

Temporary skeletal anchorage devices: The case for miniscrews

Sebastian Baumgaertel
Cleveland, Ohio

According to Newton's Third Law, for every action, there is an equal and opposite reaction.¹ Orthodontists must acknowledge this law every time they try to move teeth. Simply stated, every desired tooth movement has the potential to simultaneously create an undesired tooth movement. Orthodontic anchorage is defined as the resistance to such undesired tooth movement and can be achieved by more or less predictable methods.

For space closure, 3 anchorage situations are traditionally defined by the ratio of incisor retraction to molar protraction.² Maximum anchorage describes space closure mostly by incisor retraction and, to a lesser degree, by molar protraction (ratio of 2:1). Moderate anchorage comes with equal parts of incisor retraction and molar protraction (ratio of 1:1), whereas minimal anchorage allows spaces to close mostly by molar protraction and less by incisor retraction (ratio of 1:2). Traditionally, this type of anchorage control relies heavily on other appliances that add to the anchorage segment, such as compliance-dependent headgear or the noncompliance-dependent Nance appliance or, for instance, on elastic wear, which again depends on compliance. Although headgear incorporates skeletal structures into the anchorage segment (eg, high-pull headgear uses the occipital bone), elastics incorporate only other teeth into the anchorage segment, and this carries the potential for further side effects in the opposing dental arch.

The philosophy behind skeletal anchorage is that if the reactive forces can be absorbed by skeletal structures, tooth movement can be limited to the desired therapeutic movements, and the undesirable reactive side effects can be prevented entirely. Such a situation can nowadays be created by temporarily implanting small devices into the patient's jawbone and using

them as anchors for tooth movement. Although many different methods³⁻⁶ have been suggested, only 2 have proven reliable and feasible over the long run: single miniscrews⁵ and miniplates held in place by more than 1 screw.⁶ Since both of these methods have proven to be effective in creating the desired level of anchorage control, there can be no right or wrong in this debate.^{7,8} I am, however, a strong proponent for the use of miniscrew implants. To be clear, this is not a discussion about whether skeletal anchorage makes sense—there is no doubt about that—but, rather, it is a discussion on how skeletal anchorage is best obtained.

INVASIVENESS

The insertion of an orthodontic miniscrew for anchorage purposes is considered minimally invasive. Today, implant-site preparation is obsolete in most cases.

Preparation of the soft tissues is not required unless predrilling is indicated or the insertion takes place in highly mobile mucosa.⁹ Here, a small tissue punch can remove a minimal amount of mucosa to prevent tearing or winding of the soft tissues. Miniscrews placed in attached gingiva or limited-mobility mucosa can be inserted transmucosally with no disadvantages.¹⁰ Reflection of a flap is never indicated. If the cortical bone is excessively thick, it can be prepared with a small predrilling procedure. Further advancement into the cancellous bone is never indicated as long as self-drilling miniscrews are used.¹¹

In other words, the typical miniscrew insertion procedure can easily be carried out in the practice setting by an orthodontist and will only take a few minutes because it simply consists of direct transmucosal placement of the screw.

Likewise, removal of an orthodontic miniscrew implant usually does not require anesthetic and can be achieved simply by counterclockwise rotation of the screw.¹² Postoperative care or instructions are generally not required because the small explanation site heals without difficulty.¹³

Miniplates, in contrast, require the reflection of a flap; this carries greater risks for complications and discomfort.¹⁴ After that procedure, multiple small

Clinical associate professor, Case Western Reserve University, Cleveland, Ohio. Address correspondence to: Sebastian Baumgaertel, Case Western Reserve University School of Dental Medicine, Department of Orthodontics, 10900 Euclid Ave, Cleveland, OH 44106; e-mail, skb155@case.edu.
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screws are inserted to retain the plate, and similar procedures are required for their removal. Some of the screws used can be self-tapping only and require a pilot hole for insertion.¹⁵ Depending on the surgeon, analgesics and antibiotics might be prescribed after the placement of miniplates. Some miniplates might be placed under intravenous sedation or even general anesthesia.^{14,15} These procedures are beyond the scope of what orthodontic practitioners typically do and hence require referral to an oral surgeon. As a result, the costs for the use of miniplates are typically greater, the logistics are more complex, and the possibility for miscommunication between the orthodontist and the oral surgeon is real.⁹ This might explain why orthodontists in the United States who have liability insurance from the American Association of Orthodontists Insurance Company are covered for the insertion of temporary skeletal anchorage devices as long as they do not require reflection of a flap.¹⁶

COMPLICATIONS AND SIDE EFFECTS

Complications of miniscrew placement are rare, and the consequences are generally mild; the most common complication is loosening of the screw, which occurs in approximately 10% to 20% of insertions.^{17,18} The most recent studies have reported greater success rates; this leads me to believe that the most important factors for failure have been identified and can now be controlled.^{19,20} At times, soft-tissue irritation or inflammation can be observed, particularly if the insertion takes place apical to the “zone of opportunity” in highly mobile mucosa.^{10,17,21} I have personally experienced an irritation fibroma after a high infrazygomatic insertion.¹⁰ Root damage upon contact is rare¹⁷ and usually repairs completely as long as the pulp was not damaged during insertion.²² Nerve damage, which is theoretically possible, has not been reported in the scientific literature to date.^{16,21} That is probably because the nerves are easily avoided at the common insertion sites for miniscrew implants.¹³

INSERTION SITES

Miniscrews can be placed almost anywhere in a patient’s jaw where there is sufficient bone to anchor the implant and where no other anatomic structures, such as dental roots or nerves, will interfere with the insertion. This versatility permits freedom of choice so that a site can be selected based on biomechanics, local anatomy, and clinical preference, in addition to the indication, rather than being dictated by the restrictions of the anchorage system.

For miniscrew implants, the anterior palate appears to have the highest success rates, reaching levels comparable to the success of miniplates,⁷ probably because of ideal osseous anatomy, lack of roots, and attached gingiva throughout.²³ Incidentally, this site also comes with a plethora of biomechanical options allowing the treatment of most indications from this highly successful insertion site. However, even a complex insertion site such as the maxillary buccal alveolar process, which has 5 anatomic boundaries, with the dental roots being the most critical, can be rendered less intimidating by some diligent implant site preparation.¹⁸ Diverging roots orthodontically can establish a comfortable interradicular distance at nearly any interdental site allowing, again, the placement of miniscrews at the most suitable site, considering that most orthodontic miniscrews have an outer core diameter of 1.6 to 1.8 mm.¹²

Miniplates typically require fixation with multiple screws, which would make avoidance of roots difficult if placed interradicularly. Therefore, most plates are fixated monocortically in areas without roots, such as apically in the mandibular canine region, and at the infrazygomatic crest, the mandibular retromolar region, and the maxillary nasal process.²⁴ This limitation to mostly buccal application sites can come with some biomechanical restrictions.

INDICATIONS

Miniscrews can be used for dental changes in all 3 planes of space, offering the options of both direct and indirect anchorage, either rigid or nonrigid. This flexibility guarantees that most clinicians can design a setup that fits their treatment philosophy and comfort level. Listing all indications here would be impossible; miniscrews can be used for any high-anchorage situation, and any list would be incomplete. In fact, I do not believe that all indications have yet been explored, and the future will hold many more interesting applications for miniscrew implants. However, the [Table](#) provides an overview of indications that I have successfully treated with miniscrews.

Traditionally, miniplates are considered more appropriate when orthopedic changes are required because they have a greater load-bearing capacity and can be loaded with forces that could modify growth rather than just move teeth.²⁵ However, even here, it appears that the indications for plates and miniscrews are beginning to overlap, especially when miniscrews are used indirectly or rigidly connected.^{26,27}

Table. Routine indications for miniscrew implant support

<i>Dimension of tooth movement</i>	<i>Indication</i>
Anteroposterior	Molar protraction
	Molar distalization
	Anterior retraction
	Full-arch retraction
	Molar uprighting
Vertical	Midline shift
	Posterior intrusion
	Single molar intrusion
Transverse	Eruption of impacted teeth
	Maxillary expansion
	Maxillary constriction (Brodie bite)

BIOMECHANICS

Although the versatility of miniscrews cannot be debated, the biomechanical options clearly depend on the design of the screw head. A detailed discussion can be found in the current literature.¹³

Once the miniscrew is in place, clinicians can apply direct anchorage in which the elastic element spans directly from the screw head to the tooth (or group of teeth) that needs to be moved. This type of setup requires a screw that has an undercut only, is simple to install, and has the advantage that anchorage teeth are never loaded, rendering the debate about whether miniscrews shift under load nearly irrelevant.²⁸ Therefore, screw failure will not result in anchorage loss but simply in mobility or complete dislodging of the screw. The problems with this setup, however, are additional vectors not present in traditional orthodontic mechanics and possible loss of control during tooth movement.

Some miniscrews have a rectangular slot in the head in addition to the undercut. This permits the engagement of various auxiliaries or simply a rectangular wire that can be used for rigid indirect anchorage. Installing this setup might be slightly more complicated but has the advantage that certain teeth can be “locked in,” which means that they will not move during treatment because they are connected to the miniscrew. Here, normal biomechanics can be used with the difference of complete control over certain teeth. A trade-off is the risk of anchorage loss if the screw becomes mobile or the connection between the screw and the tooth fails because the anchorage teeth are directly loaded and only held in place by the miniscrew.

CONCLUSIONS

Miniscrew implants offer an option for high-anchorage orthodontic treatment that is relatively

inexpensive, easily implemented, and predictable enough to be used routinely in practice. Because of the low level of invasiveness and the small likelihood of side effects, the risk-benefit ratio is generally in favor of using miniscrews in most patients, not only for more severe malocclusions. However, the simplicity of the insertion and the low risk of the procedure might be temptations for overuse of these little screws. Therefore, I encourage all miniscrew users to conduct a diligent analysis of any high-anchorage situation to evaluate whether intelligently designed traditional mechanics might deliver comparable treatment results and to use miniscrews only when tangible benefits are apparent. The same analysis should be conducted to decide between the use of miniscrews and miniplates. If done objectively, the result will probably be that miniscrew implants should be used in most high-anchorage situations, and miniplates should be used more rarely, in patients with severe malocclusions that would otherwise necessitate orthognathic surgery.

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