Visual Complications After Stent-Assisted Endovascular Embolization of Paraophthalmic and Suprasellar Variant Superior Hypophyseal Aneurysms: The Duke Cerebrovascular Center Experience in 57 Patients

Andrew S. Ferrell[1], Mark L. Lessne[1], Michael J. Alexander[2], Pratish Shah[3], Kiarash Golshani[3], Ali Zomorodi[3], Tony P. Smith[1], Gavin W. Britz[3]

Key words
- Clipping
- Embolization
- Endovascular
- Intracranial aneurysm
- Ophthalmic artery
- Outcomes
- Visual complications

Abbreviations and Acronyms
ICA: Internal carotid artery
SAH: Subarachnoid hemorrhage

From the [1]Department of Radiology, Duke University Medical Center, Durham, North Carolina; [2]Department of Neurosurgery, Cedars-Sinai Medical Center, Los Angeles, California; and [3]Department of Surgery, Division of Neurosurgery, Duke University Medical Center, Durham, North Carolina, USA

To whom correspondence should be addressed: Gavin W. Britz, M.D. [E-mail: gavin.britz@duke.edu]

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■ OBJECTIVE: **To review retrospectively experience with stent-assisted coiling of ophthalmic segment internal carotid artery (ICA) aneurysms to report outcome data and identify the rate of associated visual complications.**

■ METHODS: **The Duke endovascular database was retrospectively reviewed to identify all ICA aneurysms treated with stent-assisted embolization between November 2002 and October 2009. Only aneurysms arising from the ophthalmic segment of the ICA and originating from the paraophthalmic or suprasellar variant superior hypophyseal artery were included. These aneurysms have the potential to create visual disturbances related to mass effect on the optic nerve or chiasm or to disrupt the ophthalmic artery. Chart review was performed to obtain clinical information, immediate incidence, and follow-up of aneurysm remnants and any visual complications.**

■ RESULTS: **There were 63 aneurysms (48 paraophthalmic and 15 suprasellar variant superior hypophyseal) identified in 57 patients. The ophthalmic artery was preserved in all but two (3.5%) cases, neither of which resulted in visual deficits. One (1.8%) patient experienced transient acute visual disturbances, and two (3.5%) patients had delayed, persistent deficits.**

■ CONCLUSIONS: **Stent-assisted embolization of ophthalmic segment ICA aneurysms is technically achievable and in our series did not appear to result in increased visual complications compared with coil embolization alone or surgical treatment.**

INTRODUCTION

Aneurysms of the ophthalmic segment of the internal carotid artery (ICA) are diverse in their anatomic site of origin and spatial orientation with 20% of lesions having no named branch directly associated with the aneurysm neck (5, 23). This diversity has led to numerous terms and classification systems for surgical and angiographic purposes, creating significant confusion (5). The two dominant types of aneurysms that arise from this segment are named for their associated vessel: the ophthalmic or superior hypophyseal artery (23).

The ophthalmic artery arises from the anterior or anteromedial aspect of the ICA immediately after it traverses the distal dural ring and enters the subarachnoid space (1, 3, 5, 8, 11, 14, 26). The optic nerve is intimately associated with the ophthalmic artery, coursing just superior and medial to the ophthalmic origin as it proceeds toward the optic canal. Paraophthalmic aneurysms typically arise at the distal aspect of the ophthalmic origin and point superior or superomedially, and with progressive enlargement, their anatomic proximity to the optic apparatus may lead to visual disturbances (5). Visual field loss may be seen from compressive or ischemic optic neuropathy, or diplopia may be evident from oculomotor nerve compression (21).

Superior hypophyseal aneurysms arise along one of several perforating branches from the medial or inferomedial wall of the ICA. They may extend ventrally and burrow beneath the clinoid process (paraclinoid variant) or project medially beneath and elevate the optic chiasm (suprasellar variant) (5). The suprasellar variant may produce an ipsilateral or bitemporal visual field deficit similar to a pituitary tumor; however, the paraclinoid variant is unlikely to result in visual abnormalities even when the aneurysms become quite large. In a surgical series of 39 superior hypophyseal aneurysms reported by Day (5) in 1990, no paraclinoid variant superior hypophyseal aneurysm caused visual disturbances.

The intimate relationship between the optic nerve and ophthalmic artery makes surgical exposure and clipping of paraophthalmic aneurysms challenging. Complete exposure often requires removal of the clinoid process and dissection of the dural ring to identify the aneurysm neck completely (5). During surgery, visual loss can be caused by direct vascular injury, manipulation of the optic nerve, thermogenic effects from high-speed drilling of the clinoid, or other unknown causes (9, 10, 12, 15, 18).

Endovascular techniques for intracranial aneurysms, with their own unique but equally threatening list of possible complications, have been increasingly employed over the past 2 decades. With specific regard to paraclinoid aneurysms, coil embolization does not prevent possible visual complications. Acute and delayed visual deficits after endovascular treatment of paraophthalmic aneurysms have previously been described (21, 22, 25). In the acute setting, the deficit is typically related to mass effect on the optic apparatus or loss of the ophthalmic artery; delayed deficits are attributed to either progressive mass effect or perianeurysmal inflammation (25). Delayed effects have been reported 35 days after embolization (25).

The use of stent assistance has increased further the number of aneurysms that can be treated endovascularly, and this is true for paraophthalmic aneurysms. Given the wide neck configuration of these aneurysms as the typical indication for stent placement, it is reasonable to assume that the neck of these aneurysms more often incorporates the origin of the ophthalmic artery, which could be impacted and occluded by the coil mass. In addition, the stent itself may cover the ophthalmic artery origin resulting in retinal ischemia or thromboembolic complications. It has been reported that stent-assisted coiling results in improved coil packing (2, 20). Hypothetically, this improved packing may result in increased mass affect on the optic apparatus in paraophthalmic aneurysms or the chiasm in suprasellar variant superior hypophyseal aneurysms. We investigated the outcome and visual complication rate of stent-assisted coil embolization of paraophthalmic or suprasellar variant superior hypophyseal aneurysms.

METHODS

After obtaining institutional review board approval, a retrospective review of the Duke Cerebrovascular Center database was performed to identify all patients for whom the Neuroform Microdelivery Stent System (Boston Scientific Corp., Natick, Massachusetts, USA) was successfully deployed for stent-assisted embolization of aneurysms of the ICA from November 2002 until October 2009. Angiograms obtained before and after embolization were reviewed by two of the authors (A.S.F. and T.P.S.) to identify all aneurysms originating from paraophthalmic and suprasellar variant superior hypophyseal arteries. For the purposes of our study, paraophthalmic aneurysms were defined as aneurysms arising from the anterior wall of the ICA above the roof of the cavernous sinus (intradural) and below the origin of the posterior communicating artery, at or just distal to the ophthalmic origin and with a superior or superomedial projection. Suprasellar variant superior hypophyseal aneurysms were defined as aneurysms arising from the inferior or inferomedial wall of the proximal intradural ICA, not in immediate association with the ophthalmic origin and projected medially toward the suprasellar cistern. We specifically excluded all aneurysms of the cavernous sinus, carotid cave, paraclinoid variant superior hypophyseal artery, posterior and lateral wall ophthalmic segment ICA, and supraclinoid ICA (anterior choroidal, posterior communicating, carotid terminus).

An extensive retrospective chart review was performed to identify patient demographics and clinical history. Patients were categorized into patients with or without subarachnoid hemorrhage (SAH) at presentation. Among the patients without SAH, an attempt was made to define and categorize presenting symptoms as headache, transient ischemic attack, or other incidental and unrelated neurologic symptoms. Aneurysm size was classified as small (< 5 mm), medium (5–10 mm), large (10–25 mm), or giant (≥ 25 mm). Although stents are typically placed for assistance with coiling of wide-necked aneurysms (average neck size 5.4 mm, range 2.5–10 mm, average dome-to-neck ratio 1.4), the decision to use a stent-assisted coiling technique at our institution was left to the discretion of the attending physician as deemed appropriate for patient anatomy at the time of the procedure. Immediate aneurysm remnants were categorized as small neck (< 2 mm), significant neck (> 2 mm), or partial embolization (persistent contrast opacification of the aneurysm dome). Angiographic follow-up of remnants was reviewed to record interval healing, stability, or progressive enlargement. If the aneurysm required additional interventional or surgical therapy, this was noted. Hospital notes, discharge summaries, outpatient clinic and emergency department visits, and any additional hospital admissions were reviewed further to identify any immediate or delayed visual disturbances. Deficits were considered acute if noted within 24 hours of the intervention and delayed if seen later than this. Fisher exact test was used to determine whether there was a statistical association between preservation of the ophthalmic artery and occurrence of acute or delayed visual deficits.

RESULTS

Patients

The database contained 112 patients with a stent placed in the ICA for embolization of at least one intracranial aneurysm. After review of the catheter angiograms, we identified 57 patients who harbored at least one paraophthalmic or superior hypophyseal aneurysm for which stent-assisted embolization was performed. Multiple aneurysms were identified in 20 (35%) patients; one patient had seven lesions. There was a striking female predominance, with 51 (89.5%) female patients and 6 (10.5%) male patients. The mean age was 61 years (range 28–83 years). Only five (8.8%) patients presented with SAH; three (5.3%) patients had visual symptoms attributable to mass effect from the aneurysm. Seven (12.3%) patients were being evaluated for recurrence of a lesion previously treated surgically (3) or endovascularly (4). One patient had undergone both coil embolization and surgical wrapping previously without complete occlusion. Lesions were identified during work-up for headache unrelated to SAH in 15 (26.3%) patients and for presumed transient ischemic attacks in 9 (17.5%) patients, although it is unlikely that the aneurysm contributed to these symptoms. The remaining 17 (29.8%) lesions were found incidentally during work-up for other neurologic deficits unrelated to the aneurysm (e.g., syncope, vertigo), trauma evaluations, or in one case screening evaluation of a high risk patient.

Aneurysm Characteristics

In 57 patients, 63 aneurysms were identified; 48 were paraophthalmic, and 15 were suprasellar variant superior hypophyseal. There were 36 lesions located on the left and 27 on the right. The average maximum dimension was 7.74 mm with the largest lesion measuring 20 mm and the smallest measuring 3 mm. There were 13 small (< 5