Multiple Intracranial Aneurysms: Endovascular Treatment and Complications

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Summary

This study evaluated the results of endovascular embolization of multiple intracranial aneurysms. A retrospective hospital chart and radiograph review were made of all patients with multiple intracranial aneurysms seen between March 2010 and January 2011.

Ten patients presented with subarachnoid hemorrhage, four with mass effect, two with brain ischemia and twenty were incidental. These 36 patients harbored 84 aneurysms, 63 of which were treated with endovascular techniques, two by surgical clipping, and 19 were left untreated. Of the coil-treated lesions, a complete endovascular occlusion was achieved in 54 aneurysms (85.7%), and eight (12.7%) presented neck remnants with one (1.6%) stented only. Twenty-six patients (72.2%) underwent coil embolization of more than one aneurysm in the first session. Follow-up angiographic studies in 31 patients demonstrated an unchanged or improved result in 93.0% of the aneurysms (53 lesions) and coil compaction in 7.0% (four lesions). The overall clinical outcome was excellent in 33 patients (91.7%), good in one (2.8%) and fair in two (5.5%).

Endovascular techniques may be a particularly suitable method for treating multiple intracranial aneurysms.

Introduction

The presence of multiple intracranial aneurysms represents an even higher risk than a single aneurysm because there is a higher associated mortality in patients with multiple lesions [1,2]. In addition, the risk of rebleeding from the original aneurysm is higher and occurs earlier in this group of patients [3]. The natural history of the disease has led to a consensus that when technically possible all aneurysms should be treated [4]. The type of surgical approach as well as the time of surgery have been extensively discussed in the neurosurgical literature [5-8]. The patient's clinical condition as well as the size and location of the aneurysms are important factors that must be evaluated before surgery. In patients in poor clinical condition and in aneurysms less suitable for surgical clipping, endovascular techniques have been shown to be a feasible alternative modality to clipping [9]. Occlusion of intracranial aneurysms by use of endovascular techniques has recently been introduced as a safe and controllable therapeutic method via the less invasive endovascular route [10]. The endovascular treatment of multiple intracranial aneurysms by coil embolization has seldom been reported to date [11,12]. We describe the results of endovascular management of multiple intracranial aneurysms at our institution and highlight the benefits of this technique for treating this particular subset of patients.

Clinical Material and Methods

Patient population

Between March 2010 and January 2011, 36 consecutive patients were treated for multiple intracranial aneurysms with endovascular em-

bolization at our institution. There was a female predominance (23 females and 13 males), with patient ages ranging from 38 to 67 years (mean 52.8 years). This group only comprises patients in whom at least two aneurysms were seen and initially treated with endovascular techniques. Patients treated with initial surgical clipping of one or more aneurysms followed by coil treatment of an additional single aneurysm are not included in this study. The 36 patients harbored a total of 84 aneurysms. Twenty-eight patients (77.8%) harbored two aneurysms each, six patients had three aneurysms each, and one had four aneurysms. One patient had a total of six aneurysms.

Clinical presentation

Ten patients (27.8%) presented with SAH, four (11.1%) with mass effect, two (5.6%) with brain ischemia and 20 (55.5%) were incidental. Six of the ten patients presenting with SAH were admitted during the acute phase (within two weeks post-SAH). Three patients (50%) were admitted with Hunt and Hess Grade I, one (16.7%) with Grade II, and two (33.3%) with Grade III SAH. The remaining four patients presenting with SAH were admitted between one and four months after recovery from the hemorrhage, and their SAH was not graded clinically.

Aneurysm size and neck size

Of the 63 aneurysms treated using endovascular techniques, 54 (85.7%) were less than 15 mm in size, seven (11.1%) were 15 to 25 mm, and two (3.2%) were larger than 25 mm. Fifteen aneurysms (23.8%) had necks measuring 4 mm or less, 46 (73.0%) had wide necks, and two aneurysms (3.2%) were fusiform.

Aneurysm location

Eleven of the 63 aneurysms treated using endovascular techniques were located in the posterior circulation, 21 at the ophthalmic segment of the internal carotid artery (ICA), eight at the middle cerebral artery (MCA), ten at the ICA–posterior communicating artery (PCoA) junction, nine intracavernous ICA, two anterior communicating artery (ACoA) and two distal anterior cerebral artery. In 25 (69.4%) of the 36 patients, all aneurysms were located in the anterior circulation, and in 11 patients (30.6%) at least one aneurysm was in the posterior circulation. The outcomes were assessed according to the Glasgow Outcome Scale [13].

The indications for endovascular treatment included: anticipated surgical difficulty in 33 cases (91.7%), and poor neurological grade in three (8.3%). A patient was placed in the category of anticipated surgical difficulties if at least one aneurysm was considered to be surgically complex.

As a general principle, we attempted to treat all aneurysms in one session. If this was not possible, a second session was scheduled soon after the first. Twenty-six (72.2%) of the 36 patients had more than one aneurysm treated using endovascular techniques in the first session. Eight patients (22.2%) did not return for a second session of embolization. Two patients (5.6%) returned for a subsequent session of embolization of additional aneurysms. These patients, who presented with SAH, returned for treatment of the incidental aneurysm. Sixteen aneurysms in 12 patients without SAH and three incidental aneurysms in three patients with acute SAH were untreated because of their very small size (<3 mm).

Technical considerations

All procedures were performed with the patient under general anesthesia and with systemic heparinization. Complete anterior and posterior circulation cerebral angiography was performed via a transfemoral route before embolization. The morphological aspects of the multiple intracranial aneurysms were evaluated. In patients with SAH the location of blood on the CT scans, the size and shape of the aneurysms, the presence of a nipple, and the presence of local vasospasm were used for identification of the ruptured aneurysm [7]. The aneurysms presumed to be ruptured were always treated first. Via the transfemoral route, an Echelon 10 microcatheter (M.T.I-ev3) was advanced coaxially through a 6F guiding catheter and into the aneurysmal sac. Embolization was then performed using detachable coils (Axium, ev3; Microplex, Microvention) and was considered complete when a dense packing of the aneurysm with coils was achieved without compromising the lumen of the parent artery. In patients with giant or fusiform aneurysms of the intracavernous ICA or distal vertebral artery, an angiographic and functional evaluation was conducted to assess a possible endovascular treatment with parent artery occlusion. If a stent was placed, pa-

tients were administered 300 mg clopidogrel orally two hours before the endovascular procedure for ruptured lesions and 75 mg clopidogrel and 100 mg aspirin orally at least three to five days before the endovascular procedure for unruptured lesions. Patients were each maintained on the same dosage daily for at least four weeks, and aspirin was continued indefinitely. At the end of the procedure, the microcatheter was removed and an angiogram obtained to assess aneurysmal occlusion and parent vessel patency. A follow-up angiogram was obtained in three to eight months.

Results

Ruptured aneurysms

Common locations for multiple aneurysms were the ophthalmic artery (25%), middle cerebral artery (19.0%) and posterior communicating artery (14.3%). However, locations with the highest probability of rupture were the anterior communicating artery (25%) and posterior communicating artery (25%). The middle cerebral artery was the least likely site for rupture (6.5%).

Endovascular treatment

Sixty-three (75%) of 84 aneurysms were actually treated using endovascular techniques. Two incidental MCA aneurysms (2.4%) were treated with surgical clipping after failed attempts at coil embolization. Nineteen aneurysms (22.6%), all incidental (six ICA aneurysms, six MCA aneurysms, two PCoA aneurysms, two ACoA aneurysms, one BA aneurysm, one vertebrobasilar junction aneurysm and one anterior cerebral artery aneurysm), were left untreated because of the very small size of the aneurysms (<3 mm). Ten patients harboring a total of 21 aneurysms presented with SAH. Presuming that only one aneurysm was ruptured in each of these patients, 11 incidental aneurysms were found in patients presenting with SAH. In these ten patients, the ruptured aneurysms and eight incidental lesions were treated with endovascular embolization, and three were left untreated because the lesions were very small (<3 mm). Of the 63 endovascularly treated aneurysms, 41 (65.1%) wide-necked lesions (21 ICA aneurysms, eight PCoA aneurysms, four BA aneurysms, three MCA aneurysms and five VA-PICA aneurysms) were treated with stent-assisted coiling, one VA-PICA aneurysm was stented alone, four lesions (three giant ICA aneurysms and one VA-PICA aneurysm) were treated with parent vessel occlusion and 17 lesions (six ICA aneurysms, five MCA aneurysms, two PCoA aneurysms, two ACoA aneurysms and two anterior cerebral artery aneurysms) were treated using simply coiling. In the 63 aneurysms that were embolized, total occlusion was achieved in 54 (85.7%), eight (12.7%) showed neck remnants and with one (1.6%) stented only.

Complications

Three (8.3%) complications were related to intrastent thrombosis, and one to aneurysm rupture during the procedure. Intrastent thrombosis was treated with superselective urokinase infusion resulting complete recanalization of the parent vessel and excellent clinical recovery in two patients. One patient developed paralysis and aphasia. The case of aneurysm rupture occurred during coil treatment of a third aneurysm six days post-SAH. This rupture caused a massive SAH that led to a permanent paralysis at clinical follow-up review. The overall clinical significant complication rate was 5.5% (2/36).

Angiographic follow-up studies

Follow-up angiography was performed in 31 patients (86.1%) with 57 aneurysms. The follow-up period for this group varied between three and eight months, with an average of 5.7 months. These 57 aneurysms included 47 that were initially completely occluded. Forty-six (97.9%) of the completely occluded aneurysms remained unchanged, and one (2.1%) showed coil compaction and was subsequently reembolized with endovascular techniques, achieving a complete occlusion. Five (50%) of the initially incompletely occluded aneurysms remained unchanged, with neck remnants; two (20%) demonstrated complete occlusion; and three (30%) showed coil compaction. One of the three aneurysms was reembolized and complete occlusion was achieved. The other two were followed.

Clinical outcome

The longest follow-up time was 16 months, with an average follow up of 8.2 months. The overall clinical outcome was excellent in 34 (94.5%) and fair in two (5.5%).

Discussion

Surgical treatment for multiple intracranial aneurysms

Among the patients with aneurysms, the incidence of multiple aneurysms was 10.7%. Intracranial aneurysms were present in multiples in up to 34% of patients [1,8]. The natural history in patients with multiple intracranial aneurysms was established by Heiskanen et al [4], who found that untreated unruptured aneurysms bled at a rate of 3% per year, with a cumulative mortality rate of 20%. In one series, 83% of patients with inoperable multiple intracranial aneurysms died within one year of the initial subarachnoid hemorrhage [5]. Therefore, the view that such aneurysms (including unruptured lesions) should be actively treated has recently become dominant. Mizoi et al. [5] advocated surgery for all multiple intracranial aneurysms in a one-stage operation whenever possible, or even by a second operation if this were necessary to clip the unruptured aneurysms. They reported an overall morbidity rate of 14-19% and a mortality rate of 6-8% in 372 patients who underwent surgery for unilateral or bilateral multiple intracranial aneurysms after SAH, which were comparable to rates seen in surgery for single aneurysms in the anterior circulation. The mortality rate in patients harboring multiple intracranial aneurysms involving the posterior circulation was as high as 27%. In their study, 78% of the patients received complete treatment of all aneurysms in one session, 7% underwent complete treatment in two sessions, and 15% did not receive treatment of all aneurysms. Ninety-one percent of the patients with aneurysms located unilaterally in the anterior circulation underwent treatment of all aneurysms in one session, compared with 62% with lesions located bilaterally in the anterior circulation and 42% with aneurysms in the anterior and posterior circulation. Six (11%) of 55 patients left with untreated aneurysms died when these lesions ruptured [3]. In another large series of 221 patients with multiple intracranial aneurysms treated by surgical clipping, Orz et al. [7] reported an excellent or good overall outcome in 67.9% of patients presenting with SAH, compared with 86.5% in patients with unruptured aneurysms. This was comparable to the results in single intracranial aneurysms treated during the same period. In their series, treatment of all aneurysms in one session was achieved in 132 (90%) of 147 patients harboring multiple intracranial aneurysms unilaterally in the anterior circulation, compared with only four (9%) of 44 with lesions located bilaterally in the anterior circulation and 18 (60%) of 30 with lesions in the anterior and posterior circulation. Furthermore, 64% of patients with aneurysms located bilaterally in the anterior circulation and 30% of patients with aneurysms in the anterior and posterior circulation did not receive treatment for all lesions. Older patient age, poor neurological grade, and relatively small or intracavernous lesions were the main reasons for not treating all aneurysms.

Problems of surgical treatment for multiple intracranial aneurysms

Although the surgical risk of direct operation for multiple intracranial aneurysms is only slightly worse than for single aneurysms [5]. Several factors adversely affect the outcome after surgery in these patients. As explained above, problems remain with regard to one-stage operations in patients with aneurysms located in the posterior circulation. Misdiagnosis of the location of a ruptured aneurysm among multiple intracranial aneurysms also results in a poorer outcome [6]. The use of multiple surgical approaches during the acute stage after SAH has been reported to be one of the factors leading to poor outcome [6]. Nemoto et al. [6] reported that the size of unruptured aneurysms among multiple intracranial aneurysms is also a significant prognostic factor. Postoperative morbidity in patients with aneurysms less than 5 mm in diameter was 1.3%, whereas it was 20% with aneurysms measuring 10 mm or more. In addition, the increasing rate of occurrence of multiple intracranial aneurysms with advancing age presents a therapeutic dilemma in that although the risk of rebleeding in these patients is higher, so are the associated risks of surgery [2]. Therefore, in one series comprising 105 patients with multiple intracranial aneurysms 6 surgery for unruptured aneurysms caused 2% morbidity in patients 28 to 55 years old and 18% morbidity in patients over 56 years old. A larger series of patients reported by Inagawa 14 also confirmed a poorer surgical outcome in patients older than 60 years. Surgery for internal carotid artery aneurysms resulted in 14.8% overall morbidity. Surgery for middle cerebral and anterior cerebral artery aneurysms caused below 5% morbidity [15].

Endovascular treatment for multiple intracranial aneurysms

Endovascular techniques have been proved to be a therapeutic alternative to direct surgery in cases of intracranial aneurysms [10,12]. It is possible with this technique to achieve complete occlusion in aneurysms with small or wide necks [9,16]. In endovascular embolization, difficulties may be created by the size of the aneurysm and its neck rather than its location [17]. The introduction of the stent-assisted technique [18] and the development of various soft coils have significantly improved the anatomical results of coil embolization in this kind of aneurysm by permitting tight coil packing and a more complete occlusion of the lesion's inflow. Therefore, an alternative endovascular technique would be of particular benefit in this group of patients. A further benefit of the endovascular approach for treatment of multiple intracranial aneurysms is the elimination of the hazard of misdiagnosing and thus not treating the aneurysm responsible for hemorrhage. Instead, by using this technique, all aneurysms (ruptured and unruptured) may be endovascularly occluded at the same time. This technique also eliminates the problems associated with multiple craniotomies/surgical approaches that may be necessary in some cases. Furthermore, multistaged treatment can be performed, even within relatively short intervals of follow-up after the initial treatment. Retreatment may be necessary for wide-necked aneurysms that exhibit coil compaction caused by persistent exposure to the circulation. Notwithstanding these advantages, ischemic and hemorrhagic complications do occur with the use of endovascular techniques for embolization of aneurysms. In 36 consecutive patients treated at our institution, three had ischemic complications and one a hemorrhagic complication (three resulting in permanent deficits; one transient ischemic attack). This complication rate may be higher than that of Oh et al.'s series [11]. This may be caused by a higher percentage (66.7%) of stent usage in our patients. Our experience with endovascular techniques in the treatment of multiple intracranial aneurysms, particularly those involving the vertebrobasilar system, suggests that it may be a particularly suitable therapeutic method for this high-risk condition. However, endovascular treatment of MCA aneurysms remains controversial because of favorable surgical results with low morbidity-mortality and recurrence rates at follow-up.

Untreated aneurysms

One study [15] assessed 4060 patients: 1692 did not have aneurysmal repair, 1917 had open surgery, and 451 had endovascular procedures. Five-year cumulative rupture rates for patients with unruptured aneurysms located in the internal carotid artery, anterior communicating or anterior cerebral artery, or middle cerebral artery were 0%, 2.6%, 14.5%, and 40% for aneurysms less than 7 mm, 7-12 mm, 13-24 mm, and 25 mm or greater, respectively, compared with rates of 2.5%, 14.5%, 18.4%, and 50%, respectively, for the same size categories involving posterior circulation and posterior communicating artery aneurysms. In our series, 19 incidental aneurysms [six ICA aneurysms, six MCA aneurysms, two PCoA aneurysms, two ACoA aneurysms, one basilar artery aneurysm and one vertebrobasilar junction aneurysm in 13 patients (36.1%)] were left untreated because of their small size (<3 mm) and low cumulative rupture rates.

Conclusions

In the treatment of multiple intracranial aneurysms, endovascular techniques can be used to treat the ruptured lesion and lesions technically difficult for surgery. This eliminates the risk of early rebleeding and provides the option of treating additional aneurysms by embolization or surgery in case of technical difficulties.

References

1 Vajda J. Multiple intracranial aneurysms: a high risk condition. Acta Neurochir. 1992; 118 (1-2): 59-75. doi: 10.1007/BF01400727.
2 Wilson FMA, Jaspan T, Holland IM. Multiple cerebral aneurysms: a reappraisal. Neuroradiology. 1989; 31 (3): 232-236. doi: 10.1007/BF00344349.
3 Lv X, Li Y, Wu Z. Endovascular management for bilateral ophthalmic segment "kissing aneurysms" presenting with nasal bleeding. A case report. Neuroradiol J. 2008; 21 (2): 266-269.
4 Heiskanen O, Marttila I. Risk of rupture of a second aneurysm in patients with multiple aneurysms. J Neurosurg. 1970; 32 (3): 295-299. doi: 10.3171jns.1970.32.3.0295.
5 Mizoi K, Suzuki J, Yoshimoto T. Surgical treatment of multiple aneurysms. Review of experience with 372 cases. Acta Neurochir. 1989; 96 (1-2): 8-14. doi: 10.1007/BF01403489.
6 Nemoto M, Yasui N, Suzuki A, et al. Problems of surgical treatment for multiple intracranial aneurysms. Neurol Med Chir (Tokyo). 1991; 31 (13): 892-898 [Article in Japanese]. doi: 10.2176/nmc.31.892.
7 Orz Y, Osawa M, Tanaka Y, et al. Surgical outcome for multiple intracranial aneurysms. Acta Neurochir. 1996; 138 (4): 411-417. doi: 10.1007/BF01420303.
8 Rinne J, Hernesniemi J, Puranen M, et al. Multiple intracranial aneurysms in a defined population: prospective angiographic and clinical study. Neurosurgery. 1994; 35 (5): 803-808. doi: 10.1227/00006123-199411000-00001.
9 Viñuela F, Duckwiler G, Mawad M. Guglielmi detachable coil embolization of acute intracranial aneurysm: perioperative anatomical and clinical outcome in 403 patients. J Neurosurg. 1997; 86 (3): 475-482. doi: 10.3171/jns.1997.86.3.0475.
10 Molyneux AJ, Kerr RS, Yu LM, et al. International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysm: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. Lancet. 2005; 366 (9488): 809-817. doi: 10.1016/S0140-6736(05)67214-5.
11 Oh K, Lim YC. Single-session Coil Embolization of multiple intracranial aneurysms. J Cerebrovasc Endovasc Neurosurg. 2013; 15 (3): 184-190. doi: 10.7461/jcen.2013.15.3.184.
12 Xavier AR, Rayes M, Pandey P, et al. The safety and efficacy of coiling multiple aneurysms in the same session. J Neurointerv Surg. 2012; 4 (1): 27-30. doi: 10.1136/jnis.2009.001974.
13 Jennett B, Bond M. Assessment of outcome after severe brain damage. A practical scale. Lancet. 1975; 1 (7905): 480-484. doi: 10.1016/S0140-6736(75)92830-5.
14 Inagawa T. Multiple intracranial aneurysms in elderly patients. Acta Neurochir (Wien). 1990; 106 (3-4): 119-126. doi: 10.1007/BF01809453.
15 Wiebers DO, Whisnant JP, Huston J 3rd, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 2003; 362 (9378): 103-410. doi: 10.1016/S0140-6736(03)13860-3.
16 Chung J, Shin YS. Multiple intracranial aneurysms treated by multiple treatment modalities. Neurosurgery. 2011; 69 (4): E1030-1032. doi: 10.1227/NEU.0b013e31822a5280.
17 Lv X, Li Y, Liu A, et al. Endovascular management of multiple cerebral aneurysms in acute subarachnoid hemorrhage associated with fenestrated basilar artery: a case report and review of the literature. Neuroradiol J. 2008; 21 (1): 137-142.
18 Vendrell JF, Costalat V, Brunel H, et al. Stent-assisted coiling of complex middle cerebral artery aneurysms: initial and midterm results. Am J Neuroradiol. 2011; 32 (2): 259-263. doi: 10.3174/ajnr.A2272.

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