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Title: Clinical and Biomechanical Considerations of TADs in Challenging Cases: Sagittal Correction beyond Orthodontic Boundaries

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Clinical Applications and Biomechanical Considerations for TADs

This lecture will consider:

- Space closure through the maxillary sinus with TADs
- Treatment outcome evaluations with 3D CBCT superimposition
- Class III correction with TADs
 - Considerations when performing retraction of mandibular dentition
 - Ideal locations for TADs based on expected tooth movement
 - Biomechanical considerations for mandibular posterior and anterior retraction
- Molar protraction
- Class II correction with TADs
 - Maxillary anterior retraction
 - Palatal bone thickness and TAD site selection
 - Molar distalization
 - Whole arch distalization
 - Buccal vs. palatal TAD placement

The use of temporary anchorage devices (TADs) for reinforcement of orthodontic anchorage has become increasingly popular, especially in adult patients who do not want to wear extraoral anchorage appliances. TADs are convenient and create good treatment results without patient cooperation. However, if biomechanical factors are not considered during treatment with TADs, there may be undesirable side effects (**Figure 1**). In the lecture, Dr. Park will present various cases where TADs were used to achieve sagittal correction,¹⁻⁶ and treatment outcomes will be discussed using before and after treatment superimposed three-dimensional (3D) cone-beam computed tomography (CBCT) scans.

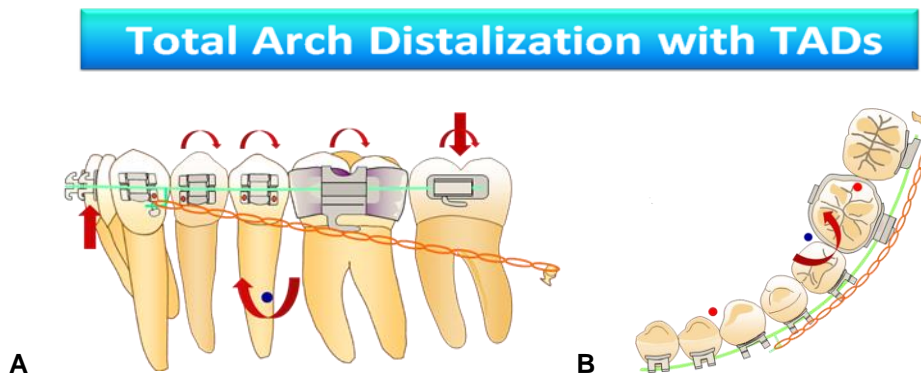


Figure 1. A. During total arch distalization around the center of resistance, there is a moment that produces extrusion of the anterior teeth, intrusion of the posterior teeth, and tip-back of posterior teeth. **B.** From the occlusal view during distalization with TADs, there is distolingual rotation of the posterior teeth around the center of resistance.

With the advent of TADs, orthodontic treatment has been simplified. Dr. Park will present molar protraction with TADs. For cases in which the mandibular first molars are missing, the conventional treatment has been to place either dental bridges or dental implants; now, with the introduction of TADs, orthodontists can efficiently close the gap(s) from missing teeth rather than treating the space(s) with restorations. During molar protraction, in order to prevent side-effects such as posterior teeth tipping, mesial rotation, and buccal sweep (**Figure 2**), a long buccal hook, uprighting spring, a toe-in bend in the posterior portion of the archwire with constriction, or a balancing lingual force can be used.³

Molar protraction with TADs

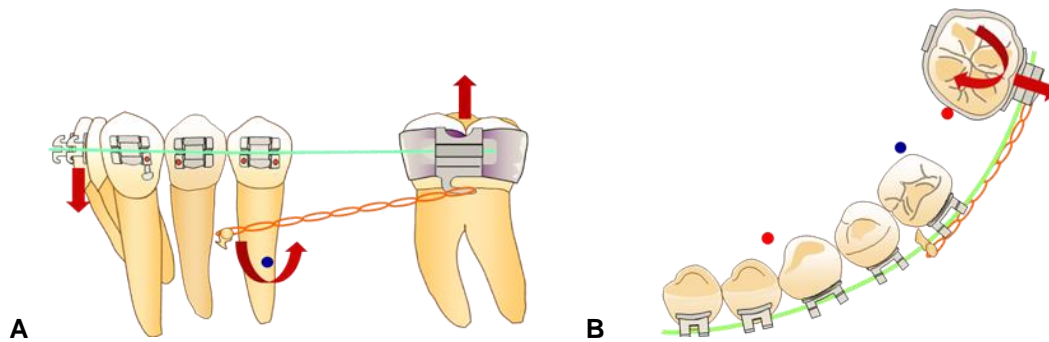


Figure 2. A. If the molars are being protracted around a center of resistance, the occlusal plane will rotate and anterior open bite can occur. **B.** During molar protraction, occlusally mesiolingual rotation and buccal sweep can occur.

3D Superimposition Techniques

Traditionally, the superimposition of serial, two-dimensional, lateral cephalograms has been used to evaluate growth and treatment effects. Nowadays, 3D assessment using the superimposition of CBCT images has become an important tool for evaluating changes with growth or treatment. However, this image superimposition method poses many challenges including accuracy and reproducibility. Various methods for the reconstruction of 3D CBCT images have been used in diagnosis, treatment planning, and simulation. In this presentation, 3D CBCT superimposition techniques, especially the iterative closest point (ICP) method, will be discussed.

To transform digital imaging and communication in medicine (DICOM) data from CBCT images into polygon data, five software programs are available — Volume-Rugle, MicroAVS, VVD2RGL, Point-Rugle, and 3D-Rugle. Precise and repeatable superimposition is possible with the ICP method because numerous corresponding points are used to compare point-based registrations.⁷⁻¹⁰ The ICP method can be used to superimpose two 3D images at pre- (T0) and post-treatment (T1) (**Figure 3**). Specific points on the cranial base can be used to superimpose two separate multi-planar reconstruction (MPR) images accurately, because the cranial base is not greatly influenced by growth. As a result, accurate superimposition of two separate MPR images is possible. The combined images can be cut down an arbitrary plane and divided into two units. The MPR images, which have excellent dimensional accuracy, are then used to compare the data at T0 and T1.⁷⁻¹⁰

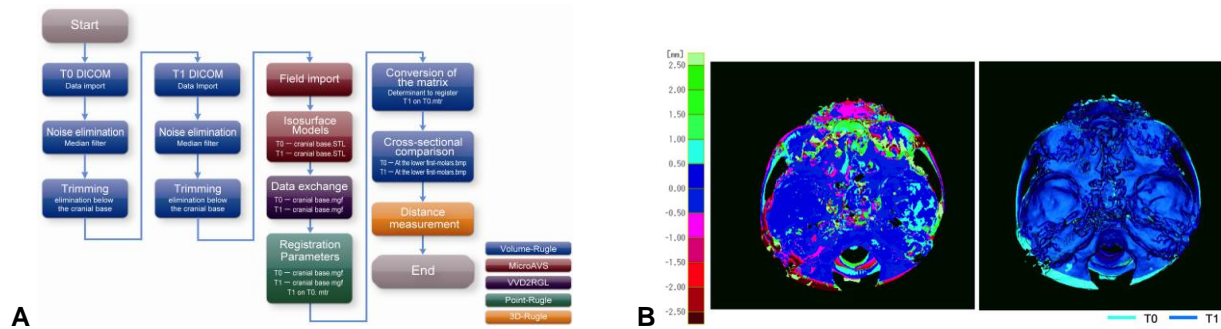


Figure 3. A. Five different software programs to transform the DICOM data from CBCT images into polygon data. **B.** The ICP method. Cranial base superimposition performed on all areas of the cranial base except the peripheral growing zone. Merged image of pre- (T0) and post-treatment (T1) CBCT scans, superimposed at the cranial base.

Summary

- Space from tooth extractions can be closed by bodily movement through anatomic barriers such as the maxillary sinus, but in view of the proximity of the maxillary sinus floor and maxillary root tips, orthodontists must be particularly careful when doing this.
- When using TADs, biomechanical factors that can produce unusual changes or side effects should be considered. If the amount of distalization is more than 3 mm, the TADs on the buccal side should be relocated.
- During total arch distalization of the mandibular arch, rotation of the occlusal plane has been seen along with tip-back of the mandibular molars.
- Although clinical factors were not considered in the finite element analysis, distalization with the palatal plate showed bodily movement of the first molar and insignificant displacement of the anterior teeth.
- Superimposition of CBCT images has become an important tool for 3D assessment of changes with growth and/or treatment.

References

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Dr. Jae Hyun Park (JPark@atsu.edu) is an Associate Professor and Chair of the Postgraduate Orthodontic Program at the Arizona School of Dentistry and Oral Health. He is a Diplomate of the American Board of Orthodontics. Dr. Park published a book entitled Computed Tomography: New Research. He also serves as an editorial board member of several peer-reviewed orthodontic and dental journals. He recently coauthored and published a book entitled Molar Protraction: Orthodontic Substitution of Missing Posterior Teeth. Since 2008, while working as a full-time faculty member, he has published more than 110 scientific and clinical articles in peer-reviewed orthodontic and dental journals. He is currently editor-in-chief of the PCSO Bulletin.