

การประเมินช่องระหว่างรากฟันสำหรับการปักหมุดเกลียว ขนาดเล็ก: ทบทวนวรรณกรรมอย่างเป็นระบบ Assessment of Interradicular Spaces for Miniscrew Implant Placement: A Systematic Literature Review

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บทคัดย่อ

ปัจจุบันหมุดเกลียวขนาดเล็กสามารถนำมาใช้เพื่อเป็นหลักยึดในทางทันตกรรมจัดฟันได้อย่างมีประสิทธิภาพ วัตถุประสงค์ของการทบทวนวรรณกรรมอย่างเป็นระบบในครั้งนี้เพื่อสรุปถึงตำแหน่งช่องระหว่างรากฟันที่สามารถปักหมุดเกลียวขนาดเล็กได้อย่างปลอดภัย รวมถึงขนาดเส้นผ่านศูนย์กลางและความยาวของหมุดเกลียวขนาดเล็กที่แนะนำให้ใช้ โดยสืบค้นจากฐานข้อมูลออนไลน์พบบัด ตั้งแต่เริ่มมีข้อมูลที่ค้นได้จนถึงสิ้นเดือนธันวาคม พ.ศ.2552 เกณฑ์ยอมรับบทความพิจารณาโดยเป็นการศึกษาในมนุษย์ซึ่งอธิบายถึงตำแหน่งช่องระหว่างรากฟันที่สามารถปักหมุดเกลียวขนาดเล็กได้อย่างปลอดภัย และเป็นบทความที่เขียนเป็นภาษาอังกฤษ การคัดเลือกบทความขั้นสุดท้ายทำโดยการอ่านบทความทั้งหมด การศึกษา

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 and the recommended diameters and lengths of miniscrew implants for use in interradicular spaces. The PubMed electronic database was searched for original articles to the end of December 2009. 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

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ส่วนใหญ่ใช้ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์และศึกษาในผู้ป่วยที่ไม่มีอาการสบฟันผิดปกติ ไม่มีฟันซ้อนเก ไม่มีฟันห่าง มีจำนวนฟันแท้ขึ้นครบยกเว้นฟันกรามแท้ซี่ที่สาม และไม่มีสภาวะของโรคปริทันต์ โดยไม่ได้ระบุถึงชนิดของการสบฟัน หรือลักษณะโครงกระดูกขากรรไกรและฟันของกลุ่มตัวอย่างที่การศึกษาในกระดูกขากรรไกรบนและล่างพบช่องระหว่างรากฟันในทุกตำแหน่งมีขนาดเพียงพอต่อการปักหมุดเกลียวขนาดเล็ก อย่างไรก็ตามระดับที่มีขนาดของช่องระหว่างรากฟันที่เพียงพอในแต่ละตำแหน่งพบห่างจากรอยต่อเคลือบฟันกับเคลือบรากฟันในระยะที่แตกต่างกัน ในกระดูกขากรรไกรบนขนาดของช่องระหว่างรากฟันที่ใหญ่ที่สุดพบที่ตำแหน่งระหว่างฟันกรามน้อยซี่ที่สองและฟันกรามซี่ที่หนึ่ง ส่วนในกระดูกขากรรไกรล่างพบที่ตำแหน่งระหว่างฟันกรามน้อยซี่ที่หนึ่งและสอง หรือตำแหน่งระหว่างฟันกรามน้อยซี่ที่หนึ่งและสอง หมุดเกลียวขนาดเล็กที่แนะนำให้ใช้ในตำแหน่งช่องระหว่างรากฟัน มีขนาดเส้นผ่านศูนย์กลางอยู่ระหว่าง 1.2 ถึง 1.5 มิลลิเมตร และมีความยาวอยู่ระหว่าง 4.0 ถึง 10.0 มิลลิเมตร อย่างไรก็ตามจากผลการศึกษาเหล่านี้เป็นเพียงแนวทางเบื้องต้นทางคลินิกประกอบการพิจารณาในการปักหมุดเกลียวขนาดเล็กควรคำนึงถึงความแตกต่างของการสบฟันผิดปกติและลักษณะของโครงกระดูกขากรรไกรและฟัน รวมถึงความแตกต่างระหว่างบุคคลซึ่งอาจมีผลต่อขนาดของช่องระหว่างรากฟันด้วย

คำสำคัญ: หลักยึด ทันตกรรมจัดฟัน ช่องระหว่างรากฟัน หมุดเกลียวขนาดเล็ก

after the author 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. The recommended miniscrew diameters ranged from 1.2 to 1.5 mm with the lengths ranging from 4.0 to 10.0 mm. Based on these results, an empirical clinical guideline can be provided. However, various malocclusions and dento-skeletal patterns, and individual variations must be considered.

Keywords: anchorage, orthodontics, interradicular space, miniscrew implant

Introduction

Recently, the use of miniscrew implants has become an accepted and reliable method for providing temporary additional anchorage during orthodontic treatment.⁽¹⁻⁵⁾ Because these miniscrews use the bone as anchorage, they have become broadly accepted as viable alternatives to extra-oral devices in patients who either have

insufficient dental support suitable for anchorage or who are not compliant in wearing extra-oral devices.⁽⁶⁻⁸⁾ Moreover, because of their small size, they can be inserted in sites that were previously unavailable, such as the interradicular space.⁽⁸⁻¹²⁾

The placement of miniscrew implants in the dento-alveolar bone has been frequently recommended in the specialized literature for allowing

simple placement and removal procedures, and for allowing the application of relatively simple force systems.^(13,14) However, concerns of damaging dental roots because of limited interradicular space still represent a barrier for the clinical application of miniscrew implants.^(10,15-17)

For miniscrew implant placement without damage to the periodontal ligament and dental root, several clinical guidelines have proposed that an interradicular space of at least 3 mm is needed.^(9,18) Therefore, 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”.^(9,11,18-21) Nevertheless, these studies had various study designs, sample sizes, characteristics of samples, and research approaches. 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?
- What are the recommended diameters and lengths of miniscrew implants for use in interradicular spaces?

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 December 2009. Terms used in the literature survey consisted of skeletal anchorage, miniscrew, miniscrew implant, mini-screw, microimplant, 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 author 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, and miniscrew diameters and lengths recommended for placement in interradicular spaces. Sites greater than 3 mm in horizontal width were identified as safe zones. Where there were 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.

Results

A total of 253 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	23
Review articles and letters	16
Case reports and case series	87
Did not follow the objective of this review	98
Paper written in a language other than English	19
Total number	243

Summarized data of the ten articles selected according to the selection criteria are listed in Table 2. Most of these articles used CT images for assessment of the availability of interradicular space, buccolingual bone width, and cortical bone thickness, except for those of Schnelle et al,⁽⁹⁾ which used panoramic radiographs, and Kim et al⁽²⁰⁾ and Hu et al,⁽²¹⁾ which used human jaw specimens for assessment. The numbers of samples ranged from 5⁽²²⁾ to 60.^(9,23) There were differences in the ages of the samples between these articles. Most of these studies measured these parameters in middle-aged samples, except for those of Hu et al,⁽²¹⁾ which used older samples, whereas Schnelle et al⁽⁹⁾ and Ishii et al⁽²²⁾ did not identify the age of the samples. In most of these articles, types of occlusion or dento-skeletal patterns of the samples were not specified, excepted for those of Deguchi et al,⁽¹⁹⁾ Lim et al,⁽²⁴⁾ and Lee et al.⁽²³⁾ Deguchi et al⁽¹⁹⁾ and Lim et al⁽²⁴⁾ measured the parameters in samples with a skeletal Class I pattern, no severe vertical discrepancy, and average mandibular plane angle, whereas Lee et al⁽²³⁾ measured these parameters in samples with a Class I molar

relationship, normal overjet and overbite, crowding less than 2 mm, and no periapical disease. However, Lee et al⁽²³⁾ did not consider the vertical facial patterns of their samples.

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 3).^(9,11,18,19,21-23,25)

Most of these studies reported that in the maxilla, the availability of interradicular space on the palatal side was greater than that on the buccal side (Table 4).^(11,18,21,22) This indicates that the safer sites for miniscrew implant placement are available on the palatal side. In the maxilla and mandible, all interradicular sites had adequate space (≥ 3 mm) 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. (Tables 4 and 5).^(9,11,18,19,21-23,25) Table 6 shows the recommended miniscrew diameters and lengths in the 10 reviewed articles. Five of the 10 reviewed articles identified recommended miniscrew diameters while the other five articles did not. These articles suggested that the recommended miniscrew diameters ranged from 1.2^(18,22,24) to 1.5^(11,18) mm. In these reviewed articles, the recommend miniscrew lengths ranged from 4.0⁽²²⁾ to 10.0⁽²¹⁾ mm.

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.

Table 2 Summarized data of the ten articles selected according to the selection criteria.

Authors and year published	Materials	Sample sizes	Age of samples	Selection criteria of samples	Type of occlusion of samples
Carano et al, 2004	CT images	3-D images of 50 maxillae from 200 patients	Age range, 20-40 yrs	Not mentioned	Not mentioned
Schnelle et al, 2004	Panoramic radiographs	60 panoramic radiographs	Not mentioned	Minimum radiographic distortion Complete eruption of all second permanent molars	Not mentioned
Ishii et al, 2004	Micro CT images	3-D CT images of 5 maxillary bone	Not mentioned	Permanent dentition The growth period ended No bone destruction No apical lesion	Not mentioned
Poggio et al, 2006	Volumetric CT images	Images of 25 maxillae and 25 mandibles from 2000 patients	Age range, 20-40 yrs	No severe crowding No missing teeth No radiographic signs of periodontal disease	Not mentioned
Deguchi et al, 2006	Volumetric CT images	10 CT images from 5 women and 5 men	Average age, 22.3 yrs	Posterior discrepancy < 3 mm	Skeletal I (ANB = 2°+ 2°) Average mandibular plane angles (35.6°+ 5.6°)
Kim et al, 2006	Maxillary section	23 sections from cadavers (16 men, 7 women)	Average age, 49.5 yrs	Presence of all maxillary premolars and molars	Not mentioned
Lim et al, 2007	CT images	CT images of maxillary bone from 15 men and 15 women	Age range, 23-35 yrs; Average age, 27.3 yrs	No asymmetric occlusion Presence of all permanent teeth (except 3rd molars) No severe crowding No impacted teeth No radiographic signs of periodontal disease	No severe skeletal discrepancy No high mandibular plane angle
Hernández et al, 2008	CT images	CT images of 21 maxillae and 21 mandibles	Age range, 17-21 yrs	No missing teeth No severe crowding No orthodontic treatments undertaken	Not mentioned
Hu et al, 2009	Human jaw specimens	20 mandibles from 17 men and 3 women	Age range, 29-75 yrs; Average age, 63.3 yrs	Not mentioned	Not mentioned
Lee et al, 2009	CT images	CT images of 30 maxillae and 30 mandibles from 24 men and 25 women	Age range, 19-45 yrs; Average age, 27.8 yrs	Crowding < 2.0 mm No periodontal disease with no alveolar bone loss No prosthesis or history of orthodontic treatment	Class I molar relationship Normal overjet and overbite

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.⁽¹⁸⁾ 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.⁽¹⁸⁾

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.^(9,11,18,19,21-23,25) 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

Table 3 *The safest sites for miniscrew placement in the interradicular spaces in the maxilla and the mandible.*

Authors and year published	Interradicular spaces identified in studies	The safest sites for miniscrew placement in the interradicular spaces	
		Maxilla	Mandible
Carano et al, 2004	Maxilla: 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, 2004	Maxilla and mandible: 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, 2004	Maxilla: 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, 2006	Maxilla and mandible: 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, 2006	Maxilla and mandible: 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, 2008	Maxilla and mandible: all interradicular spaces	Not mentioned	Between the first and second molars
Hu et al, 2009	Maxilla and mandible: 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, 2009	Maxilla and mandible: 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

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. However, dento-skeletal patterns of the subject were not specified and taken into account for the assessment of interradicular space.

Previous studies have shown that different patterns of dento-skeletal patterns are directly related to different axial inclination of the teeth due to the dento-alveolar compensation.⁽²⁶⁻²⁹⁾ The differences in dento-skeletal pattern and the respective dento-alveolar compensation of the

subject may affect the availability of interradicular space. Therefore, the effect of these factors on availability of interradicular space for miniscrew implant placement should be further evaluated in future studies.

Several methods, such as panoramic radiography,⁽⁹⁾ dehydrated human jaw specimens,^(20,21) CT,^(11,18,23,25) and micro-CT,⁽²²⁾ 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⁽⁹⁾ 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,

Table 4 Available sites for miniscrew placement in the interradicular spaces in the maxilla.

Authors and year published	Available sites for miniscrew placement in the interradicular spaces in the maxilla	
	Location	Level
Carano et al, 2004	Both buccal and palatal sides More available spaces on the palatal side than on the buccal side. Between the lateral incisor and the canine Between the second premolar and the first molar Between the first and second molars	from the alveolar crest (mm) 2-11 mm 2-8 mm 2-8 mm
Schnelle et al, 2004	Adequate bone for placement was located more than half way down the root length. Between the second premolar and the first molar Between the lateral incisor and the canine Between the central incisors	from the CEJ (mm) 4.7-10.0 mm 6.4-9.5 mm 4.4-10.5 mm
Ishii et al, 2004	Both buccal and palatal sides More available spaces on the palatal side than on the buccal side. Between the second premolar and the first molar	from the alveolar crest (mm) 6-8 mm
Poggio et al, 2006	More available spaces on the palatal side than on the buccal side. Palatal side Between the second premolar and the first molar Between the first and second molars Between the first and second premolars Between the canine and the first premolar Buccal side Between the first and second premolars Between the canine and the first premolar Between the second premolar and the first molar	from the alveolar crest (mm) 2-8 mm 2-5 mm 5-11 mm 5-11 mm from the alveolar crest (mm) 5-11 mm 5-11 mm 5-8 mm
Deguchi et al, 2006	Mesial or distal to the first molar	Not mentioned
Hernández et al, 2008	All spaces except between the lateral incisor and the central incisor, between the lateral incisor and the canine	from the alveolar crest (mm) 3-9 mm
Hu et al, 2009	More available spaces on the palatal side than on the buccal side. Anterior region (buccal side) Anterior region (palatal side) Between the second premolar and the first molar Between the first and second molars	above the cervical line (mm) at least 7 mm at least 9 mm at least 6 mm 8 mm
Lee et al, 2009	Anterior region Between the first and second premolars Between the second premolar and the first molar	from the CEJ (mm) 8 mm 8 mm 4 mm

especially in the premolar region, and the 2-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 speci-

mens,^(20,21) CT,^(11,18,23,25) and micro-CT.⁽²²⁾ 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.

Table 5 Available sites for miniscrew placement in the interradicular spaces in the mandible.

Authors and year published	Available sites for miniscrew placement in the interradicular spaces in the mandible	
	Location	Level
Schnelle et al, 2004	Between the first and second molars Between the second premolar and the first molar Between the lateral incisor and the canine	from the CEJ (mm) 2.5-5.3 mm 4.1-7.0 mm 7.6-10.2 mm
Poggio et al, 2006	Between the first and second molars Between the second premolar and the first molar Between the first and second premolars Between the first premolar and the canine	from the alveolar crest (mm) 2-11 mm 11 mm 2-11 mm 11 mm
Deguchi et al, 2006	Mesial or distal to the first molar	Not mentioned
Hernández et al, 2008	Both buccal and lingual sides Between the first and second molars	from the alveolar crest (mm) 3-9 mm
Hu et al, 2009	Anterior region Between the first and second premolars Between the second premolar and the first molar Between the first and second molars	above the cervical line (mm) less than 10 mm less than 3 mm less than 7 mm less than 2 mm
Lee et al, 2009	Between the first and second premolars Between the second premolar and the first molar Between the first and second molars	from the CEJ (mm) 4 mm 4 mm 4 mm

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.^(1,23) Therefore, a relatively small sample size was included in the CT image studies.

Recommended miniscrew diameters and lengths

Miniscrews for orthodontic anchorage as self tapping type tended to have smaller dimensions (1.3-1.5 mm in diameter) than heretofore.⁽¹¹⁾ Screws with a reduced diameter could lead to increased miniscrew breakage when the screws are inserted or removed, especially in the mandibular bone, which is harder than the maxillary bone.⁽¹¹⁾ The allowable diameter of a miniscrew is influenced by the availability of interradicular space.⁽¹⁸⁾ For miniscrew implant placement without damage to the periodontal tissue or dental root, a minimum clearance of 1 mm of alveolar bone around the screw is needed.⁽¹⁸⁾ In five of the 10 reviewed articles, for miniscrew implant

placement into the interradicular space, the recommended miniscrew diameters ranged from 1.2^(18,22,24) to 1.5^(11,18) mm.

The allowable length of a miniscrew is influenced by the buccolingual bone width of the jaw and the mucosal thickness.⁽²¹⁾ Therefore, several studies have been performed to measure the cortical bone thickness and buccolingual bone width.⁽¹⁸⁻²¹⁾

The length of miniscrew is decided by the interradicular distance, the buccolingual bone width, and the mucosal thickness.⁽²¹⁾ Different interradicular sites presented with different interradicular distances, buccolingual bone widths, and mucosal thicknesses. Therefore, for the different placement sites, the recommended miniscrew lengths ranged from 4.0⁽²²⁾ to 10.0⁽²¹⁾ mm.

A previous study has shown that buccal cortical bone thickness can vary depending on the vertical facial pattern.⁽³⁰⁾ All of the evaluated studies measured the cortical bone thickness in

Table 6 Recommended miniscrew sizes for placement in the interradicular spaces.

Authors and year published	Recommended diameters (mm)	Recommended lengths (mm)	
Carano et al, 2004	1.3 or 1.5 mm	Not mentioned	
Schnelle et al, 2004	Not mentioned	Not mentioned	
Ishii et al, 2004	1.2-1.4 mm	4-8 mm	
Poggio et al, 2006	1.2-1.5 mm	6-8 mm	
Deguchi et al, 2006	1.3 mm	6 mm	
Kim et al, 2006	Not mentioned	Not mentioned	
Lim et al, 2007	1.2 -1.3 mm	Not mentioned	
Hernández et al, 2008	Not mentioned	Miniscrew should not be longer than 7 mm	
Hu et al, 2009	Not mentioned	<p>In the maxilla 8 mm screw between the central incisor and the canine (from 9 mm above the cervical line) between the first and second premolars (from 3 mm above the cervical line) between the second premolar and the first molar (from 3-4 mm above the cervical line)</p> <p>10 mm screw between the canine and the first premolar (from 7 mm above the cervical line) between the second premolar and the first molar (from 5 mm above the cervical line) between the first and second molars (from 8 mm above the cervical line)</p>	<p>In the mandible 6 mm screw between the lateral incisor and the canine (10 mm below the cervical line) between the first and second premolars (from 3-4 mm below the cervical line)</p> <p>8 mm screw between the canine and the first premolar (from 9 mm below the cervical line) between the first and second premolars (from 5-8 mm below the cervical line) between the first and second molars (2-3 mm below the cervical line)</p> <p>10 mm screw between the second premolar and the first molar (from 7 mm below the cervical line) between the first and second molars (from 4 mm below the cervical line)</p>

subjects with average mandibular plane angles. Therefore, the effect of vertical facial pattern of the subject on the cortical bone thickness and stability of miniscrew implant should be further evaluated in future studies.

Conclusions

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 miniscrew 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.
4. The recommended miniscrew diameters ranged from 1.2 to 1.5 mm, with the length ranging from 4.0 to 10.0 mm, depending on the differences

in the availability of interradicular space, buccolingual bone width, and cortical bone thickness, of the different interradicular sites.

Based on these results, an empirical clinical guideline can be provided. However, various malocclusions and dento-skeletal patterns of patients, and individual variations should be considered. A radiographic evaluation of the available interradicular space in each individual case before miniscrew placement is needed.

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