In an era of minimally invasive surgery, new surgical methods must be developed to achieve desired clinical outcomes with decreased long-term functional morbidity. Transoral robot-assisted surgery (TORS) is one such advancement. Although in its infancy, it has shown great promise and results in carefully selected patients. As refinements continue, TORS will likely have a significant impact on the future management of surgical diseases of the head and neck.

The Section of Head & Neck Surgery at Cleveland Clinic Head & Neck Institute recognizes the future significance of robotic surgery, having been involved in the initial development and application of this technique in the first robot-assisted supraglottic laryngectomy, performed in 2007. In accordance with the institute’s goals and objectives, the Transoral Robotic Surgery Program got under way in November 2010. The focus of practice has been on the management of benign and malignant diseases of the oropharynx, larynx and the parapharyngeal space.

An institutional review board-approved prospective database has been established to gather information regarding patient demographics, tumor characteristics, treatments, prognosis and functional outcomes. Evaluation of this technique in the management of head and neck cancers will help define guidelines for the treatment of select cancers, particularly those of the oropharynx and larynx.

The Role of TORS in Head and Neck Cancers

Overall survival rates for head and neck cancers have not changed significantly over the last 50 years. However, disease factors, most notably HPV-induced oropharyngeal cancer, as well as treatment protocols have changed and may have an impact on survival rates. The introduction of organ preservation protocols shows increasing concern for functional preservation. Transoral laser microsurgical procedures have shown comparable survival rates to nonsurgical organ preservation protocols, and have demonstrated better long-term functional outcomes.

There are, however, certain procedural limitations to laser microsurgery. TORS has attempted to overcome these difficulties with better optics, utilizing 3-D telescopes to visualize the area.
From the Chairman

Dear Colleague:

Welcome to the 2011 edition of our annual newsletter, Advances in Otolaryngology & Dentistry. Another year of growth and progress is coming to a close, and I am pleased to share a few of the many successes and innovations being driven by our multidisciplinary team.

Cleveland Clinic realized long ago that the future of surgery would be highly precise and minimally invasive. The Head & Neck Institute remains a leader in this area, offering the latest advancement, transoral robot-assisted surgery (TORS) to carefully selected patients with head and neck cancers. Thus far, patients treated with TORS are experiencing improved long-term functional outcomes.

Our hearing implant program has expanded significantly as well, keeping us at the leading edge of cochlear implant technology and hearing rehabilitation for patients ranging in age from infancy to old age.

We are also providing more effective options for treating single-sided deafness with SoundBite and TransEar devices. This new generation of bone-conduction technology represents a strong advance in nonsurgical treatment when applied along with thorough patient assessment and post-fitting counseling.

Also in this issue, Claudio Milstein, PhD, explains his multimodal treatment for functional dysphonia, a difficult-to-diagnose condition that deeply impacts patient quality of life, and Joseph Krajekian, DMD, MD, outlines surgical options for temporomandibular joint dysfunction.

Finally, the Head & Neck Institute's high volume of laryngotracheal stenosis patients, many of whom are also patients of the Cleveland Clinic's world-renowned vasculitis program, allowed us to collect and analyze a great deal of data about treatment options through the largest study of its kind.

These are only a few of the milestones in research, technology, safety and quality patient care that are core to the mission of the Head & Neck Institute. I hope you will enjoy this issue of Advances in Otolaryngology & Dentistry.

Michael S. Benninger, MD
Chairman
Cleveland Clinic Head & Neck Institute
of dissection, flexibility of the arms to manipulate tissue and overcome the line-of-sight limitation of a laser coupled to a microscope, and tremor control mechanisms for precise movements.

The current system consists of a surgeon’s console that incorporates two hand controls (EndoWrist® technology) and a 3-D video projection. The robot, which has two surgical arms and a video endoscope, is stationed next to the patient. A variety of mouth gags are available and used to gain access to the surgical site. The robotic arms permit use of a full range of articulated instruments. The system tracks the surgeon's hand movements and filters out the tremor, reproducing fine surgical maneuvers. The EndoWrist allows a large range of motion and rotation that follows the natural articulation of the human wrist; particularly advantageous in the narrow confines of the oropharynx and hypopharynx. While the primary surgeon controls the robotic instruments and camera, an assistant is responsible for changing and adjusting instruments, retracting, suctioning, and aiding in hemostasis.

Limitations in mouth opening, presence of maxillary dentition, an enlarged tongue and mandible considerations may limit the movements of the robot. The other significant limitation is the lack of tactile feedback and appreciation that requires visual cues to overcome. Overall, this system allows better access, clearer visual input and increased flexibility of movements of the instruments and the tissue.

The majority of oropharyngeal cancer patients present with cancers caused by the human papilloma virus (HPV). Because of the implication of HPV in the etiology of head and neck cancers, the sensitivity to radiation therapy and the improved outcomes compared to cancers related to smoking and alcohol abuse, the debate of de-escalating treatment strategies for HPV-positive tumors is of great clinical significance and demands thoughtful study. The ability to resect these primary tumors with TORS rather than by conventional, more morbid approaches may be quite appealing for select patients, and may allow for a de-intensification of postoperative radiation or chemoradiation; hence limiting the toxic effects that can impair long-term functional outcomes.

We are extremely excited about this venture, and hope to continue to provide state-of-the-art service with the highest standards of care to our patients. We believe it will be an important option in the treatment armamentarium of head and neck surgeons.

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**Case Study: Transoral Resection**

Mrs. J. is a 46-year-old patient with a long history of tobacco use but no history of significant medical comorbidities. She presented with otalgia and a supraglottic mass to her local otolaryngologist before referral to the Cleveland Clinic. Upon presentation, she was found to have a lesion centered on the laryngeal epiglottis with extension to the left aryepiglottic fold (Figure 1); it was biopsied and found to be squamous cell carcinoma. Although no cervical lymph nodes were palpable on exam, radiologic imaging with PET/CT was interpreted as being consistent with bilateral level 2 and 3 regional metastases. She was thus clinically staged as a cT2N2CMO, stage 4 supraglottic laryngeal cancer patient. After discussion at the multidisciplinary tumor board and independent, pretreatment evaluation by the head and neck radiation oncology and medical oncology services, the patient elected to undergo a transoral robotic supraglottic laryngectomy (Figure 2) and bilateral neck dissections instead of radiation or chemoradiation options for nonsurgical management. Her final pathologic status indicated that her margins were negative around the primary tumor, and both necks were devoid of disease. She was thus pathologically staged as a pT2NOMO, stage 2 supraglottic laryngeal cancer patient—a significant downstaging from her clinical presentation stage. Her perioperative course was uncomplicated without the need for a tracheotomy, and she was taking a clear diet on postoperative day 1 with advancement to a soft diet by post-operative day two. The implications for the patient’s overall treatment were enormous in that she did not receive a recommendation for further intensification and avoided the long-term morbidity from nonsurgical treatment. She healed quite well (Figure 3) and will continue to have close oncologic surveillance.
Functional dysphonia (FD), sometimes known as vocal hyperfunction or muscle tension dysphonia, is a term used to describe a voice problem in the absence of anatomical abnormalities or vocal fold pathology.

Patients that present with this disorder show an imbalance in tension of the muscles that control voice production. The condition can include either excessive or insufficient contraction of the intrinsic and extrinsic (strap) laryngeal muscles and other accessory voicing muscles in the neck, shoulders and back. The muscle tension imbalance disrupts the delicate coordination between the structures that regulate the production of voice and breathing, resulting in impaired vocal fold vibration, impaired glottic closure and hoarseness.

Associated symptoms may vary greatly. Voices may sound raspy, gravelly and harsh, or weak and breathy. The voice may be strained and forced, give out, cut off, become too low or too high, get very tired, fade away with use or become a whisper. Patients may also experience throat irritation, soreness or pain when talking, tightness, a sensation of a lump in the throat, increased mucus and frequent throat clearing. This condition may affect the ability to communicate effectively. Patients often have difficulty being understood in noisy environments, talking on the phone, and often have to repeat what they say. Simply talking is a tremendous effort and causes fatigue. It can even result in loss of income due to an inability to work, social withdrawal and depression. This is not a psychogenic condition, although some patients have increased stress and anxiety from struggling with voice loss.

FD’s chameleon-like resemblance to a number of conditions can make it difficult to diagnose. Endoscopic findings vary greatly and can be deceptive. FD can mimic other disorders as the laryngeal behavior can present as either hypertonic or hypotonic, but it does not respond to conventional voice therapies. FD can appear to be neurologically-based, resembling conditions like spasmodic dysphonia or vocal fold paresis. The American Academy of Otolaryngology recognized that there was a need to improve diagnostic accuracy for hoarseness and reported that on average, it takes about three months to correctly diagnose patients that present with hoarseness of any etiology. In our experience, patients with FD take longer, an average of five months, with about one-third of patients going one year or longer from onset to correct diagnosis.

Elevated laryngeal musculoskeletal tension is a contributing factor for the development and maintenance of FD, and is an important diagnostic sign. Several muscles can be affected, including the trapezius, splenius capitis, sternocleidomastoid, periharyngeal and intrinsic laryngeal muscles. The jaw and tongue muscles are often involved as well. Hyperfunction can manifest as a chronically contracted state or as aberrant contractions that occur only during vocalization. The cramping and stiffness of these muscles causes an imbalance of muscle tension in the vocal mechanism, pulling the larynx upward or downward and results in a maladaptive posture that affects vocal fold vibratory patterns and voice production.
Once FD is identified, the treatment of choice is specialized voice therapy performed by a speech pathologist with expertise in voice disorders. In general, FD does not respond to conventional voice therapies. Multimodal treatment includes, among others, digital laryngeal manipulation. This technique involves:

- Manual lengthening and stretching of the cervical spine region, and strap, upper trapezius and sternocleidomastoid muscles
- Lateral displacement of the larynx to improve joint mobility
- Exertion of downward pressure on the thyroid cartilage to increase the thyrohyoid space

Manipulation of the head, shoulders, neck and spine is also performed as part of this specialized treatment. The goal is to restore the natural resting position of the larynx in the neck and reduce overall muscle tension and vocal hyperfunction. Once these biomechanical changes take place, voices rapidly return to normal. Immediately following treatment, patients report complete resolution of hoarseness, a significant decrease in vocal effort and resolution of associated symptoms such as throat tightness, effort, fatigue, and headaches.

Dr. Claudio Milstein, PhD, a speech scientist at Cleveland Clinic Head & Neck Institute, has developed a multimodal treatment for FD that results in a 95 percent cure rate. Ninety percent of patients require only one intervention, and the remaining patients may require additional treatment sessions. Patients resume normal activities right away and report a significant improvement in quality of life. Once cured, the condition rarely recurs.

Digital laryngeal manipulation appears to be most effective when employed in conjunction with other modalities, such as vegetative voicing tasks and distracting techniques to prevent maladaptive muscle posturing. With this complete approach to treatment, most patients receive prompt and permanent relief from the exhaustion, stress and discomfort that accompany functional dysphonia.

**REFERENCE:**

Early Identification and Intervention in Childhood Hearing Loss: An Interdisciplinary Approach for Successful Outcomes

Sarah Sydlowski, AuD, PhD, Lea Georgantas, AuD and Donald M. Goldberg, PhD

The diagnosis of hearing loss in an infant can be devastating for a family. However, early hearing detection and intervention (EHDI) can make a world of difference in a child’s life.

In 2007, the Joint Committee on Infant Hearing (JCIH) outlined the following benchmarks to help children with hearing loss realize their greatest potential: hearing screening by one month of age; audiologic and medical evaluations to confirm hearing loss by three months of age; and intervention services before six months of age. In the last ten years, these EHDI benchmarks have revolutionized the world of pediatric audiology.

In conjunction with JCIH guidelines, Cleveland Clinic’s Audiology Program takes an assertive, interdisciplinary approach to the early identification and thorough management of children with hearing loss. This clinical collaboration routinely results in successful outcomes. Through orchestration of various clinical programs, including audiology, auditory-verbal therapy and medical management by a pediatric ENT and/or otologist, even children identified with profound hearing loss may ultimately be on par with their hearing peers by a very early age.

In Cleveland Clinic’s system, children who fail their Universal Newborn Hearing Screening (UNHS) are referred for comprehensive, un sedated audiologic evaluation that includes a battery of tests evaluating the status of the outer, middle and inner ear as soon as possible. Children identified with hearing loss are immediately referred to the Pediatric Hearing Management Clinic, a partnership of Cleveland Clinic pediatric otolaryngologists, audiologists, speech-language pathologists and a genetics counselor. Once enrolled, families are shepherded through what can sometimes be an overwhelming intervention process. Children are fitted with hearing aids and monitored closely for appropriate auditory and language development. If progress is not observed as expected, children with severe-to-profound hearing loss may then be referred to the Hearing Implant Program (HIP) as early as three months of age. Children on the implant management track are introduced to the HIP team at this early stage so that their transition from hearing aid users to cochlear implant recipients may be seamless and accomplished as early as possible.

A strong emphasis on listening and spoken language teaching is at the core of our programs. In addition to interdisciplinary Clinic collaboration, audiologists work closely with school professionals and therapists to coordinate continuity of care that makes sense for individual children. From a family’s perspective, this team-centered, integrated approach helps give organization to a process that is unique to each child identified with hearing loss. Centralization of hearing healthcare allows for efficiency and uniquely enables the Cleveland Clinic program to better serve children with complicated medical and audiological histories. The options and opportunities that early intervention provides allow parents to offer their child with hearing loss a rich future. This interdisciplinary approach is supported by research that suggests that earlier, appropriate intervention results in more successful outcomes later in life, including attainment of listening and spoken language abilities at or above the abilities of normal-hearing peers.
Success Story: An Integrated Approach to Hearing Loss

Evan's journey highlights the successful navigation from hearing screening and hearing loss diagnosis to hearing aid trial, auditory-verbal therapy, and, ultimately, cochlear implantation. Evan was identified with profound bilateral hearing loss at two months of age after failing his newborn hearing screening, despite having no risk factors or family history of hearing loss. He returned for hearing aid consultations every one-to-two months for checks of ear mold fit and hearing aid programming. He also worked with an auditory-verbal therapist on a monthly basis.

After several months, Evan's best aided responses continued to fall in the severe hearing loss range, and his ability to detect sounds while wearing his hearing aids at home was variable. Although a consistent hearing aid-wearer with wonderfully engaged parents and family members, observations and test protocols continued to demonstrate extremely limited auditory abilities and significantly limited speech sound and language development. He transitioned into the HIP track and received bilateral cochlear implants.

Following his surgery and initial activation of the speech/sound processors of his CIs (on his first birthday), Evan's communication journey sped up exponentially. Just like a typical, almost-two-year-old with "normal" hearing, he is beginning to spontaneously utter two-word phrases like "Where's Daddy?" and "Bye-bye, boat." No auditory-verbal therapy session ends without Evan breaking into his favorite song, "Wheels on the Bus." The sky is truly the limit for this youngster and his very proud family. At just two years of age, Evan is realizing the benefits of an integrated team approach to early childhood hearing loss.
Providing Contemporary Hearing Assistive Technology for Patients with Single-Sided Deafness: New and Improved Tools

Craig W. Newman, Ph. D. Sharon A. Sandridge, Ph. D.

The loss of the binaural advantage for patients with single-sided deafness (SSD) is known to cause activity limitation and participation restriction in everyday communication situations. SSD diminishes patients’ ability to localize sound sources and reduces communication function in noisy and reverberant listening environments. These perceptual difficulties result in a variety of psychosocial consequences including frustration and withdrawal and isolation at home, at work and in social contexts.

In the past, patients with SSD had limited options for improving communication ability and were simply told to adapt by positioning their better-hearing ear more favorably toward the talker. Today, we are able to offer our patients a variety of new and improved audiologic and surgical management options in order to enhance their quality of life. Following medical consultation by an otologist, the audiologist conducts a Hearing Needs Assessment, providing an in-depth explanation and demonstration of the array of unique hearing technology solutions available for patients with SSD.

A mainstay of audiologic management of SSD has been the provision of contralateral routing of signals (CROS) hearing aids. Recent advances in miniaturization, signal processing and wireless technology have resulted in greater acceptance of this audiologic treatment. As shown, the CROS transmitter worn on the unaidable ear has been greatly reduced in size and is virtually invisible when worn behind the ear. When coupled with a matching receiver instrument worn on the hearing ear, the system offers a discreet choice for the patient.

Bone-anchored auditory implants provide a surgical option for patients with SSD. In our Audiology Research Laboratory, we have demonstrated the longitudinal benefits of and satisfaction with bone-anchored systems, providing evidence-based support for its application with our patients. Our research data have shown, however, that it is critical for the audiologist and otologist to encourage initial realistic expectations and provide ongoing counseling in the management of patients with bone-anchored technology. Clinically, the latest generation of bone-anchored implant sound processors allow for programming by the audiologist, thereby providing greater control over the amplified signal in comparison to earlier-generation sound processors.

The TransEar® bone-conduction device is an alternative nonsurgical option for patients who are unable (e.g., potential osseointegration difficulties) or unwilling to proceed with bone-anchored auditory implantation. This technology employs the use of a small bone-conduction transducer housed in a deeply-fitted earmold that makes contact with the bony portion of the external auditory meatus. Similar to the bone-anchored implant, the oscillator placed in the nonfunctioning ear provides transcranial stimulation to the opposite cochlea. Using the Speech
Perception in Noise (SPIN) test as an outcome verification measure in the clinical setting, we have been able to demonstrate improvement in speech understanding when the primary signal (i.e., high- and low-predictability sentences) directed toward the deaf ear is spatially separated from background noise (i.e., multi-talker babble) directed toward the normal-hearing ear.

The most recent addition to our clinical toolbox is the SoundBite™ hearing system. As shown, this option employs two components including: 1) a behind-the-ear (BTE) microphone unit worn on the impaired ear; and 2) a removable, custom-made, in-the-mouth (ITM) bone-conduction device, fitted around the upper left or right molars. The BTE uses a wireless chip to transmit the signal to the ITM unit. Similar in concept to the bone-anchored auditory implant and TransEar, SoundBite transmits the bone-conducted signal to the normally functioning cochlea. The multidisciplinary team in our Head & Neck Institute, comprised of otology, audiology, and dentistry, provides the optimal clinical setting for offering this new technology. SoundBite was ranked number one on Cleveland Clinic’s list of Top 10 Medical Innovations for 2010.

These technological advancements have expanded our ability to help individuals overcome communication breakdown associated with SSD and greatly improve quality of life, not only for the patient but also for his or her family, friends and/or coworkers. Because each hearing-assistive technology has associated benefits and limitations, it is critical that the hearing healthcare team provides a balanced approach when counseling patients about these SSD treatment options. A number of variables, including patient motivation, expectations, self-efficacy, manual dexterity, cognition, and financial considerations must be assessed before a specific device recommendation is made. Further, on-going, post-fitting counseling must be provided to ensure benefit from and satisfaction with the hearing technology selected. An integration of clinical services offered by our team of otologists, audiologists, and now dentists, coupled with our ongoing research efforts, results in the best possible hearing healthcare for patients with SSD.
The use of surgical navigation in paranasal sinus surgery has become pervasive since the introduction of this technology in the mid-1990s. The ability of image-guidance systems to provide the surgeon with enhanced anatomic localization during endoscopic procedures offers the potential for fewer intraoperative complications and improved clinical outcomes. In a remarkably short time, navigation systems have gone from being a curious novelty to a near-necessity in complex sinus and skull base procedures.

Image-guidance systems provide assistance with real-time intraoperative localization of surgical anatomy and are designed to identify surgical instruments, calculate the location of the instrument tip in relation to the patient and project the instrument location onto a previously-obtained imaging study (usually a CT scan). The surgeon uses this information for intraoperative navigation and preoperative planning using a computer workstation that displays the patient’s images simultaneously in all three anatomic planes: coronal, axial, and sagittal.

Image-guidance systems track surgical instruments in the operative field using either electromagnetic- or optical-based technologies. Optical-based systems use infrared light and a camera located in a boom positioned above the patient’s head to track the headset and instruments which are affixed with reflective spheres. These sphere arrays may be attached and calibrated to any rigid surgical instrument, enabling the surgeon to navigate with the instrument of his choice. Infrared light reflects off the spheres back to the system’s camera, providing a wireless mechanism for localization but requiring a clear sightline between tracking device and instruments at all times. Electromagnetic systems track through a radiofrequency transmitter in the headset and a receiver positioned within instruments. The headset and instruments are attached via wires to the system, eliminating sightline issues, however, the instruments available for tracking are more limited. Although each has its advantages and disadvantages, both platforms have been shown to be accurate to within 2mm and work very similarly in the clinical setting.

Components of Surgical Navigation Systems

Navigation systems consist of a computer workstation with registration/calibration software, imaging data, video display, tracking system and surgical instrumentation. Navigation can proceed with CT images (for sinus procedures), MR images (common for intracranial approaches) or a combination of these two datasets superimposed. Although the CT scan is an unchanging preoperative image, the movement of the instrument tip is shown as crosshairs on the image in real time. The sinonasal cavities are an ideal environment for the application of image-guidance technology since the bony borders of the sinonasal tract provide a constant framework that resists extensive shift of tissues and loss of accuracy; a major issue in the application of the technology for soft tissue navigation. Moreover, several of these borders are “fixed boundaries” that are not altered during the course of surgery, such as the lamina papyracea, skull base, and sphenoid face. For this reason, the fact that navigation systems do not reflect intraoperative changes in anatomy is not a major concern for the large majority of sinus procedures. For some approaches extending beyond the paranasal sinuses, however, navigating with “old” imaging data can be a significant limitation.

Recent Advances in Surgical Navigation

Navigation technology continues to evolve rapidly, and current systems are smaller, more powerful, cheaper and much more user-friendly than previous units. Until recently, the use of navigation to assist with externally approached techniques (such as osteoplastic frontal approaches) was not possible because conventional headsets covered the forehead. Recent innovations now provide a modified headset, placed away from the forehead and affixed percutaneously to the skull, offering unfettered access to the entire frontal region (see case vignette). Navigation systems now permit a large variety of instruments, including microdebriders, to be tracked conveniently and accurately. The emergence of portable CT scanners also provides an opportunity to update preoperative images during surgery.
Patient Experience: Large Frontal Osteoma

A 38-year-old female with a large frontal osteoma was successfully managed using an osteoplastic flap approach (intraoperative image inset). This technique has a significant rate of intracranial and intraorbital complications due to misdirected osteotomies, traditionally guided by an X-ray template of the frontal sinuses (*). Our surgeons avoided these complications by making precise bony cuts around the frontal perimeter and drilling away the lesion using surgical navigation (pointer seen). Utilizing navigation for this external approach was possible only through the use of a skull fixation array (modified headset).

Cleveland Clinic Head & Neck Institute and Image-Guided Surgery

The Section of Rhinology, Sinus, and Skull Base Surgery at Cleveland Clinic Head & Neck Institute offers state-of-the-art navigation technology and skilled surgeons who are well versed in its application and, perhaps more importantly, its limitations. We routinely utilize the latest navigation systems with both electromagnetic- and optical-based systems in our fleet. Our new navigation systems seamlessly incorporate foreign datasets (CT scans done elsewhere) which frequently minimize radiation exposure to our patients by eliminating the need for repeat CT scans. Cleveland Clinic’s internal network gives surgeons access to patients’ imaging studies at any of our sites, and the images can be transferred directly into navigation systems within our surgical suites almost instantly. This protocol obviates the need for transferring imaging data through CDs or other portable storage devices which can be problematic and cumbersome.

Although the exact role of image guidance in sinus and skull base surgery is not yet completely defined, the use of this technology for complex cases appears to be approaching standard of care. The decision to use navigation in a particular case depends upon disease-related factors as well as surgeon-related factors, including experience and familiarity with the technology. Technology is not a substitute for expertise and experience.
Due to its outstanding success, the Hearing Implant Program (HIP) at Cleveland Clinic Head & Neck Institute has undergone significant expansion in the past year. We now have four cochlear implant (CI) surgeons and four CI audiologists in addition to an already well-established auditory-verbal therapy (AVT) program. This expansion allows us to remain at the forefront of cochlear implant technology as well as deliver the most personalized approach possible to hearing rehabilitation.

**Bilateral Hearing with Cochlear Implants**

A cochlear implant is a new beginning. Many patients report that they feel reconnected with the world around them. Few, however, realize that hearing can improve with bilateral cochlear implants or bimodal hearing (cochlear implant and hearing aid in opposite ears). Binaural hearing has long been recognized as the best possible hearing condition, and now that concept has been expanded to cochlear implantation. There is now a substantial body of evidence that demonstrates the benefits of bilateral and bimodal cochlear implantation.

Bilateral recipients may perform better in background noise, and binaural hearing is critical for sound localization. Binaural hearing also improves the sound quality of speech and provides more safety in a variety of environments. Many bilateral patients also take comfort in knowing that they have a “backup ear” so that if their processor (external part) breaks or needs repair, they are not completely cut off from the hearing world. This is especially important for children who may not be emotionally well-equipped to deal with processor or implant malfunctions that plunge them instantly into deafness.

Although simultaneous bilateral implant surgery is medically safe for most individuals, many patients opt to start with just one side; then eventually receive the implant in the other side. Interestingly, when CI was a new procedure, implants were generally placed in the poorer-hearing ear. Subsequent research has shown that the patient’s better-hearing ear may benefit from cochlear implantation if bimodal hearing is not a sufficient option. It is likely that many individuals may gain even greater word understanding from an implant on the second side, even years after the first.

Third-party payors also recognize the benefits of bilateral implantation, and are covering the procedures in greater numbers. Although Medicare still provides coverage for only a single implant, implant teams are advocating for change with the goal of making bilateral CI an option for all appropriate candidates.

**Children Are Not Just Small Adults**

Creating a separate pediatric division in the Hearing Implant Program has been another meaningful change, arising from the recognition that children are not just “small adults.” Along with their families, they have very different needs and expectations for care. Pediatric implantation surgeries are performed at Cleveland Clinic Children’s Hospital, with pediatric anesthesiologists and surgeons experienced with pediatric ear surgery. Child Life therapists are also available on the day of surgery to make the hospital experience less frightening for families and children.
An additional advance in the pediatric implant division is the use of MRI instead of CT imaging for first-line preoperative radiographic evaluation, due to recent concerns about subjecting children to unnecessary ionizing radiation. Temporal bone CTs deliver much more radiation than X-rays and are unnecessary in most cases. MRIs are now detailed enough to identify individual nerves leaving the brainstem and entering the cochlea. For parents, this means that their children need not be exposed to radiation.

Looking Ahead

The rapid expansion of the HIP team at Cleveland Clinic proves that quality care can be delivered efficiently without becoming impersonal. This expansion also translates into more research opportunities for CI candidates. Cleveland Clinic’s hearing implant program is currently offering several research opportunities to its candidates, including an electroacoustic implant trial as well as experimental mapping strategies for improved performance in standard CI recipients.

In summary, many of the faces of the Hearing Implant Program have changed, but the focus of the group has remained the same: delivering world class care to patients with significant hearing impairment and helping them utilize spoken language, thus allowing them access to a full range of educational, social and vocational life experiences. Look forward to hearing much more about the fruits of these labors in the near future.
Surgical Management of Temporomandibular Joint Disease

Joseph Krajekian, DMD, MD

Temporomandibular joint dysfunction (TMJD) is estimated to affect over five percent of the general population. However, only two percent, mostly women, seek medical treatment. The pathophysiology of TMJD may be a result of muscular hyperfunction or parafunction and/or underlying degenerative changes within the joint, though it is important to note that no single causative factor leading to TMJD has been unequivocally demonstrated. TMJD is divided into two basic categories: nonarticular joint disease and articular joint disease.

**TMJ Function Anatomy**

The TMJ is a diarthroial joint with a discontinuous articulation of temporal bone and mandible that permits free movement of the joint in various directions. Functionally, the TMJ is considered a compound joint composed of four articular surfaces: the articular facet of the temporal bone, the mandibular condyle and the superior and inferior surfaces of the articular disc. The articular disc divides the joint into two compartments. The inferior compartment allows ginglymoid or hinge motion and rotation, and the superior compartment allows arthrodial or sliding movements. Surrounding the joint is the TMJ capsule, which is extremely vascular and innervated, and tightly attached to the bones, functioning to resist extreme joint movement. The articular disc is composed of dense, fibrous connective tissue that is not vascular or innervated. The disc is flexible and adapts to the functional demand of the articulating surfaces. The biconcave articular disc functions with rotation and translation during jaw opening.

**Pathology of TMJ**

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<th>Articular disorder</th>
<th>Non-articular disorder</th>
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<td>Non inflammatory arthropathies</td>
<td>Muscle disorders</td>
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<td>Primary osteoarthrosis</td>
<td>Muscle spasm/Fibromyalgia</td>
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<td>Secondary osteoarthrosis</td>
<td>Myofascial pain and dysfunction</td>
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**Inflammatory arthropathies**

**Growth Disorders**

**Neoplasms**

**Surgical Options**

- Arthrocentesis
- Arthroscopic surgery
- Synovectomy, lysis and lavage, disc repositioning, discectomy, surgical debridement
- Mandibular condylotomy (vertical ramus osteotomy)

**Arthroplasty**

- Disc repair procedures
- Discectomy without replacement
- Discectomy with replacement
- Articular surface recontouring
- Total joint replacement/reconstruction

**Nonarticular Disorders**

Most nonarticular disorders commonly manifest as masticatory muscle dysfunction, which represents over 50 percent of all TMJD pain. They invariably contribute to decreased mandibular range of motion and cause myofascial pain. Much of the pain is related to temporalis and masseter muscle spasm. Additionally, they can involve the pterygoids or any combination of supramandibular or inframandibular muscles. Parafunctional habits such as bruxism or clenching are thought to be the main causes. Treatment modalities are mostly nonsurgical and include soft diet, occlusal adjustment, night guard appliance, joint unloading, repositioning and occlusal protection, NSAIDS, muscle relaxants and physical therapy. Surgery is not indicated for nonarticular disorders.
Wilkes Stages of Internal Derangement

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<th>Stage</th>
<th>Characteristics</th>
<th>Imaging</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>I. Early</td>
<td>Painless clicking No restricted motion</td>
<td>Slightly forward disc Normal osseous contours</td>
<td>Conservative treatment with splint therapy</td>
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<tr>
<td>II. Early/Intermediate</td>
<td>Occasional painful clicking Intermittent locking Headaches</td>
<td>Slightly forward disc Early disc deformity Normal osseous contours</td>
<td>Conservative treatment with splint therapy Surgery – arthroscopy Surgery – arthroplasty with fat graft Surgery – mandibular condylotomy</td>
</tr>
<tr>
<td>III. Intermediate</td>
<td>Frequent pain, joint tenderness, headaches, locking, restricted motion, painful chewing</td>
<td>Anterior disc displacement Moderate to marked disc thickening Normal osseous contours</td>
<td>Conservative treatment with splint therapy Surgery – arthroscopy Surgery – arthroplasty with fat graft Surgery – mandibular condylotomy</td>
</tr>
<tr>
<td>IV. Intermediate/Late</td>
<td>Chronic pain, headaches Restricted motion</td>
<td>Anterior disc displacement Marked disc thickening Abnormal bone contours</td>
<td>Surgery – arthroscopy Surgery – arthroplasty with fat graft Surgery – mandibular condylotomy Surgery – total joint replacement</td>
</tr>
<tr>
<td>V. Late</td>
<td>Variable pain, joint crepitus pain</td>
<td>Anterior disc displacement with disc perforation and gross deformity Degenerative osseous changes</td>
<td>Surgery – total joint replacement</td>
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Articular Disorders

Articular disorders are divided into two classifications: noninflammatory articular disorders, most common of which are primary osteoarthritis, disc derangement, and degenerative joint disease. There is also a role for secondary osteoarthritis, which is commonly caused by trauma or infection. All of these conditions are treated surgically. Wilkes classification was established to help classify the severity of disease, which in turn, guides surgical management.

Inflammatory articular disorders are usually due to rheumatoid arthritis or juvenile rheumatoid arthritis. Noninflammatory articular disease, if severe enough, can lead to secondary inflammatory TMJD. All articular diseases are managed surgically, depending on their etiology and severity. Several surgical options are available, from the least-invasive arthrocentesis and arthroscopic surgery, to moderately-invasive arthroplasty and mandibular condylotomy, to aggressive total joint replacement surgery.

Conclusion

TMJD is more common than we think. It can be easily mistreated because of misconceptions about the disease’s pathophysiology. Our understanding of TMJD and surgically successful outcomes has significantly improved patient quality of life and lowered dependence on chronic pain medication. It is our goal at the Head & Neck Institute to treat TMJD with a multidisciplinary approach that optimizes patient outcomes and improves quality of life.

For references, please email the editor.
Analyzing Treatment Options for Laryngotracheal Stenosis

Michael S. Benninger, MD

Laryngotracheal stenosis is a thickening and constriction of the tracheal or subglottic spaces caused by scar tissue formation. The majority of cases arise from either a traumatic event, such as prolonged intubation or Wegener’s granulomatosis, which is part of the vasculitis disease process. Another subset of cases is idiopathic in nature. Options for treatment most often include surgery, with lysis and dilation of the scar being the most commonly performed procedure. In patients with small-segment tracheal stenosis, resection and end-to-end suturing is often effective, although open procedures are difficult in subglottic stenosis.

Cleveland Clinic Head & Neck Institute is leading the search for the most effective treatment for this difficult condition. More than 600 procedures to relieve laryngotracheal stenosis have been performed here over the last five years, partly due to our large vasculitis program. The high volume of procedures has allowed us to analyze and extract significant data on the demographics of the disease as well as the effectiveness of different treatment modalities, observed during a follow-up period of several years.

A simple surgical procedure coupled with balloon dilation of scar tissue (shown at right) is often preferable to open procedures for treating subglottic and tracheal stenosis.

Surgical Technique

Cleveland Clinic takes a regimented, combined approach to laryngotracheal stenosis surgery. After the patient is placed under general anesthetic, a laryngoscope is introduced and suspended. The lesion’s thickness is measured with a Hopkins rod telescope and the surrounding tissue is examined for other areas of stenosis.

The patient is then placed under jet ventilation and Depo-Medrol is injected into four quadrants for subglottic stenosis, (three-, six-, nine- and twelve-o’clock) or in three for tracheal stenosis (four-, eight- and twelve-o’clock). Incisions are made in these locations, usually with a scissors or a knife. Although CO2 laser may be substituted, precautions must be taken to avoid heat injury and further scar formation in surrounding tissues. If ventilation cannot be well sustained by jet, a No. 4 or No. 5 endotracheal tube is intermittently passed through the laryngoscope to keep the patient well oxygenated.

Next, the area is dilated with a balloon for 30 to 60 seconds, followed by application of mitomycin-C for two to three minutes, usually in two, 1-1/2 minute intervals. Though mytomycin-C’s ability to prevent scar tissue formation in humans is not clear, it has been shown to work in animal models.
Methodology, Demographics and Findings

We set out to answer the questions: Do the etiology, incision and dilation technique increase the probability that a patient will require multiple versus single procedures? Do they affect the length of time between procedures when multiple surgeries are required?

From a CPT code search, we extracted 1,125 patients. From this group, we excluded those without stenosis, patients with stenosis at levels other than the subglottis, those with concurrent supraglottic, glottic or tracheal stenosis, those that had stenosis but had never undergone a procedure, and patients with a history of irradiation for oropharyngeal or laryngeal tumors.

What remained was a group of 92 patients who had undergone a total of 247 procedures, with follow up for at least two years. To our knowledge, this was the largest patient series ever reported, with the maximum found in the literature being about 30 patients.

Of this group, 75 percent were female, 25 percent were male, with a mean age of 48 years. We found that 68.4 percent of cases were caused by Wegener's and 58.3 percent were caused by intubation. Interestingly, 96.7 percent of the idiopathic cases were women, and recent studies suggest that these women have a strong history of gastroesophageal reflux disease (GERD) and are mostly overweight. Almost all patients presented with dyspnea, with the second most common presentation being dysphonia.

Results were determined after a mean follow-up time of 3.76 years. Forty-five percent of the 92 patients needed only one procedure, while 55 percent required two or more procedures, with a mean time between procedures of slightly more than a year.

Thirty-three of the 92 patients required only a single procedure. Of those surgeries, 18 utilized cold knife incision technique, and 15 utilized CO2 laser. Twenty-four were dilated using balloon technique and eight utilized the bougie technique, although the bougie is no longer used at this time. Of the patients that required more than one procedure, the cold knife technique averaged 1.09 years between procedures, while CO2 laser was slightly less effective at 0.96 years.

Conclusions

In summary, we believe that our current approach to managing subglottic and tracheal stenosis is effective and returns patients to an excellent quality of life. Although many patients require repeat procedures, this easy and reliable procedure causes minimal morbidity and serves as a preferred option for most patients to an open surgical procedure and possible long-term stenting and tracheotomy.
Multi-Disciplinary Care in Children
Prashant Malhotra, MD

The U.S. medical system initially evolved to manage acute and subacute illnesses. In recent decades, there have been attempts to provide more comprehensive and coordinated care for individuals with complex or chronic diseases. Models have emerged that include the medical home concept, the chronic care model in primary care, and the disease-specific, multi-specialty clinic. These models promote co-management, with communication and coordination of care among primary care and subspecialty providers. 1

The medical home concept began within primary care pediatrics. In 1992, the American Academy of Pediatrics recommended that all children have a medical home, with care being “accessible, continuous, comprehensive, family-centered, coordinated, and compassionate.” 2 Since then, this model has taken root in adult medicine as well, and is part of policy discussions in the national healthcare debate.

The chronic care model emerged to improve management of chronic illnesses. Main themes of this model include evidence-based, population-based, and patient-centered care with a focus on self-reliance, education and monitoring of chronic disease markers, generally managed by primary care providers, who coordinate care with specialists. 3

A disease-specific, multidisciplinary approach to the care of patients is now developing in numerous areas of medicine and surgery. These clinics bring together specialists for genetic disorders (i.e., hemophilia, sickle cell disease, cystic fibrosis), chronic illnesses (i.e., chronic kidney disease, heart failure, chronic pain), cancer care (i.e., prostate, head and neck, breast) and other diseases.

In pediatric otolaryngology, for example, our cleft-craniofacial team serves children with cleft lip and/or palate (CL/P) and other craniofacial diseases. It is well understood that the needs of patients with CL/P extend beyond surgical repair. A multidisciplinary approach that includes pre- and postoperative education and intervention is necessary to optimize outcomes. This integration of care usually occurs in the context of a well-organized and structured CL/P team that communicates with the patient’s pediatrician or medical home. Periodic visits are usually patient-centered, with multiple physicians and allied health professionals coming to a single location. The team educates and shepherds patients from birth toward realization of surgical, speech, feeding, orthodontic and psychological endpoints. 4,5

Pediatric otolaryngologists are expanding their involvement with multidisciplinary clinics. Examples include clinics devoted to vascular anomalies, pediatric airway, velopharyngeal insufficiency, pediatric hearing loss, voice disorders and Down syndrome.

Establishing effective multi-specialty care faces numerous challenges in terms of patient/provider relationship quality, and financial reimbursement from health plans. The clinics themselves are often not profitable, but can provide increased downstream revenue from care, or from the public perception of specialized services at an institution.

Time will tell which care model results in the best outcomes for children with special health needs while preserving maximum efficiency for providers.

Fellowship-trained pediatric otolaryngologists participate in the following multidisciplinary clinics at Cleveland Clinic Children’s Hospital:

**Pediatric Center for Voice, Airway, and Swallowing**
Pediatric otolaryngology, pediatric gastroenterology, pediatric pulmonology, speech and language pathology,

**Vascular Anomalies Clinic**
Interventional radiology, pediatric plastic surgery, pediatric otolaryngology, pediatric dermatology

**Cleft-Craniofacial Clinic**
Craniofacial surgery, pediatric otolaryngology, audiology, speech and language pathology, genetics, pediatrics, pediatric psychology, social work, orthodontics

**Pediatric Hearing Management Clinic**
Pediatric otolaryngology, genetics, speech pathology, audiology

REFERENCES:
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Staff Awards

Michael S. Benninger, MD, was elected President of the American Laryngological Association 2011-12.

Brian Burkey, MD, received a Distinguished Service Award from the American Academy of Otolaryngology-Head and Neck Surgery. Dr. Burkey was also elected President of the Society of University Otolaryngologists for 2010-11.

Thomas Haberkamp, MD, received an Honor Award from the American Academy of Otolaryngology, at its 2010 meeting.

Raj Sindwani, MD, received a 2010 Honor Award from the American Academy of Otolaryngology and was named Associate Editor for American Journal of Rhinology and Allergy.

Judith White, MD, PhD, received an Honor Award from the American Academy of Otolaryngology and was awarded a certificate and letter for outstanding professional achievement from the president of the Ohio Senate.
Advances in Otolaryngology & Dentistry

FALL 2011

Advances in Otolaryngology & Dentistry offers information from Cleveland Clinic otolaryngologists, speech pathologists, audiologists and dentists about state-of-the-art medical, surgical and rehabilitative techniques. It is written for physicians and should be relied upon for medical education purposes only. It does not provide a complete overview of topics covered, and should not replace the independent judgment of a physician about the appropriateness or risks of a procedure for a given patient.

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