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Review Article

Indication and uses of temporary anchorage device in orthodontic

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ABSTRACT

Treating various types of malocclusion is dependant on providing a secure anchorage. In this context, it has been shown that teeth, intramaxillary, and/or extraoral appliances are required to achieve favorable outcomes regarding anchorage treatment. A Temporary anchorage device (TAD) has been introduced in the literature in this context. It has been described as a temporary device that can be used after completing treatment. The aim of the study was to review the indications and uses of TADs in orthodontic treatment. The current evidence shows that introducing TADs in the field of orthodontic treatment has been associated with favorable outcomes that encountered the previous multiple challenges reported with the conventional anchorage approaches. Contemporary orthodontic settings reported various uses for TADs, including corrections in transverse, vertical, and anteroposterior dimensions. Combined use of TADs and conventional approaches were also evaluated with favorable outcomes. These findings indicate the validity of TADs in orthodontic treatment and call for its future implications and clinical applications. However, it should be noted that post-treatment evaluation on a long-term basis was not adequately reported in the current literature, indicating the need for future investigations for further validation.

Keywords: Temporary anchorage devices, Dentistry, Orthodontics, Treatment, Corrections

INTRODUCTION

Treating various malocclusions is dependant on providing a secure anchorage.[1] In this context, it has been shown that teeth, intramaxillary, and/or extraoral appliances are required to achieve favorable outcomes regarding anchorage treatment.[2] However, it has been shown that these modalities might not achieve adequate anchorage control. This will cumulatively lead to unfinished inter and intra-arch alignment and loss of anchorage-related reactive units. Consequently, evidence shows that different clinicians integrated extraoral or bulky acryl appliances. Although these approaches were initially made to overcome the previous limitations, it has been shown that patient compliance was a major issue that significantly led to anchorage loss.[3]

Anchorage loss has been defined as any unfavorable movement of the anchor teeth.[1] On the other hand, no movement of anchorage teeth has been known as absolute anchorage. Dental implants and ankylosed teeth can achieve this.[4] A Temporary anchorage device (TAD) has been introduced in the literature in this context. It has been described as a temporary device that can be used after treatment.[3] The aim of the study was to discuss the indications and uses of TADs in orthodontic treatment based on evidence from previous studies in the literature.

METHODS

This literature review is based on an extensive literature search in Medline, Cochrane, and EMBASE databases which was performed on 15th November 2021 using the Medical subject headings (MeSH) or a combination of all possible related terms, according to the database. To avoid missing potential studies, a further manual search for papers was done through Google Scholar while the reference lists of the initially included papers. Papers discussing immunological and physiological responses related to orthodontic treatment were screened for useful information. No limitations were posed on date, language, age of participants, or publication type.

DISCUSSION

Various uses and indications were reported in the literature for TADs in orthodontic treatment settings. Based on a comprehensive literature review, these indications and uses will be thoroughly discussed in the present section of this article. The first set would use these modalities in midpalatal suture split and palatal expansion. Although evidence shows that rapid maxillary expanders are commonly used for managing constricted maxillary arches in adolescents, many adverse outcomes and complications were reported with their prolonged application regarding undesirable teeth movement. These include ineffective midpalatal split, post-expansion relapse, increased risk of root resorption, reduced skeletal expansion, and buccal torque of the anchoring teeth.[5,6]

Accordingly, evidence shows that TADs are suitable techniques for rapid maxillary expanders that were reported with good efficacies and reduced adverse outcomes. In this context, previous comparative investigations reported that the efficacy of bone-anchored expanders using TADs was comparable with the efficacy of using tooth-borne expanders.[7] However, it should be noted that another evidence shows that using TADs for adult patients with constricted maxillary arches was associated with favorable outcomes. It is worth noting that these defects are usually hard-to-manage using the traditional maxillar tooth expanders.[7-9]

Stress distribution and displacement were also previously investigated in another research for three different expanders, including conventional tooth-borne expander, palatal-slope bone-borne expander, and paramedian bone-borne expander.[10] It has been concluded that these outcomes were significantly variable among the three different expanders investigated in this study. Therefore, clinicians should be aware of these potential differences and variable efficacies to determine the best modality for the intended orthodontic treatment [11,12]. Using TADs was also previously indicated in the management of tooth impaction. This has been further highlighted among settings reported to be challenging to treat using traditional orthodontic appliances. As a result of the limited anchorage support and difficult access, evidence shows that orthodontic treatment of horizontally impacted mandibular molars is challenging.[13] The introduction of TADs facilitated conducting these operations. Palatally impacted canines, and maxillary canine impaction are also challenging in orthodontic settings.[14] Successful treatment was reported with TADs in these settings following the appropriate determination of the direction of forced eruption using cone-beam computed tomography.

Evidence shows that TADs are widely used in anchorage control with a limited need for compliance that overcomes the various limitations usually reported with the conventional types of anchorage control devices. In addition, it has been demonstrated that TADs are conducting corrections of issues and disorders in the anteroposterior diameter.[15,16] Distalization and mesialization are the typical approaches usually done in this regard, whether for mandibular/maxillary total arches, multiple teeth, or a single tooth. Many previous studies have compared the efficacy of using TADs and other conventional modalities for managing anchorage reinforcement in this dimension. Some reported conventional modalities include reverse-pull headgear, Nance appliances, headgear, and different distalizers.[17-20] In this context, a previous systematic review and meta-analysis compared the efficacy of treatment of en-masse retraction following premolar extraction after applying either headgear or TADs.[19]

The meta-analysis was based on 616 relevant patients retrieved from 16 included articles. It has been shown that anchorage preservation was more significant in the TADs group than with other conventional, headgear-based groups by 1.86 mm. This has been achieved by reducing mesial movements of maxillary first molars. In the same context, a previous randomized controlled trial compared the efficacy of TADs and other conventional modalities, including headgear and Nance appliances.[17] It should be noted that the authors indicated that there was no statistical significance regarding maximum anchorage between the three included techniques.[21]

However, it should be noted that comfort levels were significantly higher among patients within the TADs and Nance appliances group than other patients within the headgear group. Self-reported treatment-related problems were also significantly fewer among patients in the TADs group than other patients within the other two groups. Another retrospective investigation also compared the

efficacy of headgears and TADs in managing adult patients presenting with maxillar dentoalveolar protrusion problems in terms of orthodontic tooth movement. The authors concluded that the treatment outcomes were significantly superior among patients in the TADs group than other patients.[20]

This was valid for different outcomes, including reduced treatment duration, less maxillary molar mesial drift, and significantly enhanced maxillary anterior teeth retraction. Another meta-analysis was conducted to compare the effectiveness of applying distalizers between conventional ones (including Nance buttons and pendulum appliances) and TAD-based pendulum appliances. The authors drew their conclusions based on the findings of previous six studies, which indicated that average molar distraction was significantly longer in the TADs group than the conventional one (5.1 versus 3.3 mm).[18] It has been furtherly reported that skeletal anchorage was associated with an average premolar distalization of 4.0 mm, significantly superior to the average value reported for conventional modalities (2.3 mm).

In addition to evaluating and comparing the effectiveness of TADs with other conventional approaches, previous investigations in the literature also evaluated the combined use of conventional modalities and TADs in terms of orthodontic treatment outcomes. Evidence shows that using these combinations enhances the outcomes of conventional orthodontic appliances. For instance, it has been shown that similar amounts of maxillary premolar distalization were reported for maxillary bone-anchored pendulum appliances using TADs and conventional pendulum appliances without TADs. This has subsequently been associated with favorable premolar distalization with fewer problems regarding anchorage loss and reduced treatment duration.[22] A previous study also demonstrated that TADs could also be applied with sliding jigs to manage Class III malocclusion with dental midline discrepancy.[23] Among the included studies in the literature, it has been furtherly reported that decreased adverse outcomes (including non-favorable mandibular incisor proclination) were more significantly associated with TAD-supported Herbst appliances.[24]

The undesirable arch loss that usually results from unwanted tooth movement during orthodontic treatment was also reported by placing a mini plate and linking the infra zygomatic buttress with the outer bow.[25] This has been reported secondary to allowing protraction of the underlying maxilla. Retraction of the anterior maxillary segments can also close extraction spaces by applying palatal TADs and a double J-hook retractor.[26] This approach has been associated with desirable aesthetic outcomes for the corresponding patients. In addition, decreased treatment duration with fixed appliances has significantly been associated with using a double J-hook. Consequently, it has been concluded that these treatment approaches can be used for patients that do not favor the application of other conventional approaches.

Combining mini plates and TADs was also reported in different clinical settings in the orthodontic field. The literature has suggested using these approaches because they are not usually associated with interradicular space limitations and adjacent teeth proximity. Besides, it has been further demonstrated that these approaches can significantly bear heavier forces more than using TADs alone. Accordingly, their application has been recommended in different orthodontic treatment settings, including total arch distalization. Furthermore, obtaining better facial aesthetics, with a minimal need to perform orthognathic surgeries, was also associated with tooth extraction combined with a palatal anchorage plate to achieve total arch distalization. Moreover, it has been evidenced that the approach can effectively manage class I malocclusion with severe profiles of protrusive soft tissue, which is the best non-surgical modality.[27] This is done by applying distal arch distalization and extraction of four first premolars. Moreover, it has been demonstrated that these approaches are also well-applied in managing cases with class II malocclusion following serious modifications to the technique.[28,29] It should be noted that it is usually applied for cases without severe bimaxillary protrusion and maxillary first premolar extractions.

During distalization of posterior maxillary teeth, it has also been reported that controlling distal taping was also associated with favorable outcomes after using palatal mini plates. A previous comparative study compared conventional TADs and palatal anchorage plates in this context. It has been reported that the latter was associated with greater intrusion, distalization, and reduced distal tipping of the first molar.[30] The correlation between palatal anchorage plates, amount of maxillary arch distalization, and airway spaces were also previously investigated in a follow-up study. Following maxillary arch distalization, it has been reported that the minimum cross-sectional area of the oropharynx and airway volume were not significantly impacted by treating the included cases with premolar extraction.[31] Reports also indicate that placing mini plates on mandibular arches effectively managed class III malocclusions.[32] It has been further shown that mandibular total arch distalization and mandibular teeth retraction were also significantly achieved by placing remal plates on the retromolar fossa.[33-35] This novel approach has been validated among different studies in the literature with favorable outcomes. Therefore, it should be furtherly evaluated for potential application in clinical settings.

One of the most reported challenging issues in orthodontic settings includes treating cases with skeletal open bites or moderate-to-severe open bites. However, evidence shows that TADs can be effectively applied in correcting anterior open bites. This can be done by either extrusion of the anterior teeth or intrusion of the posterior teeth. It has been furtherly reported that placing TADs can be effectively done in different anatomical sites in this regard.[36-38] Furthermore, a transpalatal arch can also be combined with TADs to correct anterior open bites to prevent the posterior maxillary teeth and efficiently exercise the tongue.[38]

Finally, mini plates and TADs can also be effectively applied to manage cases with anterior open bites.[37] This can be done by bilaterally placing mini plates between the zygomatic arch and molar mandibular region, effectively providing complete anchorage. A counterclockwise rotation can also be introduced with approach and its ability to produce a positive overbite in treating cases with endoskeletal open bites. Correcting open bites by TADs in lingual orthodontics was also achieved by the intrusion of posterior dentition and retraction of anterior dentition.[36]

Thus, this approach has favorable outcomes and many advantages worth reviewing for clinical application. Archwire-based approaches have conventionally been used for managing cases with deep skeletal bites. However, it has been reported that these approaches are usually associated with labial torquing the maxillary incisors. Introducing TADs to this field was also associated with simple treatment and enhanced outcomes. For instance, it has been reported to effectively manage cases with a gummy smile to produce overbite and decrease underlying extensive gingival display.[39,40] Previous comparative investigations also demonstrated that adding TADs to the conventional approaches is usually associated with reduced adverse events by minimizing the risk of tooth movement.[41,42]

CONCLUSION

The current evidence shows that introducing TADs in the field of orthodontic treatment has been associated with favorable outcomes that encountered the previous multiple challenges reported with the conventional anchorage approaches. Contemporary orthodontic settings reported various uses for TADs, including corrections in transverse, vertical, and anteroposterior dimensions. Combined use of TADs and conventional approaches were also evaluated with favorable outcomes. These findings indicate the validity of TADs in orthodontic treatment and call for its future implications and clinical applications. However, it should be noted that post-treatment evaluation on a long-term basis was not adequately reported in the current literature, indicating the need for future investigations for further validation.

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