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Technique

Single-center experience with the Neuroform stent for endovascular treatment of wide-necked intracranial aneurysms ☆

Eduardo Wajnberg, MD[a,*], Jorge Marcondes de Souza, MD, PhD[b], Edson Marchiori, MD, PhD[a], Emerson L. Gasparetto, MD, PhD[a]

Departments of [a]Radiology and Interventional Radiology, and [b]Neurosurgery, University of Brazil, 21941-913 Rio de Janeiro

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Abstract

Background: Stent-assisted coiling is an accepted endovascular treatment (EVT) for wide-necked intracranial aneurysms. The Neuroform stent (Target Therapeutics, Fremont, Calif) is a flexible nitinol self-expandable stent that was designed to potentially overcome the limitations of balloon expandable coronary stents in the intracranial circulation. The aim of this study was to reenforce the use of this stent for EVT of wide-necked cerebral aneurysms.

Methods: Between March 2005 and March 2008, 24 patients harboring wide-necked cerebral aneurysms were treated with stent reconstruction of the aneurysm neck. Inclusion criteria restricted the group to adult patients with wide-necked intracranial aneurysms (ruptured and unruptured lesions). Immediate postprocedure angiography studies were performed to determine successful coil occlusion of the aneurysm as well as patency of the parent vessel. We assessed the clinical history, aneurysm dimensions, and technical detail of the procedures, including any difficulties with stent placement and deployment, degree of aneurysm occlusion, and complications. Clinical outcome was assessed with the Glasgow Outcome Scale (GOS).

Results: The stent was easily navigated and precisely positioned in 24 of 26 cases. However, technical difficulties occurred in 9 patients, including difficulties in crossing the stents interstice in 6 cases, inadvertent stent delivery (n = 1), and incapacity of stent delivery (n = 1) and incapacity of crossing the neck (n = 1). These latter 2 cases were classified as failures of the stent-assisted technique. A single procedural complication occurred, involving transient nonocclusive intrastent thrombus formation, which was treated uneventfully with abciximab. Seventeen patients experienced excellent clinical outcomes (GOS 5), with good outcomes (GOS 4) in 5 patients and a poor outcome (GOS 3) in 2 patients. There were no treatment-related deaths or neurologic complications (mean clinical follow-up, 12 months). Angiographic results consisted of 17 complete occlusions, 4 neck remnants, and 3 incomplete occlusions.

Conclusions: The Neuroform stent is very useful for EVT of wide-necked intracranial aneurysms because it is easy to navigate and to deploy accurately. In most cases, the stent can be deployed precisely, even in very tortuous carotid siphons. Although in some cases delivery and deployment was challenging, clinically significant complications were not observed.

Keywords: Aneurysm; Embolization; Intracranial stent

Abbreviations: ACom, Anterior Communicating artery; AVM, Arteriovenous Malformation; CT, Computed tomography; DNA, Desoxiribonucleic Acid; EVT, Endovascular treatment; GDC, Guglielmi detachable coils; GOS, Glasgow Outcome Scale; IDA, Incidentally diagnosed aneurysm; ISUIA, International Study of Unruptured intracranial aneurysms; MCA, Middle cerebral artery; MRI, Magnetic resonance imaging; PCom, Posterior Communicationg Artery; PICA, Posterior inferior cerebellar artery; SAH, Subarachnoid hemorrhage.

☆ None of the authors have identified a conflict of interest.

* Corresponding author. Tel.: +55 21 3874 0126; fax: +55 21 2512 5147.

E-mail address: eduardowj@gmail.com (E. Wajnberg).

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1. Introduction

During the past 15 years, the endovascular treatment (EVT) of cerebral aneurysms has been defined primarily by an endosaccular approach using platinum coils designed for controlled deployment and safe filling and conformability within the aneurysmal sac. Endovascular treatment of intracranial aneurysms by endosaccular coiling has become an accepted alternative to surgical clipping, with lower morbidity and mortality rates in selected cases [27].

Aneurysm recurrence after coiling soon appeared to be a major limiting factor of the endovascular technique. It has generally been thought to proceed through recanalization of the coiled fundus or progressive aneurysm growth from either an incompletely coiled aneurysm or an intrinsic deficiency in the wall of the nearby parent artery. The extent of the problem, first suggested in early reports [9,15,26,29], has been subject of analysis in many studies. Raymond et al [31], in a retrospective analysis of data collected from 466 patients with 501 aneurysms, observed a strong correlation between aneurysm and neck size and the prevalence of late recurrence.

In the case of wide-necked aneurysms, particularly in certain arterial segmental defects that encompass more than 180° of the cross-sectional vessel surface, selective embolization remains difficult because of the risk of coil protrusion within the parent vessel. These aneurysms are more technically challenging and frequently associated with incomplete coiling because of the loose packing of the aneurysm base. The “remodeling” technique has emerged as a successful technical alternative to achieve complete occlusion of these aneurysms [10,20,22,24,28]. A small balloon-occlusion microcatheter is used to protect the parent artery lumen during deployment of the coils within the lesion. However, this technique may fail to retain coils in aneurysms with a very large neck and also may be associated with a higher rate of thromboembolic events [11,34].

The introduction of intracranial stents has significantly contributed to the treatment options for coil occlusion of wide-necked and fusiform aneurysms. Stent-assisted coil embolization helps to prevent protrusion of the coils into the parent vessel [30]. In addition, intracranial stents might also reduce the aneurysm recanalization rate. Initially, the use of coronary stents as an adjunct to coil embolization was considered. These balloon-mounted stents developed for the coronary vessels lack the flexibility necessary to navigate the tortuosities of the carotid siphon and reach distal intracranial circulation targets.

Several authors recently reported the use of the Neuroform self-expandable intracranial stent (Target Therapeutics, Fremont, Calif) for EVT of wide-necked aneurysms with good clinical and anatomical results and demonstrated the feasibility of this technique [1-5,8,17,24]. The Neuroform stent is constructed of nitinol (a nickel-titanium alloy that assumes a predetermined shape in appropriate conditions, such as corporal temperature) and has an open cell design, which gives it high navigability. These characteristics enable the stent to be navigated within the tortuous intracranial vessels and to serve as a mechanical scaffold for placement of the coils into the aneurysm. Stent placement can allow denser packing of the lesion, while preventing protrusion of the microcoils into the parent artery. However, the Neuroform stent presents some limiting characteristics, including the inability to be repositioned when it is partially delivered, a low radial force, and some reported deployment difficulties [1,2,4-6,25]. The Leo stent (Balt, Montmorency, France), first retractable stent available, has a theoretical advantage over the Neuroform stent, in that it can be repositioned [21,23], but the need for progressively larger profile and stiffer delivery catheters is a relatively limiting disadvantage.

The Neuroform stent was designed to potentially overcome these limitations [3,10]. Only few series of patients treated with this stent has been reported in the literature [3,5,12,24]. The purpose of the present study is to report our initial clinical experience with 26 Neuroform placements in 24 patients harboring wide-necked cerebral aneurysms.

2. Patients and methods

2.1. Population

In our hospital, EVT is always considered as a therapeutic option for both ruptured and unruptured intracranial aneurysms, discussed by a neurovascular team. In the present study, only few patients with acutely ruptured aneurysms selected for EVT were included because of the risk of rebleeding associated with this antithrombotic premedication (see Therapeutic strategy and endovascular procedure), as we favored remodeling technique in this circumstances, but this was not considered an exclusion criteria. A signed informed consent was obtained from all the patients, and the institutional review board of the hospital approved the study.

Between March 2005 and March 2008, we deployed 26 Neuroform stents in 24 patients harboring wide-necked cerebral aneurysms. Inclusion criteria restricted the group to adult patients (>18 years old) with wide-necked intracranial aneurysms (ruptured and unruptured lesions). A *wide neck* was defined as a dome-neck ratio of less than 2 or a neck that was 4 mm or wider as measured on angiograms [1,24]. Immediate postprocedure angiographic studies were performed to determine successful coil occlusion of the aneurysm as well as patency of the parent vessel.

The study consisted of 14 women and 10 men with a mean age of 48 years. Sixteen aneurysms were located in the anterior circulation and 8 in the vertebrobasilar system. According to the ISUIA (International Study of Unruptured Intracranial Aneurysms) classification, 20 aneurysms were characterized as small (<10 mm), 2 large (10-25 mm), and 2 giant aneurysms (>25 mm), with a mean size of 8.8 mm. Eighteen aneurysms (75%) were nonruptured, whereas 16 of them were incidental and 3 presented with compression symptoms. Two patients presented with recanalization from