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Center for International Rehabilitation Research Information and Exchange (CIRRIE)
515 Kimball Tower
University at Buffalo, The State University of New York
Buffalo, NY 14214
E-mail: ub-cirrie@buffalo.edu
Web: <http://cirrie.buffalo.edu>

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Cleft Palate-Speech Evaluation

Benjamas Prathanee, Ph.D.

**Associate Professor, Speech and Language Pathologist, Faculty of Medicine
Khon Kaen University, Khon Kaen, Thailand 40002**

Communication problems are common in individuals with cleft lip and palate. Successful surgery in early months of life and an effective multidisciplinary approach in later years are important for minimizing the associated problems, however, most people with cleft palate still have communication stigmas associated with cleft lip and/or palate. Communication disorders in cleft palate are typical, complicated, and present significant challenges including:

- Delayed speech and language development
- Articulation disorders: Articulation disorders in cleft palate can be classified follow cleft type characteristics (CTCs) follow as (John et al. 2006)
 - Anterior oral CTCs: dentalization/ inter-dentalization, lateralization/lateral, palatalization/palatal
 - Posterior oral CTCs: double articulation, back to velar/uvular
 - Non oral CTCs: pharyngeal articulation, glottal articulation, active nasal fricatives, double articulation
 - Passive CTCs: weak and or nasalized consonants, nasal realization of plosives, and/or suspected passive nasal fricative, gliding of fricatives/affricates
 - Non-cleft speech immaturity/errors
- Voice disorders from laryngeal hyperfunction in an attempt to compensate for acoustic effects of velopharyngeal dysfunction or compensatory articulation of glottal stops
- Deviant resonance and nasal airflow from velopharyngeal insufficiency (VPI)
 - Hypernasality
 - Hypernasality
 - Nasal emission
 - Nasal turbulence

There are several protocols and methods that exist for evaluating speech and language disorders in cleft palate. These include perceptual speech assessments, intraoral examination, language assessments, articulation tests, universal parameter tests for standard speech reporting , acoustic analysis (e.g., spectrography, the oral-nasal acoustic ratio), aerodynamic measurements, observation of structure movement (e.g., nasopharyngoscopy, videofluoroscpy, electromyography). This article aims to summarize the evaluation of speech and language disorders in individuals with cleft lip and/or palate.

Oral peripheral examination

Oral peripheral examination aims to identify features affecting speech and language problems in cleft palate (Witzel 1995, Peterson-Falzone et al. 2010, Kummer 2008). The oral peripheral examination includes examination of the nose, lips, teeth, malocclusion, maxilla, mandible, tongue (ankyloglossia or short frenulum), hard palate, soft palate, pharynx, larynx and related function.

Evaluation of language

Various and broad language assessment tools have been in use for several years in many languages. It is important to keep in mind that these tools should have validity and reliability. Periodic language evaluation is recommended for appropriate tests and times (Estrem Broen 1989, Scherer and D'Antonio 1995, American Cleft Palate-Craniofacial Association 1993) due to clinic visit protocols. For infants and toddlers from age for 0-18 months, assessment of early communication skills and language development focuses on 3 major areas of communicative behavior: parent-child interaction, early social communication skills, and receptive and expressive language skills (Girolannetto 1995). For preschool children, a number of tests have been developed for language assessment (Werner and Kresheck 1983, Carrow-Woolfolk 1985, Gardner 1990, Reynell and Grube 1990). These tools can be generally used for both typical children and children with risk for delayed speech and language development including individuals with cleft lip and palate.

Evaluation of speech disorders

Systems for the assessment of cleft speech disorders have been developed to elicit cleft-type speech characteristics and have been available for use for many years. Both perceptual and instrumental assessments exist and are used for reporting speech outcomes. Recent assessments have contained a cross-country, universal, and an international system, for example, a perceptual assessment system in Sweden (Dotevall 2002); the Swedish Articulation and Nasality Test (SVANTE) (Lohmander et al. 2005); speech assessment in the Scandcleft Project (Lohmander 2009); the cleft audit-protocol for speech, augmented (CAPS-A), an updated version of the original CAPS, that measures cleft-type speech characteristics and records these using a traffic light system which aims to meet the needs of both outcome data and future treatment needs (John 2006); and the system of universal parameters for reporting speech outcome (Henningsson 2008). This later system is an easy method which is comparable across cleft centers and countries. Each center in any country can establish a speech sample that follows the guidelines for assessing speech disorders. Reliability should always be done to standardize methodology in each center.

Overall, most cleft palate speech assessments generally contain universal speech parameters including: 1) Hypernasality, 2) Hyponasality, 3) Audible nasal air emission and/or nasal turbulence, 4) Consonant production errors, 5) Voice disorder and 6) Speech intelligibility/ understandability/ acceptability. The results are reported as global parameters that can be reported for any type of speech disorders in cleft, regardless of the spoken language.

For global assessment, the parents' and layman's evaluation should also be included because children with cleft have to function in a social environment that is often highly competitive (Witt et al. 1996). The perceptual speech assessment result, as judged by a parent and or layman group (naive untrained persons), is crucial as it reflects the patient's social function.

For any developing country where there is a lack of qualified speech and language pathologists, parameters of speech outcomes may be screened by trained paraprofessionals for which reliability should be the focus for standardization. In a case of suspected VPI, the patient should be referred, and the condition confirmed, by qualified speech and language pathologist for formal evaluation and management.

Evaluation of velopharyngeal insufficiency (VPI)

VPI is the inability to completely close the velopharyngeal part of the oral cavity during speech. The resultant leakage of air into the nasal cavity during speech can cause hypernasal vocal resonance and nasal emission/turbulence. Estimation of the prevalence of hypernasality/ VPI

ranges from 5-67% (Morris 1973, Spriestersbach et al. 1973, Enderby and Emerson 1995, Peterson-Falzone and Graham 1990) based on cleft types. Although perceptual speech evaluation is subjective, it is still the gold standard and therefore a necessary measurement. Several perceptual systems have been standardized to assess VPI, and include, for example, the Pittsburgh Weighted Speech Scale (PWSS) (0 = velopharyngeal competence, 1-2 = borderline incompetence, 3-6 = moderate incompetence, and >7 = velopharyngeal incompetence (McWilliams and Philips 1979); a 5-level scale for nasality (0 = none, 1 = mild and inconsistent; 2 = mild and consistent; 3 = moderate and consistent; 4 = severe and consistent) (Sell et al. 2001); a 3-level scale for VPI evaluation (0=competent; 1=marginally competent; 2=incompetent) (Lohmander et al. 2009); and 4-level scale for universal parameters for reporting speech outcome (0 = within normal limits; 1 = mild; 2 = moderate; 3 = severe, x = missing data) (Henningsson et al. 2008). This later system seems simple and easy to universally use for VPI categorizing.

Comment [Aae1]: Hypernasality is an indication of VPI, therefore these 2 figures do not appear compatible

In addition to perceptual speech assessment, adequate measurement of velopharyngeal closure requires direct instrumental measurement in order for further management and intervention to be carried out. Many methods exist for evaluating velopharyngeal function. Each method has inherent strengths and weakness and can provide both unique and overlapping information pertaining to velopharyngeal management (van Doorn and Purcell 1998). Some popular indirect objective measurements include nasometry, the pressure flow technique, the nasality severity index (NSI), and rhinomanometry; direct measurements include nasopharyngoscopy, lateral cephalometric radiography, videofluoroscopy, and magnetic resonance imaging (MRI).

Nasometry is a technique that provides a nasalance score (the percentage of nasalance score is calculated from nasal acoustic energy divided by nasal acoustic energy plus oral acoustic energy, multiplied by 100). Nasometry is a noninvasive measurement that needs minimal patient cooperation. Standardized nasometry scores have been published in several languages such as English (Seaver et al. 1991, van Doorn and Purcell 1998); Flemish (Van Lierde et al. 2001), Thai (Prathanee et al. 2003). The nasalance score is a valid correlate of perceived nasality (Fletcher 1976), has a high specificity (86%), a high sensitivity (87%), and a high overall all efficiency (87%) (Dalston et al. 1993). However, nasalance score has a limited implication for cross-country or cross-language comparison because interpretation for identify between normal and abnormal base on the cut off point using. Therefore, it should be a supplementary but not a substitute for clinical judgment (Vallino-Napoli and Montgomery 1997).

Pressure flow technique or aerodynamic assessment provides quantitative measurement of velopharyngeal function and was developed by Warren and Dubois (Warren and Dubois 1964) based on a Theoretical Hydraulic Principle. It is assumed that the area of the velopharyngeal port can be determined if the differential pressure across the orifice is measured simultaneously with rate of airflow through it. The velopharyngeal orifice area is indirectly calculated by using hydrokinetic principle. Pressure, nasal airflow, and velopharyngeal orifice areas are determined using a speech sample that includes consonant and vowel syllables and the word “hamper”. A normal velopharyngeal area and cut off score for oral and nasal sounds were determined and used for comparison to persons with cleft palates by Smith and Guyette (Smith and Guyette 1996).

The nasality severity index (NSI) is an objective measurement of hypernasality based on a multiparameter approach. It was recently developed by Van Lierde et al. (2007). The multiparameter approach consists of the nasalance, the nasality, and aerodynamic capacities. The NSI is calculated from the equation $NSI = -60.69 - (3.24 \times \text{percent oral text}) - 13.39 \times \text{Glatel value “/a/”} + [0.244 \times \text{maximum duration time (seconds)}] - (0.558 \times \% \text{ “/a/”} + (3.38 \times \text{percent oronasal text}))$. Sensitivity and specificity of NSI were 88% and 95%, respectively.

Component rhinomanometry is a technique for partitioning nasal airway resistance into its nasal cavity and velopharyngeal components. It helps to determine nasal airway potency for functional management of the cleft nose and for management of hyponasality (Smith and Guyette 2004). Component rhinomanometry is the pressure-flow measurement which provides nasal airway resistances and orifice areas for the right and left nasal cavities and velopharyngeal region and is used to calculate total nasal airway resistance. Normative nasal resistances for different age groups, genders, and respiratory mode are provided by Smith and Guyette (Smith and Guyette 2004)

Nasopharyngoscopy is a technique for direct velopharyngeal functional examination that allows observation of the velopharyngeal port during speech using an endoscope. Movements of the soft palate, posterior, lateral pharyngeal walls, and patterns of velopharyngeal closure are seen. It is very common, and the majority of cleft teams use this procedure for the assessment of VPI. However, data obtained from nasopharyngoscopy depends on the position and angle of the tip of the endoscope and requires subjective interpretation.

Lateral cephalometric radiography is a standardization of lateral head radiography that allows development of quantitative craniometry. It allows quantifiable assessment of the skeletal framework and the associated soft-tissue structures of the velopharyngeal mechanism. Normal standards and growth of the velopharyngeal structure were established by Subtelny (Subtelny 1957). However, cephalometric images are not typically used for routine assessment of velopharyngeal function because the images are still, therefore velopharyngeal function during speech cannot be evaluated. These images also only show the midsagittal section of velopharyngeal port; lateral pharyngeal wall cannot be investigated.

Videofluoroscopy is an effective means for evaluating of the movement of the velopharyngeal mechanism during real-time speech. Three views (lateral, frontal, and the cranial base) can be investigated, providing information on the a three-dimensional structure that operates as a sphincter. It provides the best information regarding the dynamic function of velar, and pharyngeal wall movement over the entire vertical and horizontal areas of the oropharynx to determine the deficiency of velopharyngeal port. This procedure can be used to review the functional outcomes of pre- and post-surgery or primary palatoplasty and secondary velopharyngeal management. Videofluoroscopy provides helpful dynamic visualization but involves radiation exposure.

Magnetic resonance imaging (MRI) is the procedure which uses the resonant absorption and remission of radio waves by hydrogen nuclei to obtain images. MRI is noninvasive visualization of the velopharyngeal function and vocal tract without exposure to radiation or any known biohazards and provides better soft-tissue resolution. Functional images at any chosen level can be obtained in the sagittal, frontal and transaxial views without changing the position of the patient. MRI also provides an objective technique for detecting how individual sounds are produced from an anatomic perspective. The use of MRI is a new important technological tool in diagnosis and helps treatment decisions for individuals born with cleft (Ha et al. 2007). MRI also has high specificity and sensitivity of virtual nasopharyngoscopy for detection of VPI and good with accurate three-dimensional images. However, only a few studies are available, still lack of outcome data and a high cost (around 6 times more expensive than videofluoroscopy).

Nasopharyngoscopy and videofluoroscopy are widely accepted as state-of-the art techniques for direct assessment of velopharyngeal movement (Golding-Kushner et al. 1990), however, standardization for a reporting system has not been available. An international working group established a system for quantifying, recording and describing movement of velum, lateral,

posterior pharyngeal walls, as well as the size, shape, symmetry and location of velopharyngeal gaps on a relative scale (Golding-Kushner et al. 1990). This scale can be applied to both nasopharyngoscopy and videofluoroscopy. The working group concluded that both nasopharyngoscopy and videofluoroscopy should be standardized based on a ratio rather than an absolute measurement. The movement ratios could be computed for the structure being analyzed relative to the resting position of the structure at the apposite side of the value, with the movement of each structure being rated separately.

These direct assessments of velopharyngeal function provide very and necessary useful information, adding to perceptual evaluation. Information from both perceptual and instrumental evaluations usually show that the perceptual speech assessment is able to correctly predicted gap size of velopharyngeal function (70%)(Kummer et al. 2003). The strongest prediction is if the patient had nasal rustle suggesting a small gap, or if the patient had moderate to severe hypernasality suggesting a large gap (Kummer et al. 2003). For determining the surgical procedure to correct velopharyngeal insufficiency, both perceptual and direct instrumental evaluations are required.

Summary

Peripheral oral examination and perceptual assessment are the necessary first steps in cleft palate speech evaluation because treatment is recommended only when speech impairment is perceived. Perceptual assessment provides important information regarding articulation, resonance, voice and intelligibility, and indicates velopharyngeal function during speech. For determining diagnosis or diagnostic therapy, treatment or intervention, and the surgical procedure for secondary speech surgery, the additional information from direct assessments (both nasopharyngoscopy and videofluoroscopy) has been recommended by a majority of experts for several years (Rowe and D'Antonio 2005, Dudas et al. 2006, Shprintzen and , Golding-Kushner 1989, Rudnick and Sie 2008). Conventional videonasopharyngoscopy is the gold standard for the screening and diagnosis of individuals at risk for velopharyngeal insufficiency (Witt 2000). Videofluoroscopy should be an additional investigation tool if it is available and patient can afford it. For magnetic resonance imaging, it is primarily investigational and educational at this time (Smith and Guyette 2004). Because of these disadvantages, MRI is not a standard investigational tool for assessing velopharyngeal function (Kummer 2008).

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