Endovascular Management of Cavernous and Paraclinoid Aneurysms

Benjamin Brown, MD[a], Ricardo A. Hanel, MD, PhD[b,*]

KEYWORDS

• Endovascular • Cavernous • Paraclinoid • Aneurysms • Flow diversion • Coil • Stent

KEY POINTS

- Cavernous and paraclinoid aneurysms are among the most challenging microsurgical lesions due to location and complex anatomy.
- Endovascular methods have evolved over the last 2 decades with coiling, liquid embolic agents, stent-assisted coiling, and flow diverters being developed and used over time.
- The concept of flow diversion is based on placing a stent across the neck of an intracranial aneurysm, which then results in flow away from the aneurysm, inducing thrombosis and occlusion of the aneurysm over time.
- The stent itself experiences neointimal coverage, thus resulting in a remodeling of the parent vessel. As the use and application of flow diverters become more widespread, some important questions remain relating to the effective treatment of dual antiplatelet therapy, the occurrence of delayed aneurysm ruptures and intraparenchymal hemorrhages, and long-term patency rates.

INTRODUCTION

In this article the endovascular treatment of aneurysms arising from the internal carotid artery between its exit from the foramen lacerum and the takeoff of the posterior communicating artery is considered. These aneurysms often present a challenge for microsurgery because of the complex anatomy of the internal carotid artery in the region of the cavernous sinus and anterior clinoid process. Microsurgery of paraclinoid aneurysms frequently requires extensive bone removal for exposure of the neck and to achieve proximal control. Delicate dissection and manipulation of the optic nerve may be required for obtaining a surgical corridor. Aneurysms located more proximally in the cavernous sinus are often inoperable and require internal carotid artery sacrifice with or without bypass. These challenges have encouraged clinicians to develop alternative solutions to reduce morbidity and have ushered in an age of minimally invasive techniques.

In the modern era, endovascular treatment began with the use of balloons, when in 1974, Serbinenko reported 82 patients treated by occlusion of the carotid siphon with latex detachable balloons. In 1991, Guglielmi detachable coils became available and revolutionized the way neurosurgeons thought about cerebral aneurysms and their treatment.[1,2] Since this time, endovascular techniques have evolved into stent- and balloon-assisted coiling and most recently the concept of

[a] Department of Neurosurgery, Mayo Clinic, Jacksonville, FL, USA; [b] Lyerly Neurosurgery, Baptist Health, 800 Prudential Drive Tower B 11th Floor, Jacksonville, FL 33227, USA
* Corresponding author.
E-mail address: rhanel@lyerlyneuro.com

Neurosurg Clin N Am 25 (2014) 415–424
http://dx.doi.org/10.1016/j.nec.2014.04.017
1042-3680/14/$ – see front matter

flow diversion. In this article these techniques as well as the pertinent anatomy, clinical findings, and complications that arise when treating aneurysms of the cavernous and paraclinoid internal carotid artery are reviewed.

RELEVANT ANATOMY AND PATHOPHYSIOLOGY

For the purposes of this article, it is concerned with aneurysms arising from the internal carotid artery from the entrance into the cavernous sinus until just before the takeoff of the posterior communicating artery, which contains segments C4 through C6 in the classification of Bouthillier and colleagues.[3]

Cavernous Aneurysms

Cavernous aneurysms arise from segments C4 and C5. Segment C4, or the cavernous segment, extends from the petrolingual ligament to the proximal dural ring. Within this segment, the carotid is intimately associated with the cavernous sinus, which transmits cranial nerves III, IV, VI, V1, and V2. Therefore, aneurysms of this segment can present with any of the above cranial neuropathies. The postganglionic sympathetic fibers running with the internal carotid artery enter the cavernous sinus here, raising the possibility of Horner syndrome as well.[4]

The carotid then proceeds to segment C5, or the clinoidal segment. This segment is defined by the proximal and distal dural ring. The distal dural ring completely surrounds the carotid, making hemorrhage proximal to this point unlikely to result in subarachnoid hemorrhage.

Paraclinoid Aneurysms

Paraclinoid aneurysms are defined as those aneurysms occurring in segment C6, or the ophthalmic segment. This segment begins at the distal dural ring and continues until just before the takeoff of the posterior communicating artery. The ophthalmic segment contains 2 main arterial branches, the ophthalmic artery originating dorsomedially, followed by the superior hypophyseal artery arising from the ventromedial surface. Aneurysms of the ophthalmic artery generally project in a superomedial direction, whereas those of the superior hypophyseal artery generally project medially.[3,5] Various classification schemes exist for these aneurysms, but they can be broadly grouped into 3 categories:

Carotid ophthalmic—these aneurysms arise at the base of the ophthalmic artery or just distal to this on the dorsal side of the internal carotid artery

Ventral paraclinoid—aneurysms arising from the ventral C6 segment and not associated with any particular branch of the internal carotid artery

Superior hypophyseal—those aneurysms arising from the medial aspect of the C6 segment and associated with the superior hypophyseal artery.[6]

Approximately 33% to 59% of paraclinoid aneurysms are associated with the ophthlamic artery; 27% to 47% are associated with the superior hypophyseal artery, and 14% to 20% are not associated with any arterial branch.[7,8]

CLINICAL PRESENTATION AND DIAGNOSIS

Presentation

Cavernous aneurysms

True cavernous aneurysms are located proximal to the proximal dural ring and account for about 4% of all intracranial aneurysms. There is a strong female preponderance and average age at presentation is 60. They almost never present with subarachnoid hemorrhage because of their extradural location.[9–13] Most commonly, they are found incidentally during evaluation for an unrelated problem, or in investigating cranial neuropathy of those nerves traveling within the cavernous sinus (III, IV, VI, V1, and V2). In cases of rupture, the patient typically presents with signs and symptoms of carotid-cavernous fistula rather than subarachnoid hemorrhage. Carotid cavernous fistula was the presenting symptoms in 9% of cases in a series of 87 cavernous aneurysm patients by Higashida and colleagues.[1]

Diplopia is the presenting symptom in approximately 65% of cases, whereas retro-orbital pain or headache is the presenting symptom in approximately 59% of cases. A relatively high percentage (18%–20%) present asymptomatically. Decreased visual acuity affects approximately 16% of patients presenting with cavernous segment aneurysm.[12,14] With regards to visual symptoms, a variety of constellations may present (**Table 1**).[12] Epistaxis has also been reported rarely.[12,14]

Subarachnoid hemorrhage has been reported as a presenting symptom of cavernous aneurysms in 0% to 5% of cases.[2,12,14–16] The varying rates are likely due to variations in classification scheme and whether the aneurysm was truly of the cavernous segment and therefore completely intradural. The annual risk of rupture is estimated to be between 0% and 1.6%.[2,17]