

Mandibular Alveolar Bone Remodeling Following Maximum Incisor Retraction

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ABSTRACT

Objectives: The objective of this study is to evaluate changes in mandibular alveolar bone width following maximum incisor retraction. **Methods:** 125 patients with bimaxillary dentoalveolar protrusion treated with premolar extractions and maximum incisor retraction using skeletal anchorage were selected. Pre-treatment (T1) and post-treatment (T2) Cone Beam Computed Tomography (CBCT) volumes were registered using voxel-based mandible regional superimpositions. 3D models of the registered mandibles were built and T1 and T2 alveolar width were measured at the 1) inter-radicular space between the lower central incisors and the 2) mid-root of the mandibular right central incisor. ANOVA analysis was used to determine difference between T1 and T2 alveolar width.

Results: The mean lower incisor retraction was 6.12mm +/- 1.25. At the crestal level, the inter-radicular alveolus showed an average decrease of 1.02mm +/- 0.44 (20% reduction) while the mid-root alveolus showed an average decrease of 0.48mm +/- 0.39 (8% reduction) after incisor retraction. There was a statistically significant difference ($P<0.05$) between the bone change at the inter-radicular regions versus the mid-root regions.

Conclusion: There was a decrease in buccal/lingual width of the alveolus following maximum incisor retraction. At the crestal level, the reduction of alveolar width was more significant in the inter-radicular region.

INTRODUCTION

- The emergence of temporary anchorage devices (TADs)¹ has allowed a larger range of possible orthodontic tooth movement and, in some instances, reducing the need for orthognathic surgical correction.²
- Moving teeth greater distances comes with possible risks that must be more understood in order to decide between orthodontic treatment or surgical alternatives.
- Cone beam computed tomography (CBCT) is an accurate tool in evaluating alveolar changes³ and overcomes many of the limitations of 2-D radiography, including magnification, head positioning error, and challenges in superimposition of 3D anatomical regions/ structures.
- Reductions in alveolar bone width and/or height following orthodontic treatment have been demonstrated across an array of treatment techniques and sites.⁴
- A recent study by Zhang et al.,⁵ used geometric morphometric analysis to show decrease in bone height and thickness following retraction of the maxillary incisors.
- To date, no such studies have evaluated alveolar bone changes in the mandible following maximum incisor retraction using skeletal anchorage.
- The objective of this study is to further characterize the nature of these alveolar changes in the mandible, utilizing 3D mandibular regional superimposition.⁶
- Of particular interest, is the comparison of the mid-root alveolus with the inter-radicular alveolus.

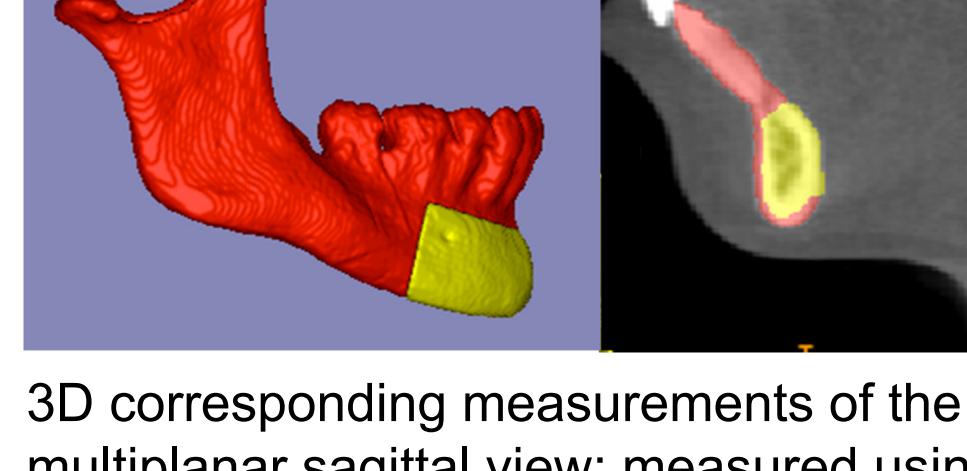
METHODS & MATERIALS

Sample

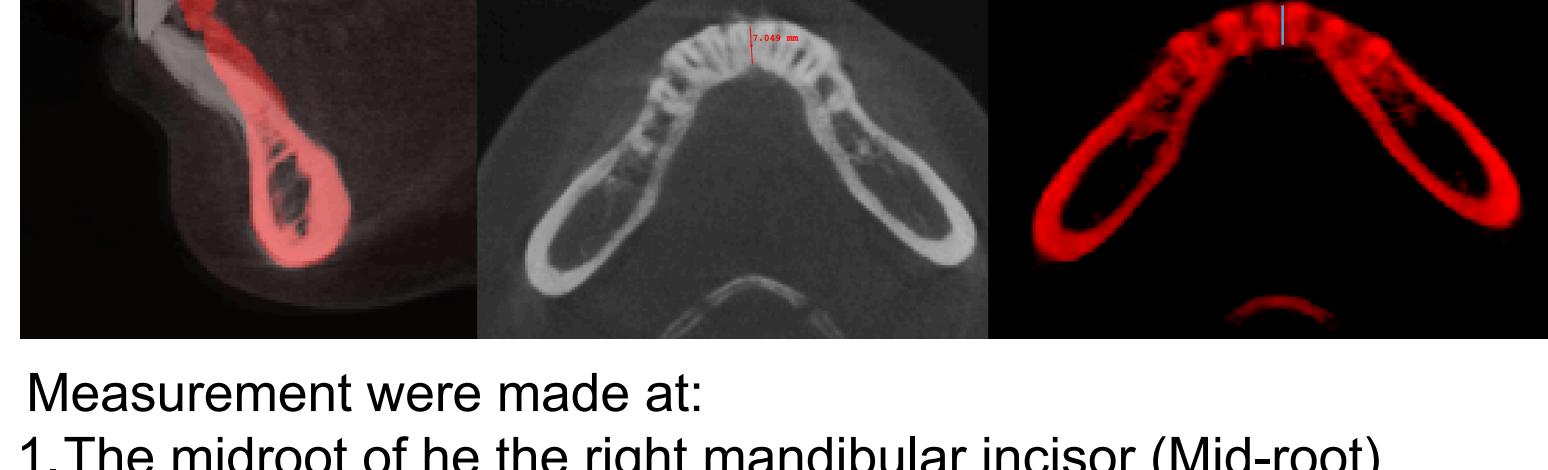
- This retrospective study consisted of 125 consecutive patients (age range 18-47) treated in the Department of Orthodontics, Gangnam Severance Hospital, Yonsei University between 2011 and 2017. Institution Review Board approval was obtained.
- The subjects were diagnosed as skeletal Class I or Class II malocclusion ($0^\circ < \text{ANB} < 7.0^\circ$) with bimaxillary dentoalveolar protrusion treated with four premolar extractions and incisor retraction greater than 4mm using temporary skeletal anchorage.
- Patients were excluded if they had distinct facial asymmetry (Menton deviation to facial midline <2 mm).

Imaging Analysis

- Pre-treatment (T1) and post-treatment (T2) CBCTs were taken using Pax Zenith 3D (Vatech, Seoul, Korea). Each scan captured 632 images surrounding the face, jaw, and cranial base with 105 kV, 5.4 mAs exposure parameters, 0.3 mm voxel size and 24 x 19 cm FOV (field of view) for 24 seconds.
- T1 CBCTs were oriented into a standardized Frankfort Horizontal plane using both orbitale and right porion.⁷
- T2 CBCTs were superimposed and registered on the T1 mandibular symphysis using ITK-SNAP 3.8 (open-source software, <http://www.itksnap.org>).
- A mask of the region of interest (ROI) was generated and served as the volume to register and superimpose T1 and T2 mandible. The superior border of the mask was defined at the level below the roots of the teeth running parallel to the lower border of the mandibular plane. The distal border of the mask was defined by a plane anterior to the mandibular 1st molar and perpendicular the lower border of the mandible (Fig 1).



- 3D corresponding measurements of the alveolar buccal-lingual width were made on the multiplanar sagittal view; measured using ITK-SNAP 3.8 (Fig 2).



- Measurement were made at:

1. The midroot of the right mandibular incisor (Mid-root)
2. The midpoint between the mandibular central incisor (Inter-radicular)
3. The midpoint of the incisal edge of the right mandibular incisor

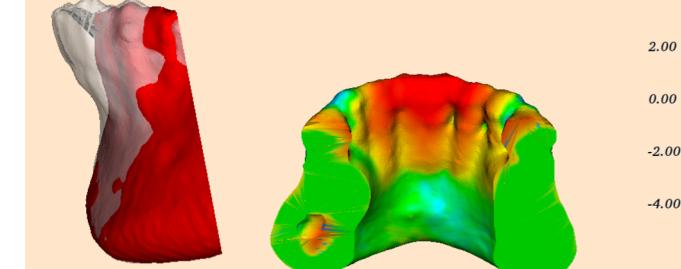
Statistical Analysis

- Data sets of ten subjects were randomly selected and the measurements were repeated with an interval of two weeks to confirm the reliability. The range of intraclass correlation coefficient (ICC) ranged from 0.89 to 1.00 indicating high reproducibility ($p < 0.001$).
- Corresponding paired T-Test and one-way ANOVA was performed to compare pre- and post-treatment measurements using the SPSS statistics (Version 24, SPSS Institute, Chicago, IL, USA) and SAS (Version 9.3, SAS Institute, Cary, NC, USA).

RESULTS

- The mean lower incisor retraction was 6.12mm +/- 1.25.
- At the crestal level, the inter-radicular alveolus showed a mean decrease of 1.02mm +/- 0.44 (20% reduction) while the mid-root alveolus showed an average decrease of 0.48mm +/- 0.39 (8% reduction) following incisor retraction.
- At the level of the root apex, the inter-radicular and mid-root alveolus showed a mean decrease of 0.28mm (6.2%) and 0.38mm (4.5%) respectively.

| | | T1 Mean | T2 Mean | Δ | P-Value |
|---------|-----------------|---------|---------|----------|---------|
| Crestal | Midroot | 5.75 | 5.26 | 0.48 | < 0.001 |
| | Inter-radicular | 5.09 | 4.08 | 1.02 | |
| Apical | Midroot | 6.30 | 6.24 | 0.38 | 0.19 |
| | Inter-radicular | 5.92 | 1.24 | 0.28 | |



CONCLUSIONS

- There was a decrease in buccal/lingual width of the alveolus following maximum incisor retraction.
- At the crestal level, the reduction of alveolar width was more significant in the inter-radicular region.

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