OVERVIEW

The T-Zone: Median vs. Paramedian Insertion of Palatal Mini-Implants

BENEDICT WILMES, DMD, MSD, PhD
BJÖRN LUDWIG, DMD, MSD
SIVABALAN VASUDAVAN, BDSc, MDSc, MPH
MANUEL NIENKEMPER, DMD, PhD
DIETER DRESCHER, DMD, PhD

(Editors Note: In this regular column, JCO provides an overview of a clinical topic of interest to orthodontists. Contributions and suggestions for future subjects are welcome.)

Mini-implants have become a commonly used adjunctive orthodontic treatment modality because of their biomechanical versatility, minimal invasiveness, and relative cost-effectiveness. Innovative solutions have been developed for a variety of treatment objectives, including molar distalization\(^1\),\(^2\) and mesialization,\(^3\) molar intrusion,\(^4\) extrusion of impacted teeth,\(^5\) midline correction,\(^6\) early Class III treatment,\(^7\) and anterior and buccal anchorage.\(^8\)

Although the preferred insertion site for mini-implants is the alveolar process,\(^9\)\(^-\)^\(^13\) this location still shows an average failure rate of 16.1% due to varying bone and soft-tissue conditions.\(^14\)\(^-\)^\(^17\)

Five strategies have been proposed to enhance the prospects of successful mini-implant retention:

1. Select the optimal insertion site.
2. Avoid direct root contact with the implant.
3. Avoid placing an implant within the intended path of tooth movement.

Dr. Wilmes is a Professor, Department of Orthodontics, University of Düsseldorf, Moorenstrasse 5, 40225 Düsseldorf, Germany; a Visiting Professor, Department of Orthodontics, University of Alabama at Birmingham School of Dentistry; and the developer of the Benefit System; e-mail: wilmes@med.uni-duesseldorf.de. Dr. Vasudavan is an adjunct faculty member, Department of Dentistry, Boston Children’s Hospital, and a Visiting Lecturer, Department of Developmental Biology, Harvard School of Dental Medicine, Boston. Dr. Ludwig is a Contributing Editor of the Journal of Clinical Orthodontics; an Instructor, Department of Orthodontics, University of Homburg, Saar, Germany; and in the private practice of orthodontics in Traben-Trarbach, Germany. Dr. Nienkemper is a Visiting Lecturer, Department of Orthodontics, University of Düsseldorf, and in the private practice of orthodontics in Düsseldorf. Dr. Drescher is a Professor and Head, Department of Orthodontics, University of Düsseldorf.
4. Use tandem implants to prevent tipping and rotational tendencies secondary to the development of couples.

5. Use implants that have sufficient length and diameter.

The anterior palate is a good alternative insertion site because it allows mini-implants with larger dimensions and greater stability\(^1,18\) to be placed in a region with high bone quality, thin overlying soft tissue, and a nearly negligible risk of root damage or interference with teeth.\(^19\) Insertion in the anterior palate rather than the alveolar ridge, combined with the previously listed strategies, can reduce the mini-implant failure rate to as low as 2.1%.\(^20\)

**Mini-Implant Insertion Sites**

The clinician should easily be able to identify the optimal insertion site within the maxilla. Available bone volume, soft-tissue thickness, and proximity to structures such as blood vessels, roots, and nerves must be assessed. Because the bone volume is reduced in the lateral and posterior areas of the palate,\(^19,21\) only a median insertion is possible in the posterior palate. Near the incisors, the palate is covered with the thick soft tissue of the palatal rugae, which is associated with an increased risk of tipping and failure.\(^22\) Additionally, the proximity of such structures as the incisor roots and the incisive canals must be considered.
Therefore, insertion of a mini-implant directly within the palatal rugae can be challenging.

The area immediately posterior to the palatal rugae, referred to here as the “T-Zone”, is a more suitable region for insertion of palatal mini-implants due to the available bone volume (Fig. 1). In a case with symmetrical anchorage requirements, a single mini-implant of adequate length and diameter (for example, 2.3mm × 9mm) may be sufficient (Fig. 2). When rotational torquing forces are applied, two mini-implants may need to be coupled to reduce the risk of tipping and potential failure. Two adjacent mini-implants can be positioned in a sagittal direction (median insertion) or a transverse direction (paramedian insertion).23 If a median pattern of insertion is indicated, the implants are placed along an anteroposterior line within the T-Zone, 7-14mm apart (Fig. 3). For a paramedian insertion, the mini-implants are placed in a transverse configuration; in this case, the presence of thick lateral soft tissue limits the distance between the mini-implants to 5-10mm (Fig. 4).

Mini-Implant Insertion

Insertion of mini-implants typically begins with two paramedian depots of a local anesthetic. The Citoject® is our preferred method of delivery because of its minuscule needle size. If the patient or orthodontist has concerns regarding the use of a needle, the mini-implant may be inserted under a topical anesthetic. In an adult patient, who will usually have areas of high bone density in the anterior hard palate, a pilot hole should be drilled to a depth of 2-3mm (Fig. 5).24 Predrilling is not required in children and young adolescents because of their low bone mineralization.25

A diameter of 2mm or 2.3mm and length of 9mm (anteriorly) and 7mm (posteriorly) will ensure stability of the implant.24-27 The implant can be inserted manually (Fig. 6) or with a motorized implant driver (Fig. 7). Specific differences regarding paramedian vs. median insertion should be considered when determining the placement pattern (Table 1).

To achieve maximal retention within bone, the tip of a median-inserted implant should be...
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perpendicular to the palatal vault (approximately 10-30° perpendicular to the occlusal plane) during insertion. Given the abundant quantity of available bone within the region of the anterior hard palate, a longer, 9-11mm mini-implant can be utilized.\textsuperscript{19}

To reduce the potential risk of incisor root contact and concomitant damage, a paramedian mini-implant should not be angled anteriorly, but should be inserted directly perpendicular to the occlusal plane. Considering the relatively lower volume of bone within this region, a shorter, 7-9mm mini-implant is indicated.

### TABLE 1

**FACTORS TO CONSIDER WITH MEDIAN VS. PARAMEDIAN MINI-IMPLANT INSERTION**

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>Paramedian</th>
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<tbody>
<tr>
<td>Angulation</td>
<td>Perpendicular to the bone</td>
<td>Perpendicular to the occlusal plane</td>
</tr>
<tr>
<td>Mini-implant length</td>
<td>Anterior: 9-11mm; posterior: 7-9mm</td>
<td>7-9mm</td>
</tr>
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</table>

Appliance Construction

When placing a single mini-implant, various abutments can be applied with a small fixation screw on top of the screw head (Fig. 8). To avoid the need for a laboratory procedure, an abutment with a prefabricated .032” or .045” wire can be selected.

In cases with higher anchorage demands, two mini-implants can be coupled using a Bene-plate,\textsuperscript{***} which is available in two different lengths (Fig. 9).\textsuperscript{23} For easy connection to an orthodontic appliance without lab work, a Beneplate with an attached .032” or .045” stainless steel wire is rec-

**NSK, Hoffman Estates, IL; www.nsk-dental.com.\textsuperscript{**}

\textsuperscript{***}PSM Medical Solutions, Tuttingen, Germany; www.psm.ms. Distributed in the U.S. by PSM North America, Indio, CA; www.psm-na.us.
Distalizing Appliance Design

The Beneslider*** is a distalization appliance anchored by one or two mini-implants in the anterior palate, using an .045" stainless steel wire for the sliding mechanism.1,13,23,28 If a single mini-implant is used, an abutment with an attached wire is affixed for the application of distalization mechanics. To improve stability, two mini-implants can be coupled with a Beneplate.23 The Bene-tubes*** of the distalization appliance are engaged in the conventional palatal sheaths of the upper molar bands.

The Beneslider system does not require adjunctive soldering or welding; it can be adapted directly at the chair without an impression or laboratory procedure. If the mini-implants are inserted in a median pattern, a Beneplate with a wire perpendicular to the body is indicated; for paramedian insertion, a parallel wire should be used (Table 2). The extension wire can be angulated to achieve either simultaneous intrusion of the upper molars...
**TABLE 2**
**BENESLIDER DESIGN WITH MEDIAN VS. PARAMEDIAN MINI-IMPLANT INSERTION**

| Supraconstruction using two temporary anchorage devices | Median: Two abutments, or Beneplate with wire perpendicular to the Beneplate body | Paramedian: Two abutments, or Beneplate with wire parallel to the Beneplate body |

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**Case 1**

A 13-year-old male patient presented with upper crowding and incisor protrusion (Fig. 12A). Distalization was performed using a Beneslider appliance and two mini-implants with median insertion (Fig. 12B). After seven months, leveling and alignment were initiated with fixed appliances‡ and an .016” SPEED Supercable†† nickel titanium archwire (Fig. 12C). Total treatment time was 13 months. The results remained stable one year after completion of treatment (Fig. 12D).

**Case 2**

A 9-year-old female patient presented with a lack of space for her upper canines. After a pair of mini-implants was placed in a paramedian pattern (Fig. 13A), a Beneslider was used for distalization (Fig. 13B). After nine months, enough space had been created to begin leveling and alignment (Fig. 13C). Total treatment time was two

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(for an open bite) or simultaneous extrusion (for a deep bite). The distalization force is delivered by compressible springs of either 240g or 500g, which are activated by bilateral locking mechanisms that push the Benetubes distally. Follow-up appointments should be scheduled every four to six weeks.

The premolars and canines normally follow the molars and migrate distally, due to the pull of the interdental collagenous fibers. After molar distalization has been completed, the remaining treatment objectives can be achieved through the use of labial or lingual fixed appliances or clear aligners. The springs are removed from the Beneslider, converting it to a passive device for molar anchorage during anterior retraction.
years. Results remained stable after six months of retention (Fig. 13D).

Discussion

The choice between a median and paramedian pattern of palatal mini-implant insertion depends mainly on the biomechanical plan devised for each patient. There is no difference between the two patterns regarding retention and stability of the mini-implants, even in children and adolescents.29,30

The potential inhibition of transverse maxillary growth by dental implants placed in the median region of the midpalatal suture was investigated in dogs by Asscherickx and colleagues.31 In this study, however, only one control animal was available, and a significant difference was found for only one parameter.32 Moreover, the applicability of the findings to mini-implants is questionable due to the greater diameter and surface roughness of dental implants. In our institution, we have not seen any tendency for median-inserted mini-implants to impede transverse maxillary growth.

In fact, a median insertion may be advantageous due to the reduced risk of injury to the upper-incisor roots (Table 3). A secondary advantage of median insertion is that the mini-implants can be placed more anteriorly, where a maximum distance through the maxillary bone is available. On the other hand, penetration of the incisive canals is more likely than with paramedian insertion. We have never observed a case of persistent anesthesia, even when penetration of the incisive canals was detected with three-dimensional imaging, but such penetration may result in reduced bony anchorage and thus contribute to a higher mini-implant failure...
The anterior palate is an ideal site for predictable and reliable placement of mini-implants. Within the demarcations of the T-Zone, the orthodontist has a choice of positioning mini-implants in either a median or a paramedian pattern. While carefully considering the anatomical features of the insertion site, the clinician must determine the biomechanics needed to achieve treatment goals and then adapt the selected location for specific

### TABLE 3

<table>
<thead>
<tr>
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<th>Median</th>
<th>Paramedian</th>
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<tbody>
<tr>
<td>Insertion with an anterior angulation possible (more available bone)?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Coupling in the line of force (sagittal tooth movements)?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Risk of root damage?</td>
<td>Very low</td>
<td>Yes</td>
</tr>
<tr>
<td>Possible penetration of the incisive canals?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Possible interference with the suture?</td>
<td>Yes</td>
<td>No</td>
</tr>
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</table>

**Fig. 13 Case 2.** A. Mini-implants with paramedian insertion in 9-year-old female patient with lack of space for upper canines. B. Beneslider appliance placed for distalization. C. After nine months of distalization, sufficient space created for leveling and alignment. D. Patient after six months of retention.
appliance design. Median insertion is appropriate for sagittal and vertical tooth movements and for maxillary expansion in patients with palatally impacted upper canines. Paramedian insertion is preferable for rapid maxillary expansion and subsequent sagittal and vertical tooth movements.

REFERENCES