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Skeletal and dental effects of maxillary expansion

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Abstract

The purpose of this review was to analyze the results from the studies on rapid maxillary expansion (RME) and mini-screw assisted rapid palatal expansion (MARPE) regarding the dental and skeletal effects. This review will describe the effects of the RME and MARPE needs to be analyzed immediately after expansion and at long term follow up after expansion. The evaluation of the dental effects of expansion include the measurements of intermolar width and intercanine width before and after expansion while the skeletal effects include the analysis of the skeletal width of maxilla. The understanding of these effects of maxillary expansion are important in treating patients with posterior crossbite.

Keywords: palatal expansion technique, rapid maxillary expansion, mini-screw assisted rapid palatal expansion, malocclusion, evidence based dentistry

Introduction

Posterior crossbite results due to the inverse positioning of the maxillary posterior teeth in relation to the mandibular posterior teeth in the transversal plane. [1] It has a significant prevalence reaching as high as 23%. [2, 3] When not treated, posterior crossbite has been found to be associated with asymmetrical positioning of the mandibular condyle, asymmetries associated with mandibular growth, and asymmetries with dental occlusion with class II pattern on the crossbite side. [4-7] It has also been found that once the posterior crossbite is treated, it leads to restoration of normal growth and development.

Treatment of Posterior crossbite can be performed with maxillary expansion. Maxillary expansion helps in developing the adequate width of maxillary arch. One such technique for maxillary expansion is rapid maxillary expansion (RME) which means the expansion is achieved fast with 2 or more activation turns per day. In the slow maxillary expansion, expansion is performed relatively slower with 1 activation turn per week. The skeletal and dental effects of different expansion protocols can be influenced by the expansion design and technique.

Effects of maxillary expansion

Hyrax expander, Quad helix, Minne expander appliance, Nitanium maxillary expander appliance, Hass maxillary expander which can be used as bonded-expander or banded-expander are some of the designs used for the traditional maxillary expansion approach. [8-10] In the contemporary approach, bone-anchored maxillary expansion is also utilized by orthodontists. The short term assessment and long term assessment of the effects of the types of maxillary expansion were reviewed in this article. For short term assessment, the studies in which the effects of expansion appliances were identified right after expansion to 6 months after expansion, were observed. For long term assessment, the studies in which the effects of expansion appliances were identified at least 1.5 years after expansion were observed. In addition, some of the studies conducted in the earlier times used two dimensional radiographs. There is considerable human error in the measurements of such two dimensional radiographs. With the development of artificial intelligence based radiographic analysis, such errors can be minimized. [11]

Effects of maxillary expansion after RPE and MARPE

When assessing the dentoalveolar effects of slow maxillary expansion with appliances such as quad helix, minne expander, and Nitanium expander, it has been reported that there is a significant increase in the maxillary intermolar width. [12, 13] In addition, an increase in the maxillary intercanine width is also observed with these conventional expanders used for slow maxillary expansion. The skeletal effects, when evaluated with slow maxillary expansion, were found to be non-significant.

When evaluating the dentoalveolar effects of rapid maxillary expansion, it has been observed that maxillary intermolar width increases significantly with Hyrax appliance or Hass appliance. [12, 13, 14] In addition, the bonded hyrax appliance and banded hyrax appliance do not show significant differences in the dentoalevolar effects. [15] There is also a significant increase in the maxillary intercanine width and interpremolar with both the Hyrax and the Hass appliance. An increase in the skeletal dimensions of the maxilla has been observed when assessing the effects of rapid maxillary expansion. In the earlier studies, the skeletal effects of expansion have been measured by utilizing the Jugale point on the postero-anterior cephalogram. Recently, Mehta et al. measured the skeletal effects of maxillary expansion have been measured using Cone Beam Computed Tomography or CBCT at the level of maxillary sinus. [16] This seems to be the new standard in the measurement of skeletal effects of maxillary expansion as many studies have followed the similar method subsequently using CBCT The

skeletal dimensions of maxilla have found to be higher after expansion than before expansion. [17, 18] With both these appliances, the molar is found to be extruded when measured from the maxillary molar cuspal level to the palatal plane. [19] This can lead to increase in overjet. [14]

On evaluation of the effects of bone anchored maxillary expansion, it was found that the maxillary intermolar width, intercanine width, and interpremolar width increases significantly immediately after expansion. [16, 20, 21] This is observed to be true for both bone anchored expanders and bone-tooth anchored expanders. In addition, the maxillary skeletal width increased significantly with bone anchored expanders.

Asymmetrical expansion can also be performed with maxillary expanders in case of unilateral crossbite. This can be undertaken with the help of asymmetric maxillary expansion (AMEX) appliance. [22] This appliance derives anchorage from the maxillary and mandibular posterior side on the non-crossbite side to result in unilateral expansion which can cause side effects on the mandibular teeth. Another appliance used to perform asymmetrical expansion is Unilateral MARPE appliance known as U-MARPE. U-MAPRE is very useful appliance and can be designed by inserting orthodontic mini screws in the palate to expand only one side of the maxillary arch and correct the unilateral posterior crossbite. [23]

Effects of maxillary expansion after long follow up

The effects of maxillary expansion at long follow up are not reported as comprehensively as the short term effects. A landmark study that examined the effects of rapid maxillary expansion at long follow up was Ladner et al. in 1995 [24] and a landmark study that examined the effects of mini-screw assisted rapid palatal expansion at long follow up was Mehta et al. in 2021. [16] In 1995, Ladner et al observed that there was an increase in the skeletal expansion with RME compared to slow maxillary expansion. [24] In this study, the authors used dental models to measure the dental and skeletal expansion. [24] However, dental models are not the ideal method to measure these effects. A three dimensional radiograph such as cone-beam computed-tomograph is an ideal method to evaluate such effects. However, CBCT was not available in 1995 and thus at that point, dental model measurements was considered to be acceptable. In 2021, Mehta et al., measured the effects of RME and MARPE using CBCT and compared with controls using the samples from a randomized clinical trial. [16] This study utilized CBCT to measure the skeletal and dental effects of expansion at three intervals namely, initial, post-expansion and post-treatment. In this study, the authors showed that there was an increase in the skeletal expansion of maxilla with MARPE and RPE in the long term compared to controls. [16] These two studies by Ladner et al., and Mehta et al. provide helpful insights into the effects of maxillary expansion at long follow up.

A higher number of studies need to be performed for the assessment of the effects of expansion at long follow up. Fortunately, this study design seems to be replicated in the recent studies. A recent study by Truong et al. on the effect of expansion on nasal cavity used a similar study design to that of Mehta et al. by measuring the effects of expansion at initial, post-expansion, and post-treatment. [25] In this study, the authors used CBCT to measure the effects of RME and found that pyriform height and pyriform width increased by RME. However, the authors did not assess the effects of MARPE in this study. Thus, from the above studies, we can conclude that RME and MARPE are safe to use in the long term and have beneficial effects on the skeletal width of maxilla.

Effects of Slow Maxillary Expansion

Slow maxillary expansion can also help in increasing the dimensions of the maxillary arch like rapid maxillary expansion. An increase in the maxillary intermolar width has been reported with the slow maxillary expanders such as Quad-Helix, Minne expander, and Nitanium expander. [13] Moreover, both bonded and banded Minne expanders have been found to perform similarly with no difference between the two. SME has found to not show an increase in the skeletal width of maxilla as compared to the RME and MARPE group. This is why, when treatment of Class III patients is being performed, RME is done frequently before facemask so that the skeletal effects of RME help to loosen the circummaxillary sutures for better class III correction.[26] In addition, for class III patients, intermaxillary elastics on skeletal anchorage can also be used after performing MARPE to achieve skeletal results of class III correction rather than facemask. [27]

Conclusions

Rapid Maxillary expansion and Mini-screw assisted rapid palatal expansion are effective techniques for the correction of posterior crossbite. Both RME and MARPE can lead to increase in dental and skeletal width of maxilla. While slow maxillary expansion can result in increased dental arch width. The results at long term follow up indicate that RME and MARPE lead to increased skeletal width of maxilla.

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