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Review Article

Molar Intrusion Techniques in Orthodontics: A Review

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Abstract:
Molar intrusion has always been a complex and difficult treatment modality. It can be approached for treating open bite patients or over erupted molar tooth/teeth. Through the decades, various treatment strategies have been developed to intrude molar teeth, ranging from non-surgical to surgical approaches, and utilizing various appliances, some which rely on patient compliance. The aim of this article is to compile and summarize the existing molar intrusive techniques and appliances with respect to their advantages and disadvantages, and their possible clinical effectiveness.

Key Words: Molar intrusion, open bite, supra-erupted molar

Introduction

Intrusion of teeth, particularly posterior teeth, has been a difficult and complex treatment modality throughout the 20th century. The mechanics used in the majority of these years relied heavily on patient compliance. The introduction of temporary anchorage devices (TADs) over the more recent years, has allowed for the intrusion of posterior teeth with minimal need of 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.[1]

Posterior teeth intrusion is one of the treatment strategies for treating anterior open bites. 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 to autorotate and subsequently close the open bite anteriorly.[2] According to jaw geometry, 1 mm of intrusion posteriorly would result in about 2 mm of anterior open bite closure.[3]

A molar can over erupt when its antagonist is lost, and there is no replacement. To avoid excessive grinding of the over erupted tooth which might end up with endodontic treatment, the orthodontic intrusion is a possible solution. True intrusion of an over erupted tooth is problematic, and careful mechanics is needed to avoid the undesirable extrusion of adjacent teeth, particularly with the use conventional fixed appliances.[4] Furthermore, due to the difficulty of molar intrusion, some recent case reports have attempted incorporating some surgical procedures to facilitate intruding the molars.[5]

Several molar intrusive treatment strategies have been published, ranging from case reports to clinical trials. Ng *et al.* have reviewed the techniques used to treat open bites.[6] However, there was limited emphasis on molar intrusion, as well as, more current techniques. Therefore, the primary objective of this review article is to comprehensively compile and update various molar intrusion techniques published in the literature.

Excluding the orthognathic surgery, molar intrusion techniques have been classified into non-surgical and surgical approaches (Table 1). Furthermore, among the non-surgical approaches, compliance and non-compliance appliances were separately discussed in details.

Non-surgical Approach for Molar Intrusion

Compliance appliances

High pull headgear

It has been published that high pull headgear has been used primarily for the purpose of producing an orthopedic force to the maxilla for correction of class II as well as open bite malocclusions.[7-9] It has been suggested to apply a force of 500 g to the upper first molar for a 6-month period.[10] Moreover, it has been claimed to produce dental changes of intrusion (0.96 ± 0.54 mm) in addition to the distal movement

Table 1: Molar intrusion techniques.

Non-surgical approach	
Compliance appliances	Non-compliance appliances
High pull headgear	Temporary anchorage devices
High pull headgear to a splint	Rapid molar intrusion device
Vertical pull chincup	Vertical holding appliance
Posterior bite-block	
Magnetic bite-block	
Spring-loaded bite-block	
Surgical approach	
Corticotomy-enhanced molar intrusion	
Osteotomy-assisted molar intrusion	

(2.6 ± 0.6 mm).[10] More intrusion has been shown with higher force levels and headgear treatment over a longer time period.[7] To create these effects, the force has to be directed carefully through the center of resistance of the upper first molar which is located at the level of buccal trifurcation area. The direction of the force above or below the center of resistance causes undesirable extrusion by tipping the crown mesially or distally, depending on the direction of the force which could result in downward rotation of the mandible. The use of a transpalatal arch (TPA) is necessary to maintain the arch width and to prevent molar rotation.[11]

High pull headgear to a splint

This type of headgear is used for intrusion a group of teeth. It works with similar principles of high pull headgear; however, the force is applied to a splint covering the intended teeth. A slight intrusion of maxillary dentition has been reported in a study using headgear that attached to a full-coverage maxillary occlusal splint in patients with the maxillary dentoalveolar protrusion.[12] However, there have been limited papers published specifically regarding this area.

Vertical pull chincap

The vertical chincap or high pull chincap has been used as a functional orthopedic appliance for the treatment of skeletal open bite. 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.[13,14] A study using vertical chincap for 6-12 months in a growing group of subjects with open bites had observed some intrusion of mandibular molars compared to the control group.[15]

Posterior bite-block

The use of passive acrylic posterior bite-blocks has also been used for the molar intrusion. 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.[16] It has been found to be effective in controlling vertical dimension which is of benefit for patients with skeletal open bite.[16,17] When intrusion of the posterior teeth is needed in adults with excess vertical face height, bite-blocks have been unsuccessful in accomplishing molar intrusion.[18]

Magnetic bite-block

This appliance was first introduced by Dellinger, in 1986, under the name active vertical corrector. The components of this appliance consist of two posterior occlusal splints, one for the upper, and one for the lower jaw. 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.[19] It has been reported as an effective therapeutic tool in reducing the open bite in growing patients by the intrusion of molar teeth.[17,20] Moreover, the magnetic repelling bite-block has been reported to significantly intrude the molars in adult patients.[21,22] Although magnetic posterior bite-blocks also have shown to produce a quick response in the dental and skeletal vertical relation, in can also help change posterior cross bite relations compared to a passive bite block. Maintaining arch width is sometimes difficult with magnetic bite-blocks. Therefore, TPA is necessary.[23]

Spring-loaded bite-block

The design of spring-loaded bite-blocks was first described, in 1986, by Woodside and Linder-Aronson. Upper and lower bite block are connected with two helical springs that are activated progressively to maintain the forces between 250 and 300 g.[24] Few authors have reported that it has an orthopedic influence in treating open bite by intruding molars in growing patients.[13,24-26] However, to this date, there is limited data regarding intrusion in adults.

Non-compliance appliances

TADs

After Branemark introduced the concept of osseointegrated pure titanium threaded implants in the clinical treatment of the edentulous patient,[27] the conventional implants replacing missing teeth have been utilized as skeletal anchorage for the correction of open bite by molars intrusion.[28]

Creekmore and Eklund introduced the vast possibilities of skeletal anchorage and inserted surgical vitallium bone screws just below the anterior nasal spine for deep bite patients.[29] New sites for implant placement were then propositioned such as endosseous implants in the retromolar pad area[30] and the midpalatal implant.[31] Kanomi and Costa *et al*. introduced the concept of miniscrew for orthodontic anchorage.[32,33] Umemori *et al*. were the first to use miniplates as temporary skeletal anchorage for molar intrusion in managing the open bite malocclusion.[34] Since then, many publications involving miniscrews as skeletal anchorage have been reported for molar intrusion.[35-37]

Molars can be intruded approximately 2-4 mm using skeletal anchorage, with better results in the maxilla than mandible.[3,38-41] The mandible is composed of thicker cortices than the maxilla which might suggest that it resists the intrusive force more than the maxilla.[38]

The mechanics for molar intrusion in the buccally positioned TADs comprises of a vertical intrusive force applied directly to the molar or molars. A TPA is placed in the maxilla or a lingual arch in the mandible to prevent distortion of the arch form and buccal tipping of the posterior teeth during force application. The use of a maxillary TPA has an added benefit because tongue pressure on the appliance may contribute to molar intrusion. The TPA must be offset (relieved) from the palatal mucosa, approximately the distance that the molars are

expected to be intruded.[42] 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. Therefore, monitoring is important to verify the torque and buccopalatal position of the molars being intruded. Hence, a buccal force from another buccal screw is combined to counteract the palatal moment.[37] 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.[43]

Rapid molar intrusion device (RMI)

This appliance has been first proposed by Carano and Machata.[44] It has two 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. 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. The effect of this appliance has been reported to intrude the upper and lower first molars significantly in growing patients and adults. Furthermore, it has been shown to intrude the first and second molars if they are attached together. However, it has the disadvantage that it intrudes both the upper and lower molars simultaneously. So, it cannot be used for the intrusion of molars in one arch.[45,46] A controlled, clinical trial study is needed to confirm its efficiency and efficacy.

Vertical holding appliance (VHA)

VHA is a TPA with an acrylic pad. Theoretically, pressure from the tongue could reduce the eruption of maxillary permanent first molars during growth. However, it has not been clinically proven.[47,48] Nevertheless, during orthodontic treatment, VHA is helpful in restricting further anterior bite opening resulting from molar extrusion during leveling and alignment.[48]

Surgical-assisted Approach for Molar Intrusion

Corticotomy-enhanced molar intrusion

Corticotomy-assisted orthodontics has been reported to limit side effects of tooth movement and also enhance the rate of tooth movement by increasing alveolar bone turnover and reducing bone density.[49,50] 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. To apply an intrusive force, various methods could be 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.[51] Furthermore, intrusive forces could be applied from a magnetic - repelling acrylic splint,[52] or skeletal anchorages, such as zygoma anchors,[53] miniplate, or miniscrew.[5]

Osteotomy-assisted molar intrusion

An osteotomy followed by an orthodontic force has been widely used as an option for movement of ankylosed teeth.[54,55] It was published in a case report, where an osteotomy had been performed, and intrusive force applied from miniplate on the zygomatic buttress in a patient with an open bite.[56] However, more research is required to determine the limitations of this procedure.

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, unfavorable growth patterns, orofacial musculature, respiratory problems, and dental movements.[57] In general, the stability of open bite treatment is greater than approximately 75%. Nevertheless, in growing patients, long-term post-treatment stability is unpredictable, particularly, in those having potential vertical growth pattern.[58]

Some retention protocols have been suggested for preventing the eruption of the posterior teeth. These methods could incorporate the use of high pull headgear, vertical chincap, or open bite activator.[6] Other retention protocols have attempted preventing relapses through controlling low tongue posture or tongue-thrusting habit by means of orofacial myofuntional therapy,[59] tongue reduction,[60] tongue crib, or tongue elevator appliances.[61,62]

Several authors have reported tendency of relapse ranging between 20% and 30% when using TADs for molar intrusion.[38-40] The majority of the relapse occurs within the 1st year after treatment. This would suggest effective retention protocols must be introduced within this 1st year of retention.[38,39] For example, a retainer covering the occlusal surfaces of the molars with elastics to the buccal TADs could be used and has shown to be a successful method.[3]

Conclusion

This paper highlighted the molar intrusion techniques in the literature. 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 with limited side effects. However, future clinical studies are needed to improve our evidence in this regard.

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