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Evaluation of rapid, slow, and mini implant assisted rapid maxillary expansion-A literature review

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Abstract
The aim of this review is to describe the dental, dentoalveolar and skeletal changes in different planes such as vertical plane, transverse plane, and anteroposterior plane, that occur with Rapid maxillary expansion (RME), slow maxillary expansion (SME), and mini implant assisted rapid maxillary expansion (MARME). In the patients undergoing expansion, a cone beam computed tomography can be done before the expansion and after expansion to observe the changes occurring due to treatment. This review will describe the effects of tipping due to expanders. The effects of dental expansion and skeletal expansion will be discussed in this review. Also, a new modality U-MARPE used for unilateral expansion will be discussed in this review article.

Keywords: maxillary expansion, cone-beam computed tomography, slow maxillary expansion, rapid maxillary expansion, mini implant assisted rapid maxillary expansion

Introduction

Crossbite is present in over 10% of the population in children and adults [1]. The prevalence of crossbite is higher in adults compared to children showing that this condition is not self-correcting. Maxillary expansion is used generally by orthodontists for rectification of crossbite in posterior region of maxilla. This treatment modality can be useful in managing the transverse maxillary deficiency [2]. Maxillary expansion can be done with various types of appliances. There are different recommended expansion rates for the appliances leading to either rapid maxilla expansion (RME) or slow maxillary expansion (SME) [3, 4]

Typically with jackscrews expansion, RME is classified as two turns per day whereas SME can use one turn every second day or even longer. Basically, the difference between RME and SME is the time period between the turns of the expansion screw. Both RME and SME have their own pros and cons. Recently, mini implant assisted rapid maxillary expansion (MARME) has been used as an alternative to RME in patients with late adolescents and adults. In this review, the changes with RME, SME, and MARME will be discussed in terms of the dentialveolar buccal tipping, skeletal changes in sagittal, vertical, and transverse dimensions immediately after expansion and during retention period after expansion.

Who requires maxillary expansion?

Patients with transverse maxillary deficiency can benefit from maxillary expanders. Typically, if the patients are seen by an orthodontist at an early age between 7-10 years of age, then a regular expander with jack screws can be used to expand the maxilla easily [5]. At this time, patients are usually in the mixed dentition period and losing the primary teeth and the permanent teeth are erupting. The number of teeth present in the patient's mouth helps in determining the teeth that will be involved in the expansion appliance. If patients present at a later age such as 14-18 or even later, MARPE expanders can be used [6]. In these appliances, palatal mini implants are used in addition to the expansion appliance. Patients are instructed to follow the expansion protocol diligently. In many instances, a log book is given to the patient to record the time and date when they turn the expansion screw. It is important to communicate clearly with the patient and demonstrate how to turn the expansion screw as it is critical for achieving the right outcome. In the patients undergoing expansion, a cone beam computed tomography can be done before the expansion and after expansion to observe the changes occurring due to treatment

Difference in the effects between RME, SME, and MARME

RME and SME can lead to changes in the maxillary arch. However, the general consensus is that RME leads to higher amount of changes right after expansion. Even MARME leads to higher amount of changes than SME when analyzed right after expansion [7]. With both RME and SME a forward displacement of A point can be observed. This means that the maxilla can move forward more with the expansion procedures. However, there is some controversy in the literature regarding this finding. Without any treatment, the normal rate of growth of SNA is than 0.1 degrees in one year [8, 9]. Some studies have shown that with RME, there is no significant anterior movement of maxilla [10, 11]. On the contrary, other studies have shown that there is significant forward movement of maxilla with the expansion procedures [12-17].

In terms of downward movement of maxilla itself, it can be observed that maxilla can move downward and palatal plane rotation can occur with RME compared to SME. This downward movement of maxilla has been hypothesized to occur due to the disposition of the maxillocraniofacial sutures. Both ANS and PNS have been observed to move downwards with expansion [11, 18]. To prevent such vertical changes, bonded RME can be used as it does not lead to any downward movement of maxilla [10]. Another point to note regarding the vertical changes is that with both RME and MARME, there is extrusion of maxillary molar compared to controls [19]. The extrusion of molars can contribute to

mandibular rotation and increased mandibular plane angle [19]. This is the reason why after both RME and MARME, there is an increased overjet. The increase in the mandibular plane angle after expansion results in changes to the SNB angle due to the downward and backward rotation of mandible. When observed at retention, the vertical changes due to extrusion of molars with MARME and RME are not significantly different than controls [19].

Immediately after expansion, maxillary width increases transversely. With all three modalities, MARME, RME and slow expansion, there is an increase in the dental arch-width at the level of the teeth. But with only MARME and RME, there is increase in the skeletal width of maxilla. When observed at the retention period, it is seen that the maxillary skeletal width is higher in MARME compared to RME and controls. So, MARME can potentially result in higher amounts of skeletal expansion. The increase in the dental arch width occurs due to tipping of the teeth, bending of alveolar bone, and lateral rotation of maxilla [8, 20]. The increase in skeletal width occurs due to increase in the transverse width of maxilla at a level higher than the teeth. Therefore, RME and MARME have a higher effect on the maxillary bone and can also lead to loosening of the circummaxillary sutures [21]. This can be useful in treatment of patients with Class III in which maxilla needs to be protracted forward [6]. In such situations, the step RME or MARME to expand and loosen the sutures is performed first. And then followed with either facemask or intermaxillary elastics from skeletal anchorage to move the maxilla forward [6].

The angle between right and left molar is known as intermolar-angle. It is measured to evaluate the level of expansion dental effects due to tipping of teeth. Tipping of teeth in buccal direction is observed with RME [13, 14, 22, 23]. This can contribute to root resorption. The tipping can be reduced by using a bonded RME or an occlusal splint [10, 12] Tipping occurs due to the lateral rotation of the maxillary right and left half as the fulcrum is at the fronto-maxillary suture. As the type of expansion with RME is triangular, there is higher tendency of the lateral rotation and lateral bending of alveolar crests. Whereas with MARPE, there is parallel suture opening. Thus, the tipping can be potentially reduced. Some authors have suggested that SME unlike RME does not lead to buccal tipping [24].

The expansion with RME, MARME, and SME leads to bilateral expansion of maxillary teeth whereas RME and MARME also cause a bilateral increase in skeletal maxillary width. In situations where only one side of maxilla is at fault resulting in unilateral posterior crossbite, unilateral expansion of maxilla can be done with appliances such as U-MARPE appliance [25]. This innovative appliance focuses the stress distribution on one half of the maxillary arch. So, the other half of the maxillary arch receives transverse force to correct the crossbite and one side does not experience as much transverse force [25].

Future studies should be focused on the comparison of the effects of RME, MARME, SME, and U-MARPE on identifying the skeletal and dental changes with these appliances in the retention period. Such studies will be provided useful information that can be used by orthodontists while treating their patients.

Conclusions

Rapid Maxillary Expansion (RME), Slow Maxillary Expansion (SME), Mini implant assisted rapid maxillary expansion (MARME), lead to molar tipping, and increased dental arch width. RME and MARME lead to increased skeletal maxillary width than SME. RME can promote forward movement of maxilla. Both RME and MARME can lead to molar extrusion immediately after expansion, but when observed in the retention period, the molar extrusion with RME and MARME is not significantly different than SME.

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