



Safe zones and guidelines for palatal miniscrews - A Review

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Abstract

Miniscrew has been used as an alternative for orthodontic anchorage reinforcement. Their smaller dimensions facilitate placement in most sites of the jaws. Palatal mini-implants have become widely used for reliable anchorage in orthodontic treatment. The palate is probably one of the most suitable sites due to its easy accessibility; it is covered with keratinized gingiva and thus is less susceptible to inflammation. The palatal mini implants are used as an anchorage for various purposes such as distalization of posterior teeth, it is used along with as transpalatal arches for posterior tooth stabilization or segmented palatal arches for incisor stabilization and for rapid palatal expansion. So this article focuses on the Safe zone and guidelines for miniscrew placement in the palate, the role of palatal screw in the correction of adult transverse malocclusion and various factors which determine the success on miniscrew such as Vertical bone height, Bone density, the size of implant, number of miniscrew used and the penetration depth of miniscrew.

Key words:

Miniscrews, Palatal Anchorage, Adult transverse discrepancy, Implant assisted Rapid Maxillary Expansion,

INTRODUCTION

Miniscrew has been used as an alternative for orthodontic anchorage reinforcement. Their smaller dimensions facilitate placement in most sites of the jaws, even with root proximity (interdental areas) without an increased risk of root injury.^{21,22} Their placement and removal require no sophisticated or complicated surgical or laboratory procedures. Since **osseointegration does not usually occur** (except possibly to a small extent when they are used for a long time³⁶), they provide only temporary stationary anchorage.²³ Consequently, there is no need for a waiting period for osseointegration, and they can be immediately loaded, decreasing total orthodontic treatment time.²³ Clinical applications of miniscrew have been expanded to include various applications: correction of deep bite, closure of extraction spaces, correction of canted occlusal plane, alignment of dental midlines, extrusion of

impacted canines, extrusion and uprighting of impacted molars, molar intrusion, distalization of either maxillary molars or mandibular teeth, en-masse retraction of anterior teeth, molar mesialization, maxillary third molar alignment, intermaxillary anchorage to correct sagittal discrepancies, and correction of vertical skeletal discrepancies that would otherwise require orthognathic surgery.²³⁻³⁴ However, failure of miniscrews can occur, mainly if there is lack of stability at placement because of inadequate thickness of the cortical bone³⁵ or irritation or inflammation of peri-implant tissues, especially in patients with poor oral hygiene.²³

FACTOR FOR MINI-IMPLANT INSERTION

The factor to be considered for patients before miniscrew insertion involve the evaluation 1) Bone condition 2) Tissue type

BONE CONDITION

It is important to identify best available bone that fits the biomechanical needs for which we require.

Develop a good implant site.

It is important for adequate inter-radicular space (ideally 1mm between the miniscrew insertion and the periodontal ligament) and miniscrew placement, since reports have shown that root proximity has a negative effect on implant stability.⁵⁻⁷

Bone thickness

Primary stability depends largely on cortical bone, studies have recommended that at least 1mm of cortical bone is needed for insertion of miniscrews.⁸⁻¹⁵

Clinical implications of insertion site

Good bone and adequate space for miniscrew placement are of paramount importance. Suitable insertion sites can usually be found between the second premolars and first molars in both arches. The palate is another excellent location for miniscrew insertion, since it is covered by keratinized gingival tissue and offers considerable flexibility in the selection of safe placement zones.^{10,16-20}

TISSUE TYPE

Together with good bone, the right type of tissue plays an important role in miniscrew stability.

Placement of miniscrew at the attached gingiva

Keratinized gingival tissue has been shown to adapt nicely and form a biological seal around titanium surfaces.³⁷ The palate is recommended as an implant area because of its tissue characteristics and its ability to heal rapidly, frenum should be avoided due to commonly reported problems of patient discomfort and tissue mobility.³⁸

Miniscrew angulation

By angulating the miniscrew, it is possible to keep the head in the attached gingiva while directing the body of the implant away from dental roots and the alveolar crest.³⁹

Reduce inflammation

Because plaque accumulation around the miniscrew head is a risk factor for peri-implant inflammation, therefore increasing the likelihood of failure,³⁸ proper oral hygiene is imperative.⁴⁰ Any attachment to the miniscrew head should be easy for the patient to clean and avoid contact with the surrounding soft tissues.

PALATAL ANCHORAGE

Palatal mini-implants have become widely used for reliable anchorage in orthodontic treatment. Palatine bone has very complex morphology and structure. Palatal miniscrews also involves a risk of damage to the nasal cavity, nasopalatine nerve or maxillary sinus, affecting the rate of implant success. Palatal implants as an anchorage site have been used in clinical practice many years, and provide the greatest anchorage force when traditional techniques cannot meet the clinical requirements.^{1,2} Anchorage in the palate has numerous advantages compared with conventional anchorage techniques: (1) there is a relatively **large bone mass** in the median and flanking region palate; (2) there are **dense soft tissues** on the surface of the hard palate, so compact connective tissues can be formed at the cervical part of the implant; and, (3) **A short implant** can provide sufficient anchorage³. In the palate the **median or paramedian area**, is probably one of the most suitable sites for several reasons: it is easily accessible, there is little danger of damaging anatomical structures other than the incisive foramen, and it is covered with keratinized gingiva and thus is less susceptible to inflammation. The median area of the palate contains high-quality cortical bone, which contributes to retention of the mini-implants.

ANATOMICAL CONSIDERATION

Roberto carrillo and Peter h. buschang has suggested the important anatomical landmark to be considered during the placement of miniscrews.

Greater palatine foramen, usually located about 15mm lateral to the midpalatal suture at the level of the maxillary second or third molars.⁴²

Greater palatine neurovascular bundle, extending anteriorly from the greater palatine foramen to the canine area⁴²; depending on the height of the palatal vault, it may be 7-17mm above the cemento-enamel junctions of the premolars and molars.⁴³

Incisive canal and foramen, including the nasopalatine bundle, **Midpalatal suture** (in growing patients), Nasal floor and maxillary sinuses.

PALATAL BONE HEIGHT AND BONE DENSITY

The two important factors which determine the stability of palatal implant placement are the palatal bone height and bone mineral density

Palatal bone height

The study done by **Jung et al.** stated that vertical bone height in the paramedian region tend to show a higher value for male patients when compared to females in some studies and **Taghizadeh, 2010** suggested that vertical bone height tended to decrease rather than increase with age.

Baumgaertel, 2009; Gracco et al., 2008; Kang et al., 2007; Lai et al., 2010; Taghizadeh, 2010 did studies showing Vertical bone height adjacent to the midpalatal suture higher for most of the palatal length, but further away from the midpalatal suture, adequate bone height is only found anteriorly⁴⁴.

Bone density

Lai et al., 2010 suggested palatal sites with the greatest vertical bone height were not necessarily those with the highest bone densities. In one study bone density (expressed as the hard tissue fraction to total bone volume) 3 mm lateral to the midpalatal suture was found to be largely higher than 50% (**Moon et al., 2010**). In another, it was about 70% and similar in the younger and older age groups (**Wehrbein, 2009**)⁴⁴.

MOST DISTAL PALATAL RUGA

Jan Hourfar from his study suggests third palatal rugae should be used as a landmark for placement of miniscrew insertion. He stated that in order to determine the appropriate path of insertion, the amount of bone in various directions needs to be taken into consideration. From his findings he prefers a 6mm long implant in line perpendicular to the long axis of tooth and when measured in an oblique direction, along a line crossing the long axis of the central incisor at the level of the palatal plane he suggests 8 mm long mini-implant can be safely inserted into the region of third palatal ruga⁴⁴.

PALATAL ANCHORAGE AND TRANSVERSE MALOCCLUSION

The palatal mini implants are used as an anchorage for distalization of posterior teeth, it is used along with as transpalatal arches for posterior tooth stabilization or segmented palatal arches for incisor stabilization and for rapid palatal expansion. Since the introduction of Temporary anchorage device, Mini-implant assisted expansion has gained more interest towards the non surgical correction of adult maxillary transverse discrepancy. The midsagittal plane or the paramedian region of the hard palate is clinically acceptable region for the placement of mini-implants for adult rapid maxillary expansion.⁴⁶⁻⁴⁸ various author have suggested various sites for the placement of mini-implant.

BENEDICT WILMES Palatal-vault grid

Benedict Wilmes used a palatal grid for identification of safe location miniscrew placement. In the palatal grid the first coordinate is the anteroposterior distance from the distal margin of the incisive foramen (3-4mm, 6mm, 8-9mm, or 12-16mm). The second coordinate is a lateral measurement from the midpalatal suture (3mm, 6mm, or 9mm). A coordinate of 1/3, for example, indicates a point 3-4mm posterior to the incisive foramen and 6mm lateral to the suture⁴⁸. Through various studies⁵⁰⁻⁵³ it clearly demonstrates that the thickest vertical bone is located **3-4mm distal to the incisive foramen** and **3mm paramedian** to the palatal suture. It is also suggests that **midpalatal suture** might appear to be the best insertion site, considering its high bone quantity and quality, The median suture (coordinate 1/1, 3-4mm posterior to the incisive foramen) does have a thick vertical layer of bone, but there is a substantial standard deviation in this thickness. Benedict Wilmes states that the anterior palate appears to be one of the best sites for orthodontic miniscrews or palatal implants. Cortical bone is typically thicker in the palate and favorable attached gingiva is readily available, ensuring high success rates. He also suggests that the area of palatal alveolus between the roots of the second premolar and first molar may be considered as an alternative miniscrew location, with some limitations. Whereas **Bernhart** and **colleagues** found a mean bone thickness of only 2.94mm at the suture and, therefore, recommended an insertion site 3-6mm paramedian to the suture and 6-9mm distal to the incisive foramen.⁵² Sungmin Kang, Shin-Jae Lee from their research state that bone thickness of the palate was found

to vary greatly among subjects. The area within 1 mm of the midpalate had the thickest bone available in the posterior palate. The thickness tended to decrease laterally and posteriorly. When a mini-implant could deviate from the midpalatal area by more than 1 mm, we recommend placing the mini-implant not far posteriorly or using a shorter mini-implant⁵⁴.

Angeliki Karagkiolidou did a study where he examined the overall success of miniscrews inserted in the **paramedian anterior palatal region** for support of various appliances during orthodontic treatment. Out of which 204 miniscrew utilized in rapid maxillary expansion for 102 patients were evaluated, the miniscrew used in the study involved of diameter, 1.6 mm at the tip and 1.8 mm at the end of the thread; length, 8.0 mm. The overall survival of the paramedian miniscrews were around 97.9%.

THREE DIMENSIONAL (3D) FINITE-ELEMENT MODEL (FEM) STUDIES

Hye Kyung Lee analyzed stress distribution and displacement of the maxilla and teeth according to different designs of Mini-Implant assisted palatal expanders⁵⁶. From his findings he suggested **Bone-borne expander with micro-implants placed 3 mm lateral** to mid-palatal suture produced more expansion in the inferior part and the displacement of teeth followed the buccal rotational movement of the alveolar bone.

Bone-borne expander with micro-implants placed at the palatal slope Showed parallel separation of the mid-palatal suture.

Combined expander with additional conventional Hyrax arms on the first premolar and first molar showed More buccal rotation of the dentition in addition to the buccal rotational movement of the alveolar bone

Surgically assisted tooth-borne expander produced Displacement of teeth occurred first, then the transformation of the periodontal ligament, and small amount of deformation of the alveolar bone⁵⁶.

In another finite element study done by **Matt MacGinnis** and **Won Moon** where they compared the stress distribution of Conventional RPE and mini implant assisted expander they concluded that Stress distribution from Conventional expansion was distributed along the three maxillary buttresses: the zygomaticomaxillary, the nasomaxillary, and the Pterygomaxillary. Stress distribution from the **mini implant assisted expander** showed less propagation to the buttresses and adjacent locations in the maxillary complex. By placing expansion forces closer to the maxilla's center of resistance, less tipping occurs with a more lateral translation of the complex⁵⁷.

Dr. Won Moon (M.S.E) Various authors have suggested the placement of mini-implants in the anterior hard palate region due to the cortical bone thickness and keratinized tissue in that area. But Dr. Won Moon and colleagues at the University of California Los Angeles (UCLA)⁵⁸ developed a device called Maxillary Skeletal Expansion (MSE) where he prefers to place the expander device as posterior as possible, close to the junction of hard and soft palate (hard palate mucosa is whiter) This design is suggested because greatest resistance against suture opening is located in the sutures between maxilla and pterygoid plates, and forces should be applied more posteriorly to overcome initial resistance and promote parallel opening of the midpalatal suture. When forces are applied directly into the center of resistance of the maxilla by means of mini-implants, and not to teeth (as in conventional expansion), the force system is more favorable due to a homogeneous force dissipation,⁵⁹ which prevents buccal tipping and produces a more parallel suture opening.⁶⁰

The appliance design and placement helps to direct the lateral forces against pterygomaxillary buttress which offers resistance to expansion in adults Other factors such as Location of the miniscrew, The number of miniscrew, The length of the miniscrew and the depth of screw penetration, which may involve only the palatal cortex (Monocortical engagement) or the palatal and nasal cortex (Bicortical engagement) all play an important role in the success of miniscrew placement in transverse malocclusion⁶¹.

CONCLUSION

The palate is probably one of the most suitable sites due to its easy accessibility; it is covered with keratinized gingiva and thus is less susceptible to inflammation. The median area of the palate contains high-quality cortical bone, which contributes to retention of the mini-implants. Out of which the midsagittal plane or the paramedian region of the hard palate is clinically acceptable region for the placement of mini-implants in the correction of adult transverse discrepancy. The placement and success of mini implant in the palate is multifactorial it depends on the site of placement, Vertical bone height, Bone density, the size of size of implant, number of miniscrew used and the penetration depth of miniscrew.

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