Paranasal Sinus Development and Choanal Atresia

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Background: Although the determinates of paranasal sinus development and sinusitis are not well defined, a candidate factor is blockage of the choana.

Hypothesis: Maxillary sinuses ipsilateral to unilateral choanal atresia are comparatively small and have more evidence of sinusitis than do the contralateral sinuses.

Design: Retrospective.

Setting: Children’s hospitals.

Patients: Sixteen nonsyndromic children with isolated unilateral congenital choanal atresia.

Main Outcome Measures: Determination of maxillary sinus volumes and mucoperiosteal thickening on preoperative computed tomograms.

Results: Maxillary sinuses ipsilateral to unilateral choanal atresia have slightly larger volumes than, and mucoperiosteal thickening that is similar to, the contralateral sinuses.

Conclusion: These data suggest that maxillary sinus development and sinusitis are independent of posterior nasal ventilation and drainage.

Subjects and Methods

Study Population

The medical records of all children with unilateral choanal atresia were requested from the 3 children’s hospitals in Atlanta, Ga, and from a private otolaryngology practice in Memphis, Tenn. Approval of the Clinical Research Coordinating Committee was obtained from the one institution that required such approval. Excluded from the study were patients with bilateral atresia or anterior nasal piriform aperture stenosis and patients with any other congenital anomaly or syndrome. Also excluded were children whose initial preoperative computed tomographic (CT) scan was unavailable or did not include the posterior choanae and maxillary sinuses.

The initial preoperative noncontrast axial sinus CT scans of 15 children and the coronal CT scan of 1 child were available for study. Each sinus was tomographically sectioned at regular parallel intervals ranging from 1 to 5 mm. The identity of each patient and the side of the atresia were known and concealed by the first author (P.M.B.) using opaque adhesive tape so that the reviewing author (N.W.T.) could view the scans without bias. Using an x-ray film review box for illumination, the bony contours of all maxillary sinus sections (caudal to cranial extent) were traced onto paper by the reviewing author. Similarly, the area of mucosal thickening (soft tissue density) within each maxillary sinus was traced to compare aerated with nonaerated maxillary sinus volumes.

Results

Sixteen children, aged 1 month to 17 years, with isolated unilateral choanal atresia were identified. Twelve children were female and 4 were male, similar to the 2:1 ratio reported by Brown.10 Nine patients had right-sided atresia and 7 had left-sided atresia.

A wide range of maxillary sinus volumes was noted (Figure). The mean maxillary sinus volume ipsilateral to the choanal atresia was 4.84 mL, compared with 4.48 mL for the contralateral side. The sinuses ipsilateral to the atresia were, on average, larger than the contralateral sinuses ($P < .06$). Symmetry of maxillary sinus size was apparent ($r = 0.97; P < .001$).

The volumes of the soft tissue (presumably mucoperiosteal thickening) in the maxillary sinuses appeared symmetrical: 6 patients had more soft tissue in the sinus ipsilateral to the atresia; 5 patients had more soft tissue in the sinus contralateral to the atresia; and 5 patients had complete opacification of both maxillary sinuses; ie, sinusitis as assessed by the preoperative CT scans was unrelated to the unilateral choanal atresia.

Comment

Classically, chronic sinusitis in children is associated with both local and systemic contributing factors. Systemic factors include upper respiratory tract infections, both allergic and nonallergic rhinitis, immunodeficiency states, primary ciliary dyskinesia, cystic fibrosis, Down syndrome, inhalant pollutants, and aspirin sensitivity. The list of local factors includes dental infections, cleft palate, and swimming, but mostly items related to nasal obstruction: adenoid hypertrophy or infection, foreign bodies, tumors, polyps, septal deviation, and choanal atresia.10,11,20 All of these conditions presumably interfere with normal nasal ventilation and sinonasal mucociliary flow and lead to obstruction of the osteomeatal unit.

Lifelong, persistent, severe paranasal sinusitis is thought to be represented radiographically by nonaerated sinuses that are smaller than usual. The nonaerated (ie, opaque) sinus is attributed to stagnated mucus or pus or to thickened mucoperiosteum. Proetz6 suggested that “the failure of some sinuses to develop may be on a kinematic basis [to Wittmaack’s contention that inflammatory middle ear disease limits mastoid pneumatization].” However, Ritter2 stated, “For unknown reasons, during growth the maxillary sinuses may cease development and produce a sinus lumen of less than normal size.”

Notwithstanding the consensus of conventional wisdom, sinusitis is not universal in children with choanal atresia. Proetz6 observed that newborns with bilateral choanal atresia do not have clinical infection of the maxillary sinuses. Stewart’s22 1931 report included the radiographs of 3 patients with unilateral choanal atresia: “The air sinuses on both sides of the skull were found to be well developed.” Mehta,4 in describing an adult with unilateral choanal atresia, reported near-symmetrical, aer-
lated, pneumatized maxillary sinuses. Similarly, Mittermaier\textsuperscript{23} illustrated a case of unilateral choanal atresia and stated in the study’s figure legend, “The sinuses are normally developed.” Klossek et al\textsuperscript{24} and Diner et al\textsuperscript{25} recently described 2 small series of patients (numbering 6 and 11, respectively) with unilateral choanal atresia: no sinusitis!

As Proetz\textsuperscript{6} suggested:

A difference apparently exists between the behavior of a nasal mucosa deprived of air after breathing has been established, and one in which, through congenital posterior closure, no breathing has ever taken place. In the latter condition normal, healthy tissues are often found in the nasal fossae. . . .

There are several potential explanations for our findings of maxillary sinus symmetry in children with unilateral choanal atresia, including (1) stagnation of sinonasal mucus per se does not limit development of the maxillary sinuses; (2) absence of nasal ventilation alone does not result in chronic sinusitis or limit paranasal sinus pneumatization; (3) the blocked choana decreases the risk of viral and other pathogens getting into the nose; and (4) our findings, and those of other investigators, are flukes (statistically, this seems unlikely).

That children with congenital unilateral choanal atresia manifest healthy, well-developed paranasal sinuses bilaterally is surprising and incongruous with the time-honored teachings that nasal ventilation and drainage are necessary for sinus health. The explanation for this unexpected finding is unknown, and may be a fertile investigative tract for improved understanding of paranasal sinuses.

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REFERENCES


