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B Singh

Author's affiliations:

Dr. Bhavna Singh – B.D.S., M.D.S.
Senior Lecturer
Department of Dental Surgery
Moti Lal Nehru Medical College
Allahabad

Address for Communication
19, Kamla Nehru Road
Old Katra
Allahabad – 211001
Uttar Pradesh, India

Mobile No: +919415140478
Fax No : 0532-2548384
Email add:
sweet.bhavnasingh@gmail.com

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POTENTIAL COMPLICATIONS OF MINISCREW IMPLANTS

Abstract:

OBJECTIVE:- Introduction of miniscrews to orthodontics has led to their extensive use in critical anchorage situations. However, their widespread use is not free from certain potential risks, which must be identified to avoid / manage them.

MATERIAL AND METHODS:- A thorough research of literature using electronic database was carried out and is being presented in combination with the author's experience with miniscrews.

RESULT:- Like all forms of medical and dental treatment, the placement of miniscrews is not free from certain potential risks, complications and limitations.

CONCLUSION: The simple design of miniscrew and ease of placement makes them comfortable for both, the clinician and the patient. However, the potential risks of their use (such as root trauma, primary instability, peri-implantitis, delayed mobility and failure) must be clearly understood and appropriate risk control procedures should be implemented. Potential complications must be considered and taken care of throughout treatment, for uneventful, secure and successful results.

INTRODUCTION

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.[1] Miniscrews are now increasingly used for a wide range of difficult tooth movements and pre-prosthetic corrections such as root uprighting for prosthetic replacements.[2]

Miniscrew usage is mostly predictable and stable. However, as with any surgical procedure, there are certain potential complications associated with its use.

MATERIAL AND METHODS

A thorough research of literature using electronic database was carried out and is being presented in combination with the author's own experience with certain miniscrew complications.

RESULT & DISCUSSION

Although miniscrew complications are generally minor, one needs to be vigilant and careful to minimize / manage them efficiently.

Problems / complications associated with use of miniscrews can be grouped into the three categories (Table I).

COMPLICATIONS DURING INSERTION / PLACEMENT OF MINISCREW

1. Inadequate Primary Stability / Immediate Mobility

Primary stability refers to the lack of movement of a miniscrew upon initial placement. Inadequate primary stability almost always leads to overt mobility, with subsequent failure. Evidence suggests that the majority of primary miniscrew stability comes from

Table I: Complications associated with miniscrew implants

Sl No.	*Category of Complication*	*Type of Complication*
A.	Complications during insertion / placement of miniscrew	1. Inadequate Primary Stability
		2 . Slippage / Soft tissue injury
		3. Tooth-root impingement
		4. Oroantral communication
		5. Nerve Injury
		6. Miniscrew Bending, Fracture and Torsional Stress
B.	Complications during loading of miniscrew	1. Periimplantitis
		2. Ulceration / Soft tissue injury
		3. Delayed mobility
		4. Undesirable tooth movement
C.	Complications during and after removal of miniscrew	1. Fracture during removal
		2. Post removal complications

cortical bone and lesser from medullary bone.[3]

Reasons / Management

- ***Bone density*** is the key determinant for stability and success of miniscrew anchorage.[4] Failure is often the result of low bone density or inadequate cortical thickness.[5]
- ***0.5 mm to 0.75 mm of available bone around miniscrew circumference*** is essential for adequate cortical bone purchase and primary stability.
- ***Over-drilled pilot hole*** is another reason for inadequate primary stability, especially in areas of thin cortical bone.[6] This is often the result of lateral movement and clinician's inability to hold the hand piece stable and perpendicular to the bone surface during drilling.
- ***Excessive trauma*** during implant surgery is another important cause of failure.[7] During pilot-hole osteotomy, most of the energy not used in the cutting process is transformed into heat. Temperature rise above 47°C for more than 1 minute negatively affects living bone and compromises its regeneration.[7] This can best be avoided by using drill-free screws.

2. Tooth-Root Impingement

Root damage is a significant complication of inter-radicular orthodontic miniscrew implant placement. Potential squeal of root damage include: loss of tooth vitality, osteosclerosis and dentoalveolar ankylosis.[8]

Prevention / Management

- Proper ***radiographic planning***, including ***surgical guide*** with panoramic and periapical radiographs determines the safest site for inter-radicular miniscrew placement.[9,10]

- Miniscrew should be placed under ***topical anaesthesia***. Avoid Nerve block, as any periodontal ligament contact can go unnoticed if the nerve supply is blocked.[11]

- If root is contacted, miniscrew may either stop or require greater insertion strength. On suspecting trauma, miniscrew should be unscrewed by 2-3 turns and evaluated radiographically.

- If the periodontal ligament (PDL) or cementum is contacted, the most frequent concern is that the tooth may undergo ***ankylosis***. Upto 2 mm of PDL loss on the root surface can be repaired by new attachment without ankylosis. Favourably, most current miniscrews are 2 mm or less in diameter.[12]

- Injury to the outer dental root without pulpal involvement might not influence the tooth's prognosis. Damaged dental teeth have demonstrated ***complete repair*** of roots and periodontium in ***12 to 18 weeks*** after removal of miniscrew.[5,12]

- Root injury involving the pulp tissue can result in ***loss of tooth vitality*** with further destruction of the adjacent periodontal tissues. Root perforation can be treated through the access cavity or by surgical intervention.

- ***Surgical repair*** is indicated if treatment of perforation with an intracanal approach has failed. Extracoronal approach is usually recommended for root perforations by miniscrews, because most perforations occur on the lateral surface and are inaccessible through the coronal access cavity.[12,13]

3. Slippage / Soft Tissue Injury

The clinician may sometimes fail to fully engage cortical bone during

placement and inadvertently slide the miniscrew under the mucosal tissue along the periosteum.

Reasons / Management

- ***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.[14]
- 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 soft-tissue trauma.
- Careful attention is usually sufficient to avoid most soft-tissue injuries

4. Oroantral Communication

During placement in the maxilla, there are chances that the miniscrew might perforate the maxillary sinus.

Reasons / Management

- The chance of perforation increases if ***pneumatisation of the sinuses*** is noted in the preoperative radiographic evaluation.[15]
- The most concerning sequelae following a sinus perforation are postoperative ***maxillary sinusitis*** and formation of a ***chronic oroantral fistula***. The probability that either of these sequelae will occur is related to the size of the communication.[14]
- If communication is ***2 mm or less***, no further management is required other than routine postoperative observation and sinus precautions.[11] Fortunately, this is usually the case, because most current miniscrews are less than 2 mm in diameter.
- ***Greater than 2 mm*** communication would require surgical repair.

5. *Nerve Injury*

Nerve injury can sometimes occur during placement of miniscrews in the maxillary palatal slope, the mandibular buccal dentoalveolus, and the retromolar region. Placement in these areas risks injury to the greater palatine nerve; inferior alveolar nerve in the mandibular canal; and the long buccal nerve and the lingual nerve respectively.

Management

- Most minor nerve injuries not involving complete tears are ***transient***, with full correction in 6 months.[16]
- Long-standing ***sensory aberrations*** may require pharmacotherapy (corticosteroids), micro neurosurgery, grafting, or laser therapy.[16]

6. *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 adversely affect miniscrew stability.[17,18]

Reasons / Management

- 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.[19]
- During miniscrew placement in dense cortical bone, the screw may be ***periodically derotated 1 or 2 turns*** to reduce the stresses on the miniscrew and the bone.
- ***Over-insertion*** can add torsional stress to the miniscrew neck, leading to screw loosening and soft-tissue overgrowth.[18,19] Insertion of the miniscrew should be stopped as soon as the smooth neck of its shaft has reached the periosteum.
- Once the miniscrew has been inserted, ***wiggling the hand-driver off*** the miniscrew head can introduce torsional stress and weaken the stability.[19]

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.[20] 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 ap-

propriate, 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 (Figure 1).

Figure 1: Localized Peri-Implant infection / Temporary Anchorage Periimplantitis (TAP)

Progressive mobility and pain due to bone loss may result if the localized infection is not controlled. Clinicians must identify the potential existence of peri-implant infections by a careful, thorough clinical evaluation as the radiographic evidence may not be seen.

Prevention / Management

- Use of properly ***sterilized instruments*** during the implant placement procedure and further recall examination visits.
- Patients should be instructed ***not to push / play with*** the implant with the tongue or finger.
- Place the patient on a regimen of ***0.2% Chlorhexidene rinses*** for the initial 5 to 7 days to promote better oral hygiene.[20]
- For ***cleaning*** any soft/hard deposits:-
    - A small, ***soft-textured brush*** is most efficient.
    - ***Cavitron, prophy jets and sonic units*** should *NOT BE USED* as they are too abrasive.

- ***Proxy brushes*** may be used but, with extreme *CAUTION*.

- In case of an infection, patients should be instructed to clean the implants and surrounding tissue initially with cotton wool buds & then with small headed tooth brush as soon as the mucosal tenderness wards off.

- ***Metronidazole*** gels can be used for local application to control the infection.[20]

- ***Frequent visits and examinations*** are prudent in order to avoid further complications.

- Pus discharge, increasing pain, fever, malaise, and other signs and symptoms of infection indicate the need for a course of ***antibiotics*** along with ***analgesics***.[20]

- Failure to control the infection may sometimes necessitate ***deloading*** and/or ***removal of implant***.

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 (Figure 2).

Figure 2: Soft tissue ulceration in the peri-implant area

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 (Figure 3).[20]

Figure 3: Use of Composite to cover miniscrew head for avoiding overlying soft tissue injury

- Soft tissues that are adjacent not only to the miniscrew itself but also to ***auxiliary mechanical devices*** are subject to trauma and irritation. The bunching and rubbing of loose alveolar tissue can lead to coverage of both the miniscrew head and its attachments (i.e., coil spring, elastic chain) even within a day after placement. Addition of an auxiliary wire lifts the coil spring away from the gingival tissue and avoids tissue impingement.
- Any presenting ulceration / soft tissue injury needs to be managed symptomatically for relieving discomfort.

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.

Reasons

- ***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 miniscrews lies in the range of 50 – 450 gm.[21]
- 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.[22] 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.

4. Undesirable tooth movement

A well planned vector analysis is critical to miniscrew success. Unwanted intrusive or extrusive movements are common with miniscrews unless careful attention is paid to vector and force analysis.

Cause / Management

- Retraction of anterior tooth segments may be subject to ***intrusive forces*** or to ***excessive palatal crown torque***. If intrusion is not part of the treatment plan, auxiliaries must be used to keep the point of force application closer to the centre of resistance, thus providing a translational movement of the segment.[23,24]
- Molar intrusion may introduce ***unwanted tipping or crown torque*** unless proper counter-forces are used to prevent such problems. If a miniscrew is used in the buccal cortex to intrude a maxillary molar, an opposite force must be placed on the lingual via another miniscrew or a transpalatal arch to prevent unwanted buccal crown torque.[25,26]

COMPLICATIONS DURING AND AFTER REMOVAL OF MINISCREW

1. ***Fracture during removal***

The miniscrew head could sometimes fracture from the neck of the shaft during removal.

Management

- Use of ***proper technique*** during insertion, with ***minimal stress incorporation*** minimizes the risk of fracture on removal.
- A ***minimum diameter of 1.6 mm*** for self-drilling miniscrews that are 8 mm or longer placed in dense cortical bone is usually recommend.
- If the miniscrew is left in place for a very long time, it may undergo ***osseointegration*** which could be the reason for fracture during removal.
- In case of ***fracture***, radiograph must be taken to locate size and position of remaining piece. Small, ***asymptomatic*** piece of implant may sometimes be left in place with ***periodic follow up***.
- If the root has been contacted or penetrated by the fractured miniscrew, ***removal of the remnant*** is necessary.
- If the miniscrew is difficult to remove, a small, round bur can be used to create a trough around the exposed miniscrew remnant, allowing adequate access for retrieval.

2. ***Post removal complications***

Post-removal healing complications relate directly to the site of miniscrew removal.

- If miniscrew was removed due to localized ***infection***, sometimes the pain, swelling, or drainage may persist even after screw removal. Chlorhexidene rinses for 5 days normally resolve the localized infection.
- ***Sinus perforation*** that may have occurred at the time of insertion,

may not present itself until the miniscrew is removed.

- If a perforation is suspected, the clinician needs to evaluate for the possibility of a ***fistula*** and treat accordingly.
- Late complications associated to ***adjacent teeth*** may present after screw removal. Progressive pain and sensitivity to pressure may indicate that a tooth root was penetrated by the TAD and that pulpal damage has ensued. Any tooth pain in the area of a recent miniscrew removal should be thoroughly investigated managed accordingly.
- If ***ankylosis*** is suspected due to previous root damage, periapical radiographs should be taken to examine the PDL and document the same. The clinical relevance of single-tooth ankylosis in an adult is likely minimal, but it should be monitored in the long term for internal or external resorption.

CONCLUSION

The introduction of miniscrews to the orthodontic armamentarium has opened up a vast, new era of biomechanics that has widened the horizon of orthodontic possibilities. However, lack of training and careless execution can lead to a number of potential complications. Careful vigilance is often sufficient to avoid or manage such problems.

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