IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 9 Ser. 3 (September. 2025), PP 32-41
www.iosrjournals.org

"Comparative Evaluation Of Skeletal And Dental Parameters Before And After Posterior Maxillary Teeth Intrusion With Different Locations Of Mini Implants In Adults – A Prospective Clinical Study"

Dr. Anjali Ganatra, Dr. Santosh Kumar Goje, Dr. Prishita Mehta, Dr.Yahsraj Kharade[4], Dr. Nancy Agrawal

(Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopedics, K.M. Shah Dental College And Hospital/ Sumandeep Vidyapeeth Deemed To Be University, India)
(Professor & Hod, Department Of Orthodontics And Dentofacial Orthopedics, K.M. Shah Dental College And Hospital/ Sumandeep Vidyapeeth Deemed To Be University, India)
(Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopedics, K.M. Shah Dental College And Hospital/ Sumandeep Vidyapeeth Deemed To Be University, India)
(Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopedics, K.M. Shah Dental College And Hospital/ Sumandeep Vidyapeeth Deemed To Be University, India)
(Post Graduate Student, Department Of Orthodontics And Dentofacial Orthopedics, K.M. Shah Dental College And Hospital/ Sumandeep Vidyapeeth Deemed To Be University, India)

Abstract:
Introduction *- Posterior maxillary intrusion is a preferred nonsurgical option to correct vertical discrepancies in patients with VME. With the advent of orthodontic mini-implants (OMIs), especially infrazygomatic crest (IZC) bone screws and palatal implants, more controlled and effective intrusion mechanics have become possible. However, variations in implant placement may influence treatment outcomes, including unwanted tooth tipping and root resorption.*
Aim *- To evaluate and compare Skeletal and Dental parameters before and after maxillary posterior dentoalveolar intrusion using IZC bone screw, palatal mini implants and a combination of both.*
Material and Methods *– A clinical trial for three groups with 8 participants (age ≥18 years) each requiring maxillary posterior intrusion were treated using custom-fabricated acrylic splints incorporated with transpalatal bars. Group 1 received intrusion via infrazygomatic crest (IZC) bone screws, Group 2 via palatal mini-implants, and Group 3 via both IZC and palatal implants to ensure balanced force application. Immediate implant loading was done using elastomeric chains. Follow-up visits were scheduled every 28 days for 6 months.*
Results *– Skeletal and dental parameters did not differ significantly across groups, according to ANOVA ($p > 0.05$). However, after maxillary posterior teeth intrusion, paired t-tests showed significant intragroup skeletal and occlusal changes. SNB increased and ANB decreased ($p < 0.01$), indicating improved sagittal relationships. Vertical dimensions (N-Me, ANS-Me) and angles (SN-GoGn, FMA, Y-axis) reduced significantly ($p < 0.01$), suggesting mandibular counterclockwise rotation. Dental analysis showed significant intrusion of maxillary molars (Mx6-SN, Mx6-PP; $p <0.01$), increased overbite, and decreased overjet. Root resorption was significant within groups but not between them ($p > 0.05$), indicating no clinically relevant differences. Buccolingual inclination changed significantly within Groups 1 and 2 ($p < 0.05$), while Group 3 showed no flaring ($p > 0.05$). Tipping values differed significantly among groups ($p < 0.01$), with Group 1 showing the most, and Group 3 the least tipping.*
Conclusion *- Maxillary posterior teeth intrusion resulted in significant skeletal and occlusal improvements, including mandibular counterclockwise rotation, reduced facial height, and enhanced overbite and overjet. While root resorption and tooth inclination changes occurred, they were minimal in Group 3 due to balanced force application.*
Keywords – *Maxillary posterior intrusion, Anterior open bite, Vertical maxillary excess, Infrazygomatic bone screws, Palatal mini implants.*

Date of Submission: 08-09-2025 Date of Acceptance: 18-09-2025

I. Introduction

Vertical maxillary excess (VME) is a dentofacial condition characterized by excessive midface height due to downward elongation of the maxilla, often presenting clinically as a "gummy smile." Beyond esthetic concerns, VME is associated with functional and cosmetic complications such as anterior open bite, long midface proportions, and incompetent lips. While anterior open bite is commonly observed in these cases, deep bites may also occur. The condition is defined by an increased lower anterior facial height (LAFH) relative to the upper anterior facial height (UAFH)[1]. According to Nahoum, individuals with balanced facial esthetics typically exhibit a UAFH/LAFH ratio of 0.81, whereas patients with open bite malocclusion demonstrate an average ratio of 0.686.[2]

Open bite development is multifactorial, influenced by genetic, skeletal, dental, functional, and soft tissue factors, making it one of the most complex orthodontic problems to manage.[3] Treating adult patients is particularly challenging, as growth modification is no longer possible. Consequently, combined orthodontic-surgical approaches are often recommended. However, given the risks, costs, and invasiveness of surgical interventions, many patients prefer nonsurgical alternatives. Orthodontic approaches for vertical control include anterior extrusion, posterior intrusion, or both, with posterior intrusion favoured in cases of excessive LAFH.[4]

Over the years, various modalities such as headgear, magnetic forces, vertical chin cups, posterior bite blocks, and multiple-loop edgewise archwire (MEAW) therapy have been employed for vertical control. Nevertheless, these methods offer limited benefits in non growing individuals or in cases of severe vertical skeletal dysplasia.[5,6] The success of posterior intrusion depends on appropriate force magnitude, direction, and anchorage stability. Conventional techniques often face limitations due to anchorage inadequacy, leading to unwanted side effects. The advent of orthodontic mini-implants (OMIs) has revolutionized anchorage, enabling predictable posterior intrusion with minimal side effects.[7,8]

Mini-screw implants (MSIs) are particularly advantageous as they allow application of light, continuous, and controlled forces, reducing risks such as apical root resorption, a frequent complication of intrusive tooth movements. Compared to titanium miniplates, MSIs are easier to insert and remove, cost-effective, and versatile in placement.[9] Common anchorage sites include the infrazygomatic crest (IZC), interradicular spaces, and palatal regions.[10] Among these, IZC implants are preferred due to their strong cortical anchorage and ease of placement[11], though they carry a risk of buccal flaring when used alone. Palatal implants, especially when combined with rigid transpalatal bars, provide enhanced stability and can counteract unwanted tipping.[12]

For effective posterior intrusion, forces must pass through the center of resistance of the teeth in both bucco-palatal and mesio-distal directions, requiring force application from both buccal and palatal aspects to prevent tipping.[13] Despite the clinical utility of IZC and palatal implants, no studies have evaluated their combined use to optimize posterior arch intrusion while minimizing crown tipping. Moreover, orthodontic intrusion is considered one of the most resorption-prone tooth movements, making external apical root resorption (EARR) a significant concern.[14,17] Previous studies[14-17] have investigated root resorption following intrusion using lateral cephalograms and CBCT, with outcomes varying depending on the type and magnitude of applied force.

Therefore, the present study aimed to compare the effects of posterior maxillary teeth intrusion using different mini-implant placement sites in VME patients, while also evaluating the extent of root resorption through CBCT analysis. Findings from this study will provide valuable clinical insights into the optimal anchorage strategy for effective and safe posterior intrusion.

Null hypothesis for the research study was that there is no difference between dental and skeletal parameters before and after posterior maxillary dentoalveolar intrusion using either IZC bone screw, palatal mini implants or a combination of both.

II. Material And Methods

This prospective clinical study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth Deemed-to-be University, Piparia, Vadodara, with CBCT and lateral cephalograms obtained from the Department of Oral Medicine and Radiology of the same institution. Ethical approval was obtained prior to commencement.

Study Design: A Prospective Clinical study

Study Location:

1) The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth Deemed-to-be University, Piparia, Vadodara.
2) The CBCT and lateral cephalograms for the patients were obtained from Department of Oral Medicine and Radiology, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth Deemed-to-be University, Piparia, Vadodara.

Study Duration: May 2023 to May 2025

Sample size: 24 patients (8 in each group)

Sample size Calculation: The sample size was calculated using data from Akbaydogan L. et al.[18] Based on a power of 80% and a significance level of 0.05, the minimum sample size required was 7 participants; however, accounting for a 20% dropout rate, a total of 24 participants were enrolled, with 8 subjects in each group.

Subjects & selection method: Participants who were undergoing orthodontic treatment were selected from the Department of Orthodontics and Dentofacial Orthopedics, K. M. Shah Dental College and Hospital, Piparia, Vadodara.Allocation of the participants to the study groups were randomized using Microsoft excel Randomization tool into following study groups:

- **Group 1**: IZC Bone Screw
- **Group 2**: Palatal Mini Implants
- **Group 3**: IZC Bone Screw with Palatal Mini Implants

Inclusion criteria:
1. Age ≥ 18 years
2. Patients with a need for posterior maxillary dentoalveolar intrusion.
3. Increased Lower anterior facial height (↑LAFH)

Exclusion criteria:
1. Patients with poor oral hygiene.
2. Patients with poor periodontal health.
3. Medically compromised patients.
4. Patients with skeletal Class III malocclusion.
5. Previous orthodontic treatment.

Procedure Methodology:

After obtaining informed consent, detailed case histories and clinical examinations were performed. Pre-treatment CBCT and lateral cephalograms (T0) were recorded, and levelling and alignment of the maxillary arch were carried out up to 0.019 × 0.025 stainless steel wires in few of the crowded cases. Alginate impressions and bite registrations were taken to fabricate custom acrylic splints extending from the first premolar to the last erupted molar, reinforced with transpalatal bars to minimize transverse flaring. Hooks were incorporated into the splints according to group allocation for attachment of elastomeric chains.

Implant placement was performed under local anesthesia.

For Group 1 - IZC bone screws were inserted bilaterally near the maxillary first molars, 14–16 mm above the occlusal plane at an insertion angle of 55°–70°.

For Group 2 - Two palatal mini-implants were placed bilaterally along the mid-palatal suture between the second premolar and first molar.

For Group 3 - Both IZC and palatal mini-implants were placed at their respective sites.

Following implant placement, the splints were inserted and immediate loading was carried out with elastomeric chains extending from implants to splint hooks.

Participants were recalled every 28 days[18] for activation and replacement of elastomeric chains and were followed up for a total period of six months. Post-treatment CBCT and lateral cephalograms (T1) were recorded, and both skeletal and dental cephalometric parameters were evaluated. In addition, CBCT measurements were performed to assess root lengths, buccolingual inclinations assessing tipping of posterior teeth.

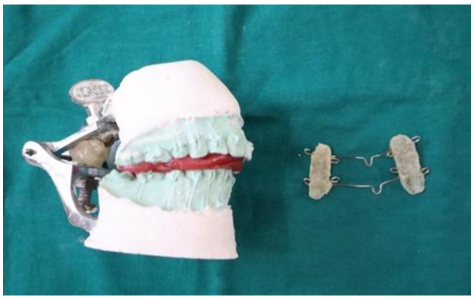


Fig 1: Working models mounted in an articulator with registration bite for fabrication of splint

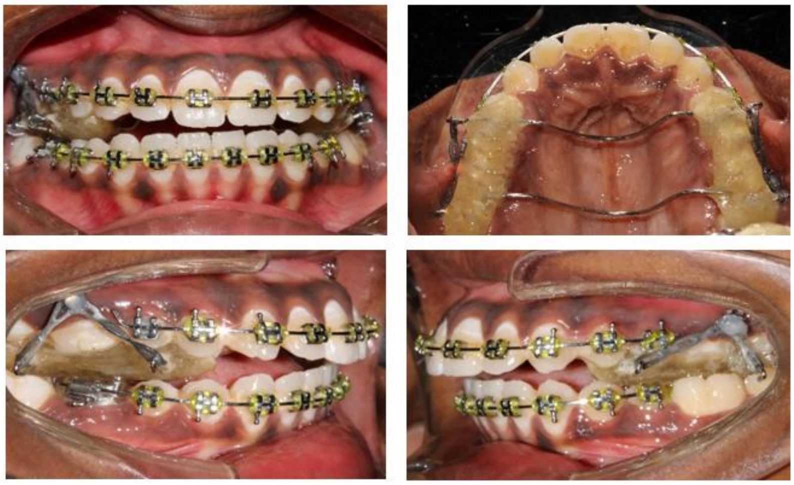


Fig 2: Maxillary posterior intrusion using custom fabricated acrylic splint and IZC implants

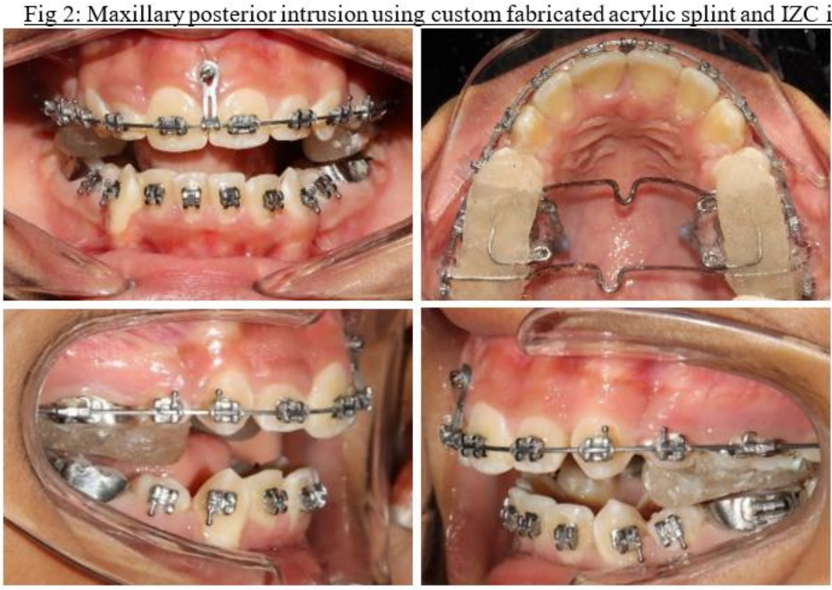


Fig 3: Maxillary posterior intrusion using custom fabricated acrylic splint and Palatal implants

Fig 4: Maxillary posterior intrusion using custom fabricated acrylic splint, IZC bone screw and Palatal implants

Fig 5: Pre-treatment Lateral Cephalogram

Fig 6: Post intrusion Lateral Cephalogram

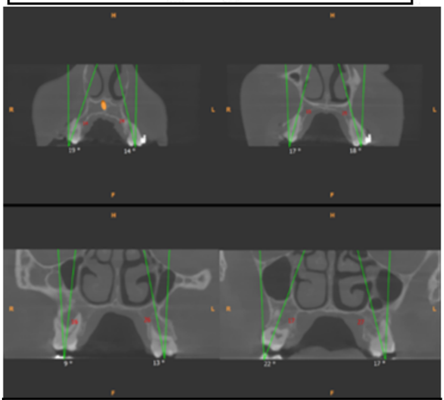


Fig 7 : Pre-treatment CBCT for Buccolingual inclination of maxillary posteriors (Inclination measured on coronal section using an angle formed between a line passing through the long axis of the tooth to a vertical line parallel to the mid-sagittal plane)

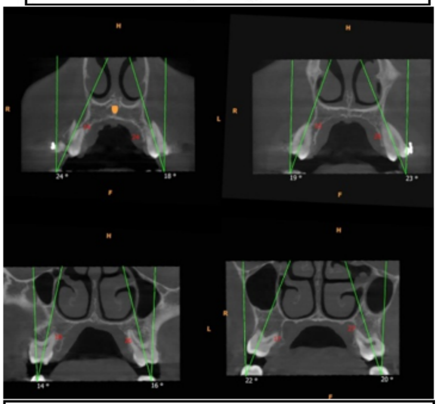
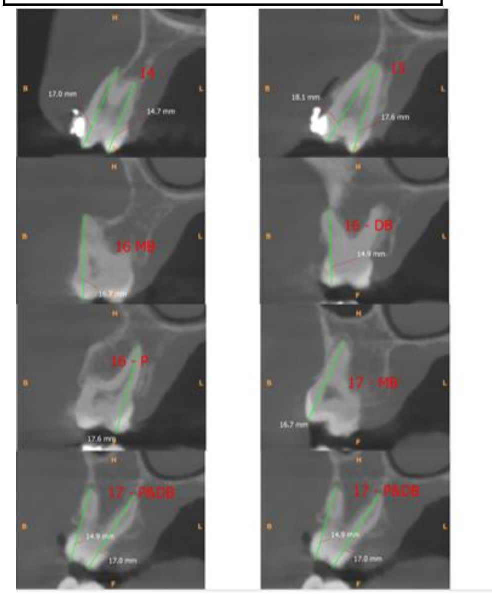
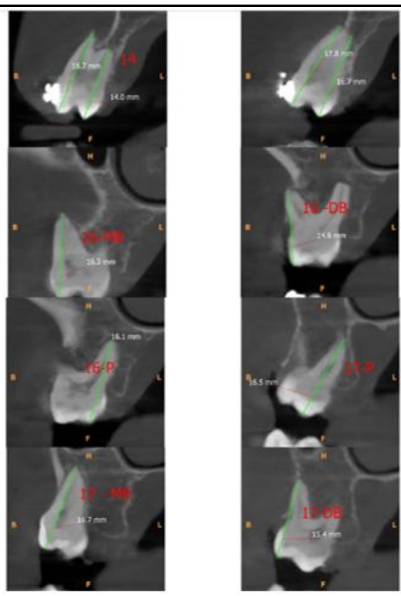


Fig 8 : Post intrusion CBCT for Buccolingual inclination of maxillary posteriors (Inclination measured on coronal section using an angle formed between a line passing through the long axis of the tooth to a vertical line parallel to the mid-sagittal plane)





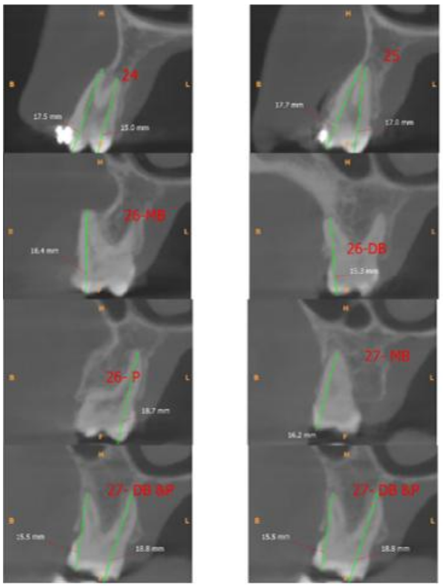


Fig 9: Pre-treatment CBCT for root length measured along long axis of tooth in sagittal section

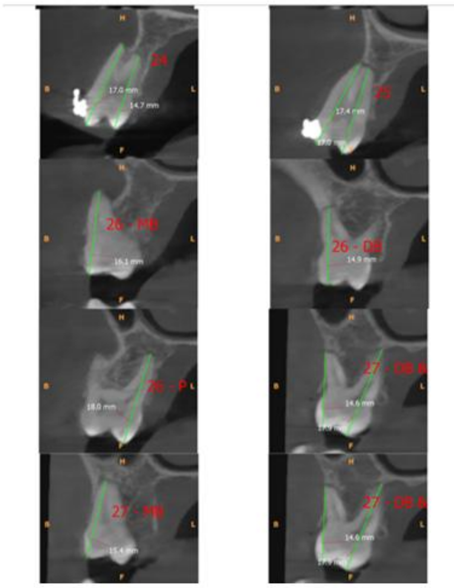


Fig 10 : Post treatment CBCT for root length measured along long axis of tooth in sagittal section

Statistical analysis:

A spreadsheet in Microsoft Excel was used to enter the data. The SPSS Windows software, version 25.0 (IBM SPSS Statistics Inc., Chicago, ILLINOIS, USA), was used for the analysis. Values below or equal to 0.05 were considered statistically significant, with p=0.05 serving as fixed level of significance. The Paired T Test for intragroup mean comparison and the ANOVA test for intergroup mean comparison were employed to determine the study's results.

III. Results

Table 1 – Intergroup Comparison of Pre-treatment and Post-treatment Skeletal changes

	Group 1 T0 – T1			Group 2 T0 – T1			Group 3 T0 – T1			ANOVA test
Parameters	**Mean**	**SD**	**P value (T-test)**	**Mean**	**SD**	**P value (T-test)**	**Mean**	**SD**	**P value (T-test)**	**P value**
SNA (°)	0.25	0.70	0.35	0.38	0.74	0.19	0.5	0.75	0.10	
SNB (°)	-1.13	0.35	<0.001	-1	0.53	0.001	-1.25	0.46	<0.001	
ANB (°)	1.37	0.74	0.001	1.37	0.91	0.03	1.75	0.88	<0.001	
NA – Pog (°)	1.12	0.64	0.001	1.25	0.7	0.001	1.37	0.51	<0.001	
N- Me (mm)	2.12	0.83	<0.001	2.5	0.92	<0.001	2.62	0.91	<0.001	
N- ANS (mm)	-0.37	0.74	0.19	-0.13	0.83	0.68	-0.25	0.71	0.35	
ANS – Me (mm)	2.5	0.53	<0.001	2.62	0.51	<0.001	2.88	0.83	<0.001	
ANS - Me / N – Me (%)	1.00	0.41	<0.001	0.92	0.45	<0.001	1.07	0.47	<0.001	
N - ANS / ANS-Me (%)	-2.95	1.27	<0.001	-2.70	1.35	<0.001	-3.10	1.36	<0.001	
Jarabak Ratio (%)	-1.68	0.54	0.001	-1.91	0.82	<0.001	-2.07	1.34	0.003	> 0.05
SN – GoGn (°)	2.12	0.64	<0.001	2.00	0.53	<0.001	2.5	0.75	<0.001	
FMA (°)	2.25	1.03	<0.001	2	0.75	0.001	2.37	0.74	<0.001	
FH – OP (°)	-1.50	1.19	0.009	-1.75	0.70	<0.001	-2	0.52	<0.001	
SN – OP (°)	-1.62	0.51	<0.001	-1.50	0.75	<0.001	-1.75	0.46	<0.001	
PP - MP (°)	1.5	0.75	0.003	1.38	0.91	0.003	1.75	0.46	<0.001	
MP –OP (°)	2.88	0.83	<0.001	2.63	0.74	<0.001	3.25	0.46	<0.001	
PP-OP (°)	-1.38	0.51	<0.001	-1.25	0.46	<0.001	-1.5	0.53	<0.001	
Y – Axis (°)	2	0.53	<0.001	1.87	0.35	<0.001	2.25	0.88	<0.001	
Articulare angle (°)	2.5	0.75	<0.001	2	0.92	<0.001	2.75	0.70	<0.001	
Saddle angle (°)	-0.38	0.51	0.07	-0.13	0.83	0.68	-0.25	0.7	0.35	
Gonial angle (°)	0.25	0.70	0.35	.37	.91	0.28	0.5	0.75	0.10	
P ≤ 0.05 - statistically significant										

Table 2 – Intergroup Comparison of Pre-treatment and Post-treatment Dental changes

	Group 1 T0 – T1			Group 2 T0 – T1			Group 3 T0 – T1			ANOVA test
Parameters	**Mean**	**SD**	**P value (T-test)**	**Mean**	**SD**	**P value (T-test)**	**Mean**	**SD**	**P value (T-test)**	**P value**
Mx1 - NA (°)	-0.25	0.70	0.35	-0.33	0.75	0.10	-0.30	0.74	0.19	
Mx1 - NA (mm)	-0.12	0.64	0.59	-0.25	0.91	0.28	-0.25	0.70	0.35	
IMPA (°)	0.37	0.51	0.07	0.25	0.46	0.17	0.50	0.90	0.17	
Md1 - NB (°)	0.50	0.75	0.10	0.38	0.74	0.19	0.62	1.06	0.13	
Md1 - NB (mm)	0.30	0.51	0.07	0.38	0.51	0.07	0.50	0.75	0.10	> 0.05
Md6 - MP (mm)	-0.25	0.46	0.17	-0.13	0.35	0.35	-0.25	0.46	0.17	
Mx6 - SN(mm)	2.37	0.51	<0.001	2.13	0.35	<0.001	2.62	0.51	<0.001	
Mx6 – PP (mm)	2.37	0.51	<0.001	2.13	0.64	<0.001	2.50	0.75	<0.001	
Overjet (mm)	1.12	0.35	<0.001	1.00	0.75	0.007	1.25	0.46	<0.001	
Overbite (mm)	-2.62	1.18	<0.001	-2.38	1.06	<0.001	-2.75	1.16	<0.001	
Interincisal angle (°)	-0.5	0.75	0.10	-0.38	0.74	0.19	-0.62	0.91	0.09	
P ≤ 0.05 -statistically significant										

Cephalometric analysis before (T0) and after (T1) maxillary posterior intrusion demonstrated significant skeletal and occlusal changes across all groups. SNA showed a slight, non-significant reduction ($p>0.05$), whereas SNB increased significantly ($p<0.01$), resulting in a significant decrease in ANB ($p<0.01$), indicating improved sagittal skeletal relationships.

Vertical dimensions showed a significant reduction in N-Me and ANS-Me ($p<0.01$), with a corresponding increase in Jarabak ratio ($p<0.01$), consistent with counter-clockwise mandibular autorotation. Significant reductions were also observed in SN-GoGn, FMA, and Y-axis angle. Occlusal plane parameters (FH-OP, SN-OP, PP-OP, MP-OP, and PP-MP) demonstrated significant flattening following posterior intrusion, while the articulare angle and the sum of posterior angles also decreased significantly ($p<0.01$).

Intragroup analysis confirmed significant vertical and occlusal changes, with reductions in Mx6-SN and Mx6-PP ($p<0.01$), validating maxillary posterior intrusion with a significant increase in overbite and a decrease in overjet. Changes in incisor inclination were minimal and not statistically significant. Intergroup comparison using ANOVA revealed no significant differences in skeletal or dental parameters among the three groups ($p>0.05$) indicating that all three treatment modalities were equally effective in achieving vertical control and improving occlusal relationships.

Table 3 – Intergroup comparison of Pre-treatment and Post-treatment changes of External Apical root resorption and Buccolingual inclination

	Group 1 T0 – T1		Group 2 T0 – T1		Group 3 T0 – T1		ANOVA Test
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
#27 Mesiobuccal root (mm)	0.52	0.12	0.46	0.09	0.53	0.07	
#27 Distobuccal root (mm)	0.55	1.17	0.45	0.09	0.50	0.10	
#27 palatal root(mm)	0.67	0.15	0.63	0.08	0.70	0.09	
#26 Mesiobuccal root (mm)	0.5	0.09	0.44	0.07	0.51	0.08	> 0.05
#26 Distobuccal root (mm)	0.43	0.07	0.40	0.09	0.42	0.10	
#26 palatal root (mm)	0.60	0.10	0.50	0.10	0.53	0.11	
#25 Buccal root (mm)	0.45	0.10	0.38	0.07	0.48	0.16	
#24 Buccal root (mm)	0.46	0.07	0.47	0.12	0.56	0.15	
#24 Palatal root (mm)	0.41	0.08	0.40	0.09	0.47	0.12	
#17 Mesiobuccal root (mm)	0.42	0.19	0.49	0.11	0.51	0.08	
#17 Distobuccal root (mm)	0.58	0.08	0.50	0.13	0.53	0.07	
#17 palatal root (mm)	0.62	0.13	0.55	0.10	0.61	0.09	
#16 Mesiobuccal root (mm)	0.46	0.77	0.43	0.07	0.48	0.08	
#16 Distobuccal root (mm)	0.45	0.09	0.35	0.09	0.40	0.07	
#16 palatal root (mm)	0.58	0.14	0.46	0.05	0.62	0.11	
#15 Buccal root (mm)	0.41	0.09	0.39	0.08	0.43	0.09	
#14 buccal root (mm)	0.43	0.09	0.42	0.07	0.52	0.17	
#14 Palatal root (mm)	0.45	0.14	0.35	0.09	0.42	0.08	
#27 tipping (°)	-1.63	1.19	1.25	0.71	-0.37	0.92	
#26 tipping (°)	-2.62	0.74	1.50	0.53	0.00	0.93	
#25 tipping (°)	-1.87	1.46	1.12	0.35	-0.25	0.89	
#24 tipping (°)	-2.00	0.93	1.00	0.53	-0.13	0.83	<0.001
#17 tipping (°)	-1.75	0.89	1.25	0.71	-0.25	0.89	

#16 tipping (°)	-2.25	1.16	1.62	0.52	-0.25	0.89	
#15 tipping (°)	-1.75	0.71	1.25	0.46	-0.13	1.25	
#14 tipping (°)	-2.5	1.20	1.25	0.46	-0.37	1.19	
P ≤ 0.05 -statistically significant							

Table 4 - Post Hoc Analysis for Intergroup Comparison of Buccolingual Inclination of teeth

Parameter	Comparison	Mean Difference	P value
# 14 Tipping (°)	Group 1- Group 2	3.75	<0.001
	Group 1- Group 3	2.12	0.001
	Group 2- Group 3	1.62	0.01
#15 Tipping (°)	Group 1- Group 2	3.00	<0.001
	Group 1- Group 3	1.62	0.003
	Group 2- Group 3	1.38	0.01
#16 Tipping (°)	Group 1- Group 2	3.87	<0.001
	Group 1- Group 3	2.00	<0.001
	Group 2- Group 3	1.87	0.001
#17 Tipping (°)	Group 1- Group 2	3.00	<0.001
	Group 1- Group 3	1.5	0.004
	Group 2- Group 3	1.5	0.004
#24 Tipping (°)	Group 1- Group 2	3.00	<0.001
	Group 1- Group 3	1.87	<0.001
	Group 2- Group 3	1.12	0.02
#25 Tipping (°)	Group 1- Group 2	3.00	<0.001
	Group 1- Group 3	1.62	0.01
	Group 2- Group 3	1.37	0.03
#26 Tipping (°)	Group 1- Group 2	4.12	<0.001
	Group 1- Group 3	2.62	<0.001
	Group 2- Group 3	1.50	0.001
#27 Tipping (°)	Group 1- Group 2	2.88	<0.001
	Group 1- Group 3	1.25	0.04
	Group 2- Group 3	1.62	0.007
P ≤ 0.05 -statistically significant			

Evaluation of external apical root resorption showed a statistically significant but clinically insignificant reduction in maxillary posterior root lengths from T0 to T1 across all groups while ANOVA confirmed no significant intergroup differences (p>0.05) as shown in Table 3.

Buccolingual inclination analysis revealed significant buccal flaring in Group 1 and significant palatal flaring in Group 2 (p<0.05), while Group 3 exhibited no significant inclination changes (p>0.05).

Intergroup comparisons using ANOVA and post hoc tests showed highly significant differences across all groups (p<0.01), with Group 1 demonstrating the greatest tipping, followed by Group 2, and minimal tipping in Group 3 (Table 4).

IV. Discussion

Anterior open bite represents one of the most complex malocclusions to manage, particularly in adults where growth modification is no longer an option. Our findings indicate that posterior intrusion using TADs is an effective and predictable method for bite closure, producing significant vertical and sagittal skeletal improvements with minimal adverse effects.

In the current study, the maxillary molars were intruded by 2.3–2.8 mm across all groups. These values are in close agreement with the results of Scheffler et al[19], Erverdi et al[20], and Deguchi et al[21], who reported 2.3–2.6 mm of intrusion using TAD-supported mechanics. Greater values have been reported by Leyla Cime et al[18], who achieved 4 mm of intrusion with palatal implants and splints. The extent of molar intrusion in this study produced mandibular counterclockwise autorotation, reflected by a 2° reduction in the SN–GoGn angle. These results parallel earlier reports[18,20] of 1.7–2.7° reductions, the degree varying according to both the severity of the initial open bite and the magnitude of molar intrusion. This mandibular autorotation also contributed to forward movement of point B, as shown by a 1.2° increase in SNB. Such a change is particularly advantageous in skeletal Class II patients, where it improves both occlusion and facial profile. Deguchi et al[21] and Xun et al[22] observed similar increases of around 1.5°, while Leyla Cime et al[18] reported a 1.76° improvement. The consequent reduction in ANB observed in this study highlights the dual benefit of molar intrusion in both vertical control and sagittal skeletal enhancement.

One of the major skeletal changes associated with molar intrusion is the reduction in lower anterior facial height (LAFH), which is particularly desirable in hyperdivergent individuals. In this study, LAFH was reduced by 2-3 mm, which is in agreement with findings of Steele et al[23], Hart et al[24], and Chunlei Xun et al[25]. These results confirm the effectiveness of posterior intrusion in improving vertical proportions and highlight its role in addressing excessive facial height.

With respect to dental changes, there was a mean overbite increase of 3 mm, which was lower than the 4.3–5.8 mm correction reported in earlier investigations[18,23]. This variation may be attributed to differences in initial severity of AOB and to the fact that some patients in our study presented with deep bite and underwent full-arch intrusion. In certain cases, premature anterior contacts limited mandibular rotation and resulted in posterior open bite tendencies. Comparable limitations have been reported by Scheffler[19], who attributed incomplete correction of overbite to splint design, as intrusion forces were primarily directed at posterior teeth, leaving the canines and incisors unaffected. These findings underline the importance of appliance design and the need to control mandibular posterior eruption in order to achieve optimal occlusal outcomes.

External apical root resorption (EARR) is a frequent iatrogenic consequence of orthodontic intrusion because of the concentration of forces at the root apex. In this study, EARR ranged from 0.38–0.73 mm, values consistent with the 0.55 mm reported by Bilal Al-Falahi et al[14] and within the <1 mm threshold identified in meta-analysis[26] as not clinically significant. The use of splints for equal force distribution among posteriors and the application of CBCT for precise measurement likely contributed to these favorable outcomes, suggesting that intrusion with TADs can be performed safely when appropriate biomechanics are employed.

Posterior tooth inclination following intrusion is another important parameter. In Group 1, buccal flaring of 2–3° was recorded, which, though statistically significant, remained clinically negligible. Erverdi et al[20] reported a comparable 2.8° of buccal tipping, while Marzouk et al[27] observed minimal change of 1.3°, likely due to a more rigid transpalatal bar design. In this study, Groups 2 and 3 exhibited lesser or minimal flaring, with Group 3 showing the greatest stability due to the balanced application of intrusive forces from both buccal and palatal directions. This suggests that force distribution plays a key role in controlling axial inclination during intrusion. However, as intrusion was measured using lateral cephalograms, which provide only two-dimensional information, the possibility of underestimating buccolingual changes cannot be excluded. Future studies using three-dimensional CBCT evaluation are recommended for a more accurate assessment of amount of intrusion.

Overall, the results of this study support the growing body of evidence that maxillary posterior intrusion using TADs is a highly effective treatment option for anterior open bite correction in adults. Variations in outcomes across studies appear to be influenced by differences in anchorage design, severity of initial malocclusion, and splint mechanics, highlighting the importance of individualized treatment planning. The clinical implications of these findings are particularly relevant for hyperdivergent and Class II patients, for whom molar intrusion not only addresses vertical discrepancies but also enhances overall facial balance. Future studies should focus on the long-term stability of bite closure after intrusion, since relapse remains a critical concern in open bite correction. Ultimately, integrating these insights into clinical practice will refine treatment strategies and optimize outcomes for adult patients with anterior open bite.

V. Conclusion

1) In all groups maxillary posterior dentoalveolar intrusion led to notable skeletal and dental alterations, including better occlusal plane orientation and mandibular position.
2) Intergroup comparisons showed no significant differences in skeletal or dental outcomes, while notable differences were observed in buccolingual inclination of teeth.
3) Group 3, which used forces from both buccal and palatal aspects, showed minimal to no flaring, indicating better control.
4) Overall, all techniques were effective, but intrusion with IZC and palatal implants together demonstrated the most controlled and stable results.

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