Review Article

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Risk and Complications of Mini Screws in Clinical Orthodontics

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ABSTRACT

Background: Introduction of miniscrews to orthodontics has led to their extensive use in critical anchorage situations. Miniscrews can provide stationary anchorages for various tooth movements and even make it possible to move the tooth in directions which have been impossible with traditional orthodontic mechanics. However, their widespread use is not free from certain potential risks, which must be identified to avoid / manage them. Complications can arise during miniscrew placement and after orthodontic loading that affect stability and patient safety. A thorough understanding of proper placement technique, bone density and landscape, peri-implant soft tissue, regional anatomic structures, and patient home care are imperative for optimal patient safety and miniscrew success. The objective of this article was to review the potential risks and complications of orthodontic miniscrews in clinical orthodontics.

Keywords: Mini screws, anchorage, miniscrew slippage.

INTRODUCTION

Anchorage preservation has always been a challenging goal during orthodontic therapy,[1] especially when simultaneous movement of group of teeth are planned. Extraoral appliances and intraoral elastics have conventionally been used, despite the compliance issue of extraoral bulky appliances.[2,3] A major advance in orthodontic treatment in recent years is the introduction of skeletal anchorage with miniscrew implants, which is widely used in orthodontic treatments for expanding the boundary of tooth movement and has no patient compliance requirement.[4] In 1980s, Creekmore and Eklund threw a concept of skeletal anchorage in orthodontic field. They placed a titanium screw under the nasal spine, which has been used as intermaxillary fixation after orthognathic surgery, and intruded the maxillary incisors.[5] In 1990s, orthodontic anchorage devices, such as miniscrews and mini-plates, were newly developed in eastern Asia and these devices have been well accepted in all over the world.[6-10] Miniscrews, also known as temporary anchorage devices (TADs), are small titanium alloy or stainless steel surgical bone screws placed into the buccal or palatal alveolar bone to provide a source of rigid, bone-supported, intra-oral anchorage used for the purpose of enabling any type of tooth movement.[11] Miniscrews are now increasingly used for a wide range of difficult tooth movements and pre-prosthetic corrections such as root uprighting for prosthetic replacements.[12] Miniscrew usage is mostly predictable and stable. However, as with any surgical procedure, there are certain potential complications associated with its use.[13]

COMPLICATIONS DURING INSERTION / PLACEMENT OF MINISCREW

1. Trauma to the periodontal ligament or the dental root

Interradicular placement of orthodontic miniscrews risks trauma to the periodontal ligament or the dental root. Potential complications of root injury

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include loss of tooth vitality, osteosclerosis, and dentoalveolar ankylosis.[14,15] Dental roots damaged by orthodontic miniscrews have demonstrated complete repair of tooth and periodontium in 12 to 18 weeks after removal of the miniscrew.[14] During interradicular placement in the posterior region, there is a tendency for the clinician to change the angle of insertion by inadvertently pulling the hand-driver toward their body, increasing the risk of root contact. To avoid this, the clinician may consider using a finger-wrench or work the hand-driver slightly away from their body with each turn. If the miniscrew begins to approximate the periodontal ligament, the patient will experience increased sensation under topical anesthesia.[16,17] If root contact occurs, the miniscrew may either stop or begin to require greater insertion strength.[17] If trauma is suspected, the clinician should unscrew the miniscrew 2 or 3 turns and evaluate it radiographically.[18]

2. Miniscrew slippage

High risk regions for miniscrew slippage include sloped bony planes in alveolar mucosa such as the zygomatic buttress, the retromolar pad and the buccal cortical shelf.[18] Mandibular cortical bone, 3 mm or more thick, may prove in some instances to be too dense to allow drill-free insertion of a miniscrew thereby increasing chances of slippage. Miniscrew slippage can also occur in dentoalveolar regions of attached gingiva if the angle of insertion is too steep. Placement at less than 30° to the occlusal plane, to avoid root contact in the maxilla or to gain cortical anchorage in the mandible, increases the risk of slippage. To avoid this, the clinician can initially engage bone with the miniscrew at a more obtuse angle before reducing the angle of insertion after the second or third turn. Minimal force should be used with the hand-driver, regardless of bone density. Greater forces increase the risk of miniscrew slippage. When placing miniscrew in a location covered by unattached gingiva, it may be necessary to utilize a sterile tissue punch to remove the mucosa and periosteum. Otherwise, the mucosa has a tendency to wrap around the drill or the miniscrew during insertion, causing needless softtissue trauma. Careful attention is usually sufficient to avoid most soft-tissue injuries.[13]

3. Nerve involvement

Nerve injury can occur during placement of miniscrews in the maxillary palatal slope, the mandibular buccal dentoalveolus, and the retromolar region. Most minor nerve injuries not involving complete tears are transient, with full correction in 6 months.[19] Placement of miniscrews in the maxillary palatal slope risks injury to the greater palatine nerve exiting the greater palatine foramen.[20-22] Miniscrews inserted in the palatal slope should be placed medial to the nerve and mesial to the second molar. Placement of the miniscrew above the nerve could increase the risk of palatal root contact and reduce biomechanical control. Placement of the miniscrews in the mandibular buccal dentoalveolus risks injury to the inferior alveolar nerve in the mandibular canal. The mandibular canal travels forward in an S-shaped curve moving from buccal to lingual to buccal.[23] The inferior alveolar nerve occupies its most buccal position within the body of the mandible at the distal root of the second molar and the apex of the second premolar, before exiting from the mental foramen.[23,24] Miniscrews inserted near the mandibular second molar and the second premolar are at greatest risk for accidental damage to the inferior alveolar nerve.[23] The soft-tissue appearance of the dentoalveolus can be deceptive, and a panoramic radiograph should be taken to determine the vertical position of mandibular canal and the location of the mental foramina. Greater caution is needed in adult patients who might have a more occlusal position of the mandibular canal due to resorption of the alveolar ridge. Placement of miniscrews in the retromolar pad risks injury to the long buccal nerve and the lingual nerve. The long buccal nerve branches off the mandibular nerve trunk and crosses high on the retromolar pad supplying the mucosa of the cheek. The lingual nerve runs immediately under the floor of the mouth and supplies general sensory innervation to the anterior two thirds of the tongue. To avoid nerve involvement and slippage, we recommend that the retromolar miniscrews should be no longer than 8 mm and placed in the buccal retromolar region below the anterior ramus.[18]

4. Nasal and maxillary sinus perforation

Perforation of the nasal sinus and the maxillary sinuses can occur during miniscrew placement in the maxillary incisal, maxillary posterior dentoalveolar, and zygomatic regions. A posterior

atrophic maxilla is a major risk factor for sinus perforation.[25] Penetration of the Schneiderian membrane is a well-documented phenomenon that often occurs when the thin, lateral wall of the sinus is infractured from the buccal side.[25] Ardekian et al[25] and Branemark et al[26] reported that immediately loaded dental implants that perforated the nasal and maxillary sinuses showed no differences in implant stability. If the maxillary sinus has been perforated, the small diameter of the miniscrew does not warrant its immediate removal. Orthodontic therapy should continue, and the patient should be monitored for potential development of sinusitis and mucocele. For miniscrews placed in pneumatized, edentulous regions of the maxilla, or placed higher in the posterior maxilla when intrusive forces are desired, the clinician should consider angulating the miniscrew perpendicular to the alveolar ridge to avoid damage to the sinus.[27]

5. **Miniscrew bending, fracture, and torsional stress**

Increased torsional stress during placement can lead to implant bending or fracture, or produce small cracks in the peri-implant bone, that affect miniscrew stability.[28-30] Self-drilling miniscrews should be inserted slowly, with minimal pressure, to assure maximum miniscrew-bone contact. A purchase point or a pilot hole is recommended in regions of dense cortical bone, even for self-drilling miniscrews. During miniscrew placement in dense cortical bone, the clinician should consider periodically derotating the miniscrew 1 or 2 turns to reduce the stresses on the miniscrew and the bone. The clinician should stop inserting the miniscrew as soon as the smooth neck of its shaft has reached the periosteum. Overinsertion can add torsional stress to the miniscrew neck, leading to screw loosening and soft-tissue overgrowth.38 Once the miniscrew has been inserted, torsional stress from wiggling the hand-driver off the miniscrew head can weaken stability.[31]

COMPLICATIONS DURING ORTHODONTIC LOADING OF MINISCREW

1. Periimplantitis

Periimplantitis is defined as the pathologic changes confined to the surrounding hard and soft tissues adjacent to an osseointegrated implant.[32] The diagnosis of periimplantitis is confirmed by a gradual loss of bone around an osseointegrated implant documented via probing depths and serial radiographs. Because no such osseointegration takes place with most miniscrews, and they are usually removed less than 12 months after initial placement, to label infections involving the soft tissue / bone surrounding miniscrews as periimplantitis is actually a misnomer. The term 'Temporary anchorage periimplantitis', or TAP, would be more appropriate, and easily differentiated from true periimplantitis. Infections related to miniscrews are commonly seen in patients who fail to maintain good oral hygiene levels or implant placed in areas difficult to access for cleaning. Peri-implant infections are easy to recognize and treat. Slight erythema and discomfort immediately adjacent to a miniscrew is the earliest sign of localized infection. Progressive mobility and pain due to bone loss may result if the localized infection is not controlled. Clinicians must identify the potential existence of periimplant infections by a careful, thorough clinical evaluation as the radiographic evidence may not be seen.[13]

2. Soft tissue injury

Soft tissue injuries related to miniscrews are relatively common during the course of orthodontic treatment. Careful attention is sufficient to avoid most soft-tissue injuries. Minor aphthous ulcerations can develop around the miniscrew or on the adjacent buccal mucosa, due to injury/trauma to soft tissue overlying the implant head. This can be prevented by placement of a healing abutment, a wax pellet, a large elastic separator or an acrylic/composite button over the miniscrew head, with daily use of 0.12% chlorhexidine rinses.[32]

3. **Delayed Mobility**

Delayed mobility, which occurs days to months after placement, is a separate entity from immediate mobility upon placement which is due to inadequate primary stability. Delayed mobility is usually caused by implant overloading or underloading.[13] Implant overloading is caused by force levels applied to the implant that exceeds the functional loading capacity of the bone-to-implant interface. Optimal force for miniscrew lies in the range of 50 – 450 gm.[33] Not all mobile miniscrews

must be removed. Miniscrews with subtle mobility need not be removed. If the miniscrew is stable enough to be loaded by orthodontic forces without frank mobility, it can be left in place. Static and immediate loading of miniscrew stimulates bone formation around the loaded surface, thereby enhancing bone-to-implant contact. Therefore, if a miniscrew is not loaded immediately, epithelial ingrowth may occur between the bone and the implant, possibly leading to mobility that may worsen with time.[34] Once frank implant mobility is confirmed, the loose miniscrew should be removed and replaced in another location. Infection in peri-implant area is another cause for delayed mobility and implant failure.[13]

COMPLICATIONS DURING REMOVAL

1. Miniscrew fracture

The miniscrew head could fracture from the neck of the shaft during removal. The authors recommend a minimum diameter of 1.6 mm for self-drilling miniscrews that are 8 mm or longer placed in dense cortical bone. The proper placement technique can minimize the isk of miniscrew fracture during its removal. If the miniscrew fractures flush with the bone, the shaft might need to be removed with a trephine.[35]

2. Partial osseointegration

Although orthodontic miniscrews achieve stationary anchorage primarily through mechanical retention, they can achieve partial osseointegration after 3 weeks, increasing the difficulty of their removal.[35,36] The miniscrew typically can be removed without complications a few days after the first attempt of removal.[35]

CONCLUSION

The introduction of miniscrews to the orthodontic procedures has widened the horizon of orthodontic possibilities. However, lack of training and careless execution can lead to a number of potential complications. The potential risks and complications can be minimized by educating clinicians. Clinicians keep in mind that screw fracture will occur not only at placement but also at removal. All possible efforts need to be made for preventing screw fracture and failure.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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