

Assessment of Condylar volume changes in Class II Division 2 patients treated with proclination of maxillary incisors, overbite reduction and dentoalveolar expansion using Clear Aligners

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Abstract

Purpose: To assess the possible three-dimensional changes in condylar volume in Class II Division 2 growing patients following using Invisalign clear aligners to “unlock” the mandible. Unlocking the mandible was done through proclining the maxillary incisors, correcting the overbite, and expanding the maxillary arch.

Methods: The study sample was provided by (T.E), an Invisalign-experienced orthodontist in Edmonton, AB, Canada. The inclusion criteria in this study are as follows: (1) Adolescent patients (age range: 12-16 years), (2) Skeletal Class II (ANB > 4°), (3) Dental Class II Division 2 Malocclusion (molar and canine Class II, retroclined maxillary incisors, increased overbite), (4) Normal or forward grower (FMA < 29 degrees) (5) Planned dual arch Invisalign orthodontic treatment (to procline the maxillary incisors, correct the overbite and expand the maxillary arch)- except for the control group (6) Available T1 (before the start of treatment) and T2 (one year after T1) cone-beam computed tomography (CBCT) generated lateral and posteroanterior cephalograms, (7) Aligners made of SmartTrack material (year 2012 to present), (8) Good patient compliance throughout treatment as assessed by the treating orthodontist, and (9) No planned Class II mechanics. A total of 15 patients served as a treatment group, and 8 patients served as a control group. Individuals in both groups were matched according to age, gender, growth pattern, Class II and malocclusion severity. For each participating subject, a CBCT was obtained at T1 and T2 time points. Invisalign clear aligners were used for the treatment group to procline maxillary incisors, correct the overbite, and expand the maxillary arch. No intervention was introduced for the control group between T1 & T2. The mean condylar volume at T1 and T2 was analyzed with 3D Slicer Software, and was compared between the two, treatment and control, groups. The semi-automatic segmentation via 3D Slicer software and the identification of cephalometric landmarks was done by the principal investigator (H.M). Twenty-five percent of the samples will be randomly selected to be re-analyzed after two weeks of the first assessment.

Results: our preliminary data indicates a more condylar volume increase for the treatment group versus the controls ($p < 0.05$).

Clear Aligners

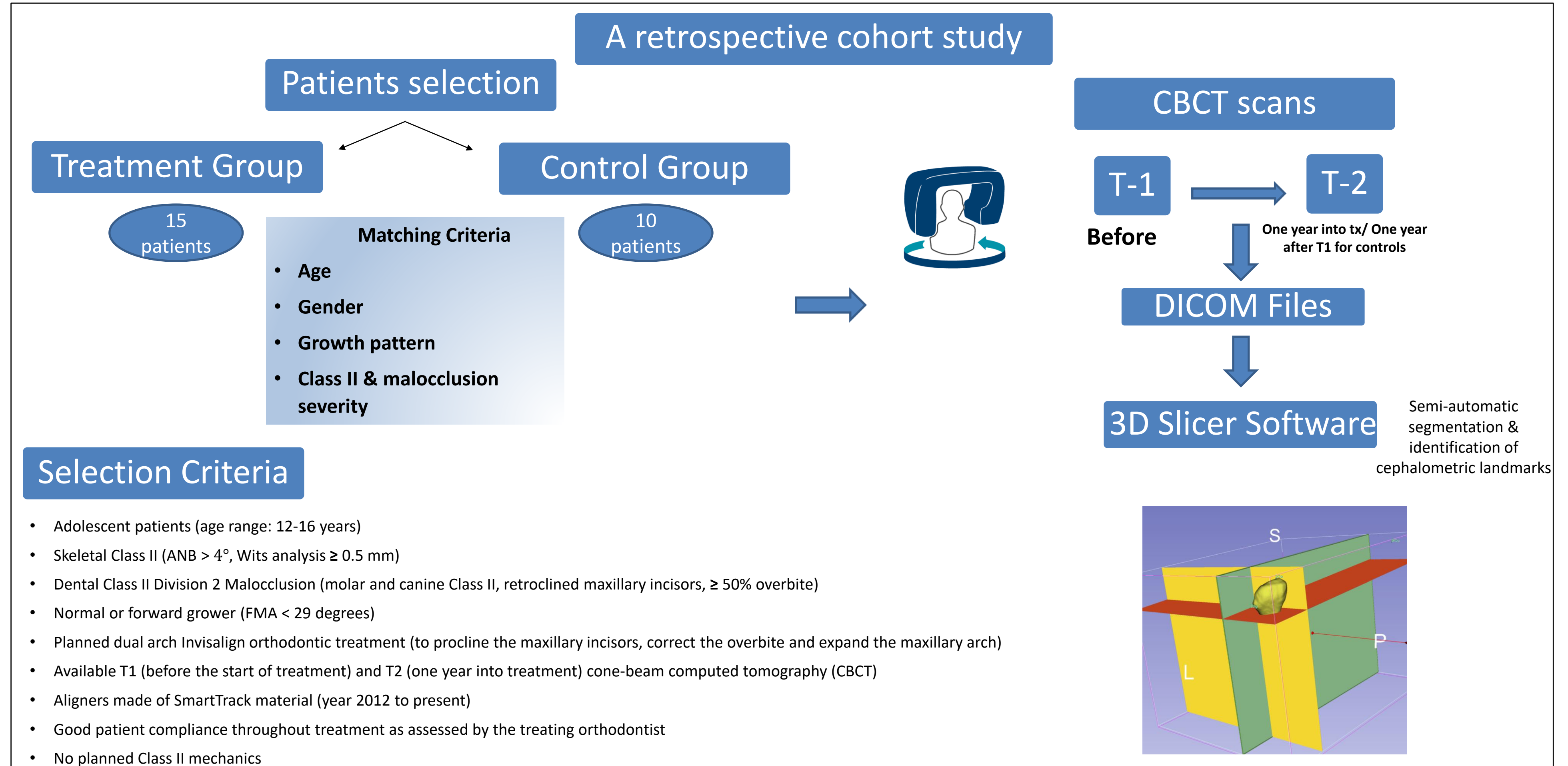
- There is an increased demand for clear aligner therapy due to a growing need for aesthetic orthodontic treatments among adolescents and adults(10,11)
- A recent study has shown significant forward positioning and increased skeletal growth of the mandible in the treatment group, Class II Division 2 subjects treated with unlocking the mandible using clear aligners, versus the control group (12)
- Whether the treatment stimulated the skeletal growth, or whether the condyles repositioned anteriorly or underwent actual growth remains unknown



Figure 5. To encourage the “unlocking” of the mandible, utilizing clear aligners, the orthodontist can expand the upper arch, procline the upper incisors, and correct deep overbite, through modifying the teeth positions



Methods



Class II Division 2 Malocclusion

Figure 1. Dental Features of Class II Div 2 Malocclusion

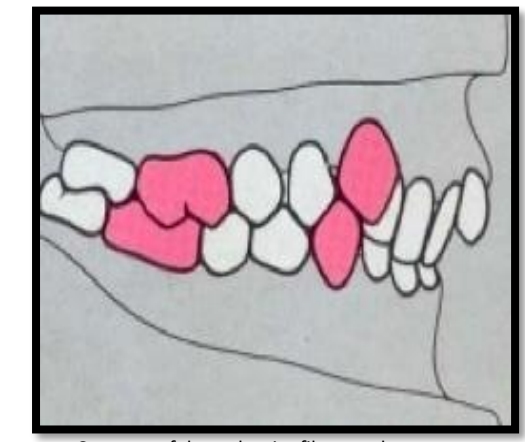


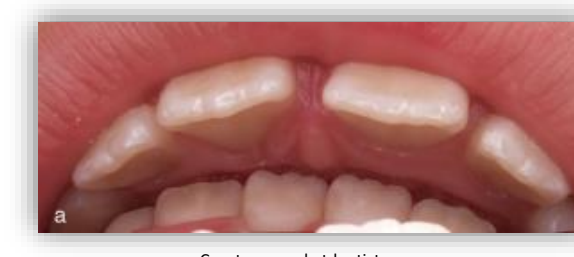
Figure 3. C II D 2 Prevalence

- 2-5% in different populations
- About one fifth of all class II cases in some populations (2)

Figure 2. C II D 2 problems (1)



- Appearance
 - Convex profile
 - Brachyfacial pattern
 - Prominent chin



- Palatal soft tissue trauma



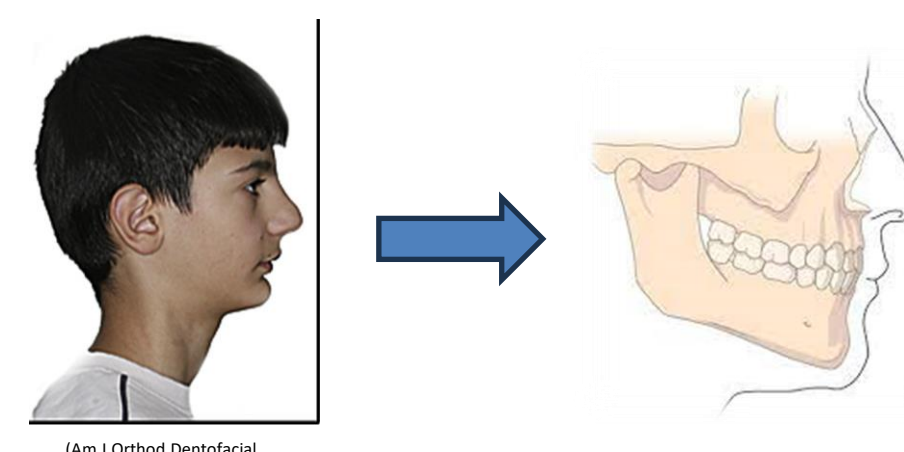
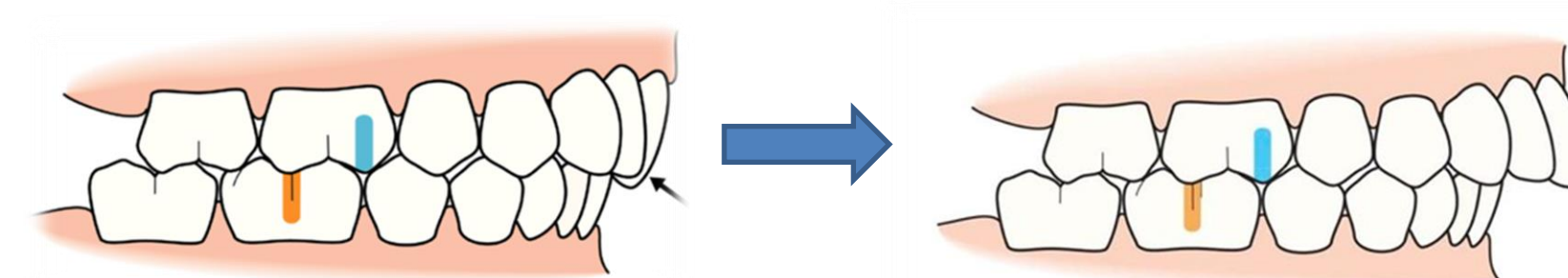
- Mandibular anterior teeth attrition

The concept of “unlocking” the mandible



“Many orthodontists who have treated a patient with a Class II Division 2 Malocclusion by changing it to a Class II Division 1 contend that they have observed the mandible move forward as much as one-half premolar width virtually every time and the author concurs” Dr. HAAS, 2000 (3)

Figure 4. Unlocking the mandible by proclining maxillary incisors, correcting the overbite, and expanding the maxilla



- The mandible is thought to rotate counter-clockwise to compensate for the length discrepancy, giving it a more prominent chin and prognathic appearance than Class II Division 1 (4)
- The body of the mandible is underdeveloped with a retroclined symphysis, while the chin tends to be prominent (5). This has been explained by inhibiting the development of the alveolar process by the retroclined upper incisors, while the absence of the same inhibition to the normal growth of the mandible and symphyseal area (6)
- Consequently, mandibular forward repositioning could theoretically be encouraged if those restrictions are eliminated

Mandibular Condyles

- Condyles cartilage does have the ability to grow to adapt to different stimuli (7)
- Whether the mandibular growth is primarily influenced by the environment, or genetically determined is still debatable (8)



Theories of Condylar growth

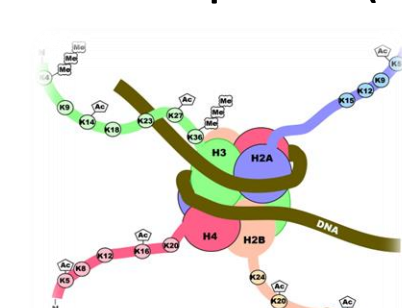
Genetic control

Condyles grow under genetic control to push the mandible downward and forward (7,8)



Epigenetic control

- (indirect genetic control) along with soft tissue stimuli (like skeletal muscles) determine the condylar growth
- Under soft tissue stimulation, the mandible will move downward and forward, and the condyles will respond by growth on the posterior and superior aspects (9)



Preliminary Data

- Change in condylar volume was calculated by taking T2 Avg -T1 Avg to determine how much this variable changed
- Repeated measures (within-subjects) ANOVA was used to assess the preliminary data for condylar volume
- A total of 20 subjects (10 tx and 10 controls) condylar volume were included. The average of right & left condylar volumes were taken at each time point
- Overall, our preliminary data highlight that the mean condylar volume statistically significantly increased for both groups from T1 to T2 ($p < 0.05$).
- As depicted in Table 1, at T2, the differential growth between the two groups was significant ($p = 0.10$), with the treatment group undergoing more condylar volume increase.
- Results should be interpreted with caution owing to the limited sample size

Table 1

Group	Time	Mean Condylar Volume (mm ³)	Std. Error	Significance (T2-T1)*	Inter-group difference at T1*	Inter-group difference at T2*
Control	1	1074.5	51.4	(63 ± 28.4)	(168 ± 83.3)	(254.9 ± 89.7)
	2	1137.5	55.3	0.039		
Tx	1	1242.5	65.6	(149.9 ± 36.2)	0.058	0.010
	2	1392.4	70.6	< 0.001		

* Values shown are (mean ± SE). The mean difference is significant at the .05 level.

Figure 6

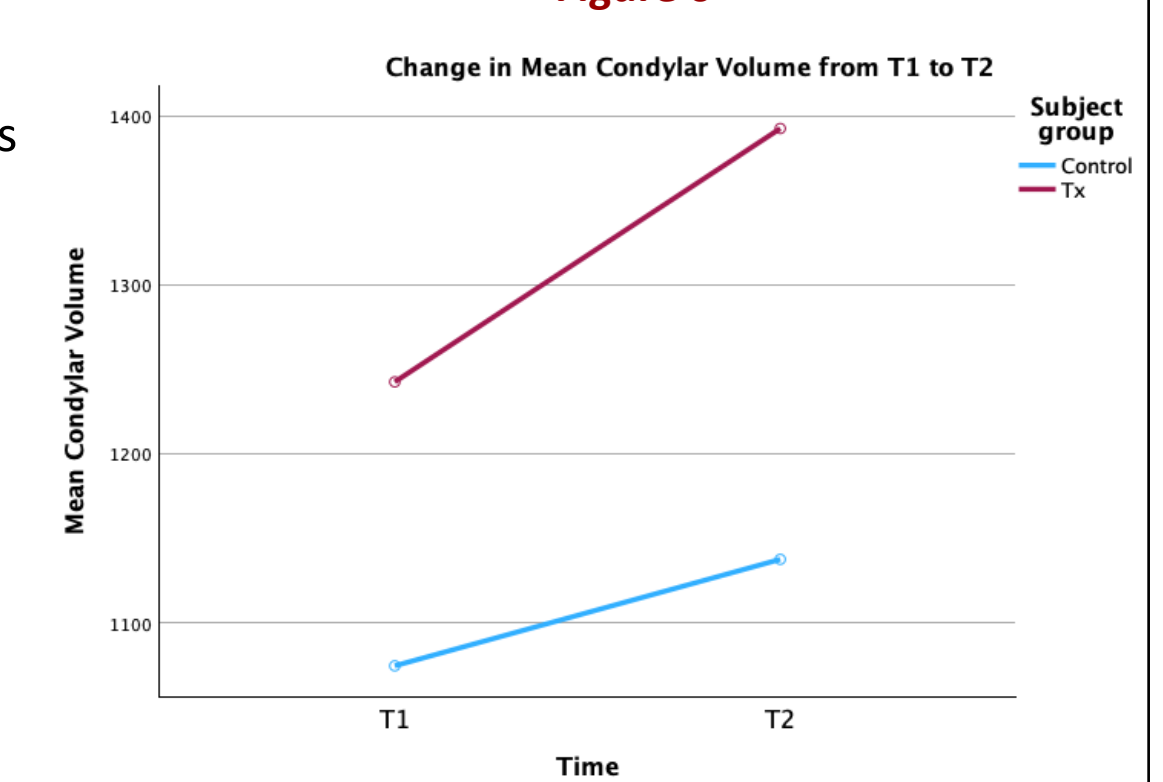


Figure 6 & Table 1. Change in condylar volume over time for tx and control groups

Significance & Summary

- Mandibular condyles are established in the literature as growth sites for the mandible, and the condyles play a critical role in formulating the final skeletal dimensions of the mandible
- Growing demand for clear aligners. Determining whether actual condylar growth is happening could affect the treatment options offered by the orthodontists to treat Class II D2 patients
- Our preliminary results indicate a statistically significant increase in condylar volume for the treatment group from T1 to T2
- Further studies with larger sample sizes are recommended to corroborate our findings

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