AAO Foundation Award Final Report

Type of Award: Orthodontic Faculty Development Fellowship Award

Name(s) of Principal Investigator(s):
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Title of Project
The 2015 Anthony A. Gianelly Teaching Fellowship Award
Effect of mandibular and bimaxillary orthognathic surgical modalities on upper airway volume and minimum cross section area

Period of AAOF Support :07-01-15 to 06-30-16

Amount of Funding: $20,000

Summary/Abstract (250 word maximum)

Objective: To evaluate volumetric changes of upper airway in response to three different orthognathic surgical modalities.

Methods: For this retrospective, cohort study the sample included 36 sets of pre and postsurgical CBCT scans. The subjects were grouped based on the type of surgery performed; maxillary advancement (n=11), mandibular advancement (n=12), bimaxillary advancement (n=13). We used Mimics V.18 software (Materialise, Leuven, Belgium) to isolate upper airway into 5 compartments; anterior nasal cavity (ANC), posterior nasal cavity (PNC), nasopharynx (NP), oropharynx (OP) and hypopharynx (HP). The following planes were used to delineate each of these compartments: Pronasale Plane (a plane passing through Pronasale and right and left Ala nasi), Vertical Nasal Plane (a plane passing through Nasion and right and left piriform apertures), PNS vertical (a plane passing through Posterior Nasal Spine and parallel to vertical nasal plane), Frankfort derivative (A reference plane passing through right and left infraorbital foramens and most inferior point on zygomaticotemporal suture), PNS plane (a plane passing through Posterior Nasal Spine and parallel to Frankfort Derivative plane), Basion plane (a plane passing through Basion and parallel to a plane passing through right and left Porions and Nasion), C3 plane (a plane passing through the most anterior inferior point on C3 and parallel to Frankfort derivative), C4 plane (a plane passing through most anterior inferior C4 and parallel to Frankfort derivative plane). Basion plane delineated the superior border of ANC, PNC and NP. PNS plane marked the inferior border of PNC and NP. Pronasale plane was used as most anteroinferior border of ANC. C3 plane separated Orophayngeal and Hypopharyngeal volumes, and C4 plane demarcated the inferior border of HP. The following landmarks were located on maxilla and mandible to determine the amount of surgical movement in sagittal and vertical directions: Incisive Foramen, right and left Greater Palatine foramens, B point, Genial Tubercle, right and left Gonions.

T-test and correlation analyses were performed to detect volumetric and minimum cross sectional area changes between different surgical treatment groups. All statistical analyses were performed using SAS 9.4.

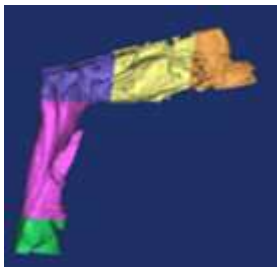

Figure 1: Color coded compartments of upper airway: ANC: gold, PNC: yellow, NP: purple, OP: pink, HP: green

Results:

In the maxillary advancement group the amount of advancement of the landmarks were as follows; Incisive Foramen 4.8 mm (±1.9), Greater Palatine Foramen right 4.7 mm (±3.4), Greater Palatine Foramen left 5.3 mm (±3.4). For the Mandibular advancement group mean amount of advancement was, 3.8 mm (±1.6) at B point, 3.8 mm (±1,9) at Genial Tubercle, 1.4 mm (±2.5) at right Gonion and 1.4 mm (±1.8) at left Gonion. The bimaxillary advancement group showed mean amount of advancement as follows; 5.1 mm (±1.3) at Incisive Foramen, 4.7 mm (±1.8) at right Greater Palatine Foramen, 4.7 mm (±2.1) at left Greater Palatine Foramen, 6.4 mm (±3.1) at B point, 8.1 mm (±4.3) at Genial Tubercle, 2.3 mm (±2.2) at right Gonion and 2.6 mm (±1.7) at left Gonion.

We found significant increase in total upper airway volume in maxillary advancement group (7465 mm^3 (±1735), $p<0.05$), mandibular advancement group (2966 mm^3 (±946), $p<0.05$), and bimaxillary advancement group (12681 mm^3 (±1626), $p<0.05$). We also found significant increase in minimum cross sectional area of the upper airway in all three groups; maxillary advancement group showed mean increase of 61 mm^2 (±20.8), mandibular advancement group showed mean increase of 51 mm^2 (±10.2) and bimaxillary advancement group showed mean increase of 117 mm^2 (±23.7).

In the maxillary advancement and mandibular advancement groups we only found significant increase in the oropharyngeal airway with mean difference of 5500 mm^3 (±1371) $p<0.05$ and 2490 mm^3 (±515) $p<0.05$, respectively. In the bimaxillary advancement group we found significant increase in anterior nasal cavity volume with mean difference of 706 mm^3 (±229) $p<0.05$, in nasopharyngeal volume with mean difference of 1365 mm^3 (±479) $p<0.05$, in the oropharyngeal volume with mean difference of 7997 mm^3 (±1445) $p<0.05$, and hypopharyngeal volume with mean difference of 1988 mm^3 (±612) $p<0.05$.

Within the bimaxillary advancement group we found significant positive correlation between amount of advancement of Right Greater Palatine Foramen and total volume, oropharyngeal volume and hypopharyngeal volume change while advancement of Left Greater Palatine Foramen showed significant positive correlation with total airway and oropharyngeal volume change. Within the mandibular advancement group, we found significant positive correlation between vertical movement of genial tubercle and change in oropharyngeal volume.

Conclusion: All three surgical advancement modalities improved the total upper airway volume and minimum cross sectional area. With maxillary and mandibular advancements, this improvement was most significant in the oropharyngeal area, while with bimaxillary advancement anterior nasal cavity, nasopharyngeal and hypopharyngeal volumes were also significantly improved in addition to oropharyngeal volume. Bimaxillary advancement is the most effective surgical modality in improving different airway compartments.

Response to the following questions:

1. Were the original, specific aims of the proposal realized? Yes
2. Were the results published? No, we are working on the manuscript and will be submitting for publication within the next few weeks.
   a.) If so, was AAOF support acknowledged. AAOF support will be acknowledged on the manuscript.
   b.) If not, are there plans to publish? If not, why not? Yes
3. Have the results of this proposal been presented? Yes
   a.) If so, when and where? And was AAOF support acknowledged? Oral presentation at 2017 AADR meeting. Yes, AAOF was acknowledged.
   b.) If not, are there plans to do so? If not, why not?
4. To what extent have you used, or how do you intend to use, AAOF funding to further your career?

   AAOF support helped me achieve all the goals outlined in my original plan further enhancing my educational, teaching, research and clinical skills. I was able to attend the Orthodontic and Orthognathic surgery course directed by Drs. Arnett and Gunson. Completing this 5-day course helped me enhance my expertise in orthodontic-orthognathic diagnosis and treatment planning, procedures, outcomes and stability. Over the coming years I hope to gain more experience in treating orthognathic cases and become an excellent teacher in the field. I was also, able to complete a web-based course on morphometrics given by Professor Klingenberg from University of Manchester, UK. This gave me an opportunity to further look into the applications of shape analysis in evaluating growth and treatment outcomes in the head and face region.

   I continued teaching the biomechanics course at the orthodontic department and am now the course director. I also, started an ABO review course for the second year residents in preparation for the written portion of the ABO exam. To further enhance my teaching skills, I attended the 2015-2016 Academy for Faculty Advancement Program at the Boston University Medical Campus as well as Faculty Development Programs at the dental school. Different aspects of teaching, public speaking, funding and publications, career development, leadership and work-life balance were discussed at these developmental programs.

   The funds provided by the AAOF contributed towards acquiring the Mimics V.18 software (Materialise, Leuven, Belgium) used for this research project as well as others being conducted at our orthodontic department. The support also helped me cover the travel expenses and application fees for the ABO clinical exam that I successfully completed in February 2016.