Miniscrews—a focal point in practice
Six-part series by Dr Björn Ludwig, Dr Bettina Glasl, Dr Thomas Lietz & Prof. Jörg A. Lisson—Part I

In view of the plethora of publications, courses, and advertising material on this subject, it would seem that miniscrews are widely used. Once some candid questions have been asked and answered, however, it becomes apparent that the reality is quite different. It seems evident that there are valid reasons that miniscrews are not yet in daily use in many practices. With this series, the authors intend to encourage those practitioners who are hesitant to use miniscrews to use them routinely, by providing a compendium of experiences and new findings in this field.

The basis and history of anchorage: the selection of screws
Anchor in general
Moving a body requires an anchorage of the form of a counter support. The force required for the movement acts on both body and abutment. In his theory of anchorage, the support is provided by the individual teeth. Figure 1.1a shows that a single premolar is not sufficient as an abutment to distalise a canine. The premolar is clearly distalised in reaction to the application of force. Figure 1.1b shows how two, equally strong, anchorage segments are formed. Action and reaction are comparable in this case; the result is reciprocal tooth movement. In the case of maximum anchorage (Fig. 1.1c), the posterior group of teeth is secured and held stationary by using a miniscrew. The canine can be retracted by the complete force vector, as the reactive force is completely absorbed by the anchorage block formed.

Apart from anchorage quality, the basis, ie, the type of anchorage location, plays a role.

History and overview of skeletal anchorage
Bony anchorage has its roots in Gainsforth’s unsuccessful attempt to insert screws into the jawbone as load anchors in 1945. Many later experiments were unsuccessful and the method had become obsolete by the late 1970s. From 1980 onwards, various research groups (such as Creekmore, Roberts, and Turley8) took up the subject once more. Creekmore published the first, clinically successful patient treatment case.

There are now numerous options for cortical anchorage (Fig. 1.2), including (artificial or pathologically) avulsed teeth on the basis of miniplates normally used in crani-maxillo-facial surgery and the use of prosthetic implants. Vehrenkam and Glatzmaier were the first to present an implant system specifically designed for orthodontics.20 A number of such miniplates are currently available from 2 to 154 different types. The most important decision-making criteria for choosing implant systems are discussed below.

Material
All miniplates are made from pure titanium or from an alloy of titanium with aluminium or vanadium. The biocompatibility of such materials, the metal surface of which is in direct contact with the bone, has been firmly established.13,14

Osseo-integration
Bränemark was the first to define the concept of osseo-integration, which he described as “a direct functional and structural link between living bone tissue and the surface of a force-absorbing implant.”15,16 Several authors, such as Costa and Maino, view an-

1. dental or desmodontal support: for jaw orthodontic and orthodontic devices (nance, palatal arch, lingual arch, lip bumper);
   - modification of fixed appliance (buccal root torque, blocking); and
   - incorporation of the teeth of the other jaw (Class II or III elastic bands).
2. extra-oral support:
   - headgear; and
   - face mask.
3. endosseal support:
   - implants, miniscrews, etc.

This article only deals with anchorage in bony structures. The terms skeletal or cortical anchorage are used interchangeably in this case.

1. dental or desmodontal support: for jaw orthodontic and orthodontic devices (nance, palatal arch, lingual arch, lip bumper);
   - modification of fixed appliance (buccal root torque, blocking); and
   - incorporation of the teeth of the other jaw (Class II or III elastic bands).
2. extra-oral support:
   - headgear; and
   - face mask.
3. endosseal support:
   - implants, miniscrews, etc.

There are now numerous options for cortical anchorage (Fig. 1.2), including (artificial or pathologically) avulsed teeth on the basis of miniplates normally used in crani-maxillo-facial surgery and the use of prosthetic implants. Vehrenkam and Glatzmaier were the first to present an implant system specifically designed for orthodontics.20 These orthodontic jaw implants, which are already used in palatal implants (HDC), are mainly inserted into the palate. This method has been found to be both safe and successful.

In recent years, the requirements for cortical anchorage techniques have been defined in the literature. However, upon closer inspection, only orthopaedic mini-implants meet these requirements favourably, in terms of:

- biocompatibility;
- small size;
- simplicity of insertion and use;
- primary stability;
- immediate load capacity;
- adequate resistance against orthopaedic forces;
- usability with standard orthopaedic appliances;
- independence of patient cooperation;
- clinically superior results in comparison with standard alternatives;
- ease of removal; and
- cost-effectiveness.

Mini-implants
Any form of skeletal anchorage, including miniscrews, is by definition an implant: “An implant is an artificial material implanted into the body, which is to remain there either permanently or for an extended period.”

More than thirty different types for orthodontic screws are used in the international literature. The most common of these are mini-implant and miniscrew, while the terms mini-implant or mini-implants are preferred when speaking to patients. At present, there are over thirty manufacturers of mini-implant systems (Fig. 1.5). The number of screws per system ranges from two to 154 different types. In order to assist practitioners in selecting such devices according to their practice’s needs, the most important decision-making criteria for choosing implant systems are discussed below.

Material
All miniplates are made from pure titanium or from an alloy of titanium with aluminium or vanadium. The biocompatibility of such materials, the metal surface of which is in direct contact with the bone, has been firmly established.13,14

Osseo-integration
Bränemark was the first to define the concept of osseo-integration, which he described as “a direct functional and structural link between living bone tissue and the surface of a force-absorbing implant.”15,16 Several authors, such as Costa and Maino, view an-

1. dental or desmodontal support: for jaw orthodontic and orthodontic devices (nance, palatal arch, lingual arch, lip bumper);
   - modification of fixed appliance (buccal root torque, blocking); and
   - incorporation of the teeth of the other jaw (Class II or III elastic bands).
2. extra-oral support:
   - headgear; and
   - face mask.
3. endosseal support:
   - implants, miniscrews, etc.

This article only deals with anchorage in bony structures. The terms skeletal or cortical anchorage are used interchangeably in this case.

1. dental or desmodontal support: for jaw orthodontic and orthodontic devices (nance, palatal arch, lingual arch, lip bumper);
   - modification of fixed appliance (buccal root torque, blocking); and
   - incorporation of the teeth of the other jaw (Class II or III elastic bands).
2. extra-oral support:
   - headgear; and
   - face mask.
3. endosseal support:
   - implants, miniscrews, etc.
choring a miniscrew not as osseo-integration, but as a skeletal re-
sistance block.18,19 In the opinion
of Cope and Bamann, miniscrews
are anchored by mechanical sta-
bilisation and not by osseo-inte-
gration.20,21

Diameter of the miniscrew

The diameter of the mini-
screws on the market varies be-
tween 1.2 and 2.3 mm. Diameter
specifications of a screw normally
refer to its outer diameter, ie, the
size of the shaft, including the
thread. For secure and primarily
mechanical anchorage, a certain
amount of bone is required
around the screw. To date there
have been no studies on the
amount of bone actually required;
the information available sug-
gests 0.5 to 2 mm. At an inter-
radicular level, the amount of
space available prescribes the
maximum diameter of the screw.

Poggio et al.22, Schnelle et al.23,
and Costa et al.24–25 provide some
suggestions as to the vertical
space required, ie, the space be-
tween the enamel/cement inter-
face and the mucogingival line.
These investigations clearly indi-
cate that the diameter of a mini-
screw should not exceed 1.6 mm.

It should be noted that the stabil-
ity of a miniscrew in the bone de-
PENDS on its diameter and not on
its length.26–27

Length of the miniscrew

The length of the miniscrews
on the market varies between
5 and 14 mm. Length specifications
of a miniscrew usually refer to the
shaft, ie, the threaded section.
Like the diameter, the length
of the screw selected depends on

Enhance your patients’ confidence with the
range of COREGA denture Fixatives and Cleansers.

Benefits of COREGA denture Fixatives:

- Forms a protective cushion to keep irritating food particles out
- Increases the bite force up to 3 times even for well fitting dentures
- Provides increased denture retention and stability

Benefits of COREGA denture Cleaners:

- Eliminates 99.9% of the odour causing bacteria
- Cleans areas that brushing can miss
- Removes plaque, stains and food debris
- Freshens breath
the amount of bone available. Depending on the region, the total thickness of the bone is between 4 and 16 mm.\(^28\) The length of a screw is of secondary importance to the diameter when it comes to secure anchorage, as mentioned above. Various studies have shown that it is the thickness of the cortical section that plays a more important role.\(^28-31\) As far as the distribution of force over the body of the screw is concerned, FEM analyses have shown that the load is applied only in the region of the cortical bone.\(^32-33\)

When selecting the length of the screw, the depth of the gingiva must also be taken into account, with an average layer depth of 1.25 mm. Thus, the ratio between the length of the head (the part of the screw outside the bone) and the length of the threaded section (the part of the screw inside the bone) should be at least 1:1. Poggi et al.\(^22\) recommend lengths of 6 to 8 mm. Costa\(^24,25\) suggests mini screws with a length of between 6 and 10 mm. Based on these studies, it would appear that it is not necessary to use longer screws. This has been confirmed by numerous clinical studies. Easy identification of length and diameter through colour-coding of the screws can be accomplished by means of anodisation, using for example, Ortho easy (FORESTADENT). A positive side effect of this is that the oxide layer formed results in firmer anchorage of the implant in the bone.\(^34\)

**Screw head**

Some suppliers have a special head variant for each potential application in their range, such as:

- hook tops;
- ball-shaped heads;
- eyelets;
- simple slots;
- cross-shaped slots; and
- universal heads (Figs. 1.8).

The screw head should be very small and compact, to ensure that the patient experiences minimal discomfort. However, it must be large enough for the coupling elements to be securely fastened to it (Figs. 1.9).

**Transgingival portion**

The transgingival portion, also known as the gingival neck, is the most vulnerable part of an implant or a mini screw. Perforation of the gingiva provides a potential access point for micro-organisms, posing the risk of peri-implantitis or peri-implantitis. This is one of the main causes of the premature loss of miniscrews.\(^35-36\) During the immediate post-operative phase, the mucosa should be as close as possible to the screw, to seal the area.\(^37\) The most advantageous shape transgingival column is that of a cone, as this shape naturally results in safe sealing without a pressure zone. This makes it more difficult for micro-organisms to penetrate, thus preventing infections. The cone shape also seals the perforation wound, as a cork would seal a bottle, thus reducing bleeding.

**Conclusions**

The correct method of anchorage with regard to shape and quality is crucial for successful treatment. Maximum anchorage is not necessary in all cases, and thus, neither is the use of a mini screw necessarily essential. From an historical point of view, the cortical anchorage system is, in common with other jaw orthodontic techniques, not new at all. The idea was conceived more than 75 years ago. Of all forms of skeletal anchorage, the mini-implant is the most universally used and is the most suitable for routine use. However, before practitioners can select the most appropriate miniscrew for use in their practice from the large range on offer, they will need to review the literature thoroughly.\(^38\)

Editorial note: A complete list of references is available from the publisher. The next edition of Dental Tribune Asia Pacific will feature Part II – Basic information on the insertion of miniscrews.

Contact Info

Dr Björn Ludwig can be reached at bludwig@kieferorthopaedie-mosel.de.