Surgical Stents for Accurate Miniscrew Insertion

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Orthodontic miniscrews provide stable skeletal anchorage for both direct and indirect orthodontic traction.[1-8] These implants, which have evolved from maxillofacial fixation screws, rely primarily on mechanical engagement, although a variable amount of osseointegration may also occur. While the commercially available materials and designs differ, there are two basic types of miniscrew threads. Non-drilling (or "self-tapping") miniscrews such as Leone Orthodontic Mini Implants* require pilot holes to be drilled before they are inserted. More recent self-drilling screws such as the Aarhus Mini-Implants** may require indentation of the cortical plates, but do not need pilot drilling.

Precise three-dimensional positioning of palatal implants has been found critical to their success.[9,10] The insertion technique for miniscrews should maximize the available bone volume while avoiding adjacent anatomical structures such as dental roots, nasomaxillary cavities, and neurovascular tissues.[11,12] Although root surfaces appear to repair after traumatic contact with bone screws,[13] it is still prudent to minimize the risk of such iatrogenic damage. Planned tooth movements should be taken into account, especially when the insertion site is adjacent to a space that is to be closed. Improper positioning may result in interference with the required tooth movement and hence limit the effectiveness of the skeletal anchorage.

Visual and instrument access can be difficult when miniscrews are placed in posterior or palatal locations. Problems may also arise when the treatment planning and implant insertion are performed by different clinicians. Several manufacturers and authors currently recommend the use of a brass separating wire or custom-made wire guide, which is radiographed in place to show the relationship to the planned insertion site and the adjacent dental roots.[6,8,14-16] Aside from the additional radiographic exposure, such wire markers provide only limited topographical information, rather than a direct indication of the implant angulation.

The ideal solution would be a stent that would transfer the planned three-dimensional implant position to the surgical placement procedure. Kyung and colleagues used vertical and mesiodistal measurements from a lateral cephalogram to construct an acrylic marker, but this provides only a two-dimensional location.[17] Kitai and colleagues described a technique requiring several complicated and expensive steps: a computed tomography scan of a template in the appropriate position, a digital surface scan of the working cast and template, production of a stereolithographic model, and finally fabrication of a removable stent.[18] Morea and colleagues designed an acrylic stent with a metal sleeve to guide the pilot drill for non-drilling miniscrews,[12] but the initial wax fixation of the sleeve to the working cast seems fragile, there appears to be no access for external irrigation, and retention of the acrylic stent may be problematic.

This article describes a modification of the three-dimensional stent we previously developed for palatal implants.[10] The design and fabrication are simple, and the stent provides reliable guidance for either the pilot drill or the self-drilling miniscrew in terms of both location and angulation. The stent allows access for both visual monitoring and saline irrigation. It is particularly valuable when the miniscrew is prescribed and inserted by different clinicians, or when the orthodontist is inexperienced in implant techniques.

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**MEDICON eG, Tuttlingen, Germany; www.medicon.de. ScanOrto A/S, Charlottenlund, Denmark; www.aarhus-mini-implant.com.

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Positional Planning

The optimum three-dimensional position for each miniscrew is determined from a panoramic or intraoral radiograph and a dental cast. To maximize the depth of cortical and cancellous bone while avoiding adjacent roots, gingival papillae, neurovascular tissues, and nasomaxillary cavities, the clinician must consider three major parameters:

- Topographical entry point of the implant
- Anteroposterior angle of entry
- Vertical inclination of entry

For example, when a patient requires retraction of the anterior teeth into a first premolar space, the miniscrew is commonly placed buccally between the second premolar and first molar (Fig. 1). The insertion point and angle of entry will be influenced by the position and morphology of the adjacent roots (Fig. 2). The vertical level and angulation of the entry point will affect the screw head's proximity to the gingivae and its emergence angle, which, in turn, will determine the prominence of the screw head and the ease of traction attachment. Potential migration and tipping of the miniscrew, as observed by Liou and colleagues,[19] may need to be anticipated by offsetting the entry point and angulation.

Once the position and insertion angle of the miniscrew have been decided, the diameter, length, and neck length of the screw are selected. The self-tapping Leone miniscrews are available in diameters of 1.5mm and 2mm and endosseous lengths of 6-12mm, with corresponding pilot drill diameters of 1.1mm-1.7mm. The Aarhus self-drilling screws come in diameters of 1.5mm and 2mm and endosseous lengths of 5.4-8.7mm.

Non-Drilling Miniscrew Stent

The guide channel for the pilot drill may be fabricated from either acrylic or metal tubing supported by acrylic. The metal channel provides a smooth, inert surface, but does not allow the drill to be clearly seen. On the other hand, drilling within an acrylic channel might contaminate the surgical site with acrylic debris. Therefore, we prefer the metal guide, which is fabricated as follows:

Fig. 1 Aarhus Mini-Implant inserted buccally between upper second premolar and first molar roots, at 45° angle to long axes, provides direct anchorage for retraction of canine (using elastomeric attachment) and anterior teeth.

Fig. 2 Angulation of Aarhus Mini-Implant and relationship to adjacent roots.

1. Mark the planned location of the miniscrew on the working cast with a pen.
2. Coat the cast with a plaster separating medium.
3. Determine the internal diameter of the metal guide tube, which must be equal to or slightly greater than the diameter of the pilot drill. The external diameter of the metal tube will dictate the size of the drill bit used by the technician on the working cast.
4. Drill a hole in the cast, 5mm deep, at the prescribed insertion site, angulation, and inclination. The drilling may be performed either freehand or by mounting the model on an adjustable table or angled support at the prescribed inclination to the vertical plane. Mounting requires the use of a magnetic angle finder to adjust the table's tilt relative to a vertical drill press[10] (Fig. 3).
5. Insert a 10mm length of metal tubing so that 5mm of the tube protrudes from the cast (Fig. 4). If necessary, stabilize the tube with wax that has a high melting point. The orthodontist can double-check the position and angle of the metal tube at this stage.
6. Pressure-form a .75mm thermoplastic blank over the cast and tube, then remove the blank and trim its labial and lingual edges.

Fig. 3 Working cast mounted on adjustable table at 45º angle to vertical plane, as indicated by magnetic angle finder, for drilling.

7. Block out the area around the metal tube with utility wax. After supporting the tube with cold-cure acrylic to the height of the occlusal surface, remove the wax.
8. Open the end of the metal tube by cutting through it and the adjacent acrylic on the occlusal side of the baseplate, thus creating the stent's guide channel.
9. Relieve the fitting surface of the stent baseplate and channel by removing 1-2mm of the tube and adjacent acrylic (Fig. 5). This pro-

Fig. 4 Metal tube placed in cast at prescribed miniscrew insertion site.

Fig. 5 Fitting surface of metal guide channel relieved for visual and irrigation access. Metal tube with 1.5mm internal diameter is used for 1.3mm pilot drill.

vides an unobstructed view of the pilot drill and direct access for irrigation, without affecting the positive guidance that the guide tube provides for the drill.
10. Polish the acrylic parts of the baseplate.

For surgical insertion of the non-drilling screw:

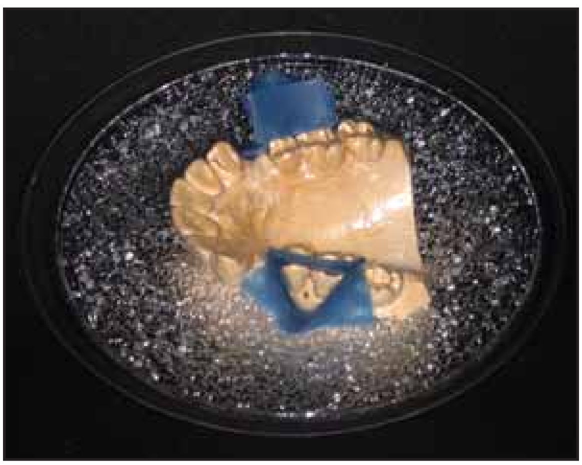

Fig. 6 Utility wax used to block out bilateral guide channels on untrimmed stent baseplate, with miniscrew insertion points in centers of wax triangles.

Fig. 7 Working cast mounted on adjustable table at 45º angle to vertical plane, as indicated by magnetic angle finder, for channeling through acrylic block with 4mm drill press.

1. Administer local anesthesia, and have the patient rinse with a chlorhexidine mouthwash.
2. Place the stent in the mouth temporarily, so that the mucosa at the insertion site can be indented with a dental probe or round bur.
3. Remove a circular section of mucosa from the insertion site using a circular punch/trephine or round bur.
4. Replace the stent, then use a drill of the appropriate diameter to create an implant hole in the bone. Keep the handpiece speed low, and use copious saline irrigation to minimize heat build-up.
5. After removing the stent, insert the miniscrew slowly with a manual screwdriver or a slow handpiece.
6. If desired, take a radiograph to verify the implant position relative to the adjacent roots.

Self-Drilling Miniscrew Stent

Fabrication is as follows:
1. Mark the planned location of the miniscrew on the working cast with a pen.
2. Coat the cast with a plaster separating medium.
3. Pressure-form a .75mm thermoplastic blank over the cast, then remove the blank and trim its labial and lingual edges.
4. Block out a triangle around the insertion site with utility wax, to a depth of about 12-14mm (Fig. 6). To provide a minimum acrylic width of 2mm around the guide channel, each side of the wax triangle should be about 15mm long. Fill this compartment with acrylic, cure the acrylic, and remove the utility wax.
5. Mount the cast and stent on an adjustable table or angled support at the prescribed inclination.
6. Use a drill press to create a 4mm-diameter channel through the acrylic (Fig. 7), corresponding to the diameter of the implant screwdriver head.
7. Contour the acrylic block to an acceptable size for patient comfort, while ensuring that it remains rigid. Remove about 3mm of acrylic from the stent's fitting surface to allow visualization of the implant at the mucosal level during final seating and to facilitate subsequent

Fig. 8 Aarhus screwdriver and Mini-Implant within acrylic guide channel.

removal of the stent (Fig. 8).

8. If multiple self-drilling miniscrews are to be inserted, the stent may be divided into segments so that each one can be fitted and used independently (Fig. 9), or a separate stent may be fabricated for each implant.

The surgical procedure for placing a self-drilling miniscrew:

1. Administer local anesthesia, and have the patient rinse with a chlorhexidine mouthwash.
2. Place the stent in the mouth temporarily, so that the mucosa at the insertion site can be indented with a dental probe or round bur.
3. Remove a circular section of mucosa from the insertion site using a circular punch/trephine or round bur.
4. Use a round bur to indent the cortical plate at the center of the surgical site.
5. Replace the stent, then insert the miniscrew slowly by hand or with a slow contra-angle handpiece. The screwdriver will fit precisely within the acrylic channel (Fig. 10).
6. When the implant is almost completely seated, remove the stent to make minor adjustments to the insertion depth and screw head projection.
7. If desired, take a radiograph to verify the implant position relative to the adjacent roots.

Fig. 9 Separate self-drilling miniscrew stents for bilateral miniscrews between upper second premolars and first molars.

Fig. 10 Aarhus Mini-Implant inserted through stent.

Conclusion

This surgical stent provides accurate three-dimensional positioning of miniscrews so that bone support can be maximized and damage to adjacent structures can be avoided. It reduces the need for direct visual access to posterior or palatal insertion sites, and is particularly valuable when the operator is inexperienced or the insertion is not performed by the prescribing orthodontist. By minimizing lateral movement of the pilot drill and implant, it also prevents widening of the implant hole and thus improves mechanical stability.

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