Effectiveness of Rapid Palatal Expansion (RPE) in Class II Malocclusion and the Relationship with Muscle Contraction in Childhood Growth: Systematic Review

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ABSTRACT

**Background:** In general, patients with Class II malocclusion are often associated with a narrow transverse dimension. The shape of the narrowed jaw space can cause various problems such as crowding, jaw mismatch, protrusion of incisors. Given this, the use of Rapid Maxillary Expansion or Rapid Palatal Expansion is a treatment option that has been the choice for decades.

**Objective:** To systematically review the benefits of using RPE in the improvement of malocclusion in child development. This device is used to correct maxillary constriction and posterior crossbite. Methods: From four database sources PubMed, GoogleScholar, Wiley and Cochrane from 2016 to 2021. The database search process used the keywords "Rapid Palatal Expansion" "Rapid Maxillary Expansion" "Class II", from full journals published in less than 5 years.

**Results:** After eliminating duplicated articles, the abstract title of each article was analyzed from 136 articles which were excluded a total of 123 articles. The text of the article is complete and meets the eligibility as many as 13 articles.

**Conclusion:** Rapid Palatal Expansion is effective in correcting class II malocclusion in child development.

**Keywords:** Rapid maxillary expansion, rapid palatal expansion, class II.

I. INTRODUCTION

The reason for the interceptive treatment of early mixed dentition is to provide sufficient space for spontaneous alignment of the upper lateral incisors before complete eruption. When the teeth are crowding up to a few millimeters, normal growth can provide sufficient space, but when the palate is narrow and the teeth are crowded, RPE can be used as an effective procedure. Space will be obtained not only at the level of the alveolar bone, but also at the basal bone where the canines and premolars are also crowded [1].

The most rapid maxillary expansion treatment uses expanders that are passed through the tissues and teeth. Rapid maxillary expansion is characterized by widening of the midpalatal sutures produced by forcing lateral displacement of the two horizontal maxillary processes [2]. Rapid Maxillary Expansion is a type of skeletal expansion that involves the separation of the mid-palatal sutures and movement of the maxillary jaws away from each other. The palatal bone forms a connection with the maxilla to form the hard palate and most of the lateral wall of the nasal cavity. The interpalatal suture connects the two palate bones on a horizontal plate and continues as the intermaxillary suture, forming the junction of three pairs of opposing bones: the premaxilla, maxilla and palate. The mid palate plays 3 major key roles; when babies are Y-shaped, when teenagers are T-shaped, when teenagers are in the form of Jigsaw Puzzles [3].

When the mid-palatal suture is open, the upper jaw always moves forward and down, and this causes a downward and backward rotation of the sandible, which decreases the effective length of the mandible and increases the vertical dimension of the lower face [4]. Many effects are evident when the mid-palatal suture is exposed. One of the most obvious early changes is a diastema that forms between the maxillary central incisors. As the maxillary arch width increases, the mandibular posterior teeth tend to be erect and
tilted buccally. Haas theorized that the change in orientation of the mandibular posterior teeth was caused by the tongue being forced down by the palatal apparatus. In addition, the buccinator muscle, due to the buccal movement of the maxillary teeth, will have less of a restraining effect on the mandibular molars [5]. The average suture closes at the age of 25 years and the fastest in women at the age of 15 years [3]-[5].

The most common bone problem in orthodontics is Class II malocclusion, which is characterized by mandibular retrognathia [6]. Therefore management of mandibular growth is the key to successful treatment of Class II malocclusion. A sagittal or transverse component is seen in patients with Class II malocclusion. The maxillary transverse dimension also affects the sagittal position of the mandible. Maxillary transverse deficiency is a common characteristic of Class II skeletal malocclusions [7], [8]. Maxillary transverse deficiency is a morphological skeletal change in the upper arch characterized by reduced transverse arch, clinically identified by a deep palate, V-shaped upper arch [9]. The transverse component of Class II malocclusion results in a narrower maxillary arch in Class II division 1 malocclusion. The transverse dimensions of the maxilla are narrower by 3 to 5 mm in Class II patients compared to the ideal maxillary width with the mandible without showing a posterior crossbite in centric occlusion [6]-[9].

RME indication is lateral abnormalities resulting in unilateral or bilateral posterior crossbite involving multiple teeth are indications for RME patients with Class II skeletal malocclusion, Division 1 with or without posterior crossbite, patients with Class III malocclusion, and patients with skeletal and pseudo Class III problems. is an indication if they have maxillary constriction or posterior crossbite [3].

Contraindication of RME is anterior open bite and convex profile are generally not suitable for RME. Patients with maxillary or mandibular bone asymmetry, and adults with severe anteroposterior and vertical bone abnormalities. The RME Tissue Borne type is for example the Hass type expansion, and the Tooth Borne type is the Hyrax or Biederman type expansion, the Mini Expander type or the Isacson type. The aim of this appliance is to correct the transverse difference of the upper arch by opening the maxillary medial palatal suture with rapid activation of the appliance screw, twice daily [2].

Factors to consider in RME Expansion Rate: expands by 0.3mm-0.5mm per day, expansion completed 2-4 weeks. Tool Shape: When the force is directed to the maxillary inferior free border, expansion must be made to reach the base. Age and Gender: the older you get, the more rigid the skeleton limits movement. Upper and lower jaw differences: First molar and premolar widths of 4 mm or more are indicative of RME. The severity of the crossbite; multiple teeth involved. Initial molar or premolar angulation: When maxillary molars tilt buccally, conventional expansion will direct them further into the buccal muscles and if mandibular molars tilt lingually, buccal movement to enforce them will increase the need to widen the upper arch. Assessment of primary tooth roots. Availability of space for expansion. Nasal obstruction: if found first refer to ENT. Medical history: because expansion depends on the patency of the sutures and adaptation of the flexibility of the craniofacial complex. Metabolic disorders: include hyperthyroidism, hypophosphatemia vitamin D-resistant rickets, and mucopolysaccharides and mucolipidosis. These disorders are mostly related to bone metabolism. Expansion of the maxilla would be futile even in a young patient. Periodontal Type: Muco gingival health significant effect on mucogingival tissue and therefore it is important to assess the patient's periodontal health [3].

Rapid Palatal Expansion is an ortho device that is used by attaching the maxillary first molars and first premolars. The RPE tool consists of screws that are attached to the teeth via a metal frame. The patients were treated by rotating two activation cycles every day. After the desired activation is achieved, the expansion screw will be stopped and maintained for 12 months to allow reminalization and formation of new tissue in the open middle suture [6].

II. MATERIAL AND METHODS

A. Literature Search and Research Methods

Searching for relevant publications and abstracts identified by using an online database search engine from PubMed, GoogleScholar, Cochrane, Wiley published five years from 2016 to 2021. The designs include Prospective Study, Review, Cross Sectional, Cohort and Case Control.

B. Inclusion Criteria

Articles published from 2016 to 2021, articles in English, articles that have been published online and articles researching on Class II malocclusion using RPE.

C. Exclusion Criteria

Class II malocclusion articles in child development outside the use of Rapid Palatal Expansion include exclusion criteria and articles that cannot be accessed freely.

III. RESULT

The identification process for the review is shown in Fig. 1. There is an article (PubMed, GoogleScholar, Chrono, and Wiley) had some of the same articles excluded. Based on the titles and abstracts available, the journals were selected for analysis. After eliminating duplicate articles, the title and abstract of each article were analyzed. From 136 articles, 104 articles were excluded. Articles with the full text of the remaining 20 articles and analyzed again were excluded as many as 12 articles. The text of journal articles that are complete and meet the eligibility criteria are 13 articles that will be reviewed and included in the synthesis table.

Treatment of skeletal class II cases depends on growth, age, compliance, and the severity of the malocclusion. Various types of functional apparatus exist and are designed to alter the activity of various muscle groups that affect the position and function of the mandible. By changing the vertical and sagittal positions of the mandible, muscle strength can cause orthodontic and orthopedic changes to the teeth [10]. In the case of class II malocclusion, according to a study by Iwasaki T et al. [22] Pulling the mandible back is the basis for the possible association with mandibular retrognathia in children. The use of RPE can give the effect
of lower nasal resistance and lower negative airway pressure.

RME treatment is often advised before Class II therapy. Maxillary transverse deficiency may result in functional impairment, and removal of maxillary constriction may result in Class II spontaneous repair. To properly coordinate the arch, overcome the maxillary transverse deficit, and even out the increased Wilson curve, maxillary arch expansion is required. A tool supported by bone is used so that the orthopedic force exerted by the tool will produce pure skeletal movement, and provide sufficient negative torque [8]. Research conducted by Oliva et al using Modern Geometric Analysis (GMA) can illustrate with color visualization the presence of lateral expansion, however, the weakness of this analysis did not investigate palatal asymmetry in that the presence of a posterior crossbite was associated with asymmetric reduction in dimensions of the palatal curve [26].

To evaluate the mandibular response in a sagittal manner, RME therapy was used in patients with Class II malocclusion in the mixed dentition phase. A significant decrease in the ANB angle was obtained from an increase in the SNB angle. Significant sagittal occlusal improvement during the mixed-to-permanent transition has helped in the occlusal anteroposterior changes at the end of RME therapy. In use RME bonded acrylic. The occlusal surface acts as a bite block, inhibiting posterior tooth extrusion and possibly providing some posterior tooth intrusion. Bonded RME is recommended for correction of the transverse dimensions in patients, who need to better control the vertical growth pattern, minimizing tipping of the maxillary posterior teeth.

The acrylic bonded RME is unique in that it incorporates posterior occlusal coverage into the appliance. This posterior closure allows less extrusion of the maxillary molars as occlusal forces are directed to the acrylic, Treatment with bonded RME is known to have an intrusive effect on the maxillary first molars, this can contribute to the maintenance of vertical dimensions Once the desired expansion is achieved, the bonded expander is stabilized in a passive state for at least 5 months to allow stabilization of the expansion [11].

The use of the Hyrax RME expander supported by one or two pairs of miniscrews placed on the bone, successfully opened the midpalatal suture, bone-supported devices are a good choice for Rapid Palatal Expansion [12]. Although not all have used the Hyrax type expander. Research conducted using acrylic splint RPE showed a wider difference than Hyrax-Haas [13]. Several reports have shown that the Haas type of palatal expander can produce better therapeutic results due to the acrylic pads propped up on the palate [14]. The use of RPE for posterior crossbite correction can use quad helix type more efficiently than the use of removable appliances, both approaches with quad helix and removable RPE produce changes in teeth compared to changes in bone [14].
| NO | Author/Year | Title                                                                 | Malocclusion Criteria                          | Study Design / Type of Intervention                      | Study Conclusion                                                                 |
|----|-------------|----------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1  | Reference [18] | Mandibular response after rapid maxillary expansion in Class II growing patient: a pilot randomized controlled trial | Class II malocclusion after posterior cross bite | Random Clinical Trial                                   | The use of bonded RME reduced facial divergence and gonial angle when compared to those treated with banded RME |
| 2  | Reference [19] | Long-term result of a modified removable expansion plate to increase arch length: A series of 10 cases | Class II malocclusion with narrow transverse dimension | Retrospective Study                                      | The use of modified RME allows for additional space and makes it easy to remove and install the device |
| 3  | Reference [10] | Multi stage treatment of a class II Division I malocclusion with severe crowding | Class II division I malocclusion               | Using Rapid Palatal Expansion, followed by removement of the premolars and the use of fixed devices | The use of RPE resulted in the position of the mandible with increased SNA. Post-treatment vertical dimension improvement. Resulting significant changes |
| 4  | Reference [6] | Effect of Rapid palatal Expansion (RPE) and Twin Blok Mandibular Advancement Device (MAD) on Pharyngeal Structures In Class II Pediatric Patients from Cluj-Napoca, Romania | Class II malocclusion with large overjet        | Comparing before and after treatment                    | The duration of treatment with RME is shorter. In the treatment of Class II Phase I malocclusion, SNA and NSAR changed significantly |
| 5  | Reference [7] | Comparision of the effect of rapid maxillary expansionversus Twin Block Appliance on Mandibular growth in Skeletal Class II patient | Class II malocclusion                          | Comparing RME before and after fixed appliance treatment | Correction of Class II malocclusion after RME in early mixed dentition is advantageous in cephalometry shows a decrease in mandibular length and angle superior gonial at the start of treatment |
| 6  | Reference [8] | Prediction of class II improvement after rapid maxillary expansion in early mixed dentition | Class II malocclusion                          | Retrospective Study                                     | Class II malocclusion was corrected successfully and safely during 2 years of treatment In general, rapid palatal bonding shows minimal facial vertical changes in developing skeletal Class II cases |
| 7  | Reference [12] | Class II treatment by palatal miniscrew system appliance: A case report | Class II Division II malocclusion               | Case Study                                              | Class II malocclusion was corrected balanced facial profile                          |
| 8  | Reference [11] | Assessment of vertical changes during maxillary expansion using quad helix or bonded rapid maxillary expander | Skeletal Class II                               | Retrospective Study                                     | Class II malocclusion was corrected balanced facial profile                          |
| 9  | Reference [20] | Bone Anchored intermaxillary elastic in an asymmetric class II malocclusion: A case report | Class II division I malocclusion                | Rapid Palatal Expansion bonded compared to quad Helix | Class II malocclusion was corrected balanced facial profile                          |
| 10 | Reference [14] | Seven years follow up of the non surgical expansion of rapid maxillary and mandibular arches in a young adult: A case report | Class II malocclusion with narrowed maxillary and mandibular arches | Rapid Maxillary expansion of the upper and lower jaws followed by the use of fixed tools | Class II malocclusion was corrected balanced facial profile                          |
| 11 | Reference [9] | Three-dimensional assessment of Craniofacial asymmetry in children with transverse maxillary deficiency after rapid maxillary expansion: A prospective study | Posterior Crossbite                             | Retrospective Study                                     | The use of RPE in children with a narrow maxilla without a posterior unilateral crossbite has a risk of maxillary asymmetry |
| 12 | Reference [21] | 3D facial soft tissue changes after rapid maxillary expansion on primary teeth: A randomized clinical trial | Transverse deficiency with or without crossbite | Randomized Clinical Trial                               | RPE resulted in an increase in the nose base of 1.98 mm Use of RPE can correct posterior crossbite compared to non treatment with RPE |
| 13 | Reference [26] | Palatal changes in crossbite patients in treated with rapid maxillary expansion vs untreated ones: a geometric morphometric study | Class II malocclusion with posterior crossbite | Retrospective Study                                     | Class II malocclusion was corrected balanced facial profile                          |
IV. DISCUSSION

During growth and development, orthodontic treatment is very good for efficient correction of malocclusion. Treatment of malocclusion is also related to the behavior of the muscles around the mouth [15]. RME has been shown to be a very efficient and effective method for widening the maxillary bone base, the study results suggesting that spontaneous repair of Class II malocclusions. Forward movement of the mandible after maxillary expansion, just as the foot in a narrow shoe moves forward after the shoe is extended [6].

In RPE therapy the buccal end of the tooth reduces the thickness of the buccal bone plate of the supporting tooth and exposes the bone to the buccal aspect of the anchorage tooth, especially in the thinner buccal bone plate [24]. Rapid activation of more than 2 to 4 mm per week is likely to cause tissue damage, while slow activation will not provide sufficient force to open the suture [9]. In modern geometric analysis (GMA) it is known that the movement is lateral but there is a deformation in the palatal midline [26]. Correction of Class II malocclusion requires an increase in maxillary molar width, by about 2 mm for unilateral Class II molar relationships and 4 mm for bilateral Class II molar relationships. 7 RPE can also increase the inter-canine and intermolar width significantly between the start and end of treatment [13].

Patients with a smaller mandible length and a more acute superior gonial angle are expected to show greater improvement in the class II molar relationship. Most studies show some limitations: studies were not randomized, were not prospective, and did not have a control group or used patients from growth studies as the source for the control group. The reported significant occlusal improvement can be attributed to other reasons namely, bone growth or use of additional equipment during the transition from mixed dentition to permanent dentition during the post RME period, anterior displacement of the mandible can be observed due to excessive maxillary expansion.

Spontaneous correction of patients with a propensity for class II malocclusion cannot be expected during the period of active expansion but rather during the period of retention patients treated with RPE equipment after long-term evaluation. A number of investigators have investigated the stability of the RPE, and factors such as patient age, length of retention period, rate of expansion, device design, and biologic response of the maxillary sutures suggest that expansion of the maxillary and mandibular arches followed by fixed orthodontic appliances causes an increase in width 5 to 7 mm arch in young adult patients [14].

Tooth movement and bone growth are largely determined by bone remodeling where the process of bone resorption with bone deposition and chondrogenesis occurs, it has a function in regulating tooth movement and craniofacial growth [23] with increasing age the anterior opening decreases significantly to half posterior at the age of 15 years [13]. It is generally easier and more beneficial to perform palatal expansion at a younger age, before puberty.

V. CONCLUSION

Recent literature shows that the use of RME is effective for correcting transverse mismatches in the jaw skeleton because it provides maxillary expansion at the suture level and reduces dentoalveolar side effects. RME should be considered as an alternative for adjusting the length of the arch circumference, especially in orthodontic treatment.

CONFLICT OF INTEREST

We do not have any conflict of interest.

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