

Skull base defect in a patient with ozena undergoing dacryocystorhinostomy

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ABSTRACT

Ozena, which is often used interchangeably with atrophic rhinitis or empty nose syndrome, is a progressive and chronically debilitating nasal disease that results in atrophy of the nasal mucosa, nasal crusting, fetor, and destruction of submucosal structures. Although the etiology is not completely understood, infection with *Klebsiella ozaenae* is widely believed to contribute to the destructive changes. We present a case of a patient with ozena secondary to *K. ozaenae* with extensive destruction of bony structures of the nasal cavity undergoing elective dacryocystorhinostomy. An extensively thinned skull base secondary to the disease process resulted in an unforeseen complication in which the skull base was entered leading to a cerebrospinal fluid leak. Patients with known history of ozena or atrophic rhinitis often have extensive destruction of the lateral nasal wall and skull base secondary to progression of disease. Submucosal destruction of these bony structures mandates the need for extreme caution when planning on performing endoscopic intervention at or near the skull base. If physical examination or nasal endoscopy is suspicious for atrophic rhinitis or a patient has a known history of infection with *K. ozaenae*, we recommend preoperative imaging for surgical planning with careful attention to skull base anatomy.

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Ozena, often used interchangeably with atrophic rhinitis or empty nose syndrome, is a progressive and chronically debilitating sinonasal disease that can result in characteristic changes of the nasal anatomy. Derived from the Greek term denoting “stench,” ozena was first described in 1876 and subsequently used to denote patients presenting with breath that emitted such a foul odor their presence was often not tolerated.¹ The disease process, although not well understood, often results in extensive destruction of nasal structures including characteristic progressive nasal mucosal atrophy, formation of thick nasal crusts, fetor, and enlargement of the nasal cavity and sinonasal space secondary to resorptive bony changes.² Often, patients will present with complaints of decreased sense of smell or anosmia, chronic nasal congestion, paradoxical obstructive nasal breathing despite a widely patent nasal cavity on examination, facial pain or pressure, foul nasal odor, or epistaxis.² The fetid odor that is described may be so severe that patients may be socially ostracized.

The bony changes that result from the underlying disease process are typically resorptive in nature. Moore *et al.*² identified 242 atrophic rhinitis patients, analyzed 158 computed tomography (CT) scans, and found that most common CT findings for these patients included diffuse mucosal thickening of the paranasal sinuses and enlargement of the intranasal space with bowing of the nasal walls.² In addition, resorption or destruction of the ethmoid sinuses was seen in 100% of scans, with hypoplasia of the maxillary sinuses noted on 126 studies. Bony resorption or destruction of the middle and inferior turbinates with atrophic thinning of mucosa was seen on all studies as well.² These findings were found to be consistent with a prior review by Pace-Balzan *et al.*, which coined the term “empty nose syndrome” to describe the vast changes to the anatomy of ozena patients on CT imaging.³

The importance of the characteristic findings on CT imaging should be doubly noted for those ozena patients undergoing additional sinonasal endoscopic-based procedures as they present a serious risk of injury or complication secondary to the presence of skull base and lateral nasal wall bony defects. We present a case of a patient undergoing an elective dacryocystorhinostomy (DCR) at our institution who experienced an intraoperative complication consisting of inadvertent entry into the right anterior skull base with subsequent cerebrospinal fluid (CSF) leak requiring immediate assessment and repair. We identify a significant clinical issue that should lead to additional precautions in surgical planning for patients with atrophic rhinitis and/or ozena.

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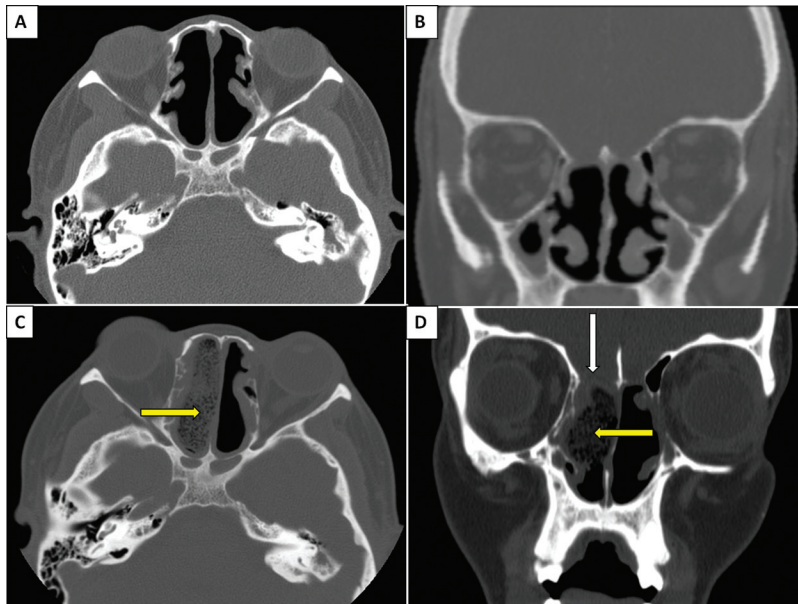


Figure 1. (A) Axial and (B) coronal preoperative computed tomography (CT) imaging of the orbits and paranasal sinuses show extensive submucosal destruction of the skull base and lateral nasal wall with no evidence of bone in the right fovea ethmoidalis. (C) Axial and (D) coronal postoperative CT imaging show the acellular dermal allograft in the right fovea ethmoidalis (white arrow) and Merocel nasal tampon supporting the skull base repair site (yellow arrows).

CASE REPORT

A 33-year-old Egyptian woman who recently immigrated to the United States was evaluated by the ophthalmology service for chronic epiphora and bilateral nasolacrimal duct obstruction. The patient denied any history of previous sinonasal trauma, irradiation, and rhinologic or ophthalmologic procedures. CT scanning of the orbits and paranasal sinuses showed destruction of the ethmoid air cells and lateral nasal wall with excessive thinning of the anterior skull base and a Keros type I cribriform configuration (Fig. 1, A and B). The patient underwent an uncomplicated elective left DCR with insertion of a Crawford tube by the ophthalmology service and did well in the postoperative period. Forty-two days later, the patient returned to the operating room for a planned right DCR. Intraoperatively, an area of submucosal dehiscence was encountered with CSF extravasation. The rhinology service was emergently consulted intraoperatively for evaluation and potential repair. A 4-mm-diameter right fovea ethmoidalis defect in the region of the anterior ethmoid artery and CSF leakage were confirmed. There was also evidence of an actively bleeding and avulsed anterior ethmoid artery. Hemostasis was obtained with a bipolar cautery, and the defect was repaired using two layers of acellular dermal allograft/Alloderm (LiteCell Corp., Branchburg, NJ). The first layer was placed intracranially and extracranially, and the second layer was placed extracranially. The repair site was then supported with a layer of Gelfoam (Pharmacia, Kalamazoo, MI) soaked with gentamicin solution and two Merocel tampons (Medtronic-Xomed, Jacksonville, FL) coated with bacitracin antibiotic ointment. The patient was subsequently awakened and tolerated the repair well.

The patient's postoperative course was complicated by low-grade fever and frontal headaches 5 days postoper-

atively. Postoperative CT scan showed no intracranial pathology (Fig. 1, C and D). Sinonasal endoscopy was performed and mucopurulent discharge was suctioned and cultures grew *Klebsiella ozaenae*. The nasal packing was changed, she was treated with i.v. prophylactic antibiotics, and had an uneventful course thereafter. Her follow-up examination 18 months after surgery revealed a well-mucosolized defect site with a widened nasal cavity (Fig. 2, A–D).

DISCUSSION

The incidence of primary atrophic rhinitis or ozena has decreased markedly over the past 100 years. This has likely been the result of increased antibiotic use in patients with chronic nasal discharge and obstruction.⁴ However, this disease can still be found in underdeveloped countries and has been reported in India, Turkey, China, and Egypt.² In contrast, secondary atrophic rhinitis, which is generally encountered by otolaryngologists and typically results from prior trauma or iatrogenically from extensive reductive sinonasal surgery has been reported extensively in the literature.² Other potential causative factors of secondary atrophic rhinitis include chronic rhinosinusitis, prior radiation, nutritional deficiencies, hereditary causes, vascular or autoimmune diseases, and chronic granulomatous diseases.² There has been a great deal of contention in the literature regarding turbinate resection and development of atrophic rhinitis as well.

Primary atrophic rhinitis is an entity that is not well studied. Several hypotheses have been proposed, including nutritional deficiencies, genetic factors, endocrine factors, and bacterial infection.^{4–11} Several studies have shown a relationship between primary atrophic rhinitis and underlying *K. ozaenae* infection for

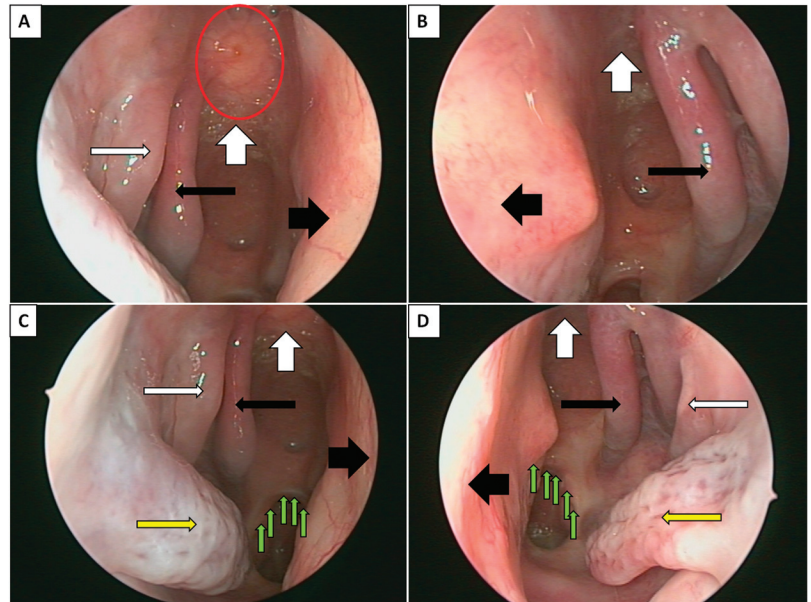


Figure 2. Eighteen months postoperative 4-mm 30° nasal endoscopy shows (A) a well-mucosolized repair site (red circle) of the right anterior skull base defect, with an intact skull base posteriorly (wide white arrow), and widened nasal cavity bilaterally. (A) Right and (B) left images show the superior sinonasal cavity and (C) right and (D) left images depict the inferior nasal cavity. Thin white arrow, uncinat process; thin black arrow, middle turbinate; wide black arrow, nasal septum; thin yellow arrow, inferior turbinates; green arrows, choanal arch.

which it has been named.^{2,12} Moore *et al.*² report that 44% of patients with atrophic rhinitis who had positive cultures were positive for *K. ozaenae*. In a smaller review, Zohar *et al.*¹³ report that *K. ozaenae* was the pathogen in 77% of positive cultures. In addition, there have been reports of isolation of *Pseudomonas aeruginosa*, *Proteus*, *Escherichia coli*, *Bacillus pertusis*, *Coccobacillus foetidus ozaena*, *Coccobacillus* of Loewenberg, Diphtheroids, and *Haemophilus influenzae* from the nasal secretions of patients as proposed causative organisms.¹⁰ Some theories on the microbiological pathogenesis of this disease have suggested a possible superinfection with a mixed flora of these organisms leading to stasis of nasal cilia and resultant destruction of epithelium with progressive mucosal changes.¹⁰ Inhibition of mucosal cilia by *K. ozaenae* has been previously studied as a potential mechanism in the pathogenesis of ozena.¹² Despite these theories, it has proven difficult to establish that *K. ozaenae* infection is the underlying etiology in humans. There remains the question of whether this infecting organism directly causes tissue destruction or whether it is simply an opportunistic invader of the atrophic mucosa. Despite this uncertainty, the disease has been observed to be infection related in sheep, cattle, and pigs. In a study by Dutt *et al.*, the authors found evidence that the disease in pigs is triggered by infection by the bacteria *Pasteurella multocida* and *Bordetella bronchiseptica*.¹⁰ Whether or not infection is the underlying cause of ozena, there does appear to be at least one distinguishing factor found in this condition that is not usually found in secondary atrophic rhinitis. Patients with ozena tend to have a greater risk of submucosal bony dehiscence, compared with secondary atrophic rhinitis patients who typically do not exhibit findings of skull base defect on imaging.⁴ This

finding was noted in our presented case in addition to culture-proven infection with *K. ozaenae*.

Clinical management of the disease is limited and primarily medically based. Medical management consists of aggressive nasal irrigation and good nasal hygiene. Patients are instructed to irrigate their noses daily without cessation, because symptoms return when the artificial humidification is discontinued.⁴ In addition to saline rinses, topical antibiotic irrigations with gentamicin have been used at varying frequencies depending on patient tolerance.² Many patients also benefit from scented topical treatments to relieve significant odor that can be socially intolerable.²

Surgical management of this condition has been attempted and includes procedures designed to reestablish nasal airflow patterns and provide intranasal volume to increase the humidification properties of the nasal cavity. In a study by Guilherme *et al.*, the role of air conditioning within the nasal cavities in the development of atrophic rhinitis was investigated. The authors concluded that excessive evaporation of the mucus layer of nasal mucosa is the basis for the relentless nature of this disease.⁴ They used computational fluid dynamics to study the effects of enlarged nasal geometry in the continued destruction caused by atrophic rhinitis. According to their flow studies, the atrophic nose did not condition inspired air as effectively as those with normal geometric anatomy.⁴ The findings in this study and others propose that the aim of surgical therapy should be to restore symmetry, as well as the original surface area of the nose, which would allow for more physiological airflow distribution.

Surgical procedures that have been performed and reported in prior literature include endonasal microplasty, which requires placement of autogenous cartilage and acellular dermis to provide some restoration of nasal

resistance and volume.² Various materials are available for this use including autologous bone, cartilage, and fat as well as biomaterials such as plastipore, bone source, Gore-Tex (WL Gore and Associates, Flagstaff, AZ), and AlloDerm (LifeCell Corp., Branchburg, NJ).² Rice reported success with hydroxyapatite.⁵ Goldenberg reported use of plastipore.⁶ Friedman and Kern both reported some success with acellular dermis.^{2,7} These procedures usually provide relief of nasal crusting and other symptoms; however, results may be poor or lack permanent relief because the resorption or extrusion of the implants can occur in up to 80% of cases.² The only procedure known to provide permanent relief from the symptoms is temporary abolition of nasal respiration by sequential surgical closure of the nostrils for a period of time followed by reopening as described by Young.^{8,9} Young's technique essentially involves raising skin folds in the vestibule by circumferential incisions and suturing them together, which prevents the rapid and turbulent airflow through an enlarged nasal cavity that is destructive to mucosa.^{8,9,12} By eliminating turbulent airflow and essentially resting the mucosa with Young's procedure, an environment is created that allows for regeneration of respiratory epithelium.¹² Since its first description, there have been a number of modifications to Young's technique that have been described including Ghosh vestibuloplasty, which incorporates a flap raised from the lateral wall of the nasal vestibule anteroposteriorly, which is sutured on itself, therefore decreasing lateral flow of air toward the turbinates and instead directing flow into the nasal cavity.¹⁴

Irrespective of the potential treatment options for ozena patients, the need for added precaution in patients with known or suspected ozena undergoing sinonasal procedures can not be overly stressed. The typical findings in these patients can be missed on physical examination alone. A thorough history including review of ethnicity, travel history, and infectious exposures is imperative when concerns for either primary or secondary atrophic rhinitis exist. In addition to complete history and physical examination, we recommend use of CT imaging and image guidance in preoperative and operative planning for these patients. A potential intraoperative complication, such as a CSF leak, may be avoided with careful attention to anatomic detail and high index of suspicion of potential bony skull base dehiscence. This holds especially true for patients undergoing endoscopic endonasal procedures that require dissection near the skull base. Limawaranut *et al.* recommend fine cut coronal sections and three-dimensional imaging when planning for DCR in patients with suspected or known abnormalities of sinonasal anatomy.¹⁵ CSF leak with DCR is exceedingly rare and is only encountered as case reports in the literature with documented incidences of up to 0.04%.^{16,17} Our patient had a history of immigration from a country endemic for ozena and bony changes in the anterior skull

base on CT. Additionally, she had a suspected history of allergic fungal rhinitis, which is also associated with bony destruction in up to 20% of patients.¹⁸

CONCLUSIONS

Ozena is an uncommon entity. However, it is an important process to recognize because submucosal bony resorptive changes are common findings that can lead to potentially disastrous consequences for those patients requiring endonasal surgery. Insight into the typical sinonasal anatomic changes in these patients is critical for appropriate preoperative surgical planning and execution of endoscopic procedures to avoid troublesome and preventable complications.

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