Claire J Bates

Lucy Chung

# The Use of Implants in Modern Orthodontics

**Abstract:** Recent advances in the use of implants in orthodontics have greatly expanded the scope of tooth movement for the practising orthodontist. Not only in routine high anchorage demanding cases, but also in complex cases where few teeth are available to act as anchors.

Implants in orthodontics are fast becoming another tool for the astute contemporary orthodontist to consider when providing anchorage reinforcement. Perhaps a growing evidence base may suggest that implants, as part of anchorage management, are the future, and that headgear may become consigned to history.

**Clinical Relevance:** This article is intended to highlight to practising dental surgeons the rapidly increasing use of dental implants to reinforce anchorage in orthodontics.

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Good anchorage control lies at the heart of successful orthodontic tooth movement. However, preventing anchorage loss during treatment still remains a challenge in orthodontics.

Anchorage can be defined as the source of resistance to the forces generated in reaction to the active components of an orthodontic appliance and is required to prevent unwanted tooth movement during orthodontic treatment.[1]

Traditional techniques to supplement anchorage have utilized extra-oral methods, such as unpopular headgear devices (Figure 1), which suffer from compliance problems and the risk of eye injury as a major disadvantage. Intra-oral appliances are also useful but still have the disadvantage of some unwanted movement of anchor teeth. Many of the strategies used to reduce anchorage loss during treatment have, to date, provided limited success.

In cases where suitable anchor teeth are missing or non-existent, such as in hypodontia, certain tooth movements are near impossible. This has led orthodontists increasingly to utilize the ability of implants to derive a source of anchorage from the underlying skeletal or alveolar bone. This form of anchorage is known as absolute anchorage and allows the use of available space for desired tooth movement rather than losing some of it to unwanted movement of anchor teeth.

## History

Since the popularization of osseointegrated implants in restorative dentistry, the potential of implants customized for orthodontic use has become increasingly evident. The concept of utilizing metal implants that are screwed into bone to provide orthodontic anchorage is not novel. This was first reported in 1945 by Gainsforth and Higley,[2] who used them to affect tooth movement in dogs. Since this time there has been further development from surgical mini-implants, such as those described by Creekmore and Eklund,[3] who reported use of such implants in the anterior nasal spine to reinforce orthodontic anchorage whilst reducing a deep overbite. It then took several years before Kanomi[4] described a miniscrew implant that was specifically designed for orthodontic use.

## Terminology

The modern use of implants in orthodontics has developed rapidly and can be categorized into:

- Osseointegrated implants; or
- Mechanically retained implants.

**Figure 1**. Traditional use of headgear to reinforce anchorage.

Osseointegrated implants are those with which we are familiar in the dental literature, where the metal structure has integrated with bone to provide a source of absolute anchorage (with the implication that the implant does not move under orthodontic

**CJ Bates,** BChD (Leeds), MClinDent(Dist)(Edin), DDS(Edin), MFDS RCS Ed, MOrth RCS Ed, FTTA in Orthodontics and **LL-K Chung,** BChD (Leeds), FDS RCPS, MSc(Glasg), MOrth RCS(Eng), FDS(Orth) RCPS, Consultant Orthodontist, Edinburgh Dental Institute, Edinburgh.

**Figure 2**. Osseointegrated palatal implant.

**Figure 3**. Variation in screw head design and size. Short screw driver (top); 1.5–2.0 mm diameter stainless steel in lengths of 8–12 mm with short and long head designs (left); 1.2 mm diameter Ti alloy in lengths of 6–8 mm with small head and bracket head designs (right).

loading). These include endosseous, transosseous or subperiosteal implants, such as bone plates.

Mechanically retained implants are essentially bone screws which are able to provide anchorage by mechanically interlocking with bone. There are a confusing number of terms relating to these, such as mini-implants, micro-implants, micro-screw implants, temporary anchorage devices (TADs) and bone anchorage devices (BADs). For the purpose of this article, we shall refer to them as *miniscrew implants*.

Implants can be used to provide anchorage directly or indirectly. The term 'direct anchorage' implies that a force is applied directly to an implant to aid tooth movement. The term 'indirect anchorage' is used when forces are applied to teeth that are stabilized by an implant, ie a midpalatal implant.

## Osseointegrated implants

Sites for osseointegrated implants specifically placed for the purpose of tooth movement are often limited owing to lack of space. They are usually placed close to the mid-palatal suture (Figure 2), in an edentulous part of the ridge, or at a distant site such as the zygomatic buttress with the advantage of being positioned well away from the roots of teeth.

All of these devices need removal after use and their removal requires local anaesthesia and usually the use of a trephine. The procedure is often met with some anxiety for both the patient and the orthodontist since osseointegration can create difficulties in removal after use. For the adult patient with missing teeth, it is tempting to derive anchorage from an endosseous implant that can be ultimately used to restore an edentulous space. Careful planning between the restorative specialist and the orthodontist is essential. However, this can prove frustrating to both as the implant can seldom be placed in the ideal location for both purposes.

The more obvious disadvantages include the necessary time delay (usually 3 months) to allow osseointegration and their contra-indication in growing adolescents when the majority of orthodontic treatment is carried out. There is the risk if such implants are used in growing individuals that midpalatal growth could be affected or that the implant may become infra-occluded as the patient continues to grow.

The cost of materials and chairside time are other considerations when deciding on the use of implants in orthodontic treatment.

Therefore, the main disadvantages of osseointegrated implants may be summarized to include:

- Implant site limitation;
- Need for removal;
- Time lag for osseointegration;
- Growing patient;
- Cost.

As technique and success rate improve, the use of osseointegrated palatal implants in orthodontic anchorage is appearing more frequently in the orthodontic literature.[5,6] Patients appear to accept the use of implants for orthodontic purposes more readily than initially expected, as shown in a recent study by Gunduz *et al*, which reported a high acceptance of palatal implants for orthodontic treatment.[7]

The increased reporting of palatal implants is occurring alongside the expansion of miniscrew implants on the market. High success rates have been quoted from South East Asia by the Korean team[8] and also in Europe by Melsen,[9] whose animal studies confirmed that the immediate loading of these implants was possible.

The remainder of this article concentrates on the use of miniscrew implants in orthodontic treatment as the authors believe that this form of implant is the future of anchorage reinforcement.

## Design features of miniscrews

Miniscrews are usually made of pure titanium or titanium alloy, but some are made of stainless steel (Leone).[10] Titanium is the material of choice for miniscrews owing to its biocompatibility, lightweight characteristics and ability to resist fracture and corrosion.[11] Miniscrews have a generally tapering shape but the diameter of the threaded portion of miniscrews varies[12] (1.2–2 mm). Figure 3 shows two types of miniscrew implants with variations in size, length and screw head. They are available in various intraosseous lengths (6–15 mm) and are usually described as being self-tapping (require an initial pilot hole) or self-drilling (able to cut the bone during insertion). Differing head designs allow for attachment to the orthodontic appliance.

a

b

c

**Figure 4**. **(a–c)** Distal movement of upper right premolar to create terminal premolar to support pontic between premolar and canine. **(b)** Use of one miniscrew implant on the buccal aspect placed as distally as possible. **(c)** Use of 2 implants when one is insufficient; an additional palatal miniscrew to prevent rotation as premolar is distalized.

**Figure 5. (a–c)** Impacted premolar was first intruded to disimpact from molar furcation then extruded. Miniscrew implant was placed between roots of LR5, LR4 and high between UR3, UR2. Intrusion force is applied using nickel titanium coil spring from the miniscrew to traction hook bonded to impacted UR4 to intrude the premolar. Wire auxiliary is bonded to UR3 to prevent soft tissue trauma from the coil spring. Extrusive force was then applied using elastics.

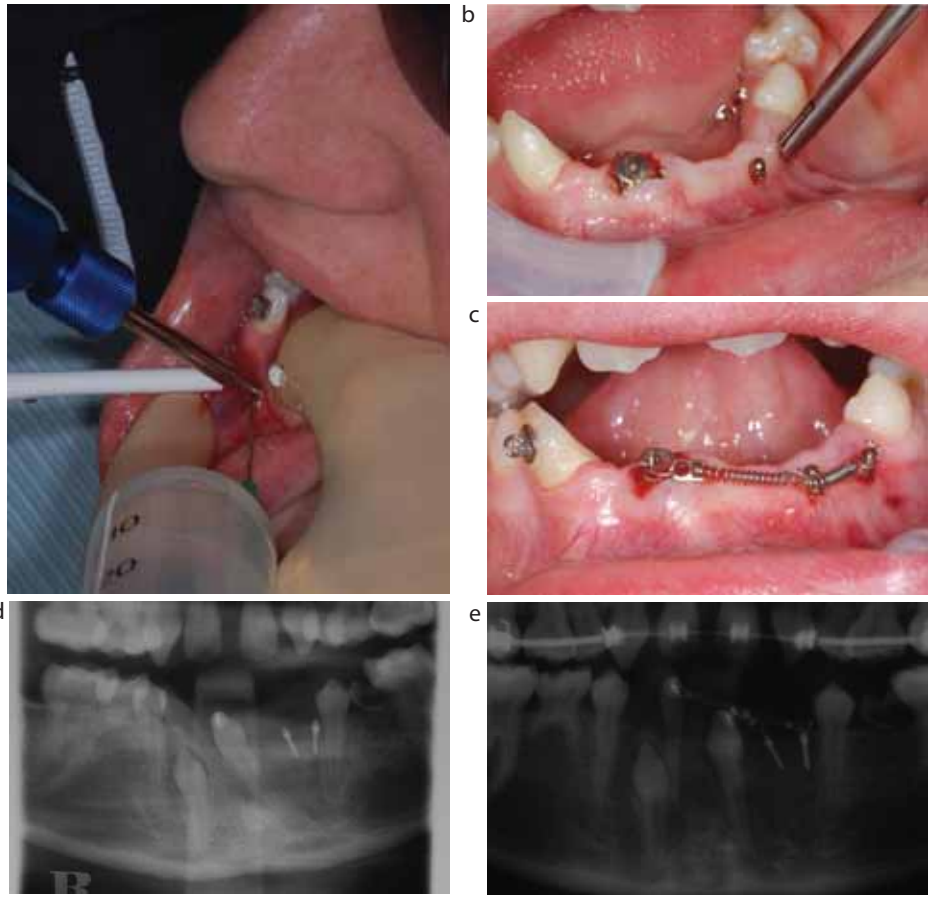

**Figure 6. (a–b)** Insertion of miniscrew implants in a patient with severe hypodontia and impacted teeth. **(c)** Immediately post-insertion and loading of miniscrews using a nickel titanium coil spring to traction hook of exposed LL3 to provide the uprighting force. **(d)** DPT showing positions of miniscrews to help upright impacted teeth. **(e)** DPT showing progress of tooth movements after 6 months using miniscrews.

## Indications for miniscrew implants

Precise indications for the use of miniscrews as sources of orthodontic anchorage are not well documented at present. The majority of published articles are case reports describing new miniscrew designs and demonstrating the use of miniscrews as alternatives to traditional anchorage methods. Authors report that they are able to accomplish tooth movements which would previously have been impossible as a result of anchorage limitations.

The experience so far gained with these devices by the present authors would support this (Figure 4). Three-dimensional control of tooth movement can be achieved in addition to that obtained in the bracket slot prescription. Figure 5 shows intrusion initially to dis-impact the crown of the premolar from the molar furcation, followed by extrusion to erupt the tooth. The tooth movements involved would be extremely difficult with conventional orthodontic appliances.

The use of miniscrews is constantly evolving and, at present, may be indicated in the correction of dental and skeletal discrepancies in the following situations:

- Large amount of tooth movement, eg labial segment retraction or movement of multiple posterior teeth, alignment of ectopic teeth, hypodontia;
- Protraction/retraction of one arch;
- Dental anchorage is insufficient as a result of loss of teeth or periodontal support;
- Lack of compliance with headgear;
- Asymmetric movements;
- Intrusion or extrusion of teeth;
- Intermaxillary fixation after orthognathic surgery.

## Placement

Miniscrews do not rely on osseointegration but on mechanical retention to provide anchorage. Thus, the two-stage procedure historically described by Brånemark[13] is not required and hence they are less technique sensitive than osseointegrated implants. Miniscrews are gaining in popularity as they are simple to place in a variety of locations, easy to remove and can be loaded immediately (Figure 6).

The placement of a miniscrew has been reported as a simple 5–15 minute procedure including anaesthetic,[12] and many orthodontists are confident to place miniscrews themselves. This can be economical and convenient for patients and avoids the necessity of referral to a surgeon. Removal of a miniscrew is also simple and can be carried out with, or often without, local anaesthesia (Figure 7).

## Complications

The potential complications which arise with miniscrews are generally

a

b

**Figure 7. (a–b)** Removal of miniscrew is simple and without the need for local anaesthesia.

minor in nature and can be reduced or avoided with the use of careful technique and planning.

#### Damage to roots or periodontal ligament

A major complication when using miniscrews can be damage to the roots of adjacent teeth during placement. It is thought that damage to the root is unlikely to influence the tooth's long-term prognosis as long as there is no pulpal damage.[9] If the periodontal ligament is contacted, the patient should be informed and the implant should be removed and repositioned. A manual screwdriver is used for insertion rather than a drill so that the operator is able to detect resistance if a root is contacted by the miniscrew. Any resultant damage would be considered minimal.

#### Miniscrew fracture

The risk of fracture of a miniscrew is considered to be low following design improvements and advances in placement techniques. The risk of fracture is thought to be increased in narrow miniscrews. However, their advantage is ease of insertion between the roots of the teeth which reduces the risk of damaging the roots.

#### Soft tissue inflammation/infection

The maintenance of immaculate oral hygiene around a miniscrew is vital to prevent local inflammation, which is thought to be an important factor in miniscrew failure.[12]

#### Instability

If a screw should become loose it will not regain stability and should simply be removed and relocated if necessary.

| | Osseointegrated Implants | Miniscrew Implants |
|---|---|---|
| **Advantages** | ■ Avoid roots of neighbouring teeth<br>■ Osseointegration | ■ Easy to insert and remove<br>■ Immediate loading<br>■ Increased choice of locations<br>■ Placement by orthodontist<br>■ Economical |
| **Disadvantages** | ■ Implant site limitation<br>■ Time lag for osseointegration<br>■ Avoid in growing patients<br>■ Cost<br>■ Chairside time<br>■ Removal can be difficult | ■ Risk of damage to roots<br>■ Fracture of miniscrews |

**Table 1**. Advantages and disadvantages of osseointegrated and miniscrew implants.

The use of miniscrew implants has been outlined above and their advantages are apparent and can be summarized as follows:

- Easy to insert and remove;
- Immediate loading;
- Increased choice of locations;
- Placement by orthodontist;
- Cost effectiveness.

Table 1 highlights the relative advantages and disadvantages of the two systems, osseointegrated and miniscrews implants currently used in orthodontic anchorage reinforcement.

## Conclusion

Implants are gaining in popularity and success as a source of orthodontic anchorage. Anchorage from the use of osseointegrated implants gained from a restorative abutment, or specifically placed in the palate, have obvious advantages in the adult patient with missing or periodontally compromised teeth. However, mechanically retained miniscrew implants expand the scope for treatment of problems in growing adolescent and adult patients. With both, an element of patient compliance is removed; a factor which can always hamper treatment results. The choice is for the astute contemporary orthodontist to consider, as implants are fast becoming another tool in the provision of anchorage reinforcement.

Perhaps, with a growing evidence base, implants, as part of anchorage management, are the future, and headgear may be becoming consigned to history.

## References


1. Mitchell L. *An Introduction to Orthodontics* 2nd ed. Oxford: Oxford University Press, 2001.
2. Gainsforth BL, Higley LB. A study of orthodontic anchorage possibilities in basal bone. *Am J Orthod Oral Surg* 1945; **31**: 406–417.
3. Creekmore TD, Eklund MK. The possibility of skeletal anchorage. *J Clin Orthod* 1983; **17**: 266–269.
4. Kanomi R. Mini-implant for orthodontic anchorage. *J Clin Orthod* 1997; **31**: 763–767.
5. Cousley R. Critical aspects in the use of orthodontic palatal implants. *Am J Orthod Dentofacial Orthop* 2005; **127:** 723–729.
6. Travess HC, Williams PH, Sandy JR. The use of osseointegrated implants in orthodontics: 2. Absolute anchorage. *Dent Update* 2004; **31**: 355–362.
7. Gunduz E, Schneider-Del Savio TT, Kucher G, Schneider B, Bantleon HP. Acceptance rate of palatal implants: a questionnaire study. *Am J Orthod Dentofacial Orthop* 2004; **126:** 623–626.
8. Park HS, Jeong SH, Kwon OW. Factors affecting the clinical success of screw implants used as orthodontic anchorage. *Am J Orthod Dentofacial Orthop* 2006; **130**:18–25.
9. Melsen B. Mini-Implants: where are we? *J Clin Orthod* 2005; **39**: 539–547.
10. Fortini A, Cacciafesta V, Sfondrini MF, *et al*. Clinical applications and efficiency of miniscrews for extradental anchorage. *Orthodontics* 2004; **1**: 1–12.
11. Prabu J, Cousley RJ. Bone anchorage devices in orthodontics. *J Orthod* 2006; **33**: 288–307.
12. Mah J, Bergstrand F. Temporary anchorage devices: a status report. *J Clin Orthod* 2005; **39**: 132–136.
13. Brånemark P-I, Adell R, Breine U, *et al.* Intra-osseous anchorage of dental prostheses. I. Experimental studies. *Scand J Plast Reconstr Surg* 1969; **3**: 81.