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Orthopedic Treatment of Maxillary Expansion: A Review of the Literature

Review Article

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Abstract

Transverse maxillary deficiency, no matter in adolescents or in adults, is frequently seen in the patients seeking orthodontic treatment. The treatment goal of detaching the midpalatal suture can be achieved using an expansion device. In present article we give a review on various palatal expansion appliances and treatment protocol. A comprehensive search of the literatures was performed to observe the regime of different maxillary expansion appliances and therapies.

Keywords: Maxillary Expansion; Maxillary Deficiency; Orthopedic Treatment.

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Introduction

The narrow maxillary arch compared to the mandibular arch usually results in the transversal discrepancy of posterior teeth.Characterized by unilateral or bilateral crossbite, it is necessary to expand the constricted upper arch in order to correct the transverse discrepancy in these malocclusion cases. [1] By dental tipping and midpalatal suture opening, the dentofacial abnormity including transverse maxillary deficiency, unilateral crossbite and minimal crowding can be corrected. There are different types of methods and appliances for maxillary enlargement, but since the midpalatal suture becomes more tortuous and interdigitated with increasing age [2], arch expansion is suggested to initiate before pubertal peak in skeletal growth.

The overall goal of this review is to compare different types of maxillary expansion treatment and to describe both the advantages and disadvantages of some common sorts of expanders.

Types of Maxillary Expansion and Mechanism

According to the duration of the activation period and the expansion rate, there are three main kinds of maxillary expansion treatment protocol, which will be described below.

Rapid Maxillary Expansion (RME)

RME therapy is one of the most common orthopedic treatments for narrow maxilla. The RME device usually composed of a midline screw that is either tooth-borne or tooth and tissue-borne. The rational being with rapid force is that with rapid force application to the posterior teeth, there would not be enough time for tooth movement, the force would be transferred to the suture, and the suture would open up while the teeth moved only minimally relative to their supporting bone. It can not only increase the width and perimeter of the upper arch, but also create space for maxillary dentition to relieve crowding.

With rapid expansion, at a rate of 0.1 to 0.5 mm per day, one centimeter or more of expansion is obtained in 2 to 3 weeks, with most of the movement being in separation of the two halves of the maxilla. Two to four turns of the midline screw per day are applied to the expansion device for couples of weeks to correct crossbite until overcorrection. During arch expansion, median diastema occurs between the upper central incisors. However, the space created at the midpalatal suture is filled initially by tissue fluids and hemorrhage, which makes the expansion highly unstable. Therefore, the expansion device must be stabilized so that it cannot screw itself back shut. Generally, the appliance is left in place for 3 to 4 months after expansion. By then, new bone has filled in the space at the suture, and the skeletal expansion is stable. In a study of Sandikciolu [3], RME showed remarkable dental and skeletal results in transversal, sagittal and vertical planes compared to slow maxillary expansion and semi-rapid maxillary expansion.

Slow Maxillary Expansion (SME)

An alternative to traditional RME is SME, which uses relatively lower orthopedic forces in longer time to accomplish similar amount of expansion. Instead of several weeks, lower force takes months to induce palatal expansion with less dental tipping and less sutural trauma. The theory is that rather than the suture itself,

the main resistance to opening the midpalatal suture is offered by the surrounding tissues such as midface sutures and circumaxillary structures. Relatively slower and lower maxillary expansion may causes minor tissue resistance in the nasomaxillary complex.A retrospective study done by Huynh [4] showed a stability rate of 84% for posterior crossbite correction using SME.

Other than RME, SME allows the maximum rate with approximately 0.5 mm per week at which the tissues of the midpalatal suture can adapt. In this way, tissue damage and hemorrhage at the suture are minimized, and a large diastema would never appear, so a more physiologic response is obtained. For a Haas and Hyrax expander, SME is defined as roughly 0.25 mm or quarter turn of expansion every other day, or 1 molar of width activation for a quad-helix appliance.

Semi-rapid Maxillary Expansion (SRME)

Although RME has been demonstrated having an effective impact on palatal expansion, its long term evaluation has shown a relapse tendency. High level orthopedic force generated by RME is applied to various structures in the craniofacial complex which have different degrees of resistance depending upon their location and orientation to the direction and center of force. There is research showing that rapid deformation and displacement of maxillofacial bones leads to remarkable relapse in the long run. [3,5]

Thus, Iseri [6] suggested SRME, whose regime is that instant SME following the separation of midpalatalsuture produced by RME. To be specific, two turns per day for the first 5 to 6 days followed by three turns per week for the remainder of the SRME treatment. Through stimulating the adaptation process in nasomaxillary complex, SRME would minimize relapse in post-retention period even in young and adult patients.

In order to investigate the effects of RME and SRME, a research [7] was performed in the mixed dentition. The results showed that SRME had a similar impact on dentofacial structures as the RME did, and the modifications occurred in vertical, sagittal and transverse planes. But since the activation protocol is faster for RME than SRME, RME has the advantages of shorter active treatment time as well as shorter bonded device wearing. Regarding to the possibilities of relapse, further research should be performed to investigate whether the decrease of residual stresses in dentofacial structures after SRME therapy would be advantageous.

Types of Expansion Appliances and Therapeutic Effects

A wide variety of appliances and methods are available for accomplishing maxillary and palatal expansion. It often depends on the degree of maxillary deficiency, the amount of expansion desired and the age of the patient.

Jackscrew Appliances

Differences in treatment effect and stability are attributed to appliance design to some extent. Patients, whose growth has not ceased, are advised to use jackscrew appliances to achieve skeletal expansion along with dental expansion. There are two types of jackscrew appliances are most often used. The Haas-type expander is tooth tissue-borne with acrylic pad close to palate-distributed expansive force between palatal vault and posterior teeth, while the Hyrax expander is tooth-borne with bands on anchorage teeth instead of acrylic pad. [8] Haas [9] advocates that expander with a soft tissue-borne device delivers a more even force to two halves of the maxilla and is then dispensed evenly into both the teeth and alveolar process.

However, previousstudies [4,10] were performed to compare the treatment outcome of these two kinds of expanders showed no significant difference between them. Both types of expanders produced similar orthopedic effects. The only difference was that Hyrax expander was found to be more hygienic, whereas the Haas-type appliance induced a greater change in the axial inclination of anchorage teeth.

Rapid Palatal Expander (RPE)

RPE is a conventional appliance designed to rapidly widening the midpalatal suture with fixed band and soldered wire attaching a jackscrew device at the midline. The main treatment protocol is that the device would be activated twice a day (quarter turn for each time) followed by a passive retention period for 3 months. Palatal midline would be detached approximately 5 days after the first activation.

A number of studies [11-13] have been done to evaluate the long term stability of the maxillary changes by RPE. For patients who received RPE treatment in prepubertal period, RPE therapy is able to create both dental and skeletal changes in the transversal plane with significantly more favorable skeletal changes. [14] In terms of dental changes, both of the maxillary and mandibular arch perimeters have been increased significantly,and additional arch width is gained for upper molars, first premolars and canines. [15,16] Baccetti et al [17] compared the dental changes using Haas-type rapid maxillary expansion between prepubertal group and pubertal group. They found significant greater increase in maxillary intermolar width demonstrated in both prepubertal and pubertal group compared to the control. But in the long term, maxillary skeletal and intermolar width, lateroorbital and lateronasal width were all significantly greater in the prepubertal group. In addition, transverse skeletal maxillary changes have been indicated an increase up to 25% of dental expansion in prepubertal adolescents but with no significant skeletal change for postpubertal adolescents. [18] Therefore, treatment started before pubertal peak shows more effective and stable long-term changes at the skeletal level in both maxilla and its surrounding structures. Nonetheless, Garib et al [10] indicated that there was neither clinically significant anterior-posterior or vertical dental change nor position change of maxilla or mandible has been found.

Removable Expanders

Instead of fixed jackscrew appliances, some orthodontists prefer removable jackscrew expanders to enlarge the maxilla. It is a kind of appliance with removable acrylic plate covering the palate and occlusal surfaces of posterior teeth to disarticulate the occlusion. To reach a total of 0.5 mm expansion weekly, the screw in the midline is activated twice per week. The plate is suggested to be worn for 24 hours a day except during meals and tooth brushing, and then the activation can be discontinued when sufficient expansion to correct the crossbite is reached. Previous studies [19,20] have confirmed its treatment effect in both dental and

skeletal expansion with insignificant relapse.

Nonscrew Expanders

Palatal arch is a type of nonscrew expander which is widely used for expanding the maxilla. It is made of arch wire loops attached to the palatal aspects of bands encircling upper first molars, and is activated before cementation. The palatal arch incorporates quad-helix with four helices, and the expansion force is delivered via the wires against the teeth. Nonscrew expanders are mainly used in the primary or mixed dentition to open up the maxillary suture, but the sutural expansion is minimal. However, Boysen et al [19] demonstrated that the basal expansion the quad-helix accomplished was beyond the removable jackscrew expander. Additionally, McNally et al [12] found no difference in clinical effectiveness between quad-helix and expansion arch regarding to the crossbite correction. And other research also indicated quad-helix had similar results with jackscrew expanders. [4]

Surgically Assisted Rapid Palatal Expansion (SARPE)

SARPE is a surgical procedure and optional treatment indicated for adult patients with transverse maxillary deficiency because skeletal maturity has already been reached in midpalatal suture. The surgery involves median palatine suture split with or without pterygoid osteotomy, after which a maxillary expander is cemented and activated on the upper arch for a couple of weeks until overcorrection. The retention period usually lasts for 3 to 6 months. When compared with only RPE in some studies, SARPE is indicated to loosen the circummaxillarysutural resistance therefore to restrict unwanted tooth movement from dentoalveolar expansion. [21] Nonetheless not every patient is willing to accept SARPE because of surgical risks and economic factors.[8]

Age Limits

Previous studies have shown that the morphologic development of themidpalatal suture diverse from each growth period with broad and Y shaped in infantile stage and more wavy during juvenile stage. During adolescent stage of development, the two maxillary segmentsare highly interdigitated in a very tortuous course. The transverse growth of the suture continues up to 16 year-old age in girls and 18 in boys.

Midpalatal suture opening can be achieved in both children and adults, but as the skeletal components mature, the rigidity of the bony interdigitation becomes so heavy that it is not possible to separate the two halves of the maxilla unless assisted by surgical fracturing of the maxilla. [22]

Conclusion

Many palatal expansion devices can be used to modify maxillary deficiency. After orthopedic expansion of the midpalate, the most prominent dental and skeletal changes appear in the transverse plane rather than in the sagittal or vertical planes. The stability of the expansion with different appliances and therapies vary. Maximum treatment effect would be achieved if the orthopedic expansion is done before pubertal peak. For patients that have passed the growth spurt assisted surgery to separate the midpalatal suture can be considered.

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