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Review

The Use of Orthodontic Mini-Implants and Temporary Anchorage Devices (TADs) for the Management of Complex Orthodontic Cases

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Abstract

Orthodontic treatment often involves correcting improperly positioned teeth and jaws, as well as malocclusion or misaligned bite patterns. Anchorage is a critical component of all types of orthodontic tooth movement, and temporary anchorage devices (TADs) and orthodontic mini-implants (OMIs) have become popular adjuncts to conventional orthodontic treatment. TADs and OMIs provide stable anchorage, reduce the need for patient compliance, and can decrease treatment time. These devices can be used in various orthodontic cases, such as Class II and III malocclusions, deep bites, open bites, and impacted teeth. However, proper case selection, placement, and maintenance are crucial for achieving successful treatment outcomes with TADs and OMIs. The result of these devices is influenced by factors such as the insertion site, insertion angle, and amount of bone contact. The factors contributing to TAD and OMI failure are multifactorial and include conditions related to the device, the patient, and the clinician. The review provides a comprehensive analysis of the benefits and drawbacks of TADs and OMIs, their clinical applications, and the factors influencing their success.

Keywords: anchorage, orthodontics, mini-implants, temporary anchorage devices

Introduction

Orthodontics is a specialized field of dentistry that focuses on the correction of improperly positioned teeth and jaws, as well as malocclusion or misaligned bite patterns. The principle of equal and opposite reactive forces applies to all types of orthodontic tooth movement, whether fixed or removable appliances are utilized. The reactive force generated during tooth movement can lead to unfavorable outcomes. To minimize these negative effects, clinicians utilize various approaches collectively referred to as anchorage (reinforcement) (1). One of the main challenges in orthodontic treatment is achieving adequate anchorage, particularly in cases where significant tooth movement is required or where there is a shortage of available teeth for the procedure. In such cases, temporary anchorage devices (TADs) and orthodontic mini-implants (OMIs) have become popular adjuncts to conventional orthodontic treatment (2, 3).

TADs and OMIs offer several advantages over traditional anchorage methods such as headgear and intermaxillary elastics (4). They provide stable fixation, reduce the need for patient compliance and treatment time. TADs and OMIs can be used in various orthodontic cases, such as Class II and III malocclusions, deep bites, open bites, and impacted teeth. They can also be used in conjunction with clear aligner therapy to enhance treatment outcomes (5). Proper case selection, placement, and maintenance of TADs and OMIs are crucial for achieving successful treatment outcomes. The success of TADs and OMIs is influenced by the following factors: the insertion site, the insertion angle, and the amount of bone contact. Proper placement and maintenance are crucial for achieving good treatment outcomes (2, 6).

The factors contributing to TADs and OMI failure are multifactorial and include conditions related to the device, the patient, and the clinician. Device-related factors include improper placement, inadequate bone contact, and implant fractures. From the patient's side, poor oral hygiene, parafunctional habits, and systemic diseases that affect bone metabolism may lead to unfavorable outcomes. Clinician-related factors involve inadequate training, poor technique, and a lack of experience with TAD and OMI placement. It is important for clinicians to be aware of these factors and take steps to minimize the risk of failure, including careful patient selection, proper placement and maintenance, and regular monitoring of the devices during treatment (7).

Like TADs, OMIs are typically inserted into the cortical bone, which is the dense outer layer of bone that surrounds the alveolar bone. This provides a stable anchorage point for orthodontic forces to be applied to the teeth, helping to correct malocclusions or other dental issues. However, in some cases, mini-implants and TADs can also be inserted into the alveolar bone, depending on the specific needs of the patient and the treatment plan determined by the orthodontist (8). OMIs are usually easier to apply than TADs as they do not require as much force during insertion. They may cause more discomfort to the patient during the procedure and may have a higher risk of failure (2).

In recent years, TADs and OMIs have become increasingly popular in orthodontic treatment. However, proper case selection, placement, and maintenance are crucial for achieving successful outcomes with these devices. Orthodontists must be well-versed in the use of TADs and OMIs to provide their patients with the best possible treatment options.

The purpose of this review article is to provide an in-depth analysis of the current knowledge and practices regarding TADs and OMIs in the management of complex orthodontic cases. This article will discuss the advantages and disadvantages of TADs and OMIs, clinical applications, and factors affecting their success. A thorough understanding of these factors is essential for orthodontists to provide their patients with the best possible treatment options.

Methodology

The aim of the study was to extract valuable information from papers discussing the use of mini-

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implants and temporary anchorage devices in orthodontics. A literature search was conducted on April 24, 2023, utilizing medical topic headings (MeSH) and relevant terms available in the Medline and Cochrane databases to collect scientific evidence on the topic. We primarily included articles published between 2000 and 2023, and to ensure comprehensive coverage, a manual search of publications was conducted using Google Scholar. The search did not impose limitations on the type of publication, participant age, language, or publication date.

Discussion

Orthodontic treatment has undergone significant advancements over the years, with the development of orthodontic mini-implants (OMIs) and temporary anchorage devices (TADs) being one of the most significant. OMIs and TADs provide additional anchorage for orthodontic appliances, allowing for more predictable and efficient tooth movement. They have several advantages over traditional anchorage methods such as headgear and intermaxillary elastics, including reduced treatment time and improved treatment predictability (9). This review article aims to provide a detailed overview of the use of OMIs and TADs in orthodontic treatment.

Orthodontic Mini-implants (OMIs)

OMIs are small screw-like devices that are inserted into the cortical or alveolar bone to provide additional anchorage for orthodontic appliances. OMIs are usually made of biocompatible materials such as titanium and are 1.2 to 2.0 mm in diameter and 6 to 12 mm in length (10). The insertion of OMIs is a minimally invasive procedure that can be performed in the orthodontist's office under local anesthesia. They can be used to provide anchorage for various orthodontic mechanics such as intraoral elastics, springs, and wires (11).

OMIs offer several advantages over traditional anchorage methods such as headgear and intermaxillary elastics. They provide stable fixation, which is essential in cases where significant tooth movement is required. OMIs reduce the need for patient compliance as they do not require the patient to wear external appliances such as headgear. OMIs also decrease treatment time while allowing for more efficient tooth movement (12).

OMIs can be used to manage various orthodontic cases, such as Class II and III malocclusions, deep bites, open bites, and impacted teeth. They can also be used in conjunction with clear aligner therapy to enhance treatment outcomes (11, 13).

Factors Affecting the Success of OMIs

The success of OMIs is influenced by several factors, such as the size and shape of the implant, the insertion site, the insertion angle, and the amount of bone contact. Mini-implants with a larger diameter have been found to have a higher success rate compared to those with a smaller diameter. OMIs with a tapered shape have also been found to have more favorable outcomes compared to those with a cylindrical shape (14).

The insertion site and angle of the OMI can also affect its success rate. OMIs inserted into the interradicular space have been found to be more beneficial than those inserted into the buccal or lingual alveolar bone. Studies have shown that the success rate of OMIs inserted perpendicularly to the alveolar bone is higher than that of those inserted at an oblique angle (6).

The amount of bone contact is another factor that can influence the outcomes of OMIs insertion. Research has indicated that OMIs that come into greater contact with the bone tend to have a higher success rate than those with less bone contact. Proper placement and maintenance of OMIs are crucial for achieving successful long-term treatment outcomes (3).

Temporary Anchorage Devices (TADs)

TADs are small, temporary implants that are used to provide anchorage for orthodontic mechanics. They are usually made of titanium and are 1.2 to 2.0 mm in diameter and 6 to 12 mm in length. TADs are inserted into the alveolar or cortical bone and are removed once treatment is completed (15). In orthodontic treatment, they are employed as a means

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of securing support for a range of mechanisms such as intraoral elastics, springs, and wires.

Compared to conventional anchorage methods like headgear and intermaxillary elastics, TADs have various advantages. They provide reliable anchorage, particularly in situations that require significant tooth movement. TADs also minimize the need for patient compliance, as they don't require the use of external devices like headgear. Additionally, they facilitate more efficient tooth movement, resulting in reduced treatment duration (2).

TADs have diverse applications in orthodontic treatment, including the management of Class II and III malocclusions, deep bites, open bites, and impacted teeth. Furthermore, TADs can be employed alongside clear aligner therapy to augment treatment results (16, 17).

Factors Affecting the Success of TADs

The success of TADs is influenced by several factors, such as the insertion site, the insertion angle, and the amount of bone contact. TADs inserted into the cortical bone have been found to have a higher success rate compared to those inserted into the alveolar bone (16). Studies have demonstrated that the success rate of TADs is higher when inserted perpendicularly to the cortical bone than when inserted at an oblique angle. Additionally, the extent of bone contact is a key factor influencing TAD success. TADs with more significant bone contact have been observed to have higher success rates than those with less bone contact (2). Therefore, appropriate insertion and maintenance of TADs are essential to achieve favorable treatment outcomes.

Comparison between OMIs and TADs

OMIs and TADs are both effective in providing additional anchorage for orthodontic appliances. However, there are some differences between the two devices. Both are inserted into the cortical bone or the alveolar bone (14, 16). As a consequence, they provide greater anchorage stability when inserted into the cortical bone, which is denser than the alveolar structures. TADs can also be used in cases where there is insufficient alveolar bone for the insertion of OMIs.

OMIs are usually easier to insert than TADs, as they do not require as much force during the insertion procedure. OMIs can also be inserted at different angles, which allows for greater flexibility in treatment planning (12). However, OMIs may cause more discomfort to the patient during insertion and may have a higher risk of failure due to their placement in the alveolar bone (7).

Compared to OMIs, TADs are generally more challenging to insert since they require greater force. Additionally, their placement in the cortical bone can increase the risk of fracture or breakage. Nonetheless, TADs offer greater versatility in terms of placement options and can be used when OMIs are unsuitable (16).

There are several factors that contribute to the failure of TADs and OMIs, and these include device-related, patient-related, and clinician-related origins. Device-related factors that could lead to failure include improper placement, insufficient bone contact, and implant fractures. Patients can also contribute to device failure through poor oral hygiene, parafunctional habits, and systemic conditions that affect bone metabolism (2, 7).

Clinician-related factors can also play a significant role in TAD and OMI failure. These include inadequate training, poor technique, and lack of experience with these devices. To minimize the risk of failure, clinicians should be aware of these factors and take appropriate steps, including careful patient selection, proper placement and maintenance, and regular monitoring of the devices during treatment. This involves ensuring that the TAD or OMI is placed in the correct position, with adequate bone contact, and that the device is appropriately loaded with the orthodontic force required for treatment. Regular monitoring of the devices during treatment is essential to detect any potential issues that may arise and allow for prompt intervention. Overall, a thorough understanding of the factors contributing to TAD and OMI failure is critical for achieving successful treatment outcomes in orthodontics (1).

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Clinical Applications of OMIs and TADs

OMIs and TADs have revolutionized the management of complex orthodontic cases, providing specialists with a more predictable and efficient treatment option. However, proper case selection, placement, and maintenance are crucial for achieving successful outcomes with these devices (13, 17). OMIs and TADs have numerous clinical applications in the management of complex orthodontic cases, including anchorage reinforcement, space closure, correction of malocclusions, treatment of impacted teeth, skeletal discrepancies, and orthognathic surgery cases, as well as enhancing the efficiency of clear aligner therapy. These applications make OMIs and TADs essential tools for orthodontic treatment, and they have significantly improved treatment outcomes for complex orthodontic cases. For orthodontic treatment options to be optimal, it is essential for orthodontists to possess a thorough understanding and expertise in the use of OMIs and TADs.

Conclusion

In conclusion, OMIs and TADs have significantly enhanced the management of complex orthodontic cases. These devices provide stable anchorage, reduce treatment time, and improve treatment predictability. OMIs and TADs have numerous clinical applications and can be used to manage various orthodontic cases. Proper case selection, placement, and maintenance are crucial for achieving successful outcomes with these devices. Orthodontists must be knowledgeable in the use of OMIs and TADs to provide their patients with the best possible treatment options.

Disclosure

Conflict of interest

There is no conflict of interest

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Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection, and final writing of the manuscript.

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