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THE CURRENT MODALITIES IN MOLAR MESIALIZATION – A REVIEW ARTICLE.

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ABSTRACT

Objectives: To evaluate the current trends of Molar Mesialization Materials and Methods: This Review article includes articles (2019–2025) .Studies included orthodontic patients in the permanent dentition with Angles Class II division1 or 2, Class II subdivision, class I, mild or no skeletal discrepancies, 2-6 mm crowding, treated with CA.

Results: Both Aligner and the Temporary Anchorage Devices (TADs) are effective in the molar mesialization. TADs (or a Hybrid TAD-Aligner system) are vastly superior and essential for predictable molar mesialization.

Conclusions: The integration of Temporary Anchorage Devices (TADs) has effectively addressed the historical challenge of anchorage loss, while the advent of shape memory aligners and specialized molar protraction devices has refined the precision of tooth movement.

KEY WORDS: molar mesialization, molar protraction, space closure, mandibular molar movement. TADs, mini-implants, transpalatal arch (TPA), skeletal anchorage

INTRODUCTION

Molar mesialization, the process of protracting posterior teeth into edentulous spaces, is a critical procedure for closing extraction sites or replacing congenitally missing teeth. Mesialization, as opposed to distalization, entails advancing the dental arch's biggest components despite substantial opposition. Achieving body translation while avoiding the typical dangers of anterior anchoring loss and mesial tipping continues to be the key issue.

In order to keep the crown from toppling forward, the gap closure was primarily carried out by the stationary appliance using friction-based mechanics that controlled the moment-to-force ratio through rigid archwires.[1] The application of force at the bracket level results in unwanted crown tipping and the

loss of anterior anchoring in the absence of such strict control. Because the maxilla has more trabecular bone than the mandible, molar protraction is easier in the former. Anteroposterior molar mobility is negatively impacted by the posterior mandible's substantial cortical bone and strong surrounding musculature. As the alveolar bone narrows over time, this difficulty increases..[2].

By removing the requirement for anterior dental support, the Mesialslider—which is anchored by palatal mini-implants—offers a "direct anchorage" approach that prevents undesired incisor retraction..[3] On the other hand, because of its dense cortical bone, the mandible is more difficult. Molar protraction is significantly more challenging in adults than in children, even though Temporary Anchorage Devices (TADs) have long been the norm for mandibular protraction. Compared to older adults, children and young adults experience fewer periodontal and root resorption issues after space closure..[2]. In order to produce the consistent force levels required for intricate tooth movements, clear aligner therapy is now also essential for molar mesialization and 3D-printed shape memory polymers.[5]

AIM :

In order to achieve predictable, natural tooth movement in arches, skeletal anchorage is crucial. This article will discuss the state of molar mesialization today and compare the effectiveness of fixed and Clear aligner systems.

METHODOLOGY :

A structured search was performed across PubMed, Scopus, ,Cochrane, and Google Scholar upto 2025. Keywords: molar mesialization, molar protraction, space closure, mandibular molar movement.Anchorage Devices: TADs, mini-implants, transpalatal arch (TPA), skeletal anchorage

BIOMECHANICS

FRICTION MECHANICS:

Molar protraction is comparable to canine retraction in terms of space-closure mechanics: the anteroposterior translatory displacement of teeth is the main biomechanical factor. Planning effective and efficient space closure requires an understanding of two key concepts: the function of friction during sliding and the deflection of t

he arch wire. If these two variables are not managed, the arch wire may become bound, resulting in undesirable movements such mesial molar tilting. [6] This can result in protraction (mesial shunting) of the entire dental arch and incisor intrusion. This manifests as a reduction in overjet and overbite. [7]

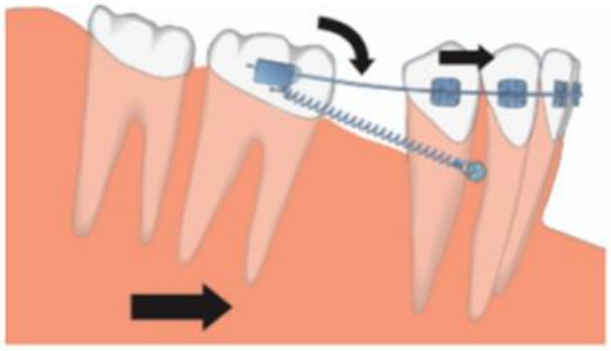
$$\text{Frictional Resistance } \alpha \quad \frac{FXD}{MTW}$$

F- Force Applied, D– Distance b/w point of force application and COR, MTW– Molar tube width Thus, utilizing optimal force levels nearer to the COR and implementing broader brackets can decrease frictional resistance in molar protraction.

To decrease the friction between the wire and molar tube, the wire ends must be rounded using a diamond bur and polished with a rubber wheel prior to insertion. If the molars are to shift along a continuous arch wire, a 0.016 X 0.022-inch or 0.017 X 0.025-inch SS wire (for 0.018-inch slots) or a 0.019 X 0.025-inch SS wire (for 0.022-inch slots) is advised to prevent mesial tipping.

Anchorage should be supported by medium Class II elastics measuring 3/16 or 1/4 inch between the mandibular second molars and maxillary canines (or lateral incisors).[2]

During the first stage of protraction, applying an elastic force from a mini-implant to the molar creates an Mf since the force is exerted above the CR of the molar. This leads to mesial tipping caused by the gap between the bracket slot and the wire [6]As molar tips mesially, arch wire contacts molar-tube edge, creating moment of couple(Mc)that uprights mesially tipped molar with decay of applied force.



FRICTIONLESS MECHANICS

If frictionless mechanics are preferred, a 0.017 X 0.025 inch SS wire with a closing loop can be used. A distal tip back and toe-in should be made to avoid mesial tipping and mesio-lingual molar rotation. It is important to maintain the axial inclination of the molar by controlling the amount of activation of the loop.[2] During protraction, the force is applied buccal to the COR, which can cause mesio-lingual rotation. This can be prevented either by incorporating a toe-in bend in the arch wire or by attaching a lingual sheath in the molar and a lingual button in canines thereby incorporating an additional A-P force vector lingually.[8]

INTRA ORAL APPLIANCE :

MESIALIZATION USING LOWER MOLAR PROTRACTION APPLIANCE:

Applying optimal force levels closer to the CR and using wider brackets can reduce frictional resistance during molar protraction.[7.2.]

APPLIANCE DESIGN:

Each molar band has .036" buccal and lingual tubes, 4-5mm wide. An .032" stain less steel wire is inserted in the tubes on each side and soldered anteriorly to the second-premolar band. Hooks are soldered close to the CR of the molar and premolar for application of elastomeric chain. The premolar band has a slot soldered buccally to engage an .021" × .025" rigid wire for in direct anchorage from a mini-implant between the lower premolars.

The appliance is cemented in place, and a rigid stainless steel power arm is bent from the buccal mini-implant, engaged in the premolar tube, and cinched. The stainless steel segment is splinted over the mini-implant using flowable composite. After stabilization of the appliance, 75g of force is applied on each side with elastomeric chain. The appliance is reactivated every six to eight weeks.

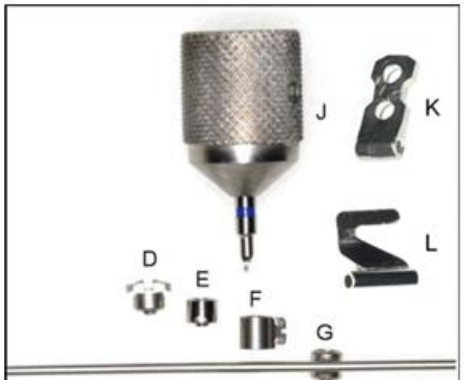
Simultaneous buccal and lingual force application helps reduce 1st-order frictional resistance. Because the power arm extends close to the CR of the molar, the point of force application is near the CR, which minimizes mesial tipping of the molar.[2] New elastomeric chains were attached to the buccal and lingual sides of the appliance every six weeks. The appliance was taken out when the mesialization was finished, and a cephalometrix and panaromic x-ray were required. .[9]

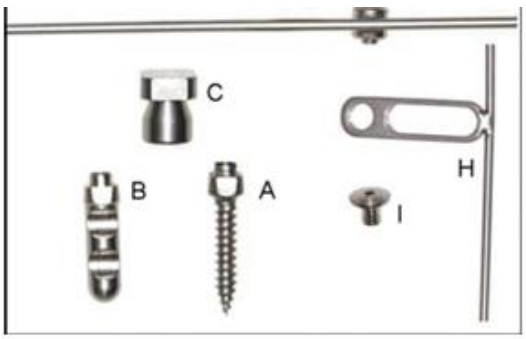
INCORPORATING PALATAL MINI IMPLANT FOR DIRECT ANCHORAGE IN ADOLESCENT PATIENT:

Because titanium mini-implants are easier to use, less expensive, and more convenient than endosseous implants, they are frequently utilized as a source of absolute anchoring throughout various forms of tooth movement. [10,11]

On the other hand, forces are applied directly to the teeth that need to be shifted when using mini-implants with direct anchorage ideas. The clinical process and design of direct anchorage mechanics for maxillary space closure using two palatal mini-implants (Mesialslider) are presented in this research. .

APPLIANCE DESIGN



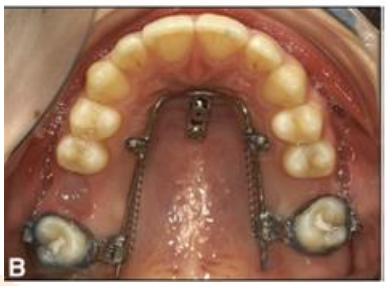


Mesialslider (1.1 mm stainless steel wire) connected to 2 median palatal mini-implants (anterior 2 3 11 mm, posterior 2 3 9 mm; Benefit System, PSM North America), as reported previously by Wilmes et al,[12-] was intended to serve as a direct anchorage source for the maxillary arch. Under local anesthetic, the two palatal mini-implants were inserted distal to the third palatal rugae (T-zone) to begin treatment.[17]

During the same appointment, an imprint was taken and stainless steel circumferential bands were glued to the maxillary second molars in order to fabricate the Mesialslider in the lab. Impression caps and laboratory analogs were employed for this purpose. A few days later, the maxillary second molars were

fitted with the Mesialslider appliance. The bilateral mesialization of maxillary molars was started by applying a 200 g nickel-titanium closure coil spring. The application of a nickel-titanium closing coil spring (200 g) initiated the bilateral mesialization of maxillary molars. A vacuum-formed stent was recommended for retention once mesialization was finished.

The article finds that a very successful "bracket-free" technique for molar protraction in teenagers is the use of palatal mini-implants for direct anchorage. By offering a biologically sound substitute for prosthetic replacements, it spares the patient from the long-term expenses and possible bone atrophy that come with dental implants



MESIALIZATION using T shaped palatal indirect anchorage

With a single midpalatal miniscrew anchorage, this novel procedure achieved simultaneous maxillary and mandibular posterior protraction using a modified T-PIAD. In order to effectively avoid anterior dental lingual tipping while minimizing problems, the design rationale focuses on three-dimensional force management through strategic attachment arrangement. Following mesialization, the patient expressed great happiness with the improved smile confidence, harmonious facial musculature, restored occlusal function, and primary straight profile. While indirect anchorage stabilizes anchor teeth to move others, direct anchorage uses miniscrews to assist tooth movement..[18]

APPLIANCE DESIGN :

0.022 × 0.028-inch preadjusted appliance was bonded to all erupted teeth. Alignment/levelling progressed through nickel-titanium archwires to 0.019 × 0.025-inch stainless-steel archwires for space closure.

The anterior palate was fitted with a 1.6 × 11 mm miniscrew. The ideal placement is 3–4 mm posterior to the incisive foramen and 3–9 mm paramedian to the midpalatal suture. For indirect skeletal anchorage, a specially made T-shaped device (0.019 × 0.025-inch stainless steel wire) was bonded to the maxillary anteriors and the miniscrew. For molar protraction, a 100g power chain is utilized.The full-time vacuum-formed retainers were used to maintain the retention phase after the treatment was finished.

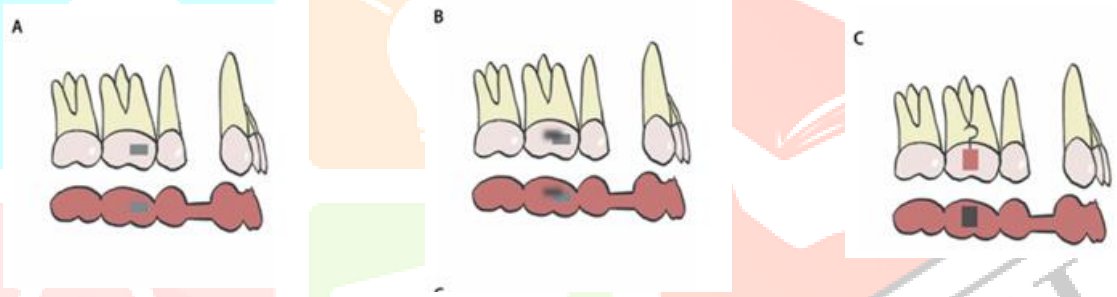
Unwanted molar mesial tipping is eliminated by palatal indirect anchorage. Because of its advantageous bone density, sufficient keratinized tissue, low risk of root damage, unfettered tooth movement, and excellent success rates, the anterior palate—especially the paramedian zone—is favored.[19 -22] Rigid anterior attachment provided by the T-PIAD allowed for the simultaneous application of buccolingual force to reduce molar rotation during mesialization, increasing movement efficiency.Mesial tipping and lingual rotation during molar protraction can be corrected by simultaneously applying buccal-lingual force and including the proper tip-back and toe-in angles in the archwire[23] The T-device system facilitated mesial movement of mandibular pos terior teeth via Class II elastics while preventing extrusion of maxillary anterior teeth.

Conclusions

The posterior edentulous spaces were successfully closeded through mesialization of third molars, achieved via a T-PIAD. This anchorage system effectively reduced dependence on skeletal anchorage screws and mitigating complications associated with conventional orthodontic protocols. It offers a biologically compatible alternative to prosthetic rehabilitation during active craniofacial growth periods, preserving vital dental structures while maintaining physiological occlusal relationships

MOLAR MESILIZATION WITH INVISALIGN IN MODERATE ANCHORAGE CASES :

Clinicians frequently meet issues like aligner disengagement and mesial tilting of molars in moderate an choring conditions, which are generally described as cases requiring ≥ 2 mm of mesial movement of the posterior teeth.The fundamental idea of genuinely bracket-
free orthodontics is undermined by these side effects, which may jeopardize the predictability and effecti veness of space closure and may call for the use of supplementary mechanics like segmented archwire a pproaches.Therefore, enhancing anchoring control and guaranteeing posterior teeth's naturalAlthough a number of supplementary techniques, including the use of power arms, dual attachments, and overcorrec tion, have been put forth, none have been able to consistently stop molar mesial tilting. [11,12,13] . The attachment play a vital role in the aligner in this article they Divide the attachment into three groups (1) single rectangular attachment group, (2) power arm group, and (3) double rectangular attachment group.



While the use of multiple rectangular attachments seemed to offer better control of crown angulation as compared to single attachment or power arm, molar mesial tilting remained a common biomech anical restriction.It is still a clinical difficulty to achieve controlled, upright movement of posterior te eth with transparent aligners.According to the study, orthodontists should "overplan" for tilting in t heir digital designs and employ double rectangular attachments for improved root control..[14]

MOLAR MESIALIZATION USING THE SHAPE MEMORY ALIGNER :

As a pleasant and aesthetically pleasing substitute for traditional fixed orthodontic appliances, clear alig ner therapy has advanced dramatically.However, research on the predictability of some complex tooth m ovements, like the physiological mesialization of molars, is still ongoing.
The current study's objective was to compare results with and without the usage of attachments in order t o determine how well a modified clear aligner design achieved mesialization of permanent molars by ev aluating the type of tooth movement caused (tipping vs. bodily movement).The study was conducted in vitro because it was still in its infancy.

GROUPING:

Group 1 included aligners without attachments, Group 2 included aligners with attachments placed on both buccal and palatal surfaces, Group 3 included aligners with attachments placed on the palatal surface only, and Group 4 included aligners with attachments placed on the buccal surface only. In order to stimulate the tooth movement electric typodont model was used.

Aligner manufacturing :

Aligners were manufactured with a thickness of 0.5 mm using Graphy Tera Harz TC-85DAC resin (Graphy Inc, Seoul, Korea), a shape memory polymer material that is designed for the production of clear aligners. Optimized attachments were designed with precise dimensions of 4 mm in width, 3 mm in height, and 2 mm in depth for all aligners. The aligners were printed using a Uniz Slash-C LCD 3D printer (Uniz, San Diego, CA, USA). They were positioned vertically at a 20° angle to the build platform and printed simultaneously and finally curing was done for 20 min to complete the polymerization process. The tooth movement was initiated using the electric current. The aligners were designed to move the upper first molar mesially by 3 mm. Pre- and post-treatment positions of the molars were measured and analyzed to determine the nature and extent of tooth movement.

Conclusion:

On a typodont model, tooth movement was effectively accomplished by using shape recovery forces that were triggered by heat stimuli.The upper left first molar moved mesially in all groups, but only Groups 1 (no attachments) and 2 (buccal and palatal attachments) were able to reach the intended 3 mm movem entThere was a little less movement in groups 3 and 4The upper first molar's mesial tipping was caused by the modified transparent aligner design made of shape memory polymer (Graphy material), however bodily mesialization was not achieved.To provide more predictable control over mesial molar movem ent, more study is required to refine aligner design and biomechanical techniques.

DISCUSSION :

The management of posterior space through molar mesialization remains one of the most biomechanically demanding tasks in orthodontics, primarily due to the difficulty in achieving translation rather than tipping. The contemporary literature review on molar mesialization underscores a transformative shift toward integrating skeletal anchorage with advanced material science to address missing posterior teeth. Central to this discussion is the utilization of Temporary Anchorage Devices (TADs), which current research identifies as the gold standard for achieving absolute anchorage, effectively neutralizing the "reciprocal loss" of anterior position while facilitating the mesial movement of large molar root surfaces. A significant technological leap discussed in recent reviews is the emergence of shape memory aligners (direct-printed or advanced thermoplastic); these appliances leverage smart polymers that provide constant, physiologic force levels over an extended range of activation, addressing the historical difficulty of maintaining root control and preventing crown tipping during protraction.

To ensure clinical success, the Molar Protraction Device (MPD) has gained attention in the literature for its ability to deliver precise, low-intensity forces that mimic biological tooth movement. Research indicates that using a dedicated protraction device—often in conjunction with a power arm—allows the force vector to pass closer to the tooth's center of resistance, significantly reducing the "rowboat effect" and unwanted vertical side effects. Scholars emphasize that while molar protraction remains a biologically intensive process requiring careful monitoring of alveolar bone density, the synergy of TAD-supported mechanics and shape memory materials offers a highly predictable, minimally invasive alternative to prosthetic implants. This approach not only preserves the natural alveolar ridge but also frequently triggers the spontaneous mesialization of third molars, ultimately delivering a more holistic and biologically stable occlusion

Limitations of Current Evidence

- **More invitro studies are needed**
- **A lack of force decay in the shape memory aligner**

Conclusion

The current literature suggests that molar mesialization has evolved from a high-risk orthodontic maneuver into a predictable clinical reality. The integration of **Temporary Anchorage Devices (TADs)** has effectively addressed the historical challenge of anchorage loss, while the advent of **shape memory aligners** and specialized **molar protraction devices** has refined the precision of tooth movement. While the procedure is biologically demanding and requires a longer treatment timeline compared to prosthetic replacement, its ability to maintain natural bone volume and achieve a functional occlusion using the patient's own dentition makes it an invaluable tool in modern multidisciplinary dentistry.

Future Clinical Implications

- **AI-Driven Planning are needed** for more accurate treatment timelines..
- **Direct-Printed Aligners:** The shift from thermoformed to **direct-printed shape memory aligners** may allow for varying thicknesses within a single tray, providing differential force levels specifically calibrated for the heavy roots of permanent molars.

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