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Physiology of Speech and Its Effect on Velopharyngeal Function

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Abstract: *Maxillofacial prosthodontics focuses on optimizing the rudimentary functions of speech and swallowing[1].These functions are disrupted because of congenital, organic, traumatic or surgical abnormalities involving the oral cavity and related anatomical structures[1].It is a prosthodontic challenge to rehabilitate a patient with soft palate defect.Palatopharyngeal dysfunction may take place when palatopharyngeal valve is unable to perform its own closing due to lack of tissues or lack of proper movement. This article gives a review on speech, palatopharyngeal function and various ways of assessment of speech in velopharyngeal functions.*
Key Words: *Speech, palatopharyngeal dysfunction*.

I. Introduction

Craniofacial clefts in the area of lips,the palate and the alveolus rank among the most frequent malformation,affecting new born[4] in the ratio of 1:5.Such morphologic anomalies can result in esthetic and functional disorder, whereas one must differentiate primary and secondary disorders[4].Primary disorders include those interfering with food ingestion,deglutition and mimicry.Speech and voice disorders as well as tympanic ventilation disorders with persistent hearing loss affecting speech development are considered as secondary disorders[4](Paul.S.et al in 2005)

Based on this ,an attempt was made to understand the components of speech,various palatopharyngeal defects and their management .

II. Anatomic And Physiologic Consideration

The soft palate is a dynamic separator of the oral cavity & nasal cavity[2].During respiration,an individual either inspires or expires through the nose or mouth but never both simultaneously(fig-1).During expiration,air passes from the lungs,through the pharynx,and then through the oropharynx.Either the air then passes behind the soft palate into the nasopharynx,the nasal cavity, and out of the nose ,or the soft palate elevates to block the nasopharynx and the air passes out the oral cavity[1].During inspiration,the air passes in the opposite direction,through either the nasal cavity or the oral cavity.

The soft palate elevates in the middle third to separate the oropharyx and nasopharynx during speech, respiration and swallowing.The soft palate musculature extends from the pharynx at the level of palate, inferiorly to the tonsillar area. The right & left muscles of soft palate attach to the distal aspect of hard palate and then intermingle on the entire midline length of soft palate, forming an aponeurosis[1].Simultaneous contraction of these bilateral muscles causes midline elevation of soft palate.

As a result,the soft palate elevates,the pharyngeal wall simultaneously moves anteriorly & medially at the level of soft palate elevation,which is in line with plane of hard palate and atlas of C1[1].The sphincter formed by the soft palate & pharyngeal wall tightly closes and prevents any passage of liquid or food into the nasopharynx during deglutition.

During phonation, the soft palate also elevates, and the pharyngeal wall moves anteriorly and medially (fig-1),but movement of both structures is usually less dramatic than the sphincter movement that occurs in swallowing.The failure of soft palate to elevate during speech results in air leak[7].These functional movements of soft palate and pharyngeal walls during speech and swallowing is called velopharyngeal closure[1].

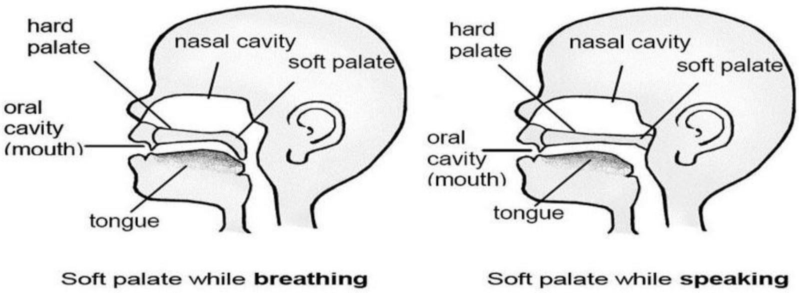

Fig-1

Normal velopharyngeal function is achieved by the synchronized movement of structures of the velopharyngeal mechanism – soft palate, lateral and posterior pharyngeal walls - which play a fundamental role in the production of speech, since it is responsible for the distribution of the expiratory airflow and acoustic vibrations to the oral cavity, during the production of oral sounds, and to the nasal cavity, during the production of nasal sounds[3] (Camargo et al., 2001; Kummer, 2001).

The inadequacy of the velopharyngeal mechanism may affect the speech in different manners. The term velopharyngeal dysfunction (VPD) is employed to indicate any alteration in the velopharyngeal mechanism[3] (Johns et al., in 2003) resulting from,

1. Lack of tissue for achievement of proper velopharyngeal closure[3,7](velopharyngeal insufficiency)(fig-2)
2. Lack of neuromuscular competence in the movement of velopharyngeal structures[3,7] (velopharyngeal incompetence)(fig-3), or
3. As a consequence of mislearning or maladaptative velopharyngeal function, not related to physical or neuromuscular problems [3]

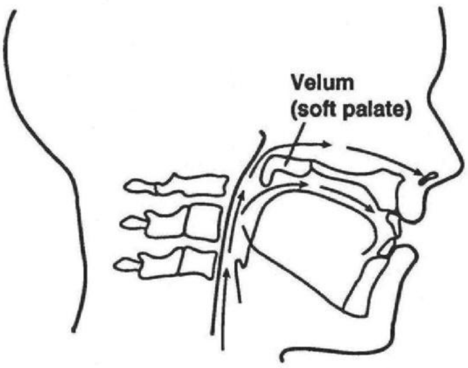

Fig-2

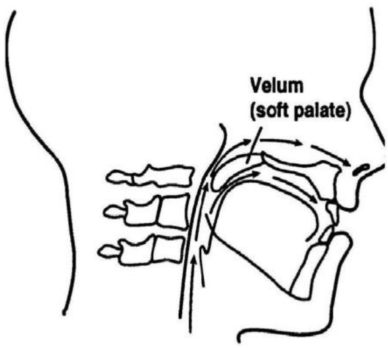

Fig-3

The most common speech symptoms of VPD [3](Trindade and Trindade Junior,1996). are ,

1. Hypernasality
2. Nasal air emission (audible or not) and
3. Compensatory articulation

III. Classification Of Soft Palate Defects (Seymorbirnbach) 5

I . Surgically unrepaired soft palate[5]:

Palatal incompetence
Congenital palatal insufficiency
Clefts of posterior one third of soft palate
Clefts of posterior two third of soft palate
Clefts of entire soft palate

II. Surgically repaired soft palate[5]:

Palatopharyngeal insufficiency with good to moderate soft palate activity
Palatopharyngeal insufficiency with little or no palatal activity
Scarred and fibrous soft palate
The short soft palate

III. The soft palate paralysis[5]:

Central nervous system injury
Muscle metabolism pathology such as myasthenia gravis
These defects can also be classified as congenital,acquired,developmental[1,6].
Congenital : Embryologic development of hard & soft palate is interrupted[1,6]
Acquired defects: Surgical resection of neoplastic disease which can alter the continuity the soft palate[1,6]

Developmental Defects: Diminished capacity of the soft palate to respond to functional demands may be the result of muscular or neurologic diseases[1,6]

IV. Soft Palate And Speech

Complete velopharyngeal (VP) closure is required during swallowing and for the production of all consonants except for the nasal consonants (Johns et al., 2003)[3]. The pattern of velopharyngeal closure depends on the degree to which each of these components of the sphincter is active during closure(Skolnick et al., 1973)[3].

The lack of velopharyngeal closure further leads to the development of compensatory articulations, which compensates for the inability to create pressure in the oral cavity. According to Trindade[3]and Trindade Junior[3] (1996), from an aerodynamic point of view stated that,

The primary effect of the failure in the articulation performance of the velopharyngeal structures is the development of a weak intraoral air pressure during production of plosive, fricative and affricate consonants, associated to with nasal air emission. Thus, individuals with VPD frequently replace orally articulated sounds by sounds articulated at points behind the area of impairment.

The most frequent compensatory articulations secondary to VPD are: (Kummer, 2001; Peterson-Falzone et al., 2001)[3].

1. Glottal stop(fig-4)
2. Velar stop
3. Pharyngeal stop(fig-5)
4. Pharyngeal frictative(fig-6)
5. Velar frictatives(fig-7)and
6. Posterior nasal fricative(fig-8)

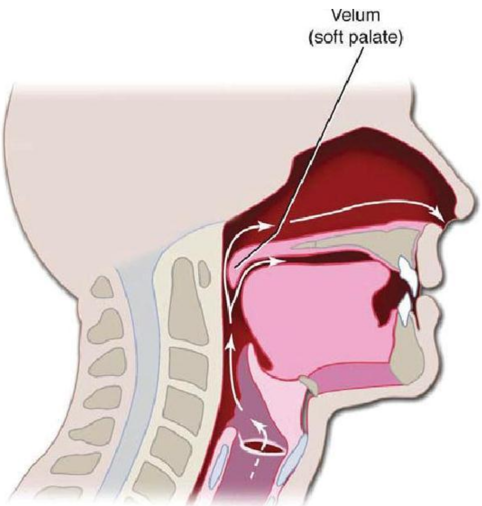

Fig- 4

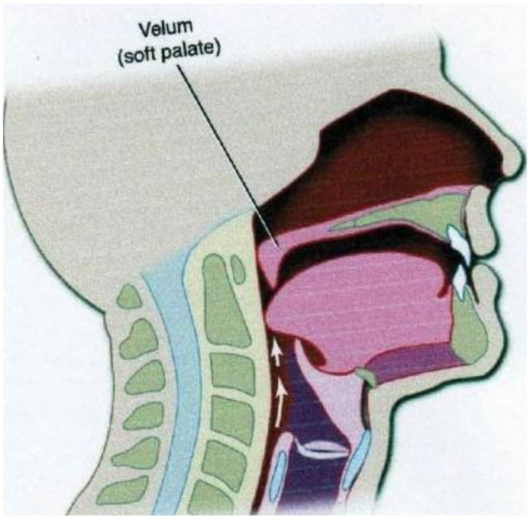

Fig-5

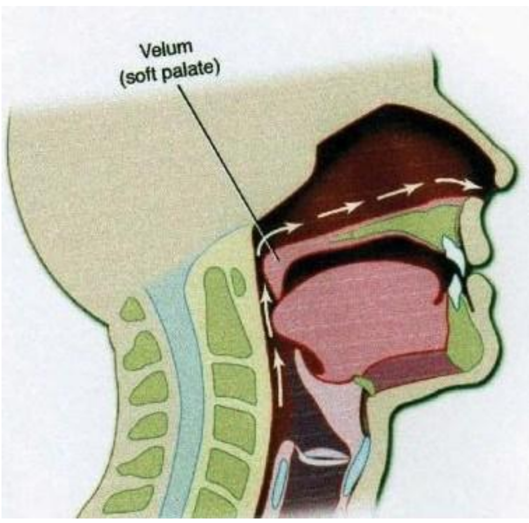

Fig-6

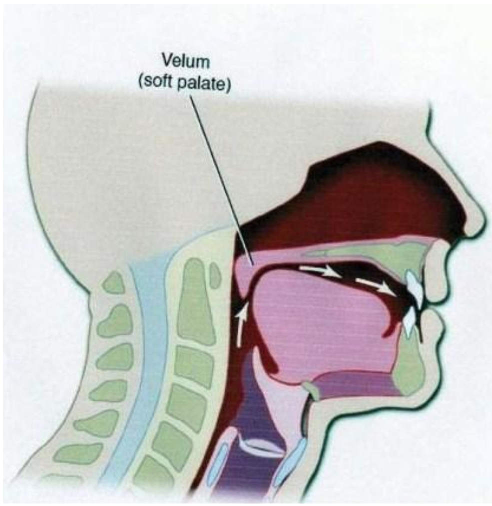

Fig-7

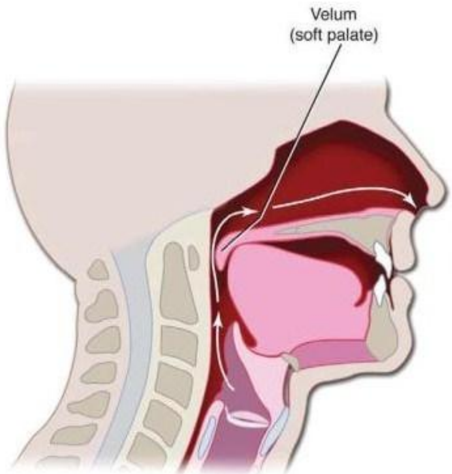

Fig-8

V. Velopharyngeal Function Rating In A Speech Perceptual Assesmemt

Perceptual assessment of speech plays a primary role in the diagnosis of VPD related symptoms[3]. Physical examination and clinical history plays the secondary role (Trindade ,Kummer et al., 2003)[3]. By perceptually evaluating of resonance and the presence or not absence of nasal air emission and compensatory articulation during speech, it is possible to rate the velopharyngeal function.

However, despite its well-recognized importance, the perceptual assessment presents some limitations due to its subjectivity which included [3],

1. The need of multiple examiners for validation of measurements
2. Difficulty to achieve uniformity between examiners, even when trained (Trindade and Trindade Junior, 1996)[3]. Thus, in order to minimize the subjectivity of VPD perceptual assessment and increase its reproducibility (improve the agreement of judgments for a same examiner at different moments or between different examiners), a new method for velopharyngeal function rating, based on scores, is proposed.

Based on the protocol of speech perceptual assessment evaluation used at the Laboratory of Physiology (HRAC-USP)[3], established according to the protocol of Dalston (1983) adapted to the Portuguese language (Trindade and Trindade Junior, 1996), velopharyngeal function is scored considering according to the following aspects of speech[3],

1. Hypernasality
2. Nasal air emission
3. Compensatory articulation

1.1.Hypernasality: Resonance is scored by using a 6-point scale[3]
Point 1 = absence of hyper nasality (normal Oro-nasal resonance)
Point 2 = mild hypernasality
Point 3 = mild to moderate hypernasality
Point 4 = moderate hyper nasality
Point 5 = moderate to severe hypernasality
Point 6 = severe hypernasality.
Scores equal or higher than 2 are considered clinically significant.

1.2.Nasal Air Emission: It is scored according to the amount of nasal air emission, as evidenced by mirror fogging, during blowing, prolonged emission of phonemes /i/,/u/, /f/, /s/ and /ò/ and of words and phrases with plosive and fricative phonemes, on a 6-point scale [3]
Point 1 = absence of nasal air emission
Point 2 = mild nasal air emission
Point 3 = mild to moderate nasal air emission
Point 4 = moderate nasal air emission
Point 5 = moderate to severe nasal air emission
Point 6 = severe nasal air emission .Scores equal or higher than 3 are considered clinically significant.
Compensatory articulation is scored on a 2-point scale, in which 1 = absent, or 2 = present.
Based on the combination of scores observed for hypernasality, nasal air emission and presence or absence of compensatory articulation, velopharyngeal function is then scored in a 3-point scale[3].
Point 1 = Adequate velopharyngeal function

Point 2 = Borderline or marginal velopharyngeal function
Point 3 = Inadequate velopharyngeal function.

According to the proposed criteria, a subject whose speech is scored as 1/1/1, meaning that there is no hypernasality, no nasal emission and no compensatory articulation, is diagnosed as having an adequate velopharyngeal function, scored as 1. Using the same rationale, a subject with a score of 6/6/2, meaning severe hypernasality, severe nasal emission and presence of compensatory articulation is diagnosed as having an inadequate velopharyngeal function, scored as 3.

VI. Classification Of Velopharyngeal Function Based On Hypernasality, Nasal Air Emission,Compensatory Articulation[3]

HYPERNASALITY	NASAL AIR EMISSION	COMPENSTORY ARTICULATION	
1	1	1	1-ADEQUATE
1	2	1	
1	3	1-2	2-MARGINAL
2	1-3	1-2	
3	1-3	1-2	
2	4-6	1-2	3-INADEQUATE
3	4-6	1-2	
4-6	2-6	1-2	

VII. Discussion

Because VPD is multifactorial, the frequency is unknown. For functional causes, determining the frequency is impossible, because some etiologies are acquired and some are congenital. Structural causes of VPD due to cleft palate occur in 1 in 2000 live births[8]. Almost half of all cleft palates have a syndromic cause,the most common syndrome is VCF syndrome (velocardiofacial syndrome)[8].VPD occurs in approximately 20% of children who undergo palatoplasty[8].

- Pattern of palatopharyngeal closure among normal speakers includes[9]
- Coronal Pattern **-** velum and palatopharyngeal walls Sagittal Pattern – Lateral pharyngeal walls
- Circular Pattern **-** All structures, sometimes includes Passavant's ridge

Palatopharyngeal dysfunction also results because of resonance disorder.Resonance is the modification of sound that is generated from vocal cord.It provides the quality of perceived sound during speech[9].Hypernasality,nasal air emission,compensatory articulation are causes of resonance disorder which in turn affects speech.

The following are specific therapy techniques that have been effective at Cincinnati Children's Hospital[9,10]. These techniques are offered as suggestions only.Oral & nasal listener [10]are used by speech pathologist to provide feedback about oral pressure,hypernasality,nasal air emission,articulation .The Nasometer[10] also provides excellent visual feedback of hypernasality and nasal emission

.

VIII. Conclusion

This article highlights the importance of considering the suitability of different speech assessment materials for individual speakers.It also gives an idea of perceptual assessment of velopharyngeal function that can contribute to our understanding of the ways in which children with speech difficulties are subjected to specific challenges of connected speech,which are intrinsic to everyday conversational interaction.Thus this article gives an idea of various velopharyngeal dysfunctions and various methods used to score nasal air emission,hypernasality and compensatory articulation.

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