Endoscopic Endonasal Clipping of Intracranial Aneurysms: Surgical Technique and Results

Paul A. Gardner[1], Francisco Vaz-Guimaraes[1], Brian Jankowitz[1], Maria Koutourousiou[1], Juan C. Fernandez-Miranda[1], Eric W. Wang[2], Carl H. Snyderman[2]

■ OBJECTIVE: **Microsurgical clipping of intracranial aneurysms requires meticulous technique and is usually performed through open approaches. Endoscopic endonasal clipping of intracranial aneurysms may use the same techniques through an alternative corridor. The aim of this article is to report a series of patients who underwent an endoscopic endonasal approach (EEA) for microsurgical clipping of intracranial aneurysms.**

■ METHODS: **We conducted a retrospective chart review. Surgical outcome and complications were noted. The conceptual application and the technical nuances of these procedures are discussed.**

■ RESULTS: **Ten patients underwent EEA for clipping of 11 intracranial aneurysms arising from the paraclinoidal internal carotid artery (n = 9) and vertebrobasilar system (n = 2). The internal carotid artery aneurysms projected medially, whereas the vertebrobasilar artery aneurysms were directly ventral to the brainstem with low-lying basilar apices. One patient required craniotomy for distal control given the size and thrombosed nature of the aneurysm. Proximal and distal vascular control with direct visualization of the aneurysm was obtained in all patients. In all cases, aneurysms were completely occluded. Among complications, 3 patients had postoperative cerebrospinal fluid leakage and 2 other patients had meningitis. Two patients suffered lacunar strokes. One recovered completely and the other remains with mild disabling symptoms.**

■ CONCLUSIONS: **EEAs can provide direct access for microsurgical clipping of rare and carefully selected intracranial aneurysms. The basic principles of cerebrovascular surgery have to be followed throughout the procedure. These surgeries require a skull base team with a neurosurgeon well versed in both endoscopic endonasal and cerebrovascular surgery, working in concert with an otolaryngologist experienced in skull base endoscopy and reconstruction.**

INTRODUCTION

Paraclinoid internal carotid artery (ICA) aneurysms present a challenge for microsurgical clipping through an anterolateral transcranial approach. They arise from the segment of the ICA located between the roof of the cavernous sinus and the origin of the posterior communicating artery (72, 74). Given the relationship of the ICA with the skull base, dissection of the cervical ICA and/or removal of the anterior clinoid process are usually required to achieve proximal vascular control and prepare the aneurysm neck for clipping. Depending on their site of origin and projection, these aneurysms can also be obscured by the optic nerve, adding the potential morbidity of its inadvertent injury (4-6, 12).

Similarly, aneurysms of the vertebrobasilar system remain a formidable challenge for the neurosurgeon because of their rarity and deep location with resultant poor visualization and limited maneuverability (58, 75, 77). Basilar apex aneurysms represent up to 5% of all intracranial aneurysms and are associated with higher surgical morbidity when compared with anterior circulation aneurysms (21, 58, 62, 75). Aneurysms of the posterior cerebral artery (PCA) are rarer yet and present similar challenges (30, 37, 71, 80). When compared with aneurysms located in other sites, they tend to be larger and present with tumor-like symptoms (30, 37). Their

Key words
- Endoscopic endonasal approach
- Intracranial aneurysm
- Microsurgical clipping

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
EEA: Endoscopic endonasal approach
EES: Endoscopic endonasal surgery
ICA: Internal carotid artery
PCA: Posterior cerebral artery

From the Departments of [1]Neurological Surgery and [2]Otolaryngology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

To whom correspondence should be addressed: Paul A. Gardner, M.D. [E-mail: gardpa@upmc.edu]

Citation: World Neurosurg. (2015) 84, 5:1380-1393.
http://dx.doi.org/10.1016/j.wneu.2015.06.032

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

1878-8750/$ - see front matter

surgical treatment may be challenging because of proximity to the brainstem, cranial nerves, and thalamic or brainstem perforating branches (30, 80, 86).

We report 11 patients with intracranial aneurysms arising from the paraclinoid ICA (9 patients), posterior cerebral artery (1 patient), and basilar apex (1 patient), which were successfully clipped through an endoscopic endonasal approach (EEA). The main goal of this article is to describe the conceptual application, technical nuances, and difficulties of these operations. We also present a literature review of endoscopic endonasal cerebrovascular surgery, emphasizing the decision-making process for this type of management based on the relationships of the ICA and the vertebrobasilar system to the endonasal corridor.

METHODS

We retrospectively reviewed and analyzed the medical records of patients who underwent EEA for microsurgical clipping of intracranial aneurysms performed by the senior authors (P.A.G.)/(CHS) at the Center for Cranial Base Surgery of the University of Pittsburgh between May 2012 and April 2014. Approximately 200 intracranial aneurysms are treated every year at the Presbyterian Hospital of the University of Pittsburgh Medical Center. Overall, around 150 of these cases are treated through endovascular techniques and the remaining cases by microsurgical clipping with open transcranial approaches.

RESULTS

A total of 10 patients, 8 women and 2 men, with a mean age of 50 years (range, 34—74), were identified with 11 aneurysms. In 7 patients, the aneurysm was incidentally diagnosed and treatment was desired due to positive family history of ruptured intracranial aneurysm, size >7 mm, and/or additional risk factors (e.g., hypertension and continued use of tobacco). Of note, 1 carotid cave aneurysm (~1 cm) was offered treatment due to uncertainty of subarachnoid extension, despite high quality imaging. Oculomotor nerve palsy, visual impairment, hypopituitarism, and subarachnoid hemorrhage were the presenting symptoms of the remaining 3 patients. One patient had 2 aneurysms. Nine aneurysms were located in the anterior circulation, whereas 2 were in the vertebrobasilar system (**Table 1**).

All patients underwent a single EEA for aneurysm clipping. One patient with a thrombosed and calcified left ophthalmic artery aneurysm had a combined and simultaneous approach (EEA and left pterional) to ensure safe distal control given the size and thrombosed nature of the aneurysm.

In all patients, aneurysms were completely occluded as demonstrated by intraoperative angiogram. Postoperative complications included 3 patients with cerebrospinal fluid (CSF) leakage, 2 of whom developed meningitis. They were successfully treated with an additional endonasal surgical repair and broad spectrum antibiotics. The 2 patients with vertebrobasilar artery aneurysms suffered lacunar strokes. One recovered completely and the other remains minimally disabled due to a coarse tremor and deconditioning (**Table 1**).

ILLUSTRATIVE CASE 1

A 74-year-old physician presented with recent onset of a progressive left third nerve palsy. Cerebral angiography confirmed the presence of a 19-mm left P1 aneurysm (**Figure 1**). Given the patient's age, endovascular treatment was recommended but surgery was also offered. Because the aneurysm was located close to the midline in the posterior fossa with a relatively low basilar apex (at or below the sella), an EEA was considered a suitable option. EEA was considered as it provided direct access to the aneurysm without brain retraction, provided full proximal and distal control (low lying basilar apex can be difficult proximal control by craniotomy), and required no additional third nerve retraction for access. After a frank discussion with the patient regarding the risks involved with all treatment options and the lack of precedent for an endonasal clipping, he chose this option.

Surgical Procedure

The patient was placed supine with his head fixed in a 3-pin radiolucent head holder rotated approximately 25° toward the right side and in slight extension. Image-guided computed tomography angiography was registered and a right femoral sheath was placed and prepared for intraoperative angiography. Neurophysiologic monitoring, including brainstem auditory-evoked responses, somatosensory-evoked potentials, and oculomotor and abducens electromyography, was applied and performed continuously throughout the procedure. The midface and abdomen were prepped and draped and antibiotic prophylaxis was administered with a third-generation cephalosporin.

An endoscopic endonasal transclival approach with continuous neurophysiologic monitoring was performed. The approach was extended with an extradural left-sided posterior clinoidectomy through interdural pituitary transposition (25-27), as well as extension to the left medial jugular tubercle (67). The dura was opened in a Y-shaped fashion starting in the midclivus and the aneurysm with its calcified and atherosclerotic neck could be identified and carefully dissected free from the left posterior cerebral and superior cerebellar arteries as well as the perforating branches and oculomotor nerve (**Figure 2A**).

Given the size and turgor of the aneurysm, temporary clipping (5 minutes) of the right posterior cerebral and basilar arteries was done (**Figure 2B**) under burst suppression to trap the aneurysm (there was only a miniscule left posterior communicating artery). During this time, a single curved 13-mm clip was placed across the midportion of the dome of the aneurysm proximal to its maximum thickness. This maneuver allowed a significant deflation of the aneurysm and better access to its proximal neck where a second curved clip was applied after the temporary clips had been removed. Intraoperative angiography showed that the aneurysm still had delayed filling. Both clips were advanced under close endoscopic inspection to avoid perforator injury, but repeat angiography showed the same problem. At this point, after careful endoscopic inspection, it was determined that the atherosclerosis in the neck and the turgor of the aneurysm were preventing complete clip closure and not allowing complete obliteration. Thus, a third, straight 15-mm tandem clip was applied across the midaspect of the upper neck just above the 2 prior clips