successful treatment with mini-screws. Such planning includes a comprehensive anamnesis and an accurate assessment of the findings. It is essential that the treatment be thoroughly explained to the patient.

Proper hygiene must be ensured throughout the entire operation. Both the chair and the treatment process must be prepared with this in mind.

During the insertion of a mini-screw, adherence to all hygiene measures required for an invasive procedure, such as a sterile work environment and gloves, must be ensured. All instruments required for insertion must be checked for completeness, functionality and sterility.

The patient may rinse with a disinfectant solution, or a suitable disinfectant can be locally applied. The patient should then be positioned to ensure a clear view of the operational area and ergonomically facilitate insertion for the treating clinician.

Pre-operative planning
To function correctly, a miniscrew requires firm anchorage in the bone (primary stability) and the positioning of its head in the denser gingival tissue (gingiva alveolaris). The selection of the insertion site must take clinical and para-clinical findings into account (X-ray image, model), as well as the goal of the treatment and the resulting orthodontic appliance.

For interradicular insertion, a bone thickness of at least 0.5 mm around the miniscrew is required. This means that for a miniscrew with an — for many reasons — optimal diameter of 1.6 mm, the roots must be at least 2.6 mm from each other. Thus, the bone status and the longitudinal axis of the insertion site must be carefully evaluated.

Basic information regarding this is obtained by carrying out measurements on the model. It often helps to mark the vertical axis of the teeth and the progression of the muco-gingival line on the model, based on the clinical and radiological findings. This will allow for an improved assessment of the spatial circumstances in combination with the X-ray image.

To assist the accurate determination of the insertion site, X-ray aids (Fig. 1) are available. Although their use facilitates the selection of the insertion site, they cannot replace other diagnostic measures.

This is because, depending on the positioning of the X-ray tube, object, film, and/or sensor, all types of X-ray devices and images may yield some optical distortion. Interpretation of images can thus
lead to false-negative or false-positive results (Figs. 2a–c). Therefore, the placement of a miniscrew should always be based on the clinical findings. If a miniscrew is to be inserted into an area in which there is no risk of damage to roots, nerves or blood vessels (e.g. into the palate just behind the transverse line linking the two canines), the position of the screw may be freely chosen (Figs. 3a–c).

Anesthetic

During the interradicular insertion of a miniscrew, the sensitivity of the periodontal tissue of the adjoining teeth should be retained. For this reason, the following two procedures are recommended:

a) a low-dose injection of about 0.5 ml anesthetic (Figs. 4a, b); and

b) the induction of superficial anesthesia of the mucous membrane at the insertion site, for which a topical anesthetic gel is suitable (Figs. 5a, b). No general anesthetic is ever required for this procedure.

Checklist for insertion

Pre-operative planning and preparation:
- planning documentation (X-ray, situational models);
- marking of the muco-gingival line and tooth axes on the model, determining the site of insertion; and
- sterilization of the instruments and preparation of the workstation.

Anesthetic and assessment of the insertion site:
- anesthetic;
- use of X-ray aids; and
- control image.

Selection of the screw:
- measuring of the thickness of the mucous membrane (optional);
- determination of the length; and
- determination of the type of screw.

Transgingival penetration:
- excision of the mucous membrane or perforation with the screw.

Preparation of the bone site:
- optional marking of the bone; and
- perforation of the cortical bone or deep pilot drilling, depending on the type of screw.

Insertion of the miniscrew:
- manually or by machine.

Start of orthodontic measures:
- attaching and fixing of the linking elements.

Post-operative care:
- notes on care and behaviour; and
- check-up dates.

Removal of the miniscrew:
- removal of the linking elements; and
- removal of the miniscrew.
Measuring of the thickness of the mucous membrane

A pointed sensor with an attached rubber ring is used to measure the thickness of the gingival tissue in the direction of insertion (Fig. 6). This information may be useful when determining the final length of the screw and possibly when inserting the miniscrew. When choosing the length, the bone repository and the thickness of the mucous membrane in the direction of insertion play a role; in the retromolar section of the lower jaw and in the palate, the thickness of the mucous membrane is often more than 2 mm.

The part of the miniscrew inside the bone must be at least as long as the part outside the bone. The various dimensions must be taken into account.

The thickness of the bone in the direction of insertion determines the required length of the miniscrew:

- bone thickness greater than 10 mm: miniscrews with a length of up to 10 mm are to be used;
- bone thickness less than 10 mm and greater than 7 mm: miniscrews with a length of 8 mm or 6 mm are to be used; and
- bone thickness less than 6 mm: miniscrews cannot be used.

The following guidelines aid in selecting the length:

- in the buccal region of the upper jaw: 8 mm or 10 mm;
- in the palatal region (depending on the region): 6, 8 or 10 mm; and
- in the lower jaw: usually 6 mm or 8 mm.

 Determination of the type of thread

Self-cutting miniscrews require pre-drilling (also known as pilot drilling) appropriate to the length and diameter of the screw, as well as to the quality of the bone. A self-tapping miniscrew will find its own way into the bone and requires no pre-drilling (Figs. 7a, 7b).

Bone is more or less elastic depending on site, age and structure. However, the screw diameter, the thickness of the cortical bone and the hardness of the bone at the insertion site limit the extent to which this method can be used.

Without pre-drilling, the bone will be strongly compressed during insertion and thus suffer a related tension stress. This may result in the cracking of the bone around the insertion site.

When the screw is screwed into the bone, it is subjected to high loads. Depending on the bone quality, the resistance against insertion and the continuity of the rotational movement, high torsional forces can result.

In regions with thick cortical bone and a much looser bone structure (e.g. the upper jaw), the use of self-tapping screws is recommended. In regions where the cortical bone is thick and the bone structure is dense (e.g. the anterior lower jaw) both self-cutting and self-tapping screws may be used, in each case following perforation of the compact bone.

Transgingival penetration

The miniscrew must penetrate through gingival tissue, which must thus be perforated during insertion. Two methods are used for the perforation of the gingival tissue: a) excision of the gingival tissue; or b) direct insertion of the screw through the gingival tissue.

There are currently no published studies that investigate the effect of these two methods on post-operative problems, histological effects and/or the loss rate of miniscrew.

Preparation of the bone site

Protection of the bone is an important aspect. Insertion without pre-drilling results in tensile stress within the bone, which may lead to post-operative complications.

Particularly in the case of crestally placed screws, bone displacement may result in a severe expansion of the periosteum. The thickness of the cortical bone, especially in the lower jaw, can have a significant effect on the torque of the screw.

To ensure that the screw is not overloaded during insertion, the compact bone of the anterior lower jaw should be perforated by pre-drilling as mentioned earlier. Pre-drilling should be done at a maximum of 1,200 rpm¹, using a short pilot drill and water-cooling to reduce the risk of damaging the root (Figs. 8a, 8b).

Insertion of the miniscrew

The miniscrew must be removed from its sterile packaging (Fig. 9) or the work rack (Figs. 10a-d) without contamination. The thread of the screw may not be touched. The screw should be inserted at a constant rotational speed (at approximately 50 rpm) and with as uniform a torque as possible.

Manual insertion

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screwdrivers and blades in several lengths for the manual insertion of the screws.

Because of their dimensions, long blades pose the risk of attaining a very high torque during insertion. Thus, insertion must be carried out carefully to avoid breaking the miniscrew.

Torque ratchets are available for use with some systems (e.g. tomas, DENTAURUM; and LOMAS, Mondeal), which provide a certain amount of control over the insertion torque.

Machine insertion
Machine insertion requires a surgical treatment unit (the torque of which can be controlled) or at least a low-rpm dual-green handpiece. Accurate setting of the torque and the number of rotations is required; the rotation rate should not exceed 30 rpm¹, and the torque must be restricted to the maximum load limit of the screw. Machine insertion helps to achieve a consistent torque during insertion but means that the operator loses perception of the bone. During manual insertion, it is possible to perceive the interaction between the screw and the bone by tactile senses. Insertion by machine is shown in figures 11a–f.

Attaching the orthodontic linking elements
As no healing phase is required, load may be placed on the miniscrew immediately after insertion. The selected linking element must be prepared accordingly and attached to the head of the screw (Fig. 12). To avoid damage to the teeth to be moved, the load on the linking element should be between 0.5 and 2 N (about 50 and 200 g).

Basic post-operative care
The healing of the gingival tissue and hygiene status after insertion must be regularly reviewed during the entire time the miniscrew remains in place. The patient must be informed that any manipulation of the screw head with the fingers, tongue, lips and/or cheeks should be avoided; otherwise the screw may be prematurely lost.

Removal of the miniscrew
A miniscrew can be removed under local anesthesia. After the linking elements have been removed, the miniscrew may be removed with the same tools used for insertion. The resulting wound requires no special care and usually heals within a short time.

Editorial note: A complete list of references is available from the publisher. This article first appeared in Dental Tribune Asia Pacific, No. 3, 2009. The next edition of Ortho Tribune will feature “Part III — Clinical examples.” All photos were provided by the authors.