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Tomographic mapping of mandibular interradicular spaces for placement of orthodontic mini-implants

Cristiane Monnerat, Luciana Restle, and José Nelson Mucha
Niterói, Brazil

Introduction: The purposes of this study were to determine the ideal sites for placement of orthodontic mini-implants in mandibular interradicular spaces by using computed tomography (CT) and to suggest length, diameter, and angulation of the mini-implants.

Methods: CT scans were performed on 15 dry human mandibles with 1-mm tomography slices. Measurements were made at 3, 5, 7, 9, and 11 mm heights from the bone crest. Bone thickness was obtained for the buccolingual, lingual cortex, and buccal cortex areas. The mesiodistal interradicular distance and the distance from the bone crest to the mental foramen were also measured. Simulated placement of 1.5 × 9 mm mini-implants was performed in the tomographic images at angulations 10°, 20°, and 30°. Twenty-four 1.5 × 9 mm mini-implants were then placed in the mandibles, and a new set of CT scans was obtained. Mandibles with implants were sectioned, enabling direct observation.

Results: Based on 3000 measurements, means and standard deviations were obtained. The thickness of the mandibular alveolar bone in the cortical buccal and lingual areas, and the interradicular distances increased from the cervical toward the apical aspects. In descending order, the widest spaces were found between the first and second molars, the second premolars and the first molars, and the first and second premolars. Between the premolars, caution should be exercised starting at 9 mm from the bone crest because of the mental foramen. Between the incisors, the placement of interradicular mini-implants is not feasible. Between the first premolars and the canines, no appropriate region was found. Between the lateral incisor and the canine, at a height of 11 mm, a device can be placed but only with utmost care.

Conclusions: The most convenient site for implant placement in a mandible was between the first and second molars, with a 10° to 20° inclination, but orthodontic mini-implants should not exceed 1.5 mm in diameter and 6 mm in length.

The full text of this article can be found at: www.ajodo.org

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EDITOR'S SUMMARY

Demetrios Halazonetis

Orthodontic mini-implants (OMIs) as temporary anchorage devices are increasingly used to facilitate orthodontic treatment and widen the spectrum of what is clinically feasible. Selection of the implant site can be a challenge; we need adequate space for the implant, sufficient distance from roots and other sensitive structures, and high density and thickness of alveolar bone. Although cone-beam computed tomography would provide this information on a per-patient basis, this might be contrary to the "as low as possible" radiation directive. Without that, would you know where the best implant sites are?

These authors used dry adult human mandibles to meticulously measure alveolar bone and space availability at 5 potential interradicular sites (between the lateral incisor and the canine, between the canine and the first premolar, between the premolars, between the second premolar and the first molar, and between the first and second molars). Actual placement of implants followed by radiographic imaging and bone sectioning were used to verify the findings.

The buccal alveolar bone cortex increased in thickness toward the posterior of the mandible and the apical direction. The greatest thickness, exceeding 2.5 mm, was between the 2 molars. This was also the area with the greatest interradicular space and was therefore recommended by the authors as their first choice. Accepting a threshold of 3.5 mm as the minimum interradicular space requirement (1.5 mm for the implant and 1 mm leeway space around it), the authors could seldom find adequate space mesially to the first premolar.

Although your patient's mandible might not have the same dimensions as those used in this study, the

Fig 3. Buccal cortex: **B,** in the mesiodistal orientation.

results can be used as guidelines when planning treatment with OMIs.

Take-home Points

1. In the adult mandible, buccal cortex bone thickness and interradicular space increase from anterior to posterior and from the cervical to the apical areas.
2. The safest implant site is between the first and second molar; the incisor region is not viable.
3. Placing the implant with an inclination almost parallel to the tooth axis allows for maximum contact with bone cortex and minimum penetration.

Q & A

Halazonetis: You used adult mandibles in this study, but OMIs are also placed in children and adolescents. What differences do you expect for these younger patients? Do you have any specific recommendations on implant sites to avoid or to prefer?

Mucha: Although the study was conducted with adult jaws, the situation will be similar in some anatomy aspects in children and adolescents, such as root proximity, but might differ in the height of the ridge bone and the thickness and density of cortical bone. To use this information in a patient, it is necessary to confirm the ideal location for the OMIs, and this should be done with less-invasive methods

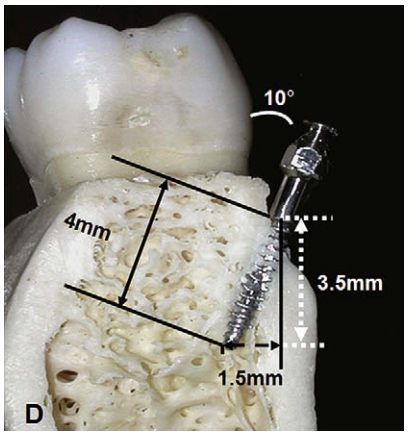

Fig 4. D, 10° angulation relative to the tooth's long axis shows a 4-mm long screw with a mere 1.5 mm of penetration into the bone, thus reducing the risk of damage to the dental roots while increasing contact with bone cortex.

such as periapical radiographs or bite-wings. Even placement of OMIs between premolars, and between premolars and molars, is possible; the posterior regions are the preferred implants sites, with small sizes, even with the risk of setting lower, due mainly to the direction of the lines of the action forces that will be used (anchorage control and intrusion).

Halazonetis: Do you envision the development of alternative types of OMIs for difficult sites in the future?

Mucha: As osseointegrated implants used in prosthodontics had changes in form and composition to fit various sites, the same will happen with OMIs; they will have changes in design and composition to be placed in specific areas to facilitate the mechanics in orthodontics. These are good avenues for future research.