



Maxillary Molar Intrusion Evaluation using Mini-implants along with Transpalatal Arch Bar

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ABSTRACT

Aim: The prospective clinical study was undertaken to evaluate the amount of maxillary molar intrusion achieved during orthodontic treatment using mini-implants along with transpalatal arch bar.

Materials and methods: The treated group consisted of 10 subjects having over-erupted maxillary molars with mean age of 20.75 years. Mini-implants of 8 mm length and 1.3 mm diameter (Dentos-Absoanchor, Dentos Inc., Korea) were placed in the inter-radicular region between the second premolar and first molar on the buccal side where the molar intrusion was planned. Transpalatal arch bar was placed 5 mm away from the palate. Intrusive force of 100 to 150 gm was applied using prestretched elastic chain. Lateral cephalograms were taken before beginning of molar intrusion and 3 months after the molar intrusion. The intrusion was measured from the distobuccal cusp tip of maxillary first molar to the true vertical and rotation of the mandibular plane was assessed in relation to Go-Me and SN plane. The mean changes in the cephalometric parameters were subjected to paired t-test to determine results under statistical evaluation.

Results: Statistically significant ($p < 0.001$) amount of molar intrusion was achieved following the usage of mini-implant with a mean value of 1.95 mm and significant anti-clockwise rotation of the mandibular plane (Go-Me) in relation to SN plane ($p < 0.001$) was seen as a result of molar intrusion.

Conclusion: The study revealed that mini-implant served as an efficient source of anchorage for achieving maxillary molar intrusion in correction of malocclusion in vertical dimensions.

Keywords: Mini-implants, Molar intrusion, Transpalatal arch bar.

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INTRODUCTION

One of the most difficult malocclusions to treat and maintain in orthodontics is the patient having problem in vertical dimension having multifactorial etiology. Morphologic traits of these cases usually include increased vertical dimension due to excessive vertical overgrowth of maxillary posterior dentoalveolar structures, which may manifest as over-erupted maxillary molars.

Intrusion of over-erupted maxillary molars in adult patients is a strenuous challenge for the orthodontist.¹ This is mainly due to the fact that the intrusive force applied is opposed by equal extrusive force acting on the supporting teeth. Maxillary molar intrusion usually derives anchorage from multiunit teeth assembly or extra-oral anchorage devices, which in turn limits the treatment results due to its dependence on patient compliance.^{2,3}

The rapid development of temporary anchorage devices presents a professional dilemma for orthodontists. They compose a broad array of implants used to support orthodontic treatment. All these temporary anchorage devices are invasive and the best recommended for malocclusion that cannot be effectively managed with conventional mechanics. At present, the most common temporary anchorage devices include miniscrews, microscrews, miniature implants or mini-implants, palatal implants, retromolar implants as well as functionally loaded prosthetic implants.^{4,5} It has been proven in many studies and case reports that these mini-implants placed within the bone tissue, is a very reliable source of molar intrusion, thus controlling vertical dimension.

However, clinical validation of such dictions becomes mandatory before advocating them into routine practice. Hence, it was felt that there is a need to explore the clinical efficacy of mini-implants while carrying out molar intrusion to correct various types of difficult malocclusion.

MATERIALS AND METHODS

The prospective study was done on a sample size of 10 (4 males and 6 females) patients in the age range of 18 to 24 years having no discrimination for gender, undergoing treatment in the department of orthodontics and

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dentofacial orthopedics. The study design was reviewed and approved by the Institutional Ethical and Review Committee and an informed consent was taken for each patient who participated in the study.

Criteria for Selection of Sample

Patients having supraerupted maxillary molar unilaterally or bilaterally and whose profile or malocclusion can be corrected by true molar intrusion having no medical problem were included in the study whereas subjects with systemic and periodontal problems and age below 18 years were not included in the study.

Armamentarium

- Mini-implant DENTOS-AbsoAnchor Inc. Korea of 1.3 mm diameter and 8 mm length.
- Dontrix gauge (ODG-503 Invecta 16 OZ, 01-39).
- Cephalostat-Rotograph 230/Eur-4 X-ray machine (Villa System Medically, Italy).
- Hardware-APC workstation Hp pavilion dv6000, Intel Centrino Duo processor with 512 MB RAM 80 GB secondary storage.
- Software Windows XP professional.
- Digital Camera-Nikon Coolpix S10 VR of 6.0 megapixels and 10× optical zoom.
- Lacquered polyester acetate tracing paper.
- Staedtler 0.3 mm mars micro lead pencil.
- Anesthetic sprays NUMMIT-Lidocaine Topical Aerosol USP with 2% lignocaine.

Method of Implant Placement

The mini-implant (DENTOS-AbsoAnchor) with length of 8 mm and diameter of head 1.3 mm was fixed in the inter-radicular region between the second premolar and first molar on the buccal side after application of anesthetic spray (NUMMIT-Lidocaine Topical Aerosol USP) with 15% lidocaine.

All mini-implants were placed by a single operator and were loaded immediately with no waiting period. An orthodontic force of 100 to 150 gm was applied by means of prestretched elastic chain from the mini-implant head to the hook of triple tube on the banded maxillary first molar for molar intrusion. The intrusive force was measured using Dontrix gauge (ODG-503 INVECTA 16 OZ. 01-39; 1 Ounce as equivalent to 28.3 gm). All the mini-implants were placed after initial alignment of teeth on continuous 0.018 inch round stainless steel premium plus archwire of AJ Wilcock Company, Australia. In order to prevent buccal flaring of maxillary molar, a modified transpalatal arch bar with two small U-loops was placed on palatal side (Fig. 1).

The transpalatal arch was kept 5 mm away from the palatal mucosa to exert an intrusive force on molar from palatal side.⁶ The time interval for which molar intrusion was carried out was 3 months. The elastic chain was changed every month in order to deliver sustained intrusive force.

METHODS OF EVALUATING TREATMENT CHANGES

Cephalometric records and methodology of assessment. The lateral cephalometric radiographs of all the patients included in the study were taken on a Rotograph 230/Eur-4 X-ray machine (Villa System Medically, Italy). Two lateral cephalograms were obtained, one before intrusion of the molar and the second one immediately after the intrusion phase was completed. The lateral cephalograms were taken with the subject in standing position, keeping the visual axis parallel to the floor under standard exposure and position.

All the tracings were made on 75 µm lacquered polyester acetate tracing papers (Garware Polyester Ltd., Mumbai) using a 0.3 mm Staedtler Mars micro lead pencil (Germany). A single operator performed the tracings in a standardized manner to avoid errors due to any interoperator error or variations. The hard tissue landmarks (Fig. 2), reference planes (Fig. 3) and angular measurements used in the study were as defined by Alexander Jacobson and Thomas Rakosi.⁷

Assessment of maxillary first molar intrusion was measured as a perpendicular from the distobuccal cusp tip of maxillary first molar to the sella-nasion plane, Frankfurt horizontal plane, palatal plane and the true vertical line. The lateral cephalometric tracings taken before and after molar intrusion were superimposed along the palatal plane registered at anterior nasal spine (Fig. 4).



Fig. 1: Modified transpalatal arch bar with loops placed 5 mm away from palate

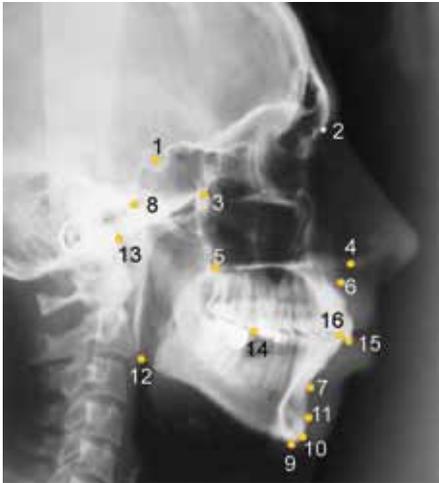


Fig. 2: Hard tissue landmarks (1: Sella; 2: Nasion; 3: Ptm point; 4: ANS; 5: PNS; 6: Subspinale; 7: Supramentale; 8: Condylion; 9: Menton; 10: Gnathion; 11: Pogonion; 12: Gonion; 13: Articulare; 14: U6; 15: Uis; 16: Lii)

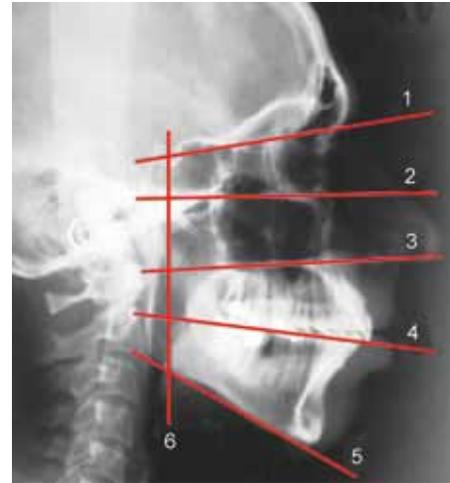


Fig. 3: Reference planes (1: Sella Nasion plane; 2: Frankfurt plane; 3: Palatal plane; 4: Occlusal plane; 5: Mandibular plane; 6: True vertical)

CEPHALOMETRIC LANDMARKS

Sella (S): Geometric center of the pituitary fossa located by the visual inspection.

Nasion (N): The most anterior point of the frontonasal suture in the midsagittal plane.

Ptm point: It is the intersection of the inferior border of foramen rotundum with the posterior wall of the pterygo-maxillary fissure.

Anterior nasal spine (ANS): The anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening.

Posterior nasal spine (PNS): The posterior spine of the palatine bone constituting the hard palate. This is a constructed point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose.

Subspinale (A): The most posterior midline point in between the ANS and prosthion.

Supramentale (B): The most posterior midline point in the concavity of the mandible between the infradentale and the hard tissue pogonion.

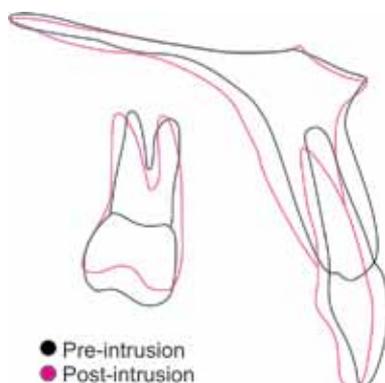


Fig. 4: Superimposition of pre-intrusion and post-intrusion tracing

Condylion (Cd): The most superior point on the head of the condyle.

Menton (Me): The lowest point on the symphyseal shadow of mandible.

Gnathion (Gn): A point located between the most anterior and inferior point of the bony chin.

Pogonion (Pog): Most anterior point of the bony chin, in the median plane.

Gonion (Go): A point on the curvature of the angle of the mandible, formed by the intersection of the lines tangent to the posterior margin of the ascending ramus and mandibular base.

Articulare (ar): It is the point of intersection of the posterior margin of the ascending ramus and the outer margin of the cranial base.

Upper molar cusp tip (U6): Distobuccal cusp tip of the permanent maxillary first molar.

Uis: Incisor superius. Tip of the crown of the most anterior maxillary central incisor.

Lii: Incisor inferius. Tip of the crown of the most anterior mandibular central incisor.

REFERENCE PLANES

Sella-Nasion plane: Line joining the center of the pituitary fossa and the nasion.

Frankfurt plane: The plane formed by the line joining porion to orbitale.

Palatal plane: The plane joined by forming ANS to PNS.

Occlusal plane: The plane formed by the line passing through the overlapping cusps of the premolars and molars.

Mandibular plane: The plane formed by joining the gonion and menton.

True vertical plane (TV): The plane drawn perpendicular to Frankfurt horizontal plane from the point Sella.

The cephalometric angular and linear measurements were used as defined by Thomas Rakosi, Alexander Jacobson and Erverdi N, Keles A, Nanda R.⁸ The pre-intrusion and the post-intrusion cephalogram tracings (Fig. 5) were analyzed and measurements were made to evaluate the amount of molar intrusion achieved.

CEPHALOMETRIC MEASUREMENTS UNDERTAKEN

Angular Measurements

SN-GoMe: Angle between Sella-Nasion plane and mandibular plane (Gonion-Menton).

Palatal plane-SN plane: Angle between palatal plane (ANS-PNS) and Sella-Nasion plane.

Palatal plane-occlusal plane: Angle between palatal plane (ANS-PNS) and occlusal plane.

Occlusal plane-mandibular plane: Angle between occlusal plane and mandibular plane.

Palatal plane-mandibular plane: Angle between palatal plane and mandibular plane.

L1-MP: Angle formed between the long axis of mandibular central incisor and mandibular plane.

U1-SN: Angle formed between the long axis of maxillary central incisor and sellanasion plane.

Linear Measurements

U6-PP: Perpendicular distance between distobuccal cusp tip of maxillary first molar and palatal plane (PP).

U6-TV: Perpendicular distance from distobuccal cusp tip of maxillary first molar and true vertical plane.

Uis-palatal plane: Perpendicular distance from the incisal edge of the maxillary central incisor to the palatal plane.

Uis-TV: Perpendicular distance from the incisal edge of maxillary central incisor to the true vertical.

STATISTICAL ANALYSIS

The data obtained were subjected to statistical analysis. The mean, standard error, and standard deviation were tabulated. The student's paired t-test was used to determine the level of significance and the correlation of intrusion achieved before and after treatment.

Statistical significance was considered at p-value of:

$p > 0.05$ not significant

$p < 0.05$ significant

$p < 0.01$ highly significant

$p < 0.001$ very highly significant.

RESULTS

- Comparison of cephalometric angular measurements (in degrees) of SN-GoMe (Table 1) for 15 patients, the mean obtained for pre-intrusion values was 31.40 ± 4.29 . The mean obtained for post-intrusion values, for the same set of patients, was 29.85 ± 4.37 . A comparison of mean of post-intrusion values with the pre-intrusion values, showed a difference of 1.55. When the mean of pre-intrusion and post-intrusion values were compared at the statistical level using student's paired t-test, significant difference were obtained at $p < 0.001$ which reveals statistically significant reduction in steepness of mandibular plane.
- Comparison of cephalometric angular measurements (in degrees) of PP-SN plane (Table 2), of pre-intrusion and post-intrusion values at the statistical level using paired t-test, no statistically significant difference were obtained at $p < 0.001$. It shows that there was no change in angular measurement of PP-SN from pre-intrusion to post-intrusion. The mean obtained for pre-intrusion values was 6.45 ± 2.43 and mean for post-intrusion values was 7.00 ± 3.01 . The mean difference obtained was -0.55 . Statistically non-significant results were obtained at $p > 0.05$ when statistical analysis was done using paired t-test.
- When the cephalometric angular measurements of PP-occlusal plane (Table 3) were done, the mean obtained for pre-intrusion values was 9.15 ± 3.75 . The mean obtained for post-intrusion values was 6.55 ± 3.71 . The comparison of mean of post-intrusion values with the pre-intrusion values showed a mean difference of 2.60. When the mean of pre-intrusion and post-intrusion

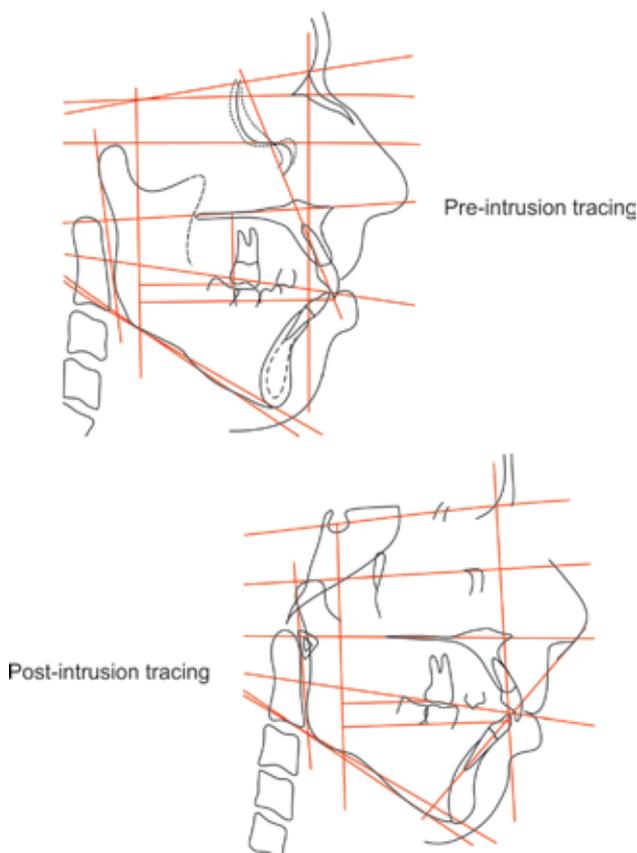


Fig. 5: Pre-intrusion and post-intrusion cephalometric tracings

Table 1: Cephalometric comparison of angular measurement of SN-GoMe (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	31.4000	4.2934	1.5500	0.5503	4.9363	8.9078	0.0000*
Post-intrusion	29.8500	4.3719	—	—	—	—	—

*Highly significant at 0.1% level of significance ($p < 0.001$)

Table 2: Cephalometric comparison of angular measurement of PP-SN (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	6.4500	2.4318	- 0.5500	1.3427	- 8.5271	- 1.2954	0.2274
Post-intrusion	7.0000	3.0185	—	—	—	—	—

Table 3: Cephalometric comparison of angular measurement of PP-occlusal plane (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	9.1500	3.7568	2.6000	1.5239	28.4153	5.3954	0.0004*
Post-intrusion	6.5500	3.7152	—	—	—	—	—

*Highly significant at 0.1% level of significance ($p < 0.001$)

values were compared at the statistical level using paired t-test, significant difference were obtained at $p < 0.001$. This showed statistically significant reduction in the occlusal plane divergence with the maxillary molar intrusion.

- Comparison of cephalometric angular measurements (in degrees) of Occlusal plane-GoMe (Table 4) at statistical level using paired t-test showed no statistically significant differences at $p < 0.001$. The mean obtained for pre-intrusion values was 16.7 ± 4.62 . The mean obtained for post-intrusion values was 15.9 ± 4.17 . The mean difference obtained was 0.80.
- Comparison of cephalometric angular measurements (in degrees) of PP-GoMe (Table 5) showed pre-intrusion values of 25.7 ± 4.90 . The mean obtained for post-intrusion values was 22.50 ± 4.70 . A comparison of mean of post-intrusion values with the pre-intrusion values showed a difference of 3.25. When the mean of pre-intrusion and post-intrusion values were compared at the statistical level using student's paired t-test, significant difference were obtained at $p < 0.001$ which confirms statistically significant reduction in the steepness of mandibular plane.

- On comparison of cephalometric linear measurements (in mm) of U6-PP (Table 6) the mean value obtained for pre-intrusion values was 23.70 ± 2.31 . The mean obtained for post-intrusion values was 22.45 ± 2.21 . A comparison of mean of post-intrusion values with the pre-intrusion values showed a difference of 1.25. On comparing the mean values at statistical level using paired t-test, significant differences were obtained at $p < 0.001$.
- Comparison of cephalometric linear measurements (in mm) of U6-TV (Table 7) the mean value n obtained for pre-intrusion was 69.8 ± 4.38 . The mean obtained for post-intrusion values was 67.85 ± 4.28 . The mean difference of 1.95 was obtained on comparing the mean of post-intrusion values with the pre-intrusion values. Statistical comparison of the mean values using student's paired t-test showed statistically significant difference in the linear measurements at $p < 0.001$.

DISCUSSION

True intrusion of a tooth takes place when the forces are directed through the center of resistance. But directing

Table 4: Cephalometric comparison of angular measurement of occlusal plane-GoMe (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	16.7000	4.6200	0.8000	1.5492	4.7904	1.6330	0.1369
Post-intrusion	15.9000	4.1753	—	—	—	—	—

Table 5: Cephalometric comparison of angular measurement of PP-GoMe (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	25.7500	4.9061	3.2500	1.4767	12.6214	6.9598	0.0001 ¹
Post-intrusion	22.5000	4.7022	—	—	—	—	—

¹Highly significant at 0.1% level of significance ($p < 0.001$)



Table 6: Cephalometric comparison of angular measurement of U6-PP (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	23.7000	2.3118	1.2500	0.6346	5.2743	6.2284	0.0002 ¹
Post-intrusion	22.4500	2.2167	—	—	—	—	—

¹Highly significant at 0.1% level of significance (p<0.001)

Table 7: Cephalometric comparison of angular measurement of U6-TV (on account of maxillary molar intrusion using paired t-test)

Measurement	Mean	SD	Mean Diff.	SD Diff.	% of change	Paired t-value	p-value
Pre-intrusion	69.8000	4.3856	1.9500	0.9560	2.7937	6.4504	0.0001 ¹
Post-intrusion	67.8500	4.2821	—	—	—	—	—

¹Highly significant at 0.1% level of significance

the force through the center of resistance has limited possibility in a clinical setup due to biologic constraints. As a result some degree of flaring is inevitable with any intrusive mechanics.⁹ When intruding an over-erupted maxillary first molar after loss of its antagonist, the intrusive force should pass through the center of resistance of the tooth buccopalatally and mesiodistally, otherwise tipping may occur. Unwanted tipping can be prevented by using four microimplants (two placed palatally and two placed buccally) or a transpalatal bar.¹⁰⁻¹⁴ In the present study, only one mini-implant has been placed high above the roots of the tooth, so that the intrusive force passed through the center of resistance of the tooth mesiodistally.¹⁰ The transpalatal arch bar was placed 5 mm away from the palate to allow resting tongue pressure to aid with molar intrusion and to prevent the intruding molar crown from tipping buccally.¹⁵

INTERPRETATION OF RESULTS

Assessment of mandibular plane, occlusal plane and palatal plane rotation due to molar intrusion:

- Comparison of angle between S-N plane and Mandibular plane (Go-Me) revealed decrease in the post-intrusion values (Table 1) indicating rotation of the mandible in the anticlockwise direction leading to reduction in steepness of mandibular plane which can be as a result of maxillary molar intrusion.
- Angular measurements between P-P and S-N plane showed no change in angular measurement from pre-intrusion to post-intrusion (Table 2), which reflected that no maxillary growth in vertical plane occurred during the time interval when maxillary molar intrusion was carried out.
- Comparison of cephalometric angular measurements of P-P and Occlusal plane showed a decrease in the post-intrusion value which reflected as rotation of occlusal plane in the anticlockwise direction thus causing flattening of occlusal plane (Table 3). This change in occlusal plane can be attributed to intrusion of maxillary molar.
- Angle between occlusal plane and mandibular plane (Go-Me) showed no change in the inclination with

respect to mandibular plane (Table 4) during maxillary molar intrusion which may be due to simultaneous rotation of mandibular plane following anticlockwise rotation of occlusal plane.

- Cephalometric angular measurement between P-P and mandibular plane (Go-Me) revealed decreased post-intrusion values (Table 5) indicating anticlockwise rotation of mandibular plane which could be as a result maxillary molar intrusion.

Assessment of Amount of Molar Intrusion

Comparison of cephalometric linear measurements of maxillary first molars (U6) with P-p (Table 6) and true vertical line (TV) (Table 7) revealed significant reduction in the linear distance from the distobuccal cusp tip of maxillary first molar to palatal plane and true vertical during maxillary molar intrusion. This decrease in the linear measurement from pre-intrusion to post-intrusion showed the amount of maxillary molar intrusion achieved.

COMPARISON WITH OTHER STUDIES

Study done by Sherwood et al¹⁶ and Erverdi et al¹⁷ to validate the true intrusion of molars bilaterally by skeletal anchorage to close anterior open bite revealed mean amount of molar intrusion of 1.99 mm with closure of mandibular plane by 2.62° and decrease in occlusal plane inclination by 2.25° leading to anterior open bite closure over the period of 5.5 months. The present study is in close agreement with this study showing comparable equal amount of molar intrusion bilaterally along with closure of mandibular plane by 1.55° and decrease in occlusal plane inclination by 2.6°.

Investigated the envelope of intrusive movements of a maxillary molar with mini-implants as anchorage source using partial or full mouth fixed edgewise appliances was done by Yao et al² which showed a mean amount of maxillary molar intrusion of 3 to 4 mm with an intrusive force of 150 to 200 gm applied by using elastic chain between buccal mini plate and attachment on the first molar band. An equal amount of force was applied from the palatal

side in between the palatal miniscrew and cleat of the molar attachment. The results of present study vary up to a great extent from above discussed study considering the amount of intrusive force applied in our study was less amounting to 100 to 150 gm. Moreover, in present study intrusive force was applied from the single mini-implant placed on the buccal side bilaterally along with transpalatal arch on the palatal side to prevent the buccal crown tipping of maxillary molar which was in contrast to the above mentioned study which used implants on both buccal as well as on palatal side.

Xun et al¹⁸ evaluated the effectiveness of mini-screw anchorage for intrusion of the posterior dentoalveolar region to correct skeletal open bite. The results showed a mean amount of maxillary first molar intrusion of 1.8 mm. There was a significant decrease in angle between MP-SN and MP-PP by 2.3° and 2.5° respectively. But there was no change in the inclination of the palatal plane.

Over-erupted molars cause difficulty in orthodontics and prosthodontics in occlusal equilibration. Lin et al¹ carried out intrusion of over-erupted maxillary molars using miniscrew anchorage. The results of the study showed successful maxillary molar intrusion in 5 months using miniscrew of 1.5 mm diameter and 9 mm length. The amount of intrusive force delivered was 150 to 200 gm both from buccal and palatal side using elastic chain for a period of 5 months. In the present study, maxillary molar intrusion was carried out for a period of 3 months with intrusive force of 100 to 150 gm from the single implant on the buccal side using elastic chain.

Another study over intrusion of overerupted molars was done by Melo et al¹⁹ to help replace the missing lower first molar, using micro-screws on buccal side and transpalatal arch bar on the palatal side to prevent undesirable buccal tipping of maxillary molar. The amount of intrusive force applied was 30 gm using short length of elastomeric chain from buccal micro-screw to terminal hook on the molar tube. The molar intrusion was carried out for 4 months. Our study had a similar study design and achieved comparable results the only difference was the different amount of force.

CONCLUSION

Contemporary orthodontic treatment requires a short treatment time and minimal patient cooperation. This study showed that skeletal anchorage can be used effectively for maxillary molar intrusion to correct malocclusion in vertical dimension in nongrowing patients. Maxillary molar intrusion can be successfully achieved with mini-implant anchorage without movement of the anchorage units by controlling the direction and amount

of intrusive force. A single mini-implant and transpalatal arch bar can be used to intrude an over-erupted maxillary molar without any undesirable molar crown tipping.

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