Temporary Anchorage Devices in the Management of Malocclusion in Pediatric Patients: Scoping Review

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ABSTRACT

Introduction: Malocclusion is a prevalent developmental disorder in children that negatively impacts dental function, aesthetics, and craniofacial growth. Temporary Anchorage Devices (TADs) have been introduced as an alternative to conventional anchorage methods in pediatric orthodontics, aiming to overcome challenges such as inadequate anchorage and poor patient compliance. **Methods:** This scoping review was conducted to systematically investigate the clinical application, effectiveness, and outcomes of TADs in managing malocclusion among pediatric patients. Literature searches were performed in PubMed, Scopus, and EBSCOhost for studies published from 2014 to 2024 in accordance with PRISMA-ScR guidelines. Inclusion criteria were human studies focusing on pediatric patients treated with TADs; studies on animals, non-English languages, or published before 2014 were excluded. Study selection followed the Population, Concept, and Context (PCC) framework, and quality assessment was conducted using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist. **Results and Discussion**: A total of 7 studies met the criteria, including cohort studies, case series, case reports, and one randomized controlled trial. Most studies demonstrated that TADs provide absolute anchorage, increase flexibility in tooth movement, and reduce dependence on patient cooperation in complex cases. **Conclusion:** In conclusion, TADs represent a significant advancement in pediatric orthodontic care, enabling more predictable and effective management of malocclusion.

Keywords
Temporary Anchorage Devices, Pediatric Orthodontics, Malocclusion, Miniscrew

INTRODUCTION

Malocclusion is one of the most common developmental oral conditions in children, significantly impacting not only aesthetics but also speech, mastication, and craniofacial growth.[1] According to the World Health Organization, malocclusion is the third most prevalent oral health condition after dental caries and periodontal disease, affecting over 50% of the global population. Orthodontic management in children seeks to address such issues early to avoid complications in adulthood.[2]

Orthodontic treatment involves several important stages and procedures that require careful consideration. One of the key determinants of successful orthodontic treatment is adequate anchorage. Dental, intramaxillary, and/or extraoral appliances are among the anchorage options needed to achieve optimal treatment outcomes. Although these approaches were originally developed to overcome previous limitations, several studies have reported that patient compliance remains a major issue that significantly compromises the effectiveness of anchorage.[3]

TADs offer a clinical solution for orthodontic treatments that were previously considered unachievable using traditional anchorage methods.[4] Anchorage control represents a major challenge in pediatric orthodontics. Conventional methods relying on intraoral or extraoral devices often demand high patient compliance, which can be difficult to maintain in younger populations. The emergence of Temporary Anchorage Devices (TADs) has introduced a revolutionary alternative, offering absolute anchorage without depending on adjacent teeth or patient cooperation.[4]

Temporary Anchorage Devices (TADs) are orthodontic auxiliaries that are temporarily inserted into the bone to provide skeletal anchorage and subsequently removed once the treatment is completed. They are also referred to as *mini-screws* or *mini-implants* due to their smaller dimensions compared to prosthodontic dental implants. Orthodontic mini-implants typically range from 1.5 to 2.0 mm in diameter and 6 to 10 mm in length. Their surfaces are designed to be smoother than those of prosthodontic implants, as osseointegration is not required; instead, stability is achieved through mechanical retention.[5]

The components of TADs include the head, neck, and body, each designed to minimize soft tissue irritation and enhance stability. There are two main types: self-drilling and self-tapping screws. Their selection depends on bone density and anatomical considerations. Despite their advantages, potential risks such as inflammation, screw loosening, and failure due to poor bone quality or hygiene need to be mitigated through careful case selection and clinical protocol.[5]

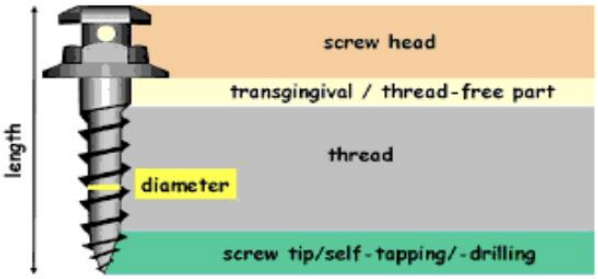

Figure 1. Design TAD [5]

Indications for the Use of Temporary Anchorage Devices (TADs)

1. Cases requiring absolute anchorage.
2. Patients with insufficient teeth to provide anchorage, such as those with partial edentulism or agenesis.
3. One or more teeth requiring intrusion or extrusion without opposing teeth.
4. Asymmetric tooth movement.
5. Anterior tooth intrusion in the absence of adequate anchorage.
6. Cases requiring mesial movement of molars while the anterior teeth should remain unaffected.
7. Space closure.
8. Molar distalization.
9. Open bite correction.

Contraindications for the placement of TADs include:

1. Patients with metabolic bone diseases.
2. Patients undergoing immunotherapy.
3. Patients receiving chronic steroid or bisphosphonate therapy.
4. Patients with severe neurological or psychological disorders.
5. Patients with inadequate bone quality or quantity to ensure screw stability.
6. Patients with active infections.
7. Patients with a history of allergy to any material contained in the implant.
8. Patients who have undergone radiotherapy in the head and neck region.
9. Patients with insulin-dependent diabetes who are at high risk of infection.
10. Patients with poor oral hygiene.
11. Patients with incomplete skeletal growth.[6]

The clinical procedure for TAD placement must take into account the conditions before, during, and after insertion. A clinician should perform a thorough examination and ensure proper infection control. Patients must be extensively informed about the factors that may

support or interfere with the surgical procedure, as well as the diagnosis and treatment prognosis.[7]

METHODS

2.1 Protocol

This scoping review adhered to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines to ensure a systematic approach.

2.2 Search Strategy

A scoping review protocol was developed using the PCC (Population, Concept, Context) framework:

- **Population:** Pediatric patients
- **Concept:** Temporary Anchorage Devices (TADs)
- **Context:** Management of malocclusion

Inclusion criteria: Studies from 2014 to 2024, English language, human subjects, and focus on TADs in pediatric orthodontics. **Exclusion criteria:** Animal studies, studies in non-English languages, and publications before 2014.

Databases searched: PubMed, Scopus, EBSCOhost **Keywords used:** “Temporary Anchorage Device”, “Pediatric Orthodontic , Malocclusion”, Miniscrew“ .

2.3 Study selection and data extraction: Two independent reviewers screened titles, abstracts, and full texts. Data extraction focused on study design, objective, sample, intervention, and outcomes.(Table 1)

2.4 Quality Assesment

The data quality was evaluated by applying to the Joanna Briggs Institute (JBI) Critical Appraisal Checklist. The JBI methodology for scoping review guideline is highly regarded for its clear scope definition, rigorous and transparent processes, and ability to incorporate diverse evidence types. Structured data extraction and synthesis processes, outlined in the JBI guideline, facilitate the derivation of impactful conclusions relevant to practice and policy.

The JBI’s Critical Appraisal Tool Checklist was assess study quality. Of the 7 studies evaluated, there were 2 cohort study, 2 case series study, 2 case report, and 1 RCT which were assesed: 7 studies were inclusion study. This assesment help determine the reliability of the research findings across different study designs.**(Table 1)**

Table 1 . Quality Score of Included Study by Joanna Briggs Institute (JBI) Critical Appraisal

No.	Study	Checklist													
		1	2	3	4	5	6	7	8	9	10	11	12	13	Assessment
	Case Report														
1	Liu et al., 2018	Yes	Yes	Yes	Yes	Yes	Yes	Part*	Yes						Inclusion study
2	Yáñez-Vico et al., 2014	Yes	Yes	Yes	Yes	Yes	Yes	Part*	Yes						Inclusion study
	Case Series														
3.	Chen et al., 2023	Yes	Yes	Yes	Un*	Yes	Part*	Yes	Yes	Part	Yes				Inclusion study
4.	Al-Moraissi et al., 2017	Yes	Yes	Yes	Un*	Yes	Yes	Yes	Yes	Yes	Yes				Inclusion study
	RCT														
5.	Eissa et al., 2018	Uc	Uc	Yes	Yes	Yes	Uc	No	Yes	Yes	Yes	Yes	Yes	Yes	Inclusion study
	Cohort Studies														
6.	Scheffler et al., 2014	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Part*	Yes	Yes			Inclusion study
7.	El-Dawlatly et al., 2014	Yes	Yes	Yes	Part*	No	Yes	Yes	Yes	Yes	Yes	Yes			Inclusion study

RESULTS

Figure.2 depicts the PRISMA-ScR flowchart, providing an overview of the result obtained from the literature search. Seven studies were included, case reports, RCT, and cohort studies. Most studies demonstrated the effectiveness of TADs in achieving desired tooth movement, profile enhancement, and occlusal improvements.

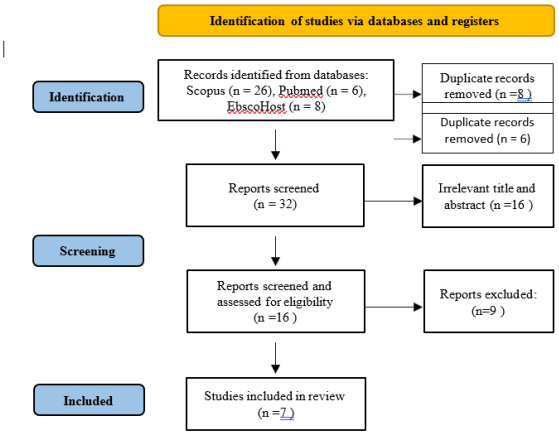

Figure 2. PRISMA-Scr Flowchart

1. **Liu et al. (2018)** used customized lingual appliances with TADs to achieve anterior tooth retraction and upper lip retraction, enhancing facial aesthetics.
2. **Eissa et al. (2018)** demonstrated that miniscrew-anchored FRD improved forward maxillary growth in Class III patients, although mesial drift of dentition persisted.
3. **Chen et al. (2023)** treated skeletal open bite with severe MIH using orthopedic appliances and TADs, achieving long-term stability.
4. **Yáñez-Vico et al. (2014)** corrected anterior open bite and occlusal cant using miniscrews, resulting in facial harmony.
5. **El-Dawlatly et al. (2014)** employed zygomatic mini-implants to treat Class II malocclusion with favorable skeletal and dental changes.
6. **Scheffler et al. (2014)** reported molar intrusion and anterior face height reduction using TADs with splints.
7. **Al-Mozany et al. (2017)** applied Alt-RAMEC with TAD-supported elastics for successful Class III correction.

Collectively, these studies demonstrate that the use of Temporary Anchorage Devices (TADs) or miniscrews can broaden the scope and effectiveness of orthodontic treatment across various types of malocclusion in both children and adults. TADs provide absolute anchorage control, resulting in better aesthetic, functional, and long-term stability outcomes, while reducing dependence on patient compliance and minimizing complications associated with conventional appliances.

The studies highlight the utility of TADs in achieving anchorage for various orthodontic goals in children. However, consistent themes across studies include the importance of patient selection, insertion technique, and monitoring oral hygiene. Mild complications such as inflammation or screw loosening were occasionally reported.

DISCUSSION

4.1 Indications for Use

The findings from this scoping review highlight that Temporary Anchorage Devices (TADs) provide a substantial benefit in the management of malocclusion in pediatric patients. Across all included studies, TADs were able to offer absolute anchorage, allowing for controlled and predictable tooth movement, especially in complex cases such as anterior open bite, asymmetric movement, and situations where conventional anchorage would be suboptimal or require high patient compliance.[8-14]

The use of TADs also allows for shorter treatment times and potentially increased stability of orthodontic results, contributing to overall patient satisfaction. However, as reported in multiple

studies, the success of TADs depends on appropriate case selection, careful insertion technique, and diligent monitoring of oral hygiene. Complications such as screw loosening and local inflammation were identified, but most could be managed effectively with standard clinical protocols.

TADs are primarily indicated for cases demanding absolute anchorage, insufficient dentition as support, asymmetric movement, molar distalization, space closure, open bite correction, and intrusion/extrusionteeth. [8-14]

4.2 Clinical Outcomes and Safety

All studies reported significant improvement in dental or facial outcomes and reduction in relapse risk, specifically in those unfit for conventional anchorage options. [8-14]
Complications such as screw loosening or local inflammation occurred but were manageable with clinical protocols.[8,12, 13]

4.3 Comparison with Conventional Appliances

Compared to traditional anchorage methods, TADs expand the possibilities of treatment by minimizing dependence on patient cooperation. For example, Eissaa et al. demonstrated that the use of miniscrew-anchored appliances supported forward maxillary growth in Class III malocclusion, while Liu et al. showed effective anterior tooth retraction with positive facial aesthetic outcomes [8,9].
Several studies have also strengthened the role of TADs in achieving movements that were previously only possible with extraoral appliances or surgical approaches, such as molar intrusion and maxillary realignment[12,13,14].
"TADs represent an effective non-surgical alternative for children and adolescents with complex malocclusions (skeletal open bite, posterior crossbite, incisor protrusion, asymmetric gummy smile), which were previously managed only through a combination of orthognathic surgery or extraoral appliances requiring a high level of patient compliance."[8-14]
Compared to traditional anchorage, TADs minimize need for cooperation and extend possibilities in complex pediatric cases. [8-14]

Table 1 Summary

Author, Year	Country	Study Type	Study Objective	Result	Conclusion
Liu et al., 2018[8]	China	Clinical study	To analyze skeletal, dental, and soft tissue changes in patients treated with customized lingual systems and miniscrew anchorage	Significant retraction of upper anterior teeth, slight mesial movement of upper first molars, and continuous retraction of upper lip were observed	Customized lingual appliances with miniscrew anchorage can effectively improve dental and soft tissue changes and reinforce molar anchorage
Eissa et al., 2018[9]	Egypt	Controlled clinical trial	To evaluate skeletal, dental, and soft tissue changes after using miniscrew-anchored inverted Forsus fatigue-resistant device (FRD) in Class III malocclusion treatment	Significant increase in maxillary forward growth, retroclination of lower incisors, and improvement in soft tissue profile were observed	Miniscrew-anchored inverted FRD can effectively increase maxillary forward growth and improve facial profile, but does not prevent mesial movement of maxillary dentition

Chen et al., 2023[10]	China	Case report	To describe combined orthopedic-orthodontic treatment of adolescent skeletal open-bite with severe molar-incisor hypomineralization (MIH)	Successful correction of open bite, improved facial aesthetics, and stable Class I occlusion were achieved and maintained after 2-year follow-up	Combined orthopedic- orthodontic treatment with modified spring-loaded bite blocks and fixed appliances after first permanent molar extraction can effectively treat skeletal open-bite with severe MIH
Yáñez-Vico et al., 2014[11]	Spain	Case report	To describe treatment of a patient using miniscrews to correct anterior open bite and canted occlusal plane with asymmetric gummy smile	Optimal occlusion with improvements to sagittal, vertical, and transverse relationships and harmonious smile were achieved	Miniscrews provided effective bone anchorage for satisfactory correction of open bite and canted occlusal plane with asymmetric gummy smile in a Class II malocclusion patient

El-Dawlatly et al., 2014[12]	Egypt	Prospective clinical trial	To evaluate skeletal and dental effects of zygomatic mini-implants for Class II correction in growing patients	Significant retrusion of point A, anti- clockwise rotation of maxillary plane, molar distalization of 2.92 ± 0.69 mm with no extrusion or tipping	Zygomatic mini- implant technique allowed Class II correction with reduction in visible gingiva without adverse effects seen with other appliances
Scheffler et al., 2014[13]	USA	Retrospective study	To evaluate outcomes and stability of maxillary molar intrusion using TADs and a maxillary intrusion splint in anterior open bite patients	Mean molar intrusion of 2.3 mm, decrease in anterior face height of 1.6 mm, positive overbite maintained in all patients	Intrusion of maxillary posterior teeth can give satisfactory correction of moderately severe anterior open bites, but 0.5-1.5 mm of reeruption likely to occur
Al-Mozany et al., 2017[14]	Australia	Case series	To evaluate effects of Alt-RAMEC protocol with TAD-supported Class III elastics for maxillary protraction	Significant maxillary protraction (SNA 1.87° ± 1.06°), improvement in jaw relationship (ANB 3.95° ± 0.57°), increase in overjet (5.62 ± 1.36 mm)	Alt-RAMEC with TAD-supported Class III elastics is an efficient treatment method for mild/moderate Class III malocclusions

However, success depends on careful anatomical review, infection control, and hygiene management.[1]

Conclusion

TADs serve as a valuable adjunct in pediatric orthodontic treatment, offering absolute anchorage, reduced treatment time, and enhanced control over tooth movement. Their use is particularly beneficial in complex cases involving skeletal discrepancies. While the overall success rate is high, clinical judgment, hygiene management, and anatomical considerations are crucial for optimal outcomes.
TADs not only improve clinical outcomes but also reduce dependency on patient compliance, making them a promising adjunct in pediatric orthodontics."

In conclusion, TADs represent a significant advancement in pediatric orthodontic care, enabling more predictable and effective management of malocclusion.

Further longitudinal and controlled studies are needed to establish standardized protocols and long-term effects of TAD use in growing patients.

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Conflict of interest
The authors declare no conflict of interest related to this article
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References

1. Proffit WR, Fields HW, Larson BE, Sarver DM. Contemporary Orthodontics. 6th ed. St. Louis: Elsevier; 2018.
2. Chen H, Lin L, Chen J, Huang F. Prevalence of malocclusion traits in primary dentition, 2010–2024: a systematic review. Healthcare (Basel). 2024;12(13):1321. doi:10.3390/healthcare12131321.
3. Bawyan RF, Al Anzi SK, Alkhadra NB, et al. Indication and uses of temporary anchorage device in orthodontic. Int J Community Med Public Health. 2022;9(1):123–8.
4. Park JH, Shin K. Temporary Anchorage Devices in Clinical Orthodontics. Oxford: Wiley Blackwell; 2020.

5. Baxi S, Bhatia V, Tripathi A, Prasad Dubey M, Kumar P, Mapare S. Temporary Anchorage Devices. Cureus. 2023 Sep 1;15(9):e44152.
6. Jandial M, Mahajan S, Singh G. Temporary anchorage devices in orthodontics. Int J Health Sci (Qassim). 2021 Dec 31;5(2):333–43.
7. Sharma R, Soni DM. Temporary Anchorage Devices in Orthodontics: A Review. Asian J Res Med Med Sci. 2023;5(1):10–7.
8. Liu D, Li J, Lei F, Wang X, Zhou Y. Dentoskeletal and soft tissue changes associated with miniscrew anchorage in customized lingual orthodontics. J Int Med Res. 2019;47(1):84–95.
9. Eissaa O, ElShennawy M, Gaballah S, ElMehy G, El-Bialy T. Treatment of Class III malocclusion using miniscrew-anchored inverted Forsus FRD: controlled clinical trial. Angle Orthod. 2018;88(6):734–42.
10. Chen J, Xu Y, Guo W. Combined orthopedic-orthodontic treatments of adolescent skeletal open-bite with severe molar-incisor hypomineralization: a case report and literature review. J Clin Pediatr Dent. 2023;47(1):91–9.
11. Yáñez-Vico RM, Iglesias-Linares A, Cadenas de Llano-Pérula M, Solano-Reina A, Solano-Reina E. Management of occlusal canting with miniscrews: case report. Angle Orthod. 2014;84(4):737–47.
12. El-Dawlatly MM, Abou-EL-Ezz AM, El-Sharaby FA, Mostafa YA. Zygomatic mini-implant for Class II correction in growing patients. J Orofac Orthop. 2014;75:213–25.
13. Scheffler NR, Proffit WR, Phillips C. Outcomes and stability in patients with anterior open bite and long anterior face height treated with temporary anchorage devices and a maxillary intrusion splint. Am J Orthod Dentofacial Orthop. 2014;146(5):594–602. doi:10.1016/j.ajodo.2014.07.020.
14. Al-Mozany SA, Dalci O, Almuzian M, Gonzalez C, Tarraf NE, Darendeliler MA. A novel method for treatment of Class III malocclusion in growing patients. Prog Orthod. 2017;18:40. doi:10.1186/s40510-017-0192-y.