The impact of an orthodontic palatal expander appliance on tongue movement and speech: Ultrasonographic, acoustic and perceptual data from a simulated orthodontic appliance

Tim Bressmann (1, 2), Gajanan Kulkarni (2), Amanda Braude (3), Parveen Thind (1), Yarixa Barillias (1)

(1) Graduate Department of Speech-Language Pathology, University of Toronto
(2) Faculty of Dentistry, University of Toronto
(3) Faculty of Dentistry, University of Western Ontario

Reduced maxillary width in repaired cleft palate

- Scarring from the palatal repair operation can lead to reduced maxillary width and a vaulted (‘gothic’) palate

Treatment of maxillary hypoplasia with rapid maxillary expansion: The Hyrax

Compensatory articulation in patients with cleft palate

Question

- How does the movement of the tongue change in the presence of a prominent and intrusive intraoral appliance such as a Hyrax maxillary expander?

Participants

- Five normal participants (3 female, 2 male)
- Mean age 31 years (SD 7.24; range 24-42 years)
- Self-reported normal speech and hearing
- Participants were fitted with simulated Hyrax appliances
Simulated hyrax appliance

Comfortable Head Anchor for Sonographic Examinations (CHASE)

Cardinal vowels in 2D

Ultrasonographic Contour Analyzer for Tongue Surfaces (Ultra-CATS)

‘... ninety-three years old.’

Acoustic analysis

- Material: Five metronome-paced repetitions of /aˈka/, /iˈki/ and /uˈku/
- Linear predictive coding (LPC) analyses of the steady-state portion of the stressed vowel were made using Kay MultiSpeech Model 3700
- Vowel space was expressed as an area function (vowel triangle)
Speech intelligibility and acceptability testing

- Test of Children’s Speech (TOCS+; Hodge et al., 2003)
- Orthographic transcriptions and ratings were made by a single listener
  - Single word intelligibility: 80 words
  - Sentence intelligibility: 80 words in 20 sentences
  - Speech acceptability: 4-point Likert scale

Results: Tongue movement in the presence of a simulated Hyrax appliance

Lingual Adaptation to Oral Perturbation
Normal /aka/

Lingual Adaptation to Oral Perturbation
Hyrax /aka/

Results: Midsagittal images of /i/ with and without a simulated Hyrax

Midsagittal tongue shapes during cardinal vowels
Conclusions (1)

• The simulated Hyrax led to retracted articulation
• The lingual retraction was reflected in a significant reduction of the vowel space
• The simulated Hyrax appliance led to speech sound distortions, which were reflected in lower speech intelligibility scores and speech acceptability ratings

Conclusions (2)

• Since the Hyrax appliance had a pronounced detrimental effect on tongue movement and speech, it is likely that these effects will be largely sustained for the duration of treatment
  - More research with real patients is needed to evaluate the long-term adaptation to the Hyrax appliance
• Patients with compensatory cleft-type sound substitutions have a tendency to retract their articulatory contacts. A Hyrax appliance may solidify the retracted compensatory speech sounds. The patient will not be able to make progress in articulation therapy during the time of treatment
  - More research with cleft palate patients is needed to evaluate the impact of the Hyrax appliance on the characteristics of compensatory sound substitutions
Compensatory articulation in patients with cleft palate

Conclusions (3)

- The orthodontist must consider the functional limitations associated with a Hyrax rapid maxillary expander
- Discuss the pros and cons of an expander appliance of the Hyrax type with the patient, the caregiver, and the speech-language pathologist
- It is important to determine the patient’s treatment priorities and goals to balance orthodontic and speech goals

Questions?

Voice and Resonance Lab webpage:
http://www.slp.utoronto.ca/People/Labs/TimLab/index.htm

Contact: tim.bresmann@utoronto.ca