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Orthodontology

SAFE ZONES FOR MINI-IMPLANTS IN ORTHODONTICS: A COMPREHENSIVE REVIEW

KEY WORDS: Mini-implants, Safe Zones, Inter-radicular Bone.

Dr. Abdul Baais Akhoon*

PG student, Dept. of Orthodontics and Dentofacial Orthopaedics, Govt. Dental College and Hospital, Shereen Bagh, Srinagar, University of Kashmir. *Corresponding Author

Prof.(Dr.) Mohammad Mushtaq

Professor and Head of the Department, Department of Orthodontics and Dentofacial Orthopaedics, Govt. Dental College and Hospital, Shereen Bagh, Srinagar.

Dr.Assiya Ishaq

Junior Resident, Dept. of Orthodontics and Dentofacial Orthopaedics, Govt. Dental College and Hospital, Shereen Bagh, Srinagar.

ABSTRACT

Miniscrews have been extensively used in orthodontics in the last few years for obtaining absolute orthodontic skeletal anchorage. Many studies are found in literature addressing the subject. However, there is still no consensus in these studies about the factors that influence the success of miniscrew implants. Many factors like the type of mini-implant, patient characteristics (age & sex), placement site, surgical technique and orthodontic and mini-implants maintenance factors determine the success of mini-implants. This study focused on only one of the factors i. e. the mini-implant placement site. The most common sites for placing the mini-implants are the palate, maxillary and mandibular alveolar process, and the buccal cortical plate in both maxilla and mandible.

Summary: The aim of this article is to provide an anatomical map for safe placement of miniscrews in maxilla and mandible and palatal region, based on dimensional mapping of the inter-radicular spaces and cortical bone thickness.

INTRODUCTION

The use of miniscrew usage in orthodontic practice to obtain absolute anchorage has increased in recent times. Mini-implants when used as temporary anchorage devices have many advantages like ease of placement and removal, immediate loading, used in a variety of locations, provide absolute anchorage, economical and requires less patient cooperation. However, concerns about damaging dental roots, allied with the limited inter-radicular space; are a major limitation for the clinical application of these miniscrews. Several studies have been performed to assess the safe locations in the inter-radicular spaces for miniscrew placement to determine the safe zones. This article provides an overview of the safe zones for mini-implant placement in both maxilla and mandible and palatal region.

MINI-IMPLANTS & SAFE ZONES

Skeletal anchorage has evolved as the best means of orthodontic anchorage 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 are currently used much for various orthodontic tooth movements because of their various advantages like minimal anatomic limitation on placement, economical and ease of placement and removal.^{5,6,7}

The major advantages of mini-implants compared with dental implants or microplates are- low cost, easy implantation and removal, and small in size thereby allowing placement in many intraoral areas. However, concerns about damaging dental roots, allied with the limited inter-radicular space are a major limitation for the clinical application of these miniscrews^{8,9}.

To preserve the periodontal health a minimum clearance of 1 mm of alveolar bone around the screw has been recommended.¹⁰ Therefore, inter-radicular space larger than 3 mm is needed for safe miniscrew placement when the diameter of the miniscrew and the minimum clearance of alveolar bone are considered.^{10,11} Several studies have been performed to assess the safe locations in the inter-radicular spaces for miniscrew placement, to determine "safe zones" (Table 1).

Table 1. Summary of articles identifying the greatest mesiodistal distance in the inter-radicular areas

Author	Method	Maxilla	Mandible
Poggio <i>et al.</i> , 2006	CBCT	4-5, 5-6	4-5
Park and Cho, 2009	CBCT	5-6	6-7
Fayed <i>et al.</i> , 2010	CBCT	5-6	5-6, 4-5
Monnerat <i>et al.</i> , 2009	CT	-	6-7
Chaimanee <i>et al.</i> , 2011	IOPAR	5-6	6-7
Schnelle <i>et al.</i> , 2004	OPG	5-6	5-6, 6-7
Our study (2017)	CBCT	5-6	6-7

Poggio *et al.*¹⁰ evaluated tomographic images of mandible and maxilla to define "safe zones" for placing mini-implants. They recommended inter-radicular spaces between the canine and the second molar (except greater palatine area) on palatal side in the maxilla and between the canine and the first molar on buccal side in the mandible. They suggested inter-radicular spaces between the canine and the second molar in the mandible.

Assessment of inter-radicular area is a critical factor for placement of mini-implants in either maxilla or mandible. Periapical radiographs are used at fixed magnification for assessing the inter-radicular area. Inter-radicular area was measured between the lamina dura of adjacent tooth roots using the reference landmarks at the alveolar crest e.g. 3, 6 and 9 mm from alveolar crest¹².

Following is the order of the safer sites available in the inter-radicular spaces of the maxilla¹⁰:

On the palatal side, the inter-radicular space between the maxillary 2nd premolar and 1st molar 2 to 8 mm from the alveolar crest and the inter-radicular space between the maxillary 1st and 2nd molars, 2 to 5 mm from the alveolar crest.

Both on buccal and palatal side, between the 1st and 2nd premolar followed by between the canine and 1st premolar, between 5 and 11 mm from the alveolar crest.

On the buccal side, in the inter-radicular space between the 2nd premolar and 1st molar, from 5 to 8 mm from the alveolar crest (Table 2).

Table 2: The order of safer sites available in the inter-radicular spaces in maxillary arch

Site	Inter-radicular space	Distance from the alveolar crest
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

The optimal site for mini-implant placement in the anterior region is between the lateral incisor and the canine in the mandible at 6 mm level from CEJ¹⁴. The mini-implant success depends on many factors such as age, sex, type and direction of applied force, loading period, bone quality and quantity of the insertion site. These questions should be studied for future research.

The anatomic measurements for safe mini-implant placement in the maxilla and mandible is affected by the sex and age of an individual. The buccolingual, palatal and buccal cortical thickness at specific levels and sites in the maxilla and mandible was higher in the males and was also higher in individuals greater than 18 years old.¹⁵

Different dentoskeletal patterns influence the availability of inter-radicular spaces for mini-implant placement¹³. Class II skeletal patterns have significantly greater inter-radicular distances and larger areas in the maxilla, while as subjects with skeletal Class III patterns have greater distances in the mandible. This could be explained because of the difference in dento-alveolar compensation observed between the two groups. Subjects with skeletal Class II patterns have retrognathic mandible and more upright maxillary incisors, and skeletal Class III patterns have prognathic mandible along with excessively retroclined mandibular incisors. Therefore, the subjects with skeletal Class II patterns have greater amounts of inter-radicular space in the maxillary arch and subjects with skeletal Class III patterns have greater amounts of mandibular inter-radicular space. The availability of inter-radicular space was greatly influenced by the axial inclination of teeth due to dento-alveolar compensatory changes for variations in sagittal skeletal discrepancies^{13,14}.

The features of the ideal titanium miniscrew for orthodontic skeletal anchorage in the inter-radicular spaces should be 1.2-1.5 mm maximum diameter, with 6-8 mm cutting thread and a conic shape. The screw obtains less bone support when inserted perpendicular to the dental axis than when inserted at an oblique angle. A miniscrew when inserted at 30-40° to the dental axis allows the insertion of a longer screw in the available bone depth. A miniscrew having conical shape has lower risk of damaging roots because of reduced tip diameter¹⁴.

CONCLUSION

The order of the safer sites for mini-implant placement available in the inter-radicular spaces of the maxilla is as follows :

- Between the second premolar and first molar; at 8 and 11 mm height from the alveolar crest.
- Between the canine and first premolar; at 11 mm height from the alveolar crest.
- Between the first and second premolar; at 11 mm height from the alveolar crest.
- Between the lateral incisor and canine; at 11 mm height from the alveolar crest.

The order of the safer sites for mini-implant placement available in the inter-radicular spaces of the mandible is as follows :

- Between the first and second molar; at 2,5,8 and 11 mm from the alveolar crest.
- Between the second premolar and first molar; at 5, 8 and 11 mm from the alveolar crest.
- Between the first and second premolar; at 5, 8 and 11 mm

from the alveolar crest.

- Between the canine and first premolar; at 8 and 11 mm from the alveolar crest.
- Between the lateral incisor and canine; at 8 and 11 mm from the alveolar crest.

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 6 mm level from the CEJ. The safest zone in the inter-radicular space of the posterior maxilla was the space between the second premolar and first molar at the buccal aspect of posterior region for all skeletal patterns. The safer zones were located between the first and second premolars and between the first and second molars in the posterior mandible. On the palatal side, the optimal site is between the first and second premolars as it has the advantage of the highest cortical thickness.

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