Case Report

Ethmoid pneumatization and a large frontal-orbital-ethmoid mucocele

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Abstract

Frontal-orbital-ethmoid mucocele is a slow-growing retention cyst of the fronto-ethmoid complex secondary to blockage of the sinus ostia. It may produce significant disfigurement of the periorbital region necessitating surgical intervention. Prior to surgery, it is imperative to study the mucocele’s extent through the variable patterns of ethmoid pneumatization as evident from clinical, imaging (computed tomogram) and endoscopic evaluation. This is illustrated in a case study of a 41-year-old woman presenting with fullness below the right eyebrow, progressive proptosis, and gaze restriction. The provisional diagnosis of frontal-orbital-ethmoid mucocele was confirmed at endoscopic surgery, when it was drained and marsupialized through ethmoidectomy and frontal sinusotomy. Understanding the relationship of an enlarging mucocele with the inconsistent pattern of ethmoid pneumatization is the primary determinant for an uneventful and complete surgery, and to minimize recurrence. The gradually expanding mucocele occupies the path of least resistance and encroaches into the available spaces of ethmoid labyrinth, distorting key anatomic landmarks and making surgical intervention potentially challenging. Thus, preoperative imaging corroborated with naso-endoscopy is of paramount importance to trace the lesion along ethmoid pneumatization, and determine the relative positions of structures vulnerable to surgery. This often requires a comparative study of the contralateral side because the mucocele generally obscures the pneumatization pattern and vital landmarks on its side. The present imaging tutorial studies the extent of a large frontal-orbital-ethmoid mucocele through interpretation of multiplanar computed tomography cuts, keeping in mind the unpredictable nature of its expansion as a function of the highly individualistic ethmoid pneumatization.

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Introduction

A mucocele is a retention cyst that usually develops from an obstructed outflow pathway, like proximal to a stenosed or scarred duct, in the exocrine secretory system. Within the anatomic domain of nose and paranasal sinuses, mucoceles are relatively common, because the area is lined by respiratory (ciliated pseudostratified columnar) epithelium that is rich in goblet cells. They mostly involve the fronto-ethmoid region, and less commonly the sphenoid, and results from blockage of the sinus ostia [1,2]. Most of them are idiopathic, or occur in the setting of chronic rhinosinusitis and allergy, but they might also result as a long-term sequela of local trauma, including endoscopic sinus surgery of the frontal recess area [1,2]. It is a slow-growing, expandile space-occupying lesion that can be left untreated, with watchful observation, unless they are symptomatic. However, they often assume large dimensions and cause pressure effects with bone remodeling based on an array of inflammatory mediators [2]. Adjacent structures like the orbital roof, the eyeball, lamina papyracea, frontal sinus tables, and anterior skull base might be affected leading to insidious symptoms (headache, orbital pain), significant disfigurement, intracranial extension, and an overall impairment of the quality of life, necessitating surgical intervention [1-3]. Mucoceles tend to expand and encroach along the pathway of least resistance into the ethmoid labyrinth. Patients may present with proptosis, deviation of the eyeball and diplopia, unilateral nasal obstruction and sinusitis as the frontal-orbital-ethmoid mucocele encroaches into the nasal cavity and blocks of the sinus outflow tracts. The extent of involvement by a slowly expanding mucocele is quite unpredictable and is dependent on the available communications through the ethmoid labyrinthine septae and pattern of ethmoid pneumatization. Therefore, the role of imaging, especially that of high-resolution computed tomography (CT) scan of the nose and paranasal sinuses, along with diagnostic nasal endoscopy, is essential prior to embarking on endoscopic surgery, which is the principal mode of present-day surgical intervention [2,3]. A large mucocele (or a mucopyocele) obscures the major surgical landmarks that are keys to a successful and complete endoscopic procedure, and distorts vital anatomic structures (like the anterior ethmoid artery [AEA], lamina papyracea, etc.), making them vulnerable to iatrogenic injury. Mucoceles are prone to recurrence [3], thus endoscopic surgeons should be particular on performing complete marsupialization of the lesion, with consideration of ethmoidectomy. This is not possible without careful interpretation of the extent of the mucocele through imaging with assistance from nasal endoscopy, given the potential risks of instrumentation in a distorted anatomy. The present discussion, through a representative illustration of a large frontal-orbital-ethmoid mucocele, highlights the paramountcy of studying the CT scan to delineate its extent in terms of ethmoid pneumatization and the relative position of vulnerable anatomic structures, with special emphasis on the corroborative evidence of diagnostic nasal endoscopy, so as to ensure an uneventful and safe endoscopic surgery, and to minimize chances of recurrence.

Clinical details and imaging study

A 41-year-old woman presented with fullness below her right eyebrow, gradually progressing proptosis and restriction of upward gaze. Her symptoms started 5 years back. She had no history of prior endonasal surgery, and was otherwise healthy without any clinical features of rhinosinusitis. High-resolution CT scan of the nose and paranasal sinuses revealed a large, well defined, homogeneous, thin-walled noncontrast-enhanced lesion in the right fronto-ethmoid complex, encroaching the orbit through a breach in its roof [Fig. 1]. Diagnostic nasal endoscopy showed a bluish-white smooth-walled, cystic lesion occupying the roof of the right middle meatus and frontal recess area [Fig. 1 (J-L); video]. A clinical diagnosis of frontal-orbital-ethmoid mucocele was made, and the patient was prepared for endoscopic drainage and marsupialization.

To get prepared for surgery, high-resolution multiplanar CT imaging and endoscopic findings were meticulously evaluated and discussed [Fig. 1; video]. Since the mucocele obscured much of the anatomy, CT findings were initially assessed on the opposite side to predict and corroborate possible information on the affected side. The agger nasi cells were absent, and the bullae ethmoidals were poorly pneumatized. There were prominent suprabullar and retrobullar recesses (lateral sinus of Grünwald [LSG]) evident on the left that extended superolaterally to form the supra-orbital cell. The AEA was pushed behind, and could be seen suspended by its bony mesentery between the LSG and supra-orbital cell. On the affected side, the LSG was not readily appreciable, and the first posterior ethmoid cell (PEC) was initially mistaken for retrobullar recess to demarcate its posterior extent. However, endoscopic view beyond the hypoplastic bulla ethmoidalis into the LSG showed the mucocele occupying the entire suprabullar recess and sitting over the retrobullar recess like an egg in an egg cup, but without the posterior terminal convexity seen on imaging. Evidently, the mucocele proceeded further to involve the PEC. During its progress, it insinuated between the skull base and the bony mesentery of AEA, which could be seen abutting its inferior surface. Subsequent re-evaluation of CT images corroborated with the endoscopic interpretation. The first PEC was differentiated from retrobullar recess by the mucocele’s posterior terminal convexity at its roof, by the position of AEA as evident on CT and endoscopy, by identifying the ground lamella, and also by counting the PECs. The AEA in such precarious form posed a threat for the endoscopic surgeon, although its intimacy with the mucocele could be anticipated given the comparable ethmoid pneumatization. The supraorbital cell was apparent on the right side too, occupied by the mucocele, as the cell communicated with the LSG, and thence the frontal recess. Apart from breaching the medial orbital roof, the mucocele also caused expansion of the air spaces, and considerably widened the middle meatus and the LSG.

The patient subsequently underwent endoscopic drainage of the mucopyocele, marsupialization of its walls, widening of the frontal recess area, and anterior and posterior ethmoidectomy under general anesthesia. The surgical events were uneventful.
The mucocele is seen as a homogeneous, cystic, expansile lesion in the right fronto-ethmoid complex, that erodes the right orbital roof [A]. The partially obscured right fronto-ethmoid sinus anatomy is inferred from comparison with the contralateral side [A-F]. The agger nasi cells were absent [A, G-I], and the bullae ethmoidalis (2) were poorly pneumatized [B].

The mucocele progressed through the frontal recess (1) [A], the suprabullar recess (3) [B], supra-orbital cell (4) [B, C].

There was widening of the right frontal recess area [A, B, F], middle meatus [B], and the supra-/retrobullar recesses [B, C].

The anterior ethmoid artery (AEA) (arrow) ran precariously with its bony mesentery between the retrobullar recess (5) [C, F], supra-orbital cell (4) [C]. It could not be located on the affected side, but was anticipated to remain apposed to the mucocele's inferior surface, as evident on nasal endoscopy [J, K; video]. Apart from locating the ground lamella (GL) in the coronal reconstruction [D], the first PEC (6) could be differentiated from retrobullar recess (5) by the mucocele's posterior terminal convexity [D, E, G-I], counting the PECs (6-9) [E, G-I], and by the position of the AEA [G-L; video]. G-I represents the sequential parasagittal cuts from lateral to medial, showing the PECs (6-9), the AEA (arrow) and its relation with retrobullar recess (5) and the first PEC (6), and the mucocele's posterior terminal convexity. The mucocele could be seen insinuating between the skull base and the AEA [C, G-K]. The mucocele had no convexity over the retrobullar recess (5), differentiating it from the first PEC on endoscopy [K, L] and imaging [C-E, G-I], while the medial terminal convexity could be well appreciated (asterisk) [I, J; video]. The dotted and solid lines in H represent axial cut levels in E and F, respectively. S, sphenoid sinus; U, uncinate process; MT, middle turbinate.
The high-resolution multiplanar CT imaging study in this patient provided with some interesting observations regarding the property of a frontal-orbital-ethmoid mucocele in relation to ethmoid pneumatization. With a given volume of air space that includes the migrated cells as well, poor pneumatization in some group of anterior ethmoid cells might lead to prominent aeration in others. Thus, absent agger and poorly pneumatized ethmoid bullae in this patient led to prominent LSGs and supra-orbital cells that communicated with frontal recesses. Besides the intrinsic expansile nature mediated by osteolytic cytokines and enzymes, a long-standing frontal-orbital-ethmoid mucocele takes advantage of the absence of resistance otherwise put up by the bony septae, and encroaches unhindered through communicating air spaces, gradually expanding, distorting, and remodeling them [2]. Therefore, careful study of ethmoid pneumatization before surgery can predict the mucocele’s extent so that a complete and wide marsupialization can be planned. This would minimize the chances of recurrence, besides clearing adjacent sinuses of disease due to compromised drainage. Since a large mucocele often obscures the surgical anatomy, studying that of the opposite side is of practical importance as there is a realistic expectation of comparable symmetry [4]. The first PEC was initially confused with retrobullar recess, because the recess was expected to be prominent due to poorly pneumatized bulla and the widening effect of the mucocele. Study of the mucocele’s contour and extent defined by its progress and terminal convexity in relation to ethmoid pneumatization is therefore crucial. Moreover, its disposition with respect to the AEA and skull base, and the evident risk of injuring the AEA during surgery, could have been difficult to realize without a comparative anatomic discourse of multiplanar reformatted CT images. Thus, careful and conscious searching for relative anatomic details emphasizing on ethmoid pneumatization is imperative for safe and effective surgery of an expanding, space-occupying mucocele.

Conclusion

Careful preoperative study of the CT scan of nose and paranasal sinuses regarding the extent of a frontal-orbital-ethmoidal mucocele is essential, along with diagnostic nasal endoscopy, for an uneventful surgery and to minimize the chances of recurrence. The mucocele should be evaluated in terms of ethmoid pneumatization, which is greatly individualistic, and thus foretells the unpredictability of its extent. The need of a comparative imaging study of the vital anatomic landmarks on the contralateral (unaffected) side might often arise to create a cell-to-cell coordinate of those of the involved side, assuming a comparable symmetry. The present illustration highlights the nuances of deciphering the CT scan details in a large frontal-orbital-ethmoidal mucocele, and emphasizes its practical importance in decision making during the surgical management of the lesion.

Please note that this manuscript has a short video clip of diagnostic naso-endoscopy as a supplementary file that has been uploaded during submission of the manuscript through the Elsevier/Evise electronic submission portal. The legend of the video is incorporated within that of Figure 1.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2018.12.011.

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