

**Selection and Application of Mini implants for MARPE**

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**Abstract**

Rapid palatal expansion (RPE) is a treatment of choice for the correction of skeletal transverse fault of maxilla in children and adolescent orthodontic population. This is due to the orthodontic and orthopedic effects of the RPE expanders. To reduce the negative effects of RPE expanders on the dentition, and optimize the skeletal effects of expansion in adolescents and adults, mini implant supported rapid palatal expansion or mini screw assisted rapid palatal expander (MARPE) have been suggested. This review presents a systematic step-by-step protocol for the selection of mini implants for the purpose of MARPE expanders by evaluating the cone beam computed tomography scans. The parameters such as bone thickness, soft tissue thickness, the length of fixation-rings of expanders, and the distance of the fixation-rings to the palatal expanders have been explained in detail to provide higher clinical success with MARPE.

**Keywords:** mini implants, mini implant assisted rapid palatal expander, mini screw assisted rapid palatal expansion (MARPE), orthodontic anchorage.

**Introduction**

The prevalence of posterior crossbite in permanent dentition is found to be about 51% when analyzed in a young population.<sup>1</sup> There are also other malocclusions such as crowded teeth, bimaxillary protrusion, increased buccal-corridors, class II and class III malocclusion have transverse fault of maxilla as the essential cause for the malocclusion.<sup>2</sup> Due to this reason, it has been suggested that the actual prevalence of posterior crossbite may be higher than actually reported.<sup>3</sup>

The technique of choice to correct the transverse fault is rapid palatal expansion (RPE) to increase the skeletal width of maxilla, due to the combination of orthodontic and orthopedic effects.<sup>4,5</sup> The biomechanics resulting in these effects is the separation of the two maxillary halves because of the remodeling at the midpalatal suture.<sup>4,5,6</sup>

Due to the biology of the midpalatal suture, the procedure of RPE has a doubtful prognostic value in adults. This is because in adults, the maxillary sutural structures are interdigitized to a higher extent than children. The rigidity of the neighboring structures such as zygomatic bone is

also important in adult patients. The histology of the midpalatal suture shows that there is greater degree of ossification of the midpalatal suture in adults. To add to this, the complex level of interdigitization of the maxillary bone and the sphenoid bones add higher resistance to the effects of the horizontally and vertically directed forces of RPE.<sup>7</sup> Subsequently, root resorption and injury to periodontal tissues of the teeth have been shown by RPE specifically in adults.<sup>8-10</sup> The stability of RPE through a long period of time has been questioned in adults.

Mini implant supported rapid palatal expansion or Miniscrew-assisted rapid palatal expansion (MARPE) was introduced with the aim to resolve the negative dental effects of RPE and increase the amount of skeletal expansion in adolescents and adult patients. An increased skeletal width of the maxilla has been shown with MARPE appliances compared to control patients.<sup>11</sup> The amount of buccal angulation of the maxillary molars shows the dental tipping of the teeth with the expander. The amount of increase in buccal angulation of maxillary molars has been found to be minimal with MARPE.<sup>12</sup>

An alternative to RPE and MARPE is aligner therapy.<sup>13</sup> Aligners, however have shown to cause only tipping movement meaning dental expansion and not actual skeletal expansion as in MARPE.<sup>14</sup> An increasing interest has been shown in the scientific literature in the field of MARPE. The recent case-reports on MARPE appliance has shown the different variations of the MARPE appliance.<sup>15-17</sup> Literature also shows the finite element analysis of the part of the mini implants on how the expansion forces are distributed with MARPE.<sup>18</sup> A retrospective analysis of MARPE on young adults has shown that in 86.9% of the patients, there is an observed opening of the midpalatal suture.<sup>19</sup> With the help of Cone Beam Computed Tomography (CBCT), it is observed that there is a significant increase in the skeletal and dental

dimensions with MARPE for one year after expansion.<sup>20</sup> A analysis of the samples from randomized controlled trial for three groups namely, MARPE, RPE, and controls has shown that MARPE increase the nasopharyngeal airway volume for 2.5 years after expansion.<sup>11</sup> Therefore, it can be summarized that MARPE is a clinically successful and stable procedure for the management of transverse malocclusion in adolescents and adult patients

### **Use of CBCT for Guiding the Mini-Implants Insertion in MARPE**

A major benefit of cone-beam computed tomography scan is the visualization of structures without the superimposition of overlying structures. This is a major advantage of three dimensional CBCT scans over the bi-dimensional dental radiographs. In addition, viewing the sections in axial-plane, coronal-plane, and sagittal-plane, can help in performing accurate measurements compared to bi-dimensional radiographs. In the bi-dimensional radiographs, the orientation of the patient while recording the CBCT, if at fault, cannot be corrected by the evaluator and the measurements made on such bi-dimensional radiographs will not be accurate.<sup>21</sup> But in the three dimensional radiographs, the orientation of the CBCT can be modified by the evaluator.<sup>22</sup> In a recent systematic review, it was found that three dimensional radiographs are more accurate in observing root resorption as compared to bi-dimensional radiographs.<sup>23</sup> In addition, the three dimensional radiographs also allow the area and volumetric measurements of the structures. The effect of MARPE on airway structures can be quantified by area and volume with CBCT by measuring the pre-treatment and post-expansion CBCT.<sup>11</sup> The characteristics of CBCT allow the evaluation of the depth or thickness or amount of bone in the palatal region for the insertion of the mini implants.

The insertion of the mini implants for MARPE is performed in the parasagittal area adjacent to the mid palatal sutures.<sup>24</sup> According to a systematic review, different designs of MARPE are available in the orthodontic world. MARPE designs can be done with 2 mini implants, 4 mini implants, with support to the teeth and mini implants, or with support to only the mini implants.<sup>25</sup> If four mini implants are used, then 2 mini implants would be inserted mesial and two would be inserted distal to the screw. The thickness of bone is found to be in the range of 3.6 to 3.9 mm in the mesial side of the screw and 2.2 to 2.5 in the distal side.<sup>24</sup> The thickness of soft tissue of the palate is observed to range from 2.5 to 2.85 mm on the mesial side of the screw and 1.7 to 1.9 mm on the distal side.<sup>24</sup> Thus, this variability in the soft tissue and bone thickness is important while consider the correct level of the fixation-ring of the screw used in the patient. A recent case report has shown the design of unilateral MARPE appliance with the mini implants on one side of the midpalatal suture and supported to teeth on another side.<sup>16</sup> Another design of MARPE has shown that longer screws leading to bicortical insertion can lead to better stability and higher expansion.

#### **How to properly select mini implants for MARPE**

##### **Evaluating the digital or physical models of the patient**

The dental models of the patients can be recorded after placing bands on the maxillary molars. Once the models are recorded, the location of the expansion screw can be positioned in the central region of the midpalatal suture in the transverse dimension. In the sagittal dimension, the location of the expansion screw can be positioned at the level of 1<sup>st</sup> molars, or between 2<sup>nd</sup> premolars and 1<sup>st</sup> molars.<sup>11,26</sup> The thickness of bone at the level of the teeth can be measured before the expansion to identify the total amount of bone for molars.

##### **Measurement of the thickness of bone**

The measurement of the thickness of bone is performed in the coronal section of CBCT scan.<sup>20</sup> The coronal section of the CBCT passing through the maxillary molar is identified first for the molar teeth. Once the specific coronal section is selected, then the measurements can be made on both the right and the left sides. The thickness of palatal bone is also assessed to select the proper mini implant length. The thickness of bone once determined would be added to the thickness of palatal soft tissue. This same protocol can be applied for inserting mini implants in the palate for intrusion of teeth.<sup>27</sup> Therefore, it is important to indicate to the patients to not touch the tongue on their palatal roof while recording the CBCT.

##### **Assessment of the mini implant fixation rings of expanders**

For achieving the proper length of the mini implants in MARPE expanders, the height of the fixation-rings of the mini implants used for MARPE are measured.<sup>28</sup> The distance of the fixation-rings to the palatal soft-tissue surface is also measured. This would allow the clinician to measure whether the length of mini implant is sufficient for the patient

##### **Selection of mini implants**

The length of mini implants is identified by measuring the variables: thickness of bone. In case of bi-cortical anchorage. Once the thickness of bone is measured, then 1 to 2 mm are added to this measurement, so that the mini implant can go beyond the thickness of bone and insert into the cortical plate of nasal fossa.<sup>29</sup> When bi-cortical anchorage is not desired, then this extra 1 to 2 mm need not be added to the measurement of the thickness of the bone. The thickness of soft-tissue, the thickness of fixation-ring, and the distance of the fixation-ring to the MARPE expander need to be added to this measurement

as well to obtain the ideal length of the mini implants for MARPE.

### Insertion of MARPE

After determining the ideal length of the mini implants, they can be inserted into the palatal bone. Once the mini implants are inserted, an impression is recorded with the mini implants in the palatal bone. The impression is poured and the model is used to construct the MARPE appliance. MARPE appliance can be cemented on the mini implants on the palatal bone with different adhesives such as resin cement, cyanoacrylate adhesive, GIC cement.<sup>30</sup> Another protocol for insertion of MARPE would be to fit the MARPE expander on the teeth first. Once that is done, then the mini-screws can be inserted in the holes of the MARPE expander into the palate.

### Conclusion

As per the current literature for the identification of mini implants for MARPE, it can be concluded that the knowledge about anatomical structures of the maxillary palate. The thickness of the region of palatal bone and soft-tissue thickness specifically adjacent to the midpalatal suture is important for the selection of mini implant. A comprehensive understanding of these concepts is beneficial for the proper diagnosis, treatment planning and success of mini implants and MARPE expanders.

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