

## Assessment of “Safe Zone” of Interradicular Spaces for Miniscrew Implant Placement: A Systematic Literature Review

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**Abstract :** The use of miniscrew implants as an orthodontic anchorage device has become an accepted method for providing absolute anchorage. The purpose of this systematic review was to summarize the safe zones in the interradicular spaces for miniscrew implants placement. The PubMed electronic database was searched for original articles to the end of November 2015. The selection criteria were human anatomical studies, written in English, about the safe zones in the interradicular spaces for miniscrew implant placement. The final selection was completed after the authors read the complete articles. Most of these studies measured the availability of interradicular space in patients without malocclusion, i.e. no severe crowding, no spacing, no missing teeth except the third molars, and no periodontal disease, by using CT images. In these studies, types of occlusion or dento-skeletal patterns of the samples were not specified. In the maxilla and mandible, all interradicular sites had adequate space for miniscrew implant placement; however, the areas with adequate interradicular space at each site presented at different distances from either the cemento-enamel junction or the alveolar crest. In the maxilla, the safest site was between the second premolar and the first molar. In the mandible, the safest sites were between the first and second molars or between the first and second premolars after the authors read the complete articles.

**Keywords:** Anchorage, Orthodontics, Inter- radicular space, Miniscrew implant

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### I. Introduction

Recently, the use of miniscrew implant has become an accepted and reliable method for providing orthodontic anchorage.<sup>1</sup> Mini-implants are a new anchorage paradigm if compared with traditional procedures; they offer many advantages over conventional implants: placement without special preparation, stable and solid anchorage, lower cost, easy placement, and immediate loading.<sup>2</sup>

The dento-alveolar bone was the most favored placement site because it allows the clinician to use simple mechanics for orthodontic tooth movement.<sup>3,4</sup>

The placement of miniscrew in the interradicular bone has been frequently recommended by the specialized literature for allowing simple placement and removal procedures, and for allowing the application of relatively simple force system.<sup>5</sup> In addition; the small size of miniscrew allows its placement into interradicular space. The interradicular alveolar ridge has been a favorable placement site, since direct application of force from the miniscrew head is possible even without flap surgery.<sup>6</sup>

However, the safe placement of miniscrew implants in the dento-alveolar bone depends on the availability of a minimal amount of interradicular bone.<sup>7,8</sup> Moreover, the proximity of miniscrew implants to the dental root has been reported to be an important risk factor for miniscrew implant failure.<sup>9</sup> A minimal clearance of 1mm of alveolar bone around the screw has been recommended to preserve the periodontal health. Therefore, when the diameter of the miniscrew and the minimum clearance of alveolar bone are considered, interradicular space larger than 3mm is needed for safe miniscrew placement.<sup>5</sup>

Therefore, several radiographic and anatomical studies have been performed to accurately assess the availability of interradicular spaces for allowing safe miniscrew implant placement while providing an anatomical guide for placing the implants between the dental roots, the so-called “Safe zones”.

Therefore, the present systematic review was undertaken to answer the following questions.

- What are the available and safest sites in the interradicular spaces for miniscrew implant placement?

## II. Materials And Methods

### Search strategy

To identify all the studies that reported interradicular space assessment for miniscrew implant placement, a literature survey was done by applying the Medline database (Entrez Pub Med, www.ncbi.nlm.nih.gov). The survey covered the period from January 1966 to November 2015. Terms used in the literature survey consisted of skeletal anchorage, miniscrew, miniscrew implant, mini-screw, micro-implant, micro-screw, mini-implant, temporary skeletal anchorage, and were crossed with a combination of the following term; Orthodontics.

### Selection criteria

Human studies written in English were included. Original articles, prospective and retrospective controlled studies were selected. Review articles, case series, case reports, abstract papers, letters, and animal studies were not considered.

### Data collection and analysis

Eligibility of the articles identified by each search engine was determined by reading their respective titles and abstracts. All the articles that appeared to meet the selection criteria on the basis of their abstracts were selected and collected. Articles from abstracts in which not enough relevant information was stated were also obtained. The final selection was completed after the authors read the complete articles, and compared their results.

Data were extracted on the following items: authors and year published, materials used in the study, sample size, age of samples, selection criteria of the samples, type of occlusion of samples, the locations of all available sites greater than 3 mm in horizontal width for miniscrew implant placement in interradicular spaces, Sites greater than 3 mm in horizontal width were identified as safe zones. Where there was more than one possible site greater than 3 mm in horizontal width in an interradicular space, the largest site was recorded as the safest site.

## III. Results

A total of 297 abstracts were identified through PubMed with the selected terms. Two hundred and forty-three of these were excluded because they did not meet the selection criteria. Ten articles were qualified for the final analysis. The number of excluded articles and the reasons for exclusion are reported in Table 1.

**Table 1** Exclusion criteria and number of excluded articles in this systematic review.

Exclusion criteria	Number of excluded articles
Animal studies	28
Review articles and letters	21
Case reports and case series	103
Did not follow the objective of this review	112
Paper written in a language other than English	23
Total number	287

All of these studies reported that the safest sites for miniscrew implant placement in the interradicular spaces, were between the second premolar and the first molar in the maxilla, and between the first and second molar or between the first and second premolars in the mandible (Table 2).

**Table 2:** The available sites for miniscrew implant placement in dento-alveolar bone in the posterior regions reported in the reviewed articles.

Authors and year published	Interradicular spaces identified in studies	The safest sites for miniscrew placement in the interradicular spaces	
		Maxilla	Mandible
		Maxilla	Mandible
Carano et al, <sup>15</sup> 2004	<b>Maxilla:</b> posterior region and between the lateral incisor and the canine	Between the second premolar and the first molar, 2-8 mm from the alveolar crest	Not mentioned
Schnelle et al, <sup>7</sup> 2004	<b>Maxilla and mandible:</b> all interradicular spaces except between the central and the lateral incisors and the premolar regions	Between the second premolar and the first molar, located more than halfway down the root length	Between the second premolar and the first molar Between the first and second molar, located more than halfway down the root length

Ishii et al, <sup>12</sup> 2004	<b>Maxilla:</b> between the second premolar and first molar	Between the second premolar and the first molar, 6-8 mm from the alveolar crest	Not mentioned
Poggio et al, <sup>8</sup> 2006	<b>Maxilla and mandible:</b> all interradicular spaces except the anterior region	Between the second premolar and the first molar, 5-8 mm from the alveolar crest	Between the first and second premolars Between the first and second molars, 2-11 mm from the alveolar crest
Deguchi et al, <sup>13</sup> 2006	<b>Maxilla and mandible:</b> mesial and distal to the first molars, and distal to the second molars	Mesial or distal to the first molar	Mesial or distal to the first molar
Hernández et al, <sup>16</sup>	<b>Maxilla and mandible:</b> all interradicular spaces	Not mentioned	Between the first and second molars
Hu et al, <sup>11</sup> 2009	<b>Maxilla and mandible:</b> all interradicular spaces	Between the second premolar and the first molar, at least 6 mm from the cervical line	Between the first and second molars, less than 5 mm from the cervical line
Lee et al, <sup>6</sup> 2009	<b>Maxilla and mandible:</b> all interradicular spaces	Between the second premolar and the first molar, 4 mm from the alveolar crest	Between the first and second premolars, 4 mm from the alveolar crest
Pajongjit Chaimanee et al <sup>5</sup>	<b>Maxilla and mandible:</b> all interradicular spaces	Between the second premolar and the first molar	Between the first and second molars, followed by the first and second premolars

#### IV. Discussion

This review of the literature highlights pertinent information concerning the safe zones in the maxilla and mandible for miniscrew implant placement in the interradicular spaces. Ten articles identified the available sites for miniscrew implant placement.

##### Safe zones for miniscrew implant placement

For miniscrew implant placement without damage to the periodontal tissue and dental root, a minimum clearance of 1 mm of alveolar bone around the screw is needed.<sup>8</sup> For example, if the diameter of a miniscrew is 1.2 mm, this screw should be considered safe if at least 3.2 mm of space are available in the interradicular space.<sup>8</sup>

All of these studies reported that the safest sites for miniscrew implant placement in the interradicular spaces, were between the second premolar and the first molar in the maxilla, and between the first and second molar or between the first and second premolars in the mandible. However, the areas with adequate interradicular space at each site presented at different distances from either the cemento-enamel junction or the alveolar crest. A probable explanation for the result is the several differences between these studies, such as material, sample age range, characteristics of the sample, especially dento-skeletal patterns of the sample. All of these studies assessed the interradicular spaces in subjects without malocclusion, i.e. no severe crowding, no spacing, no missing teeth, and no periodontal disease.

Several methods, such as panoramic radiography, dehydrated human jaw specimens,<sup>10,11</sup> CT,<sup>6,8,15,16</sup> and micro-CT,<sup>12</sup> have been used to assess the availability of interradicular space for miniscrew implant placement.

Each assessment method has advantages and disadvantages or limitations. In 2004, Schnelle et al<sup>17</sup> evaluated the availability of bone for placement of miniscrew implants by using panoramic radiographs. Panoramic radiography can be useful for assessment of interradicular space in patients. However, the distortion of the images, especially in the premolar region, and the dimensional nature of panoramic radiographs must be considered inherent limitations. Therefore, panoramic radiograph should be carefully used to examine the bone availability for miniscrew implant placement.

Because of these limitations of panoramic radiography, therefore, several studies attempted to assess availability of interradicular space by using other methods, such as dehydrated jaw specimens,<sup>10,11</sup> CT,<sup>6,8,15,16</sup> and micro-CT.<sup>12</sup> The advantage of the use of dehydrated jaw specimens for assessment of interradicular bone, is direct measurement on the jaw bone. However, there are several processes for preparing the specimens, and special equipment, such as a macrocutting machine, is needed. Therefore, the sample size was decreased in these studies because of these limitations.

The use of computed tomography provides 3-dimensional images and can give more accuracy and reliability. However, the use of computed tomography increases radiation exposure, is more expensive, and is difficult to justify in routine clinical practice.<sup>6,17</sup> Therefore, a relatively small sample size was included in the CT image studies.

## V. Conclusion

This systematic review was performed to examine the available evidence to assess the safe zones for miniscrew implant placement in the interradicular spaces and the recommended mini-screw diameters and lengths. The results are summarized as follows.

1. All interradicular sites had adequate space for miniscrew implant placement.
2. In the maxilla, the safest site for miniscrew implant placement was between the second premolar and the first molar.
3. In the mandible, the safest sites were between the first and second molars or between the first and second premolars.

Based on these results, an empirical clinical guideline can be provided. A radiographic evaluation of the available interradicular space in each individual case before miniscrew placement is needed.

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