Sinonasal complications of vasculitic diseases

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Systemic vasculitides may affect multiple organs in the body. Certain diseases, such as Wegener's granulomatosis or Churg-Strauss syndrome, are particularly prone to destructive effects in the nose and paranasal sinuses secondary to the underlying autoimmune process. These disease manifestations may occur externally, with alteration in the facies and appearance of patients with major destruction of the architecture of the bony paranasal sinuses. Results of these processes include infections that are multiple and vary from symptoms including pain, headache, and discharge to fevers and contiguous infections or potentially major organ system disasters. The orbit as well as the central nervous system are prime targets, and this paper will deal with some of those issues on a global scale using mostly patients with Wegener's granulomatosis as a model.

ANATOMY

Prior to understanding the disease processes of the sinonasal tract, one must understand both the gross and microscopic anatomy of these organs, with its complex architecture and tunneling, as well as the normal physiology of sinus and nasal homeostasis. This certainly helps to facilitate one's understanding of the infectious and inflammatory complications one may see in clinical practice.

The nose generally consists of lateral bony pyramids, also known as the nasal bones, with a midline structure coming perpendicular from the base of the skull known as the perpendicular plate of the ethmoid. Anteriorly, this bony plate attaches to two cartilaginous structures known as the vomer as well as the quadrangular cartilage. The floor of the nose is part of the roof of the hard palate, and this bony floor also separates these two anatomic compartments. The mucous membranes of the nose consist of a glandular epithelium, with a mixed respiratory glandular mixture that secretes large amounts of mucins, immunoglobulins, lactoferrins, and other immunological and active chemicals to help facilitate the cleansing of the upper airways. Laterally on the nasal wall are three turbinates, with the inferior being the largest and the superior the smallest. Under the inferior turbinate anteriorly exits the nasal lacrimal duct, which acts as a conduit for ocular secretions to leave the face of the globe and drain through the nose. Under the middle turbinate is the middle meatus, which generally drains the frontal sinuses as well as the anterior ethmoid complex of the maxillary sinus, and superiorly is the sinus ostium draining the posterior ethmoid cells. The sphenoid sinus drains directly into the back of the nose through its rostrum or anterior face. The natural ostium is classically at approximately a 23° angle from the floor of the nose.

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EXTERNAL FEATURES

Patients with granulomatous vasculitis, be it Wegener's or Churg-Strauss syndrome, may present with a cosmetic and functional deformity known as a "saddle-nose deformity." This is obvious from an external examination of the nose, and it consists of a depression and retraction of the midportion of the nose, often with tenting of the skin in that depressed region. Saddle deformities cause rotation of the nasal tip with an increase in the nasolabial angle and in very severe cases may have it approach 180°. In these patients, the lower lateral cartilages of the nose usually survive, thus producing a tip and opening that is more normal in appearance and often functionally viable. The etiology of a saddle-nose deformity from an anatomic perspective is loss of the dorsal septal cartilage.

The most common cause of saddle-nose deformity in the United States is iatrogenic, be it a complication of rhinoplasty or certain types of nasal septal surgery. Mechanical trauma, as well as blunt trauma in addition to chemical trauma, such as cocaine abuse, are other etiologies associated with this type of anatomic defect. The intranasal examination in these cases may often reveal a nasal septum with a perforation. In many patients with vasculitis, no perforation may be noted; however, there is clearly loss of the quadrangular cartilage. Other granulomatous diseases of a nonvasculitic origin can cause a similar picture, and these include acid-fast infection of the nose as well as diseases of unknown etiology, such as sarcoidosis.

Survival of the lower lateral cartilage is crucial from both a cosmetic and functional perspective, and any type of surgical restorative approach will generally rest on replacing that which has been lost anatomically. Since it is septal cartilage and a dorsal support that is lost, most surgi-

cal approaches for reconstruction will focus on that avenue. The upper lateral cartilages often survive in these patients, although they may be disfigured and partly eroded through the inflammatory destruction that occurs.

In patients with Wegener's granulomatosis who have a saddle-nose deformity, no clear-cut etiology for the cartilaginous destruction has been proven, although one may speculate as to its origin, and part of this paper will suggest a possible cause. It is well known that cartilage has low metabolic needs and hence uses a small blood supply, but nevertheless it does need blood, oxygen, and nutrients in order to survive. This blood flow generally comes to the cartilage through the perichondrium, which also can facilitate chondrogenesis with new chondrocytes, in an active process similar to that seen in bone from its periosteum and the osteoclastic osteoblastic cycles. With all that said, cartilage has a very tenuous blood supply, and small infringements on its vascular support will cause necrosis and destruction. This is well established in other cartilaginous structures, such as the ear, and diseases such as relapsing polychondritis and in infectious etiologies of the ear, such as *Pseudomonas*-based infections. The laryngeal cartilages are also susceptible to inflammation, stenosis, and destruction from both infectious and inflammatory reactions, and these diseases include etiologies such as glanders (*Pseudomonas mallei*), as well as acid-fast disease, chemical trauma (acid and lye ingestion), blunt and penetrating trauma, and complications of external beam irradiation which cause a local microvasculopathy.

In the case of patients with granulomatous vasculitis, the upper lateral cartilage to some degree, and the lower lateral cartilages to a greater degree, obtain their blood supply to the perichondrium through the overlying soft tissues and skin as well as the underlying vestibular skin. These skins are more of a squamous type of epithelium and generally less likely to be subject to a respiratory disease such as Wegener's or Churg-Strauss. My inference, therefore, is with less soft tissue inflammation in this region, the blood supply to the perichondrium for the lower lateral and usually to the upper lateral cartilages is preserved. The nasal septum, however, has more of a respiratory component to its mucoperichondrium, which is more likely to be susceptible to an attack of active Wegener's. The inference here is that since this tissue is more likely to be inflamed, the blood supply to the quadrangular cartilage and the anterior portion of the nasal septum is more likely to be compromised, particularly superiorly, with a resultant slow and insidious cartilaginous destruction. Externally, this manifests itself as a saddle-nose deformity. The nasal bones are covered by soft tissue and skin and as such are probably less susceptible to interruptions of blood flow due to inflammation of respiratory tissues.

I have seen cases through the years of patients with Wegener's granulomatosis, particularly those newly diagnosed, who recently underwent some sort of a septal procedure, either for biopsy or for functional reasons, and claim that they immediately lost their nose, ie, developed a saddle deformity after the surgery. While this is anecdotal at this time, I suspect there is already present a level of inflammation within the mucoperichondrium and by disturbing the tenuous blood supply during lifting these flaps off of the cartilage, one is essentially committing the nose to a cartilaginous breakdown. The upshot is that except in extreme and compelling cases, one should avoid any type of elective nasal septal surgery in patients with systemic vasculitis unless the patient is clearly in remission and there is no evidence of disease activity within the mucous membranes in the nose.

Reconstruction of the saddle deformity in Wegener's granulomatosis patients is a medical issue subject to debate; this author has experience with nearly ten such cases. I have also had the benefit of seeing the work of other physicians where more extensive types of rhinoplasty were performed and with unfortunately devastating consequences. The basic principle that should be considered is one of replacement of that tissue which is lost and to minimize any manipulations of other tissues. This is including but not limited to the upper and particularly the lower lateral cartilages. I do not believe there is value in dissecting them off of the soft tissue base that supports their vasculature, and in a similar vein, any type of bony work in the nose should be avoided.

In order to do a proper bony osteotomy, one needs to strip the periosteum off of the nasal bones in order to break them and reset them into their new configuration. In an analogous fashion to what was discussed earlier regarding cartilages, one may iatrogenically cause a loss of blood supply to the underlying bones with potentially catastrophic results from a cosmetic perspective. I remember one patient quite well who underwent a total of six procedures and ended with three major holes in the midface and region of the nose and was left with a residuum of lower lateral cartilage and nothing else. She dealt with the problem by keeping the areas covered with bandages as she walked in public.

DISEASE OF THE PARANASAL SINUSES

When Wegener described his first four cases of necrotizing granulomatous vasculitis in four autopsy specimens,[1] the classic description was one of inflammation within the kidneys, lungs, and paranasal sinuses. In the NIH review of 158 patients by Dr. Gary Hoffman,[2] essentially two-thirds of the patients with Wegener's granulomatosis will develop some issue related to the paranasal sinuses at some point during their illness. As opposed to the nasal cavity and nasopharynx, the paranasal sinuses have essentially a pure line of ciliated respiratory epithelium. This is one of the primary recipients of the so-called Wegener's attack in my opinion. The paranasal sinuses anatomically are invaginations within the bony skeleton of the face and head that are lined with a ciliated columnar respiratory epithelium. They secrete glandular material including lysozyme and lactoferrin as well as immunoglobulin-G and secretory immunoglobulin-A. They act as a reservoir for humidification of air going through the nasal cavity as well as a heating and cooling system for that same air. This finely tuned homeostatic system persists, and the pathophysiology of Wegener's granulomatosis revolves around inflammation of this thin lining. As the lining becomes inflamed, the small passages that allow for the outflow of fluid become

blocked, and one experiences a backup and stasis of fluid. At this point, it is not a tremendous leap of faith to assume that static fluid will eventually become infected, causing pain and the myriad of symptoms associated with acute sinusitis. As there are four paranasal sinuses on each side of the face, any permutation one can conceive of is possible for disease activity as well as signs and symptoms of sinus disease.

Additionally, anatomic considerations for each sinus dictate the clinical presentation as well as the possibility of any extra-sinus complications. In addition to stasis and backup of fluid with infection, scarring and hyperreactivity of the respiratory epithelium or mucosa becomes common with resultant mucoperiosteal thickening. This becomes infected, which stimulates the inflammatory response from both the humeral and cellular components, with subsequent activation of cytokines causing the cycle to grow and cascade in a continuing downward spiral. Treatment of disease in the paranasal sinuses at this point is directed towards restoring normal mucociliary flow and transport if possible, and if not possible then to establish new conduits in the areas of drainage to allow for surgical and mechanical cleaning postoperatively. It goes without saying that concurrent treatment of the systemic illness with the appropriate immunosuppressive therapies under the direction of the rheumatologist, immunologist, or pulmonologist is critical to breaking the cycle of inflammation and infection at two separate points.

The unique anatomy of the frontal sinus explains the clinical presentation of infection in these patients as well as potential complications. The sinuses are innervated by branches of the supraorbital nerve, and patients will present with pain over the frontal bone as well as possible headache and even fever. The anterior table of the frontal sinus has marrow within the bone, and chronic festering infection that does not drain through the nasofrontal duct can infect the bone marrow anteriorly, causing an osteomyelitis known as Pott's puffy tumor. Looking posteriorly from the frontal sinus, one must realize that the anterior cranial fossa is bordered by the posterior table of the frontal sinus, connected by valveless diploic veins. Purulent infection of the frontal sinus can therefore travel retrograde through these valveless veins and allow for the transmission of septic emboli to the meninges. Intracranial complications are therefore possible, including but not limited to meningitis, epidural empyema, subdural empyema, as well as brain abscess. Treatment of the frontal sinus is geared towards reestablishing draining, either endoscopically or through an incision from the undersurface of the frontal bone in the region not containing bone marrow, thus limiting the chance of an osteomyelitis. Intracranial complications often require combined therapy, with both a sinus surgeon and neurosurgeon in attendance.

The sphenoid sinus is similar to the frontal sinus in that its anatomic location predisposes the patient to potential intracranial disease. It sits under the Turkish saddle with the pituitary gland above with its anterior and posterior divisions. Laterally out of the sinus, you have the third and fourth cranial nerves in addition to the first branch of the trigeminal nerve and the abducens nerve. The optic nerves traveling posteriorly towards the chiasm impinge on the lateral wall of the sphenoid sinus and can often be seen endoscopically through the sphenoid sinus. Additionally, the internal carotid artery passes posterior to the sphenoid sinus, and in up to one-quarter of patients may even be dehiscent. Significant disease of the sphenoid sinus, therefore, must be addressed promptly and aggressively from both a microbiologic and inflammatory perspective. Surgical drainage anteriorly through the nose is a minimum, often required in order to deal with pain, fever, and potential orbital problems and intracranial complications.

In most patients with Wegener's granulomatosis, the most common sinuses involved are the maxillary and ethmoid sinuses. The anterior ethmoid system usually drains with the frontal sinus and infundibulum draining the maxillary sinus through the middle meatus out from under the middle turbinates. Disease can occur internally in the nose along its lateral wall in the region of the middle turbinate, blocking off the entire system or causing additional inflammation within an already narrowed ostiomeatal complex. The lateral border of the ethmoid sinus is the medial border of the orbit. Again, one does not require a major leap of faith in order to sense that potential complications of infection or inflammation of the ethmoid sinus can travel into the orbit.

Orbital complications of sinusitis include cellulitis, both the pre- and postseptal types, and they may include, but are not limited to, blepharitis, conjunctival injection, displacement of the globe, medial rectus palsy, diplopia, visual changes, and in a worst-case scenario, blindness. In a similar vein, treatment is always geared towards reestablishing drainage, either through an external or intranasal approach, in addition to antimicrobial therapy and systemic treatments. The maxillary sinus may also contribute to pain and tooth discomfort; however, it rarely causes any life-threatening complications and is often addressed through either a Caldwell-Luc approach under the lip through the canine fossa or via a medial meatal antrostomy approach to drain the sinuses.

Functional endoscopic sinus surgery, touted over the last 10 to 15 years as the future of sinus surgery, is probably not the best approach to dealing with patients who have active vasculitic disease. In these patients, the respiratory epithelium is inherently inflamed and the primary focus of inflammatory disease; it is often difficult to surgically restore normal mucociliary flow. Classical surgical techniques such as a Caldwell-Luc, external fronto-ethmoidectomy (Lynch procedure), as well as a frontal sinus obliteration may have increased utility in the surgical management for patients with active vasculitis.

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