REVIEW ARTICLE

Safe Zones for Miniscrews in Orthodontics: A Comprehensive Review

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ABSTRACT

Miniscrews have been extensively used in orthodontics in the last few years for obtaining absolute orthodontic skeletal anchorage, which is reflected in escalating number of studies addressing this subject. However, there is still no consensus in these studies about the factors that influence the success of mini-implants. The success of mini screws determine various factors like the type of miniscrew, patient characteristics (age & sex), placement site, surgical technique and orthodontic and miniscrews maintenance factors. The present study focused on only one of the factors – miniscrew placement site. The most common sites for placing the miniscrews, the palate, the aspect of the maxillary alveolar process, the retromolar pad in mandible, and the buccal cortical plate in both maxilla and mandible. So the aim of this article was to provide anatomical map for placement of miniscrews in maxilla and mandible and palatal region, based on dimensional mapping of the interradicular spaces and cortical bone thickness.

KEYWORDS: Mini Implants, Safe Zones, Interradicular Bone

INTRODUCTION

In recent times, the use of miniscrews usage increased in orthodontic practice to obtain absolute anchorage. Miniscrews offers many advantages when used as temporary anchorage devices like, easy placement and removal, immediate loading, used in a variety of locations, providing absolute anchorage, economical and requires less patient cooperation. However, concerns about damaging dental roots, allied with the limited inter radicular space; still represent a barrier for the clinical application of these miniscrews. Several studies have been performed to assess the safe locations in the interradicular spaces for miniscrew placement, the so-called ‘‘safe zones.’’ This article provides an overview of the safe zones for mini screws placement in both maxilla and mandible and palatal region.

MINI SCREWS & SAFE ZONE

Skeletal anchorage has evolved as a mainstream orthodontic technique in the past decade. Dental implants,[1,2] miniplates[3,4] and titanium screws[5,6] have been used as skeletal anchorage, because these devices can provide absolute anchorage without patient cooperation. Titanium screws, especially, are currently in vogue because the screws are quite useful for various orthodontic tooth movements with minimal anatomic limitation on placement, lower

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medical cost, and simpler placement with less traumatic surgery.[5, 6, 7]

The major advantages compared with dental implants or microplates, miniscrews are small in size, allowing placement in many intraoral areas, low cost and easy implantation and removal. However, concerns about damaging dental roots, allied with the limited interradicular space, still represent a barrier for the clinical application of these miniscrews.[8,9]

A minimal clearance of 1 mm of alveolar bone around the screw has been recommended to preserve the periodontal health.[10] Therefore, when the diameter of the miniscrew and the minimum clearance of alveolar bone are considered, interradicular space larger than 3 mm is needed for safe miniscrew placement.[10,11] Several studies have been performed to assess the safe locations in the interradicular spaces for miniscrew placement, the so-called ‘‘safe zones”.

Poggio et al[10] evaluated tomographic images of mandible and maxilla to define ‘‘safe zones’’ for placing miniscrews. In the maxilla, they recommended on palatal side interradicular spaces between the canine and the 2nd molar, (except greater palatine area) and on the buccal side between the canine and the first molar. In the mandible, they suggested interradicular spaces between the canine and the second molar.

Assessment of interradicular area is a critical factor for placement of miniscrews in either maxillary or mandibular arch. For assessing the interradicular area periapical radiographs are used which is at fixed magnification. Interradicular area measured between the lamina dura of adjacent tooth roots was calculated using the reference landmarks at the alveolar crest. For example 3,6,9 mm from alveolar creast.[12]

The order of the safer sites available in the interradicular spaces of the maxilla is as follows[10];

- On the palatal side, the interradicular space between the maxillary first molar and second premolar, 2 to 8 mm from the alveolar crest, the interradicular space between the maxillary second and first molars, 2 to 5 mm from the alveolar crest.
- Both on buccal or palatal side, between the first and second premolar, between 5 and 11 mm from the alveolar crest followed by between the first premolar and canine, between 5 and 11 mm from the alveolar crest.
- On the buccal side, in the interradicular space between the first molar and second premolar, from 5 to 8 mm from the alveolar crest.

The optimal site for mini-implant placement in the anterior region is between the central and lateral incisors in the maxilla at the 6-mm level from the CEJ. So, in the maxilla, the more anterior and the more apical, the safer the location becomes.[14]

Table-1: The order of safer sites , available in the inter-radicular spaces in maxillary arch

site	Inter -radicular space	Distance from the alveolar creast
Palatal	1st molar and 2nd premolar	2-8mm
Palatal	1st molar and 2nd molar	2-5mm
Palatal and buccal	1st premolar and 2nd premolar	5-11mm
Palatal and buccal	1st premolar and canine	5-11mm
Buccal	1st molar and 2nd premolar	5-8mm
Buccal	Central and lateral incisor	6mm

In the palatal area safer zones for placement of miniscrews determined based on bone density. Bone density is classified into 4 types D1, D2, D3 and D4. D1, D2, D3 are optimal for self-drilling miniscrews and Implant placement in D4 not recommended.[13] (Table 2)

Table 2: Bone Type and Bone Density

Bone type	Bone density (Houns field units)
D_1	>1250
D_2	850-1250
D_3	350-850
D_4	150-350

Based on bone density mid palatal suture ($D_{1\&}D_{2)}$ in the hard palate considered as safer zone in palate. D_3 bone density seen in paltal slopes at region of 1st, 2nd and 1st molar area. D_4 bone density is seen at the most posterior palate.

Based on Soft tissue considerations, Thin and keratinized mucosa is the preferred area for implant placement. (Table 3)

Amount of keratinisation	Mucosal site	Prognosis
Non-keratinized mucosa	Alveolar mucosa	Greater Failure rates
Gingiva (thin keratinized)	Dentoalveolar (or) mid paltal region	Ideal
Thick keratinized mucosa	Paltal slope	Are less likely to obtain adequate bony stability.

Table -3: Comparision of Mucosal Site And Prognosis

The following is the order of the safer sites available in the interradicular spaces of the mandible:

Interradicular spaces between 2nd and 1st molar, 2nd and 1st premolar, 1st molar and 2nd premolar at 11 mm from alveolar crest and Interradicular spaces between the 1st premolar and canine at 11 mm from the alveolar crest.[10]

The optimal site for mini-implant placement in the anterior region is between the lateral incisor and the canine in the mandible at the 6-mm level from the CEJ.[14] Many factors could play a key role for the mini implant success, such as age, sex, the type and direction of the applied force, the loading period, bone quality, and quantity of the insertion site.

Sex and age affects the anatomic measurements in certain areas in the maxilla and the mandible. The males and the age group older than 18 years had a significantly higher buccolingual, palatal, and buccal cortical thickness at specific levels and sites in the maxilla and the mandible .[15]

In the Maxilla, anteriorly the group older than 18 years significantly has thicker palatal cortex at the 2-mm level from the CEJ and higher buccal and palatal cortical thicknesses at 6 mm. Posteriorly, the group aged 19–27 years had a significantly higher mesiodistal palatal distance at the 2-mm level at the CEJ and a thicker buccal and palatal cortex with a highly significant difference at the 4-mm and 6-mm level from the CEJ. In the Mandible, anteriorly there was no significant difference amongst different age groups. Posteriorly, the group aged 19– 27 years had a significantly thicker lingual cortex at the 2-mm level from the CEJ.[15]

Different dentoskeletal patterns influence the availability of interradicular spaces for miniscrew implant placement .[13] Subjects with Class II skeletal patterns have significantly greater interradicular distances and larger areas in the maxilla when compared with the subjects with skeletal Class III patterns. In contrast, in the mandible, the interradicular distances and areas in the subjects with skeletal Class III patterns are greater than those in the subjects with skeletal Class II patterns. A probable explanation for this is the difference in dentoalveolar compensation observed between these groups. Subjects with skeletal Class II patterns presents with retrognathic mandibles and more upright maxillary incisors than did the subjects with skeletal Class III patterns; as a result, the subjects with skeletal Class II patterns presented with greater amounts of interradicular space in the maxillary arch. In contrast, subjects with skeletal Class III patterns presents with prognathic mandibles combined with excessively retroclined mandibular incisors; therefore, greater amounts of mandibular interradicular space are observed in these subjects than in the subjects with skeletal Class II patterns. The availability of interradicular space was mainly influenced by the axial inclination of teeth due to dentoalveolar compensatory changes for variations in sagittal skeletal discrepancies.[13,14]

The features of the ideal titanium miniscrew for orthodontic skeletal anchorage in the interradicular spaces should be 1.2 to 1.5 mm maximum diameter, with 6–8 mm cutting thread and a conic shape. If the screw is inserted perpendicular to the dental axis, then it obtains less bone support than when inserted at an oblique angle. A miniscrew insertion at 30–40° to the dental axis allows the insertion of a longer screw in the available bone depth. Because of the reduced tip diameter, a conic screw insertion has a lower risk of damaging roots.[14]

CONCLUSION

The safe zone for mini-implant placement in the anterior region is between the central and lateral

incisors in the maxilla and between the lateral incisor and the canine in the mandible at the 6-mm level from the CEJ. At the buccal aspect of the posterior region for all skeletal patterns, the safest zone in the interradicular space of the posterior maxilla was the space between the second premolar and the first molar. In the posterior mandible, the safer zones were located between the first and second premolars and between the first and second molars. Palatally, the optimal site is between the first and second premolars as it has the advantage of the highest cortical thickness.

Many factors could play a key role for the mini implant success, such as age, sex, the type and direction of the applied force, the loading period, bone quality, and quantity of the insertion site. These questions should be opened to future research.

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