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The Relationship Between Otolaryngology and Speech Pathology

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Abstract : A crucial link exists between the otolaryngologist and speech-language pathologist. In the Department of Otolaryngology- Head and Neck Surgery at Georgetown University Medical Center, patients with head and neck cancer, vocal fold paralyses, and benign voice disorders are seen by otolaryngology and referred to speech pathology for evaluation. Baseline digital audio recordings of speech and videostroboscopic recordings of cord motion are obtained with aerodynamic, respiratory, acoustic, and spectrographic analysis as appropriate. Speech pathology counsels surgical patients regarding expected speech, swallowing, and voice alterations following surgery. These patients are observed during initial post-operative swallows and assigned oral-motor exercises to strengthen orofacial musculature. Patients with vocal fold paralyses and benign vocal lesions are seen by speech pathology of several sessions to teach compensatory cord adduction and improved vocal strategies. Speech pathologists arrange for patients who have undergone oral/laryngeal surgeries to provide psychosocial support to patients awaiting similar surgeries. The close relationship between otolaryngology and speech pathology provides the finest quality of care with the core of therapeutic education, support, and rehabilitation provided by speech pathology. Referral protocols, diagnostic assessments and treatment strategies for patients following laryngectomy, hemiglossectomy, supraglottic laryngectomy, vocal cord carcinoma, vocal cord paralyses, and benign vocal lesions will be discussed.

The Relationship between Otolaryngology and Speech Pathology

For the past several decades, restoration of function and rehabilitation have been of primary concern to both physicians and patients with head and neck disorders. In cancer treatment, as well as vocal disorders, no longer is medical or surgical management or cure considered the primary objective for successful treatment. Voice therapy, conservation surgeries, laryngeal preservation protocols, and nonmedical strategies are utilized presently in an

attempt to maintain patients' speech, voice, and swallowing functions. Integral to this outlook is the need for collaboration among the many disciplines involved in patient care.

A multidisciplinary approach may help to avoid the many pitfalls that threaten patients who are managed by a single physician and referred to other disciplines only when problems develop¹⁾. Depending on the condition, ideal patient management from the onset of treatment may require input from the otolaryngologist- head and neck surgeon, radiation

oncologist, medical oncologist, plastic surgeon, speech pathologist, maxillofacial prosthodontist, dentist, nutritionist, radiologist, nurse, psychologist, audiologist, and social worker. This paper will describe the role of the speech pathologist as part of the otolaryngologic team in the treatment of patients with voice disorders, oral cavity and laryngeal cancer. Diagnostic assessment and treatment strategies for patients with benign vocal pathology, spasmodic dysphonia, vocal cord paralysis, partial glossectomy and malignant laryngeal pathology will be described.

Pretreatment Assessment of the Voice Disordered Patient

Patients with complaints of hoarseness typically are seen by the otolaryngologist prior to referral to speech pathology. Following an interview and mirror or nasofiberoptic examination by the otolaryngologist, videostroboscopy frequently is recommended to document laryngeal pathology and/or to evaluate vocal fold vibration. Videostroboscopy provides information about the periodicity and symmetry of vocal fold motion, degree of glottic closure, amplitude or lateral excursion of the vocal folds, degree of vertical traveling mucosal wave, presence of nonvibrating segments and information regarding the effect of lesions on vocal fold vibratory function^{2,3}. At the Georgetown University Medical Center, videostroboscopy using a Bruel and Kjaer stroboscopy unit and Panasonic camera is performed by both the otolaryngologist and speech pathologist. Joint evaluation assures technical accuracy by the otolaryngologist while the speech pathologist chooses tasks to elicit the desired vocal behaviors. In the case of suspected laryngeal carcinoma, rigid endoscopy will permit clear documentation of the lesion and possible mucosal wave aberrations. If documentation of laryngeal physiology during conversation, singing or lecturing is desired, both the rigid and nasofiberoptic endoscopes are used in tasks chosen for the patient. The videotape is then viewed by the patient, otolaryngologist, and speech pathologist. This strategy has been extremely beneficial in helping the patient to understand his/her pathology and accept responsibility for changing improper vocal behaviors

identified during the voice evaluation.

The diagnostic voice evaluation begins with a case history interview at which time a complete medical, vocal, occupational, financial, family, behavioral, and emotional history are obtained. Mechanisms for dealing with daily stresses are discussed. During conversation with the patient, the speech pathologist listens for improper vocal behaviors. Discoordinated breathing patterns, breath holding, tightening of the neck musculature and jaw clenching are noted. Patients are asked to identify characteristics of their voices that they like and those that they dislike.

Instrumental evaluation is performed utilizing a systems approach. Baseline respiratory, laryngeal, resonance, and articulatory data are obtained to provide a comprehensive picture of how the patient coordinates these systems to attain phonation. If the patient complains that his/her voice is too nasal, nasality will be assessed during the evaluation.

A computerized spirometer is used to obtain inspiratory-expiratory flow rates on patients suspected of reduced respiratory capacities. If the patient fails this screen, a referral is made to pulmonary medicine for a standardized pulmonary function evaluation. Using spirometry on patients whose videostroboscopies revealed poor breath support has helped us to distinguish patients with respiratory compromise from those who simply fail to coordinate respiration with phonation. During conversation with the patient, the speech pathologist observes the patient's pattern of breathing, depth, and timing of inhalation and exhalation. An estimate is made of the number of words spoken per breath unit.

Laryngeal function is evaluated by objectively assessing perceptual characteristics of the voice such as pitch, intensity, hoarseness, and harshness, in addition to, aerodynamic measures of glottal efficiency. A sustained vowel is input via microphone into an acoustic analysis system such as Kay Elemetric's Computerized Speech Laboratory or Dr. Speech Science for Windows by Tiger Electronics, Inc. where measures of fundamental frequency, frequency perturbation (relative average perturbation), amplitude, amplitude perturbation (amplitude

perturbation quotient), and signal to noise ratio are promptly computed. Aerodynamic measures are obtained using a pneumotachograph, such as the Aerophone II, created by the Kay Elemetrics Corporation. As the patient produces vowels and syllabic utterances into a face mask connected to a hand held flow meter, the patient's vital capacity, mean and maximum airflow rates, air pressure, and laryngeal resistance are calculated. The Nagashima Phonatory Function Analyzer and Glottal Enterprises Airflow-Air Pressure Measurement System also are used for aerodynamic assessment. Acoustic and aerodynamic measures provide an estimate of laryngeal efficiency. Patients exhibiting hoarseness due to pressed phonation are easily detected. Patients with vocal fold paresis or paralysis, benefit from objective baseline documentation of airflow and air pressure measures for comparison to measures following voice therapy and surgery, ie. thyroplasty, gelfoam or teflon injection, or transverse cordotomy. Patients who have undergone conservation laryngectomy surgeries such as cordectomy and vertical hemilaryngectomy frequently use alternative primary sources of phonation due to compromised laryngeal sphincterization. Laryngeal resistance values aid the speech pathologist in monitoring effort related to the extent of laryngeal ablation or reconstruction and that related to strain and compensatory supraglottic activity⁴.

Perceived nasality can be objectively measured using the Nasometer from the Kay Elemetrics Corporation (Figure 1) which calculates oralance (oral

resonance) and nasalance (nasal resonance) from separate oral and nasal microphones contained within a face mask. As the patient produces sustained vowels and passages containing non-nasal and nasal phonemes, measures of oralance and nasalance are calculated and compared to normative values. These are not measures of actual nasal and oral airflow but of acoustic information from the respective microphones.

The resonatory system is evaluated in patients presenting with complaints of hoarseness, spasmodic dysphonia, strain, excessive laryngeal tension, and vocal tremor. Generation of a spectrogram which portrays intensity, formant, and harmonic information about resonance within the vocal tract is very helpful in distinguishing spasmodic dysphonia from muscle tension dysphonia and vocal tremor. Although combinations of these occur, spectrograms of the three disorders reveal differences. Initial baseline spectrograms are important to obtain for later comparison following voice therapy or botulinum toxin treatment.

Following evaluation of the systems involved in voice production, the speech pathologist develops a treatment plan geared toward correcting deficiencies in one or more of the systems or in the interactions among the systems.

Management of the Voice Disordered Patient

Management of Benign Voice Disorders

In a study of 69 patients with hoarseness due to vocal misuse and hyperfunction, we found that an average of 3.6 therapy sessions was required for their voices to return to normal. Of the nine patients that required longer than six sessions, we found that the initial diagnosis was incorrect. The success of short term therapy may be due to the patient's clear understanding of the anatomy and physiology of the vocal mechanism. If a videostroboscopic examination has been performed on a patient, he/she enters therapy with a clear understanding of how the voice functions. If videostroboscopy has not been performed, the patient is shown videotapes of a normal voice and one that resembles his pathology. The normal videotape includes vocal abuses such as coughing, throat clearing, and breath holding so

Figure 1 Nasometer (complements of KAY Elemetrics Corporation)

that the patient can visualize how these actions negatively effect the voice. The patient is encouraged to eliminate other vocally abusive behaviors detected in the evaluation.

Most patients with hoarseness exhibit vocal hyperfunction which may present as excessive respiratory effort, breath holding, supraglottic constriction, jaw clenching, and decreased mouth opening. These behaviors may be compensatory secondary to laryngeal pathology such as vocal nodules or polyps, pre and post treatment carcinoma, spasmodic dysphonia, or vocal fold paresis or paralysis. Frequently these behaviors are learned during an upper respiratory infection or extremely emotional event and fail to be extinguished when the incident resolves. The goal of therapy is to restore balance among the respiratory, laryngeal, resonatory, and articulatory systems until optimal vocal efficiency is achieved. In some cases, compensatory strategies such as head positioning may be employed to decrease vocal effort.

Biofeedback utilizing mirrors, audio and videotape recordings and diagnostic equipment is incorporated into the treatment process. Equipment such as the Respirace, a plethysmograph from Ambulatory Monitoring Inc. or the Cafet for Voice may be used to help patients improve breath support and coordinate breathing with the onset of phonation. The Respirace consists of thoracic and abdominal bands which when placed around the patient and connected to an electroglottograph and oscilloscope, display thoracic and abdominal displacement and the initiation of phonation. The Cafet for Voice displays both thoracic or abdominal displacement and the onset of phonation within a computerized software program. Patients learn to increase abdominal displacement during inhalation and length of exhalation.

Excessive pharyngeal or supraglottic constriction can be eliminated using laryngeal manipulation⁶⁾, laryngeal massage, yawning, Resonant Voice Therapy (RVT)⁶⁾, Vocal Function Exercise (VFE)⁷⁾ and strategies to place the tone into the oropharynx rather than the back of the throat. Hand cupping around the ears, audiotapes and a spectrograph may be used to improve oral pharyngeal resonance. Jaw

opening, relaxation, and articulatory drills emphasizing over-articulation and forward placement improve vocal quality and enhance speech intelligibility. Hyper or hypernasality can be modified using the Nasometer for biofeedback.

Management of Vocal Paralysis

In most cases of vocal paralysis or paresis, hyperfunctional behaviors develop as compensatory strategies to improve glottic closure. Once these are managed utilizing the strategies presented in the previous section, the goal of treatment is to improve vocal fold approximation. Initially, patients are assigned forced adduction exercises consisting of pulling up on a chair or performing a valsalva maneuver as vowels are vocalized once per hour for two weeks. These exercises are expanded to connected speech the following week. Usually this strategy results in a considerably stronger voice. Head turning to either side or digital pressure applied to the thyroid area on the weak side also increases vocal intensity and decreases fatigue by permitting more words to be spoken per breath. If therapy does not result in a functional voice for the patient, surgical techniques to augment vocal fold approximation such as a thyroplasty, gelfoam or fat injections are performed. Patients presenting with bilateral abductor vocal fold paralysis undergo transverse cordotomy, if appropriate candidates. We have studied seven patients and have found return of good voice quality in 82% and improved airflow in 95% of the patients.

Management of Spasmodic Dysphonia

Patients suspected of mild spasmodic dysphonia undergo voice therapy to improve coordination of breath with smooth vocal onsets. A plethysmograph such as the Respirace interfaced with an oscilloscope quickly teaches the patient to speak on exhalatory airflow with fluent phonation; focussed in the oropharynx. If patients can utilize these learned skills in the clinic but cannot transfer them into normal speaking situations, botulinum toxin (botox) is injected typically into both vocal folds. Analysis of data accumulated on twenty five patients followed over four years, reveals that an average dose of 2.5 units of botox has been injected transcutaneously into patients' vocal folds bilaterally

every four months. Patients can increase the length of time between visits by undergoing several voice therapy sessions in conjunction with the botox injection.

Pretreatment Assessment of the Head and Neck Cancer Patient

Optimal rehabilitation of speech, voice, and swallowing in patients with head and neck cancer begins when the team develops the patient's initial treatment plan. Pretreatment discussions center on the patient's 1) previous medical/cancer management 2) radiographic imaging for baseline documentation and accurate staging 3) videoendoscopic/stroboscopic evaluation 4) speech, voice, swallowing, and dental examinations 5) nutritional status and 6) social, financial, emotional, and family concerns. Decisions about feeding are made prior to the initiation of treatment. Placement of a percutaneous endoscopic gastrostomy (PEG) or gastrostomy tube may benefit patients who are losing weight and are to undergo extensive oral surgery with subsequent risk of aspiration. Patients with pulmonary and medical complications may be candidates for alternative feeding strategies depending on the effect of the planned surgery on mastication and deglutition.

Preoperative consultation with the speech pathologist is scheduled soon after the physician has made recommendations and prior to hospital admission. During this consultation, the speech pathologist reviews normal anatomy and physiology and addresses the forthcoming surgical alterations and the patient's immediate postsurgical speech, voice, and swallowing compromises. The patient's long term rehabilitation plans are discussed. If oral communication is not a possibility following extensive oral cavity surgery, patients are provided information regarding augmentative communication devices. Patients scheduled for total laryngectomy often wish to learn of post surgical voicing alternatives such as use of an electrolarynx, esophageal speech and the tracheoesophageal puncture. We have found that patients who are willing to use an electrolarynx on their neck preoperatively feel more 'in control' and relieved that their needs can be expressed following surgery. Patients and their families are encouraged to meet with a patient volunteer who has

undergone similar surgery.

Preoperative assessment of patients with oral cavity cancer includes a formal speech evaluation, oral peripheral examination, and modified barium swallow if the patient reports swallowing difficulties. Patients with reduced hearing acuity undergo preoperative hearing assessment since they may be unable to monitor their speech intelligibility.

Standardized articulation testing typically is not performed on laryngeal cancer patients unless oral cavity surgery is planned ; however, articulation, intonation, rate, and dialect patterns are documented. An oral peripheral examination and baseline acoustic and aerodynamic analyses are completed for objective comparisons of vocal changes during and following treatment. Swallowing studies typically are not obtained on patient undergoing total laryngectomy ; however, modified barium swallow studies are performed on patients with swallowing deficits who are to undergo laryngeal conservation surgery. Hearing assessments are performed if deficits are reported.

Management of the Head and Neck Cancer Patient

Patients undergoing oral cavity or conservation laryngeal surgery are fed typically by a nasogastric tube and communicate primarily through writing. Typically seven to ten days following surgery, the otolaryngologist provides written consent for post operative speech and swallowing assessments. The speech pathologist performs a bedside dysphagia examination⁸⁾ which includes an oral peripheral and oral reflex examination and trial swallows with pureed textures and/or thickened liquids. If the patient fails the bedside examination by demonstrating clinical signs of aspiration, a modified barium swallow or fiberoptic endoscopic evaluation of swallowing (FEES) is performed. FEES utilizes a fiberoptic nasoendoscope to evaluate aspects of the pharyngeal swallow in patients who are unsuited for a videofluorographic study⁹⁾.

Management of Oral Cavity Cancer

Restoration of speech and swallowing function after glossectomy or pharyngeal surgery appears to be dependent on the quantity and mobility of resid-

ual tongue, reconstructive technique, integrity of motor and sensory nerve supply, degree of post surgical or post radiation scarring and fibrosis, psychosocial factors such as age, motivation, medical condition, and family support and early intervention of speech pathology¹⁰⁾. Following completion of the bedside, modified swallow or fiberoptic examination, the speech pathologist develops a treatment plan. This plan should include 1) exercises to improve strength and range of motion of the oral musculature, 2) diet selection, 3) compensatory techniques to overcome oral and/or pharyngeal swallowing difficulties, 4) consideration of prosthetic devices such as a palatal drop in the case of large tongue lesions or a palatal obturator following palatotomy, and 5) alternative feeding methods if an oral diet is not appropriate or if diet supplementation is needed.

Typical Recovery Patterns

Patients undergoing resection of the anterior portion or less than 50% of the mobile tongue demonstrate changes in speech intelligibility due to reduced lingual range of motion and coordination. Articulation deficits are usually mild and often characterized by a lateral lisp¹¹⁾. Dysphagia in this patient population is often minimal, and is generally characterized by a delayed swallow reflex and reduced ability to manipulate the bolus in the oral cavity. Swallowing therapy should focus on improving oral transit and bolus manipulation utilizing compensatory strategies such as placing the bolus on the non-operated side, tilting the head backward, and altering food consistency.

Articulation problems in partial glossectomy patients vary and are dependent upon residual lingual tissue and motion. Compensatory speech patterns such as contacting the tongue to the lower gum ridge are taught to obtain intelligible lingua-alveolar (t, d, n, l, s, z) and lingua-palatal (sh, ch) productions if the tongue cannot contact the alveolar ridge or hard palate. A palatal prosthesis may be considered to lower the palate and assist with lingual-palatal contact¹¹⁾. Swallowing problems in partial glossectomy patients include poor bolus formation and manipulation thus reducing oral transit time and delayed elicitation of the swallow reflex.

In base of tongue lesions where the pharyngeal constrictors are damaged, pharyngeal peristalsis may be impaired. Patients will benefit from exercises to improve oral motor function and compensatory swallowing strategies such as placing the bolus on the non-operated side, tilting the head laterally or backward, and altering food consistency.

Severe dysphagia has been reported in patients with extensive oral tumors who have undergone removal of the base of tongue, floor of mouth, and/or lateral pharyngeal walls¹²⁾. However, functional rehabilitation of speech and swallowing is now possible with the advent of new reconstructive techniques such as microvascular free flaps. The bilobed sensate radial forearm microvascular free flap is described as the best method for obtaining maximum functional speech and swallowing return following extensive oral cavity surgery^{13,14)}. This bilobed design allows for one portion of the muscle flap to serve as bulk for restoring the floor of mouth while the other portion provides volume to the 'mobile' tongue. In 1994, we performed pre and post operative sensory, videofluorographic, and speech testing at defined intervals on five patients who underwent partial glossectomy with radial forearm free flap reconstruction. All patients initiated an oral diet of pureed and liquid consistencies by postoperative day 12 and demonstrated good to excellent speech intelligibility by three months post surgery. Articulation deficits were characterized by phoneme distortion, primarily of the lingua-palatal (sh, ch) class.

Management of Early and Later Stage Laryngeal Cancer

Patients with early stage glottic carcinoma are treated with radiation therapy or laser excision. Following treatment, patients benefit from several voice therapy sessions geared toward improving vocal flexibility, breath support, and decreasing vocal strain. Videostroboscopic, aerodynamic, and acoustic analyses are performed at periodic intervals after treatment (3mos, 6mos, 1yr, 2yrs) or immediately if voice quality changes significantly.

Patients undergoing a supraglottic laryngectomy frequently experience difficulty protecting the airway during swallowing due to removal of the epi-

glottis and ventricular cords¹⁵). Decreased aspiration has been found in patients who relearn to swallow using a supraglottic swallow¹¹). These patients should avoid thin liquids, and may use a commercially available thickening agent during meals.

For most hemilaryngectomees, the epiglottis is preserved, therefore swallowing may be improved if the patient utilizes a chin tuck position to assist with airway protection¹¹). Patients demonstrate improved swallowing by turning their head toward the operated side to direct the fold away from the compromised area. Vocal changes following hemilaryngectomy are highly dependent upon the extent of surgery and post operative radiation therapy. The larynx must be able to close for phonation with vibration of the remaining vocal fold against the resected side. The speech pathologist may assign forced adduction exercises to improve vocal fold approximation ; however, some degree of supraglottic activity may be helpful in attaining a less breathy voice. Head turning toward the operated side or digital pressure on either side of the thyroid ala may improve vocal quality and increase intensity by reducing glottal opening.

Management following Total Laryngectomy

Patients undergoing a total laryngectomy typically begin an oral diet from 12 to 14 days following surgery. The speech pathologist should be present for the first postoperative swallow. Infrequently a modified barium swallow is required to properly assess cricopharyngeal problems. One to two days following surgery, the patient is loaned an electrolarynx with an intraoral adapter and is taught to coordinate the onset of the battery operated sound with articulatory movements. Soon after an oral diet is begun, esophageal speech is introduced. A few patients learn esophageal speech readily and undergo formal speech therapy, however, most patients look forward to assessment for a tracheoesophageal puncture (TEP) . The TEP technique introduced by Singer and Blom in 1980¹⁶) remains most popular in the United States, although, other types of prostheses are used internationally to restore phonation¹⁷).

Primary tracheoesophageal punctures, performed

at the time of surgery, permit speech approximately three weeks after surgery ; however, we prefer to perform the TEP three months following the completion of radiation therapy, if indicated. Success of the TEP depends on accurate placement of the tracheoesophageal fistula, adequate stoma size, lack of pulmonary complications, intact cognition, sufficient finances, and successful esophageal air insufflation testing¹⁸). It has been challenged that successful air insufflation testing prior to TEP does not predict successful TEP speech acquisition six months later¹⁹). We continue to use the esophageal insufflation as a predictor of adequacy of the pharyngoesophageal segment and have experienced no false positives. Utilizing stringent candidacy criteria, 95% of our patients have experienced successful TEP speech.

Approximately a week following surgery, the speech pathologist removes the catheter from the tracheoesophageal fistula and fits the prosthesis. Patients are initially fit with an Inhealth or Bivona 16 fr. prosthesis. If speech is strained, the puncture site is dilated and a lower resistance 20 french prosthesis is inserted. A prosthesis designed to be inserted and removed by the speech pathologist such as an Inhealth Indwelling or Bivona Provox II may be fit in a patient who is unable to independently manage his/her prostheses. If a patient's stomal configuration is suitable, the patient is taught to attach a breathing valve which permits hands free speech. For a more complete discussion of prosthesis fitting and problems, refer to Miller²⁰) and Izdebski²¹).

Summary

Communication among the otolaryngologist, speech pathologist, and multidisciplinary team begins prior to treatment and does not wane as the patient recovers and treatment is complete. Voice disordered patients return to the otolaryngologist upon discharge from therapy or when treatment has plateaued and reevaluation is necessary. Head and neck cancer patients' return visits to the otolaryngologist are coordinated with the speech pathologist and other disciplines involved in the patient's care. A head and neck cancer patient's progress is

monitored over time in the multidisciplinary Head and Neck Tumor Board which meets weekly. If management strategies have failed or recovery of function is suboptimal, decisions regarding future treatments are made by the team. Patients, as well as, the disciplines involved rely on the weekly board meeting to assure continuity and integrity of care. We have found that this model best achieves our primary goals of rapid rehabilitation and maximal restoration of function to our patients with voice disorders and head and neck cancer.

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