Maxillary Molar Intrusion Therapies

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Abstract : Introduction: Molar intrusion has always been a complicated and difficult treatment modality. Posterior teeth that are supra-erupted due to the early loss of their antagonists are commonly seen in adults that have limited or no access to dentistry during childhood and adolescence. Severely over-erupted molars or entire posterior segments pose a great challenge to the treating orthodontist. With regard to intruding posterior teeth, molar intrusion is a treatment option for patients with Anterior Open Bite (AOB); a malocclusion often characterized by the overeruption of the posterior teeth or/and under eruption of the anterior teeth. **Aim**: To compile and summarize the existing and advanced molar intrusive techniques and appliances with respect to their advantages and disadvantages, and their possible clinical effectiveness. **Conclusion:** We can utilise skeletal anchorage and surgically assisted techniques for efficient intrusion with limited side effects.

Keywords: Molar Intrusion, over eruption, TADs (Temporary Anchorage Devices)

Introduction

Supra eruption of teeth is basically over eruption of tooth due to lack of opposing force in the occlusion, **Snehal B Mali et al. (2023).[1]**With time, it can worsen the occlusion leading to detrimental effects. To avoid such type of malocclusion molar intrusion is necessary which will create a proper cusp to fossa relation**Ng J (2006)[2].** Molar supra eruption is mainly caused by missing antagonists and no replacement or by failure of eruption in growing patients.[3] Any situation can complicate the placement of prosthetic restorations and lead to lateral occlusal interferences. Although several authors have demonstrated the possibility of intruding asupra erupted molar, reported amounts of true intrusion have been modest.

According to **Sarah Abu Arqub et al.(2023)[4]**, intrusion is one of the most mechanically challenging types of tooth movement. This is primarily due to the greater root volume of these teeth. It has been described as the apical movement of the geometric centre of the root with respect to a plane perpendicular to the long axis of the tooth. The mechanical stresses are often increased with intrusion at the root apex, which might increase the risk of root resorption with this specific type of tooth movement. The mechanics used in the majority of these years relied heavily on patient compliance. Several cases reports have been published using different intrusive mechanical approaches. However, more organized clinical trials are still needed to evaluate the amount of intrusion obtained from using different techniques.

It has been reported that 82% of subjects presented with supraerupted maxillary molars would require adjunctive orthodontic restorative and/or endodontic interventions prior to prosthetic replacement for the opposing teeth to correct interocclusal space deficiency **Kiliaridis S et al.(2005).[4]**Therefore, orthodontic intrusion is a clinically desired treatment option for supraerupted teeth. Posterior teeth intrusion is one of the treatment strategies for treating anterior open bites **Zaki Hakami (2016)[6].** Treatment approaches for open bite patients differ when dealing with adults and growing patients. In growing patients, the vertical forces applied against the molars serve not only to intrude the molars but simply to control their vertical eruption. In adults or non-growing patients with the absence of vertical compensation of ramus growth, the true intrusion of molar teeth is needed to let the mandible autorotate and subsequently close the open bite anteriorly. According

to jaw geometry, 1 mm of intrusion posteriorly would result in about 2 mm of anterior open bite closure. In the past two decades, the clear aligner has been increasingly used owing to its esthetic and transparent features **Fan et al. (2022)**[7]. Aligners are effective in teeth intrusion, as they cover the entire dentition, exhibiting the "block effect" on the molars.Since the introduction of temporary skeletal anchorage devices (TSADs) into orthodontics, the range of tooth movement has expanded **Y.J. Choi et al. (2024)**[8]. Their use for the intrusion of posterior teeth has been revolutionary in enabling the nonsurgical correction of anterior open bite (AOB) while simultaneously reducing the anterior facial height. The amount of force used for molar intrusion varies significantly in the literature. The recommended force load is usually between 100 and 200 g per side for intrusion of a single molar, and between 200 to 400 g per side to intrude a maxillary posterior segment. Force exceeding 400 g is not used. There seems to be a lack of agreement regarding the timing of force application, which ranges from immediate loading to 12 weeks delay. The primary objective of this review article is to comprehensively compile and update various molar intrusion techniques published in the literature.

Molar intrusion and anatomical considerations

Molar intrusion, apart from the desired clinical effect, may also have a negative influence on the tooth itself and adjacent anatomical structures. As in other types of orthodontic tooth movement, the risk of external apical root resorption should be considered. From histological studies, it is apparent that some resorption is always present as a result of orthodontic tooth movement. In most cases, resorption lacunae are restored after the end of treatment, and in 3%–5% of cases, severe resorption with significant loss of root structure is found. Studies on experimental animals and humans have shown that during intrusion of multiradicular teeth with temporary anchorage devices only clinically negligible root resorption occurs. As the root is pushed into the bone and force is concentrated on the root apex, the blood supply may also be compromised. Some changes occur in the pulp as a result; however, it has been shown that these changes are only temporary and are restored back to normal in 3 months. During intrusion, apical remodelling of the alveolar crest also occurs due to supraalveolar trans-septal periodontal fibers.

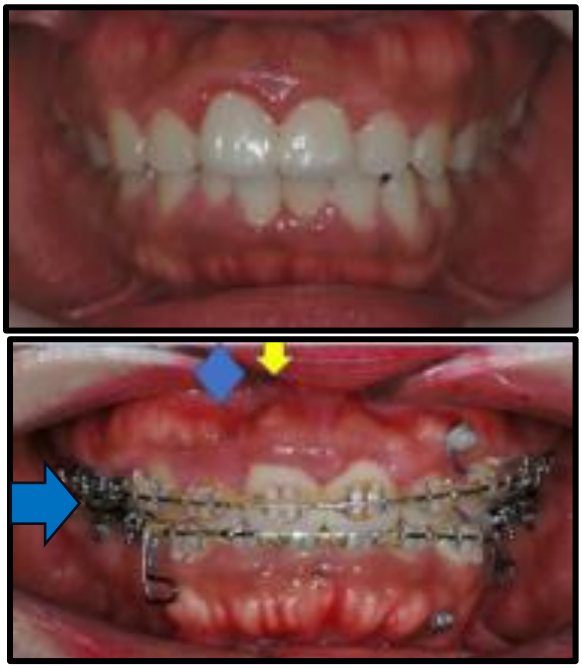

Fig 1: Esthetically compromised alveolar bone irregularity occurring due to incisor intrusion and retraction

CLASSIFICATION

Through the decades, various treatment strategies have been developed to intrude molar teeth, ranging from non-surgical to surgical approaches. Different appliances can be used which can rely on patient's compliance.

Table 1: Classification of Molar Intrusion techniques

NON-SURGICAL		SURGICAL
compliance appliances	1. High pull headgear	1. Corticotomy-enhanced molar intrusion
	2. High pull headgear to a splint	
	3. Vertical pull Chincap	
	4. Posterior bite-block	

	5. Magnetic bite-block	
	6. Spring-loaded bite-block	
Non-compliance appliances	1. Temporary Anchorage Devices (TADs)	2. Osteotomy-assisted molar intrusion
	2. Rapid molar intrusion device (RMI)	
	3. Vertical holding appliance (VHA)	
	4. Clear Aligners	
	5. Multiloop edgewise arch wire technique	
	6. Active Vertical Corrector (AVC)	

NON-SURGICAL

These are non-invasive in nature. Risk of damage to roots and adjoining structures and soft tissue irritation is reduced in these techniques.

COMPLIANCE APPLIANCES

These appliances need patient compliance for bringing about the required changes in a specific duration of time.

1) HIGH PULL HEADGEAR

It was first given by **Dr. S.J. Kloehn** who soldered the two outer bow and inner bow in **1947**.

Appliance Design

- The components of headgear consist of a facebow, force elements and extraoral anchorage straps.
- A facebow is used to transfer forces to the tooth intraorally through buccal tubes.
- The force elements are used to generate force. This can be done using elastics or with the help of springs.

Mechanism of action

- The force is directed carefully through the center of resistance of the upper first molar which is located at the level of buccal trifurcation area. The use of a transpalatal arch (TPA) is necessary to maintain the arch width and to prevent molar rotation.

Advantages

- It can be used for intrusion of the entire dental arch.

Disadvantages

- The direction of the force passing above or below the center of resistance of maxillary first molar leads to undesirable extrusion of tooth by tipping the crown mesially or distally,

Fig 2: High Pull Headgear

2) HIGH PULL HEADGEAR TO A SPLINT

This type of headgear is used for intrusion of a group of teeth and was first given by **Kloehn (1947).**

Appliance Design

- It has the same design as a high pull headgear but is attached to a splint covering the intended teeth and works with similar principles of high pull headgear.

Mechanism of action

- It works with similar principles of high pull headgear; however, the force is applied to a to a splint covering the specific teeth.

Advantages

- Light intrusion of maxillary dentition using headgear that is attached to a full-coverage maxillary occlusal splint.

Disadvantages

- There is limited research published specifically regarding this appliance.

Fig 3: High Pull Headgear with a splint

3) **VERTICAL PULL CHINCAP**

The use of restraining devices to reduce mandibular prognathism was reported in the early **1800s**. **Cellier** in France and **Fox, Kingsley, and Farrar** in the United States all designed appliances that resemble today's chin cup.

Appliance Design

- Chin cup is an extraoral appliance designed to exert an upward and backward force on the mandible by applying pressure to the chin, thereby preventing forward growth.

Mechanism of action

- A force of 400 g is applied per side, and the force vector passes through the anterior and inferior region of the mandibular corpus approximately 3 cm from the outer canthus of the eye.

Advantages

- It can be used for molar intrusion in cases of open bites.

Disadvantages

- Lingual tipping of lower incisors and crowding result following chin cup therapy.

Fig 4: Vertical Pull Chincap

4) **POSTERIOR BITE-BLOCK**

Passive acrylic posterior occlusal bite-blocks were given initially by**Altuna and Woodside**in**1985** and **Proffit and Fields**in **1986**.

Appliance design

- It consists of an acrylic pad placed on the posterior teeth.

Mechanism of action

- These functional appliances hinge the mandible open by approximately 3-4 mm beyond its resting position, thereby maintaining pressure on the neuromuscular system supporting the mandible.

Advantages

- Effective in controlling vertical dimension which is of benefit for patients with skeletal open bite.

Disadvantages

- When intrusion of the posterior teeth is needed in adults with excess vertical face height, bite-blocks have been unsuccessful in accomplishing molar intrusion.

Fig 5: Posterior Bite Block

5) MAGNETIC BITE-BLOCK

This appliance was first introduced by **Dellinger (1986**), under the name active vertical corrector.

Appliance design

- The components of this appliance are, two posterior occlusal splints, one for the upper arch, and one for the lower arch. Samarium cobalt magnets are used along with acrylic splints, on the occlusal surface of the teeth that are planned for intrusion.

Mechanism of action

- Samarium cobalt magnets are incorporated into the acrylic splints, over the occlusal region of the teeth that planned to be intruded. These magnetic modules are expected to generate forces between 600 and 650 g per module

Advantages

- Magnetic posterior bite-blocks also have shown to produce a quick response in the dental and skeletal vertical relation.

Disadvantages

- Maintaining arch width is sometimes difficult with magnetic bite-blocks.

Fig 6: Magnetic Bite Blocks

6) SPRING-LOADED BITE-BLOCK

The design of spring-loaded bite-blocks was first described, in **1986**, by **Woodside** and **Linder-Aronson**.

Appliance design

- Upper and lower bite block are connected with two helical springs.

Mechanism of action

- They are activated progressively to maintain the forces between 250 and 300 g.

Advantages

- Few authors have reported that it has an orthopaedic influence in treating open bite by intruding molars in growing patients.

Disadvantages

- However, to this date, there is limited data regarding intrusion in adults.

Fig 7: Spring Loaded Bite Blocks

NON-COMPLIANCE APPLIANCES

These devices do not require patient compliance for optimum results. This is a big advantage over

compliance appliances as we can achieve the desired results without the need for patient co-operation.

1) **TEMPORARY ANCHORAGE DEVICES (TADs)**

Kanomi (1997) and **Costa et al. (1998)** introduced the concept of miniscrew for orthodontic anchorage. **Umemori et al. (1999)** were the first to use miniplates as temporary skeletal anchorage for molar intrusion in managing the open bite malocclusion.

Mechanism of action

- Molars can be intruded approximately 2-4 mm using skeletal anchorage, with better results in the maxilla than mandible.

Appliance Design

- The mechanics for molar intrusion in the buccally positioned TADs comprises of a vertical intrusive force applied directly to the molar or molars.
- A buccal force from another buccal screw is combined to counteract the palatal moment.For intrusion of single molar tooth, the force could be applied from a cantilever attached directly to the miniscrew in combination with a TPA to counteract 3rd-order side effects.

Advantages

- simple to insert, less traumatic, and more secure under optimal force loads**.**
- Intrusion of the posterior teeth with skeletal anchorage has been shown to be stable.

Disadvantages

- With TADs located in the palate, it could be difficult to obtain a vector sum that passes through the center of resistance due to the anatomy of the palatal and buccal alveolar bone.

Fig 8: TADs

2) **RAPID MOLAR INTRUSION DEVICE (RMI)**

This appliance has been first proposed by **Carano** and **Machata (2002).**

Appliance Design

- It has 2 elastic modules that are secured on the first molars with L-shaped pins. The straight terminal end attaches into a maxillary molar tube and the angulated terminal end attaches to a mandibular tube.

Mechanism of action

- When the patient closes their mouth, the modules are flexed and deliver an immediate intrusive force of 800 g on each side. This force level decays to 450 g by the end of the 1st week and 250 g by the end of the second week. Because the intrusive forces on the labial side of the molars generate moments that tip the crowns buccally, the RMI appliance is always placed with TPA in upper and a lingual arch in lower.

Advantages

- Intrudes the upper and lower first molars significantly in growing patients and adults.

Disadvantages

- It intrudes both the upper and lower molars simultaneously.

Fig 9: Rapid Molar Intrusion Device

3) VERTICAL HOLDING APPLIANCE (VHA)

Wilson (1996) first reported on the clinical advantage of using a modified transpalatal arch dubbed as the vertical holding appliance (VHA).

Appliance design

- Vertical Holding Appliance is a Transpalatal Arch with an acrylic pad.

Mechanism of action

- Theoretically, pressure from the tongue reduces the eruption of maxillary permanent first molars during growth. However, it has not been clinically proven.

Advantages

- During orthodontic treatment, VHA is helpful in restricting further anterior bite opening resulting from molar extrusion during leveling and alignment.

Disadvantages

- Patient discomfort during chewing and swallowing.

Fig 10: Vertical Holding Appliance

4) CLEAR ALIGNERS

Stanford University students, **Zia Chishti and Kelsey Worth (1997)**, invented the world's first complete clear aligner system.It became available to orthodontists in 1999.Clear aligners showed excellent clinical vertical control of the molars.

Appliance Design

- Unlike fixed appliances, the clear aligner is composed of thermoplastic materials and attachments, which provide a consistent and gentle force.

Mechanism of action

- Aligners are effective in teeth intrusion, as they cover the entire dentition, exhibiting the "block effect" on the molars.
- For esthetic purposes, attachments are mainly used as retention aids made of resin and bonded to the target teeth surface. They can change the direction of orthodontic forces applied to the teeth to guide them toward the target position and aid in achieving orthodontic intrusion movements.

Advantages

- More esthetic and are comfortable to wear

Disadvantages

- They need to be worn for a long time during the day (almost the entire day)

Fig 11: clear aligner showing intrusion

5) MULTILOOP EDGEWISE ARCH WIRE TECHNIQUE

The multiloop edgewise archwire (MEAW) technique was originally designed by **Young H. Kim (1967)** for the treatment of severe open bite patients without the surgical intervention.

Appliance Design

- MEAW arches are made of 0.016″× 0.022″ steel wire with an ideal arch shape, in which five L- loops are incorporated in each quadrant starting distally of the lateral teeth.

Mechanism of action

- This technique uses a combination of 0.016 × 0.022 SS arch wires with multiple loops and heavy anterior elastics to achieve molar intrusion and incisor extrusion simultaneously, resulting in closure of anterior open bite and mainly affect the dentoalveolar region.

Advantages

- It provides gentle but continual orthodontic forces for biologically advantageous tooth movement.

Disadvantages

- The orthodontist needs to have a good knowledge of this method as well as good bending skills and precise execution.

Fig 12: Multiloop Edgewise Arch Wire Technique

6) ACTIVE VERTICAL CORRECTOR (AVC)

It was given by **Dellinger** in **1986**. The AVC can be a fixed or removable appliance that leads to intrusion of posterior teeth in the maxilla and mandible by reciprocal forces.

Appliance Design

- The appliance uses the repelling force of samarium cobalt magnets, incorporated in acrylic, for intrusion of the posteriors.

Mechanism of action

- The appliance uses the repelling force of samarium cobalt magnets, incorporated in acrylic, for intrusion of the posteriors.

Advantages

- Better facial balance and esthetics than most conventional orthodontic treatment procedures.

Disadvantages

- Maxillary and mandibular incisor extrusion and lingual tipping of the mandibular incisor is also seen.

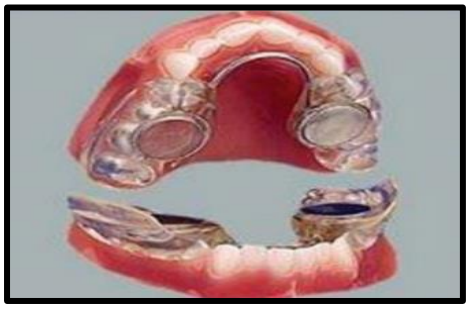

Fig 14: AVC

SURGICAL

These molar intrusion techniques are surgical intervention for accelerating the rate of tooth movement with increased treatment efficiency and less chances of relapse.

1) CORTICOTOMY-ENHANCED MOLAR INTRUSION

L.C. Bryan in **1892** was the first to report use of corticotomy as an adjuvant for malocclusion correction procedures.

Procedure

- After raising a full mucoperiosteal flap, corticotomy is performed selectively for intended molar or molars to be moved. Vertical cuts were made on both mesial and distal interproximal areas starting 2-3 mm above the alveolar crest. It extends 2-3 mm past the estimated root apices, and then a horizontal corticotomy was performed connecting the interdental cuts.

Mechanism of action

- To apply an intrusive force, various methods are used. For example, an acrylic splint covering the teeth except the tooth or teeth needed to be intruded can have an intrusive force from a coil spring attached to the J-hooks in the buccal and lingual shields which passes over the occlusal surface. Intrusive forces could be applied from a magnetic - repelling acrylic splint or skeletal anchorages, such as zygoma anchors, miniplate, or miniscrew.

Advantages

- It facilitates orthodontic tooth movement by regional acceleration phenomenon.

Disadvantages

- The apical third of the first molar mesiobuccal root undergoes high stresses, which can lead to root resorption.

Fig 15:A miniplate was attached into the L shaped fissure formed during corticotomy

1) OSTEOTOMY-ASSISTED MOLAR INTRUSION

In **1880, MacEwen** published the first book devoted entirely to osteotomy where he detailed his experience of 1800 cases with few complications.

Mechanism of action

- In a case report, where an osteotomy had been performed, intrusive force was applied from a miniplate on the zygomatic buttress in a patient with an open bite. More research is required to determine the limitations of this procedure.

Advantages

- Less need for extraoral appliances

Disadvantages

- High levels of initial stresses in PDL may relate to orthodontic external root resorption.

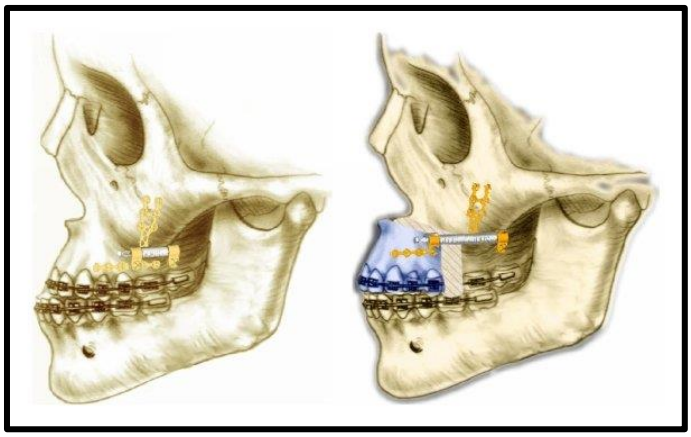

Fig 16: Intrusive force applied from miniplate on the zygomatic buttress

Stability of molar intrusion

Maintaining the position of intruded molars is a challenging step after orthodontic treatment of open bite malocclusion. Different factors may contribute in the relapse of open bites such as tongue size or posture, unfavourable growth patterns, orofacial musculature, respiratory problems, and dental movements. In general, the stability of open bite treatment is greater than approximately 75%**Huang**

GJ et al. (2002)[9]. Nevertheless, in growing patients, long-term post-treatment stability is unpredictable, particularly, in those having potential vertical growth pattern.[10]The use of temporary anchorage devices seems to be clinically efficient and a stable method in maxillary molar intrusion **(Sarah Abu Arqub,2023)**[4]. Several authors have reported tendency of relapse ranging between 20% and 30% when using TADs for molar intrusion.**Basma AlMaghlouth(2021)**[11]**.**

Conclusion

- There is limited evidence related to the effectiveness of different appliances in achieving maxillary molar intrusion.
- The use of temporary anchorage devices seems to be clinically efficient in maxillary molar intrusion.
- Some of these appliances (such as spring loaded or magnetic posterior bite blocks) and the RMI provide posterior occlusal coverage, therefore, offer the additional advantage of intruding the mandibular molars.
- The mechanics for intruding the molar/molars are usually accompanied with reciprocal effects on the anchorage units.
- With the limitation of available strong evidence, utilizing skeletal anchorage or, to a lesser extent, performing some surgical procedures such as corticotomy, to the intended teeth could be promising in efficient movements.

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