Miniscrews: a focal point in practice

Six-part series by Dr Björn Ludvig, Dr Bettina Glau, Dr Thomas Lietz & Prof. Jörg A. Lisson—Part VI

Preliminary remarks

The use of miniscrews facilitates many aspects of orthodontic treatments and in some cases actually makes such treatments possible. But miniscrew-based treatments, in common with all medical procedures, are not without their problems, complications and risks. It should be borne in mind that medical progress is only possible thanks to the pioneers and patients who are willing to enter uncharted regions. The major phase of miniscrew trials began in 2000. Today, the use of miniscrews is becoming increasingly established and consolidated, which means that the potential and limitations of miniscrews are also even more apparent.

Complications and risks

Objective reasons

- Disturbance of the osteogenic process
- Pain-related issues

Iatrogenic problems

- Perioperative complications
- Pathological failure
- Mechanical problems
- Habitual

Patient-related factors

- Pain
- Intraoral space
- Insertion process
- Experience

Fig. 1: There are many possible causes of the premature loss of miniscrews. The most common of these are perioperative-related.

Fig. 2: Classification of bone quality according to Misch.

Class D1: Alveolar, horizontally homogeneous compact bone
- Arterial bone loss + poor primary stability

Class D2: Thick compact bone/hyper paragengis
- Adjacent upper/lower arch of bone + poor primary stability

Class D3: Thick compact bone/medially hyperparagengis
- Pediatric upper/lower arch + primary stability

Class D4: Thick compact bone/periapical
- Pediatric upper/lower arch + primary stability

Fig. 3: Bone quality

Bone density

- Level
- Number
- Size
- Shape
- Structure

Fig. 4: Bone density

Table 1: Basic requirements for the insertion of miniscrews. The actual effect of these requirements on medical history, assessment findings (including possible complications), see Overview 1), diagnosis, and treatment objective. The general conditions and disorders on the use/outcome of miniscrew procedures has not yet been determined.

Screw location

The best site for the screw should be selected on the basis of the biomechanical concept. The following should be considered:

- Should there be at least 0.5 mm bone within the screw site on all sides.
- The screw head should be positioned on the mucosal surface, attached gingiva.
- It is most important to determine the quantity and quality of the bone at the selected site of insertion. This will provide initial indications of the quantity to be expected (Fig. 2). However, an X-ray will only provide limited information in this respect, although it will make it possible to assess the spatial situation in two dimensions. This prevents or reduces the risk of damaging a root (Fig. 2).

The first question (taking into account possible complications) is who should insert the screw? There is much in favor of this being done by the orthodontist. Studies have shown that orthodontists have a far better developed sensitivity in this regard. There is often failure—in other words, the loss of the miniscrew—if this is undertaken by ‘experienced’ implanters because they tend to ignore or be insufficiency aware of the requirements for the insertion of a miniscrew.

If the orthodontist is not to insert the miniscrews personally, a good line of communication with the surgeon must be maintained.

Careful planning is undoubtedly one of the main keys to success. The same documentation and information required for other orthodontic procedures are perfectly adequate when planning a miniscrew treatment. The choice of biomechanical concept should be based on medical history, assessment findings (including possible complications), see Overview 1), diagnosis, and treatment objective. The general conditions and disorders on the use/outcome of miniscrew procedures has not yet been determined.

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Overview 1

Local contraindications:

- Quantitative and qualitative deficiency of bone at the insertion site
- Poor oral hygiene
- Recent antibiotic treatment
- Recent extraction wounds
- Root canal treatment
- Dental infections
- Inflammatory processes
- Gingival recession
- crown/root ratio
- Bleeding tendency
- Inflammation of the periodontium
- Previous insertion wounds
- Newborn tooth
- Caries

Empirical data show that the differences in bone density are so small that the screws appear to be good, but the screw is rapidly lost. In order to prevent this, it is advisable to measure the thickness of the gingiva prior to insertion. When this is considered, it is the surgeon's task to find the correct bone quality at the selected site for the screws. The correct position for the screws would have been between teeth 5 and 4. This problem arose because of a misunderstanding between the orthodontist and the oral surgeon.

There are a number of reasons why the wrong drilling technique (e.g. overdrilling or underdrilling) prevents the screw from being inserted properly:

- Inflammation of the gingiva (peri-mucositis, peri-implantitis)
- Blood coagulation status
- Tension in bone because of cooling or excessive torque effect
- Pilot drilling (ø of bore hole, technique, rate)
- Inadequate biomechanical concept
- Direct anchorage
- Rotation of screw head against the thread
- Incompatibility of pilot drill and miniscrew
- Screw material

Dependent on system used and case history controlled by the practitioner only in the selection of system. For this reason, it is highly probable that a great deal of information relating to the use of implants will also apply to miniscrews. But there are certain factors that can only be assumed to minimise potential risks, particularly during insertion, it is advisable to adopt a standardised procedure for routine use.

Primary and secondary stability

The primary stability of a miniscrew in the bone must be good. Screw stability is mainly determined by the cortical layer. The screw elements inserted with the spigots contribute little towards screw retention. The reasons for poor primary stability are:

- Inadequate bone material quality (quantity)
- Oversizing of the bone hole due to wrong drilling technique (e.g. repeated insertion of the drill in the hole, deviation from required axis)
- Unsuitable screw thread (design of flanks and distance between them, relation of shaft to external diameter)

A miniscrew must have primary stability immediately on insertion, as stability cannot be subsequently achieved. No periodontal complications will occur. Numerous histological examinations have demonstrated that there is complete healing of the periodontal ligament after the removal of a screw.

Some miniscrews have depth stops (Overview 2). It should be

come apparent if the stop touches the bone surface during insertion, providing the signal to stop screwing (Fig. 8c). However, depending on clinical factors, such as bone quality, site, angle of insertion and the insertion technique, the moment of contact is not generally detectable. There is thus the risk of over-insertion, and the destruction of bone structure by the screw thread. The effect is comparable to that of a cork screw. The initial (or primary) stability of the screw appears to be good, but the screw is rapidly lost. In order to prevent this, it is advisable to measure the thickness of the gingiva prior to insertion. When this is considered, it is the surgeon's task to find the correct bone quality at the selected site for the screws. The correct position for the screws would have been between teeth 5 and 4. This problem arose because of a misunderstanding between the orthodontist and the oral surgeon.

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Checklist of the potential causes of the loss of miniscrews

<table>
<thead>
<tr>
<th>Cause</th>
<th>Grade of probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive force during insertion</td>
<td>High</td>
</tr>
<tr>
<td>Incorrect angle of insertion</td>
<td>Medium</td>
</tr>
<tr>
<td>Bone density at the insertion site</td>
<td>Low</td>
</tr>
<tr>
<td>Inadequate screw thread design</td>
<td>High</td>
</tr>
<tr>
<td>Inadequate screw length</td>
<td>Medium</td>
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The regeneration of the bone tissue required to achieve second-
Inflammation
There is a high probability that a miniscrew will fail if peri-mucosal implantitis develops. It is thus important to ensure that the patient is appropriately informed (which includes instructions on oral hygiene) and that follow up is possible. During follow up, examination of the screw (status of the surrounding tissue; stability of the screw) should be carried out. The positioning of attached elements (springs, extension arms) may cause the development of pressure sores or even ulceration of the mucosa. This is something that should also be monitored and treated as necessary.

Oral hygiene
The patient must ensure that adequate hygiene is maintained in the area around the miniscrew. A normal toothbrush should be used for this purpose. There is evidence that electric toothbrushes, particularly those with rotating heads, can loosen miniscrews, which can cause failure. In addition to the cleaning technique itself, the frequency and intensity of cleaning are undoubtedly also important. Very frequent cleaning that results in persistent micro-movements of the screw could well be disadvantageous.

Liability insurance
Orthodontists who wish to insert miniscrews themselves in their practices are frequently unsure about aspects of indemnity insurance. Policies available cover claims ranging from €1.5 to €5 million. When deciding on the extent of cover required (and thus the premiums that will need to be paid), the particular circumstances of the practice need to be considered. An indemnity insurance policy will also cover the practice’s personnel but may exclude temporary employees. If there are any changes to the activities profile in the practice, the owner should verify that this is covered by the policy. The insurer will be happy to clarify this. There are insurance companies that do not differentiate between dental practices and orthodontic practices as far as their policies are concerned.

In cases in which an orthodontist is planning to personally insert miniscrews (an approach that has many advantages), this is usually automatically covered by the policy. This is what the policy refers to when specifying ‘with implants’ or ‘with surgery’. In any case of doubt, however, policyholders should always contact their insurers and inform them of the extent, the range of treatments provided, particularly if the policy does not specifically cover surgical or implant procedures. In this case, the annual premium is likely to be increased by €20 to €50 (applicable at time of writing, June 2007). In order to protect themselves should a claim of negligence be made, orthodontists should ensure that they follow certain basic rules.

Fig. 10: The reasons for the loss of miniscrews are related.

Premature loss of miniscrews
Post-operative

Miniscrews – complications and risks

Construction
Manufacturing process

Stabilization
Secondary stability
Enhanced secondary stability
Primary stability

Fig. 8a Fig. 8b Fig. 8c

Fig. 4: Primary stability decreases while secondary stability increases. There is a critical phase at the point of crossover of the two effects in which there is a risk of screw loss.

Stability of the screw
The main parameters that determine the clinical success of a procedure are the bone quality and space available at the planned insertion site, the use of an insertion technique suitable for the system employed, and the use of a carefully considered biomechanical concept and the prevention of inflammation around the miniscrew. There are many reasons for failure, and these are interconnected, rather like the pieces of a jigsaw puzzle (Fig. 10).

Concluding remarks
These six articles cover many aspects of bone anchorage using miniscrews. The authors hope that they have achieved the objectives set out at the beginning of the series and provided the (as yet undecided) practitioner with a compendium of new information and experiences. However, it is not possible to discuss all aspects in detail, even in an extensive series of articles; thus, we refer interested practitioners to the relevant literature. But all theory remains just that if it is not applied in practice. We should be pleased if you, our readers, found the courage to use miniscrews routinely in your work. And we – Dr Ludwig, Dr Glasl (both Mosel.de) – wish you every success.