

Technical notes & surgical techniques

CSF leak post-anterior clinoidectomy: Case report and technical nuances

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ABSTRACT

Background: The anterior clinoid process represents the terminal portion of the lesser wing of the sphenoid bone and it is connected to the sphenoid bone by two roots. Extradural anterior clinoidectomy is a crucial step in surgical access to lesions involving pathologies in sellar and parasellar regions. ACP pneumatization is common and must be evaluated radiologically before surgical intervention to avoid CSF leak.

Case description: We report the case of an 11 years old girl presented with optic nerve lesion. The patient underwent craniotomy with anterior clinoidectomy for resection of optic nerve lesion en-block. Postoperatively, she suffered from CSF leak and post-operative CT scan showed an un-recognized anterior clinoid pneumatization. She was taken for endoscopic transphenoidal repair of leak and obliteration of the defect connecting between the intracranial space and the nasal cavity.

Conclusion: ACP pneumatization can be recognized in all ages including pediatric age. CT scan is recommended before anterior clinoidectomy to assess the presence and extent of pneumatization to avoid CSF leak complications. When recognized, reconstruction must be attempted to obliterate the connection between the intracranial space and nasal sinuses. If CSF leak recognized post-operatively, repair is feasible through open or endoscopic transnasal approach.

1. Introduction

The anterior clinoid process (ACP) is a bone that is located on the medial side at the posterior border of the lesser sphenoid wing [1]. From an axial view, the ACP is triangular in shape. Anteriorly, the base of the triangle continues with the medial end of the sphenoid. It attaches medially to the sphenoid bone by anterior and posterior roots. The anterior root forms the roof of the optic canal. The posterior root, which is also known as the optic strut, separates between the superior optic fissure and the optic canal [2].

ACP resection is a crucial step in skull base tumor resection, and exposure of cavernous and supraclinoid internal carotid artery in case of aneurysms [2]. However, certain complications might occur post anterior clinoidectomy due to numerous structures of the skull base and some architecture variations [3–7]. These include CSF rhinorrhea as a result of the communication between the paranasal sinuses and a pneumatized anterior clinoid process. Such risk has been reported to range from 2.7 up to 7% [4,8,9].

The incidence of the ACP pneumatization has been reported by

different studies as 4–29.3% [9,10–17]. The risk of CSF leak might be prevented by radiological imaging to evaluate the pneumatization of the ACP prior to the operation as reconstructive procedure may be planned ahead [18–20]. In case of CSF leak, conservative treatment is applied as a first step (bed rest, lumbar puncture). In case, conservative treatment has failed, then surgical repair is required [19,20]. On one hand, surgical repair is achieved by craniotomy and plugging the defect with wax, fat or polymer glue. On the other hand, defect repair is attainable through endoscopic transphenoidal approach [19].

2. Case description

An 11 year old female, previously healthy, presented to our service with proptosis and complete loss of vision in her left eye. One year prior to presentation, patient started to have left eye blurry vision and she was diagnosed in an outside hospital with left optic nerve glioma. She was managed with steroids and observation only. Since then, the patient reported progressive deterioration in her vision until she completely lost her left eye vision prior to presentation.

Abbreviations: ACP, Anterior Clinoid Process; CSF, Cerebro-Spinal Fluid

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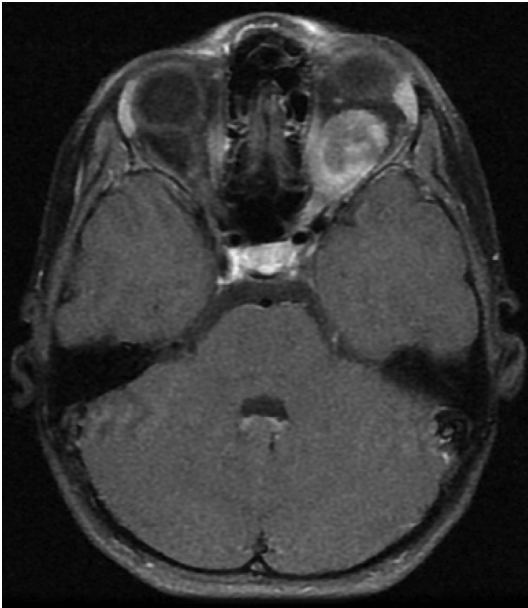


Fig. 1. MRI brain T1 Fat Saturated post contrast sequence showing the left optic nerve lesion.

MRI was done and showed 27×18 mm left optic nerve lesion occupying the orbit and causing mass effect on the eye globe (Fig. 1). CT brain/sinuses was not done.

After a multidisciplinary meeting involving the neurosurgery, pediatric oncology, and ophthalmology teams, a decision was made to go for complete resection of the lesion given her irreversible loss of her left eye vision.

The plan was to cut the optic nerve just distal to the optic chiasm and to remove the nerve along with the lesion en-block. In order to achieve it, a standard left pterional craniotomy, extradural anterior clinoidectomy and drilling of the orbital roof and lateral wall were accomplished. After the anterior clinoidectomy was performed, the bone was not waxed aggressively, given the low incidence of pneumatization of anterior clinoid at her age. After this stage, with the help of the ophthalmologist, the peri-orbita was opened using a #12 blade scissors. Blunt dissection was carried to identify the optic nerve lesion that was identified and isolated. The optic nerve was cut from the eye globe, and proximally at the orbital apex. The lesion was then removed completely. A 1 mm Medpore sheet (MTB™) was then fashioned to cover the orbital bony defect and was secured in place. The patient tolerated well the procedure and transferred to her room in stable condition.

On the first post-operative day, and while the patient was trying to sit and bend forward, she reported clear rhinorrhea, more on the left. This rhinorrhea persisted till the next day and cerebro-spinal fluid (CSF) leak was suspected. ENT team was consulted and recognized fluid in the sphenoid sinuses after scoping the patient. CT sinuses was done and showed opacification of the left sphenoid sinus suggestive of CSF leak and pneumatization of the partially drilled left anterior clinoid (Fig. 2).

The complication was discussed with the family who refused conservative management, and two options were given to obliterate the defect and to stop the CSF leak via redo-craniotomy or endoscopic trans-nasal approach. The family opted the endoscopic trans-nasal approach and the patient was taken to the operating room on the same day in order to decrease the risk of infection.

During the second surgery, and after ENT team accessed the sphenoid sinus on the left side by the endoscope, a defect was recognized in the left lateral optico-carotid recess from which CSF was obviously leaking (Fig. 3). Then, the defect was plugged using SURGICEL® followed by bone wax. Fat was used from the abdomen using an umbilical



Fig. 2. CT brain, coronal bone sequence, showing the pneumatized anterior clinoid processes and left sphenoid sinus opacification due to CSF leak.

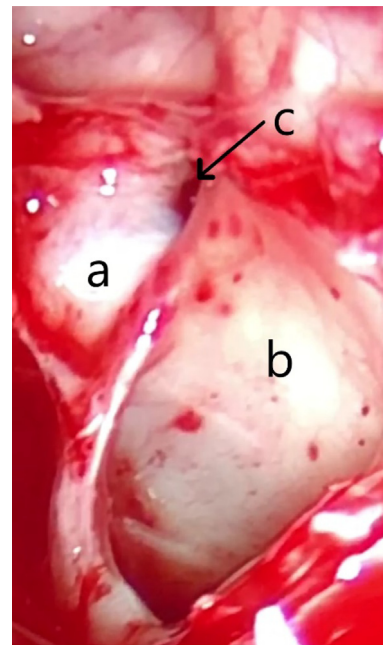


Fig. 3. Endoscopic view of CSF leak site: a) Optic Protuberance, b) Carotid Protuberance, c) Dehisced Lateral Optico-Carotid recess which represent the pneumatized optic strut and site of CSF leakage.

incision. The fat was placed in the leak area. There was no more leak noted. Then a layer of Tutopatch® was placed and fixed with BioGlue®. A free mucosal flap was elevated from the floor of the left nasal cavity. The mucosal flap was placed on the reconstruction and then several layers of Tutopatch® were placed around that flap. Tisseel sealant was placed on top of the final reconstruction followed by Gelfoam and a Kennedy sinus pack. The patient tolerated well the procedure.

The patient started to ambulate the following day and was discharged home on the third day with no evidence of CSF leak.

3. Technical nuances of extradural anterior clinoidectomy

Extradural anterior clinoidectomy is a crucial step in surgical access to lesions involving the optic nerve. It is commonly performed to tackle pathologies in sellar and parasellar regions. Dolenc was the first to describe extradural anterior clinoidectomy to approach vascular lesions within and around the cavernous sinus [1]. The anterior clinoid process (APC) represents the terminal portion of the lesser wing of the sphenoid

bone. It is directed postero-medially and it is connected to the sphenoid bone by two roots. An anterior root that forms the roof of the optic canal and a posterior root (optic strut) that separates the optic canal from the superior orbital fissure [2]. After a standard pterional craniotomy is performed, the sphenoid ridge is drilled and the orbital roof is reduced to egg shell thickness. The thin shell is removed to expose the periorbita which is dissected away from its surrounding bone. Then, the remaining posterior part of the orbital wall and roof is removed until the orbitotemporal periosteal fold is exposed. The meningo-orbital artery runs in the orbitotemporal periosteal fold and should be coagulated and cut before dividing this fold. This is an important step in order to localize the junction between the periorbital and the temporal dura. The dura propria is then peeled of the lateral wall of the cavernous sinus to uncover the whole length of the ACP. During this step, fibrin glue can be injected if bleeding is faced from the cavernous sinus. The next step will be drilling and thinning the anterior root of ACP to egg shell thickness. The drilling should be intermittent using 3 mm diamond drill bit and under continuous irrigation to avoid thermal injury to the optic nerve. The remaining egg shell is removed with periosteal dissector. Now, the optic strut is only left as attachment to the sphenoid bone. The clinoid is cored out carefully using a diamond drill to avoid injury of the underlying clinoidal part of the internal carotid artery. The left over egg shell is then fractured inwards towards the hallowed core and removed in piecemeal. Pulling it out forcefully should not be performed to avoid laceration of the carotid artery. It is important to remember that ACP is sometimes connected to the middle clinoid process. In this case, the middle clinoid process must be denuded meticulously to complete the removal of the anterior clinoid process and expose the proximal optic nerve [3].

4. Discussion

CSF rhinorrhoea is a challenging complication of surgeries that require anterior clinoidectomy as it is not self-limiting and can lead to meningitis and tension pneumocephalus, which usually demands serial lumbar punctures, surgical repair and hence extended hospitalization. The degree of ACP pneumatization and optic strut pneumatization can be determined prior to surgery with computed tomography scan. In case pneumatization recognition was not attainable before the procedure, then is identified during the operation by the presence of large air cells in the anterior clinoid bone, by the presence of mucosal lining in the sphenoid sinus or by an internal layer of cortical bone inside the optic strut [2,21,22]. Entering air cells inside the pneumatized ACP alerts the surgeon about the near location of the neurovascular structures. Hence, then act as safety limits. The more the degree of pneumatization, the more the safety limit for drilling. Accordingly, with pneumatization degree evaluation prior to surgery, the surgeon is able to estimate the extent of ACP drilling, leading to a safe ACP resection.

The incidence of the ACP pneumatization has been reported by different studies as 4–29.3% [9,10–17]. However, studies have shown no gender differences in the ACP pneumatization with male to female ratio of 1:1 [16,17]. Mikami et al. has proposed ACP pneumatization system as per the route of pneumatization with: Type I being pneumatization through the optic strut, Type II through the anterior recess and Type III; through both the optic strut and anterior recess. Although, in a study of 648 subjects, 57.9% were found to have bilateral pneumatization of the ACP [16].

The ACP pneumatization according to age has been reported by different studies showing non-homogenous results. For instance, in one cross sectional study of individuals ranging from 1 to 80 years, ACP pneumatization was recognized by scan to start at age of 5 years and continues till the age of 30 [23]. However, Park et al. reported pneumatization begins at the age of one year, tackles linear progression at the ages of 6 till 10 and stops at the age of 15 years [24]. Lee et al. found that linear progression of pneumatization occurs till age of 18 [25]. The sensitivity of the methodology of these studies are questioned

as non is a cohort study. That derives us to the importance of having a CT scan prior to the surgery, in all ages, in order to identify ACP pneumatization.

5. Conclusion

ACP pneumatization can be recognized in all ages including pediatric age. This phenomenon is common and must be identified before attempting craniotomy that involves anterior clinoidectomy to avoid CSF leak complications. CT scan is recommended before anterior clinoidectomy to assess the presence and extent of pneumatization. When recognized intra-operatively, reconstruction must be attempted to obliterate the connection between the intracranial space and nasal sinuses. If CSF leak recognized post-operatively, repair is feasible through open or endoscopic transnasal approach.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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