

Voice Disorders in Children: Structure and Evaluation

Lawrence A. Bloom, Stewart R. Rood

(Pediatric Clinics of North America, Vol 28, No 4, November 1981)

Structure and Function of the Child's Vocal Tract

The pediatric vocal tract is different from its postpubescent counterpart. The upper airway in the child is characterized by its own set of structural parameters. The section briefly reviews the characteristics of the pediatric larynx and pharynx that make it unique, the functional consequences of these, and the brief discussion of the phonation and resonance process.

Larynx and Pharynx

The larynx in the child is not simply a "small" adult larynx. It is basically different in shape and extralaryngeal relationships. The neonatal thyroid cartilage is best described as a gradually curving semicircle, the two laminae meeting at an angle of about 130 degrees. The cricoid cartilage is quasi-oval in shape. The cricoid lamina tilts posteriorly, such that the subglottic airway resembles a funnel. Thus, the diameter of the immediately subglottic airway is less than that of the supraglottic in about 92 per cent of the population. Fishman and Parkley recently reported that about 8 per cent of the infant specimens studied were found to have a tracheal diameter less than that of the cricoid. The subglottic tube extends posteriorly and inferiorly in relation to the larynx, as well. The narrow internal cricoid and the direction that it takes are two points that should be remembered in attempting to intubate a neonate. The most significant difference in the neonatal arytenoid cartilage is that it is far less mobile than that of the adult owing to its grossly different shape.

At birth, the vocal cords are about 3 mm in length. They almost double in length through the first year of life. In the neonate, the cords appear somewhat concave from above because of the extension of the vocal process of the arytenoid cartilage almost halfway into the muscular cord. The bowed condition of the cord and the fact that about half of the cord is rigid, reduce the vibratory capacity of the structure and limit its use as a phonatory organ.

The most basic difference observed in the infant vocal tract is the high position in the neck maintained by the larynx. The cricoid cartilage lies opposite the third cervical vertebra, with the larynx tucked within the hyoid bone, which itself is high in the neck. This allows for the maintenance of a two tube system whereby the infant can breathe during extended periods of sucking. The position of the larynx in the infant makes it an excellent respiratory organ but a poor phonatory one. The reduction in vertical dimensions of the supraglottic pharynx to the level of the oral cavity makes this area a poor resonating cavity and prevents the cephalad laryngeal excursion necessary for the phonation of high pitched sounds.

Oral Cavity

The second significant difference in the infant's vocal tract is the relationship between the hard palate and the cranial base. The neonate's osseous palate is located in a more superior

position than that of the adult. Thus, the velum, too, is found more cephalad. At this stage, the levator veli palatini runs laterally rather than superolaterally, acting as a tensor rather than as an elevator of the palate. The position of the velum and the orientation of the extrinsic muscular elevator limit the capacity of the velum to function effectively in its role in phonation. The tongue is also limited in its ability to function as an articulator owing to its structure and position in the neonate. The tongue is located entirely within the oral cavity at this early stage, having no pharyngeal portion. In addition, it is short anteriorly-posteriorly and wide laterally, making it a clumsy organ for articulation. Also, in that the tongue fills the oral cavity in the infant, the capacity of the cavity to act as a resonator is severely reduced.

Thus, the structure of the vocal tract in the infant is more suited to respiration than phonation. However, the system is certainly capable of producing voice, grossly no doubt, but sound nevertheless.

Function of the Larynx in Phonation

In addition to being at a less than mature stage of development, the phonatory mechanism of the child is not subject to as fine motor control as that of the adult. Thus, the voice changes one may hear in a child are often more gross and more dramatic than those heard in the adult. Important to the production of voice is the ability to maintain a threshold subglottal pressure that is relatively constant during an utterance. This ability is one that improves with physical growth and language development. The production of sound is explained by the interaction of the elastic properties of contracted muscle and aerodynamic forces (see Borden and Harris for a more detailed review). The sound produced at the level of the vocal cords (the fundamental frequency) is subsequently modified by the pharynx at all levels (resonance) and finally altered by the shape of the oral cavity (articulation) to produce speech sounds.

Pitch changes are accomplished by shifts in the length, thickness, mass, and isometric tension of the vocal cords. Increased length and decreased thickness, hence decreased mass and increased isometric tension, within the body of the cords will result in the production of a higher pitch. A sudden increase in expiratory force, subglottal pressure, can also lead to the production of a high pitch voice, usually as a pitch break. Discrete pitch change is a learned behavior. Thus, the infant does not have the exacting motor control at this early stage to produce the wide range of pitches observed in the adult.

Intensity and pitch changes often interact in the untrained voice, certainly that which describes the young child. Intensity change by itself is accomplished by increasing subglottal pressure, resulting in a greater sinusoidal displacement of the vocal cords. Ability to produce a loud voice independent of pitch shifts will also improve with increased motor control.

Thus, although the pediatric larynx is structurally different from its adult counterpart, the organ works in a similar fashion to that of the adult. With improving competence in motor control and changes in structure with development, the child begins to approximate the variety of laryngeal postures necessary for human communication of thought and feeling.

Common Pediatric Voice Disorders

Deviant voices are generally tolerated and frequently prized in our culture. The freckle-faced, raspy-voiced kid in the television commercial warms our hearts, and the tough-guy with a voice that speaks of cigarettes and whiskey at three o'clock in the morning readily becomes a movie folk hero. Thus, the clinician is hard-pressed to determine which deviant voices require treatment. The physician may base this determination on pathologic changes in the vocal cords; the speech-language pathologist may have to rely on less objective determinants. A deviant voice may be considered in need of treatment if it meets one of the following three criteria: calls attention to itself, interferes with communication, or causes the speaker to be unhappy.

Incidence reports of voice disorders in children range from below 1 per cent to more than 20 per cent of the population. The majority of surveys indicate that approximately 6 to 9 per cent of children in the USA demonstrate a voice disorder. Of the many voice disorders which have been described, those most likely to appear in a pediatric practice fall into three basic categories: disorders of vocal quality, disorders of pitch, and disorders of resonance. This system of categorization is arbitrary and by no means exclusive. Quite frequently the disorders overlap. The production and the perception of voice are multidimensional phenomena, and it is unlikely that a voice will be perceived to be defective along only one dimension.

The most common pediatric disorder of voice quality is that of hoarseness. This quality is sometimes referred to as roughness or huskiness, and it usually implies a voice which is low pitched, strained, and grating. It may also contain aspects of harshness, such as raspiness and a crackling quality. Pitch range may be narrow. Breathiness may also be present, together with inappropriate variations in audibility. When no organic disorder is present, this problem is essentially caused by excessive muscle tension, sometimes referred to as vocal hyperfunction, vocal abuse, or vocal misuse. This type of voice is commonly heard with laryngitis, and may frequently occur after periods of excessive vocal use such as vociferous participation in sporting events. It is probably only worthy of concern if it persists beyond a few weeks, or if it occurs frequently. Hoarse patients tend to be intense people who may present with behavior problems.

Voice pitch may be considered deviant if it is higher or lower than is expected in the culture for the child's age and sex. Other problems of pitch include excessive pitch breaks and very narrow pitch ranges. Disorders of pitch may reflect organic disorders, or they may result from vocal misuse and/or personality problems.

Disorders of resonance typically refer to problems of hypernasality or hyponasality. Some nasal resonance may be found in all speech. In the English language, the m, n, and ng are nasalized. One frequently hears slightly nasalized production of vowels that precede or follow those three consonant sounds; if this is not offensive, it may be considered normal. When inappropriate or excessive nasal resonance becomes objectionable, a problem of resonance is present. Hypernasality may also be present on other consonants such as s, k, z, and g, which may be nasally emitted with a characteristic snort. Such problems are frequently associated with velopharyngeal dysfunction, though they may be primarily a result of defective functional articulation. Hyponasality is a lack of nasal resonance on the m, n, and

ng sounds. The patient may sound as if he has a severe cold, and may appear to be substituting b, d, and g for the nasal consonants. Hyponasality frequently is the result of an obstruction in the nasal pathway.

In evaluating a child with a voice disorder, the pediatrician should consider the possibility that the deviant voice is an index symptom suggesting a broader physical and/or emotional problem. Changes in physical and emotional states should be explored, along with a history of past and present stresses. Careful monitoring of the voice symptom over time should be undertaken. Referral for laryngological evaluation and consultation with a certified speech-language pathologist should be considered if the problem persists for more than a few weeks.

Evaluation by Speech-Language Pathologist

The speech-language pathologist is likely to engage in an evaluation of a pediatric voice disorder only in conjunction with an evaluation by an otolaryngologist. The speech-language pathologist brings to this evaluation unique and complex skills that require intensive training on the graduate level. Although the evaluation will vary in relation to the age of the patient, the chief complaint, and the results of the laryngological investigation, certain basic elements are likely to pertain. An evaluation generally involves a thorough history taking, a series of observations, and a series of tests.

The history will likely include general information regarding the patient and the patient's family, a detailed history of the complaint, a supplementary medical history, a history of the patient's voice usage, and possibly a psychosocial history. Information gathered in such a history will be used not only in the formulation of a concept of etiology, but also in planning for a treatment procedure that is tailored to the individual and the family.

The speech-language pathologist will observe the patient in both structured and unstructured situations. It will be important to determine the patient's effectiveness as a communicator, his habitual vocal usage, his strategies for dealing with his voice problem, and other vocal habits that may affect voice, such as excessive talking, excessive shouting, coughing and throat clearing.

The formal tests available to the speech-language pathologist in the evaluation of voice are numerous and varied. The evaluator is likely to develop a voice profile for the patient, and may include specific evaluation of pitch and loudness, quality, phonation time, breathing, resonance, articulation, vocal habits, and others. In addition, the speech-language pathologist is likely to attempt some brief therapy or "stimulability examination" in order to obtain some indication as to how the patient may respond to therapeutic approaches.

Results of the evaluation will be considered in conjunction with the findings of other professionals who may be involved with the patient. Recommendations may be made for voice therapy, or for voice therapy in coordination with other treatment, on the basis of the results of all evaluations and the statements of the child and family regarding their motivation and attitudes toward treatment.

Treatment

Voice therapy is usually considered the treatment of choice under the following circumstances: to determine if a laryngeal disorder can be alleviated through voice therapy; for adaptation to congenital or acquired anomalies; and for nonorganic cases. Laryngeal problems that are likely to respond favorably to voice therapy include vocal nodules, vocal fold thickening, polypoid conditions, and chronic nonspecific laryngitis. This is especially true in patients in whom vocal misuse or abuse is felt to be the cause of the problem. Surgical removal of vocal nodules is usually postponed until the patient has had a significant trial with voice therapy. A trial period of voice therapy cannot be expected to produce significant results unless that period is longer than three months, with sessions taking place at least once a week. The use of complete vocal rest is controversial; it is a rare child who can tolerate complete vocal rest for as long as 14 days. The stress that may be created for a child and his family when any length of vocal rest is prescribed may in itself contraindicate such a procedure. Whispering is never helpful.

The treatment of voice disorders by the speech-language pathologist will vary greatly as a result of the training of the professional, the philosophical basis of the therapeutic approach, the age and disorder of the patient, the time available for the treatment, and the like. The therapy is likely to involve an approach to helping the young patient understand the nature of the voice disorder, the importance of voice improvement, and the nature of the therapeutic steps that must be taken by the child. The therapist is likely to engage both the child and the family in environmental manipulation, which may include reduction of shouting in the home, reduction of shouting at play, appropriate amounts of rest, and attention to other aspects of vocal hygiene.

A significant portion of the therapy will be devoted to symptom management. The patient is likely to be taught to discriminate between appropriate and inappropriate voice production, to produce voice correctly, and to habituate the new and more desirable vocal patterns. Space does not permit a discussion of the multitudinous methods by which these objectives may be obtained. The therapist must be knowledgeable in the areas of anatomy and physiology of voice production, techniques of therapy, and above all, human nature.

Personality factors are frequently believed to play a significant role in the development of vocal disorders. Therefore, vocal psychotherapy is often undertaken as an integral part of the management of voice disorders. This aspect of the treatment may be undertaken by a specifically trained speech-language pathologist, or in conjunction with a psychiatrist or psychologist. In many cases, it is the quality of the vocal psychotherapy which will determine the outcome of the treatment.

It is important that the physician and the speech-language pathologist engage in periodic objective reassessment of the patient's condition. In the early stages of treatment, it is wise to undertake reassessment at three months intervals. Decisions regarding termination should be made in a collaborative manner, and periodic reevaluation should be done by all members of the voice team. An approach to the treatment of voice disorders which combines the skills of the physician and the speech-language pathologist should serve to produce optimal results for the pediatric patient.