Interdisciplinary Neurosurgery: Advanced Techniques and Case Management 8 (2017) 50–56

Contents lists available at ScienceDirect

Interdisciplinary Neurosurgery: Advanced Techniques and Case Management

journal homepage: www.inat-journal.com

Technical Note & Surgical Technique

Long-term review of selected basilar-tip aneurysm endovascular techniques in a single institution

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ARTICLE INFO

Article history:
Received 28 November 2016
Accepted 2 January 2017

Keywords:
Basilar tip aneurysm
Coiling
Stent-assisted coiling
Long-term follow up

ABSTRACT

Background: Several endovascular techniques and devices are presently available for the non-surgical treatment of basilar-tip aneurysms in dedicated neurovascular departments. However, the revolving drawback to treatment to angiographic approach remains the long-term coil-mass durability and less patent published results regarding treatment outcome and long-term efficacy. We aim to share our experience of selected endovascular techniques for treating basilar-tip aneurysms and its long-term clinical and angiographic outcome.

Material and methods: We retrospectively reviewed 109 patients basilar-tip aneurysm who had endovascular treatment in our department from 2003 to 2014. Three groups were based on treatment method: single microcatheter (SM), multiple microcatheters (MM), and stent-assisted (SA) coiling techniques. All procedural-related complications and outcomes were followed and analyzed. Angiographic follow-up with accompanying skull-series review were evaluated from initial coil-mass occlusion time to the last follow-up outpatient attendance.

Results: In our study, sac size ($p < 0.001$), neck size ($p < 0.001$), and ruptured status ($p < 0.001$), were the determining factors of endovascular techniques selection in treating basilar-tip aneurysm. Technique selection was validated as clinically and angiographically effective over a mean 43.5 month follow-up in 90% of outpatients' attendances. Logistic regression analyses concluded factors that were directly linked to a "major recanalization" outcome include: (i) ruptured-status ($p = 0.05$), (ii) aneurysm size >11 mm ($p < 0.001$), and (iii) aneurysm neck size >4 mm ($p = 0.006$).

Conclusion: Small aneurysms particularly those with a small-neck size can be treated with SM or MM approach. Medium-large sized aneurysm can be treated effectively by combined MM and SA techniques.

1. Background

Basilar-tip aneurysm is the most common aneurysm found in the posterior fossa circulation, representing 5–8% of the total intracranial aneurysms [1–4]. Given the literature findings of (i) higher bleeding tendency in the posterior circulation aneurysm and (ii) worse post-rupture clinical outcome, the treatment of these aneurysms should be elevated to a more urgent status to obviate the conservative imaging approach for aneurysm regrowth [3,5–9]. Microsurgical and neurointerventional therapies are the two current literatures' options to treat basilar-tip aneurysms. However, given the acknowledged challenge of the (i) neurosurgical approach (ii) clipping technique and (iii) current paucity of trained young vascular neurosurgeons, many aneurysm-centers has largely replaced the microsurgical treatment for the endovascular option [10–16]. The main limitating factor of the endovascular approach treatment however, remains the coil-mass endurance. This factor places the patient in the continued unsecured situation of increased aneurysm rupture (or re-rupture) risk [17–20]. To address this issue, scrutiny of the endovascular literature revealed the utilization of (i) multiple microcatheters (ii) balloon remodeling (iii) various stent-reconstruction (iv) flow-diverter, and (v) new devices e.g. Woven EndoBridge (WEB) [13,21–31]. The efficacy of these techniques without long-term monitoring yet remains uncertain. Moreover, knowing the limited access of developing countries to these advanced devices, due consideration should be exercised. Thus, cost-effective endovascular treatment remains a logical rationale. In our department,

Abbreviations: DNR, Dome-Neck Ratio; TFCA, Trans Femoral Catheter Angiography; HH, Hunt-Hess; GOS, Glasgow Outcome Score; MM, Multiple Microcatheter; MRA, Magnetic Resonance Angiography; MRI, Magnetic Resonance Imaging; *P*1, First segment of posterior cerebral artery; PGLA, Polyglycolic/polylactic acid; SA, Stent-Assisted Coiling; SM, Single Microcatheter; RR, Raymond-Roy; TE, Thromboembolic; WEB, Woven EndoBridge.

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http://dx.doi.org/10.1016/j.inat.2017.01.005

senior neurointerventional staff and authors (OK·K and GJH) utilized a few classic endovascular techniques for basilar-tip aneurysm and which was categorized simply into three groups: (i) single microcatheter (SM) (ii) multiple microcatheters (MM) and (iii) stent-assisted coiling (SA) techniques. We aim to evaluate the performance of each selected technique with concurrent statistical analyses of the long-term efficacy of these three neurovascular approaches. (See Figs. 1 and 2.)

2. Methods

A retrospective analysis was conducted on all clinical and neuroradiological data concerning the endovascular treatment of basilar-tip aneurysms at the Department of Neurosurgery, Seoul National Bundang Hospital (SNUBH) from January 2003 to December 2014. In this cohort, the last follow-up time ended on June 2016. This study was approved by our institutional research board. The pre-and post-procedural neuroradiological examinations, measurements and analyses were mostly based on trans-femoral catheter angiography (TFCA), magnetic-resonance angiography (MRA), magnetic-resonance imaging (MRI), and skull X-ray series.

2.1. Clinical data

Retrospective analysis of the pre-procedural clinical data included (i) patient's age (ii) sex (iii) ruptured-status with Hunt-Hess (HH) scale. HH scale was categorized as unruptured (HH0), low grade (HH1 − 2), high grade (HH 3–5). Each patient's clinical outcome was assessed using Glasgow Outcome Scale (GOS), i.e., favorable (GOS 4–5), unfavorable (GOS 2–3), and dead (GOS 1). We recorded the GOS upon discharge and final outpatient attendance. Any clinical complication was recorded and classified into (a) major thromboembolism with significant clinical symptom(s) or sign(s) (b) minor thromboembolism with imaging regardless of mild symptom(s) and/or sign(s) (c) coil-mass effect and (d) hemorrhage.

2.2. Neuroradiological data

Neuroradiological imaging for each study was obtained from biplane TFCA (Toshiba Medical System Corporation, Otawara, Japan), 1.5T/3T MRA/MRI studies (Phillips Healthcare, Eindhoven, Netherland). The imaging findings were analyzed using multi-dimensional reconstructions, Vitrea software (Vital Images Inc./Toshiba, Minnetonka, MN, USA). These data sets were obtained from the Infinit PACS system (INFINITT Inc., Seoul, Korea). Pre-procedural aneurysm dimensions, shape, and working-projections were assessed. The sac size was categorized very small (<3 mm), small (3–6.9 mm), medium (7–13.9 mm), large (14–24.9 mm), and giant (≥25 mm). The neck size was assessed as either wide or narrow (threshold = 4 mm) following recommendations from Zubillaga et al. [32]. Dome-neck ratio (DNR) was evaluated and was considered as high(≥1.2 mm) or low (<1.2 mm).

Post-procedural (i) aneurysm packing-density of the coil mass—AngioCalc® software (LLC, Charlottesville, VA, USA) (ii) aneurysm occlusion-rate—classic Raymond-Roy (RR) classification for basilar tip aneurysm, and (iii) aneurysm recanalization were calculated . Any aneurysm recanalization was categorized as (1) no recanalization or stable coil-mass (2) minor recanalization—contrast fills aneurysm neck and (3) major recanalization—increased contrast-filling of sac. Minor and major recanalization detection-times were recorded along with repeat coil-embolization treatments. At the last follow-up, the previous aneurysm occlusion-rate was compared and re-assessed using the classic Raymond-Roy (RR) system. Any patient with repeat embolization treatment(s) was serially reviewed to update the findings from the last diagnostic angiogram.

2.3. Clinical and angiographic follow-up

According to our departmental guidelines, all treated patients with initial complete occlusion or neck remnant, should have a 6 to 12 months angiogram (MRA or TFCA) follow-up. For a stable coil-mass, a similar angiographic evaluation is recommended every 1–2 years. For partial occlusion-rate with sac remnant, a 6-month TFCA follow-up is advised; repeat MRA or TFCA is then recommended every year to re-assess for coil-mass stability. For progressive recanalization, a reduced 6-month interval angiogram is advised.

2.4. Statistical analysis

Statistical analyses were performed using SPSS software version 22.0 (SPSS Inc., Chicago, IL). The categorical variables presented as percentages and continuous variables are presented as means. Categorical variables were tested using Chi-square test. Continuous variables were tested using the Kruskal-Wallis or ANOVA test. Continuous variable

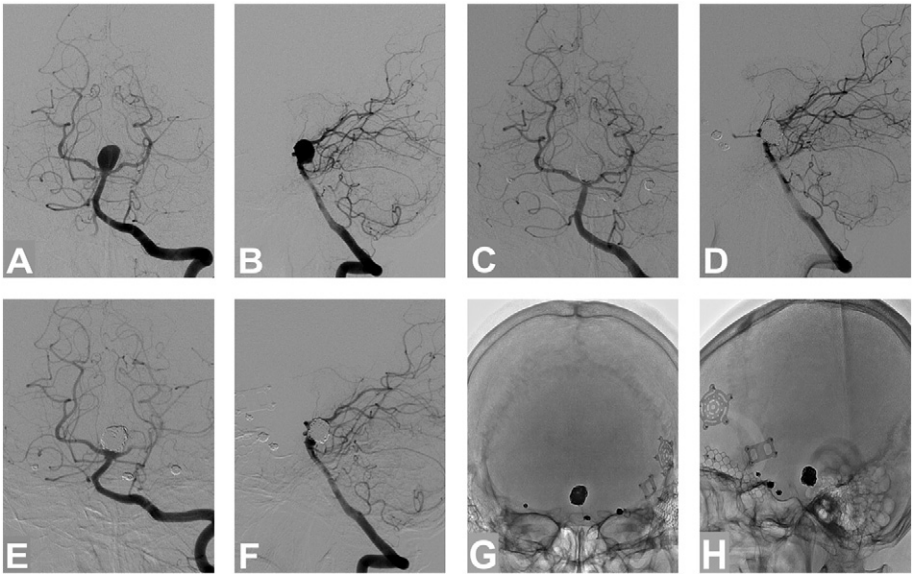

Fig. 1. Double-microcatheter technique. Unruptured basilar-tip aneurysm case of 41-year-old female. Aneurysm size is 10 mm, neck 5.2 mm, and DNR = 1.94. Panels A and B show the pre-embolization imaging on catheter angiography. Panels C and D show the initial occlusion. Panels E and F show the angiographic follow-up at 100 months. Panels G and H show the skull x-ray follow-up at 120 months, which demonstrates stable and solid coil mass structure.