarction caused by a large dissecting OSA. A favorable outcome was achieved in 97.6 % (41 of 42) of the patients at the time of follow-up. No sign of bleeding or re-bleeding was observed in any patient during the follow-up period (1 to 44 months, mean 14.2 months). Minor aneurysm recanalization occurred in 2 (4.5%) cases. The OSA–associated visual disorders completely recovered in 9 (64.3%) patients.

CONCLUSION: Endovascular treatment is a safe and effective treatment modality for intracranial OSAs.

KEYWORDS: Intracranial aneurysm, Ophthalmic segment, Carotid artery, Endovascular treatment

INTRODUCTION

Anatomical complexity of the paraclinoid region has made surgical treatment of intracranial ophthalmic segment aneurysm (OSA) difficult. The clinical outcome of patients is occasionally compromised by complications after clipping operations.

With advances in endovascular techniques, coiling of intracranial aneurysms became a valid and safe alternative to surgical treatment (4,19). However, OSAs are usually considered be larger and more wide-necked than those located in other locations, pose particular technical challenges for endovascular treatment, and the anatomical complexity of the paraclinoid region makes surgical treatment challenging (1,4,5,6,22,27) These challenges are related to the inability to obtain a stable microcatheter position, the necessity of stent assistance, as well as skull base techniques. For these reasons, there are few studies pertinent to OSA treatment. However, with improved endovascular devices, increasing endovascular embolization experiences, and the introduction and widespread adoption of the adjunctive technique of stent-assisted coiling, OSA has been treated with endovascular techniques frequently in our center (15,26).

We report our own experience in order to improve the understanding of safety and efficacy profiles associated with the endovascular treatment of OSAs.

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MATERIAL and METHODS

Between January 2007 and November 2010, the data of 42 consecutive patients with 44 OSAs, who were treated with endovascular coil embolization at our institution, were retrospectively reviewed. Clinical and radiographic data of 42 patients were reviewed. There were 12 men (28.6%) and 30 women (71.4%) with a mean age of 50.8 years (range 15–78 years).

Typically, a 5F or 6F guiding catheter was placed into the internal carotid arteries. All of the rotation digital subtraction angiography (DSA) examinations were performed by using a digital angiography suite (GE Medical Systems). A volume of 18 mL of non-ionic contrast medium was injected through a 5F guiding catheter using an injector with a velocity of 3 mL/s. DSA images of the entire circulation were usually obtained, followed by a "working-projection" DSA. Patients were typically treated under general anesthesia (4). Heparin was administered intravenously just after the guiding catheter was introduced, first as a 3000-U bolus followed by infusions at 1000 U/hour. A coaxial technique was used for microcatheter, balloon, and stent catheter access. In general, balloon assist was used in 2 cases and stent was used in 26 cases.

Outcomes for endovascular coiling were stratified into 3 categories based on the degree of angiographic aneurysm filling just after the coiling (4):

1. Complete or nearly complete occlusion: It is defined as a lack of angiographic filling of the aneurysmal sac and the neck, or no filling of the sac but small residual neck filling, respectively.

2. Incomplete occlusion: It is defined as persistent angiographic filling of a portion or portions of the aneurysmal sac.

3. Failed occlusion: It is defined as an aneurysm that could not be embolized. Thus, no coil was introduced or remained in the aneurysm.

The outcome of each procedure was determined by the operator, who evaluated the post-procedural 3D-DSA images of the aneurysm. Immediate post-procedural outcomes, as well as a 6-month angiographic follow-ups, were collected in this study.

Peri-procedural complications for each procedure were also recorded. Complications were determined by the operator who performed the endovascular embolization. Data on morbidity and mortality resulting from these complications were also recorded.

Clinical and Angiographic Follow-Up

The patient's clinical status was checked at the time of follow-up by using the Glasgow Outcome Scale (GOS) and conventional angiography was performed.

A GOS score of 5 means good recovery (normal daily life despite minor deficits), a GOS score of 4 means moderate disability (disabled but independent), a GOS score of 3 means severe disability (conscious, but disabled and dependent for daily life), a GOS score of 2 means a persistent vegetative state, (unresponsive to stimuli and no speech), and a GOS score of 1 means death of the patient (9,12).

Major recanalization was defined as contrast filling within the aneurysm dome, or significant coil loosening or compaction. Minor aneurysm recanalization was defined as minimal coil compaction at the aneurysm neck (10,12). If there was a neck remnant at the end of the embolization procedure and the neck remnant persisted at follow-up period without any increase, the radiographic condition was defined as "stable occlusion" rather than recanalization (12). The Fisher exact and Student's test were performed with software (SPSS version 16.0, SPSS Inc. Chicago, IL).

RESULTS

There were 7 (15.9%) ruptured and 37 (84.1%) unruptured OSAs (Table I). Among the patients with ruptured aneurysms, the Hunt and Hess grade was I in 5 patients, and III in 2. Among the patients with unruptured OSAs, 14 patients presented with visual disorders, including blurred vision (n=7), cranial nerve III palsy (n=4) and cranial nerve VI palsy (n=3), associated with OSAs and the other 21 patients were incidental. Among the 44 aneurysms, 2 were dissecting type with proximal narrowing and partial thromboses and 42 were saccular type. Most of the aneurysms were large (largest diameter ≥10 mm), and there were 15 small aneurysms (largest diameter<10 mm). The mean aneurysm size was 14.4 ± 9.6 mm. Two patients had bilateral OSAs.

The types of coils used varied by operator and changed over the period of the study. The types of coils varied; bare platinum coils and Hydrocoils from Microvention, Cordis, and M.T.I-ev3 were used in the treatment of 44 aneurysms. In the recent 7 patients, Chinese-manufactured coils (Jasper, Shanghai, China) were used in conjunction with other coils.

Of the 44 aneurysms, 26 (59.1%) were treated with stent assistance, 9 (20.5%) were treated without the assistance of adjunctive techniques, 7 (15.9%) were treated with parent vessel occlusion for their giant size, and 2 (4.5%) were treated with balloon assistance. Results from immediate post-embolization angiography demonstrated that 41 (93.2%) aneurysms had complete or nearly complete occlusion, and 3 (6.8%) aneurysms had incomplete occlusion.

Of those aneurysms with incomplete occlusion, all were unruptured aneurysms. Forty patients (95.2%) had a follow-up angiogram, the average time between initial treatment and follow-up was 7.6 months (range from 3 to 18 months). The follow-up modality was DSA. Among those cases, 35 (79.5%) aneurysms were completely, 4 (9.1%) were near completely, and 5 (11.4%) were incompletely occluded on angiographic follow-ups. Three aneurysms, which were incompletely occluded, showed stable occlusion on the follow-up angiogram, and there was minor recanalization in 2 aneurysms, of which one was re-treated completely.

Among unruptured aneurysms, 2 ischemic complications occurred in 2 cases where a stent was used. There were no evidence of thromboembolism on post-embolization

angiogram and computed tomography (CT) scanning. There were no cases of intraprocedural rupture/perforation. Of the 2 procedural complications, one was weakness of the right arm, which completely recovered, and one was aphasia and hemiparesis that resulted in persistent hemiparesis.

The permanent complication related to treatment occurred 24 hours after embolization when one patient became suddenly hemiparetic and aphasic. It was associated with a non-occlusive clot and distal emboli. She made a good recovery but still has a residual paresis of the right hand. There was one death (2.4%) in our series, which resulted from major embolic infarcts of middle cerebral artery. The major embolic event occurred in a 20-year old man who presented with a larger partially thrombosed dissecting aneurysm on post-coiling 6 days. Mean length of follow-up for our patients was 14.2 months (range, 1 to 44 months). A favorable outcome (GOS score of 4 or 5) was achieved in 41 (97.6%) patients at the time of follow-up. During the follow-up period, there was no episode of hemorrhage and no death. The OSA–associated visual disorders completely recovered in 64.3% (9 of 14) patients. Complete and subtotal occlusion was observed in 37 (95%) patients and recanalization in 2 patients (5%) at 6 and 18 months, one was re-treated.

Neither age (p=0.815) nor aneurysmal size (p=0.256) had any significant association with rupture. Perioperative complications (p=1.000), post-procedural angiographic results (p=0.579), clinical (p=0.309) and angiographic outcomes (p=1.000) were also not statistically significantly different between ruptured and unruptured aneurysms (Table II).

Table I: Aneurysm Characteristics in Consecutive Case Series

	Ruptured	Unruptured
Patient number	7	35
Patient age (mean±SD, years)	52±19.1	50.6±13.4
Male	3	9
Female	4	26
Mean size(mm)	10.6±7.8	15.1±9.8
Saccular type	6	34

DISCUSSION

In this article, we have presented a single-center series focused on the safety, procedural techniques, and short- and long term occlusion rates for coil embolization of OSAs. Our results have demonstrated high rates of complete or nearly complete occlusion immediately and at the follow-up period.

Many papers have been published on surgery for paraclinoid (OSA) aneurysms (2,3,6,16-18,20,22,23,27). They reported a wide range of mortality rates from 0 to 13.8% and morbidity rates up to 26.8% (Table III). The complication rates associated with surgical treatment are 0%-25% and the complete obliteration rates of aneurysms are 66.7%-100%. The mean age in these studies is 42-50 years, with SAH rate of 0-80.8%, mostly large and giant but with some small aneurysms (Table IV), which are comparable to those in our study (13).

Despite the advantages and improvement in surgical techniques, significant morbidity and mortality was associated with surgical treatment of these aneurysms (13). Our group of OSAs, which included small, large and giant aneurysms, had a procedure-related morbidity of 4.5%, permanent major morbidity of 2.4% and mortality of 2.4%. This compares favorably with the previously reported surgical series.

Advances in adjunctive techniques, such as stent or balloon-assisted coiling, have made the endovascular occlusion of intracranial aneurysms easy and safe (11, 13). However, a few series of OSA, which were treated with endovascular coiling, were reported (13) (Table III). Hauck et al. (8) reported a complete obliteration rate of 26.7% without any complication and death. Heran et al.(9) published a mortality rate of 11.8% in their series. Roy et al.(21) published 28 cases of OSAs with 3 deaths (10.7%), one permanent morbidity (3.6%) and 50% complete obliteration rate. In the other 2 papers (14,24), the reported complete obliteration rates of OSAs were as high as 87.3% and 88.9% with a complication rate of 18.3% and 0%. In our series, the favorable clinical outcome rate was 97.6% and complete to near-complete occlusion rate was 88.6%.

The indication for treatment of unruptured intracranial aneurysms is controversial. OSAs include a subset with a relatively low rupture rate (15). For unruptured carotid cave and small OSAs, decision-making regarding whether or not to treat the aneurysm may be the most difficult step (7). Therefore, when deciding for the treatment of unruptured OSAs, the risk of the treatment procedure should be balanced against the benign

Table II: Procedure-Related Complications, Angiographic and Clinical Outcomes

	Ruptured	Unruptured	p value
Perioperative complications	1	2	1.000
Complete occlusion after embolization	5	30	0.579
Complete occlusion at follow-up	6	29	1.000
Good recovery at follow-up	6	34	0.309
Total	7	35	-

Table III: Review of Studies on Surgical and Endovascular Treatment of Consecutive Intracranial Ophthalmic Segment Aneurysms

Study (ref. no.)	Study design	No. of patients	Total no. of aneurysms	Age, Mean (range) years	SAH	Treatment	Complications	Death	Follow-up (months)	Good outcome	Complete occlusion
Sharma et al. (22)	retrospective	56	60	42 (12-75)	80.8%	Surgical	12	2	Mean 8 months	46	not available
Sherif et al. (23)	retrospective	23	23	Not available	Not available	Surgical	3	0	Mean 58.7 months	17	22
Sherif et al. (23)	retrospective	41	41	Not available	Not available	Endovascular	4	1	Mean 58.7 months	30	34
Zhao et al. (27)	retrospective	60	60	45.7 (11-68)	58.3%	Surgical	11	0	Not availabe	49	60
Beretta et al. (2)	retrospective	76	86	Not available	44.9%	Surgical	12	5	Not availabe	61	not available
De Jesús et al. (5)	retrospective	28	35	Not available	24%	Surgical	7	1	Mean 39 months	27	24
Raco et al. (20)	retrospective	104	108	47.2 (23-76)	70.2%	Surgical	21	0	Mean 126 months	78	91
Boet et al. (3)	retrospective	6	6	49 (36-76)	Not available	Surgical	0	1	1 week-84 months	5	4
Boet et al. (3)	retrospective	15	15	50.7 (36-72)	Not available	Endovascular	0	0	1 week-84 months	15	11
Nagasawa et al. (16)	retrospective	48	52	Not available	Not available	Surgical	not available	1	Not availabe	44	not available
Fries et al. (6)	retrospective	51	58	Not available	62.7%	Surgical	not available	8	4 months-10 years	38	not available
Nagasawa et al. (17)	retrospective	27	30	Not available (37-72)	0%	Surgical	2	1	Not available	24	21
Hauck et al. (8)	retrospective	15	15	65 (13-76)	0%	Endovascular	0	0	Median 22 months	11	4
Heran et al. (9)	retrospective	17	17	Not available (38-83)	0%	Endovascular	0	2	Mean 34.8 months	13	8
Lubicz et al. (14)	retrospective	18	18	42 (22-77)	16.7%	Endovascular	0	2	Mean 30 months	16	0
Roy et al. (21)	prospective	26	28	51 (20-70)	30.8%	Endovascular	3	3	Mean 23.5 months	22	14
Thornton et al. (24)	retrospective	66	71	50.1 (13-75)	25.8%	Endovascular	13	2	Mean 13 months	62	33
This series	retrospective	42	44	50.8 (15-78)	16.7%	Endovascular	2	1	Mean 14.2 months	40	35

Table IV: Indications for Surgical and Endovascular Treatment according to the Studies in the Literature

Study	Indications
Sherif et al. (23)	Indications for **microsurgery**: superior aneurysm projection, giant/large or wide necked aneurysms and aneurysms at branching sites. Indications for **embolization**: narrow necks, neck calcification, close aneurysm relation to the clinoid process or adhesion to the distal dural ring, and aneurysm location in the concavity of the carotid siphon curve.
Nagasawa et al. (16)	Microsurgery would be more advantageous for cases where the neck is broad and where the topography concerning aneurysmal multiplicity or the branching site of the ophthalmic artery is not fully understood by preoperative imaging.

natural history of the OSA (4). Our experience has shown that the risk of treating unruptured intracranial OSA is as low as 2.4%.

Delayed aneurysm ruptures have been previously reported but the mechanisms are still unclear. Flow diverter stents are devices designed to treat complex aneurysms. Today, some randomized clinical studies and registries are in progress and will contribute to our current knowledge especially on the place of flow diverters in the treatment of intracranial aneurysms (25).

This study has various limitations. Most of the series in the literature were single-center and retrospective studies. In addition, possible publication bias may be present in these series because series with positive results were mostly published (4). Meanwhile, our study showed that endovascular treatment of intracranial OSAs can be performed with an acceptable risk.

CONCLUSION

We treated OSAs with endovascular techniques in 42 patients. We have demonstrated complete or near complete occlusion in 93.2% at initial treatment, with a mortality of 2.4% and a morbidity of 2.4%. Endovascular embolization is a safe and effective treatment modality in cases of OSAs.

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