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A review on the therapeutic results of miniscrew rapid palatal expansion (Marpe)

J Skanda Keerthana[1], Abbas Sanjeliwala[2]
[1] Orthodontics and Dentofacial Orthopaedic, GDCH, Ahmedabad, Gujarat, India
[2] Orthodontics and Dentofacial Orthopaedics, GDCH, Ahmedabad, Gujarat, India

Abstract
A common maxillary abnormality is the transverse deficiency, which can contribute to development of malocclusions such as posterior crossbite. Treatment can be done with either rapid palatal expansion in children (RPE) and surgically assisted rapid palatal expansion appliances in adults for this type of malocclusion in adults. There is evidence that Miniscrew rapid palatal expansion (MARPE) can be used as a non-surgical treatment for this type of malocclusion after the pubertal growth spurt for maxillary expansion. This article is aimed to review the therapeutic results of the MARPE technique. The maxillary expansion occurs with a high rate of success with MARPE technique. The skeletal expansion is higher with MARPE than RPE. MARPE technique has been put forth as a treatment modality for the correction of transverse maxillary abnormality in adults, but it can also be used effectively in patients under the age of 14 years.

Keywords: maxillary transverse deficiency; crossbite; miniscrew; miniscrew-assisted rapidpalatal expander (Marpe)

Introduction
The correction of craniofacial defects with surgical treatment have undergone numerous improvement since it was first done in the 19th century. [1] Dentofacial abnormalities can affect the quality of life negatively. The resolution of the malocclusion results in improvement in the function and esthetics of dental and facial structures. [3] The third and important goal of orthodontics is stability of the results achieved with treatment. [4] Malocclusion can be divided into dental issues and skeletal issues. With skeletal issues, the transverse maxillary deficiency a very common malocclusion. [5]

Maxillary transverse abnormality
Maxillary transverse abnormality is defined as the mis-match between the maxillary width and mandibular width of the base of the dental-arches. [6] The resulting malocclusion can contribute to esthetic issues as well as functional disorders like low masticatory ability index (MAI). [7] Transverse maxillary deficiency can develop due to habits such as mouth breathing, thumb sucking, etc. [8] The differences in the size of jaws due to disorders of muscular system, congenital syndromes, cleft palate can also contribute to maxillary transvers abnormality., [9-11] Posterior Crossbite is one of the indicators for maxillary transverse abnormality and has a prevalence of 7 percentage to 17 percentage. [12] Other causes of posterior crossbite are early loss of deciduous teeth, crowding, hereditary, genetics, anatomy of teeth, alignment of teeth, mouth-breathing, and other habits. [12] In many cases, posterior crossbite, there is an underlying skeletal issue. Therefore, posterior crossbites can occur due to the following reasonsi) small maxilla and normal mandibular, ii) normal maxilla and large mandible, and iii) small maxilla and large mandible. Allen *et al*. observed the dental and skeletal characteristics of patients with and without crossbite. They observed that patients with increased mandibular plane angle, increase lower facial height and decreased maxillary to mandibular width ratio are more likely to develop posterior crossbite. [14] In patients with sleep apnea, the palatal depth was decreased and posterior crossbite was increased than patients without sleep apnea. [13]

Rapid Palatal Expansion and Surgically Assisted Rapid Palatal Expansion
Rapid palatal expansion (RPE) without anchor implant is a very popular method for maxillary expansion. This method is non-surgical and can be successfully undertaken in children. This method is not very successful in patients after their growth spurt. The expansion forces are mainly located in the posterior teeth and this results in buccal tipping and minimal expansion of suture. [14] To compensate of the negative-complications of conventional maxillary expansion, surgically assisted rapid palatal expansion (SARPE) was developed. [15] In this method, a surgical procedure is performed to divide the maxilla into two halves, following which the rapid palatal expansion procedure ie undertaken. The success rate of expansion in adolescents is increased with this approach. However, the disadvantages of this method is the hospitalization procedure, general anesthesia, and increased cost. [15]

Miniscrew Rapid Palatal Expansion
An alternative technique for successfully expanding maxillary arch in adolescents is Miniscrew rapid palatal expansion (MARPE). [16] This device is designed to utilize palatal bone as the main anchorage support. The expansion force is transmitted from the expander to the palatal bone resulting in opening of mid-palatal suture. It results in the movement of maxillary halves away from each other and not just buccal tipping. [17] The application of miniscrews with expander has become common in recent years. The technique for miniscrew placement varies with the anatomical variation of palate, bone height, etc. [17, 18] Miniscrews selected for MARPE technique can be from 1.6 mm to 2 mm in diameter and 8 to 12 mm in length

depending on the engagement – whether unicortical or bicortical engagement with the nasal floor. The miniscrews are inserted into the palate which has a high success rate. [19] MARPE results in opening of midpalatal suture and increase in skeletal width of maxilla compared to RPE. [20] The advantage of increasing the skeletal width of maxilla is that there is a decrease in the nasal resistance. [21] In a research study by Lee, after MARPE the tissuesnear the nose revealed significant changes after expansion in adults. [22] In a study by Mehta, the airway volume of nasal cavity and nasopharyngeal airway showed an increase after MARPE expansion in late adolescents. [20] When expansion is performed, there is a chance that the expansion is not bilaterally symmetrical. It has been reported that RPE can lead to asymmetrical expansion of maxilla. This can affect the associated structures such as the temporomandibular joint (TMJ). [23] The mandibular condylar position can be affected by the expansion procedures. It has been reported that RPE can lead to asymmetrical position of condyle on one side after expansion whereas MARPE does not negatively affect the TMJ after expansion. When both RPE and MARPE were compared in the retention period, then no side effects were found on the condylar position with both treatment options indicating that expansion is a safe procedure. [24]

Factors affecting expansion

Maxillary expansion is dependent on patient's age and skeletal maturation. [25] The skeletal maturation can be identified with the help of cervical vertebral maturation index on lateral cephalometric radiograph or a cone-beam computed tomography (CBCT). [26] MARPE expanders have been designed so that they have anchored structure directly onto the palatal bone and not on the teeth. Because of this they can increase the width of circummaxillary sutures after expansion. [27] This procedure is useful in the correction of class III malocclusion in which patients have posterior and anterior crossbite. For such malocclusion, MARPE appliance can be combined with Class III Intermaxillary elastics and miniscrews to achieve ideal result. [28] MARPE appliances can therefore increase the age range of the nonsurgical treatment for patients with maxillary transverse abnormality. The facial and dental changes in patients with MARPE expansion have been observed to be more skeletal (60%) and less dental. These changes can be different depending on the design of the MARPE therapy. In contrast to Gholinia *et al*., which used bone and tooth anchored MARPE expansion appliance, Mehta *et al*. used the complete bone anchored MARPE expansion appliance, this could be responsible for the higher skeletal expansion observed by Mehta *et al*. [20, 29] In addition to these two designs, MARPE appliance can also be designed with different number of miniscrews such as two, three, or four mini-screws. [30] The objective of MARPE therapy is to correct the transverse maxillary abnormality. It is useful when the transverse abnormality in on both the sides of maxilla leading to bilateral posterior crossbite. [31] MARPE appliances can be designed for correction of not only bilateral crossbite but also unilateral crossbites. [32]

Alternatives to Marpe

For MARPE technique, osteoperforations have been performed in adult patients in the midpaltal region to increase the effectiveness of the separation of the suture.[33] Osteperforations can contribute to an increase in inflammatory response and therefore more effective tooth movement. [33, 34] It has been shown that osteoperforations can also result in an increased rate of tooth movement. [34] In situations where the patient wants esthetic options, aligner therapy can be used for the treatment of transverse maxillary abnormality. Aligners are clear material and can be changed every week for sequential alignment of teeth. Aligners can be used to expand the maxillary arch successfully, however, most of the tooth movement is tipping of the teeth buccally. [35] The comparison of various designs of MARPE was done by Kolge in a case series study and it was found that MARPE results in increase in the skeletal width of maxilla. [36] With MARPE the amount of buccal tipping of molars is low. In contrast, aligners would lead to more buccally tipping.

Conclusion

MARPE procedure is put forth as a treatment option for patients with maxillary transverse abnormality in young adults and adolescent patients. RPE is used in children but does not give the same results in adults. Studies have shown that even patients under 14 can be benefitted by MARPE. Increased skeletal expansion and reduced dental tipping can be expected with this treatment procedures. Alternative techniques with osteoperforations and aligner therapy can be used for maxillary expansion but higher amount of buccal tipping may occurs with aligners.

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