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Review Article

Palatal Anterior Teeth Retraction Assisted by Temporary Anchorage Devices - A Review

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ABSTRACT

Successful orthodontic resolution of bimaxillary dentoalveolar protrusion depends on successful retraction of anterior dentition, which also involves acquiring proper buccolingual inclination and vertical position of anterior teeth. To fulfill these requirements, clinicians have devised numerous biomechanical and surgical orthodontic options. A palatal retractor for retraction of maxillary anterior dentition is the result of clinician's long-time creative endeavors and an evolution of the biomechanical design. A palatal retractor splints the maxillary anterior dentition on the lingual side with bonded mesh plates connected by a supporting wire. Two long palatally extended arms are soldered to the supporting wire where adequate retraction force can be applied. Palatal retractors have several advantages over conventional bracket/wire systems. The two most prominent ones are biomechanical superiority and esthetic invisibility. As the palatal retractor is positioned on the lingual surface of the maxillary anterior dentition, it is not visible from the frontal view and since the anterior dentition retraction constitutes a significant portion of the total treatment time in extraction orthodontic treatment, it is a distinct esthetic advantage. Biomechanical disadvantage of the conventional bracket/wire system lies in its innate ineffectiveness of the torque and vertical control because of the long distance between the point of force application and the center of resistance of the anterior dentition. A combination of TADs and palatal retractors provides the possibility of maximizing control of both the torque and vertical position. This article aims to describe clinical considerations, applications, and results of palatal retractor use in clinical cases.

Keywords: extraction treatment, anterior teeth retraction, palatal retractors, temporary anchorage devices.

INTRODUCTION

Proper buccolingual inclination and vertical position of anterior teeth are prerequisites for successful retraction of anterior dentition which is commonly involved in orthodontic resolution of bimaxillary dentoalveolar protrusion. When the six maxillary anterior teeth are retracted in premolar extraction cases, the control of force vectors and moments is important to achieve the desired tooth movement. The applied moment-to-force ratio on the six anterior teeth determines the type of tooth movement, such as uncontrolled tipping, controlled tipping, bodily movement, or root thrusting. In addition, the direction and the application point of retraction force in relation to the location of the center of resistance (Cres) are critical factors in predicting and planning the esthetic tooth movement of anterior teeth. Numerous biomechanical and surgical orthodontic options have been devised by clinicians to fulfill these requirements, the palatal retractor for retraction of maxillary anterior dentition being one of the most important evolution of the biomechanical design. Among various retraction methods, the lingual approach is preferred to the labial appliance in cases demanding not only esthetic braces but also critical torque control of anterior teeth. From a biomechanical viewpoint, TAD on the palatal area has a greater advantage in applying force towards the desired direction rather than on the buccal area. Longer retraction hooks beyond the level of Cres are possible when the TAD is placed on the palatal area. The key is to find a proper combination of retraction device design and the position of TAD for each treatment plan. A lingual retractor in combination with palatal skeletal anchorage has been proposed. A palatal retractor splints the maxillary anterior dentition on the lingual side with bonded mesh plates connected by a supporting wire. Two long palatally extended arms are soldered to the supporting wire in order to provide a point at which to apply adequate retraction force. Palatal retractors have several advantages over conventional bracket/wire systems. The two most prominent ones are biomechanical superiority and esthetic invisibility. As the palatal retractor is positioned on the lingual surface of the maxillary anterior dentition, it is not visible from the frontal view, which is a distinct esthetic advantage. Moreover, anterior dentition retraction constitutes a significant portion of the total treatment time in extraction orthodontic treatment, so this invisibility feature is a real boon to the patients. It is not an easy task to control the torque of anterior dentition during retraction with a conventional bracket/wire system. This is due not only to the long distance between the point of force application and the center of resistance of the anterior dentition, but also because of the innate ineffectiveness of the torque control biomechanics of a bracket/wire system [1]. The center of resistance of the anterior dentition is commonly reported to be positioned in a high position, far from the brackets [2–4]. To address this limitation, high torque values have often been prescribed on the anterior brackets, the curve of Spee has been expressed on the main working archwire, an additional spring or loops have been added, and other methods have been proposed in everyday orthodontic practice [1, 5] but even with these strategies, some cases still lose torque control and fail to finish in a proper buccolingual inclination [6]. Vertical control is even more difficult with conventional bracket/wire systems. The best option is to maintain the vertical position during retraction while intruding the anterior dentition in bialveolar/bimaxillary protrusion cases. Extrusion of the anterior dentition can be useful in anterior open bite cases but is harmful in deep bite cases and may impair smile esthetics in gummy smile cases. The palatal arms on the retractors can extend to the center of resistance of the anterior dentition [3, 7–10]. By adjusting the length of the palatal arm and the point of force origin, the line of force can be controlled. As a result, bodily retraction and an increase or decrease in torque can be achieved [7, 10]. Both torque and vertical position of the anterior dentition can be controlled with palatal retractors. Kim et al. [10] reported a severe Class II anterior deep bite case treated with a C-lingual retractor. They showed successful simultaneous intrusion and retraction of maxillary anterior dentition with this type of palatal retractor. Nahm et al. [11] also showed a gummy smile case treated by intrusion of the maxillary anterior segment with a palatal retractor. Since the advent of temporary anchorage devices (TADs) in orthodontics, anchorage management has been much simpler than before, and anterior dentition can be retracted to planned positions with higher predictability. A combination of TADs and palatal retractors provides the possibility of maximizing control of both the torque and vertical position [7, 8, 10, 12, 13]. Furthermore, palatal bone quality is good and there are a wide range of possible TAD placement sites with lower failure rates [14–17]. Clinicians can choose palatal TAD placement sites based on the planned direction of the retraction of the maxillary anterior dentition with fewer anatomic limitations than on the buccal side of the alveolar bone, and with a lower failure rate. By changing the position of the palatal TADs and length of the palatal retractor arm, anterior dentition can be displaced to the desired retraction in three dimensions. The design of the palatal retractor has evolved over the past two decades, and many designs have been proposed, such as the C-lingual retractor, lingual lever arm, double-J retractor, anteroposterior lingual retractor, etc. [3, 8, 12, 18]. Although different names have been given to these appliances by their inventors, all these palatal retractors share common major components, such as palatal arms and splinting of the maxillary anterior dentition on the palatal side.

The C-lingual Retractor System with a C-palatal Plate

Design The C-lingual retractor was introduced and developed by Chung and co-workers [19, 20] and Kim et al. [21, 22] have reported on several cases treated with them. To fabricate the C-lingual retractor, a lingual arch and two lever arms made of a 0.032-in stainless steel (SS) wire are soldered to anterior mesh pads. After the retractor is fabricated, it is bonded to the lingual surface of the anterior teeth. Two nickel–titanium (NiTi) closed coil springs are used as a power source. They are stretched palatally from the retractor to the soldered hook of the transpalatal arch (TPA). A TPA, also made of 0.032-in SS wire, is needed for the intra-arch anchorage unit and to control the desired direction of force (Figure 1).

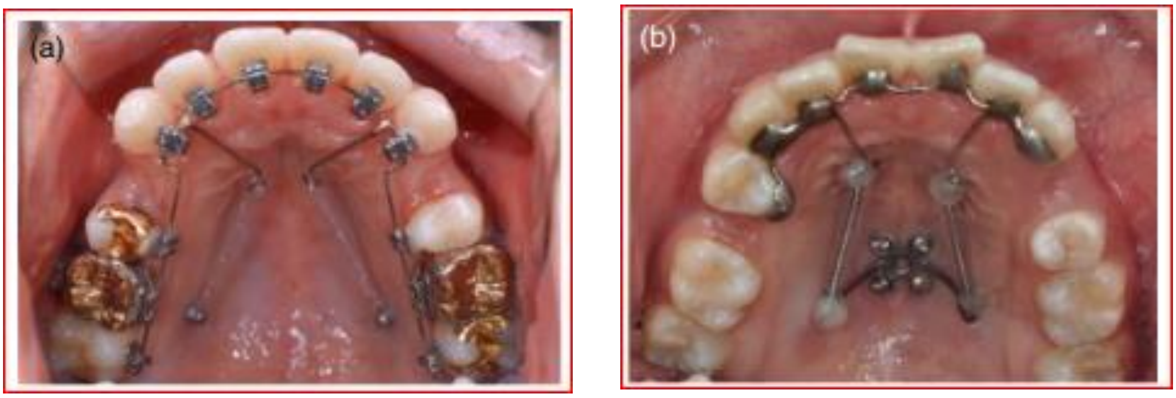

Figure 1. Retraction of anterior teeth using a lingual system and TADs. (a) Conventional lingual brackets. (b) C-lingual retractor.

C-palatal Plate When maximum anchorage is required during retraction of the anteriors, TADs are inserted in the midpalatal area. In the early days, a miniscrew was placed when retracting an anterior portion using a C-lingual retractor. However, as orthodontic treatment progresses, the miniscrew is often buried in the soft palatal tissue. In patients with thick soft tissue, shallow placement of the miniscrew in order to expose the screw head can decrease the stability of the miniscrew. On the other hand, when the miniscrew is inserted deeply to increase the primary stability of the screw, the screw head is often not exposed. Based on this experience, it is now common to use a C-palatal plate (Jin Biomed, Bucheon, South Korea) instead of a miniscrew. Chung et al. [12, 23] and Kim et al. [10] reported on several cases treated by combining a C-lingual retractor and a C-palatal plate (Figure 1b).

Advantages of C-lingual Retractors

- Early resolution of the problem.
- Anterior teeth can be retracted before alignment of the teeth.
- very simple and easy to manufacture design.
- very economical device without any expensive material and low laboratory costs.

Biomechanics A combination of TADs and C-lingual retractors maximizes the ability to control torque and vertical position of anterior teeth. By changing the position of

the palatal TADs and length of the power arm of the lingual retractor, anterior dentition can be retracted as needed [7].
The lingual retractor is applied to the incisors and canines, and lever arms are connected on the lateral incisors. A C-palatal plate is inserted in the midpalatal area. After delivery of the retractor, two NiTi closed coil springs are used as a power source. They are stretched from the lever arm to the C-palatal plate. On the lower arch, conventional treatment using full fixed appliances (0.022-in slot) is performed. A C-tube is implanted between the mandibular central incisors to intrude the mandibular anterior teeth and reduce the curve of Spee. After using a C-lingual retractor for seven months, the maxillary incisors are retracted by 4 mm from their initial position and exhibit controlled tipping. There can be upto 1 mm of anchor loss in the maxillary molars, but no significant vertical movement of the maxillary incisors or molars has been reported yet. After nine months of continued retraction, the C-lingual retractor is removed and brackets were bonded to close the remaining space and perform the finishing stage.

Double J Retractor (DJR)
Although the lingual retractor has long lever arms, it still shows problems, such as anterior torque loss and vertical bowing of the occlusal plane. It is not possible to determine the optimum length of lever arms and the fittest vertical position of TAD in relation to the location of the Cres in each individual. To overcome this clinical limitation, a modified type of lingual retractor, Double J Retractor (DJR), was introduced. The DJR has additional torquing springs with helixes on the conventional lingual retractor (Figure 1). The torquing springs are designed to slide along the palatal miniscrew, providing reinforced vertical support, especially on the canine area, while en masse retraction proceeds. It is presumed clinically that the torquing springs play a role in counterbalancing the torque loss of anterior teeth and intrusion with distal tipping of canine teeth during retraction. Moreover, the combination of DJR with the proper position of miniscrew is expected to allow bodily-like parallel retraction of anterior teeth.

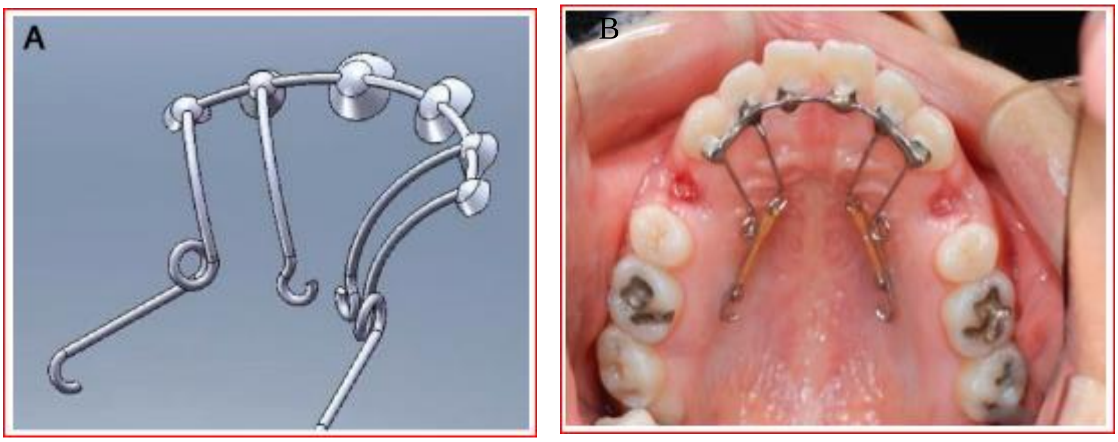

Figure 2(A and B): Double J Retractor

The center of resistance of six maxillary anterior teeth retracted by the DJR with palatal miniscrews is estimated to be 12.2 mm apically from the incisal edge of the central incisors. Teeth displacement when retracted by DJR is proven to be affected primarily by the vertical position of palatal miniscrews associated with lever arm length, rather than the existence of torquing springs. At the 8 mm level of miniscrews, bodily-like parallel retraction could be obtained with DJR. The direction of the retraction force that correlated with the points of force application is another critical factor affecting the type of tooth movement in relation to the location of the Cres. Whether the force direction is upward, downward, or parallel is determined according to the length of the lever arms and the vertical position of anchorage, affecting the degree of torque loss.

Anteroposterior Lingual Retractor

The use of an anteroposterior lingual retractor (APLR) has been proposed to compensate for the limitations of the conventional lingual retractor. The main difference between the APLR and the C-retractor is that the APLR is attached to the posterior segment. The teeth are grouped into three segments, so the orthodontic force is not concentrated on any individual tooth. Moreover, friction is minimal compared to that of conventional lingual brackets because the only site of friction during the sliding movement is between the posterior extension wire and the tube from the first molar.

Design The APLR includes an anterior and two posterior segments, which are connected to the TADs on the palate

Figure 3 - Anteroposterior lingual retractor

Anterior Segment - The anterior segment is similar to the C-lingual retractor. Additionally, a 0.036-in SS guidewire is soldered to the retraction hooks and extends distally through the tube of the posterior parts.

Posterior Segments - The second premolar, the first molar, and the second molar are splinted together into a single unit with a soldered extension arm from the mesh of the first molar, which ends in a short tube (diameter 1 mm). The tube is generally parallel to the occlusal plane and functions as a sliding yoke. The guidewire from the anterior segment passes through the tube hole. The play between the posterior extension wire and the tube is 0.1 mm.

Accessory Parts - The TPA can be soldered to the extension arm from the mesh of the first molar. For intrusion or torque control of the posterior teeth, additional hooks can be attached to the TPA.

Biomechanics The APLR produces bodily movement with significant intrusion of the anterior teeth. The posterior extension wires give vertical stabilization to the anterior teeth, preventing an unwanted clockwise bowing effect of the anterior segment [18, 24, 25]. The APLRs can control torque and angulation of the anterior segments effectively and prevent unwanted canine tipping [25]. On the aspects of posterior segment, when the intrusive retraction force is applied, the kinetic energy from the guide bar also causes molar intrusion. Typically, the amount of intrusion of the posterior teeth is less than the anterior teeth, which results in flattening of the occlusal plane. In summary, the APLR exhibits good vertical control ability to incorporate the entire upper dentition, it can be advantageously applied in treatment of skeletal Class II hyperdivergent with gummy smile [24]. To reinforce the anchorage, a TPA is soldered to the posterior segments. Two TADs are inserted in the paramedian area of the palate. The APLR is bonded using transfer jigs with chemical cure adhesive. The anterior section is bonded first and the posterior sections are then slipped onto the guidewires. Later a retraction force of 300 g is applied on each side with elastic chains connected from the anterior retraction hooks to the TADs. The anterior segment also functioned as an anterior bite plane; therefore, deep bite correction is easily achieved. No significant anchorage loss is expected during the enmasse retraction and the extraction spaces are closed gradually. After retraction, the APLR is removed and brackets are bonded to close the remaining space and complete the finishing stage. In the mandibular arch, conventional treatment using full fixed appliances is performed. After the APLR is removed 4-5 mm of retraction and intrusion of the upper incisors is expected without any torque loss, and 2 mm of upper molars intrusion without significant anchor loss which results in flattening of occlusal plane up to 3.2°. As a result of intrusion of the entire maxillary arch, counterclockwise rotation of the mandible occurs, which contributes to the patient's relaxed lip closure.

CONCLUSION

For treatment of lip protrusion, a lingual retractor combined with TADs offers effective vertical and torque control of the anterior teeth by simple biomechanics with an esthetic advantage. In particular, the APLR results in significant intrusion and bodily retraction of anterior teeth concurrent with intrusion of the posterior teeth.

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