Lingual Ultrasound Study of DFD Patients' Speech Following Orthognathic Surgery

Erika Rezende Silva[1], Griffin Lowry[1], Jeff Mielke[2], David Zajac[1], Laura Anne Jacox[1]
[1]University of North Carolina at Chapel Hill, [2]North Carolina State University

Objectives

Dentofacial Disharmonies (DFD), such as Class III 'underbite', require orthodontics and jaw surgery for full correction, as severe jaw disproportions negatively impact jaw function, esthetics, speech, and quality of life. DFD patients have a prevalence of speech distortions twenty times greater than the general public, and their speech-sound disorders often do not respond to speech therapy (i.e. non-stimulable) because they are caused by structural abnormalities. However, speech improves post-operatively in many Class III DFD patients, both perceptually and in consonant acoustic measures. Limited data are available on the mechanisms underlying DFD patients' speech errors and the articulatory adaptations following orthognathic surgery, particularly for vowels. Consonants demonstrate significant normalization in perceptual scores, center of gravity, and peak amplitude differences, with alterations in lingual articulatory strategies after surgery.

Methods

We sought to understand the effects of surgical correction on the speech of Class III DFD patients (N=10) through lingual ultrasound imaging and vowel formant frequency measurements during speech. Patients were recorded before (T0) and after jaw surgery (T1-short-term, 3-months post-op; T2-long-term, 12-months post-op). Class I non-surgical controls were recorded in two sessions, 3 months apart. Lingual gestures, including vowel height, were compared using Smoothing Spline ANOVA models. Mixed-effects linear regression models were used to evaluate for significant articulatory and acoustic changes pre- to post-surgery.

Results

DFD patients' lingual gestures for corner vowels adapt after jaw surgery. While there are no significant changes in formant frequencies, there were significant changes in tongue height relative to the palate for each vowel ($p<0.001$ for /a/, /i/, /u/; $p=0.006$ for /æ/). Controls showed no articulatory changes over time.

Conclusions

Data suggest that DFD patients adjust their articulatory movements post-surgery to achieve their pre-surgical vowel formant qualities, such that post-op changes in perceived speech are primarily linked to changes in consonants. Lingual ultrasound imaging can provide unique articulatory information that cannot be perceived but contributes to our understanding of how jaw surgery impacts DFD patients' speech.