Techniques for Dilation of Eustachian Tubes

Vijay K. Anand, MD, Clinical Professor, Department of Otolaryngology-Head and Neck Surgery, Weill Cornell Medical College, Cornell University; Director, Post Graduate Fellowship in Rhinology and Sinus Surgery, New York Presbyterian Hospital/Weill Cornell Medical Center; New York, NY

History: inflation of balloon in ear first described between 1665 and 1673; early interventions carried out blindly; bougie dilation once used to stimulate circulation to peripheral nerves of eustachian tube (ET); catheterization developed in 18th and 19th centuries; myringotomy for disorders of ET introduced in 1950s and adopted more widely in early 2000s; some unusual treatment approaches used in past; in 1955, catgut strung through ET and pulled out through nose while Gigli saw used to open ET; in another technique, bougie placed through nasopharynx into ET and radium seeds introduced

Management: 12% of population has disorder of ET; treatment usually medical therapy and polterization or Valsalva maneuver; steroids often used for 4 to 6 wk or longer; ET manometry recently introduced

Anatomy: isthmus of tube oblique, not vertical; carotid artery courses through petrous apex of temporal bone; opening of tube elliptical, but tube becomes circular in region of isthmus and oblong in bony compartment; dilation of tube based on muscular movement of tensor veli palatini and levator veli palatini; levator veli palatini produces vertical elevation of ET; levator veli palatini causes horizontal dilatation of tube

Manometry: in first 2 patients treated by speaker, computed tomography (CT) performed to confirm that bony canal surrounded carotid artery; manometry used to assess movement of tympanic membrane (TM); electrode placed in mastoid; patient asked to drink water while mouth and lips tightly closed; 2 olive-tip cannulas used to measure movement of air during swallowing; however, signals random and nonrepeatable

Evaluating outcomes: 7-item Eustachian Tube Dysfunction Questionnaire (ETDQ-7) validated; content validity studied in light of review of items on instrument; qualitative scoring system developed; questions reflected proposed indications for surgery; initial 5-item questionnaire tested on focus groups; questions assessed for reliability of recall using measures of discriminant validity and internal consistency; low Cronbach alpha indicates valid questionnaire; 7 questions ultimately selected; on ETDQ-7, mean score ≥2.1 indicates disease or failure of treatment; score <2.1 indicates cure

Surgery: minor procedures may be performed under general or local anesthesia; 4 to 6 wk required for recovery; prospective study of consecutive patients conducted to assess value of balloononing of ET; responses on ETDQ-7 correlated with Sino-Nasal Outcome Test (SNOT-22); preoperative evaluation — patients underwent tympanography, otoscopy, nasal endoscopy, CT of sinuses, and audiography; surgery — included balloon dilatation, partial turbinectomy, and in some cases submucous dissection with treatment of nasal septum and endoscopic sinus surgery; 3 wk after surgery, questionnaire completed again and nasal endoscopy and tympanography performed; patients examined at 12 wk and at 6 and 12 mo; some patients followed for up to 4 yr; population — surgical population included patients referred to tertiary center in whom 2 mo of maximal medical therapy had failed; study excluded patients undergoing head and neck surgery or radiation, and those with acute infection of upper respiratory tract, hypertrophy of adenoids, cleft palate, craniofacial syndrome, and immunodeficiency; intervention — ambulatory surgery performed under general anesthesia with off-label use of balloon; dilatation performed with 6 by 16 mm or 7 by 24 mm balloon at 12 bars for 2 min; only cartilaginous portion of tube dilated; submucosal resection (SMR) — inferior turbinate performed with SMR; if SMR not performed, torrential flow of air with turbulence produces negative pressure and eddy currents at outlet of tube and retraction of TM; laminar flow of air permits neutral condition and ventilation of middle ear; turbinate for patients with obstruction of ET; anatomic pearls — Otozinn fat pad enlarges during pregnancy, which may result in symptoms of patulous ET after pregnancy; except in children <12 yr of age, course of ET oblique or sinusoidal, not horizontal; surgeon should retract posterior cushion to look for prominent mucosal blood vessels before performing dilatation; dilatation — F70 cannula used to push posterior cushion outward; next, guidewire with light introduced; ear canal then examined with otoscope or endoscope to see light reflex from ET in anterior, superior quadrant of TM to confirm that light in lumen of ET; catheter threaded over guidewire to isthmus; wire removed and dilatation completed; procedure must be performed carefully to avoid tearing mucosal surface; histologic studies show that balloon produces microtare in tube and expresses mucosal edema

Outcomes, follow-up, and adverse events: 35 cases performed in 22 adults (mean age 55 yr); median follow-up during initial study 10 mo; ETDQ-7 improved (fell) at 3 wk, rose slightly at 6 and 12 wk, and fell again at 6 mo; long-term results excellent; responses on ETDQ-7 mirrored those on SNOT-22, suggesting that disease of ET correlated with rhinologic

Educational Objectives

The goals of this program are to improve diagnosis and treatment of disorders of the eustachian tube (ET) and pediatric sinusitis. After hearing and assimilating this program, the clinician will be better able to:

1. Describe the development and interpretation of the Eustachian Tube Dysfunction Questionnaire.
2. Illustrate the proper technique for performing dilation of the ET.
4. Act as a resource for pediatricians in the community regarding infectious etiologies of sinusitis.
5. Manage a child with recurrent bacterial sinusitis.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, members of the faculty and planning committee reported nothing to disclose. In his lecture, Dr. Anand presents information related to the off-label or investigational use of a therapy, product, or device. In his lecture, Dr. Cable presents information related to the off-label or investigational use of a therapy, product, or device.
Pathology: one patient with tympanosclerosis not improved; another patient had persistent retraction; other 33 patients had good outcomes; ballooning causes microscopic hemorrhages, alters fibrous cartilage, removes mucosal edema, and may release paracrine mediators; conclusions — balloon dilatation effective and ETQD-7 valuable; follow-up — 90 procedures performed in 51 patients; group had ETQD-7 scores of 4.8 at baseline and 3.3 to 3.4 postoperatively; ETQD-7 score mirrors symptomatic improvement; adverse events — in one patient with unilateral, patulous ET, loss and gain of weight may have contributed to problem; one patient had posterior epistaxis with hemotympanum but successful dilatation; one patient in whom dilatation failed had chronic otitis media necessitating tympanomastoidectomy, and ET procedure failed; one patient had synchiae that required dilatation; long-term follow-up — improvement in symptoms stable over 36 mo.

Medical treatment: in addition to steroid spray, ipratropium (Atrovent) spray may be used in concentration of 0.3%, progressing to 0.6%; topical antihistamines also helpful; mucolytic agents such as guaifenesin (eg, MucaPlex, Mucinex, Q-Tussin) may be effective; ipratropium may reduce secretion of paracrine mediators; ipratropium blocks neuromuscular motor endplate and production of mucus.

Questions and Answers

Avoiding sphenopalatine artery: artery unlikely to complicate operation on posterior part of inferior turbinate; artery in sphenopalatine foramen between anterior and posterior vertical processes of palate bone; however, branch occasionally found in inferior turbinate; although branches of sphenopalatine unlikely to be encountered, oozing common in this area because of mulberry hypertrophy.

Injury to carotid artery: axial CT scan should be examined carefully to determine whether carotid canal completely surrounded by bone; patients with questionable anatomy should not undergo dilatation; if injury occurs, surgeon may need to compress carotid artery bilaterally and should immediately perform angiography and insert coil.

Reduction of size of posterior turbinate: Medtronic tissue shaver used for this purpose; suction cautery used to treat oozing; crust resolves as area reepithelializes and should not be removed.

Venue: surgery performed in operating room within office with facilities for general anesthesia; however, most patients in studies treated in hospital.

Balloon sizes: patients with large or acromegalic face need larger balloon sizes.

Billing: dilatation in clinic not covered by procedural code.

Pediatric Sinusitis: The Stair-step Approach

Benjamin B. Cable, MD, Chief, Otolaryngology-Head and Neck Surgery Department, Tripler Army Medical Center, Honolulu, HI

Key points: essential to manage expectations of parents; bacteria not most important issue.

Case: 5-yr-old presented with 7 episodes of rhinorrhea in 1 yr; most schools now require children with colored nasal discharge to be sent home; episodes began with fever and malaice, followed by 1 wk of nasal discharge; each episode required visit to primary care provider, resulting in prescription for amoxycillin or amoxicillin/clavulanate (Augmentin); children with this history often on cetirizine (Zyrtec), fluticasone (Flonase), montelukast (Singulair), and inhalers; assessment — average child contracts 6 to 9 viruses/yr, especially children in day care; viruses last 6 to 9 days on average and usually begin with fever; although parent expects prescription for antibiotic, color of mucus does not indicate whether patient has viral or bacterial infection; in such cases, task of otolaryngologist to stop medications and reassure parent; although some children with mucopus discharge from nose no longer contagious, they still may not be permitted to attend school or day care.

Diagnosis: difficult to distinguish between viral and bacterial infections in children; longer duration of illness only factor reliably associated with bacterial infection; viral infection results in edema, creating conditions for bacterial infection; persistent mucopus lasting >10 days more likely to be bacterial infection and should be treated; other signs that may indicate acute bacterial sinusitis include severe illness (defined as fever >102.2°F for >3 days), fever for >48 hr, and biphasic symptoms (second fever and increased mucus at 4 to 5 days).

Management: bacteria — treatment of acute bacterial sinusitis should be customized based on local flora; amoxicillin recommended by American Academy of Pediatrics; causative organisms Streptococcus pneumoniae, Haemophilus influenzae, and Moraxella catarrhalis; pneumococcal conjugate vaccines initially decreased incidence of infection with S pneumoniae, but infections returned as serotypes changed; common distribution of causative organisms in many locations 30% S pneumoniae, 20% H influenzae, and 20% M catarrhalis; resistance to penicillin — higher dose of penicillin effective for treating resistant S pneumoniae because resistance of organism related to binding affinity of penicillin; high-dose amoxicillin dosed at 90 mg/kg instead of 40 mg/kg; however, rates of resistance vary; for example, resistance to S pneumoniae found in 15% of patients in general, but >47% in Hawaii; otolaryngologist should learn local resistance rates and offer guidance to pediatricians; H influenzae and M catarrhalis produce β-lactamase; infections by these organisms may be treated with addition of clavulanic acid or using cephalosporin; in most areas, H influenzae and M catarrhalis have high rates of resistance to penicillin; if bacterial infection suspected in region of high resistance to penicillin, high-dose amoxicillin and clavulanate both required; extra-strength amoxicillin/clavulanate supplied as 600 mg amoxicillin in 5 mL; this formulation contains less clavulanate than others and therefore produces less diarrhea; dose 80 to 90 mg/kg; allergy to penicillin — cross-reactivity with cephalosporin quoted as 1% but may be 0.1%; if rash only allergic response to penicillin, cephalosporin may be used safely; for patients with history of true anaphylaxis, cephalosporin may be given after skin testing performed by allergist; azithromycin (Zithromax) and trimethoprim/sulfamethoxazole (Bactrim) no longer effective antibiotics; duration of therapy — optimal duration unknown; 7 to 10 days of therapy may be given; child who does not respond in 48 to 72 hr should be reassessed; in such cases, other options ceftriaxone, clindamycin, or of-label levofloxacin or moxifloxacin; Achilles tendinitis rare in children and reversible; rinazolin (protein inhibitor) has good gram positive coverage but expensive.

Imaging: CT overused; patients <20 yr of age at greater risk from radiation than adults; children <10 yr of age 5 times more sensitive to radiation than 20-yr-olds; radiation exposure from 3 CTs of head equivalent to that experienced by individuals 2000 to 3000 yards from atomic blast in Hiroshima, in whom increased risk for cancers demonstrated; CT inadvisable in children unless complication suspected.

Management: principles — after appropriate diagnosis discussed, role of bacteria should be explained to family and stair-step approach to management should be adopted; role of edema — most children carry organisms responsible for bacterial sinusitis; however, organisms not pathologic until edema present; causes of edema include viruses and allergy; first step — radical-largosorbent testing (RAST) simple to perform, useful, and inexpensive; RAST provides practical information for parents; for example, in child allergic to dust mites, pillowcases and mattress covers may be discussed, but if no allergy to dust mites, household routines need not be altered; second step — to broaden evaluation; other basic allergic disorders tested in first step along with RAST; in second step, immune function assessed; true immunologic disorders uncommon in children but subtle problems may be found by checking immunoglobulins including IgA, IgG, and...
IgG subclasses; computerized assessment may be incorrect if not based on norms for children; normal levels of immunoglobulins in children differ from those in adults; *third step*—rule out cystic fibrosis; sweat chloride should be performed on initial screen, especially in children with chronic disease or lower respiratory tract; most children with allergies may be successfully treated; *fourth step*—40% of those who do not respond have biopsy-positive reflux; pH probe or biopsy not necessary, but empiric trial of proton pump inhibitor reasonable; when proceeding through steps of evaluation, medications should be changed one at a time; children on proton pump inhibitors treated with 15 mg/kg, up to adult dose; most studies based on cisapride; *fifth step*—adolescent, irrespective of size of glands; 50% to 80% of children with acute or chronic sinusitis improve significantly after adenoidectomy, allowing fewer children to be treated with functional endoscopic sinus surgery (FESS); *final step*—FESS; balloons used to manage maxillary sinuses; washing sinuses and limited FESS appropriate; success rates of FESS as high in children as in adults, and complication rates low; limited FESS typically includes ethmoid-to-maxillary antrostomy

**Complications:** most common complication subperiosteal abscess; 90% of complications in children with sinusitis occur in orbit; Lynch incision no longer used because it often causes visible scarring; rather than making cut on face, surgery with CT guidance used; anterior ethmoidectomy quick to perform; with stealth guidance, probe may be placed and pus removed easily using sickle knife; family should be counseled that need for incision may arise

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**Suggested Reading**

EUSTACHIAN TUBE SURGERY/PEDIATRIC SINUSITIS

1. The primary reason for performing computed tomography (CT) before manometry or ballooning of the eustachian tube (ET) is to:
   (A) Assess the course of the ET  
   (B) Confirm a bony canal around the carotid artery  
   (C) Look for disease of the nasal sinuses  
   (D) Look for hypertrophy of the adenoids

2. In a patient with dysfunction of the ET, a postoperative score of 2.0 on the Eustachian Tube Dysfunction Questionnaire (ETDQ-7) suggests that the patient has been cured.
   (A) True  
   (B) False

3. In patients with disease of the ET, the main reason for using submucosal resection when performing inferior turbinectomy is to:
   (A) Promote laminar flow of air  
   (B) Decrease bleeding  
   (C) Decrease crusting  
   (D) Reduce the size of the turbinate

4. When performing dilatation of the ET, how should the surgeon confirm placement of the guidewire in the ET?
   (A) Use CT guidance  
   (B) Feel the obstruction when the catheter reaches the isthmus  
   (C) Use an otoscope to examine the tympanic membrane  
   (D) Confirming placement is not necessary

5. In a study to assess dilatation of the ET and the ETDQ-7, which of the following findings was interpreted as showing that rhinologic disease is associated with disease of the ET?
   (A) Histologic studies of previously treated ETs  
   (B) Release of paracrine mediators during dilatation  
   (C) Adverse events of posterior epistaxis  
   (D) Correlation of scores on the ETDQ-7 with those on the Sino-Nasal Outcome Test

6. Which of the following signs suggests bacterial infection in a child with symptoms of sinusitis?
   (A) Green color to mucopus  
   (B) Drainage of mucopus for >5 days  
   (C) Fever of >102.2°F for >3 days  
   (D) Increase in mucus discharge at 48 hr

7. Which of the following organisms is the most frequent cause of pediatric bacterial sinusitis?
   (A) Streptococcus pneumoniae  
   (B) Haemophilus influenzae  
   (C) Moraxella catarrhalis

8. A child with a history of rash associated with penicillin has bacterial sinusitis. Which of the following is the appropriate treatment?
   (A) Levofloxacin  
   (B) Azithromycin  
   (C) Cephalosporin without skin testing  
   (D) Cephalosporin only if skin testing negative

9. In children with recurrent bacterial sinusitis, which of the following interventions should be performed first?
   (A) Adenoidectomy  
   (B) Radioallergosorbent testing  
   (C) Trial of proton pump inhibitor  
   (D) Assessment of immunoglobulins

10. Which of the following is the most common complication of bacterial sinusitis in children?
    (A) Scarring  
    (B) Lower respiratory tract disease  
    (C) Subperiosteal abscess

Answers to Audio Digest Otolaryngology Volume 48, Issue 14: 1-D, 2-B, 3-B, 4-C, 5-D, 6-A, 7-D, 8-C, 9-A, 10-C

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