



Rapid Maxillary Expansion and Conductive Hearing loss- Review

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ABSTRACT

In recent years, great emphasis has been given to the Stomatognathic system. Constricted maxillary arch is not only a dental issue, but it has other systemic concerns. This maxillary constriction is one of the causes of nasal stenosis, which may be associated with mouth breathing, that can affect the Eustachian tubes and the middle ear, and resulting in hearing loss. Rapid maxillary expansion is an orthodontic procedure for the correction of transverse maxillary problems. Rapid maxillary expansion produces changes in the oral and nasopharyngeal region thus improve the hearing. The purpose of this article is to make the clinician aware of some cases of conductive hearing loss, a relationship may exist with constricted maxillary arch and review the literature and to evaluate the effect of maxillary expansion on conductive hearing loss.

Keywords: Cross bite, Conductive hearing loss, Expansion, Hyrax, Rapid maxillary expansion appliance.

INTRODUCTION

It was estimated by the World Health Organization that 42 million people with more than three years of age have some kind of hearing loss. Middle ear disorders such as otitis affect 28–38% of the children¹. This can be caused by the Eustachian tube dysfunction which can lead to some hearing disorder.²

The stomatognathic system consists of those parts of the head, neck, and upper respiratory area concerned with the osseous, muscular, ligamentous, fascial, and nervous system. This system consists of 27 bones including the maxilla and mandible.³

Craniofacial morphology has been investigated in middle ear diseases^{4–8} and a correlation was suggested between hearing loss and narrow maxilla. Conductive hearing loss and a narrow maxilla could have a direct relationship, when there is a Eustachian tube dysfunction^{9–10}. Maxillary deficiency frequently results in a decreased nasal permeability and mouth breathing, and within this environment a middle ear dysfunction. Impaired Eustachian tube functions may cause pathologic changes in the middle ear that in turn can lead to conductive hearing loss and/or other complications such as otitis media¹¹.

Rapid maxillary expansion (RME) is an orthodontic and orthopaedic procedure commonly used for the correction of bilateral cross bite with constricted maxillary arch. Rapid maxillary expansion not only produces dental changes but provides improvement in other conditions also. As positive effects were clinically proven in Obstructive Sleep Apnea, nocturnal enuresis, conductive hearing loss the number of indications for rapid palatal expansion has continuously grow. In patients with conductive hearing loss associated with constricted maxillary arch, this orthopedic approach may aid in improving hearing due to a more normal functioning of the pharyngeal ostia of the Eustachian tubes as a result of the effect of rapid maxillary expansion on the palatal and nasopharyngeal tissues. However, the RME seems to influence hearing quality only in cases where there is dysfunction of the middle ear and Eustachian tube¹¹.

CONDUCTIVE HEARING LOSS (CHL)

Hearing loss can be divided into two categories depending on the site of disease in the auditory system: Sensori neural hearing loss and conductive hearing loss. Sensorineural type hearing loss is characterized by lesions in the cochlea or involves the eighth cranial nerve.¹² The degree of the conductive hearing loss greatly depends on the severity and the type of the physical changes imposed on the mechanical system of the outer or middle ear. Conductive hearing loss is one of the auditory disorders characterized by elevated air-conduction thresholds. It is known that transversal maxillary deficiency and high palatal arches have close relationship with conductive hearing loss.^{10,12}

Audiologic tests such as comparative measurements of air- and bone conduction thresholds help distinguish a conductive hearing loss from a disorder of the sensor neural type.¹² The air and bone-conduction thresholds interweave in normal hearing. The difference between these two thresholds is called air-bone gap. The air-bone gap provides information about

the magnitude of conductive hearing loss. The air-bone gap of 20–30 dB indicates a mild conductive hearing loss, 30–45 dB a moderate conductive hearing loss, and 45–60 dB a maximum hearing loss.¹³

Maxillary constriction and concomitant posterior cross bite is perhaps one of the most common dento skeletal problems encountered clinically, and this constriction may affect some functions of the stomatognathic system. A possible association between CHL and maxillary constriction has been previously reported in the literature.¹⁴

Rudolph reported that Eustachian tube malfunctions were found more frequently in children with high palatal arches and malformations of the palate and nasopharynx that may predispose them to otitis media.¹² Braun stated that palatal constriction was one cause of nasal stenosis and oral respiration and that the aberration from normal breathing pattern could even affect the Eustachian tube and the middle ear, and result in hearing loss.¹⁵

Laptook described the features of skeletal development syndrome as constricted maxillary arch, high palatal vault, decreased nasal permeability resulting from nasal stenosis, elevation of the nasal floor, mouth breathing, bilateral dental maxillary cross bite along with a high palatal vault, and enlargement of the nasal turbinates causing a decrease in nasal airway size.¹⁰

According to Fingeroth, maxillary deficiency frequently results in a decreased nasal permeability with mouth breathing, and within this environment a CHL may develop.¹⁶ Impaired Eustachian tube functions may cause pathologic changes in the middle ear that in turn can lead to hearing loss and/or other complications such as otitis media.¹⁷

MAXILLARY EXPANSION APPLIANCES

Expansion appliances can be broadly divided into 2 groups.

1. Rapid maxillary expansion appliances
2. Slow expansion appliance

Rapid maxillary expansion appliances further classified into Banded expanders and Bonded expanders.¹⁸ They are commonly used in mixed dentition and early permanent dentition for expansion of the maxillary arch.

Banded expanders, are fully made up of stainless steel components, expansion screw is soldered to the stainless steel molar and premolar bands that are cemented to maxillary tooth. The bonded expander is characterized by full coverage of the occlusal surface and partial coverage of the buccal and palatal surfaces of the buccal teeth, commonly using an acrylic material, attached to a midline jackscrew. This RME appliances are fixed to the tooth by means of luting cements.

The earliest cited report of maxillary expansion was by Angell (1860) who claimed to have achieved opening of mid palatal suture in 19th century. He used a double jack screw type appliance to expand the maxillary arch in a young girl. Later, in 1877 walter coffin achieved maxillary expansion by means of his coffin spring which separated the mid palatal suture in young children. Although this expansion technique was discredited at that time, Andrew hass extensive animal studies and advancements in the rapid palatal expansion devices has been popularized this method of transverse maxillary expansion.^{19,20}

Since the beginning of the 20th century this orthopaedic procedures are commonly used in orthodontics. Hass mentioned to reduce the dental tipping and achieve more bodily movement, acrylic palatal coverage is added to support the appliances, thus permitting forces are transfered to not only teeth but also palatal region. Inflammation is a complication.²¹

The monkey studies of Starnbach et al demonstrated that the effect was not only in midpalatal suture but on the circum maxillary suture system.²²

Chaconas and caputo and Gardner and kronman reported actual opening of the spheno occipital synchondrosis^{23,24}

Hyrax type Expander

In this type stainless bands are placed on the first premolar and first molar, expansion screw placed close enough to the palate, To increase the rigidity of the appliance buccal and palatal supporting wire also added.

Bonded RME produces changes not only in transverse dimension but anteroposterior and vertical dimension also.

Rapid maxillary expansion (RME) separates the two maxillary halves by the way increases the transverse dimension of the maxillary arch and, in addition, the posterior teeth and alveolar processes move buccally. The force for mid palatal splitting is delivered by the activation of the expansions crew. Mid palatal suture is separated by the application of heavy intermittent forces (0.9–4.5 kg) for a short period (1–3 weeks).²⁵⁻²⁸

RME appliances are fixed orthodontic appliances and generally generate 3-10 pounds of force.²⁹

RPE is indicated for the Correction of a unilateral or bilateral cross bite, Mobilization of maxillary sutures to facilitate correction of a Class III mid face deficiency, Increasing maxillary arch width and length, Increasing the apical base width to facilitate buccal root torque of the posterior teeth, Reducing nasal resistance and providing a normal breathing pattern.^{30,31}



Fig 1 Constricted Maxillary arch

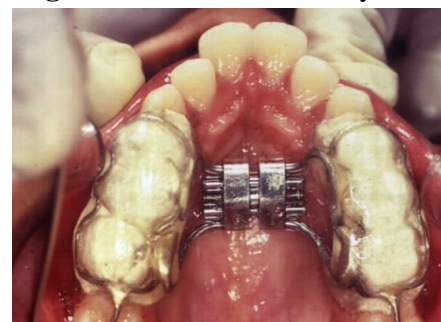


Fig 2 Bonded RME appliance



Fig 3. After maxillary expansion

EFFECTS OF RME

The suture's vertical opening is triangular, with the greatest width at the prosthion and the least near the apex of the nasal cavity.²⁸ As the maxilla starts to separate, the translation of the maxillary segments occurs. Wertz mentioned the triangular widening of the maxilla with the apex at the posterior nasal spine and its base anteriorly in the midline diastema that usually forms between the central incisors.³²

The lateral walls of the nasal cavity with the attached conchae move laterally, and the floor of the nose drops inferiorly as the alveolar processes bend laterally and the free margins of the horizontal palatine processes move inferiorly. The mechanical widening of the nose is said to facilitate nasal respiration.^{28,33}

There are two distinct stages in palatal expansion, active adjustment of the screw and the passive retention to allow healing. 3-6 month retention period is sufficient for the ossification of the mid palatal suture and reorganization and stabilization of the other maxillary sutures.

Orthodontic Effects

RME fixed to the posterior teeth while activation the posterior teeth tend to tip buccally, slight bending of adjacent alveolar bone and downward movement of maxillary posterior teeth happen in some cases. This extruded maxillary posterior teeth will rotate the mandible downward and backward. Midline diastema will form while activating RME.

Orthopedic Effects

The palatal process separate in a triangular or wedge pattern with the base of the triangle facing anteriorly and apex facing posteriorly.

Both short and long-term studies evaluated the effect of RPE on CHL. Short-term studies reported improved hearing levels in young patients after treatment with tooth-borne expanders.^{10,34,35}

The effect of RME on hearing improvements can be explained by the relationship among the nasopharynx, the Eustachian tube and the mastoid air cells, comprising the middle ear system. Active opening of the Eustachian tube is mainly accomplished by the medial portion of the tensor veli palatine muscle, allowing pressure and nasopharyngeal secretion management.¹⁴ After RME, the stretching that occurs in the elevator and tensor velipalatini muscles opens the pharyngeal orifice of the Eustachian tube, thus allowing air to enter or leave the middle ear. By allowing air to go through the tube, pressures on either side of the tympanic membrane are balanced and the ossicular chain can vibrate freely and function normally.⁹

Patients suffering from recurrent serous otitis media and CHL showed functional improvement after treatment and retention of RPE. In most of the studies, tooth-borne RPE appliances were used to expand the maxillary arch.

Chronic otitis media is an example of conduction deafness because in this disorder air conduction is impaired. With RME, palatal and pharyngeal soft tissues can be modified and tubal ostia may function more normally. As a result, air passes through the tube, and pressures on both sides of the tympanic membrane are balanced. Thus, the tympanic cavity and the ossicular chain can vibrate freely and function normally.^{10,14}

Ceylan et al. found that hearing levels were significantly improved during the active maxillary expansion period, although some relapse in hearing levels occurred during the retention period.³⁴ Such relapse was also found by Taspinar et al.³⁶

In another study performed on 25 subjects having recurrent serous otitis media and CHL, Villano et al found a functional improvement in all patients at the end of the retention period of 8 months.³⁷

Based on low to moderate evidence, hearing levels and middle ear function can be improved in patients with constricted maxillary arches.³⁸

In a long-term study of Kilic et al, RPE was performed with tooth-tissue-borne appliances. Hearing levels and middle ear functions were improved after an active expansion period, and remained relatively stable during the long term observation period. The function of the Eustachian tube in patients with transverse maxillary deficiency and CHL was improved after RPE.³⁹

Kelly Regina Micheletti et al evaluated the effects of rapid maxillary expansion (RME) on middle ear function in 18 patients with posterior cross bite before, after, 3 months and one year from expansion procedure. Audiometric and tympanometric exams were taken before rapid maxillary expansion, after RME (15 days), 3 months and one year after rapid maxillary expansion. Rapid maxillary expansion has no deleterious effect in hearing quality and seems to improve middle ear function in children with posterior cross-bite in a one-year perspective.⁴⁰

According to Timms,⁴¹ the most important feature of RME is that no relapse of the basal bone occurs if adequate retention is maintained initially. This has been shown similarly in respiration.⁴²

However, the RME seems to influence hearing quality only in cases where there is dysfunction of the middle ear and Eustachian tube.

Midpalatal suture ossification can occur from 14-15,⁴³ but the optimal age to treat with rapid maxillary expansion appliance is considered between 8-15 years.⁴⁴

CONCLUSION

Orthodontics is not just limited with mere alignment of the teeth and smile esthetics but it has an expanded health care role that has established a new standard of health care for conductive hearing loss individuals. Even though

orthodontic expansion is mainly indicated to correct dental and skeletal discrepancies, RME treatment has a positive and statistically significant effect on both improvements in hearing and normal function of the eustachian tube in patients having transverse maxillary deficiency and CHL. However, it must be kept in mind that this respect of RME was evaluated in a little number of long term studies.

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