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Stent-assisted treatment of ruptured intracranial aneurysms in the acute phase: A single center experience

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ABSTRACT

Introduction: The purpose of this study was to analyze the results of patients with ruptured aneurysms who were treated with a specific microstent in the acute phase of subarachnoid hemorrhage.
Methods: Data from patients with acutely-ruptured intracranial aneurysm treated with the Neuroform stent in the period between 2003 and 2016 were retrospectively assessed, addressing aneurysm occlusion and clinical outcome with a focus on periprocedural complications.
Results: Twenty-nine consecutive patients with ruptured intracranial aneurysms were included in the analysis. Periprocedural hemorrhagic complications were stated in six patients, leading to death in four. Thromboembolic complications were observed in seven patients, among whom only one affected the clinical outcome with death due to basilar thrombosis. Immediate complete occlusion and occlusion with residual neck was achieved in 79.3% of cases.
Conclusion: Stent-assisted coiling of acutely-ruptured aneurysms achieves good immediate aneurysm occlusion. Rates of intra- and periprocedural adverse events observed in this series were significant, but did not translate to corresponding morbidity and mortality in all cases. The retrospective analysis did not allow assessing the overall risks of endovascular therapy with stent use in ruptured and complex aneurysm when compared to the overall risks with other alternative options.

1. Introduction

Stent-assisted coiling has become an established treatment option for intracranial aneurysms, enabling endovascular treatment (EVT) for complex ruptured aneurysms with good occlusion rates [1–3]. However, dual antiplatelet therapy is required to avoid thromboembolic complications. Previous studies have shown that dual antiplatelet therapy is associated with an increased risk of hemorrhagic complications, which might be further aggravated in the setting of subarachnoid hemorrhage (SAH) with an abnormal coagulation status [4]. The purpose of this study was to retrospectively analyze the consecutive series of patients who underwent attempted stent-assisted coil embolization with a Neuroform stent (Neuroform, Stryker Neurovascular, Kalamazoo, MI, USA) between January 2003 and January 2016 at the Institute of Diagnostic and Interventional Radiology and Neuroradiology at the University Hospital of the University Duisburg - Essen to evaluate this treatment strategy for acutely-ruptured aneurysms.

2. Materials and methods

2.1. Patient selection

Data for patients who underwent attempted stent-assisted treatment of acutely-ruptured intracranial wide-neck and fusiform aneurysms with a Neuroform I, II or III microstent between January 2003 and January 2016 was retrieved from the institutional aneurysm databank.

Abbreviations: AComA, Anterior communicating artery; AICA, anterior inferior cerebellar artery; BA, Basilar artery; DSA, Digital subtraction angiography; DWI, Diffusion-weighted imaging; EVD, External ventricular drainage; HH, Hunt and Hess; ICA, Internal carotid artery; MR, Magnetic resonance; PcomA, Posterior communicating artery; PICA, Posterior inferior cerebellar artery; TOF, Time of flight; VA, Vertebral artery

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An acutely-ruptured intracranial aneurysm was defined as an aneurysm treated no > 30 days after the initial rupture. A vascular neurosurgeon and a neuroendovascular specialist jointly made the decision concerning whether EVT or surgical clipping of the ruptured aneurysm was the appropriate treatment option on a patient-by-patient basis [5]. Whenever a high-surgical risk (esp. in posterior circulation aneurysms or with patients in the vasospastic period between day 4 and 14) existed or aneurysm occlusion by coiling alone was considered too risky, the decision was made to perform EVT with stent-assisted coil embolization. Stent deployment was also performed as bailout procedure where coil protrusion into the parent artery would have posed a risk of vessel occlusion. Demographic data, aneurysm occlusion grades, clinical outcome, procedural and periprocedural complications were retrospectively analyzed by an independent reviewer (MH). Approval for data collection and the retrospective analysis of all interventional procedures and follow-up reported in this study was given by the ethical board of the University Duisburg - Essen, Germany (reference no: Z-14-57744-BO).

2.2. Endovascular procedures

If necessary, external ventricular drainage (EVD) was usually placed prior to the procedure. EVT was performed via a femoral approach and under general anesthesia. A triaxial approach was applied using a long femoral introducer, a guiding catheter and a microcatheter under the guidance of roadmaps. Using a coil-through technique, coils were deployed over a microcatheter, which was positioned through the stent interstice into the aneurysm sac after releasing the stent from the stent delivery system across the neck of the ruptured aneurysm. Alternatively, coils were deployed using the jailing technique, releasing the stent after positioning the microcatheter within the sac of the aneurysm.

2.3. Anticoagulation/antiplatelet regimen

In all patients, shortly before or during the procedure, a combination of an intravenous bolus of aspirin (500 mg) followed by clopidogrel (300 mg) through the gastric tube was administered. The clopidogrel treatment (75 mg) was continued for 6–12 weeks. Aspirin (100 mg/day) was continued indefinitely. Due to the emergency situation, responsiveness to antiplatelet therapy was not tested. During the procedure, patients received a bolus dose of heparin 2–3 times above the baseline for anticoagulation to maintain an activated clotting time (ACT) or alternatively a body-weight adjusted bolus without ACT control.

2.4. Follow-up protocol

As a baseline examination for the non-invasive evaluation of aneurysm occlusion, possible parent vessel stenosis and possible procedural adverse events, a brain magnetic resonance (MR) study was performed within 48 h after the procedure. The magnetic resonance imaging (MRI) protocol included a time of flight (TOF) MR angiography and diffusion-weighted sequences (DWI). If a MRI could not be performed due to contraindication for MRI or critical clinical status, a cranial computed tomography (cCT) scan was carried out. The standardized follow-up examination protocol comprised a digital subtraction angiography (DSA) and brain MR study scheduled at six months after treatment, followed by controls one year later and further controls every 2–3 years, depending on the individual findings. If recurrence or progression was suspected on MRI, DSA with possible retreatment was offered.

2.5. Data collection and data analysis

Patient data was collected including age, gender, severity of SAH using Hunt and Hess (H&H) grade, type of aneurysm (fusiform/dissecting, blister-like or saccular), location of aneurysm, size of aneurysm dome and neck, as well as post-interventional information including clinical outcome using the Glasgow outcome score (GOS), degree of aneurysm occlusion, periprocedural thromboembolic and hemorrhagic complications.

The initial degree of occlusion was graded using the Raymond-Roy classification as 1—complete, 2—residual neck and 3—residual aneurysm [6]. At follow-up, recurrence was stated if an aneurysm that was previously completely occluded showed a partial recurrence of the neck and/or the sac.

Procedural thromboembolic events were defined as complications in cases of visible thrombus formation and/or parenchymal ischemia not related to vasospasm. The detected ischemic complications were considered minor if their size did not exceed 10 mm on DWI sequences in non-eloquent areas. Lesions larger than 10 mm – as well as smaller infarcts located in the brainstem or basal ganglia – were considered major infarcts. Only major infarcts were recorded as stent procedure-related thromboembolic complications since minor DWI lesions are noted after catheterization itself in up to 26% of cases [7].

Hemorrhagic events were categorized into intraprocedural complications due to aneurysm re-rupture, as well as into periprocedural complications as aneurysm re-rupture, intraparenchymal hemorrhage (not ventricular drain-related) and intraparenchymal hemorrhage (ventricular drain-related) as observed during follow-up examinations.

3. Results

3.1. Patient and aneurysm characteristics

A total of 29 patients (18 females, 11 males, mean age 52, range 31–83 years) underwent attempted stent-assisted coiling for ruptured intracranial aneurysm. One patient had two aneurysms mirroring at the proximal basilar stem in which one was responsible for the hemorrhage, whereby both were treated at the same time.

Eleven (37.9%) patients were admitted in a clinically poor grade condition (H&H of IV or V), while six (20.7%) patients presented in moderate clinical condition (HH III) and twelve (41.4%) in a good status (HH I or II). Nine (31%) patients harbored more than one aneurysm, although the site of ruptured aneurysms could be identified. The majority had broad-based (72.4%) saccular aneurysms and six fusiform/dissecting aneurysms as well as two blister-like aneurysm were identified. The mean diameter of the dome of the saccular aneurysms was 7.5 ± 6.3 mm, with a mean neck width of 4.7 ± 3.3 mm. The size of fusiform/dissecting aneurysms was 5.7 ± 1.8 mm, with an average width of 5.2 ± 1.5 mm. Twenty-five (86.2%) aneurysms were localized in the posterior circulation and four (13.8%) aneurysms were situated in the anterior circulation (Table 1).

3.2. Embolization results

In 27 (93.1%) cases, the stent was deployed in the desired position, while in 25 (86.2%) of these cases additional coiling was performed. In one patient the stent was not deployed in the desired position. In another patient, stent placement was not possible due to extreme vessel

Table 1
Location of aneurysms.

Vessel	Abs.	%
ICA	3	10.3
AomA	1	3.4
PcomA	1	3.4
BA tip	11	37.8
BA trunk	5	17.2
VA	8	27.6

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