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Review Article

Retraction of Anterior Teeth with Temporary Anchorage Devices (TADS) – A Review

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Abstract: One of the most important contemporary use of Temporary anchorage devices also known as TADS is anterior teeth retraction, most commonly needed in bimaxillary protrusion cases or Class II dentoalveolar cases involving extraction of premolars. This function is performed by providing absolute anchorage by using direct or indirect means depending upon the mechanism used. Various clinicians have adopted different methods and different miniscrew systems for the purpose. The aim of this article is to describe some of these methods for their effective use in enabling this function of providing a powerful anchorage so that orthodontic concern of loosing anchorage in critical cases could be addressed efficiently.

Keywords: Extraction cases, Retraction of anterior teeth, TADs, Different methods.

1. INTRODUCTION

Temporay anchorage devices (TADS) have set a remarkable trend in the evolution of orthodontics by providing a mean of absolute and secure anchorage in terms of providing cent percent resistance to movement of the anchor teeth and no hindrance to the freedom of movement of the active unit teeth in the desired direction (Creekmore TD *et al*., 1983; Herman R *et al*., 2005). This absolute anchorage has made possible the resolution of some of the most ferocious malocclusions and easy accomplishment of some of the most difficult movements of teeth which have bothered orthodontists for decades (Cope JB, 2005; Mah J *et al*., 2005). Such difficult movements include retraction of anterior teeth in premolar extraction cases, intrusion of anterior and posterior teeth, distalization of molars, mesialization of molars, asymmetrical tooth movements, extrusion of impacted canines etc (Hoste S *et al*., 2008).

According to a survey (Shirck JM *et al*., 2011) in 2011, the most common use for TADs is anterior retraction in cases in which bicuspids have been extracted, or the occasional case with generalized spacing where anchorage concerns are significant.

Retraction of the anterior teeth with TADs is performed in two general ways. In the first, called *direct anchorage*, the active unit is attached to the TAD and bypasses anchorage to the other teeth. Biomechanical principles must be strictly adhered to while exercising this approach (Figure 1).

Fig 1: The Direct Anchorage

In the second approach called *indirect anchorage*, the traditional teeth comprising the anchorage or reactive unit are tied to the TAD; that is, the unit to be moved is not attached directly to the TAD (Figure 2).

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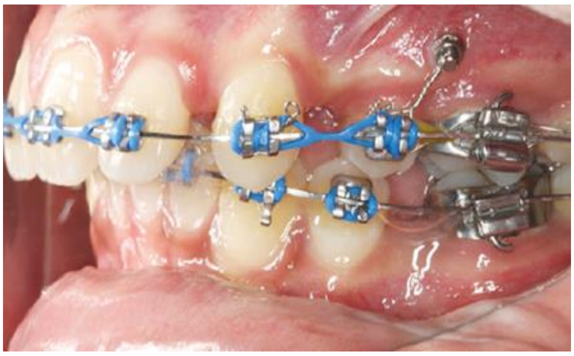

Fig 2: The Indirect Anchorage

2. METHODS AND SYSTEMS BY VARIOUS AUTHORS:

Several authors have devised different methods using TADs to retract the upper anterior teeth in non-compliant Class II extraction patients. Here few of them will be discussed in the present context.

2.1. Retraction using Conventional lingual brackets (Park K-H *et al*., 2020)

Conventional approach using routine lingual brackets can be employed for retraction of anterior teeth if the anchorage requirements are not severe. Power arms are attached to the archwire in between lateral incisor and canine and two TADs are placed in the palate juat distal to the distal margin of palatal surface of first molar.

Fig 3: Conventional Approach

Elastics are attached to the power arms from the TADs to generate the retraction force.

2.2. Palatal segmental approach by Park (Park YC *et al*., 2007)

Park described a segmental approach using a palatal appliance connected to two midpalatal mini-implants. Two main objectives of this approach were: first to reduce the patient's time in visible appliances. This is accomplished by retracting 6 anterior teeth by splinting on the lingual side without appliances during the initial retraction period. The second purpose was to obtain the desired type of movement of teeth by using orthodontic mini-implants and a segmented arch technique. Although this technique is frictionless and allows easy control of the moment-to force ratio, the need for reinforcement of anchorage in the reactive unit makes these appliances complicated. These problems can be overcome by orthodontic mini-implants that simplify the appliance (Park YC *et al*., 2003; Lee JS *et al*., 2004 and Park YC *et al*., 2005).

To splint 6 teeth into 1 unit and retract them on the palatal side, 0.9-mm stainless steel wire was bent according to the lingual surface of the 6 maxillary anterior teeth and the contour of the palatal slope in the canine area. It was then soldered with metal mesh. Four orthodontic mini-implants (Orlus, Seoul, Korea), 2 mm in diameter and 7 mm in length, were placed - 2 in the midpalatal area, 10 mm apart, and the other 2 in the interproximal alveolar bone, between the maxillary second premolar and the first molar of each side. The mini-implant-supported transpalatal arch (TPA) was made with 0.9 mm stainless steel wire. The bent TPA has a hook to which elastic chains are connected to give the retraction force. The middle part of the bent wire was soldered with metal mesh (3.0 ×12.0 mm) and then bonded to the midpalatal mini implants. The mini-implant-supported TPA was used as indirect absolute anchorage on the palatal side (Fig 4).

The type of movement of the 6 maxillary anterior teeth (controlled tipping, bodily movement, root movement) can be changed by shifting the line of force that passes through the palatal lever arm and the hook of the mini-implant-supported TPA (Smith RJ *et al*., 1984; Park YC *et al*., 2000).

The teeth were retracted 6.1 mm via an extension arm connected to the palatal appliance with elastomeric chain.

Fig 4: Palatal segmental approach by Park

The clear lever arm was made by cutting 1.0 mm DURAN (Scheu-Dental, Iserlohn, Germany), a hard, elastic, 1 mm-thick transparent acrylic plate, that was bonded to the labial surface of the canine. The line that passed between the clear lever arm and the miniimplant in the buccal interproximal bone was adjusted so that it was parallel to the occlusal plane. This line was about 4 mm in the cervical direction from the alveolus; the maxillary anterior teeth would be retracted with lingual tipping, as on the palatal side. After the maxillary extraction space was closed after 10 months, the appliances were bonded for leveling and alignment of mild crowding, correction of root axes, and bite seating. Treatment was finished 6 months after bonding. During space closure, invisibility can be ensured because the splinting wire is bonded to the lingual surface, and the facial profile can be improved from the beginning of treatment.

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

The C-lingual retractor was introduced and developed by Chung and coworkers (Chung KR, 1986; Chung KR *et al*., 2001) and Kim *et al*., (Kim SH *et al*., 2003; Kim SH *et al*., 2004) 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. Two nickel–titanium (NiTi) closed coil springs 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 4).

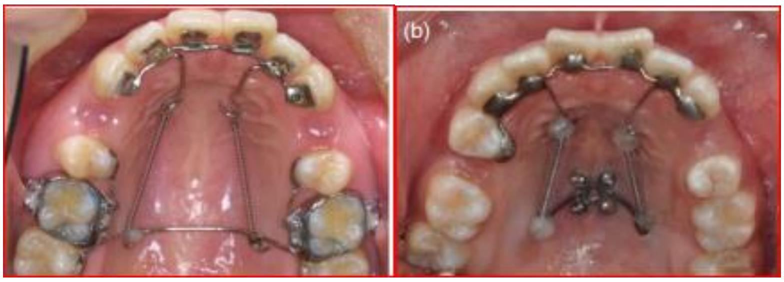

Fig 4: Design of the C-lingual retractor system a) without TADs; b) with TADs

C-palatal Plate When maximum anchorage is required during retraction of the anteriors, TADs are inserted in the midpalatal area using a C-lingual retractor. it is now common to use a C-palatal plate (Jin Biomed, Bucheon, South Korea) instead of a miniscrew. when a C-lingual retractor is used to treat patients with lip protrusion, their chief complaint can be addressed early because the anterior teeth are retracted before they are aligned. 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. (Hong RK *et al*., 2005)

2.4. Anteroposterior Lingual Retractor (APLR)

Anteroposterior lingual retractor (APLR) has been introduced to compensate for the limitations of the conventional lingual retractor. Unlike C-lingual retractor the APLR is attached to the posterior segment and the teeth are grouped into three segments. The force is not concentrated on any individual tooth and friction is minimal compared to conventional lingual brackets as the only site of friction during the sliding is between the posterior extension wire and the tube from the first molar.

The APLR has an anterior and two posterior segments, which are connected to the TADs on the palate (Figure 5). The anterior segment is similar to the C-lingual retractor. A 0.036-in SS guidewire is also soldered to the retraction hooks in addition and extends distally through the tube of the posterior parts. In the 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. 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.

Fig 5: The Anteroposterior Lingual Retractor (APLR)

Biomechanics: Bodily movement is produced by APLR with effective intrusion of the anterior teeth. Vertical stabilization is provided to the anterior teeth by the posterior extension wires which prevent the unwanted clockwise bowing effect of the anterior segment (Seo KL *et al*., 2015; Kwon SY *et al*., 2014; Hwang M *et al*., 2018.) The APLRs can control torque and angulation of the anterior segments effectively and prevent unwanted canine tipping (Hwang M, 2018). In the posterior segment, the intrusive retraction force 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. The APLR exhibits good vertical control ability to incorporate the entire upper dentition, so it can be efficiently used in the treatment of skeletal Class II hyperdivergent with gummy smile (Kwon SY *et al*., 2014).

2.5. Double J Retractor (DJR) (Jhanga H-J *et al*., 2010)

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.

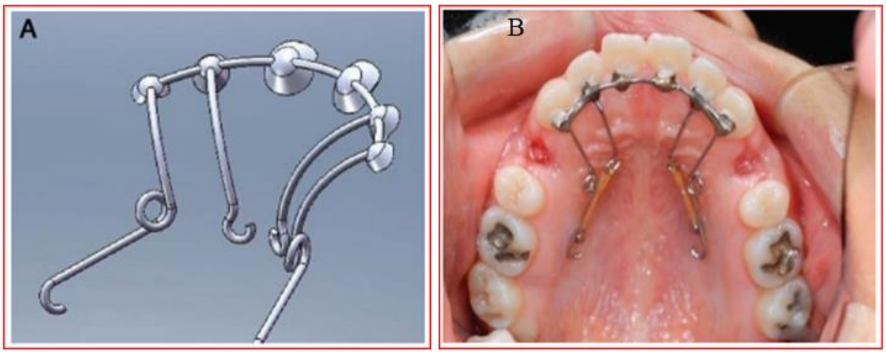

Figure 6(A and B): Double J Retractor

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.

2.6. En-masse retraction using C- implant without banding/bonding posterior teeth (Chung KR *et al*., 2007)

This method demonstrates the efficiency and the multiple functions of a new type of microimplant to effectively retract anterior teeth without bracketing on the posterior teeth. The C-implant provides stability primarily through osseointegration and secondarily by mechanical retention (Fig 7) (Chung KR *et al*., 2004; Lee SJ *et al*., 2001; Chung KR *et al*., 2007). It has 2 components, a titanium head and a screw. The screw is 1.8 mm in diameter and 8.5 mm long, and the entire surface except for the upper 2 mm is sandblasted, large-grit, and acid-etched (SLA) for optimal osseointegration (Fig 7) (Buser D *et al*., 1998) The head has a 0.032-in diameter hole and is connected to the screw by friction; this provides mechanical retention without cementing. This retention is strong enough to control torque and ensure 3-dimensional tooth movement while osseointegration resists rotational components of force. The 2-component design keeps the neck from fracturing during implantation and removal. The long span between the head and the screw body prevents gingival irritation during retraction and makes it possible to apply multi-directional elastics.

Fig 7: Osseointegrated 2-component orthodontic microimplant (C-implant). Sandblasted, large-grit, acid etched screw portion of implant allows better bone-toimplant contact

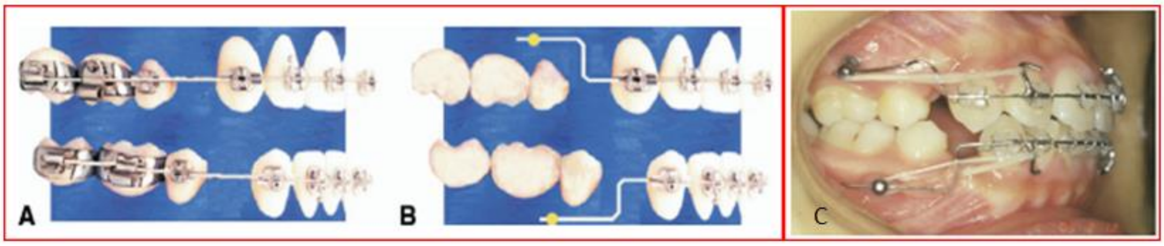

Fig 8A: Conventional orthodontic treatment; B,C- microimplant-dependent en-masse retraction mechanics, without orthodontic appliances on anchorage teeth during retraction

In sliding mechanics, there is a tendency for extrusion or tipping of the posterior teeth during anterior retraction. Friction on the posterior teeth is produced when a continuous archwire is combined with a mini implant for anterior retraction. Both anterior and posterior teeth along the continuous archwire can be negatively affected (Chung KR *et al*., 2007). Alternatively, the C-implant, when placed on both sides of the posterior maxilla, can be used as a modified segmental approach for en-masse retraction of anterior teeth (Fig 8A). A utility arch on the 6 anterior teeth can be connected to the implant hole. The C-implants can take the primary role for tooth anchorage and movement control because the archwire is inserted into the tube in the implant head. Friction between the implant and the archwire is negligible. The retention portion of the C-implant is better able to resist the rotational tendency of heavy dynamic loads and to control 3-dimensional tooth movement than coventional miniscrews because of its higher osseointegration potential. The basic concepts of C-implant en-masse retraction mechanics and conventional fixed orthodontic treatment are similar (Chung KR *et al*., 2005). It performs en-masse retraction when the leveling begins, with little or no change in the posterior occlusal relationship. Elastics are preferred over coil springs or closing loops as the retraction mechanism because they make oral hygiene easier, offer mild and continuous force application, and do not irritate the gingivae. The force magnitude of elastics is 2.5 to 3.5 oz for an individual tooth and 4.5 oz for en-masse retraction. After en-masse retraction, finishing can be performed with fixed appliances or custom aligners (Fig 8B) (Park YC *et al*., 2005).

2.7. Combination mechanics with buccal and palatal implants (Barthélemi S *et al*., 2019)

All patients are treated with a 0.022 × 0.028 slot fixed appliance with self-ligating or conventional brackets, since the literature has demonstrated that there is no difference in sliding mechanics between conventional and self-ligating brackets (Miles PG, 2007). Extractions are performed after leveling when there is no or minor crowding and, for ethical reasons, at the beginning of treatment when crowding is moderate or severe in order to avoid increasing the overjet and for periodontal considerations. All patients undergo either first or second bicuspid extractions. During en masse space closure, 0.019 × 0.025 Stainless Steel archwires with power arms are applied. The length of the power arm is adjusted to obtain horizontal force between the power arm and the TAD. On the palatal side, a power arm is bonded to the palatal side of the cuspid with length adjusted as described above (Figure 9A and 9B).

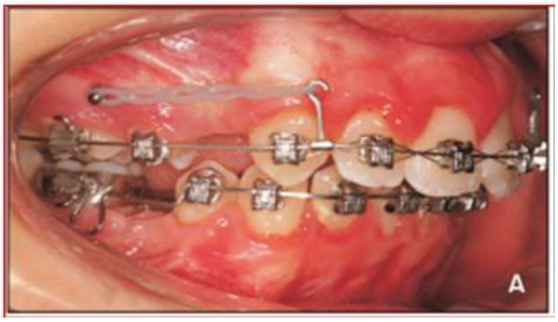

Fig 9A: Intra temporary anchorage device (TAD) insertion on the labial side

Fig 9B: TAD insertion on the palatal side

Immediately after leveling, four TADs are placed: two on the buccal side and two on the palatal side between the second bicuspid and the first molar. On the buccal side, TADs measuring 1.3 to 1.2 mm or 1.4 to 1.3 mm in diameter and 8 mm in length are inserted depending on the inter-radicular spaces, as recommended by Wu *et al*., (Wu TY *et al*., 2009). On the palatal side, thicker and longer TADs (diameter, 1.6–1.7 mm; length, 10 mm) are chosen to compensate for the mucosal thickness. TAD insertion is performed in the attached gingival tissue without predrilling, in accordance with the recommendations made by Dalessandri *et al*., (Dalessandri D *et al*., 2014).

In the TAD group, a loading force of 100 g (3.5 ounce) is applied on the labial and buccal sides immediately after TAD insertion by using power chains, according to the method described by Hsieh *et al*., (Hsieh YD *et al*., 2008). The power chains are replaced every month.

2.8. Biocreative orthodontics using preformed C-wires (assembly of nickel-titanium (NiTi) and SS archwires) (Jee J-H *et al*., 2014)

Two-component C-implants (C implant Co., Seoul, Korea) or C-tubes (Jin Biomed Co., Bucheon, Korea) are used for direct anchorage (Figure 10). The C-tube is a miniplate with an extended arm that includes an adjustable tube to accept a wire.

Fig 10 A: Two-component C-implants

Fig 10B: C-tubes

The TADs are placed at the beginning of the treatment for simultaneous leveling and space closure. The C-implants are placed in the maxillary interseptal bone between the second premolars and the first molars bilaterally. If C-tubes are used, the fixation screws are located more apically, and the heads of C-tubes are placed in the same vertical level as that of C-implants.

Fig 11: Preformed C-wire fabrication. A, Bending of stainless steel (SS) archwire for the retraction hooks and soldering of the crimpable stop tubes. B, Insertion of nickel-titanium archwire into the tubes and contouring of the hooks for passive sliding according to the height of the C-tubes

Preformed C-wires have two components, as shown in Figure 11. One component is the NiTi archwire, designed to engage the maxillary anterior teeth (canine to canine). 0.016 × 0.022-inch superelastic NiTi archwires without built in torque (BioTorque; Forestadent Bernhard Förster GmbH, Pforzheim, Germany), which can be easily ligated to crowded teeth are used. The other component consists of 0.017 × 0.025-inch SS archwires with retraction hooks. Furthermore, 0.022- inch crimpable inside diameter tubes are soldered to the SS archwire and the NiTi archwire is inserted into the tubes. The tubes are positioned on the NiTi archwire between the lateral incisors and the canines bilaterally and crimped firmly in place. The SS archwire is then inserted into the TADs, creating a rigid sliding section with a built in power arm. The archwire did not need to be bent for vertical correction of high canines during retraction. During the initial alignment, 2.5- oz elastics or elastic chains delivering 0.7 N of force are applied to the canines. The canines are retracted while the incisors are aligned. Once all the anterior teeth are aligned with the archwire, closed-coil NiTi springs (1.2 N) or 4.5-oz elastics are used for en-masse retraction.

Fig 12 (A) and (B): Bonded mesh–tube appliance (BMTA) on the mandibular arch. The BMTA is comprised of a 0.022-inch single tube on the mandibular second premolar connected to metal mesh on the mandibular first molar

Bonded mesh-tube appliances (BMTAs), comprising 0.022-inch buccal tubes on the mandibular second premolars and metal mesh on the mandibular first molars, are used bilaterally for anchorage reinforcement and maintenance of normal posterior occlusion in the preformed C-wire group (Figure 12). During leveling, 0.018-inch reverse curve NiTi archwires and Class III elastics attached to the TADs are used to prevent mesial tipping of the mandibular molars. During retraction, bilateral Class I elastics are used between the canines and the hooks of the BMTAs. After space closure, short-term fixed appliances, tooth positioners, or clear aligners are used for finishing.

2.9. Sectional Mechanics for Simultaneous Orthodontic Retraction and Intrusion (Venugopal A *et al*., 2020)

The design consists of three segments of wires. One segment of 0:019″ × 0:025″ SS wire extends from tooth 1.2 to 2.2. Hooks are extended on the wire distal to the lateral incisor brackets to reach close to the center of resistance of the anterior segment. Posterior segments consists of a segment of 0:019″ × 0:025″ SS extending from the first molar to the canines on either side. A closing loop is fabricated on the segment just distal to the canines (Figure 13). Three TADs (1:6 × 8 mm) are inserted, two of them are placed between the upper first and second molars (1.6-1.7, 2.6–2.7) and the third between the two upper central incisors (1.1–2.1) (Figure 13).

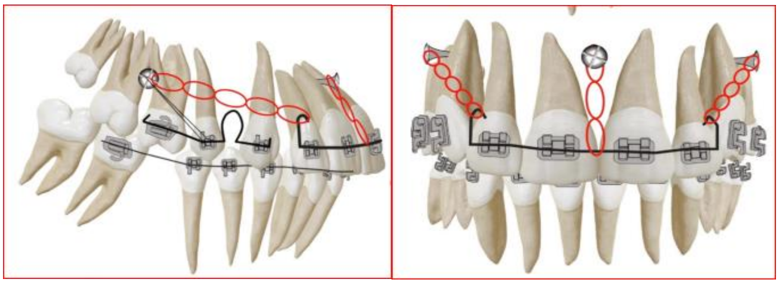

Fig 13: Biomechanical setup for canine retraction and simultaneous anterior retraction and intrusion

Elastic traction using a power chain from the posterior TADs is directed to the hooks just distal to the lateral incisor brackets. The force is measured to be 150 grams per side using a Dontrix force gauge. Elastic traction using an elastic thread is applied from the anterior miniscrew to the sectional archwire between the two incisors in order to prevent the uncontrolled tipping, which would be a direct result of the posterior traction. At the same time, this would help intrude the anterior segment eventually correcting the deep bite. The force for intrusion is measured to be 60 grams. The posterior segment is activated by cinching the wire posteriorly distal to the first molar and anteriorly mesial to the canines, thereby activating the closing loop, eventually retracting the canines. A passive ligature is tied from the posterior TADs to the second premolar brackets for indirect anchorage in order to prevent molar mesialization during canine retraction. In six months, the anterior segment and the canines are retracted, and the deep bite is also corrected. The lower arch is stabilized passively with a 0:019″ × 0:025″ SS wire from the third month itself as the arch had leveled and the minor spaces had closed early in the treatment

Following space closure, the arch is releveled using a 0:017″ × 0:025″ NiTi archwire for two months.

The wire is tightly engaged in the bracket slots, and a power chain is placed from the upper first molar to the first molar on the other side to prevent space opening. This helps in paralleling the roots without opening up spaces.

Finishing is done on a 0:019″ × 0:025″ SS with light settling elastics following which the brackets are debonded. The anterior TAD is not removed and still kept in place to aid in the retention. Essix retainers are planned on the upper and lower arches with the addition of a lingual button embedded in the upper Essix between the two central incisors. The patient is informed to wear the retainers for 24 hours for the next 2 years. In addition, patient is instructed to attach a light intermaxillary elastic (3/16″, 2 Oz) from the anterior TAD to the button on the Essix at night for the next two years to retain the intrusion of the anterior segment.

3. CONCLUSION

The invent of TADS has revolutionized the field of orthodontics in the recent years by making possible the most difficult of tooth movements accomplished easily. This has opened up doors for new innovations in the use of TADS for achieving correction of most difficult of malocclusions hitherto thought to be herculean in nature. Some of these methods used by different authors have been described in this article for their optimum use in the future endevours.

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