Common Complications in Orthodontic Bone Screws: Causes, Management, and Prevention

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Introduction

Orthodontic bone screws, also known as temporary skeletal anchorage devices (TSADs), have significantly expanded the possibilities in orthodontic treatment. However, like any orthodontic intervention, complications can arise. This article examines three common complications associated with TSADs: soft tissue damage, hard tissue damage, and screw fracture. We explore the causes, management strategies, and preventive measures for each of these issues.

1. Soft Tissue Damage

Causes:

Soft tissue injuries frequently occur in the use of temporary skeletal anchorage devices (TSADs). The risk of soft tissue injury during installation often arises when clinicians encounter difficulties with screw placement, potentially leading to unintended slips in the positioning stage.[1]

Likewise, the angle and location at which TSADs are inserted play a crucial role in influencing the soft tissue response. Improper placement can result in excessive soft tissue hypertrophy, inflammation, or peri-implantitis. There has been an ongoing debate regarding the advantages and disadvantages of screw placement through movable mucosa (MM) versus attached gingiva (AG). Generally, it is recommended to position the screw within the area of keratinized gingiva due to its potential to reduce irritation and enhance resistance to inflammation, thereby decreasing screw failure rate.[2,3]

However, it is worth noting that Chang et al.[4] did not observe significant differences between MM and AG placements. Placing the screw head in an upright and elevated position about 5 mm away from MM can also effectively maintain screw stability with good oral hygiene practices, thereby minimizing the risk of peri-inflammation (Fig. 1).

Oral hygiene plays a vital role in bone screw stability, with patients demonstrating better oral hygiene exhibiting a higher success rate compared to those with poor oral hygiene.[5] Unsatisfactory oral hygiene can result in soft tissue overgrowth around the TSADs and increase the risk of peri-implantitis, a polymicrobial disease driven by plaque accumulation. Poor oral hygiene may consequently decrease screw maintenance and lead to screw failure.[5,6] Therefore, patient compliance and postoperative care are closely correlated to screw stability.

Management and Prevention:

Excessive soft tissue growth covering TSADs is best corrected with electrosurgery or diode lasers, to meticulously remove the surplus tissue so the screw can be accessed clinically. In the case of severe inflammation, antibiotics may be necessary. In certain situations, relocating the TSADs to a more suitable

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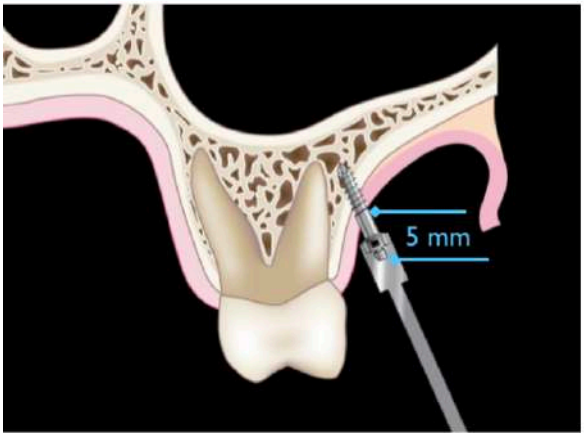

Fig. 1:
Placing the screw head in an upright and elevated position (about 5 mm away from the gingiva) within the MM or MG location can effectively maintain screw stability by facilitating good oral hygiene practices, thereby minimizing the risk of peri-inflammation.

position may be necessary to prevent further soft tissue overgrowth and other complications.

To prevent slippage during insertion, especially in the maxilla, it is suggested to insert the TSADs with the following procedures (refer to video demonstration on YouTube: How to prevent screw fracture | 【Chris Chang Ortho】 CC657):

1. Begin with local anesthesia administration to ensure patient comfort.

2. Retract the mucosa gently to achieve a taut and level surface.

3. Employ a cotton roll to cleanse and dry the surface thoroughly, providing a clear field of vision.

4. Utilize a dental explorer to create a small indentation at the preferred insertion location.

5. Start inserting the TSAD at a modest, near-perpendicular angle to the bone. Once it engages with the cortical bone (approximately 2 mm deep), gradually alter the direction to minimize any impact on nearby roots.

Assuming adequate soft tissue clearance (approximately 5 mm) for better hygiene control, screws can be positioned in MM or AG.[4] It is

imperative to advise patients on the importance of maintaining optimal oral hygiene practices to enhance TSAD stability.

2. Hard Tissue Damage

Causes:

The precise positioning of TSADs can sometimes lead to inadvertent contact with tooth roots, posing a risk of root resorption. Vigilance in preventing root damage is of utmost importance in orthodontic practices. TSAD insertion sites are generally categorized into two locations: inter-radicular (I-R) and extra-alveolar (E-A). I-R TSADs are typically placed within the alveolar process between tooth roots, a common clinical choice (Fig. 2). However, when TSADs are situated in the path of root movement, they may interfere and potentially damage the periodontal ligament or induce root

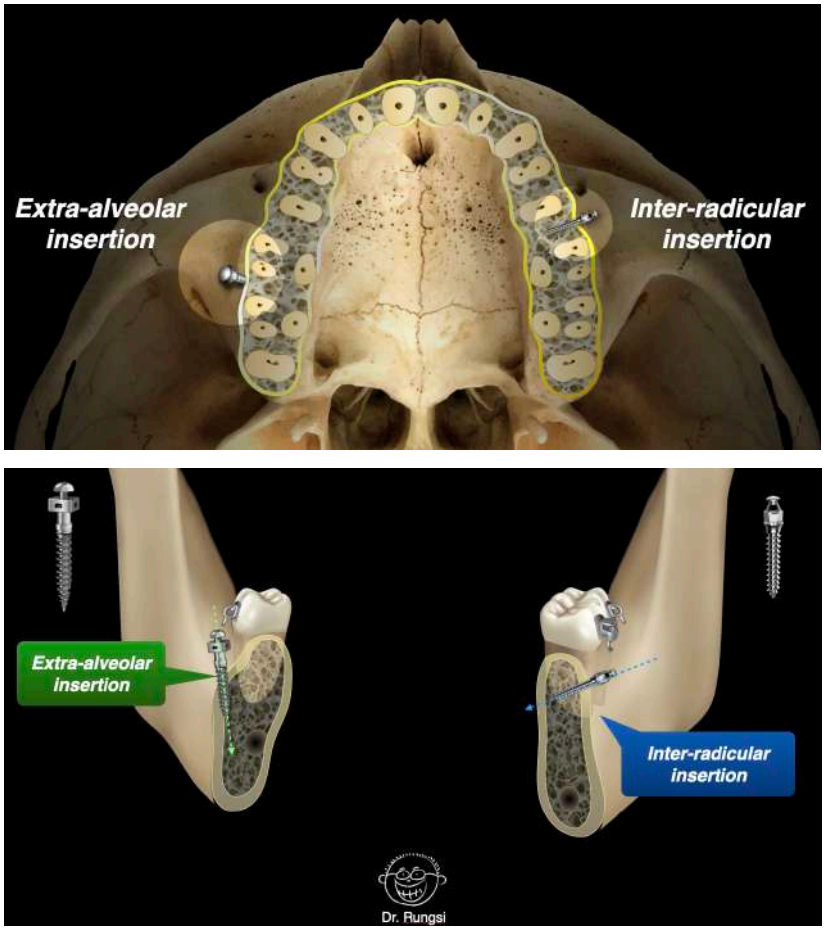

Fig. 2:
TSAD insertion sites are generally categorized into two locations: Inter-radicular (I-R) and Extra-alveolar (E-A). I-R TSADs are typically placed within the alveolar process between tooth roots, E-A TSADs are installed away from the root structures. Both the mandibular buccal shelf (MBS) and infra-zygomatic crest (IZC) have become well-established E-A sites for TSADs insertion. These locations offer broader and more abundant bone, allowing for the placement of thicker screws (2 mm in diameter), thus reducing the risk of screw fracture and enhancing stability for effective anchorage.

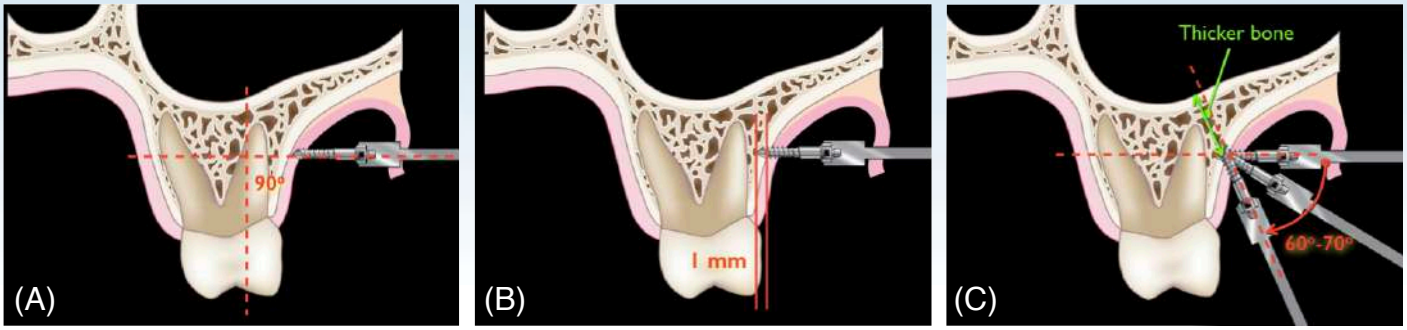

Fig. 3:
Illustrations by Dr. Runsi Thavarungkul of a 2x12-mm miniscrew inserted into the IZC as skeletal anchorage. (A) Initial insertion of the tip is perpendicular to the bone surface. (B) After the screw tip has engaged, (C) continue inserting whilst gradually changing the angle to 60-70 degrees so the screw can engage in the thicker bone away from the roots.

resorption. Research has indicated that root resorption may be stimulated when the mini-implant is positioned less than 0.6 mm to the root.[7]

Management and Prevention:

Upon detecting hard tissue damage, such as root resorption, it is advisable to promptly remove the bone screw and explore alternative placement locations. To reduce the risk of interference-related problems or to facilitate relocation, E-A bone screws have emerged as an attractive option. Unlike I-R TSADs, which are inserted between roots, E-A screws are installed away from the root structures. Both the mandibular buccal shelf (MBS) and the infra-zygomatic crest (IZC) have become well-established E-A sites for TSADs insertion. These locations offer broader and more abundant bone, allowing for the placement of thicker screws (2 mm in diameter), thus reducing the risk of screw fracture and enhancing anchorage (Fig. 2).[8,9] Furthermore, E-A TSADs anchorage helps circumvent interference with the path of tooth movement, minimizing the risk of dental hard tissue damage.

Fig. 4:
Interference between the bracket and the screw occurred when the screw was placed too close to the dental arch.

Orthodontists should carefully assess the angle and location for TSADs installation to minimize the risk of damaging adjacent hard tissue structures. Given that E-A TSADs are designed to minimize damage to the periodontal ligament and root structures, careful consideration of screw insertion orientation is essential throughout the orthodontic process. The optimal angle for an IZC bone screw is approximately 60 degrees below a perpendicular

line along the long axis of the first molar root (Fig. 3).[10] Complications arise when a MBS screw is positioned too closely to the molars. While placing the screw closer to the dental arch may offer distalization forces with a reduced horizontal component, there is a risk of interference between brackets and the screw during posterior movement (Fig. 4). If such interference occurs, placing another screw may be necessary, which subjects the patient to additional surgery. However, this can be avoided by positioning the MBS bone screw approximately 5 mm lateral to the interproximal area between the lower first and second molars.

3. Screw Fracture

Causes:

Screw fracture is a critical risk that neither the patients nor the clinicians want to encounter. It was reported that maximum cross-sectional stress often occurred at the cervical or apical part of the screw as it penetrates cortical bone. Fracture often occurred at this point.[11] Screw fracture may occur during both insertion and removal, and excessive insertion torque during TSAD placement or removal was documented to be closely related to screw fractures.[1,12] Different designs and internal diameter may also affect the possibility of such incidence. Furthermore, drastic angle changes during TSAD insertion may bring the screw under the impact of excessive torsional forces. Bone thickness and insertion site are also factors that cause screw breakage. Insertion in the mandible appeared to have higher rate of screw fracture since the bone is thicker than in the maxilla.[13] Therefore, clinicians' experiences play a vital role in controlling and avoiding such issues.

Management and Prevention:

(a) Surgical Removal

In cases of screw fracture, surgical removal is often necessary to prevent further complications. Surgical procedure details are-as follows:

1. **Identification:** Accurate identification of the fracture's extent and location is paramount. This involves a meticulous examination, complemented by radiographs. This step ensures a comprehensive understanding of the fracture's scope and aids in planning the removal procedure effectively.

2. **Anesthesia for patient comfort:** To ensure the utmost comfort for the patient during the procedure, it is imperative to administer adequate anesthesia. This not only minimizes discomfort but also allows for a smoother and more controlled operation.

3. **Vertical or flap incision:** A vertical or flap incision is strategically made at the site of the fracture. This incision provides access to the fractured miniscrew and facilitates its safe removal. Careful planning of the incision site is crucial for minimizing tissue trauma and enhancing the healing process.

4. **Fragment exposure and bone removal:** To expose the fractured miniscrew fragments fully, the surrounding bone is delicately removed. This

step extends access to the fracture tip for better grasp. It is imperative to exercise caution during bone removal to avoid any damage to nearby dental roots, ensuring the preservation of overall dental health.

5. **Utilizing Weingart plier for removal:** A specialized instrument, such as a Weingart plier, is employed to grasp and securely hold the exposed fragment. With precision, the broken tip is gently unscrewed and removed. This step requires a steady hand and a cautious approach to ensure complete removal of the fractured miniscrew while safeguarding adjacent structures.

By following these surgical steps, orthodontists can effectively address miniscrew fractures, while ensuring patient comfort and minimal impact on surrounding dental structures. This meticulous approach not only resolves complications but also promotes successful orthodontic treatment outcomes.

(b) Evaluation for Removal

Depending on the extent of fracture and clinical circumstances, some orthodontists may consider leaving a fractured portion of the screw in place or opt for delayed removal after radiographic examination. For instance, if a patient needs crown lengthening surgery at the end of treatment, a fractured screw remnant can be removed at that time.

To prevent screw fractures, orthodontists should adhere to adequate torque limits during TSAD placement.[14] It is crucial to maintain a consistent angle and avoid abrupt angle changes during TSAD insertion, to minimize the risk of screw fractures. Additionally, the screwdriver should be turned slowly. Clinical experience plays a pivotal role in reducing the fracture rate. In the unfortunate event of a screw fracture, clinicians must consider the risks and benefits of surgical removal. Retention may be a viable option in some cases.

Conclusions

Orthodontic mini screws (or TSADs) are valuable tools in modern orthodontics, but they are not without complications. Soft tissue damage, hard tissue damage, and screw fractures can occur in the absence of careful planning and precise execution. Preventive measures, such as thoughtful TSAD placement and torque control, can significantly reduce the occurrence of these complications. Additionally, early detection and appropriate management are essential when complications arise to ensure successful completion of orthodontic treatment.

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Reference: Failure Rates for SS and Ti-Alloy Incisal Anchorage Screws: Single-Center, Double Blind, Randomized Clinical Trial (J Digital Orthod 2018;52:70-79)

** The overall success rate of 93.7% indicates that both SS and TiA are clinically acceptable for IZC BSs.
Reference: Failure rates for stainless steel versus titanium alloy infrazygomatic crest bone screws: A single-center, randomized double-blind clinical trial (Angle Orthod 2019;89(1):40-46)

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Dr. Chang received his PhD in bone physiology and Certificate in Orthodontics from Indiana University in 1996. As publisher of Journal of Digital Orthodontics-a journal for interdisciplinary dental treatment, he has been actively involved in the design and application of orthodontic bone screws.

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