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, miniplates and titanium screws 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.

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.

To preserve the periodontal health a minimum clearance of 1 mm of alveolar bone around the screw has been recommended. 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.

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

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

Poggio et al. 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 crest.

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

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

- Between the central and lateral incisors at 6 mm level from the CEJ.
- Between the lateral incisor and canine at 11 mm height from the alveolar crest.
- Between the canine and first premolar at 2 mm from the alveolar crest.
- Between the first and second premolars at 5 mm from the alveolar crest.
- Between the lateral incisor and canine at 8 and 11 mm from the alveolar crest.
- Between the second premolar and first molar at 11 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 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.

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Inter-radicular space</th>
<th>Distance from the alveolar crest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palatal</td>
<td>1st molar and 2nd premolar</td>
<td>2-8mm</td>
</tr>
<tr>
<td>Palatal</td>
<td>1st molar and 2nd molar</td>
<td>2-5mm</td>
</tr>
<tr>
<td>Palatal and buccal</td>
<td>1st premolar and 2nd premolar</td>
<td>5-11mm</td>
</tr>
<tr>
<td>Palatal and buccal</td>
<td>1st premolar and canine</td>
<td>5-11mm</td>
</tr>
<tr>
<td>Buccal</td>
<td>1st molar and 2nd premolar</td>
<td>5-8mm</td>
</tr>
<tr>
<td>Buccal</td>
<td>Central and lateral incisor</td>
<td>6mm</td>
</tr>
</tbody>
</table>

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

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

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 diameter.

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.

### REFERENCES:

13. Dr Nagarathna KN, Dr Prashanth Kamath. Factors Affecting Success of Mini-implants – A Review. orthodontic cyber journal,feb-2012.