Journal of Clinical Neuroscience 21 (2014) 2140–2144

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Clinical Study

Single-centre comparison of procedural complications, clinical outcome, and angiographic follow-up between coiling and stent-assisted coiling for posterior communicating artery aneurysms

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ARTICLE INFO

Article history:
Received 5 October 2013
Accepted 29 March 2014

Keywords:
Endovascular treatment
Intracranial aneurysm
Posterior communicating artery aneurysm
Stent-assisted coiling

ABSTRACT

Aneurysm recurrence is a principle limitation of endovascular coiling procedures, especially in posterior communicating artery aneurysms, with reported recurrence rates of >30%. The adjunctive use of self-expandable stents has revolutionised the treatment of intracranial aneurysms, especially for complex morphologies, wide necks, or unfavourable dome-to-neck ratios. However, there are limited data concerning a direct comparison between simple coiling and stent-assisted coiling in posterior communicating artery aneurysms. This study aimed to compare the durability and outcomes of coiling *versus* stent-assisted coiling procedures. Imaging data of patients with posterior communicating artery aneurysms treated with coiling or stent-assisted coiling between January 2008 and October 2012 were retrospectively analysed. The initial angiographic results, procedural complications, and clinical outcomes were assessed at discharge. Imaging follow-up was performed with cerebral angiography. Complete aneurysm occlusion was achieved on initial angiography in 23/56 (41.1%) stent and 83/235 (35.3%) non-stent patients. At the latest follow-up (mean follow-up 14.3 ± 10.4 months for stent and 13.2 ± 9.5 months for non-stent patients), aneurysms had recurred in 5/47 (10.6%) stent and 57/203 (28.1%) non-stent patients ($p = 0.014$). Procedural complications occurred in 6/56 (10.7%) stent and 27/235 (11.5%) non-stent aneurysms. No rebleeding occurred during clinical follow-up (mean duration, 46.7 months). Recurrence rates at the latest follow-up were significantly lower in patients undergoing stent-assisted coiling than those undergoing simple coiling. Thus, use of the stent-assisted neck remodelling technique in the treatment of wide-necked posterior communicating artery intracranial aneurysms appears to improve the long-term clinical outcome.

1. Introduction

Endovascular treatment of cerebral aneurysms with detachable coils has been increasingly adopted over the past two decades. However, the widespread acceptance of endovascular coiling has been limited by the likelihood of aneurysm recurrence, concerns over the durability of treatment, and the significance of incompletely treated aneurysms [1]. The introduction of intracranial stents has significantly contributed to the treatment options for aneurysms with complex morphologies, wide necks, or unfavourable dome-to-neck ratios [2]. Selective embolisation of wide-necked intracranial aneurysms remains difficult, because of the risk of coil protrusion within the parent vessel, but stent-assisted coil embolisation helps to prevent this [3]. In addition, intracranial stents might also reduce the aneurysm recanalisation rate. Several authors have documented the feasibility and safety of these devices [2,4,5].

In this study, we present a series of 291 posterior communicating artery (PcomA) aneurysms that were treated with endovascular coil embolisation; 56 of these aneurysms were treated with a stent. We demonstrate that the use of a stent is related to a lower aneurysm recurrence rate in this population.

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http://dx.doi.org/10.1016/j.jocn.2014.03.033
0967-5868/

2. Materials and methods

2.1. Patients

Our Institutional Review Board approved this study. We retrospectively reviewed the clinical and radiological data of patients with PcomA aneurysms who underwent endovascular coil embolisation between January 2008 and October 2012 at our institute. In our practice, the decision to employ surgical clipping or endovascular treatment of the aneurysm was made by agreement between a vascular neurosurgeon and a neuroendovascular specialist. Indications for stent use mainly included complex unruptured or ruptured aneurysms, including fusiform, large and/or giant, or wide-neck aneurysms; additionally, small aneurysms, which might be untreatable by conventional coiling or prone to recurrences, can be considered amenable to such a technique. Wide-necked aneurysms were defined as having a neck $\geqslant$4 mm or a dome-to-neck ratio <2 [5,6].

2.2. Endovascular procedures

Endovascular therapeutic procedures were performed on a biplane angiographic unit, with the patients under general anaesthesia and systemic heparinisation. All aneurysm embolisation procedures were performed via transfemoral arterial access, using detachable platinum coils, which included the GDC (Boston Scientific, Fremont, CA, USA), MicroPlex (MicroVention, Aliso Viejo, CA, USA), Trufill-DCS (Cordis, Miami Lakes, FL, USA), and Axium (ev3, Irvine, CA, USA) coils. Modified coils, such as Matrix (Boston Scientific) or Hydro-Coil (MicroVention) coils, were not used. Stent-assisted coil embolisation was used in 56 aneurysms. The stents used for remodelling were the Enterprise (Codman Neurovascular, Miami, FL, USA), Neuroform (Boston Scientific), and the Solitaire AB (ev3); the stents were successfully deployed to cover the aneurysmal neck in all cases. Stent overlapping was not used in any case.

Systemic heparinisation was performed after placing a femoral introducer sheath. According to our embolisation protocol, 5000 international units (IU) of heparin were administered as an intravenous bolus injection, followed by an additional 1000 IU per hour, maintaining an activated clotting time 2–2.5 times that of baseline until completion of the procedure. For patients with unruptured or non-acutely ruptured aneurysms, dual antiplatelet drugs (75 mg/day clopidogrel and 100 mg/day aspirin) were given for 5 days before the procedure. For patients with acutely ruptured aneurysms, four clopidogrel pills (300 mg) were administered orally 2 hours before stent placement, and aspirin (100 mg) was injected at the start of the procedure. All patients who underwent stent-assisted coiling were maintained on aspirin (100 mg/day) and clopidogrel (75 mg/day) for 6 months, followed by aspirin (100 mg/day) alone, which was continued for 1 year.

Both post-embolisation and follow-up angiograms were graded on a three point Raymond scale, with 1 = complete obliteration of the aneurysm, including the neck; 2 = contrast filling of the neck of the aneurysm, without opacification of the aneurysm sac; and 3 = contrast filling of the sac of the aneurysm [7].

2.3. Procedural complications

Periprocedural complications, including intra-procedural rupture or thromboembolic events, were recorded.

2.4. Clinical and angiographic follow-up

All patients were evaluated clinically 4–6 weeks after treatment and were then followed up at the Outpatient Clinic or by telephone. Angiographic images obtained immediately after embolisation for each patient were compared with images obtained at each follow-up visit. For follow-up imaging, patients had either conventional digital subtraction angiography, magnetic resonance angiography, or both. Digital subtraction angiography was used for analysis whenever available.

Changes in angiographic outcome were classified as follows: stable (no change in coil configuration, obliteration grade, or contrast filling), improved (progressive occlusion or involution of the neck remnant or contrast filling in aneurysm), and recanalised (aneurysm recurrence evident due to neck growth, coil compaction, coil extrusion by aneurysm degradation, or new sac formation). In addition, newly visualised or increased contrast filling inside an aneurysm was also considered to indicate recanalisation [8].

2.5. Data collection and statistical analysis

Patient age, sex, aneurysm size, presence of multiple aneurysms, aneurysm status (ruptured *versus* unruptured) and admission Hunt and Hess grade (for ruptured aneurysms) were examined. Data were analysed using the Statistical Package for the Social Sciences version 13.0 (SPSS, Chicago, IL, USA). Two-tailed Student's *t*-tests were used to compare means and Fisher exact tests were used to compare proportions. A probability value <0.05 was considered statistically significant. Data are presented as mean ± standard deviation.

3. Results

3.1. Patient population and aneurysm characteristics

A total of 291 endovascular procedures were performed, including 56 aneurysms treated with a self-expandable stent. Patient demographics and aneurysm characteristics are shown in Table 1. The mean age in the stent and non-stent coiling groups was 53.6 ± 12.8 years and 52.2 ± 11.3 years, respectively. Thirty-seven of the 56 patients in the stent group and 151 of the 235 patients in the non-stent coiling group were women. The mean aneurysm size was 10.55 ± 5.03 mm in the stent group and 7.11 ± 3.80 mm in the non-stent coiling group, with a mean neck size of 6.34 ± 2.98 mm and 4.08 ± 2.85 mm in the stent and non-stent groups, respectively. Fifteen of the 56 aneurysms in the stent group and 165 of the 235 aneurysms in the non-stent coiling group were ruptured.

3.2. Immediate angiographic results

Immediate angiographic results following the embolisation procedure were analysed and the results are summarised in Table 2. Complete aneurysm occlusion was achieved in 23/56 (41.1%) of the stent patients and in 83/235 (35.3%) of the non-stent patients. Neck remnants were present in 25/56 (44.6%) of the stent group and 99/235 (42.1%) of the non-stent group. Sac remnant was present in 8/56 (14.3%) of the stent group and 53/235 (22.6%) of the non-stent group. Although complete occlusion and neck remnant was achieved in a larger percentage of patients in the stent group, this result was not statistically significant ($p = 0.442$).

3.3. Follow-up angiographic results

Angiographic follow-up time ranged from 3–60 months in both the stent group and the non-stent group. At latest follow-up, 47/56 (83.9%) stent-assisted and 203/235 (86.4%) non-stent-assisted patients had repeat imaging (Table 3). The mean angiographic