Evaluating Impacts of Orthognathic Surgery on Speech in Class III Dentofacial Disharmony Patients
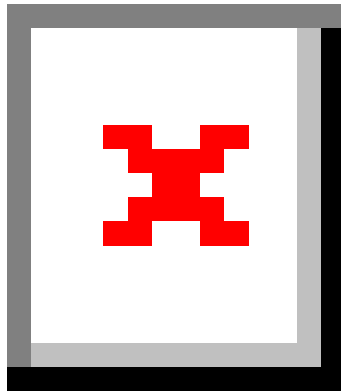
2023 Research Aid Awards (RAA)

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FollowUp Form

Award Information

In an attempt to make things a little easier for the reviewer who will read this report, please consider these two questions before this is sent for review:

- *Is this an example of your very best work, in that it provides sufficient explanation and justification, and is something otherwise worthy of publication? (We do publish the Final Report on our website, so this does need to be complete and polished.)*

- *Does this Final Report provide the level of detail, etc. that you would expect, if you were the reviewer?*

Title of Project:*
Evaluating Impacts of Orthognathic Surgery on Speech in Class III Dentofacial Disharmony Patients

Award Type
Research Aid Award (RAA)

Period of AAOF Support
July 1, 2023 through June 30, 2024

Institution
University of North Carolina at Chapel Hill

Names of principal advisor(s) / mentor(s), co-investigator(s) and consultant(s)
Dr. Laura Jacox, Dr. Jeff Mielke, Dr. David Zajac

Amount of Funding
$6,000.00

Abstract
(add specific directions for each type here)

Patients with severe Class III dentofacial disharmonies (DFD; jaw disharmonies) seek orthognathic surgery and orthodontic care to address issues with mastication, esthetics and speech. Preliminary data from thousands of DFD patients generated by our colleagues at UNC-CH indicate speech concerns surpass impaired chewing function as a motivator for surgery. In addition, others have determined that abnormal articulation impedes communication and profoundly impacts quality of life. Articulation errors are seen nearly twenty times more frequently in Class III DFD patients than in the general population, but limited longitudinal, quantitative data exist to evaluate post-operative outcomes in speech. As a result, it is unknown whether surgical correction yields lasting improvement in articulation. As providers, we are unable to give evidence-based recommendations as to whether our orthodontic and surgical intervention will address their speech disorders. Despite this, patients undergo invasive jaw surgery in hopes of articulation and speech improvement. To address this gap in knowledge, we have gathered pre- and post-operative orthodontic records, audio and ultrasound recordings of patients with Class III DFD to quantitatively characterize their speech up to a year after surgery.

There are three classes of DFD presentation, including underbites (Class III), anterior open bites (AOB), and overbites (Class II). Here we focus on Class III because our data indicate there are profound speech distortions associated with this malocclusion, and we are the first to find linear correlations between this malocclusion's severity and degree of distortion. Common speech distortions associated with Class III DFD include sounds that depend on articulation of the tongue and alveolus including the stop "t" (represented as /t/), fricatives (/s/, /ʃ/ pronounced "sh"), the alveolar approximant /r/, and the affricate /tʃ/ (pronounced "ch"). Because the tongue and alveolus interact for sound generation, it follows that pathologic speech can occur when the oral cavity is deformed. Our preliminary data indicate that Class III malocclusions are most associated with articulation errors of these consonants, so we will focus our investigation on them.

Treatment for patients with DFD and speech-sound disorders includes orthodontics to align the teeth, oral surgery to reposition the jaws, and an evaluation by a speech-language pathologist for therapy. It is unknown whether surgery, speech therapy or a combination of both are necessary and sufficient for improvement. As a result, there is no consensus on how to manage the speech-sound disorders of our DFD patients.

Together published and preliminary data lead us to hypothesize that corrective jaw surgery yields long-term improvements in speech within the Class III DFD population. We propose the following aim to explore the relationship between correction of Class III jaw disharmonies and speech.

Aim 1: Assessment of short- and long-term effects of corrective orthognathic surgery on speech distortions in patients with Class III underbites. We hypothesize that patients with Class III jaw disharmony who undergo corrective surgery to achieve proportional jaw relationships will have normalization of tongue gestures, and acoustic properties of stop (/t/ or /k/), fricative (/s/ or /ʃ/), alveolar approximant (/r/), and affricate (/tʃ/) consonant sounds.

To test our hypothesis, we will collect surgical records paired with audio (Aim 1A) and lingual ultrasound recordings (Aim 1B) to quantitatively examine speech and tongue movement in Dentofacial Disharmony (DFD) patients (n=40 Class III, consecutively enrolled) and well-proportioned Class I reference subjects (n=40). Data from DFD patients will be collected 1-month pre-operation (T0) and at 3 months (T1) and 12-months (T2) post-surgery to quantitatively examine changes in speech and tongue movements before and after surgery.

During the proposed grant term, we will collect longitudinal data from 40 Class I controls and 40 Class III DFD surgical patients with speech-sound disorders (consecutively enrolled) and analyze their pre- and post-op records using acoustic, quantitative measures. Our affiliation with a major surgical referral center grants us access to the largest patient cohort in the southeastern region, allowing for long-term, reliable data collection at clinical appointments, with enrollment and data collection ongoing. Aim 1 will provide long-term surgical follow-up data to inform evidence-based standard of care for DFD and speech disorder treatment, while clarifying relationships between jaw position and speech for speech pathology, oral surgery and orthodontic providers.

Respond to the following questions:

Detailed results and inferences:*

If the work has been published, please attach a pdf of manuscript below by clicking "Upload a file".
OR
Use the text box below to describe in detail the results of your study. The intent is to share the knowledge you have generated with the AAOF and orthodontic community specifically and other who may benefit from your study. Table, Figures, Statistical Analysis, and interpretation of results should also be attached by clicking "Upload a file".

The final enrollment in our study was 47 Class III DFD subjects and 49 Class I control subjects. Of the Class III patients 34 received a two-jaw surgery (Lefort Advancement/BSSO setback), 11 received a Lefort advancement only, and 2 received a BSSO setback only. Speech recordings were completed on the Class III patients pre operatively, 3mo post op and 12 months post op. We then analyzed the speech recordings utilizing SMA and multitaper analysis which are quantitative methods that have never been used in the DFD population. Previous studies from our lab show that both SMA and multitaper analysis have been validated in lay listeners. These quantitative analysis methods allow us to understand speech disorders at a much higher level and directly correlate how speech changes with jaw position and severity of initial malocclusion.

The results in our Class III population showed a statistically significant reduction in the first spectral moment of consonant sounds /t/, /tʃ/, /s/ and /ʃ/ following jaw surgery at short and long term post-op visits, approaching the frequencies of Class I controls. The second spectral moments of /t/ and /tʃ/ showed statistically significant reduction after surgery approaching the Class I controls. These results show that there

is improvement in speech at the short term post-op that continues to improve up to 12 months post-op. Multitaper analysis demonstrates that peak frequencies increase towards the control population at short and long term post-op visits, indicating that speech continues to improve with minimal relapse after surgery. Quantitative measures have never been used in DFD patients so we validated these methods in this Class III population with a lay listener survey. Forty-five lay listeners rated Class III DFD patients less distorted post-op consistent with our quantitative spectral analysis thus showing there is a clinically significant improvement in speech post-op.

In conclusion there is a 20x fold higher prevalence of perceptual, visual and quantitative speech distortions seen in Class III DFD patients relative to the Class I control population. Our results indicate significant normalization of speech by some Class III DFD patients post-operatively. Specifically the center of gravity (first spectral moment), peak frequency and peak amplitudes of consonants produced by Class III participants post surgery approached the values of Class I controls. Clinically these results establish a functional benefit of orthognathic surgery which may improve the odds of insurance reimbursement for DFD patients with speech sound disorders. We plan to extend this research to Class II and Anterior Open Bite patients as well as incorporating lingual ultrasound imaging of tongue gestures before and after surgery to evaluate additional mechanisms that contribute to speech distortions and could affect post-operative outcomes.

Were the original, specific aims of the proposal realized?*

Yes the aims of the proposal were realized. Our results showed a statistically significant improvement in the first spectral moment for the /t/, /s/, /ʃ/, and /tʃ/ consonant sounds at both the short and long term post-op visits approaching the frequencies of the control population. Power spectrum demonstrate that peak frequencies increase towards the control population at short and long-term post-op visits, indicating that speech continues to improve with minimal relapse after surgery.

Were the results published?*
No

Have the results of this proposal been presented?*
Yes

To what extent have you used, or how do you intend to use, AAOF funding to further your career?*
Funding from the AAOF allowed me to purchase necessary equipment as well as fund participant incentives for their time and speech recordings. Due to this funding, I was able to recruit 47 Class III patients and 49 Class I control participants. The results of this study were presented at UNC Dental Research Day where it was awarded first place in the Turner Research Award. This research was also awarded a Joseph E. Johnson clinical award at the annual American Association of Orthodontist meeting. The results of this study provide evidence-based recommendations for surgical patients presenting with speech disorders and fills a gap in knowledge in the existing literature. As a clinician this helps me provide better care for my patients in terms

of discussing expectations to treatment options as well as creating a comprehensive approach with the addition of a speech pathologist to my team. I hope that additional research in other DFD groups on this topic will allow clinicians to better advocate for insurance reimbursement by showing improvement in speech is a functional benefit to treatment.

Accounting: Were there any leftover funds?
$0.00

Not Published

Are there plans to publish? If not, why not?*
Yes. We are currently finalizing data analysis and then plan to publish. We will send the completed manuscript once published.

Presented

Please list titles, author or co-authors of these presentation/s, year and locations:*
2024   Dr. William R. Proffit Scholar Award poster presentation: Bode, C*, Rezende Silva E., Ghaltakhchyan N., Turvey T., Blakey G., White R., Zajac D., Mielke J., Jacox L. Speech in Class III Dentofacial Disharmony Patients following Orthognathic Surgery. American Association of Orthodontists. New Orleans, LA.

2024   Poster presentation: Bode, C*, Rezende Silva E., Ghaltakhchyan N., Turvey T., Blakey G., White R., Zajac D., Mielke J., Jacox L. Speech in Class III Dentofacial Disharmony Patients following Orthognathic Surgery. American Association of Orthodontists. New Orleans, LA.
*Joseph E. Johnson Clinical Award Winner (2nd Place)

2024   Poster presentation: Bode, C*, Rezende Silva E., Ghaltakhchyan N., Turvey T., Blakey G., White R., Zajac D., Mielke J., Jacox L. Speech in Class III Dentofacial Disharmony Patients following Orthognathic Surgery. UNC Dental Research Day. Chapel Hill, NC.
*Derek T. Turner Student Research Award (1st Place MS/Resident Category)

Was AAOF support acknowledged?
If so, please describe:

Yes. All of the posters acknowledged any sources of funding and AAOF was listed.

Internal Review

Reviewer comments

Please ask PI to notify us when the publication is accepted whenever that maybe.

Reviewer Status*

Approved

File Attachment Summary

Applicant File Uploads
No files were uploaded