Volume 4

Advances in Otolaryngology–Head and Neck Surgery

Myers · Bluestone
Brackmann · Krause

Advances in Otolaryngology—Head and Neck Surgery

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Preface

Volume 4 of *Advances in Otolaryngology–Head and Neck Surgery* contains a variety of good chapters on stimulating and provocative topics which represent true advances in our field. Our Editorial Board, consisting of Drs. Charles Bluestone, Charles Krause and Derald Brackmann, has been extremely enthusiastic and supportive in the efforts to continue the young tradition of excellence in the *Advances*, and they have my sincere thanks. Our Editorial Coordinator, Barbara A. Sigler, R.N., M.N.Ed., has, once again, contributed immensely to the production of Volume 4.

Although we have dealt with functional endonasal surgery of the paranasal sinuses in the past, the opening chapter by Drs. Rande Lazar and Ramzi Younis entitled "Functional Endonasal Sinus Surgery in the Pediatric Age Group" gives us a more sharply focused view of this technique.

The area of otology has been emphasized in this volume, and the excellent chapters on "Otitis Media" by Dr. Charles Bluestone, "Cochlear Implants in Children" by Drs. Karen Berliner, William Luxford, William House, and Lisa Tonokawa, and "The Business of Dispensing Hearing Aids and Assistive Listening Devices" by Dr. Tubergen are all excellent contributions in this area.

Those interested in otology will also find Dr. Mohamed Hamid's chapter entitled "New Tests of Vestibular Function" and Dr. Margareta Møller's chapter entitled "Disabling Positional Vertigo" offering many insights into diagnosis and management of these vexing problems.

The chapter by Drs. Charles Koopmann, Jr. and Charles Krause entitled "Correction of the Cleft Lip Nasal Deformity" offers excellent technical advances in the management of this difficult problem. The chapter entitled "Rigid Internal Fixation for Facial Fractures and Reconstruction" by Drs. Marion Ridley and Douglas Klotch also revisits an old problem of fractures of the facial skeleton and shows us how much has been accomplished by the use of internal fixation with plating in this area. "Interventional Neuroradiology in Head and Neck Surgery" by Drs. Joseph Horton and Robert Tarr again brings new technology to our attention in the diagnosis and management of problems in cranial base surgery, as well as other problems in otolaryngology which have been difficult to manage prior to the introduction of this technique.

Dr. Jerome Klein, who is a specialist in infectious disease, presents a chapter entitled "Recent Advances in Antibacterial Therapy for Pediatric Otolaryngology." In the past we have presented the advances in antimicrobial therapy, but Dr. Klein's chapter focuses us sharply on the use of antimicrobials in the pediatric age group.

We feel that Volume 4 of *Advances in Otolaryngology–Head and Neck Surgery* is of high quality, and we hope that it will be both interesting and enjoyable to our readers.

Eugene N. Myers, M.D.

Contents

Functional Endonasal Sinus Surgery in the Pediatric Age Group

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Sinusitis is commonly seen in pediatrics. It is a dynamic, multifactorial process whose symptoms are variable. Upper respiratory tract infections and allergy are the major predisposing causes of sinusitis. Most patients respond to medical treatment. Surgery is generally indicated when optimal conservative management fails.

Functional endonasal sinus surgery (FESS) using endoscopes can form the mainstay of surgical therapy for pediatric patients with chronic/recurrent sinusitis. It is a surgical approach that can potentially restore the physiologic function of the paranasal sinuses. Although it was only introduced 5 years ago by Kennedy,[1] it is becoming a popular surgical treatment for sinus disease in the United States. Most past reports have addressed its use in the adult population.

In children, we believe that FESS may be a curative and safe procedure. Gross et al.[2] were the first to report on its use in the pediatric age group. They reported their experience with a series of 57 patients.

The diagnosis of sinusitis in children may be difficult. The child is frequently unable to communicate many of the characteristic symptoms of sinusitis. Additionally, radiographic findings may be confusing. Ostensibly normal children may have abnormal findings on plain radiographs.[3]

With the introduction of a wide variety of chemotherapeutic agents and new technologies, our therapeutic choices have become very broad. Accurate diagnosis and appropriate decisions can be made when a thorough understanding of the pathophysiologic mechanism of the disease entity is known.

Development and Anatomy of the Paranasal Sinuses

The paranasal sinuses are among the most poorly described anatomic sites in the human body.[4] This is even more evident in children where the sinuses are small and changes in location and size are almost continuous. The sinuses are also in close proximity to critical structures. Therefore, every surgeon should have an intimate understanding of sinus development and anatomy before attempting any surgical intervention of the sinuses.

The sinuses may be understood by the study of their embryology. Each of the four pairs of sinuses is named after the cranial bones in which they are located. All sinuses contain air and are covered by ciliated pseudostratified columnar epithelium, interspersed with goblet-type mucous cells. The size of the sinuses depends on the age of the individuals.[5] Asymmetry of the sinuses may occur in the same individuals.[5]

The Ethmoid Sinuses

The ethmoids have the greatest variation among the paranasal sinuses.[4] The anterior cells first appear in the third fetal month as pits of the frontal recess.[4, 6] The uncinate process and bulla ethmoidalis can be considered as accessory folds.[4, 6, 7] At birth the ethmoids are fluid filled and are difficult to recognize on routine radiography until approximately 6 months of age. By the age of 12 years, the ethmoids are nearly adult size.[4]

The most constant part of the ethmoid sinus is the lateral wall or the lamina papyracea.[4] This is a paper-thin bone that forms the medial wall of the orbit. The ethmoid roof is formed by the fovea ethmoidalis and extends 2 to 3 mm above the medial cribriform plate.[4] The ethmoid cells are generally divided into the smaller but more numerous anterior cells and the larger posterior cells. The anterior cells can be further subdivided into frontal recess cells, infundibular cells, agger nasi cells, bullar cells, and conchal cells.[8]

The anterior and posterior ethmoids are separated by the grand or basal lamella.[4, 9] Other lamellae or septae help to compartmentalize the ethmoids and may offer a barrier to the spread of infection.[4]

The Maxillary Sinuses

The uncibullous groove[4, 7] gives rise to the maxillary sinus in the third fetal month. At birth, the sinus is filled with fluid, making interpretation of plain film radiography difficult.[10, 11] Between birth and 3 years of age, and between 7 and 12 years, the sinus undergoes rapid growth.[4, 10, 12] Thereafter, modest enlargement occurs. Growth is completed by adulthood.[13] The sinus ostium is located in the superior aspect of the medial wall of the sinus. This then drains into the hiatus semilunaris.[4] Variations in ostial location occur; however, most authors agree that the ostium is usually found posterior to the midpoint of the bulla ethmoidalis.[4, 10, 14, 15] Accessory ostia may be found in 15% to 40% of cases.[4, 12, 14, 15]

The Frontal Sinuses

Several origins of the frontal sinuses have been proposed. Kasper, in his study of 100 adult specimens, found that pits or furrows in the frontal recess that were rudimentary anterior ethmoid cells are the most common origin.[4, 6] Less commonly the frontal sinus is derived from direct extension of the frontal recess.[4, 6] At birth, the sinus is indistinguishable from the anterior ethmoid cells.[4] Usually after the fourth year of life, the frontal sinus begins to vertically invade the frontal bone. It can usually be demonstrated radiographically after 6 years of age. Growth is generally completed before the age of 20 years.[4, 13]

The Sphenoid Sinuses

The sphenoid sinus is primarily an evagination of the sphenoethmoid recess with essentially no growth until the age of 3 years.[4] By the age of 7 years, it extends posteriorly towards the sella turcica. Variations in the size are accounted for by possible arrests in development.[4] The sinus is in close proximity to crucial structures such as the internal carotid artery, optic nerve, pituitary gland, and vidian nerve, among others.[13, 16, 17] The close relationship to critical structures makes surgery in the sphenoids potentially hazardous. This sinus usually drains by a single ostium into the sphenoethmoid recess.[4] The ostium is located 10 to 15 mm from the floor of the sinus; hence, drainage depends on mucociliary flow.[4, 16]

Pathophysiology of Sinusitis

The paranasal sinuses were first described 1,800 years ago[5]; however, their exact function is not well understood. Many theories have been proposed, but none of them have met with wide acceptance. Among these theories are that the sinuses humidify and warm inspired air, impart resonance to the voice, and act as a shock absorber during head trauma, among others.[5] No matter what the functional significance of the sinuses are, their physiologic function can be maintained by adequate flow of their secretions. This is achieved by patent ostia and sufficient mucociliary function. Any incident interfering with one or both functions may lead to sinusitis.

Sinusitis is an inflammatory process of the mucosal lining of the sinuses. This process can result in thickening and engorgement of the subepithelium of the sinonasal mucosa with capillary dilation and acute inflammatory exudate. The resulting edema will lead to ostial obstruction, pooling of sinus secretions, and secondary bacterial infection. On the other hand, ostial obstruction or the pooling of secretions might be the primary event leading to sinusitis. The causes are multiple and summarized in Table 1.

The single most important pathologic factor in sinus disease is ostiomeatal complex obstruction. The ostiomeatal complex is the region of the middle meatus where the pathway of mucociliary flow converges from the frontal, maxillary, and ethmoid sinuses. It consists of the infundibulum, hiatus semilunaris, frontal recess, uncinate process, anterior ethmoid bulla (bulla ethmoidalis), and the anterior wall of the middle turbinate (Fig 1). Multiple causes may lead to ostiomeatal complex obstruction. Any cause

TABLE 1.
Etiologic Factors in Pediatric Sinusitis

Inflammatory
Upper respiratory tract infection
Allergy
Mechanical
Nasal/septal deformity
Ostiomeatal complex obstruction
Turbinate hypertrophy
Polyps
Tumors
Adenoid hypertrophy
Foreign bodies
Cleft palate
Choanal atresia/posterior stenosis
Systemic
Cystic fibrosis
Immotile cilia syndrome/Kartagener's syndrome
Immunodeficiency
Cyanotic congenital heart disease
Miscellaneous
Diving, swimming

shown in Table 1 may be a causative factor in ostiomeatal complex obstruction (Fig 2).

Viral upper respiratory tract infections and allergic inflammatory diseases are the most common causes of acute sinusitis in the pediatric age group. However, patent sinus ostia were estimated to be found in 20% of children with acute rhinitis.[18] Allergy also appears to play a significant role in sinusitis. Almost 50% of our 210 pediatric FESS patients had positive testing for allergy.

The mucociliary transport system forms a defense mechanism. This is achieved through the function of ciliary beating, mucous blanket, lysozymes, secretory IgA, and many other surface active enzymes. Conditions such as cystic fibrosis or immotile cilia syndrome may compromise mucociliary function leading to sinusitis. Even a common cold may disturb the mucociliary transport system.

A critical factor that can produce chronic or recurrent sinusitis is mechanical obstruction of the ostia. In contrast to an inflammatory process, which is usually reversible medically, mechanical obstruction is relieved only by surgically removing the obstructing object.

Ostiomeatal complex (OMC) obstruction and ethmoid disease are the