Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Role of Palatal Expanders on Speech: A Review

Prachi Hazari[1], Nitinpreet Kaur [2], Nitin Jaggi[3], Sushil Bhagwan Mahajan[4], Ankur Dhuria[5], Heena Tiwari[6]

1. Senior lecturer, Dept. of Pediatric And preventive dentistry, Nanded Rural Dental College & Research Center, Nanded, Maharashtra;
2. Dasmesh Institute of Research and Dental Sciences, Faridkot, Punjab, India;
3. HOD & Professor, Department of oral surgery, Shri. Yashwantrao Chavan Memorial Medical & Rural Development Foundation's Dental College & Hospital, MIDC, Ahmednagar, Maharashtra;
4. PG Student, Dept of Orthodontics And Dentofacial Orthopedic, Dr.H.S.R.S.M. Dental College And Hospital Hingoli, Maharashtra;
5. MDS, Dept of Orthodontics and Dentofacial Orthopaedics, Assistant professor, Jaipur dental college, Jaipur Rajasthan;
6. BDS, PGDHHM, Ex-Government Dental Surgeon, Kondagaon, Chhattisgarh, India.

***ABSTRACT*:**
Rapid palatal expanders (RPEs) are a commonly used orthodontic adjunct for the treatment of posterior crossbites. RPEs are cemented to bilateral posterior teeth across the palate and thus may interfere with proper tongue movement and linguopalatal contact. It is important to identify what specific role RPEs have on speech sound production for the child and early adolescent orthodontic patient. Numerous phonemes were distorted upon RPE placement which indicated altered speech sound production. For most phonemes, it takes longer than two weeks for speech to return to baseline, if at all. Clinically pre-treatment and interdisciplinary counseling for orthodontic patients receiving palatal expanders is important
Keywords: Palatal Expanders, Rapid Palatal Expanders, Posterior Crossbite, Orthodontic movement, Speech.

Received: 02/06/2020 **Modified:** 20/07/2020 **Accepted:** 24/07/2020

Corresponding Author: Dr Prachi Hazari, Senior lecturer, Dept. of Pediatric And preventive dentistry, Nanded Rural Dental College & Research Center, Nanded, Maharashtra

This article may be cited as: Hazari P, Kaur N, Jaggi N, Mahajan SB, Dhuria A, Tiwari H. Role of Palatal Expanders on Speech: A Review. J Adv Med Dent Scie Res 2020;8(9):53-56.

ANATOMY

The supralaryngeal system is composed of the pharyngeal, oral, and nasal cavities. Most of the sounds of the American English language are formed by modifying one of these three cavities. Air travels from the larynx to the supralaryngeal system and is acted on by one of the moving structures called articulators.[1] There are numerous articulators but the most important of these is the tongue located at the floor of the oral cavity. The two main groups of muscles making up the tongue are the intrinsic muscles involved in changing the shape of the tongue, and the extrinsic muscles which allow movement of the tongue in the oral cavity.[2] There are four main areas of the tongue: tip, blade, dorsum, and root. The tongue tip (apex) at rest is the most anterior part of the tongue. It is involved in over 50% of consonant contacts spoken in English. The tongue blade is just posterior to the tip and seldom used for constriction and shaping the tongue. The dorsum (back) is a large segment that contacts the hard and soft palate during articulation. Lastly, the root of the tongue is

involved in shaping the vocal tract as it extends from the dorsum to the front wall of the pharynx.[1]

CONSONANTS

American English speech sounds can be classified into two main categories: consonants and vowels. Consonants are differentiated from vowels based on the degree of airway constriction caused by the articulators. This leads to far more defects in articulation for consonants than vowels.[3] According to Bloodstein (1984)[3], consonant articulation is categorized in three basic dimensions: place, manner, and voice. The place of articulation in the vocal tract can be further divided into bilabial, labiodental, linguadental, lingual-alveolar, linguopalatal, linguavelar, and glottal sounds. We will primarily focus on bilabial consonants (approximation of the two lips), labiodental sounds (lower lip contacting the upper teeth), lingua-alveolar sounds (tip of tongue located at alveolar ridge), linguopalatals (front of tongue contacting the hard palate), and linguavelar sounds (elevating back of tongue to velum). The last dimension of consonants is voicing which can be further subdivided into voiced and voiceless sounds. Cognate pairs share the same place of articulation and manner but differ based on their voicing. For example, the alveolar fricative /z/ as in "zip" is considered voiced meaning the vocal folds vibrate, while another alveolar fricative /s/ as in "sip" is voiceless.[4] The six most frequent consonant sounds are summarized in Table 1.[3] Note that all six consonant sounds are voiceless.

VOWELS

A vowel is defined as "a voiced sound in forming which the air issues in a continuous stream through the pharynx and mouth, there being no obstruction and no narrowing such as would cause audible friction".[5] Vowels are formed by vocal tones that are modified in the oral cavity by changes in tongue position.[6] The listeners' perception of a particular vowel is determined by the position of the major constriction of the tongue (front, center, or back), the degree of constriction (high, middle, or low), and lip rounding.[2] As described by Shriberg & Kent (2003)[4], the vertical position of the tongue, high-low (superior-inferior) is termed tongue height. High vowels are produced with the tongue superior towards the roof of the oral cavity while low vowels are produced with the tongue depressed towards the oral cavity floor. All the intermediate tongue positions can be described accordingly (e.g. high-mid, mid, mid-low). The horizontal position of the tongue, front-back (anterior-posterior), is termed tongue advancement. As the terms imply front vowels are articulated with the tongue in the most anterior position while the back vowels are formed with the tongue in a retruded position. Any intermediately formed vowels in the sagittal plane are termed central. The 6 most frequent vowels are summarized in Table 2.[2]

RAPID PALATAL EXPANDERS

Rapid maxillary expansion (RME) is commonly used in young, growing patients who present with a posterior crossbite. The transverse discrepancy can be skeletal (narrow maxillary base or a wide mandible), dental, or a combination of the two.[7] The three main types of fixed palatal expanders containing jackscrews are the Haas (Fig.1), Hyrax (Fig.2), and bonded types. Hyrax and Haas expanders are secured by bands around the upper first molars and often the first premolars. The bonded expander requires no bands and is secured with cement over the occlusal surfaces of the posterior teeth. Regardless of expander type, a central jackscrew stretches across the palate, is soldered to the bands, and is activated at home. One of the main disadvantages of an expander incorporating a jackscrew is its bulkiness in the palatal area.[8] This can lead to temporary speech difficulties as approximately 90% of all consonants are articulated in the anterior portion of the oral cavity.[9] Various broad range of consonants /f/, /s/, /ʃ/, /p/, /t/, and /k/, as well as a more inclusive list of vowel sounds /i/, /e/, /æ/, /u/, /o/, and /ɑ/ to better understand the effects of RPEs on speech sound production are analyzed in studies and literature. Clinically, this information can be shared with the patient undergoing orthodontic treatment during initial pre-treatment counseling.[10]

TABLE 1: CATEGORIZATION OF AMERICAN ENGLISH CONSONANT SOUNDS

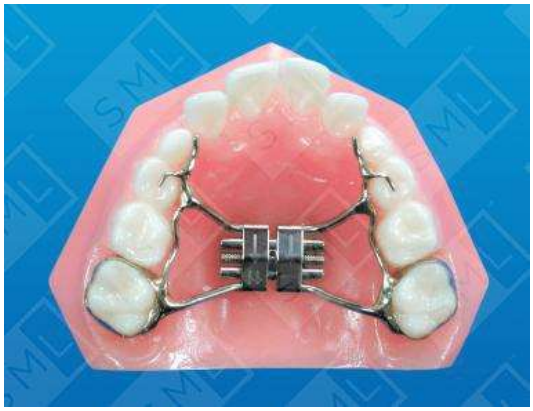
Manner of Articulation	*Position of Articulation*				
	Bilabial	Labiodental	Lingua-alveolar	Linguopalatal	Linguavelar
Stop-plosives	/p/ - pen		/t/ - top		/k/ - call
Fricatives		/f/ - fill	/s/ - sun	/ʃ/ - she	

TABLE 2: CATEGORIZATION OF AMERICAN ENGLISH VOWEL SOUNDS

Tongue Height	Tongue Advancement	
	Front	Back
High	/i/ - eat	/u/ - suit
Mid	/e/- vacation	/o/ - obey
Low	/æ/ - at	/ɑ/ - father

FIGURE 1: HASS APPLIANCE

FIGURE 2: HYRAX APPLIANCE



DISCUSSION:

Previous studies have utilized perceptual analysis to rank the degree of speaker impairment on a scale.[11-13] There are several problems with auditory judgements: the assumption that listeners utilize similar perceptual labels, are calibrated to the same scale values, can isolate one perceptual dimension from numerous occurring, uniform reliability when judging, and can discern at a level accurate enough to make judgements smaller than interjudge differences needed for clinical classification.[14-15] Perceptual inaccuracy has been demonstrated when listener's fail to recognize when a non-speech sound, such as a cough, has been substituted for a speech sound.[16-18] Studies had shown that Hyrax rapid palatal expanders influenced two of the six vowels and four of the six consonants analyzed. For both frequency bands and vowel phonemes, a decrease in frequency were noted. This suggests that talkers may have learned to compensate somewhat for the RPE by adapting tongue position, but a full return to baseline which was not noted within the two-week period, suggesting that they could not produce these phonemes using the baseline tongue positions. While trying to adapt to the orthodontic appliance, the tongue was positioned more inferior and posterior for /i/, and more posterior for /e/ when forming vowel sounds.[19] It is no surprise that that most affected vowel, /i/, is formed in the most anterior and superior aspect of the oral cavity and /e/ is formed anterior and in the mid height range. The affected consonants out of the six selected for analysis are: /s/, /ʃ/, /t/, and /k/. It appears that for this sound the tongue adapted to the appliance in under 2 weeks. It has been shown that there is more flexibility for a perceptually appropriate /t/ than for a /s/ sound which requires relatively more accurate tongue positioning for its production.[20] For /ʃ/, the S1 frequency decreased from T1-T2 but then increased from T2-T3 to a frequency higher than T1. This was not noted for any other consonant and indicates tongue over adaptation by dramatically changing how the sound was articulated, resulting in a totally different /ʃ/ sound. In the study by Stevens et al. (2011)[19], they analyzed spectral moments for /s/ and /ʃ/ and likewise found significant distortions. It wasn't until 2-4 weeks post insertion that adaptation occurred at levels similar to baseline. In a retrospective patient survey subject to RPE's, 89.4% claimed the expander affected their speech; however, no conclusions were drawn regarding which phonemes were affected[21]. Previous studies utilizing an intraoral bite block and an artificial palate have shown that consonant production is more affected than vowels.[22, 23]

CONCLUSION:

More insight can be given to patient's pre-treatment that are treatment planned for Hyrax expanders. For those patients under the care of both an orthodontist and speech pathologist, interdisciplinary collaboration can now be more goal focused to help with tongue position changes for specific phonemes. It is also clear that talkers do not learn to adjust tongue position for the RPE for all sounds within a 2-week period, which is typically about the time an orthodontist may do an expansion check. Future research may incorporate: inclusion of more phonemes, longer study length to include fixed appliance treatment and retention time points, and a larger sample size to look across more factors such as age, gender, and native language.

REFERENCES:

1. Seikel, J. A., Drumright, D., & Seikel, P. (2004). Essentials of anatomy & physiology for communication disorders Thomson Delmar Learning.

2. Skinner, P. H., & Shelton, R. L. (1978). Speech, language and hearing normal processes and disorders (Second ed.) John Wiley & Sons, Inc.
3. Bloodstein, O. (1984). Speech pathology: An introduction (Second ed.) Houghton Mifflin Company.
4. Shriberg, L. D., & Kent, R. D. (2003). Clinical phonetics (Third ed.) Pearson Education, Inc.
5. Roach, P. (2004). Phonetics (Third ed., pp. 73-74) Oxford University Press.
6. Travis, E. L. (1957). Handbook of speech pathology. New York: Appleton Century Crofts, Inc.
7. Bishara, S. E., & Staley, R. N. (1987). Maxillary expansion: Clinical implications. American Journal of Orthodontics and Dentofacial Orthopedics, 91(1), 3-14.
8. Profitt, W. R., Fields, H., & Sarver, D. M. (2013). Contemporary orthodontics (Fifth ed.). St. Louis, Missouri: Elsevier.
9. Leavy, K. M., Cisneros, G. J., & LeBlanc, E. M. (2016). Malocclusion and its relationship to speech sound production: Redefining the effect of malocclusal traits on sound production. American Journal of Orthodontics and Dentofacial Orthopedics, 150(1), 116-123.
10. Costello, J. M., & Holland, A. L. (1986). The phonological system: normal acquisition. Handbook of Speech and Language Disorders (pp. 25-74). San Diego, CA: College-Hill Press.
11. Chen, J., Wan, J., You, L. (2017). Speech and orthodontic appliances: a systematic literature review. European Journal of Orthodontics, 1-8.
12. Patel, R., Connaghan, K., Franco, D., Edsall, E., Forgit, D., Olsen, L., Ramage, L., Tyler, E., Russell, S. (2013). "The Caterpillar": A Novel Reading Passage for Assessment of Motor Speech Disorders. American Journal of Speech-Language Pathology, 22 1-9.
13. Milenkovic, P. (2005). TF32-Computer Program (Madison, WI).
14. Lobanov, B. M. (1971). Classification of Russian vowels spoken by different speakers. The Journal of the Acoustical Society of America, 49, 606-608.
15. Kent, R. D. (1996). Hearing and Believing: Some Limits to the Auditory-Perceptual Assessment of Speech and Voice Disorders. American Journal of Speech- Language Pathology, 5(3), 7-23
16. Warren, R. (1976). Auditory illusions and perceptual processes. In N. J. Lass (Ed.),
17. Contemporary issues in experimental phonetics (pp. 389-418). New York: Academic Press.
18. Warren, R. (1976). Auditory illusions and perceptual processes. In N. J. Lass (Ed.), Contemporary issues in experimental phonetics (pp. 389-418). New York: Academic Press.
19. Stevens, K., Bressmann, T., Gong, S. G., & Tompson, B. D. (2011). Impact of a rapid palatal expander on speech articulation. American Journal of Orthodontics and Dentofacial Orthopedics, 140(2), e67-75.
20. Flege, J. E., Fletcher, S.G. & Homiedan, A. (1988). "Compensating for a bite block in /s/ and /t/ production: Palatographic, acoustic, and perceptual data." The Journal of the Acoustical Society of America, 83, 212-228.
21. De Felippe, N. L., Da Silveira, A. C., Viana, G., & Smith, B. (2010). Influence of palatal expanders on oral comfort, speech, and mastication. American Journal of Orthodontics and Dentofacial Orthopedics, 137, 48-53.
22. McFarland, D. H., & Baum, S. R. (1995). Incomplete compensation to articulatory perturbation. The Journal of the Acoustical Society of America, 97(3), 1865-1873.
23. Baum, S. R., & McFarland, D. H. (2000). Individual differences in speech adaptation to an artificial palate. The Journal of the Acoustical Society of America, 107(6), 3572-3575.