IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 7 Ser. 1 (July. 2026), PP 05-19
www.iosrjournals.org

Posterior Intrusion In Anterior Open Bite: Evidence, Biomechanics, And Clinical Outcomes

Dr Varsha Dogra, Dr Ram Kishore Ratre, Dr Alka Dubey, Dr Shafna Abid, Dr Sakshi Chouhan

(Department Of Orthodontics & Dentofacial Orthopaedics, Government College Of Dentistry, Indore, Madhya Pradesh, India)

Abstract:

Background: *Anterior open bite (AOB) is one of the most challenging malocclusions to treat, especially in patients with a hyperdivergent skeletal pattern where increased posterior dentoalveolar height contributes to a steep mandibular plane and excessive lower facial height. Posterior tooth intrusion has emerged as an important nonsurgical strategy to close AOB by reducing posterior vertical dimension and promoting counterclockwise mandibular autorotation.*

Objective: *This review aims to summarize current evidence on the effectiveness, biomechanics, clinical outcomes, and stability of posterior intrusion for anterior open bite correction.*

Methods: *A narrative review of relevant clinical trials, retrospective studies, systematic reviews, and case reports was undertaken, focusing on posterior intrusion achieved with skeletal anchorage systems (miniscrews, miniplates, palatal TADs), adjunctive appliances, and clear aligner protocols. Emphasis was placed on intrusion magnitude, overbite correction, skeletal effects, side effects, and long-term stability.*

Results: *The evidence shows that skeletal anchorage can achieve clinically meaningful posterior intrusion (commonly 2–4 mm), producing significant bite closure through mandibular autorotation and reduction in vertical facial parameters. Comparative studies indicate that molar intrusion with skeletal anchorage can produce outcomes comparable to orthognathic surgery in selected severe adult cases, but with less incisor extrusion. Miniplates generally provide higher stability and allow heavier mechanics, whereas miniscrews offer a simpler and less invasive option but require careful biomechanical control. Clear aligners can improve mild AOB, although correction is largely driven by incisor extrusion with minimal true molar intrusion. Relapse remains a major limitation, with most occurring during the first year of retention, highlighting the importance of overcorrection, posterior occlusal coverage, and functional habit control.*

Conclusion*: Posterior intrusion is a reliable and effective modality for anterior open bite correction, particularly when supported by skeletal anchorage, as it enables true molar intrusion with favorable skeletal and facial effects. However, long-term stability depends on retention strategies and correction of functional etiologic factors such as tongue posture. Further well-designed controlled trials with long-term follow-up are needed to strengthen clinical protocols and improve predictability.*

Keywords: *anterior open bite, posterior intrusion, molar intrusion, skeletal anchorage, miniscrews, miniplates, mandibular autorotation, vertical control, relapse, retention*

Date of Submission: 26-06-2026 Date of Acceptance: 06-07-2026

I. Introduction

Skeletal open bite malocclusion is characterized by the difficult combination of an anterior open bite (AOB) on a hyperdivergent skeletal base, typically accompanied by increased lower facial height, a steep mandibular plane (MP), and excessive maxillary gingival display on smiling. (1,2)

Skeletal anterior open bite is considered one of the most difficult problems in orthodontic treatment. In adults, management of severe skeletal anterior open bite has traditionally relied mainly on surgical repositioning of the maxilla or mandible, with these procedures showing acceptable treatment outcomes and long-term stability.(1,2) More recently, dental implants, screws, (3) and miniplates(4) have been introduced for skeletal anchorage, providing stationary anchorage for various tooth movements even without patient cooperation. Previous reports have documented the successful treatment of severe skeletal anterior open-bite patients using molar intrusion with titanium screws for skeletal anchorage, and several other studies have also described molar intrusion using miniplates in anterior open-bite patients.(4) As a result, molar intrusion with skeletal anchorage has become an important treatment strategy for these patients; however, it remains unclear whether molar intrusion with skeletal anchorage or orthognathic surgery is the superior approach for treating severe anterior open bite.(5)

However, it has been suggested that effective camouflage treatment using posterior buccal segment intrusion may produce treatment effects comparable to surgery. Accordingly, miniplate-supported posterior intrusion (MSPI)(6) and Invisalign clear aligner therapy(7) have emerged as promising non-surgical alternatives that may avoid the cost, complexity, procedural risk, and morbidity associated with orthognathic correction. Skeletal plates provide absolute anchorage for posterior intrusion and are generally well tolerated, while offering better survival rates than miniscrews, reduced risk of anchorage loss, and the ability to deliver heavier and more complex force systems. Following the foundational work of Umemori et al(8), multiple studies have confirmed successful open bite closure with miniplates placed in the maxilla or mandible, and the use of one miniplate in all four quadrants has been advocated to maximize intrusion while limiting opposing arch extrusion. Using this approach, Kuroda et al(5) reported 100% overbite correction with minimal incisor extrusion in a small mainly adult sample with severe AOB, achieving approximately 2.3 mm of maxillary molar intrusion and 1.3 mm of mandibular molar intrusion, with mandibular autorotation and facial changes comparable to a matched orthognathic surgery group.

The use of Invisalign for AOB was initially proposed after anecdotal reports of a frequent bilateral posterior open bite developing during treatment, leading to the hypothesis of an intrusive posterior bite-block effect from aligner material interposed in the interocclusal space under elevator muscle activity.(9) Although some studies have shown treatment changes consistent with this theory, the validity and clinical significance remain uncertain,(10) and evidence from recent retrospective case series indicates that the relative contributions of incisor extrusion and lingual tipping versus true molar intrusion are still unclear, with any potential Invisalign-related molar intrusion appearing minimal and likely insufficient to produce a meaningful reduction in lower facial height.

II. Materials & Methods

A systematic literature search was conducted using electronic databases including PubMed, Scopus, Google Scholar, and Web of Science to identify relevant studies on posterior intrusion for the correction of anterior open bite. The search was performed for articles published between 2000 and 2025, with no language restrictions applied. Keywords and combinations used included: “posterior intrusion,” “molar intrusion,” “anterior open bite,” “skeletal open bite,” “temporary anchorage devices,” “miniscrews,” “miniplates,” “skeletal anchorage,” “mandibular autorotation,” “vertical control,” “clear aligners,” and “Invisalign.” Reference lists of retrieved articles and relevant orthodontic journals were also hand-searched to ensure comprehensive coverage.

Inclusion criteria consisted of studies that evaluated the clinical, skeletal, dental, and/or soft tissue effects of posterior intrusion therapy in human subjects with anterior open bite malocclusion. Randomized controlled trials, controlled clinical trials, cohort studies, and observational studies (prospective and retrospective) were included. Review articles, case reports, animal studies, in vitro studies, and studies unrelated to posterior intrusion for anterior open bite correction were excluded. Data extracted from eligible studies included sample size, patient demographics, severity and type of open bite, appliance or anchorage system used (miniscrews, miniplates, or aligners), force mechanics, duration of intrusion, amount of molar intrusion achieved, degree of overbite correction, mandibular plane changes, facial height changes, and reported stability or relapse.

Since this was a narrative literature review, ethical approval and patient consent were not applicable.

III. Literature Review

Anterior open bite (AOB) is defined by the absence of vertical overlap or contact between the maxillary and mandibular anterior teeth and is commonly classified into dental, skeletal, and functional types. However, in clinical practice, it is often difficult or even impossible to categorize a case strictly into only one type because of the complex and multifactorial nature of the condition.

Dental AOB typically presents with a normal craniofacial pattern along with proclined and under-erupted anterior teeth, and may occur due to ankylosis of anterior teeth following traumatic replantation, systemic or localized factors causing delayed eruption, or persistent thumb-sucking that prevents complete incisor eruption.

Skeletal AOB is characterized by increased mandibular plane and gonial angles, increased anterior and total facial height, an anteriorly upward-tilting palatal plane, and a retrognathic mandible, and may result from disturbances in the growth of the maxilla, mandible, and dentoalveolar complex such as hereditary predisposition, developmental disorders, or trauma. These disruptions contribute to hyperdivergent inter-base angles and an increased posterior vertical dimension, where posterior vertical excess prevents the development of a normal overbite even when anterior teeth are overerupted.

Functional AOB is closely related to head and neck muscle behavior during speech, breathing, mastication, and swallowing, as dentition equilibrium may be altered by orofacial muscular imbalance—particularly involving the tongue, lips, and cheeks(11). The mandibular resting position is influenced by the temporomandibular joint, and maintaining occlusal stability is especially difficult in patients with temporomandibular disorders (TMD)(12), where AOB may predispose to TMD and TMD may also contribute to

AOB. This relationship may be associated with internal disc derangements and compression of retrodiscal tissues, hemifacial dystrophy of the lower face secondary to joint disease, or neuromuscular deficiency of the masticatory muscles.(13) Additionally, macroglossia due to amyloidosis, acromegaly, or Beckwith–Wiedemann syndrome can induce tongue thrusting, which may procline the incisors, produce a V-shaped maxillary arch, and disrupt orofacial muscular balance, thereby contributing to AOB. Finally, retrognathia, adenoid or tonsillar hypertrophy, and nasal obstruction may promote mouth breathing, which can further aggravate anterior open bite.

Etiology

The etiology of anterior open bite malocclusion is multifactorial, and has been explained through several theories involving genetic, anatomic, and environmental influences. Since anterior open bite often results from a combination of skeletal and dental components, classifying it strictly as either skeletal or dental is frequently difficult; therefore, an etiology-based classification has been suggested to be the most clinically useful approach(14)

Genetic and Growth-Related Factors

Anterior open bite is strongly related to unfavorable growth potential and heredity, and obtaining a detailed family history can help in predicting a patient's vertical growth pattern.(1,2) Cephalometric findings indicate that a steep mandibular plane is a key skeletal feature of skeletal anterior open bite, with contributing factors including an increased gonial angle, a downward and backward position of the mandibular ramus, and a shortened posterior facial height. The Overbite Depth Indicator (ODI) (15) has been proposed as a predictor of skeletal open bite tendency, where the ODI is the arithmetic sum of the angle of the A–B plane to the mandibular plane and the angle of the palatal plane to the Frankfort horizontal plane, with a reported norm of 74.5° ± 6.07°, and a value of 68° or less indicating skeletal open bite tendency. Another predictive method is Nahoum's AUFH:ALFH ratio(16), where an open bite with a ratio less than 0.65 suggests a skeletal open bite that cannot be corrected by orthodontic treatment alone.

Anatomic Factors

Anatomic conditions, especially those related to tongue size and posture, can significantly influence both skeletal and dental components of open bite. Macroglossia has been suggested as a possible cause, and correlations have been reported between open bite morphology (including mandibular plane angle, mandibular ramus height, and anteroposterior maxillary dimension) and the movement of the anterior dorsal tongue during deglutition.(11) Additionally, conditions such as enlarged adenoids and/or tonsils, swollen nasal turbinates, and deviated nasal septum may impair normal nasal respiratory function. Although mouth breathing due to airway obstruction may contribute to anterior open bite, a direct causal relationship has not been conclusively proven.(17)

Temporomandibular Joint and Condylar Resorption

Mandibular condylar resorption has been identified as an etiologic factor in anterior open bite. This may occur due to multiple local and systemic pathologies, including local causes such as osteoarthritis, reactive arthritis, avascular necrosis, infection, and traumatic injuries, as well as systemic connective tissue and autoimmune diseases such as rheumatoid arthritis, psoriatic arthritis, scleroderma, systemic lupus erythematosus, Sjögren syndrome, and ankylosing spondylitis. (12)

Environmental and Habit-Related Factors

Environmental factors and oral habits are frequently implicated in the development of anterior open bite. Habits such as thumb and finger sucking, forward tongue posture, (2) and tongue thrust have been widely reported. Digit sucking may produce an asymmetrical open bite, most severe on the side where the digit is placed, and not all digit suckers develop open bite; the most important determinants are duration and frequency, with habits exceeding 6 hours per day being strongly associated with significant malocclusion.(18) A forward resting tongue posture, where the tongue lies between the incisors, may prevent incisor eruption and contribute to open bite development, and a diagnostic cephalometric feature suggestive of this posture is a reverse curve of Spee in the mandibular arch due to reduced incisor eruption. This should be distinguished from secondary adaptive tongue thrust, where forward tongue movement during swallowing develops as a compensatory mechanism to form an anterior oral seal in response to an existing open bite.

Neuromuscular Factors

Neuromuscular deficiencies also contribute to the skeletal characteristics of open bite. Patients with generalized muscle pathology, such as muscular dystrophy, may be more prone to increased vertical facial dimensions and anterior open bite. Reduced force of contraction of the masticatory muscles, both at rest and during function, may promote excessive vertical skeletal growth and molar overeruption, thereby increasing the vertical dimension and contributing to open bite development.(13)

Clinical features

Clinical Features of Skeletal Open-Bite Type (Sassouni, 1969)(1)

A. Skeletal and Cephalometric Characteristics

Skeletal open bite is characterized by steep divergence of the four facial planes (supraorbital, palatal, occlusal, and mandibular), resulting in the center of convergence being positioned close to the facial profile. The cranial base angle and gonial angle are obtuse, and the overall skeletal pattern is marked by reduced posterior facial height, where total posterior facial height (S–Go) tends to be approximately half of the total anterior facial height (SOr–Me). The lower anterior facial height exceeds the upper anterior facial height, while the opposite relationship exists in the posterior face. A short ramus, an antegonial notch, and an underdeveloped mandible with infantile characteristics are described, along with a narrow anteroposterior but vertically long symphysis and deficient chin development.

B. Facial Form and Soft Tissue Features

Clinically, the open-bite skeletal type tends to exhibit a narrow facial breadth, producing a long, ovoid facial appearance in the frontal view, along with narrow nasal apertures. The mouth is described as wide, and the lips are broad but short vertically relative to their skeletal support, remaining separated at rest and contributing to a mouth-breathing appearance. When lip closure is forced, upward displacement of the mentalis muscle occurs, further accentuating the characteristic "chinless" facial appearance.

C. Dental and Arch Characteristics

At the dentition level, the masseter muscle is positioned posterior to the buccal teeth, producing a mesial component of force that contributes to dental protrusion. Bidental protrusion is frequently present, along with crowding and proportionally large teeth. A high and narrow palatal vault is commonly observed, and impaction or ectopic eruption of third molars is reported as frequent. Incisors often demonstrate a small interincisal angle, and although they may be more extruded in the open-bite type, the extrusion is still insufficient to establish vertical contact.

D. Functional and Developmental Associations

Sassouni described that open-bite development may be related to downward tipping of the posterior palate, carrying molars downward and increasing the palatomandibular plane angle, combined with excessive development of upper midfacial height and inadequate development of posterior facial height, which together promote downward and backward mandibular rotation. Because the short ramus and low palate contribute to a constricted pharyngeal space, individuals may posture the tongue forward to facilitate breathing, which may be further reinforced by the presence of a dental open bite and enlarged tonsils. The narrow palatal vault reduces tongue space, encouraging tongue protrusion, which may further contribute to bidental protrusion.

Treatment modalities

Treatment of anterior open bite is considered a major challenge in orthodontics, and multiple approaches have been described. Successful correction can improve the patient's ability to incise and chew, enhance facial and dental esthetics, and improve speech; however, treatment planning must always be directed toward the underlying etiology of the malocclusion.

Habit Interception and Early Management

Finger and thumb sucking are common in children, and parents should encourage cessation of the habit before 6 years of age to create a favorable environment for eruption of the permanent teeth. Habit elimination should ideally be achieved before initiating orthodontic treatment, and if initial attempts fail, an intra-oral appliance with loops may be used as a mechanical reminder and obstruction. Tongue thrusting can also adversely affect the teeth and oral environment, and tongue cribs have been used to modify tongue behavior, showing effectiveness in closing open bite when worn for a minimum of one year.(19) Myofunctional therapy is also beneficial for muscle retraining through tongue exercises aimed at correcting harmful resting and functional postures.(20)

Muscle Training and Masticatory Exercises

Mastication exercises combined with concentrated vertical control have been suggested to reduce abnormal vertical growth patterns, particularly in patients with neuromuscular deficiencies. (21)Patients were instructed to clench on a soft bite wafer (GAC International, Bohemia, NY) for 1 minute, five times daily, where each 1-minute session consisted of six cycles of 5 seconds of isometric clenching (80% maximum) followed by 5 seconds of rest, repeated continuously for the full minute. (21,22)

Management of Macroglossia

Tongue size and position influence both skeletal and dental components, and macroglossia has been proposed as a possible cause of open bite and mandibular prognathism. Bernard and Simard-Savoie performed a medial glossectomy in a monkey with open bite, and follow-up over 52 months showed a steady increase in overbite. Therefore, partial glossectomy for tongue mass reduction has been suggested as an effective approach for correcting open bite in patients with macroglossia.(23)

Airway Considerations

Although mouth breathing due to chronic upper airway obstruction has been suggested as a possible contributor to anterior open bite, a direct relationship has not been proven. Consequently, prolonged mouth breathing may not necessarily be the primary etiologic factor for malocclusion. Diagnosis of airway obstruction should be made by an appropriate multidisciplinary team, and surgical procedures such as adenoidectomy or tonsillectomy are not recommended for prevention of malocclusion, and should be performed only for medical indications

Treatment of Skeletal Open Bite in Growing Patients

Treatment options for skeletal open bite differ between growing and adult patients. In growing patients, therapy is aimed at modification of vertical growth, with the overall objective being reduction or redirection of vertical skeletal growth using intra-oral and/or extra-oral forces. Several approaches have been described for vertical control. The vertical holding appliance (VHA),a modified transpalatal arch with an acrylic pad, uses tongue pressure to reduce vertical dentoalveolar development of the maxillary permanent first molars. Posterior bite blocks can inhibit posterior eruption, and studies suggest they can effectively modify the vertical skeletal pattern; they may be constructed using wire or plastic, may be spring-loaded, or may incorporate magnets(24). Functional appliances such as activators, bionators, and Fränkel regulators often combined with posterior bite blocks have been used to control vertical maxillary growth in mixed dentition. A bionator is particularly useful when open bite is associated with a Class II molar relationship. Fränkel IV regulator was introduced for hyperdivergent patients, and Fränkel suggested that vertical changes may be related to lip-seal training, with the appliance acting as an exercise device and promoting postural balance between forward- and backward-rotating muscles. Extra-oral appliances, particularly high-pull headgear, have also been used to restrict vertical skeletal and dental growth; Schudy and Brandt advocated high-pull headgear combined with a mandibular splint covering the second molars and anterior vertical elastics, while Ngan et al reported favorable results in Class II open bite cases during mixed dentition using a combination of an activator and high-pull headgear. The vertical chin cup, used with fixed appliances, has also been applied to control vertical growth, and Pearson reported in a single case that a vertical-pull chin cup could reduce mandibular plane angle and increase posterior facial height.

Gürton, Akın, and Karacay (2004) evaluated a newly designed removable appliance (Molar Intruder) for early treatment of anterior open bite, reported significant bite closure with mean maxillary and mandibular molar intrusion of 1.86 mm and 1.04 mm, respectively, producing a significant overbite increase of 4.00 mm and improvement in vertical skeletal pattern through counterclockwise mandibular rotation, reflected by significant increases in SNB (+1.57°) and decreases in ANB (−1.29°), SN/MP (−1.57°), Y-axis (−1.36°), and gonial angle (−1.50°), along with reduced anterior face height (−1.86 mm) and increased PFH/AFH ratio (+2.25%). A small side effect was maxillary incisor extrusion (0.54 mm) with labial tipping (1.46°), and they noted that intrusion was almost double when only one molar was intruded compared to simultaneous intrusion of both first and second molars.(25)

Ng, Major, and Flores-Mir (2006) conducted a systematic review to quantify the amount of true molar intrusion achievable during orthodontic treatment and reported a mean maxillary first molar true intrusion of 0.96 mm (SD 0.54) in 12 adolescents, achieved with Interlandi-type high-pull headgear delivering 500 g per side for 6 months, worn approximately 12 hours/day, with a transpalatal arch for symmetry and control. (26)

Kiliaridis, Egermark, and Thilander (1990) compared posterior repelling-magnet splints with acrylic posterior bite-blocks for treating skeletal anterior open bite. In the magnet group, the response was faster, with open bite generally closing in less than 4 months, and overbite improvement in younger patients ranging from 2.5 to 4.5 mm, but transverse side effects were common: unilateral crossbite (with tendency toward scissor bite on the opposite side) occurred in 4 of 10 patients, particularly those in early mixed dentition who wore the appliance nearly 24 hours/day, leading to early interruption of treatment at 3–4 months. In contrast, the bite-block group showed overbite correction of 1.5 to 3 mm, with most improvement occurring early followed by a plateau period, and no transverse problems were observed. No craniomandibular dysfunction was detected in either group.(27)

Dellinger and Dellinger (1996) presented 5 long-term follow-up cases treated with the Active Vertical Corrector (AVC) to evaluate whether anterior open bite could be corrected by intrusion of posterior teeth with stability over time. Before treatment, the patients showed increased vertical proportions, with lower facial heights ranging from 1.2 to 2.6 standard deviations above normal, and all cases were corrected to normal facial heights

after therapy. The authors reported that the AVC used repelling magnets (initially cobalt-samarium producing ~700 gf in opposition, but clinically acting within 60–180 g due to freeway space) and emphasized that there was no evidence of iatrogenic response despite earlier criticism of heavy force. Long-term records showed that AVC therapy produced effective bite closure with stable outcomes, with correction in lower facial height ranging from 2.4 SD to 0.9 SD reduction. They concluded that the AVC is an efficient nonsurgical method for treating skeletal open bite by posterior intrusion, demonstrating long-term effectiveness comparable to or better than other treatment modalities, while noting that accurate bite registration and compliance are essential for successful outcomes.(24)

Osman, Mohie-Eldin, Sharaby, and Soliman (2017) performed a PRISMA-based systematic review to evaluate the efficiency of different molar intrusion methods for anterior open bite correction, results showed that the Frankel-4 appliance produced a significantly greater overbite improvement (~2 mm) than untreated controls, mainly due to vertical eruption of upper and lower incisors and retraction of upper incisors, but there was no significant difference between Frankel-4 and controls for mandibular plane angle changes or maxillary molar intrusion. When comparing bite blocks, the Magnetic posterior bite block (MPBB) produced a significantly greater overbite improvement (~1 mm) than the Spring posterior bite block (SPBB), and also showed greater maxillary molar intrusion (~0.6 mm more) than SPBB.(28)

Camouflage Orthodontics in Mild Cases

Mild anterior open bite cases may be corrected using fixed appliances through dental camouflage, where only dental movements are performed and the skeletal profile remains unchanged. Various extraction strategies have been proposed, aiming to extrude the anterior segment through a "draw-bridge effect" by reducing upper and lower incisor inclination to increase overbite, and/or to move posterior teeth anteriorly through a "wedge effect," or a combination of both. These extraction approaches include removal of second molars, first molars, second premolars, or first premolars. Another common orthodontic approach is extrusion of upper and lower incisors using vertical elastics, extrusion arches, (29)or the multiloop edgewise archwire (MEAW) technique(30). However, excessive incisor extrusion—especially in patients with anterior vertical maxillary excess—may lead to increased incisor and gingival display, and therefore must be performed cautiously in individuals with increased facial height.

Chang and Moon (1999) evaluated the Multiloop Edgewise Arch Wire (MEAW) technique. Overbite improved significantly from −4.63 mm to +0.91 mm, and correction occurred mainly through dentoalveolar changes with minimal skeletal change, achieved by distal uprighting of posterior teeth, occlusal plane alteration, and distal movement of the dentition. Anterior dentoalveolar heights increased (U1–PP: 28.56→30.57 mm; L1–MP: 43.14→45.92 mm), while lower posterior dentoalveolar height decreased (L7–MP: 30.31→29.27 mm), indicating prevention of posterior extrusion and a significant reduction in lower posterior height. (30)

Isaacson and Lindauer (2001) described the extrusion arch as a biomechanical method to close anterior open bites using an asymmetrical V-bend (off-center bend) in an auxiliary archwire, functioning as the reverse of an intrusion arch and eliminating the need for anterior vertical elastics (therefore not requiring patient compliance). They explained that activation produces a second-order couple at the molar (crown mesial/root distal rotation) along with an extrusive force at the incisors and a reciprocal intrusive force at the molar, and noted that clinically anterior teeth can extrude rapidly (~1–2 mm/month). (29)

Sifakakis, Pandis, Makou, Eliades, and Bourauel (2009) compared the bioprogressive utility arch technique and the segmented Burstone intrusion technique by evaluating the posterior extrusive forces and torquing moments generated during simulated incisor intrusion. At 3 mm of simulated intrusion, the 0.016 × 0.016-inch Blue Elgiloy utility arch produced the highest posterior extrusive forces, being 15% higher than the 0.017 × 0.025-inch TMA utility arch and 40% higher than the 0.017 × 0.025-inch TMA Burstone intrusion arch, while the Burstone intrusion arch produced the lowest forces (1.30 N in the maxilla and 1.56 N in the mandible). The lowest posterior moment in the sagittal plane was also generated by the Burstone 0.017 × 0.025-inch TMA intrusion arch, whereas the Blue Elgiloy utility arch produced 15% higher moments and the TMA utility arch produced 25% higher moments. Across all wire types, both forces and moments were consistently greater in the mandible than in the maxilla. The authors concluded that the Burstone intrusion arch generates the most favorable posterior force/moment profile, and that utility arches should be activated less than Burstone intrusion arches to avoid excessive posterior side effects. (31)

Vela-Hernández, López-García, García-Sanz, Paredes-Gallardo, and Lasagabaster-Latorre (2017) evaluated posterior resin build-ups as a nonsurgical method for treating adult skeletal and dental anterior open bite treated with Tip-Edge Plus fixed appliances and 2–3 mm bonded build-ups on all maxillary molars. Their results showed statistically significant correction in all patients, with a mean overbite increase of 3.98 mm at T2 and only 0.56 mm relapse at T3; correction was achieved through combined maxillary molar intrusion (~1.15 mm), mandibular incisor extrusion (1.44 mm), maxillary incisor extrusion (1.57 mm), and counterclockwise mandibular rotation (mandibular plane angle decrease ~1.19°, PP–MP decrease ~0.84°, and occlusal plane angle

decrease ~1.53°) with a mean AFH decrease of 0.7 mm. Maxillary molar intrusion remained stable during retention with only 0.10 mm relapse, and the authors concluded that posterior build-ups are a simple, noninvasive, compliance-free option for adult skeletal open bite, producing significant dental and skeletal improvements with clinically acceptable long-term stability.(32)

Molar Intrusion with Skeletal Anchorage

Before the development of skeletal anchorage, molar intrusion for anterior open bite correction was difficult. Currently, skeletal anchorage systems including dental implants, surgical miniplates(6), and miniscrew or microscrew implants(33) have become increasingly popular because they provide absolute anchorage. Molar intrusion achieved through skeletal anchorage produces counterclockwise mandibular rotation and reduction of the open bite.

Sherwood, Burch, and Thompson (2002) investigated closing anterior open bite in adults by true molar intrusion using titanium miniplate anchorage, with the aims of validating molar intrusion, assessing miniplate stability, and recording dentoskeletal effects. In four adult patients with long-standing anterior open bite who refused orthognathic surgery, the authors achieved true maxillary molar intrusion in all cases, with a mean intrusion of 1.99 mm (range 1.45–3.32 mm) and no detectable miniplate movement during treatment. All patients demonstrated successful open bite closure, with a mean incisor closure of 3.62 mm (range 3.0–4.5 mm) accompanied by counterclockwise mandibular rotation, reflected by a mean reduction in mandibular plane angle of 2.62° (range 1.5°–4.5°), a mean reduction in occlusal plane angle of 2.25° (range 1.0°–3.5°), and a mean reduction in N–S–Gn of 2.62°, along with decreased anterior facial height and increased SNB.(34)

Erverdi, Keles, and Nanda (2004) evaluated the effectiveness of zygomatic buttress titanium miniplates for correcting anterior open bite by intruding maxillary posterior teeth. The mean anterior open bite was −0.6 mm, and intrusion was produced using 9-mm NiTi coil springs from the miniplate to the maxillary first molar buccal tube, with the open bite corrected in a mean of 5.1 months and total treatment time averaging 18.3 months. Results showed significant skeletal and dental improvements: maxillary molars were intruded by 2.6 mm ($P<0.01$), overbite improved from −0.6 mm to +3.1 mm (mean change +3.7 mm, $P<0.05$), overjet reduced from 5.4 mm to 3.4 mm ($P<0.05$), and mandibular plane angle (GoGn-SN) decreased by 1.7° ($P<0.05$) with counterclockwise mandibular autorotation (~1.78°); maxillary incisors showed significant retroclination (U1-SN −9.6°) with ~1.1 mm extrusion, and mandibular incisors extruded ~1.1 mm during leveling. The occlusal plane rotated clockwise by ~3.1°, the palatal plane showed no significant change, and posteroanterior analysis showed only slight buccal tipping of maxillary molars (2.8°).(35)

Xun, Zeng, and Wang (2007) evaluated microscrew anchorage for posterior dentoalveolar intrusion in 12 patients with skeletal anterior open bite (age 14.3–27.2 years, mean 18.7 years) using self-drilling miniscrews placed in the posterior midpalate (maxilla) and buccal alveolar bone between lower molars, supported with a transpalatal arch and lingual arch, and applying 150 g force per side. All patients achieved open bite correction in a mean of 6.8 ± 1.1 months, with mean overbite improving from −2.2 mm to +2.0 mm (+4.2 mm, $P<0.001$) and overjet decreasing by 2.0 mm ($P<0.05$). Maxillary and mandibular first molars were intruded by 1.8 mm and 1.2 mm respectively (both $P<0.001$), producing significant counterclockwise mandibular rotation with a reduction in SN–MP by 2.3° and PP–MP by 2.5° ($P<0.001$), and decreases in N–Me (−1.8 mm) and ANS–Me (−1.6 mm) ($P<0.001$).(36)

Baek, Choi, Yu, Lee, Kwak, and Park (2010) evaluated the long-term stability of anterior open-bite correction in 9 adult patients treated by intrusion of the maxillary posterior teeth using miniscrew implants, and compared their stability outcomes with previously reported surgical results. During treatment, the maxillary first molars were intruded by 2.39 mm and incisal overbite increased by 5.56 mm, with associated skeletal improvements including reduced SN-GoMe (−2.03°), reduced anterior facial height (−2.53 mm), decreased ANB (−0.66°), and forward/upward movement of pogonion (VP–Pog +2.40 mm), confirming correction through counterclockwise mandibular rotation. At the 3-year follow-up, the maxillary molars erupted by 0.45 mm, giving a 22.88% relapse rate, and overbite decreased by 1.20 mm, giving a 17.00% relapse rate, with more than 80% of molar relapse occurring in the first year of retention; overbite relapse was significant during the first year but not between 1 and 3 years. Importantly, they found no correlation between initial open bite severity, mandibular plane angle, or lower anterior facial height and overbite relapse, but a significant correlation between the amount of overbite correction achieved and the extent of relapse, supporting planned overcorrection. When compared with orthognathic surgery outcomes, the authors reported that their success rates (77.12% for molar intrusion and 83.00% for overbite correction) were similar to published surgical success rates (approximately 75%–88%), suggesting that posterior intrusion with miniscrews can provide stability comparable to surgical approaches in mild to moderate skeletal anterior open bite, with retention during the first year being critical. (37)

Çifter and Saraç (2011) used finite element analysis to compare three maxillary posterior intrusion mechanics supported by mini-implant anchorage, applying a total 300 g intrusive force per posterior segment distributed to the implants in proportion to calculated root surface areas. They found that the most balanced

intrusion and most uniform stress distribution occurred when forces were applied concurrently from both vestibular and palatal sides, whereas mechanics using a transpalatal arch with buccal force application showed prominent vestibular tipping and higher overall stress values. Across all models, the highest stress concentrations consistently occurred at the apical region of the first premolar roots and the apical region of the mesial root of the first molar, indicating these areas may be more prone to root resorption during posterior intrusion. (38)

Flieger, Ziebura, Kleinheinz, and Wiechmann (2012) reported a simplified protocol for true maxillary molar intrusion using palatal mini-implants placed in the palatal slope, a palatal bar, and intrusion cantilevers, designed to reduce complications seen with other methods such as interradicular mini-implants (risk of root damage) and miniplates (need for incision and suturing). In three female patients (ages 14, 18, and 19) who refused surgery, the authors achieved an open bite reduction >1 mm within 4 months, and established an anterior overbite ≥2 mm within 6–9 months; in one case, cephalometric superimposition showed approximately 4 mm molar intrusion, though a slight maxillary incisor extrusion was also noted. They concluded that this method provides a clinically effective and less complex way to intrude molars using a safe, accessible palatal insertion site, while avoiding intermaxillary elastics and minimizing surgical difficulty.(39)

Marzouk and Kassem (2016) evaluated the 4-year posttreatment stability of skeletal anterior open bite correction in 26 adults (19–28 years) treated with maxillary posterior segment intrusion using zygomatic miniplates, and compared their stability with previously reported surgical stability. They achieved a mean maxillary molar intrusion of 3.04 mm ($P \leq 0.01$) and a mean overbite increase (bite closure) of 6.93 mm ($P \leq 0.01$), with correction occurring mainly through counterclockwise mandibular rotation along with maxillary incisor extrusion (2.5 mm; $P \leq 0.01$). At follow-up, molar intrusion relapse was 10.20% at 1 year and 13.37% at 4 years, while overbite relapse was 8.19% at 1 year and 11.18% at 4 years; importantly, the first year accounted for ~76.29% of total molar relapse and 73.2% of total overbite relapse. Relapse at 4 years was positively correlated with pretreatment severity (greater pretreatment molar height → more molar relapse; more severe initial open bite → more overbite relapse) and negatively correlated with the amount of intrusion/correction achieved, supporting the concept of planned overcorrection. (40)

Giancotti, Germano, Muzzi, and Greco (2014) reported that combining Invisalign with buccal miniscrew-supported posterior intrusion improved the predictability of molar intrusion compared with aligners alone. Using 150 g NiTi coil springs from miniscrews (3 × 8 mm) placed buccally mesial to maxillary first molars, they achieved posterior intrusion in 4 months in Case 1 and 6 months in Case 2, with total treatment completed in 10 months and 15 months, respectively. Overbite improved from −1 mm to +2 mm and −2 mm to +1 mm, while overjet reduced from 6 mm to 2 mm and 5 mm to 2 mm, with reduced mandibular divergence (35°→33° and 41°→38°) and improved mandibular projection (SNPg 71°→74° in Case 1). They concluded that this hybrid approach provides a reliable, minimally invasive alternative to surgery, producing posterior intrusion and counterclockwise mandibular rotation, while aligners help prevent molar extrusion and assist with molar torque control.(41)

Hart, Cousley, Fishman, and Tallents (2015) retrospectively evaluated 31 consecutively treated anterior open bite patients (age 11.6–55.5 years, mean 20.7 years) to assess dentoskeletal changes specifically at the end of the maxillary molar intrusion phase using orthodontic mini-implants. Results showed successful intrusion of the maxillary molars in most cases: maxillary first molars were intruded in 90% (28/31) with a mean of 2.3 mm, and second molars in 74% (23/31) with a mean of 1.6 mm; however, mandibular molars frequently erupted during this phase (mandibular first molars in 77%, mean +1.1 mm; second molars in 65%, mean +0.9 mm). Overbite improved in 97% (30/31) with a mean bite closure of 3.9 mm (range 0–8.5 mm), mandibular plane angle decreased significantly (mean −1.1°), lower anterior facial height decreased (mean −1.5 mm), occlusal plane inclination increased (mean +1.3°), and ANB reduced significantly (mean −1.2°). Age-related analysis showed adolescents demonstrated more favorable mandibular autorotation (greater SNB increase and MP-FH reduction), whereas adults showed greater maxillary dental changes (more maxillary molar intrusion, greater occlusal plane steepening, and a tendency toward more SNA reduction). (42)

Paik, McComb, and Hong (2016) presented a clinical series demonstrating differential molar intrusion using temporary anchorage devices (TADs) as a key nonsurgical strategy for anterior open-bite correction, emphasizing that open bite is difficult both to close initially and to retain, and that many conventional surgical and nonsurgical modalities (including miniplates, MEAW therapy, posterior bite blocks, functional appliances, active vertical correctors, vertical-pull chin cups, and glossectomy) are often incapable of achieving substantial closure. The authors highlighted the commonly cited concept that 1 mm of molar intrusion can produce approximately 3 mm of bite closure through counterclockwise mandibular rotation, although they noted that clinically the achieved closure may be less than 3 mm in some cases. Using three cases, they compared treatment effects of lower-molar intrusion, upper-molar intrusion, and simultaneous upper and lower molar intrusion, showing that all approaches successfully closed the anterior bite and produced counterclockwise mandibular rotation, with treatment selection based on clinical presentation. (22)

Tasanapanont et al (2017) prospectively evaluated segmental maxillary posterior intrusion in 15 anterior open bite patients (105 teeth) using one midpalatal miniscrew + intrusion TPA + NiTi closed coil springs, delivering a resultant vertical intrusive force of 50 g per side. Results showed a marked and statistically significant rise in chondroitin sulphate (CS) levels in gingival crevicular fluid around the maxillary experimental teeth during loading (maxillary 2nd premolar 0.006 → 2.592, 1st molar 0.055 → 5.738, 2nd molar 0.056 → 4.727 ng/μg total protein), while the mandibular 1st molar control showed no significant change (0.012 → 0.163). Clinically, mean intrusion rates over 12 weeks were 0.72 mm (2nd premolar), 0.58 mm (1st molar), and 0.40 mm (2nd molar), with mean overbite improvement of 1.12 mm. Conclusion: the authors concluded that this miniscrew-assisted segmental intrusion protocol using 50 g per side was sufficient to produce measurable biochemical bone remodeling activity and clinically detectable posterior intrusion with improved anterior overbite.(43)

Al-Falahi, Hafez, and Fouda (2018) assessed the effects of maxillary posterior intrusion using miniscrews in anterior open bite patients, focusing on external apical root resorption (EARR) using CBCT for accurate 3D evaluation. In 15 non-growing patients (13 females, 2 males; mean age 18.1 ± 2.03 years) with anterior open bite ≥3 mm, 300 g intrusive force per side was applied, achieving true intrusion of maxillary posterior teeth averaging 2.79 ± 0.46 mm in 5.1 ± 1.3 months. All examined roots showed statistically significant EARR ($p < 0.05$), ranging from 0.34 to 0.74 mm, with a mean of 0.55 mm, except the distobuccal root of the left first molar and the buccal and palatal roots of the left first premolar, which were not statistically significant. Despite statistical significance, the authors concluded that the magnitude of EARR was clinically insignificant, and emphasized that CBCT allowed superior visualization of all posterior roots (especially palatal roots) without overlap or magnification errors, making it effective for detecting minimal degrees of EARR.(44)

Gökalp, Efendiyeva, Bilgili, and Efe (2018) treated an 18-year-old skeletal Class II open-bite patient using a triple intrusion system (zygomatic multipurpose implants + posterior occlusal cap splints + palatal miniscrews) delivering 750–1,000 g intrusive force with balanced buccal and palatal vectors. After treatment, overjet reduced from 6 mm to 2 mm and overbite improved from 0 mm to 3 mm, with skeletal improvement due to mandibular autorotation shown by SNB increasing from 76° to 78° and ANB decreasing from 11° to 9°, along with reduced vertical dimensions (ANS–Me 78.5→74 mm; SN–MP 35→32°; N–Me 125→122 mm). The authors reported no buccal flaring, and no adverse effects such as root resorption, caries, periodontal bone loss, condylar changes, or posterior segment flaring, and stability was maintained at 1 year and 4 years posttreatment. They concluded that the triple intrusion system provides reliable, parallel maxillary posterior intrusion and stable mandibular autorotation, achieving functional occlusion and improved facial esthetics without surgery or unusual patient compliance. (45)

Akl, Abouelezz, El Sharaby, El-Beialy, and El-Ghafour (2020) conducted a double-blind randomized clinical trial on 22 adults with skeletal open bite (3–8 mm), comparing 200 g vs 400 g intrusive force for maxillary buccal segment intrusion using 4 miniscrews per patient (2 infrazygomatic + 2 palatal), with CBCT evaluation over 6 months. Results: both groups showed statistically significant posterior intrusion with no significant difference between forces (mean pooled intrusion 2.42 ± 2.06 mm in the 200 g group vs 2.26 ± 1.87 mm in the 400 g group), and both achieved significant open bite closure with no significant intergroup difference (2.24 ± 1.18 mm vs 3.15 ± 1.06 mm). Tooth tipping was statistically insignificant, but lower posterior extrusion occurred significantly in both groups (0.84 ± 1.22 mm vs 0.57 ± 0.55 mm).(46)

Shirasaki et al. (2020) demonstrated that in an adult Class II anterior open bite case, a simultaneous approach using miniscrew-supported maxillary molar intrusion combined with concurrent canine retraction achieved faster correction than conventional stepwise mechanics. After 4 months, they obtained a positive overbite through 1.5 mm maxillary molar intrusion without undesirable side effects, while also reaching a Class I canine relationship. Total active treatment time was 21 months, and the results were stable, with acceptable occlusion and ideal overbite/overjet maintained at 4.5 years of retention. They concluded that this biomechanics protocol allows independent control of vertical and anteroposterior dimensions with optimal force, minimal side effects, shorter overall duration, and good long-term stability.(47)

Akan, Karadede Unal, Oğuz Şahan, and Kızıltekin (2020) evaluated anterior open bite correction achieved through maxillary posterior segment intrusion using bilateral zygomatic miniplates supporting an acrylic bite-block appliance in 19 post-peak patients (mean age 16.5 years). The authors reported statistically significant dentofacial improvements after a mean intrusion period of 9.4 ± 0.7 months, with the maxillary first molars intruded by an average of 2.32 mm, the maxillary occlusal plane rotating clockwise by 2.76°, and overbite increasing by 2.48 mm, while SN-GoGn decreased by 1.68° and anterior facial height (ANS–Me) decreased by 1.81 mm. Significant sagittal changes were also observed, including reductions in ANB (−1.18°) and Wits appraisal (−3.54 mm), along with a reduction in overjet (−1.31 mm), whereas soft tissue measurements did not show statistically significant change.(48)

Akbaydogan and Akin (2021) evaluated the effectiveness of maxillary posterior intrusion using a single palatal miniscrew connected to a maxillary occlusal splint in 20 postadolescent patients (mean age 14.71 ± 1.77 years) with anterior open bite and Class I or mild Class II malocclusions. Over an 8-month period, 250 g of

intrusive force per side was applied using elastic chains from the palatal miniscrew to hooks on the splint. The authors reported significant improvement in the vertical skeletal pattern, including a reduction in SN-GoGn by 2.72 ± 1.90° and a decrease in anterior facial height (N–Me) by 3.63 ± 1.87 mm, along with mandibular advancement and counterclockwise rotation reflected by an increase in SNB by 1.76 ± 1.09° and a decrease in ANB by 1.86 ± 0.90°. Dentally, significant maxillary molar intrusion was achieved (Mx6–SN: 4.00 ± 1.01 mm; Mx6–PP: 4.01 ± 1.00 mm) with a reduction in open bite of 5.81 ± 0.97 mm. The study concluded that this miniscrew–splint approach effectively corrects anterior open bite through maxillary posterior intrusion and mandibular autorotation, providing a minimally invasive alternative compared with more invasive miniplate-based approaches.(49)

Steele, Pandis, Darendeliler, and Papadopoulou (2022) conducted a multicenter retrospective cohort study comparing clear aligners (Invisalign) and miniplate-supported posterior intrusion (MSPI) with fixed appliances in adult anterior open bite patients. Both modalities improved overbite, although a small residual open bite remained in 12.5% of the MSPI group and 17.2% of the Invisalign group. Compared with Invisalign, MSPI produced significantly greater maxillary molar intrusion (1.5 mm) and significantly greater reductions in lower anterior face height (ANS–Me: −2.77 mm), mandibular plane angle (Mp–SN: −1.95°), Y-axis (−1.23°), and ANB (−1.69°), along with significantly greater increases in SNB (+0.94°) and forward pogonion projection (+2.45 mm), indicating correction primarily through molar intrusion and counterclockwise mandibular autorotation. In contrast, Invisalign achieved correction mainly through dentoalveolar changes, showing significantly greater increases in maxillary and mandibular incisal edge positions relative to their apical bases (+1.05 mm and +0.9 mm, respectively), with borderline greater lingual tipping of the maxillary incisors. Appliance type and initial overbite were consistent predictors of final overbite, and the difference in final overbite between modalities was evident only in male patients.(6)

Manea, Dinu, Băciuț, Buduru, and Almășan (2022) performed a systematic review on maxillary posterior tooth intrusion using skeletal anchorage for anterior open bite correction or pre-prosthetic leveling of overerupted molars. Results showed the mean intrusion ranged from 2.1 ± 0.9 mm to 4.57 ± 0.98 mm (most commonly 2–3 mm) using forces between 100–500 g, with miniscrews (10 studies) and zygomatic plates (7 studies) as the main anchorage types. The average treatment time was 6.9 months with miniscrews and 7.9 months with zygomatic plates, and most studies reported only minor side effects (including soft tissue overgrowth, variable external apical root resorption, miniscrew loosening, and occasional relapse). (50)

Omidkhoda et al. (2023) performed a systematic review and meta-analysis evaluating the effects of posterior maxillary molar intrusion using skeletal anchorage (TADs) for treating anterior open bite, with a specific comparison between miniplates and miniscrews. The meta-analysis showed a significant mean molar intrusion of 2.89 mm using TADs. Subgroup comparison demonstrated that miniplates produced significantly greater intrusion (3.29 mm) than miniscrews (2.25 mm) *(P = 0.03)*, while force magnitude did not significantly influence intrusion. Significant dental improvements were reported, with overbite increasing by 4.81 mm and overjet decreasing by 2.06 mm. Skeletal changes were also significant, with increases in SNB, ANB, and SN–Pog, and significant reductions in mandibular plane angle and lower anterior facial height (LAFH), whereas SNA and palatal plane angle changes were not significant. Overall, Omidkhoda et al. (2023) concluded that posterior intrusion with TADs produces meaningful dental and skeletal improvement in anterior open bite, with miniplates being more effective than miniscrews for achieving greater molar intrusion.(51)

Invisalign

Moshiri, Araújo, McCray, Thiesen, and Kim (2017) evaluated the vertical effects of non-extraction Invisalign treatment in 30 adult patients with mild anterior open bite (mean pretreatment open bite 1.8 mm) and reported that Invisalign produced statistically significant improvement in overbite, with a mean change from −1.8 mm to +1.5 mm (+3.4 mm, $p < 0.001$) over an average treatment time of 21 months. Significant skeletal/vertical improvements were also observed, including decreases in SN–MP (−0.9°), SN–GoGn (−0.9°), and lower anterior facial height (−1.5 mm), indicating counterclockwise mandibular rotation, while palatal plane inclination (SN–PP) did not change significantly. Dentally, the main contributors to bite closure were significant lower molar intrusion (L6–MP −0.6 mm) and significant lower incisor extrusion (L1–MP +0.8 mm); in contrast, maxillary molar intrusion (U6–PP −0.4 mm) and maxillary incisor extrusion (U1–PP +0.5 mm) were not statistically significant. The authors concluded that Invisalign is a viable option for adult mild anterior open bite, with bite closure achieved mainly through a combination of mandibular plane counterclockwise rotation, mandibular molar intrusion, and mandibular incisor extrusion, rather than significant maxillary posterior intrusion.(7)

Xiang, Wang, Guan, Wang, and Cang (2023) reported successful correction of a complex adult malocclusion using clear aligners with four-premolar extractions in a 24-year-old female presenting with skeletal anterior open bite, bimaxillary dentoalveolar protrusion, and mesiocclusion. After 33 months of treatment (including an initial phase, progress phase, and a refinement phase), the anterior open bite was completely closed, with overbite improving from −2.8 mm to +1.2 mm and overjet maintained close to normal (2.2 mm to 2.6 mm).

Incisors were retracted and uprighted (UI/ANS-PNS 129°→118°, LI/GoGn 91°→82°), and a stable Class I molar and canine relationship with improved aesthetics and natural lip competence was achieved, while facial height reduction and planned counterclockwise mandibular rotation were not achieved (SN/GoGn remained 48°). They concluded that aligners combined with premolar extractions can effectively correct skeletal AOB with protrusion and mesiocclusion in adults, but the case also highlighted limitations of CAT in producing significant mandibular rotation, and they emphasized that stronger evidence is needed beyond single-case reports.(52)

Vilamas and Leethanakul (2024) compared posterior tooth intrusion using fixed appliances with TADs versus clear aligners and found that root length significantly decreased in all evaluated maxillary posterior roots in both groups after 6 months. The fixed appliance + TAD group produced greater molar intrusion (2.10 ± 0.12 mm) than the clear aligner group (0.86 ± 0.13 mm), and although both showed significant root length reduction, only the palatal root of the maxillary first molar (U6-Pa) showed a significantly greater reduction in the fixed appliance group (−0.50 ± 0.13 mm) compared with the aligner group (−0.29 ± 0.15 mm, p=0.04). Overall root length reduction ranged from 0.15 to 0.50 mm, corresponding to only 1.42%–2.13% of pretreatment root length, so the authors concluded that the changes were not clinically significant, and CBCT-based 3D segmentation is accurate for detecting such root length changes.(53)

Suh, Garnett, Mahood, and Oh (2026) concluded that clear aligners can effectively correct adult anterior open bite, but the main mechanism is incisor extrusion, while molar intrusion is limited and less predictable. Across multiple retrospective studies summarized in the review, they reported modest mandibular plane angle change (−0.9° to +0.7°), minimal molar vertical change (U6: −0.7 mm to +0.1 mm, L6: −0.6 mm to +0.2 mm), and more consistent incisor extrusion (U1: +0.5 to +1.48 mm, L1: +0.7 to +1.36 mm). A cited 2024 meta-analysis found that 2–3 mm of AOB closure can be predictably achieved with clear aligners, mostly via ~1 mm extrusion of both maxillary and mandibular incisors, with molars generally maintained. They further highlighted that skeletal anchorage produces greater posterior intrusion (~1.45–4 mm, average ~2 mm), and comparative evidence shows miniplate-supported intrusion yields ~1.5 mm more maxillary molar intrusion and ~1.95° greater mandibular plane reduction than aligners. Overall conclusion: clear aligners are most suitable for AOB < 3 mm where incisor extrusion is acceptable; more severe skeletal open bites usually require TADs or surgery, and long-term stability depends heavily on retention and addressing habits (especially tongue posture).(54)

Orthognathic Surgery for Non-Growing Patients

Orthognathic surgery is frequently indicated for adult or non-growing patients, especially in cases with esthetic concerns, significant open bite, or skeletal discrepancies in multiple planes. Surgical approaches include maxillary surgery, mandibular surgery, bimaxillary surgery, anterior maxillary and mandibular surgery, and mandibular surgery combined with temporary anchorage devices (TADs). Superior repositioning of the maxilla through total or segmental osteotomies is indicated in skeletal open bite patients with vertical maxillary excess, and maxillary impaction promotes mandibular autorotation, thereby reducing lower facial height and eliminating the anterior open bite. Closing rotation of the mandible using rigid fixation is another surgical option when maxillary osteotomies are not required for esthetic improvement; however, mandibular-only closing rotation has been shown to be highly unstable because it increases ramus length and stretches the pterygomandibular sling musculature. Therefore, two-jaw surgery involving superior repositioning of the maxilla with a Le Fort I osteotomy is recommended to achieve more predictable and stable correction of skeletal open bite. Mandibular surgery combined with TADs has been suggested as an alternative that reduces surgical invasiveness and decreases the possibility of alar flaring associated with maxillary impaction. (55,56)

Hoppenreijs et al. (1997) retrospectively evaluated 267 patients with maxillary hyperplasia, Class I or Class II/1 occlusion, and anterior open bite, treated with Le Fort I intrusion osteotomy either as a one-piece or multi-segment procedure, with or without BSSO advancement, and stabilized using either wire fixation or rigid internal fixation, with a mean follow-up of 69 months (range 20–210 months). They found good skeletal stability of the maxilla overall, and reported that rigid internal fixation produced the best maxillary and mandibular stability. At the longest follow-up, the mean overbite was 1.24 mm, but 19% of patients still showed lack of vertical overlap between incisors; importantly, overbite did not differ significantly among the different surgical protocols, which the authors attributed to compensatory movements of the maxillary and mandibular incisors masking skeletal differences.(56)

Kuroda, Sakai, Tamamura, Deguchi, and Takano-Yamamoto (2007) compared molar intrusion using skeletal anchorage (n=10) with orthognathic surgery (Le Fort I + mandibular osteotomy) (n=13) in 23 nongrowing severe anterior open bite patients (overbite < −3.0 mm). Both approaches produced similar overall correction, with total facial height reduced by 4.0 mm (implant group) vs 3.8 mm (surgery group) and overbite increased by 6.8 mm vs 7.0 mm, respectively, showing both were effective for severe AOB correction. However, the mechanism differed significantly: the skeletal anchorage group achieved correction through true molar intrusion (3.6 mm) with no significant incisor elongation, producing significant counterclockwise mandibular rotation and reduction in mandibular plane angle (−3.3°), whereas the surgery group showed minimal molar intrusion (0.2

mm) and instead had significant incisor elongation totaling 4.6 mm, with no significant reduction in mandibular plane angle (−0.3°). The authors concluded that since skeletal anchorage achieves comparable bite closure and facial height reduction without undesirable incisor extrusion, and with less invasiveness than two-jaw surgery, molar intrusion using skeletal anchorage is a simpler and more useful alternative for severe anterior open bite management.(5)

Retention and stability

Retention is essential in anterior open bite management to enhance long-term stability, particularly by eliminating the etiologic factors responsible for the open bite. Long-term evaluations of orthodontically treated open bite cases by Lopez-Gavito et al(57) and surgically treated cases by Denison et al[6] have reported relapse rates ranging from 35% to 42.9%. Relapse following anterior open bite correction has been attributed to factors such as tongue posture, unfavorable growth patterns, treatment mechanics and parameters, and surgical fragment instability, which may be related to increased facial height and extrusion of maxillary molars.(58) Surgical relapse may also be influenced by the type of surgical procedure, fixation method, and maxillary transverse relapse.(59) In terms of surgical stability, better overbite maintenance is generally achieved with maxillary repositioning alone or bimaxillary surgery, whereas mandibular surgery alone tends to show less stable outcomes. Failure of tongue posture adaptation after orthodontic and/or surgical correction has been suggested as the primary reason for relapse, and a relative increase in tongue volume within the oral cavity may also contribute to mandibular positional relapse after mandibular setback, leading to reduced overjet and overbite.(60)

Myofunctional therapy and tongue crib placement may improve stability, especially in patients with an anterior tongue resting posture. For growing patients, clinicians often attempt to maintain corrected open bite using a vertical chin cup or high-pull headgear applied to the maxillary molars along with a standard removable retainer. Retainers with occlusal coverage can be used to prevent further molar extrusion, and an additional approach includes wearing conventional retainers during the day combined with a functional appliance incorporating bite blocks (such as an open bite activator or bionator) at night. Some clinicians have suggested that prolonged retention with fixed or removable retainers is advisable and necessary in most open bite cases to improve long-term stability.

Janson, Crepaldi, de Freitas, de Freitas, and Janson (2008) evaluated anterior open-bite relapse correction using occlusal adjustment in 20 adults (mean age 21.81 ± 4.06 years) who had relapsed after fixed orthodontic treatment (mean relapse period 4.15 years) with a mean pretreatment overbite of −1.06 mm. After selective grinding until a positive overbite was achieved, the authors reported a significant overbite increase of 2.38 mm, correcting the mean overbite from −1.06 mm to +1.32 mm, along with significant decreases in vertical skeletal parameters (FMA −0.93°, SN.GoGn −0.89°, NSGn −0.71°) and a significant reduction in posterior molar height (PMH −1.29 mm), which was used to estimate enamel reduction (≈ 0.645 mm per second molar). Functional outcomes improved significantly, with immediate anterior guidance increasing from 0% to 70%, canine guidance increasing from 25%→90% (right) and 20%→95% (left), and total occlusal contacts increasing from 13.80 to 16.25 teeth. Dentinal sensitivity increased significantly shortly after the procedure (mastication, heat, percussion) but returned to baseline by 4.61 months.(61)

IV. Discussion

Posterior tooth intrusion has become a key nonsurgical approach for correcting anterior open bite (AOB), particularly in hyperdivergent skeletal patterns where excessive posterior dentoalveolar height prevents incisor overlap. The biological and biomechanical basis is consistent across studies: true intrusion of posterior segments reduces the posterior vertical dimension, allowing counterclockwise mandibular autorotation, reduction in lower anterior facial height, and improvement in overbite with less reliance on incisor extrusion. Early clinical evidence using skeletal anchorage systems showed that clinically meaningful intrusion is achievable even in adults; Umemori et al. (1999)(8) reported approximately 3–5 mm mandibular molar intrusion, producing mandibular autorotation, decreased lower facial height, and open-bite improvement with minimal lower incisor extrusion.

A major strength of posterior intrusion is that it can approximate the dentofacial effects of surgery in selected patients while avoiding morbidity. Kuroda et al. (2007)(5) directly compared skeletal anchorage molar intrusion with orthognathic surgery in severe nongrowing AOB patients and found similar facial height reduction (4.0 mm vs 3.8 mm) and overbite improvement (6.8 mm vs 7.0 mm) in both groups; however, the mechanism differed, as the intrusion group achieved correction through true molar intrusion (3.6 mm) with minimal incisor elongation, while the surgery group showed minimal molar intrusion (0.2 mm) and relied on incisor elongation (4.6 mm). These findings support posterior intrusion as more than camouflage, since it can generate meaningful skeletal changes through autorotation.

The literature also indicates that the anchorage system influences efficiency and predictability. Miniplate-supported intrusion has repeatedly demonstrated stable anchorage and significant intrusion without plate displacement; Sherwood et al. (2002)(34) achieved a mean 1.99 mm maxillary molar intrusion with open

bite closure and a mean reduction in mandibular plane angle of 2.62°. Similarly, Erverdi et al. (2004)(35) reported 2.6 mm molar intrusion and overbite improvement from −0.6 mm to +3.1 mm in nongrowing patients using zygomatic miniplates. Miniscrews offer a less invasive and more economical alternative and have shown consistent results, but outcomes can be more sensitive to biomechanics and placement. Xun et al. (2007)(36) reported correction of skeletal AOB in 12 patients within 6.8 ± 1.1 months, with intrusion of 1.8 mm (maxillary molars) and 1.2 mm (mandibular molars) and a 2.3° reduction in SN–MP, demonstrating that miniscrews can deliver meaningful skeletal effects when posterior segments are controlled.

Biomechanics remains central to successful intrusion. Finite element evidence by Çifter and Saraç (2011)(38) demonstrated that applying intrusive forces from both buccal and palatal directions produces more balanced intrusion and lower stress values than transpalatal-arch mechanics, and they highlighted stress concentration near premolar and molar apices as a potential resorption risk. Clinically, multiple authors used transpalatal arches, lingual arches, or splints to prevent tipping and maintain transverse control. Hart et al. (2015)(42) also highlighted an important clinical limitation: during maxillary intrusion, mandibular molars often erupted (mandibular first molars erupted in 77% of patients), potentially reducing net bite closure and autorotation, which supports the rationale for either controlling both arches or planning overcorrection.

Clear aligners have been suggested to close AOB via a posterior bite-block effect, but comparative studies indicate that their mechanism is largely different from skeletal anchorage. Steele et al. (2022)(6) found that miniplate-supported posterior intrusion produced significantly greater maxillary molar intrusion (~1.5 mm) and significantly greater skeletal improvements including reduced ANS–Me (−2.77 mm) and reduced mandibular plane angle (−1.95°), whereas Invisalign correction occurred mainly through incisor extrusion (maxillary +1.05 mm, mandibular +0.9 mm) with minimal true molar intrusion. Moshiri et al. (2017)(10) similarly reported that Invisalign correction of mild adult AOB was mainly due to mandibular incisor extrusion (+0.8 mm) and small mandibular molar intrusion (−0.6 mm), while maxillary posterior intrusion was not significant. Collectively, this suggests aligners are more appropriate for mild AOB where incisor extrusion is acceptable, whereas skeletal anchorage is more predictable for moderate-to-severe skeletal open bite requiring vertical facial improvement.

Force magnitude and tissue response have also been explored. Akl et al. (2020)(46) compared 200 g vs 400 g intrusive forces in adults and found no significant difference in intrusion or open bite closure between groups, suggesting heavier forces do not necessarily increase effectiveness. At the biological level, Tasanapanont et al. (2017)(43) demonstrated that even 50 g per side during segmental maxillary posterior intrusion produced measurable biochemical remodeling, with increased chondroitin sulphate levels in gingival crevicular fluid and clinically detectable intrusion with overbite improvement. These findings support using controlled forces rather than excessive loading.

Stability remains one of the most important limitations in AOB correction, regardless of treatment modality. Baek et al. (2010)(37) reported that after miniscrew-supported maxillary posterior intrusion, the 3-year relapse was 0.45 mm molar eruption (22.88%) and 1.20 mm overbite reduction (17.00%), with more than 80% of molar relapse occurring in the first year. Long-term data from Marzouk and Kassem (2016)(40) showed relapse after zygomatic miniplate intrusion remained relatively low over 4 years (13.37% molar relapse; 11.18% overbite relapse), but again most relapse occurred in the first year. These studies support the clinical strategy of planned overcorrection and strong retention, especially early in retention.

Overall, the literature supports posterior intrusion as an effective, increasingly predictable method for anterior open bite correction, with evidence showing it can produce skeletal changes comparable to surgical correction in selected cases (Kuroda et al., 2007)(5), and with greater true intrusion and skeletal benefits than aligner-based therapy (Steele et al., 2022)(6). However, success depends heavily on biomechanics, controlling the opposing arch, addressing functional etiologies such as tongue posture, and long-term retention protocols, with relapse risk highest in the first posttreatment year (Baek et al., 2010; Marzouk and Kassem, 2016)(37,40).

V. Conclusion

Posterior tooth intrusion is an effective method for anterior open bite correction, especially in nongrowing hyperdivergent patients, as it reduces posterior vertical dimension and produces counterclockwise mandibular autorotation with improvement in overbite and facial proportions. Evidence shows that skeletal anchorage–supported intrusion (miniplates or miniscrews) can achieve results comparable to orthognathic surgery in selected cases, while aligner therapy tends to correct open bite mainly through incisor extrusion with limited true molar intrusion. However, stability remains a key concern, with most relapse occurring during the first year, making overcorrection, strict vertical retention, and control of functional etiologies such as tongue posture essential for long-term success.

References

[1]. Sassouni V. A Classification Of Skeletal Facial Types. American Journal Of Orthodontics. 1969 Feb;55(2):109–23. Doi:10.1016/0002-9416(69)90122-5

[2]. Subtelny JD, Sakuda M. Open-Bite: Diagnosis And Treatment. American Journal Of Orthodontics. 1964 May;50(5):337–58.

Doi:10.1016/0002-9416(64)90175-7
[3]. Park YC, Lee SY, Kim DH, Jee SH. Intrusion Of Posterior Teeth Using Mini-Screw Implants. American Journal Of Orthodontics And Dentofacial Orthopedics. 2003 Jun;123(6):690–4. Doi:10.1016/S0889-5406(03)00047-7
[4]. Marzouk ES, Kassem HE. Evaluation Of Long-Term Stability Of Skeletal Anterior Open Bite Correction In Adults Treated With Maxillary Posterior Segment Intrusion Using Zygomatic Miniplates. American Journal Of Orthodontics And Dentofacial Orthopedics. 2016 Jul;150(1):78–88. Doi:10.1016/J.Ajodo.2015.12.014
[5]. Kuroda S, Sakai Y, Tamamura N, Deguchi T, Takano-Yamamoto T. Treatment Of Severe Anterior Open Bite With Skeletal Anchorage In Adults: Comparison With Orthognathic Surgery Outcomes. American Journal Of Orthodontics And Dentofacial Orthopedics. 2007 Nov;132(5):599–605. Doi:10.1016/J.Ajodo.2005.11.046
[6]. Steele BP, Pandis N, Darendeliler MA, Papadopoulou AK. A Comparative Assessment Of The Dentoskeletal Effects Of Clear Aligners Vs Miniplate-Supported Posterior Intrusion With Fixed Appliances In Adult Patients With Anterior Open Bite. A Multicenter, Retrospective Cohort Study. American Journal Of Orthodontics And Dentofacial Orthopedics. 2022 Aug;162(2):214-228.E4. Doi:10.1016/J.Ajodo.2021.03.022
[7]. Moshiri S, Araújo EA, Mccray JF, Thiesen G, Kim KB. Cephalometric Evaluation Of Adult Anterior Open Bite Non-Extraction Treatment With Invisalign. Dental Press J Orthod. 2017 Oct;22(5):30–8. Doi:10.1590/2177-6709.22.5.030-038.Oar
[8]. Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal Anchorage System For Open-Bite Correction. American Journal Of Orthodontics And Dentofacial Orthopedics. 1999 Feb;115(2):166–74. Doi:10.1016/S0889-5406(99)70345-8
[9]. Boyd RL. Complex Orthodontic Treatment Using A New Protocol For The Invisalign Appliance. J Clin Orthod. 2007 Sep;41(9):525–47; Quiz 523. Pubmed PMID: 17921600.
[10]. Moshiri S, Araújo EA, Mccray JF, Thiesen G, Kim KB. Cephalometric Evaluation Of Adult Anterior Open Bite Non-Extraction Treatment With Invisalign. Dental Press J Orthod. 2017 Oct;22(5):30–8. Doi:10.1590/2177-6709.22.5.030-038.Oar
[11]. Fujiki T, Inoue M, Miyawaki S, Nagasaki T, Tanimoto K, Takano-Yamamoto T. Relationship Between Maxillofacial Morphology And Deglutitive Tongue Movement In Patients With Anterior Open Bite. American Journal Of Orthodontics And Dentofacial Orthopedics. 2004 Feb;125(2):160–7. Doi:10.1016/J.Ajodo.2003.03.009
[12]. Wolford LM. Idiopathic Condylar Resorption Of The Temporomandibular Joint In Teenage Girls (Cheerleaders Syndrome). Baylor University Medical Center Proceedings. 2001 Jul;14(3):246–52. Doi:10.1080/08998280.2001.11927772
[13]. Katsaros SK Christos. The Effects Of Myotonic Dystrophy And Duchenne Muscular Dystrophy On The Orofacial Muscles And Dentofacial Morphology. Acta Odontologica Scandinavica. 1998 Jan;56(6):369–74. Doi:10.1080/000163598428347
[14]. Lin LH, Huang GW, Chen CS. Etiology And Treatment Modalities Of Anterior Open Bite Malocclusion. Journal Of Experimental & Clinical Medicine. 2013 Feb;5(1):1–4. Doi:10.1016/J.Jecm.2013.01.004
[15]. Kim YH. Overbite Depth Indicator With Particular Reference To Anterior Open-Bite. American Journal Of Orthodontics. 1974 Jun;65(6):586–611. Doi:10.1016/0002-9416(74)90255-3
[16]. Nahoum HI. Anterior Open-Bite: A Cephalometric Analysis And Suggested Treatment Procedures. American Journal Of Orthodontics. 1975 May;67(5):513–21. Doi:10.1016/0002-9416(75)90297-3
[17]. Watson WG. Open-Bite-A Multifactorial Event. American Journal Of Orthodontics. 1981 Oct;80(4):443-6.
[18]. Moyers RE, Moyers RE. Handbook Of Orthodontics. 4. Ed. Chicago: Year Book Medical Publ; 1988. 577 P.
[19]. Parker JH. The Interception Of The Open Bite In The Early Growth Period. The Angle Orthodontist. 1971 Jan 1;41(1):24-44.
[20]. Huang GJ, Justus R, Kennedy DB, Kokich VG. Stability Of Anterior Openbite Treated With Crib Therapy. The Angle Orthodontist. 1990 Mar 1;60(1):17-24.
[21]. English JD, Olfert KDG. Masticatory Muscle Exercise As An Adjunctive Treatment For Open Bite Malocclusions. Seminars In Orthodontics. 2005 Sep;11(3):164–9. Doi:10.1053/J.Sodo.2005.04.010
[22]. Paik CH, Mccomb R, Hong C. Differential Molar Intrusion With Skeletal Anchorage In Open-Bite Treatment. 2017.
[23]. Bernard CL, Simard-Savoie S. Self-Correction Of Anterior Openbite After Glossectomy. The Angle Orthodontist. 1987 Apr 1;57(2):137-43.
[24]. Dellinger EL, Dellinger EL. Active Vertical Corrector Treatment—Long-Term Follow-Up Of Anterior Open Bite Treated By The Intrusion Of Posterior Teeth. American Journal Of Orthodontics And Dentofacial Orthopedics. 1996 Aug;110(2):145–54. Doi:10.1016/S0889-5406(96)70102-6
[25]. Gurton AU, Akın E, Karacay S. Initial Intrusion Of The Molars In The Treatment Of Anterior Open Bite Malocclusions In Growing Patients. 2004.
[26]. Ng J, Major PW, Flores-Mir C. True Molar Intrusion Attained During Orthodontic Treatment: A Systematic Review. American Journal Of Orthodontics And Dentofacial Orthopedics. 2006 Dec;130(6):709–14. Doi:10.1016/J.Ajodo.2005.05.049
[27]. Kiliaridis S, Egermark I, Thilander B. Anterior Open Bite Treatment With Magnets. The European Journal Of Orthodontics. 1990 Nov 1;12(4):447–57. Doi:10.1093/Ejo/12.4.447
[28]. Osman A, Mohie-Eldin E, Sharaby F. The Efficiency Of Different Molar Intrusion Methods In The Treatment Of Anterior Open Bite:A Systematic Review.
[29]. Isaacson RJ, Lindauer SJ. Closing Anterior Open Bites: The Extrusion Arch. Seminars In Orthodontics. 2001 Mar;7(1):34–41. Doi:10.1053/Sodo.2001.21064
[30]. Chang YI, Moon SC. Cephalometric Evaluation Of The Anterior Open Bite Treatment. American Journal Of Orthodontics And Dentofacial Orthopedics. 1999 Jan;115(1):29–38. Doi:10.1016/S0889-5406(99)70313-6
[31]. Sifakakis I, Pandis N, Makou M, Eliades T, Bourauel C. Forces And Moments On Posterior Teeth Generated By Incisor Intrusion Biomechanics. Orthod Craniofacial Res. 2009 Nov;12(4):305–11. Doi:10.1111/J.1601-6343.2009.01466.X
[32]. Vela-Hernández A, López-García R, García-Sanz V, Paredes-Gallardo V, Lasagabaster-Latorre F. Nonsurgical Treatment Of Skeletal Anterior Open Bite In Adult Patients: Posterior Build-Ups. The Angle Orthodontist. 2017 Jan;87(1):33–40. Doi:10.2319/030316-188.1
[33]. Park HS, Kwon OW, Sung JH. Nonextraction Treatment Of An Open Bite With Microscrew Implant Anchorage. American Journal Of Orthodontics And Dentofacial Orthopedics. 2006 Sep;130(3):391–402. Doi:10.1016/J.Ajodo.2005.07.014
[34]. Sherwood KH, Burch JG, Thompson WJ. Closing Anterior Open Bites By Intruding Molars With Titanium Miniplate Anchorage. American Journal Of Orthodontics And Dentofacial Orthopedics. 2002 Dec;122(6):593–600. Doi:10.1067/Mod.2002.128641
[35]. Erverdi N, Keles A, Nanda R. The Use Of Skeletal Anchorage In Open Bite Treatment: A Cephalometric Evaluation. 2004.
[36]. Xun C, Zeng X, Wang X. Microscrew Anchorage In Skeletal Anterior Open-Bite Treatment. The Angle Orthodontist. 2007 Jan 1;77(1):47–56. Doi:10.2319/010906-14R.1
[37]. Baek MS, Choi YJ, Yu HS, Lee KJ, Kwak J, Park YC. Long-Term Stability Of Anterior Open-Bite Treatment By Intrusion Of Maxillary Posterior Teeth. American Journal Of Orthodontics And Dentofacial Orthopedics. 2010 Oct;138(4):396.E1-396.E9. Doi:10.1016/J.Ajodo.2010.04.023

[38]. Çifter M, Saraç M. Maxillary Posterior Intrusion Mechanics With Mini-Implant Anchorage Evaluated With The Finite Element Method. American Journal Of Orthodontics And Dentofacial Orthopedics. 2011 Nov;140(5):E233–41. Doi:10.1016/J.Ajodo.2011.06.019

[39]. Flieger S, Ziebura T, Kleinheinz J, Wiechmann D. A Simplified Approach To True Molar Intrusion. Head Face Med. 2012 Dec;8(1):30. Doi:10.1186/1746-160X-8-30

[40]. Marzouk ES, Kassem HE. Evaluation Of Long-Term Stability Of Skeletal Anterior Open Bite Correction In Adults Treated With Maxillary Posterior Segment Intrusion Using Zygomatic Miniplates. American Journal Of Orthodontics And Dentofacial Orthopedics. 2016 Jul;150(1):78–88. Doi:10.1016/J.Ajodo.2015.12.014

[41]. Giancotti A, Germano F, Muzzi F, Greco M. A Miniscrew-Supported Intrusion Auxiliary For Open-Bite Treatment With Invisalign. Journal Of Clinical Orthodontics. 2014;48(6):348-58.

[42]. Hart TR, Cousley RRJ, Fishman LS, Tallents RH. Dentoskeletal Changes Following Mini-Implant Molar Intrusion In Anterior Open Bite Patients. The Angle Orthodontist. 2015 Nov 1;85(6):941–8. Doi:10.2319/090514-625.1

[43]. Tasanapanont J, Wattanachai T, Apisariyakul J, Pothacharoen P, Ongchai S, Kongtawelert P, Et Al. Biochemical And Clinical Assessments Of Segmental Maxillary Posterior Tooth Intrusion. International Journal Of Dentistry. 2017;2017:1–7. Doi:10.1155/2017/2689642

[44]. Al-Falahi B, Hafez AM, Fouda M. Three-Dimensional Assessment Of External Apical Root Resorption After Maxillary Posterior Teeth Intrusion With Miniscrews In Anterior Open Bite Patients. Dental Press J Orthod. 2018 Dec;23(6):56–63. Doi:10.1590/2177-6709.23.6.056-063.Oar

[45]. Gökalp H, Efendiyeva M, Bilgili F, Efe E. Triple Intrusion Of Maxillary Posterior Teeth With Zygomatic Multipurpose Implants, Palatal Miniscrews, And Occlusal Cap Splints In A Skeletal Class II Open-Bite Patient. Am J Orthod Dentofacial Orthop. 2018;153(4):586-600.

[46]. Akl HE, Abouelezz AM, El Sharaby FA, El-Beialy AR, El-Ghafour MA. Force Magnitude As A Variable In Maxillary Buccal Segment Intrusion In Adult Patients With Skeletal Open Bite: The Angle Orthodontist. 2020 Jul 1;90(4):507–15. Doi:10.2319/082819-558.1

[47]. Shirasaki K, Ishihara Y, Komori H, Yamashiro T, Kamioka H. Comprehensive Approach To Simultaneous Molar Intrusion And Canine Retraction In The Treatment Of Class II Anterior Open Bite Using Miniscrew Anchorage. Dental Press J Orthod. 2020 May;25(3):E1. Doi:10.1590/2177-6709.25.3.30.E1-12.Onl

[48]. Akan B, Ünal BK, Şahan AO, Kızıltekin R. Evaluation Of Anterior Open Bite Correction In Patients Treated With Maxillary Posterior Segment Intrusion Using Zygomatic Anchorage. American Journal Of Orthodontics And Dentofacial Orthopedics. 2020 Oct;158(4):547–54. Doi:10.1016/J.Ajodo.2019.09.018

[49]. Akbaydogan LC, Akin M. Cephalometric Evaluation Of Intrusion Of Maxillary Posterior Teeth By Miniscrews In The Treatment Of Open Bite. American Journal Of Orthodontics And Dentofacial Orthopedics. 2022 May;161(5):621–7. Doi:10.1016/J.Ajodo.2020.11.033

[50]. Manea A, Dinu C, Băciuţ M, Buduru S, Almășan O. Intrusion Of Maxillary Posterior Teeth By Skeletal Anchorage: A Systematic Review And Case Report With Thin Alveolar Biotype. JCM. 2022 Jun 30;11(13):3787. Doi:10.3390/Jcm11133787

[51]. Omidkhoda M, Bardideh E, Jahanbin A, Zarei M. Effects Of Posterior Intrusion Using Skeletal Anchorage On Treating Anterior Open Bite: A Systematic Review And Meta-Analysis. J Dent Res Dent Clin Dent Prospects. 2023 Dec 30;17(4):196–210. Doi:10.34172/Joddd.2023.40754

[52]. Xiang X, Wang C, Guan X, Wang L, Cang S. Treatment Of An Anterior Open Bite, Bimaxillary Protrusion And Mesiocclusion By The Extraction Of Premolars And The Use Of Clear Aligners. Australasian Orthodontic Journal. 2023 Jan 1;39(1):72–85. Doi:10.2478/Aoj-2023-0007

[53]. Vilamas K, Leethanakul C. THE ROOT LENGTH CHANGE IN POSTERIOR TEETH INSTRUSION IN ANTERIOR OPEN BITE PATIENT.

[54]. Suh H, Garnett BS, Mahood K, Oh H. Anterior Open Bite Treatment With Clear Aligners In Adults. Seminars In Orthodontics. 2026 Feb;32(1):231–43. Doi:10.1053/J.Sodo.2025.10.006

[55]. De Oliveira JM, Dutra AL, Pereira CM, De Toledo OA. Etiology And Treatment Of Anterior Open Bite. Health Sci Inst J. 2011;29:92-5.

[56]. Hoppenreijs TJM, Freihofer HPM, Stoelinga PJW, Tuinzing DB, Van'T Hof MA, Van Der Linden FPGM, Et Al. Skeletal And Dento-Alveolar Stability Of Le Fort I Intrusion Osteotomies And Bimaxillary Osteotomies In Anterior Open Bite Deformities. International Journal Of Oral And Maxillofacial Surgery. 1997 Jun;26(3):161–75. Doi:10.1016/S0901-5027(97)80813-2

[57]. Lopez-Gavito G, Wallen TR, Little RM, Joondeph DR. Anterior Open-Bite Malocclusion: A Longitudinal 10-Year Postretention Evaluation Of Orthodontically Treated Patients. American Journal Of Orthodontics. 1985 Mar;87(3):175–86. Doi:10.1016/0002-9416(85)90038-7

[58]. Greenlee GM, Huang GJ, Chen SSH, Chen J, Koepsell T, Hujoel P. Stability Of Treatment For Anterior Open-Bite Malocclusion: A Meta-Analysis. American Journal Of Orthodontics And Dentofacial Orthopedics. 2011 Feb;139(2):154–69. Doi:10.1016/J.Ajodo.2010.10.019

[59]. Maia FA, Janson G, Barros SE, Maia NG, Chiqueto K, Nakamura AY. Long-Term Stability Of Surgical-Orthodontic Open-Bite Correction. American Journal Of Orthodontics And Dentofacial Orthopedics. 2010 Sep;138(3):254.E1-254.E10. Doi:10.1016/J.Ajodo.2010.03.021

[60]. Togawa R, Iino S, Miyawaki S. Skeletal Class III And Open Bite Treated With Bilateral Sagittal Split Osteotomy And Molar Intrusion Using Titanium Screws. The Angle Orthodontist. 2010 Nov;80(6):1176–84. Doi:10.2319/021910-102.1

[61]. Janson G, Crepaldi MV, De Freitas KMS, De Freitas MR, Janson W. Evaluation Of Anterior Open-Bite Treatment With Occlusal Adjustment. American Journal Of Orthodontics And Dentofacial Orthopedics. 2008 Jul;134(1):10.E1-10.E9. Doi:10.1016/J.Ajodo.2007.12.022