Miniscrews: a focal point in practice

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

Complications and risks

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.

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

Miniscrews: Complications and risks

Objectives

- Diagnostic problems
- Proximal-related problems
- Operative problems
- Pre-operative problems
- Intrusive factors
- Mechanical problems
- Post-operative problems
- Material problems
- Functional problems

Treatment planning and organisation

It is most important to define from the outset any possible secondary problems that might arise during the course of orthodontic treatment. These factors will vary considerably between the individual cases.

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

- There should be at least 0.5 mm bone around the screw on all sides.
- The screw head should be positioned on an inflammation-free, attached gingiva.

This simple procedure helps prevent the risk of miniscrew perforation on the oral side (Figs. 6a & c). The directed approach to insertion movement must also be considered during planning. This causes the resultant spatial situation to change during the course of treatment. A miniscrew must not interfere with or obstruct the desired movement (Fig. 7).

Insertion

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’ implantologists because they tend to ignore or be insufficiently aware of the requirements for the insertion of a miniscrew.

If the orthodontist is not to insert the miniscrew personally, a good line of communication with the surgeon must be maintained.
Overview 1

Local contraindications:

- Quantitative and qualitative deficiency of bone at the insertion site
- Infection
  - in the mobile mucosa
  - on the lingual side of the mandible
  - non-healing wounds and bone cysts
- Dental fillings or diseased teeth
- Poor oral hygiene
- Recent oral or dental surgery
- Antibiotic therapy
- Local development of the cranial region

General contraindications:

- Compromised immune system
- Therapy with corticosteroids
- Blood coagulation disorders
- Uncontrolled endocrine disorders
- Rhythmic disorders
- Disorders of the skeletal system
- Hepatic cirrhosis

Miniscrews with deep stop

Miniscrew**

Screw and device system

<table>
<thead>
<tr>
<th>Name of screw</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aarhus Mini Implant</td>
<td>Tekna</td>
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<tr>
<td>Akuna Anchor</td>
<td>Surgi-tec</td>
</tr>
<tr>
<td>Ankylo</td>
<td>Dentos</td>
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<tr>
<td>Morita</td>
<td>Surgi-tec</td>
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<tr>
<td>Inferosil</td>
<td>Surgi-tec</td>
</tr>
<tr>
<td>Licon</td>
<td>Dentos</td>
</tr>
<tr>
<td>S.I.N. Implant System</td>
<td>Tekka</td>
</tr>
<tr>
<td>DF Nasal Screw</td>
<td>Surgi-tec</td>
</tr>
<tr>
<td>*tomax-pc</td>
<td>*Surgical FUSION</td>
</tr>
</tbody>
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* Screw type: system A and fixed and/or fixed position
** as available for form of insertion

Otherwise, there is a risk of problems of the sort illustrated in Fig. 7. Here, it is no longer possible to achieve the aim of treatment (mesialisation of the molar). This is because the screws are in the way and as they are in the wrong location, the screws are too short and thus ineffective. The correct position for the screws would have been between teeth 5 and 4. This problem arose because of a misunderstanding, lack of communication between the orthodontist and oral surgeon with regard to the aim of treatment and the positioning of the screws. The surgeon was unwilling to take risks and inserted the screws where there was plenty of space. Perfectly understandable from the surgeon’s point of view, but a mistake in this case – an iatrogenic error!

It is only possible to test the bone quality at the selected site immediately prior to insertion. In regions in which the bone quality is likely to be DS or D4 (Fig. 2), a probe should be first inserted in the bone. If the probe penetrates deeply into the bone, the bone quality is adequate for the insertion of a miniscrew. A different site should be selected.

The miniscrew must not be in contact with the tooth root. If this happens, the physiological movement of the tooth can cause persistent micro-movements of the screw (Fig. 5). This impairs the healing process and means that secondary stability will not be achieved. No persistent 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 corkscrew. 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 in relation to the transverse section of the bone, it is immediately apparent how far the miniscrew can be inserted in the bone.

The fracture of a miniscrew is a rare occurrence. The following parameters (alone or in combination) determine the risk of fracture:

- Screw design: thin screws (8x1.4 mm) and long screws (>10 mm) tend to fracture more easily
- Anatomical factors
- Thick cortical layer (>2 mm) without perforation
- Insertion conditions: too much torque and/or inconsistent rate of insertion

Many problems arise because of inadequate training or lack of experience. There may well be a higher rate of loss after the first five insertions than the number of insertions performed by an individual. The personal learning curve can be vastly improved by practising on porcine bone samples (Fig. 8). Various clinical situations can be simulated (bone quality, effect of drilling etc.). This training gives the individual the necessary ‘feeling’ for bone and screw. In order 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 spongiosa contribute little towards screw retention. The reasons for poor primary stability are:

- Inadequate bone material quality/quantity
- Overlarge bone hole due to wrong drilling technique (e.g. repeated insertion of the drill in the hole, deviation from required axis)
- Unstable 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. If this is not the case, it is best to remove the screw and select an alternative insertion site where the preconditions are better.

The regeneration of the bone tissue required to achieve second-

Checklist of the potential causes of the loss of miniscrews

There are many possible causes, but the probability of these occurring differs greatly.

Table 1

<table>
<thead>
<tr>
<th>Grade of probability</th>
<th>Source of information</th>
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<tbody>
<tr>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Nitrogenic diabetes</td>
</tr>
<tr>
<td>Renal failure</td>
<td>Cushing's syndrome</td>
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<tr>
<td>Osteoporosis</td>
<td>Rheumatoid arthritis</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>Poor oral hygiene</td>
</tr>
<tr>
<td>Tobacco and alcohol</td>
<td>Osteoporosis</td>
</tr>
<tr>
<td>Regional osteomyelitis*</td>
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*Regional osteomyelitis is not derived from studies but from the experiences reported by various authors. Regional osteomyelitis is an important and severe condition that can only be assumed to be likely to cause the failure of miniscrews – but there is no empirical evidence to confirm this.

3.2. Attenuation to orthodontic appliance

Miniscrews can be covered by documenting medical history and findings carefully and providing the patient with adequate information.

Table 2

<table>
<thead>
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<th>Parameter of screw head</th>
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<tr>
<td>High</td>
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</tr>
<tr>
<td>Overwinding of screw/slipping</td>
<td></td>
</tr>
<tr>
<td>Screw-in force (&lt; 5 Ncm, &gt; 10 Ncm)</td>
<td></td>
</tr>
<tr>
<td>Contact w/ mucosa or bone</td>
<td></td>
</tr>
<tr>
<td>Screw head near mobile mucosa or bone</td>
<td></td>
</tr>
<tr>
<td>Screw head on cortical bone</td>
<td></td>
</tr>
<tr>
<td>Screw head with root</td>
<td></td>
</tr>
<tr>
<td>Screw near dental follicles or not yet ossified bone</td>
<td></td>
</tr>
<tr>
<td>Screw head on cortical bone</td>
<td></td>
</tr>
<tr>
<td>Screw head near mobile mucosa or bone</td>
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3.3. Phase of therapy

Miniscrews can be covered by documenting medical history and findings carefully and providing the patient with adequate information.

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3.4. Attenuation to orthodontic appliance

Miniscrews can be covered by documenting medical history and findings carefully and providing the patient with adequate information.
For force application it is probable that using a miniscrew immediatley or later to apply force has no influence on the failure rate. Forces applied should be such that no damage is caused to the teeth to be moved. When a miniscrew is coupled to elastic chains or springs, micro-movements of the screw can result. The distance between miniscrew and site of application of force of any springs directly attached to it should be kept to a minimum. Otherwise, these will be ineffective (Fig. 7).

Post-operative complications

Inflammation

There is a high probability that a miniscrew will fail if peri-implantitis or implant loosening develop. 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 fol-

low-up, examination of the screw (status of the surrounding tissue, stability of the screw) should be carried out. The positioning of attached elements (springs, ex-

traction 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 mini-

screws, which can cause failure. In addition to the cleaning tech-

nique itself, the frequency and intensity of cleaning are un-

doubtedly also important. Very frequent cleaning that results in persistent micro-movement 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 €5 to €5 million. When deciding on the extent of cover required (and thus the premiums that will need to be paid), the particular cir-

cumstances of the practice need to be considered. An indemnity insurance policy will also cover the practice’s personnel but may exclude temporary employ-

ee’s. 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 prac-

tices as far as their policies are concerned.

In cases in which an ortho-

dontist 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, policy-

holders should always contact their insurers and inform them of the extent of the range of treatments provided, partic-

ularly if the policy does not specifically cover surgical or im-

plant procedures. In this case, the annual premium is likely to be increased by €20 to €50 (applica-

ble 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.

Duty of information

Prior to beginning any proce-

dure, the patient must be informed of the nature and effect of potential risks, of alternative treatments and of the consequences of no treatment were to be provided. It is a good idea to use pre-printed material to gather information on medical history and provide information. These facts set an aide-mémoire or prompt when in-

terviewing the patient. Written material should not be used to replace personal dialogue. The printed material used must document (e.g. in the form of a note) that the relevant verbal information has been given to the patient. It is not enough to have the signature of the patient, a witness and the practitioner.

Documentation

Documentation is an absolu-

tely essential aspect. Treatment records (patient card, X-ray plates, models etc.) must clearly docu-

ment the course of the procedure and any problems or complica-

tions. Lawsuit is often lost owing to incomplete documentation.

Insurance claims

If a patient suffers an injury or registers a claim, it is advisable to contact the policy provider. The insurer will supervise all the financial and legal aspects.

Summary

The main parameters that de-

termine the clinical success of a procedure are the bone quality and space available at the planned insertion site, the use of an inser-

tion technique suitable for the system employed, and the use of a carefully considered biome-

chanical concept and the preven-

tion of inflammation around the miniscrew. There are many rea-

sons for failure, and these are interconnected, rather like the pieces of a jigsaw puzzle (Fig. 10).

Concluding remarks on the article series

These should cover many aspects of bone anchorage using miniscrews. The authors hope that they have achieved the objec-
tives set out at the beginning of the series and provided the (as yet un-

decided) 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 inter-

ested practitioners to the relevant literature. But all theory remains just that if it is not applied in prac-

tice. We should be pleased if you, our readers, found the courage to use miniscrews routinely in your work. And we—in Dr Ludwig, Dr Glas (both Trauen-Trabach), Dr Lietz (Neltingen) and Prof. Liason (Clinic of Orthodontics, Saarland University Hospital)—wish you every success.

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