Clinical Case Report

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Extradural anterior clinoidectomy and aneurysm clipping using transcranial neuroendoscopic approach

A case report

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Abstract

Rationale: Anterior clinoidectomy is an important technique for neurovascular and skull base surgery. Until now, extradural anterior clinoidectomies have been performed under a microscope in almost all clinical cases, with only one clinical case performed an extradural pathological anterior clinoid process resection using neuroendoscopy. Additionally, no normal ACP resections have been performed extradurally via neuroendoscopy, especially for aneurysms. We tried to perform extradural anterior clinoidectomies by neuroendoscopy.

Patient concerns: A 63-year-old woman was admitted to hospital presented with sudden onset of headache without any accompanying neurological deficit. A computed tomography (CT) scan of the head revealed a subarachnoid hemorrhage, which was positioned mainly in the left slyvian fissure and interpeduncular and basilar cisterns.

Diagnoses: 1. Left side posterior communicating artery aneurysm; 2. subarachnoid hemorrhage.

Interventions: Extradural anterior clinoidectomy and aneurysm clipping were performed using transcranial neuroendoscopic approaches.

Outcomes: The patient recovered well after the procedure, and the post-operative image view revealed that the ACP had been removed and that the clip was located just at the ACP area.

Lessons: This case provided the first evidence that extradural anterior clinoidectomy could be performed by transcranial neuroendoscopic approach.

Abbreviations: ACP = anterior clinoid process, CS = cavernous sinus, CT = computed tomography, CTA = computed tomography angiography, EDAC = extradural anterior clinoidectomy, ICA = internal carotid artery, LSW = lesser sphenoid wing, ON = optic nerve, OS = optic strut, SOF = superior orbital fissure.

Keywords: aneurysm, anterior clinoidectomy, transcranial neuroendoscopic approach

1. Introduction

The anterior clinoid process (ACP) is shaped like a "canine tooth" that protrudes from the posteromedial border of the lesser sphenoid wing (LSW).[1] The ACP is situated in a narrow interdural space called the paraclinoid space and shares a close relationship with delicate structures such as the internal carotid artery (ICA), optic canal (OC), superior orbital fissure (SOF) and cavernous sinus (CS), marking the limit between the anterior and middle fossae.[1] These vital structures may be involved in certain diseases whose surgical exposure requires ACP resection. Since the first description of the intradural removal of the ACP by Hauser in 1952,[2] numerous modifications have been proposed to simplify and enhance the safety of the technique. In 1985, Dolenc[3] originally described an extradural anterior clinoidectomy, which provided a safe approach to the cavernous sinus and allowed optimal mobilization of the optic nerve and the internal carotid artery. Over the following decades, extradural anterior clinoidectomies facilitated tumor removal from the parasellar and cavernous sinuses and were also extended for use in the treatment of optic nerve decompression and internal carotid aneurysms.[4]

During the development of modern microscopic skull base surgery, extradural anterior clinoidectomies have been performed under the microscope in almost all clinical cases. With the evolution of endoscopic endonasal skull base surgery in the last decade, the procedure has been shown to improve anatomic

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visualization, reduce exposure and brain retraction, and minimize surgical morbidity.[4] Currently, neuroendoscopy is the widely accepted modality for neurosurgical strategies and has become increasingly important in treating lesions of the cranial base. More recently, extradural anterior clinoidectomy was performed by neuroendoscope via a supraorbital keyhole[5] and was used in optic nerve decompression through a minimally invasive pterional port in cadaveric heads.[4]

To date, only 1 clinical case of extradural anterior clinoidectomy has been performed by neuroendoscopy to resect a cavernous sinus pituitary adenoma; the anterior clinoid process was easily removed because of bone erosion to the optic strut by the tumor.[6] But this case involved a pathological anterior clinoid process which was corroded by pituitary adenoma. So there was requirement for normal anterior clinoid process removal by neuroendoscopy.

To our best knowledge, this is the first reported case in the world of extradural anterior clinoidectomy and aneurysm clipping performed using transcranial neuroendoscopic approach.

2. Case report

A 63-year-old woman was admitted to our hospital who presented with sudden onset of headache without any accompanying neurological deficit. A computed tomography (CT) scan of the head revealed a subarachnoid hemorrhage, which was positioned mainly in the left sylvian fissure and interpeduncular and basilar cisterns. Computed tomography angiography (CTA) indicated a posterior communicating artery aneurysm in the left side, and the ACP was closely related to the internal carotid artery and the aneurysm (Fig. 1A–D).

A left pterional approach craniotomy was performed in the standard fashion. After cutting the bone flap, the neuroendoscope was introduced, and a cutting drill was used to remove the lesser sphenoid wing from the medial part of the sphenoid ridge. Then, a small diamond drill was used to “egg-shell” the cortical bone of the ACP, with continuous irrigation to avoid heat injury to the nerve. Finally, the thin layer of bone of the ACP was fractured using a fine curette and was removed with a needle holder, and the ACP was completely resected. Then, the dura matter was

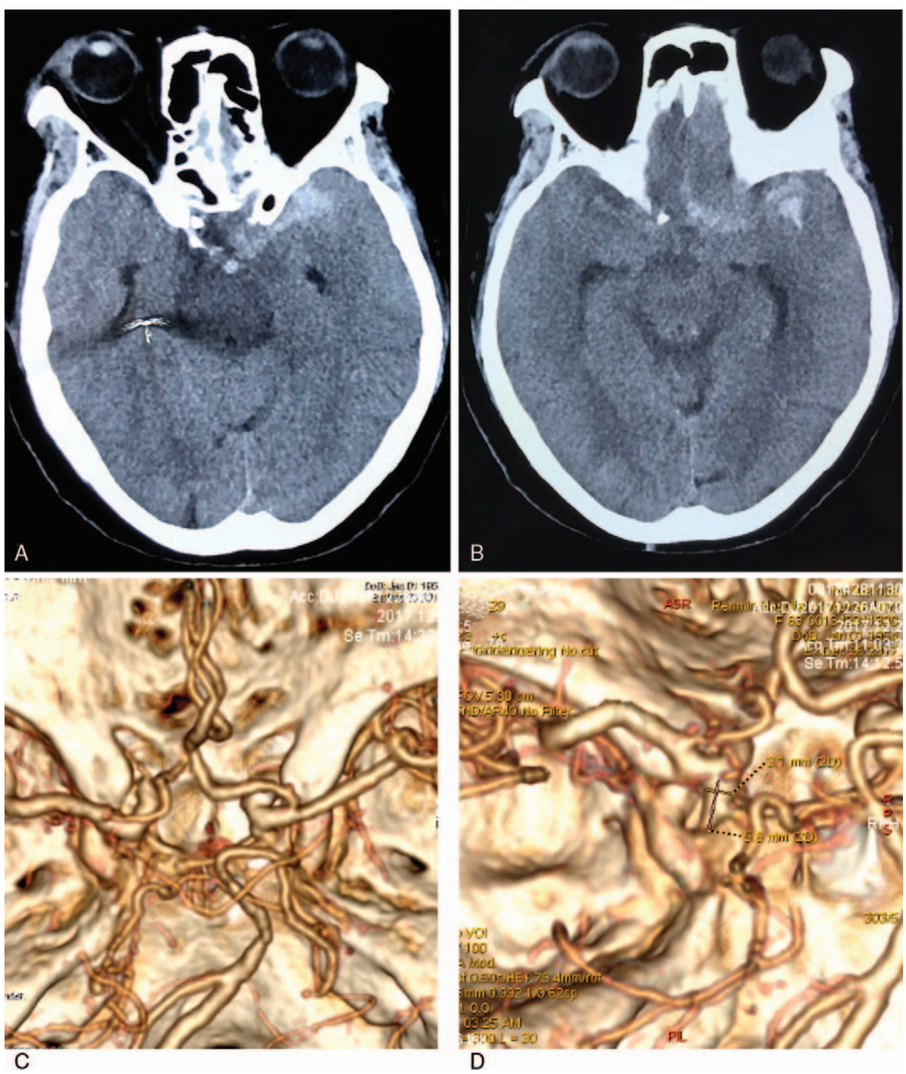

Figure 1. CT scan and CTA of the patient before the procedure. A, B. Head CT scan revealed a subarachnoid hemorrhage located mainly in the left ACP area. C, D. CTA indicated a posterior communicating artery aneurysm in the left side, and the ACP was closely related to the internal carotid artery and the aneurysm. CT=computed tomography, CTA=computed tomography angiography.

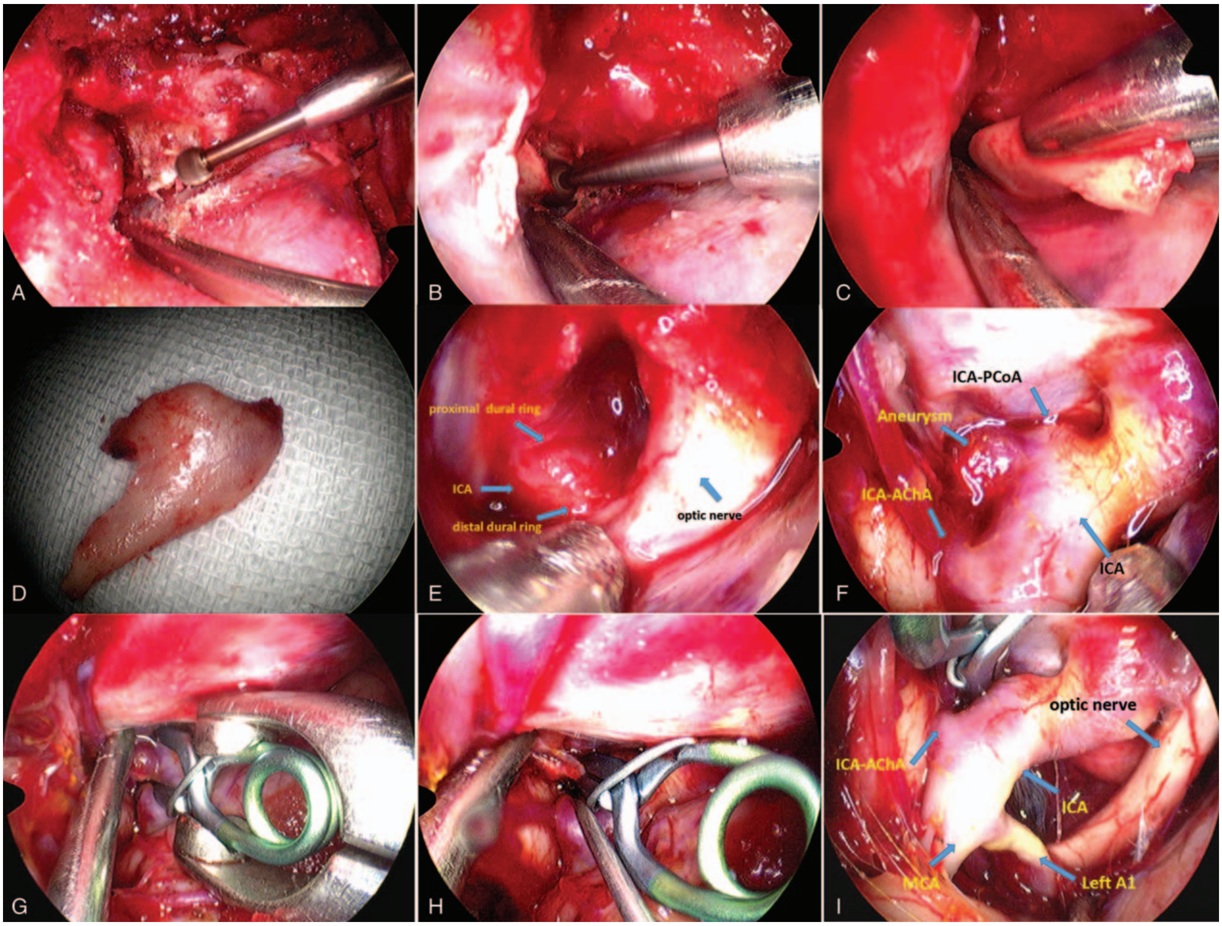

Figure 2. Operation view of extradural anterior clinoidectomy and aneurysm clipping using transcranial neuroendoscopic approaches. A. A cutting drill was used to remove the lesser sphenoid wing from the medial part of the sphenoid ridge. B. A small diamond drill was used to "egg-shell" the cortical bone of the ACP, with continuous irrigation to avoid heat injury to the nerve. C. The thin layer of bone of the ACP was fractured using a fine curette and was removed with a needle holder. D. The ACP was completely resected. E. The extradural space, the ICA, the distal and proximal dura rings, and the optic nerve were viewed and identified under endoscopy after the ACP was removed. F. The posterior communicating artery aneurysm was revealed, which was located just at the edge of the dura when the dura matter was opened and the sylvian fissure was split. G. The aneurysm was clipped after the neck of aneurysm was carefully separated. H. The aneurysm subsided, and no bleeding occurred, and complete clipping was confirmed when the body of the aneurysm was punctured. I. The surrounding structure of the aneurysm was explored under the endoscope and was determined to be intact. ACP = anterior clinoid process, ICA = internal carotid artery.

opened, the sylvian fissure was split, and the posterior communicating artery aneurysm was revealed. After the neck of the aneurysm was carefully separated, it was completely clipped under the neuroendoscope (Fig. 2A–I). During the surgery, the endoscope was hold by assistant and adjust the angle and direction at any time according the procedure of the operation. The duration of the operation was 3 hours and the blood lost was around 100 ml. The patient was follow-up to 3 months and recovered well after the procedure, and the post-operative image view revealed that the ACP had

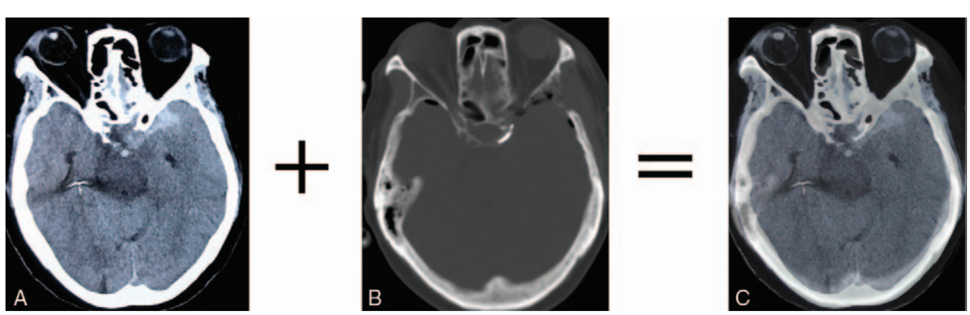

Figure 3. Post-operation image view after the neuroendoscopic surgery. A. The pre-operative CT scan showed that the ACP was buried in the SAH. B. The post-operative CTA showed that the ACP had been removed. C. The merged picture shows that the aneurysm clip was correctly located at the ACP area. CT = computed tomography, CTA = computed tomography angiography. ACP = anterior clinoid process.

been removed and that the clip was located just at the ACP area (Fig. 3A–C).

Written informed consent was obtained from the patient's family for publication of this case report and the accompanying images. All procedures were performed according to the guidelines of the ethics committee of Renmin Hospital of Wuhan University.

3. Discussion

Anterior clinoidectomy is an important technique for neurovascular and skull base surgery. The most fundamental goal of this procedure is to expand access to the proximal carotid artery, sella, optic nerve, and the central skull base. However, removal of ACP is still technically challenging due to its proximity to certain delicate structures, such as the ICA or the optic nerve, the complexity of dural reflections in the region, and the variability of the adjacent bony anatomy.[7] The ACP is covered with two layers of dura mater; the superficial dural layer penetrates into the orbit through the SOF, while the inner meningeal layer enters intracranially. The key landmark of ACP exposure at the early stage is the meningo-orbital band, which is positioned at the transition between the periosteal dural layer and the periorbita; this fibrous, thick fold of dura is devoid of any vital neurovascular content. The dura that covers the tip of the ACP is the anterior petroclinoid ligament, which gives rise to the free edge of the tentorium posteriorly.

Two main techniques have been widely accepted and used for anterior clinoidectomy: extradural and intradural approaches. Both of these techniques have their advantages and disadvantages, and the selection of one over the other is based on the surgeon's preference. The main advantage of the intradural technique is having all adjacent neurovascular structures under visual control while drilling; at same time, due to the lack of the protection of the dura, injury of the neurovascular structures is one of the most feared risks, as it can lead to catastrophic situations during power drilling of the ACP.[8] Another disadvantage of the intradural technique is postoperative headache, which can occur in approximately 28% of patients due to subarachnoid accumulation of bone dust.[9] The main advantage of the extradural anterior clinoidectomy is its increased safety, and it contributes to decreased morbidity, as the dura mater in the extradural space acts as a natural barrier that protects the brain and neurovascular structures. Another advantage is that this extradural technique allows for complete anterior clinoidectomy which can provide up to 473.67 mm^2 area and 611.13 mm^3 volume of operation space, equivalent to 2.5 times the anterior bed area and 2.7 times the ACP volume.[8] This step can effectively expose the proximal side of the aneurysm and control an intraoperative aneurysm rupture, which greatly improves the safety factor. However, the main shortcoming of this technique is also due to the dura, which blocks the view of key neurovascular structures near the ACP. To avoid the shortcomings of the above surgical methods, in 2017, Ali et al developed a hybrid technique based on localization of the optic strut (OS). They resected the ACP in 2 steps: the segment anterior to the OS was resected extradurally, while the segment posterior to the OS was resected intradurally. The proposed technique was successfully performed in all cadaveric specimens and all 6 patients, and no operative complications were encountered.[7]

At present, ACP resection is performed under the microscope, but due to the linear visual field and the light attenuation at deep sites, the surgeon must adjust the focus and angle of the microscope continually. Neuroendoscopy can overcome these shortcomings, and several scholars have performed in-depth studies the feasibility of extradural anterior clinoidectomy. In 2011, Fuminari Komatsu successfully performed endoscopic extradural anterior clinoidectomy in eight fresh cadaver heads.[5] Two years later, André described an endoscopic extradural anterior clinoidectomy and optic nerve decompression through a minimally invasive pterional port on 5 preserved cadaveric heads4. Until 2017, Fuminari Komatsu first reported a clinical case of anterior clinoidectomy by endoscopy which was a pathological ACP corroded by a pituitary adenoma. Till now, there are no clinical case reports of extradural anterior clinoidectomy in aneurysm patients. This procedure is difficult and requires skill to avoid rupture of aneurysm during the drilling. Our successful case demonstrated that extradural anterior clinoidectomy using transcranial neuroendoscopic approaches was technically feasible and safe. However, due to the lack of depth of field, its operation was not as skilled as the microscope. And although this case was performed under endoscopy, the same principles of microscopic extradural anterior clinoidectomy were applied:

1. osteotomy along the medial sphenoid wing to disconnect the lateral connection;
2. osteotomy along the orbital roof to disconnect the anterior and medial connections;
3. drilling within the clinoid to "egg-shell" the bone and disconnect the anteroinferior connection to the optic strut.

After the completion of the above 3 steps, the shell of the clinoid can be mobilized and dissected away from the clinoidal ligaments. From our experience, we suggest that extradural anterior clinoidectomy can be performed in patients only when the ACP is closely related to the internal carotid artery and the aneurysm.

Author contributions

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Formal analysis: Qiang Cai.
Funding acquisition: Qiang Cai.
Investigation: Qiang Cai.
Methodology: Qiang Cai.
Supervision: Qiang Cai.
Writing – original draft: Qiang Cai.
Writing – review & editing: Qiang Cai.

References

[1] Troude L, Bernard F, Bauchet G, et al. Extradural resection of the anterior clinoid process: how I do it. Neuro-Chirurgie 2017;63:336–40.
[2] Hauser MJ, Gass H. Optic nerve pressure by aneurysm relieved by decompression of optic nerve; report of a case. AMA Arch Ophthalmol 1952;48:627–31.
[3] Dolenc VV. A combined epi- and subdural direct approach to carotid-ophthalmic artery aneurysms. J Neurosurg 1985;62:667–72.
[4] Beer-Furlan A, Evins AI, Rigante L, et al. Endoscopic extradural anterior clinoidectomy and optic nerve decompression through a pterional port. J Clin Neurosci 2014;21:836–40.
[5] Komatsu F, Komatsu M, Inoue T, et al. Endoscopic extradural anterior clinoidectomy via supraorbital keyhole: a cadaveric study. Neurosurgery 2011;68(2 Suppl Operative):334–8. discussion 337-338.
[6] Komatsu F, Imai M, Shigematsu H, et al. Endoscopic extradural supraorbital approach to the temporal pole and adjacent area: technical note. J Neurosurg 2017;1–7.

[7] Tayebi Meybodi A, Lawton MT, Yousef S, et al. Anterior clinoidectomy using an extradural and intradural 2-step hybrid technique. J Neurosurg 2018;1–10.
[8] Tripathi M, Deo RC, Damodaran N, et al. Quantitative analysis of variable extent of anterior clinoidectomy with intradural and extradural approaches: 3-dimensional analysis and cadaver dissection. Neurosurgery 2015;11(Suppl 2):147–60. discussion 160-141.
[9] Barnett SL, Whittemore B, Thomas J, et al. Intradural clinoidectomy and postoperative headache in patients undergoing aneurysm surgery. Neurosurgery 2010;67:906–9. discussion 910.