Original Article

Dentoalveolar and Airway Changes Following En Masse Distal Movement of the Maxillary Dentition with Infrazygomatic Crest Anchorage: A Prospective Study

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ABSTRACT

Aims and Objectives: Mini screws placed buccal to the maxillary first or second molars in the infra zygomatic crest (IZC) region can be used as anchors for various types of tooth movement. En masse distal movement of the maxillary dentition with IZC anchorage is routinely practiced nowadays as more patients demand a non-extraction treatment and it should be evaluated. The goal of this study was to assess dentoalveolar and airway changes in individuals with class II malocclusion after en masse distal movement of the maxillary dentition utilizing infrazygomatic anchorage. **Materials and Methods:** This prospective study included patients who required en masse distal movement of the maxillary dentition. Following initial leveling and aligning, mini screws were placed in the IZC region, and the maxillary arch was distalized en-masse. Pre (T0) and post distalization (T1) lateral cephalograms were traced for dentoalveolar and airway changes. Statistical tests were done with SPSS software. Shapiro-Wilk test for normality and paired *T* test for comparison between before and after en masse distalization were done. **Results:** The changes in dental angular and linear measurements such as U1 to N-A, L1 to N-B and interincisal angle, U1 to N-A and U1 to point A distance, U1 to palatal plane, L1 to N-B, L1 to Apo line distance, U6 to PtV were statistically significant ($P > 0.05$). Linear parameters such as L1 to ApO line, upper airway, and lower airway were not statistically significant (<0.05). **Conclusion:** Class II div I malocclusions can be efficiently corrected without extractions using IZC anchorage by en masse distal movement of the maxillary dentition. Significant reduction in upper anterior inclination, intrusion of maxillary anterior teeth, and distal movement of the posterior teeth were noted. No changes in airway dimensions were noted.

KEYWORDS: *Airway changes, dento-alveolar changes, en masse distalization, fixed appliance treatment, infra-zygomatic screw*

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INTRODUCTION

Many types of complex tooth movements such as en masse distal movement of the entire upper dentition to treat Class II malocclusion,[1] intrusion of the anterior segment for correction of excessive gingival exposure,[2] dental correction in skeletal asymmetry,[2,3] maxillary canine-lateral incisor transposition,[4] and scissors bites,[5] can be effectively performed with mini implants placed in the infrazygomatic crest region of the maxilla. The infrazygomatic crest of the maxilla

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is separated from the dentoalveolar zone, allowing for unrestricted tooth movement and a lower risk of root contact.[6] Liou *et al.*[7] has developed a method for implanting infrazygomatic crest (IZC) screws next to the buccal surfaces of the maxillary first molars.

Distal movement of molar teeth for class II malocclusion correction has been documented in the past with pendulum and distal jets, which can result in anterior teeth proclination if not augmented with skeletal anchors. Mini-screw-supported modified Hyrax appliances can also be used for distalization of molar teeth.[8] Shaikh *et al.*[9] noted about 5 mm distal movement of posterior teeth at the crown level and 4 mm at the apex level, as well as maxillary incisor retraction of 6 mm, in a case report on en masse distal movement of the maxillary dentition with IZC anchorage. Shaikh *et al.*[10] reported on the efficiency of infrazygomatic crest screws in combination with mini-implants in the anterior portion for en masse distal movement and intrusion of anterior teeth in subjects having class II division I malocclusion. They found that by distalizing the entire maxillary dentition to gain space for correcting the anteroposterior discrepancy and intruding the maxillary anterior segment the skeletal discrepancy and gummy smile can be treated without surgery using non-extraction technique with IZC anchorage.

En masse distal movement of the maxillary arch with IZC anchorage is practiced but there are no prospective studies reported and this distal movement of the entire maxillary arch can influence the airway and the overlying soft tissues hence it is very important to assess them. Null hypothesis of this study is that no significant dentoalveolar and airway changes were observed using IZC anchorage. Alternate hypothesis of this study is that significant dentoalveolar and airway changes were observed using IZC anchorage. The purpose of this study was to assess dentoalveolar and airway changes in participants with class II malocclusion after en masse distal movement of the maxillary dentition utilizing infrazygomatic crest anchorage.

Materials And Methods

The current prospective trial was performed on subjects with class II malocclusion who required Orthodontic treatment and reported to the Orthodontic department of Saveetha Dental College, Chennai, India. The study was approved by the institutional scientific review board (IRB number: SRB/SDC/ORTHO-2007/22/067).

The sample size was estimated using G power software at a significance level of 0.05 and a power of 95%, resulting in a sample size of 11 based on a previous study.[11]

Inclusion criteria for the study were:

1. Class II malocclusion subjects with bilateral end on or class II molar and canine relationship in the age range of 15–30 years.
2. Subjects with good compliance, adequate oral hygiene, full complement of dentition.
3. Subjects with overjet not more than 5–6 mm and with mild to moderate crowding of the lower arch.

Exclusion criteria were subjects indicated for extraction of teeth to gain space, subjects who exhibited symptoms of temporomandibular disorders, and subjects who had active periodontal disease. Randomization of the study subjects was not performed as there was no control or comparison group. Pretreatment records of all subjects were taken before beginning the study. All participants in the study underwent orthodontic treatment with a 0.022 inch slot MBT prescription and after initial alignment was completed en masse distalization assisted with IZC anchorage was begun on a 19 × 25 SS wire. All study participants gave their consent for placement of mini screws in the IZC site.

Site and placement of IZC screw

The infra-zygomatic crest region of the maxilla above the 1st and 2nd permanent molar region is the best location for placement of bone screws. Before placing the screws, a cone beam computed tomography of the maxillary arch was taken to examine the IZC region. The thickness of the IZC region was measured using the method given by Liou *et al.*[7] 2 × 14 mm Orthodontic bone screws by Fav Anchor (Pune, India) were used. The bone screwdriver direction was changed to 55°–70° toward the occlusal plane of the maxillary teeth (vertical distance between the point of insertion and the occlusal plane was 14–16 mm) downward after creating the initial notch in the bone with a few rotations of the driver, allowing the mini screw to bypass the roots of the teeth and direct it to the infra-zygomatic area of the teeth. After placement of the bone screw only the head and a part of the collar were visible outside and the threaded portion was completely in the bone.

The miniscrews were loaded with an elastomeric chain with the force level of 300 g per side and every 6 weeks once reactivation was done. In every review visit, the screws were examined for screw loosening or soft tissue proliferation. Distalization was carried out until a class I molar and canine relation was established. The mean duration of treatment in patients undergoing en masse distalization was 18 ± 3 months whereas the average time taken for en masse distal movement was

4 ± 1.5 months. In both upper and lower arches non-extraction protocol was followed. The patients were advised Beggs wrap around retainer full time wear for 1 year and night time wear for next 1 year in the upper arch and lower lingual bonded retainer.

Cephalometric analysis

A single operator used the same machine to acquire lateral cephalograms for all study subjects at the end of leveling and aligning (T0) and at the end of en masse distalization (T1) (Carestream CS 9600 model, 80.00 kV, 10.00 mA, 9.99 S, 26.47 mGy cm^2). Cephalograms were taken at the end of en masse distal movement after achieving a class I with overjet less or equal to 2 mm and good finishing and proper interdigitation. The superimposition of pre and post cephalograms for Dentoalveolar and airway changes was done using facad cephalometric software version 23 (Ilexis, Sweden).

Parameters assessed in the study are mentioned in Table 1.

Statistical analysis

SPSS software version 23.00 was used to conduct the statistical analysis (SPSS Inc., Chicago, IL). At T0 and T1, the Shapiro-Wilk test was used to check normality, and the paired *t*-test was used to compare intragroup differences. [Figures 1 and 2]

Results

The parameters assessed in this study are given in Table 1. Numerical and graphical normality tests using Shapiro-Wilk test and p–p plot showed that the dependent variables are normally distributed. The kappa statistics used for inter-rater reliability comparison showed moderate agreement (0.50).

Table 2 gives the results of paired t tests for significance of difference between end of leveling and aligning stage (T0) and end of en masse distal movement (T1). The dental angular measurements such as U1 to N-A, L1 to N-B and interincisal angle showed significant change at T1 ($P > 0.05$) and changes in dental linear

Table 1: Cephalometric parameters assessed

Parameters	Description
U1 to N-A (mm)	Upper incisor position
U1 to pt A (mm)	Upper incisor position
U1 to N-A (°)	Upper incisor angulation
L1 to N-B (mm)	Lower incisor position
L1 to ApO line (mm)	Lower incisor position
L1 to NB (°)	Lower incisor angulation
U1-L1 (°)	Interincisal angle
Upper airway	The distance between the most posterior point on the soft palate's outline and the closest point on the pharyngeal wall is measured.
U1-palatal plane (mm)	The distance between the incisal edge of upper incisors and the palatal plane is measured perpendicularly.
Lower airway	The distance between the place where the tongue's posterior border joins the mandible's inferior border and the nearest point on the posterior pharyngeal wall is measured.
U6 to PtV	The distance between the pterygoid vertical (back of the maxilla) and the upper molar's distal end.
Nasopharynx (mm)	Sagittal linear dimension at the lowest border of the airway-level of PNS.
Retropalatal (mm)	Sagittal linear dimension at the lowest border of the airway-level of base of soft palate.
Retroglossal (mm)	Sagittal linear dimension at the lowest border of the airway-level of base of epiglottis.
Soft palate	
NL/PM-U (°)	Angle between Pterygo-maxillare-Uvula line and Nasal line.
PM-U (mm)	distance from Pterygo-maxillare to Uvula.
SPA (mm^2)	Maximum thickness of the soft palate perpendicular Pterygo-maxillare-Uvula.
Hyoid bone	
AH-CV (mm)	Length from Anterior hyoid to Cervical plane.
AH-FH (mm)	Distance from Anterior hyoid to Frankfort horizontal plane.
AH-MP (mm)	Distance from Anterior Hyoid to Mandibular plane.
Tongue	
H-VT	Distance from superior part of the tongue to long axis of the tongue.
TA (mm^2)	Area within the contour of the tongue (superiorly and posteriorly);the line passing through Vallecula,Anterior hyoid,Genial tubercle (inferiorly);lingual contour of the chin and of the lower incisor (anteriorly).
VT (I) (mm)	Long axis of the tongue.

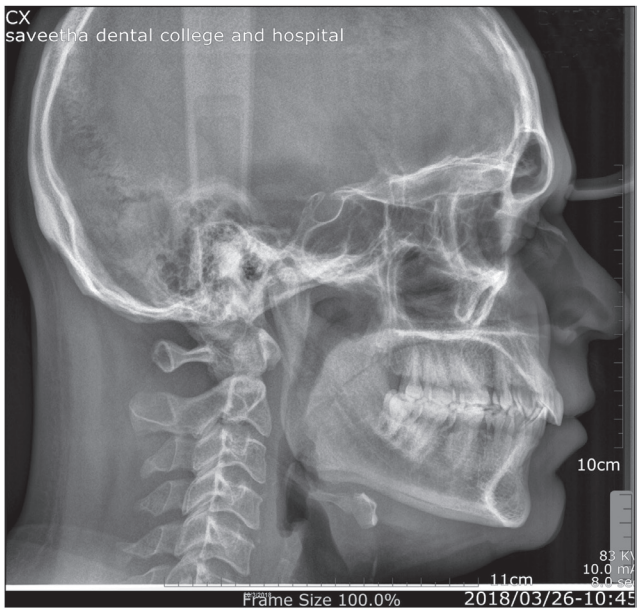

Figure 1: Pre-treatment cephalogram

Figure 2: Post-treatment lateral cephalogram

measurements U1 to N-A and U1 to point A distance, U1 to Palatal plane, L1 to N-B, L1 to Apo line distance, U6 to PtV were statistically significant ($P > 0.05$). Linear parameters such as L1 to ApO line, upper airway, and lower airway were not statistically significant (<0.05).

Table 3 gives the results of paired t tests for significance of difference between end of leveling and aligning stage (T0) and end of en masse distal movement (T1). Soft palate angulation (NL/PM-U) was not statistically significant ($P > 0.05$) and changes in linear airway assessment at nasopharynx, retropalatal region, and retroglossal region were not statistically significant ($P > 0.05$). Changes in the soft palate position and surface area at T1 were not statistically significant ($P > 0.05$). Changes in the hyoid bone position with respective to different plane measurement at T1 were not statistically significant ($P > 0.05$). Changes in the tongue posture and area at T1 were not statistically significant ($P > 0.05$).

Discussion

In the present study, 11 subjects with class II div I malocclusion requiring en masse distal movement were included and IZCs were placed bilaterally followed by en masse distalization. Upper incisor inclination reduced at T1 and was found to be significant ($P < 0.05$). Significant distal movement of upper incisors was noted at T1 ($P < 0.05$). Significant proclination of lower anterior incisors were noted at T1 ($P < 0.05$) as we had not attempted any distal movement in the lower arch. Significant changes in lower anterior linear position were noted ($P > 0.05$). Upper molar to pterygoid vertical linear distance was measured for assessing molar distal movement and a significant change was noted at T1 ($P < .05$). An average of 3 mm distal movement of the upper molar teeth was noted at T1. The interincisal angle reduced significantly at T1 ($P < 0.05$). Significant amount of upper anterior

Table 2: Comparison of linear and angular cephalometric values with paired *T*-test for significance of difference between end of leveling and aligning stage (T0) and end of en masse distalization (T1)

Cephalometric points	Mean difference (T1-T0)	Standard deviation	*P*-value
U1 to N-A (mm)	3.14	1.01	0.00
U1 to N-A (°)	7.69	2.69	0.00
L1 to N-B (mm)	–0.89	1.22	0.03
L1 to NB (°)	–3.20	3.81	0.01
Interincisal (°)	–5.30	3.03	0.00
U1 to pt A (mm)	1.24	0.52	0.000
L1 to ApO line (mm)	–1.30	1.26	0.006
U1-palatal plane (mm)	0.82	0.35	0.000
Upper airway	–1.13	2.18	0.115
Lower airway	–1.24	2.94	0.192
U6 to PtV	3.02	1.06	0.002

Statistical significance (*P* value < 0.05)

Table 3: Comparison of angular and linear cephalometric values for airway, soft palate, hyoid bone and tongue with paired *T*-test for significance of difference between end of leveling and aligning stage (T0) and end of en masse distalization (T1)

Airway assessment	T0	T1	Mean difference (T1-T0)	Standard deviation	*P*-value
Nasopharynx region (mm)	17.8 (2.9)	17.3 (1.8)	0.5	1.13	0.13
Retropalatal region (mm)	9.6 (1.8)	9 (1.1)	0.6	0.69	0.06
Retroglossal region (mm)	9.3 (2.4)	8.9 (1.8)	0.4	0.61	0.06
Soft palate					
NL/PM-U (°)	7.6 (0.26)	7.5 (0.14)	0.1	0.12	0.171
PM-U (mm)	11.5 (0.98)	11.3 (0.7)	0.2	0.28	0.12
SPA (mm^2)	162.2 (2.3)	161.9 (1.6)	0.31	0.7	0.073
Hyoid bone					
AH-CV (mm)	25.3 (2.6)	25.1 (1.97)	0.27	0.63	0.13
AH-FH (mm)	75.4 (3.5)	75.1 (2.89)	0.38	0.61	0.19
AH-MP (mm)	9.9 (2.5)	9.3 (1.12)	0.6	1.38	0.09
Tongue					
H-VT (mm)	20.2 (2.7)	20.1 (1.97)	0.14	0.73	0.08
TA (mm^2)	2004.7 (217)	2004.5 (216.9)	0.2	0.1	0.16
VT(I) (mm)	50.4 (1.99)	50.3 (0.19)	0.19	1.8	0.19

Statistical significance (*P* value < 0.05)

intrusion was noted ($P < 0.05$). No significant changes in upper and lower airway linear measurements were noted ($P > 0.05$). On airway analysis as proposed by Joy *et al.* and Shen *et al.* it was noted that there was no effect of distalization of maxillary molars with IZC anchorage on airway dimensions at nasopharynx, retropalatal and retroglossal regions. No differences in tongue area and tongue posture were noted. No changes in hyoid bone position with respect to the various planes was noted.

Various case reports for en masse distal movement of the maxillary dentition with interdental mini screws and IZC screws have been reported previously. In a case study by Tekale *et al.*,[12] they used mini-screws between the second premolar and the first molar to move maxillary molars distally and achieve full cusp class I molar relation from class II molar relation. A patient with class II malocclusion was treated with IZC screws in a case study by Ghosh *et al.*,[13] and a Class I molar and canine relationship was attained at the end of treatment. According to Deshmukh and Vadera,[14] precise positioning of the miniscrews in the arch is required for efficient and effective en masse distal movement of the entire maxillary dentition.

For maxillary en masse distal movement for dentoalveolar Class II correction, Beyling *et al.*[15] used a completely customized lingual appliance in combination with miniscrew anchorage and found that mean correction of the class II canine relationship of 0.43 mm per month from T1 to T2 was achieved with mini screw supported en masse distalization in an average of 10.5 ± 4.5 months (min. 5.2, max. 19.8). Patil *et al.*[11] used IZC implants in combination with anterior micro implants to distalize and intrude the entire maxillary dentition nonsurgically and without extraction for the treatment of class II malocclusion with mild skeletal discrepancy and gummy smile and noted that the maxillary first molar moved distally by 4.6 mm. Chang *et al.*[16] reported successful use of multiloop edgewise archwire for distal en masse maxillary dental movement. The IZ crest anchored mini screw according to Wu *et al.*[17] is an excellent device for maxillary dental distal movement and they reported that the maxillary first molars' mesial buccal cusp showed 3.5 mm of distalization and 2.8 mm of distalization was observed in the distal buccal cusp. Shahani *et al.*[18] demonstrated that employing both passive self-ligation and aligner appliances, en masse distal movement of the maxillary dentition with IZC anchorage was successful and concluded that first molar distalization was measured as 3.8 ± 1.16 mm in passive self-ligation and as 3.2 ± 0.43 mm in clear aligners. In passive self-ligation, the second molar is distalized by 3.4 ± 2.05 mm, while in clear aligners, it is distalized by 3.08 ± 1.68 mm.

The thickness of the IZC region changed according to vertical skeletal patterns, according to a study by Murugesan *et al.* The dimension of the IZC region above the maxillary second molar was greater than the region above the first molar region. In individuals with vertical growth patterns, TAD placement in the IZC region above the mesio-buccal root of the maxillary second molar is preferable.[19] A study by Arvind *et al.*[20] concluded hypodivergent individuals had the highest bone density

levels in IZC sites. Junaid *et al*.[21] found that the best IZC site is distal to the anatomic ridge and buccal to the mesiobuccal root of the second maxillary molar.

The limitation of the study is that the evaluation is two-dimensional and there is no control group to compare with any other method of en masse distalization. Cone beam computed tomography evaluation of airway changes was not considered.

Conclusion

Class II div I malocclusions can be efficiently corrected without extraction using IZC screws and en masse distal movement of the maxillary dentition. Significant reduction in upper anterior inclination, upper anterior intrusion, and molar distal movement can be achieved. No effect on the airway dimensions was observed with molar distal movement and there was no significant difference in tongue posture position of soft palate and hyoid bone.

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Conflicts of interest

There are no conflicts of interest.

Authors contributions

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Ethical policy and institutional review board statement

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Patient declaration of consent

Not applicable.

Data availability statement

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