Rapid Maxillary Expansion and Conductive Hearing Loss

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Quick Response Code

doi: 10.5866/4.3.900

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Article Info:
Received: July 10, 2012;
Review Completed: August, 9, 2012;
Accepted: September 10, 2012
Published Online: October, 2012 (www. nacd. in)

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ABSTRACT:

Rapid maxillary expansion (RME) increases the transverse dimension of the upper arch by separating the two maxillary halves and, in addition, the posterior teeth and alveolar processes move buccally.

RME is frequently used in the treatment of maxillary constriction with a bilateral posterior crossbite. RME increases the width of the nasal passages and improves respiration.

Treatment of a maxillary deficiency by rapid maxillary expansion may change the oral, nasal, and pharyngeal tissue form so as to benefit respiration as well as correct a dental cross-bite.

In patients with conductive hearing loss concomitant with a maxillary deficiency, this orthopedic procedure 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.

The purpose of this article is to make the clinician aware that in some cases of conductive hearing loss, a relationship may exist. Rapid maxillary expansion may improve the oral and nasopharyngeal anatomic environment so as to result in improved hearing.

Thus, the purpose of ials and management of burning mouth syndrome.

Key words: Rapid Maxillary Expansion, Conductive Hearing Loss.

Introduction:

RAPID MAXILLARY EXPANSION

Rapid Maxillary Expansion (RME) increases the transverse dimension of the upper arch by separating the two maxillary halves and, in addition, the posterior teeth and alveolar processes move buccally.[1] The force for mid-palatal splitting is delivered by the activation of the expansion screw.

With such an approach, mid-palatal suture is separated by the application of heavy intermittent forces (0.9- 4.5 kg) for a short period (1-3 weeks).[2-7] The suture's vertical opening is triangular, with the greatest width at the prosthion and the least near the apex of the nasal cavity.[7] As the maxilla starts to separate, the translation of the maxillary segments occurs.[8] 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.[7]

Several investigators[6, 9- 15] have evaluated the effects of RME and reported a decrease in nasal resistance and an increase in nasal width after treatment. According to Wertz,[14] the stenosis caused by an obstruction in the more anterior-inferior portion of the nose could possibly be relieved by maxillary suture opening, whereas a stenosis located in a more posterior or superior area would not benefit from this procedure.

Recently, Basciftci et al1[6] also have reported that RME is effective in patients with respiratory problems. RME is frequently used in the treatment of maxillary constriction with a bilateral posterior crossbite.

Maxillary constriction, together with a high palatal vault, are two characteristics of the "skeletal development syndrome."[17] Laptook[17] described other features of this syndrome as (1) decreased nasal permeability resulting from nasal stenosis, (2) elevation of the nasal floor, (3) mouth breathing, (4) bilateral dental maxillary crossbite along with a high palatal vault, and (5) enlargement of the nasal turbinates causing a decrease in nasal airway size.

CONDUCTIVE HEARING LOSS:

Conductive hearing loss is one of the auditory disorders characterized by elevated air-conduction thresholds. The loss in hearing varies according to the severity and type of the physical change imposed on the mechanical system of the outer or middle ear.[18] Another auditory disorder is of the sensori-neural type and is characterized by lesions in the cochlea or involves the eighth cranial nerve.[18] Therefore, Auditory disorders are broadly classified as conductive (external and middle ear) and sensori-neural (referring to lesions in the cochlea or involving the eighth nerve).

Audiologic tests such as comparative measurements of air- and bone conduction thresholds help distinguish a conductive hearing loss from a disorder of the sensori-neural type.[18] 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.[18,19]

The major dysfunction observed in conductive dis-orders is a loss in hearing sensitivity reflected by elevated air-conduction thresholds. The loss var-ies greatly depending on the severity and type of physical change imposed on the mechanical system of the outer or middle ear. Because the cochlea and eighth nerve are often unimpaired in individuals with only a conductive lesion, bone-conduction thresholds are found at normal or near-normal levels.[20]

RELATIONSHIP BETWEEN RME & CONDUCTIVE HEARING LOSS:

Maxillary arch contraction or maxillary width deficiency, concomitant with a high palatal vault, is a manifestation of a skeletal development syn-drome that causes some rhinologic problems and has certain negative effects on the dentofacial pattern.[21]

The dental manifestations of this malocclusion are generally treated orthodontically by rapid maxillary expansion (RME). RME is a dramatic procedure with a long history. This treatment procedure was introduced by E.C. Angell in 1860, and has gone through subsequent periods of popularity and decline.[22] Graber[23] advocated RME for the treatment of cleft lip and palate pa-tients in the late 1940s. As a result of the studies made by Haas, [24, 25] RME gained more attention in the 1960s. At the present time, this treatment pro-cedure is being applied successfully to both chil-dren and young adults in most orthodontic departments.

Although the main object of RME is to correct maxillary arch narrowness, its effects are not lim-ited to the upper jaw. The maxilla is associated with 10 bones in the face and head, so RME may affect structures directly or indirectly related to the maxilla,[21, 22, 26, 27] mandible,[22,24,25,27,28] nasal cavity,[21,24,25,28,29,30,31] pharyngeal structures,[21,32,33] tem-poro-mandibular joint,[27] middle ear,[21,28,32,34,35] and the pterygoid process of the sphenoid bone.[32] RME has also been reported to cause improve-ments in breathing, to correct dental crossbite and crowding,[24,25,29,33,36,37,38,39,40] and to restore con-ductive hearing loss due to middle ear and Eus-tachian tube problems.[21, 28,32,35,37,38]

The Eustachian tube connects the tympanic cavity to the nasal part of the pharynx, and its orifice lies on its respective lateral nasal pharyn-geal wall.[21] Physiologic obstruction of the Eusta-chian tube comes from the tensor veli palatini muscles, at their origins. The tensor and levator palatini muscles are part of the soft palate. This keeps the tube from opening in response to nega-tive pressure in the middle ear.

Negative pres-sure in the middle ear may, by itself, be another cause of tubal malfunction. The physiologic mal-formation is seen in all the diseases that affect the palatal musculature and the shape of the na-sopharynx.[41] If the tube is blocked, air in the tym-panic cavity is absorbed into the mucosal cells (and may at times be replaced with serous or mucous secretions) with loss of pressure, increas-ing concavity of the tympanic membrane, and progressive deafness.[41] Braun[37] believed that a re-lationship existed between conductive hearing loss and maxillary width deficiency.

Rudolph[41] stated that tubal malfunction is seen more fre-quently in children who have extremely high palatal arches, and that malformations of the pal-ate and nasopharynx are predisposing factors for otitis media.

Gray[38] found that recurrent serous otitis media decreased remarkably in patients who had un-dergone RME. After Laptook[21] applied RME to a patient who had conductive hearing loss, he re-ported that hearing improved dramatically within the first 1.5 weeks and the improvement continued during the active treatment period.

Timms[28] reported on the medical aspects of 200 patients treated with RME and cited a case that was related to a hearing problem. He reported that the patient's hearing problem improved within the first week of the expansion.

Hazar and co-workers[35] also observed that a patient with conductive hearing loss experienced significantly improved hearing after four weeks of RME, and that the air-bone gap decreased. The relationship between RME and changes in hearing levels has not been investigated statisti-cally in a large sample.

Thus, the purpose of this article is to REVIEW whether or not RME has any effect on conductive hearing loss.

MAJOR STUDIES DONE BY PROMINENT AUTHORS:

According to Laptook

Laptook in (AJO 1981) used RME for the treatment of a patient who had conductive hearing loss and reported improved hearing in the first 1.5weeks and also noted that this improvement continued during the active phase of the treatment.

He suggested that the orthopedic effect of the RME procedure helps improve hearing loss because of a more normal functioning of the pharyngeal ostia of the eustachian tubes.[42]

According to Ceylon etal

Ceylan and Oktay et al (Angle 1996) performed RME in 14 patients with conductive hearing loss, and they found that hearing level with significantly improved during the active expansion period.

They observed some relapse in the hearing level after the retention period, but it did not significantly affect the overall results obtained.[43]

According to Taspinar etal

Taspinar and Bishara et al (Angle 2003) evaluated the effect of rapid maxillary expansion on conductive hearing loss in 35 subjects (21girls and 14 boys) with an average age of 14 year 6 months.[44]

Results indicates that significant changes occurred in both the hearing levels and air-bone gaps in both timing and frequency after the active treatment period. For most patients these improvements were maintained two years after active treatment.

Improvement in conductive hearing loss is considered as a possible additional benefit of RME treatment. It does not indicate that people with conductive hearing loss should consider this a treatment approach without an accompanying maxillary constriction.

Hazar et al reported on a patient with conductive hearing loss who showed significant improvement in hearing loss and a decrease in air-bone gap within four weeks of RME.

DISCUSSION - MAIN MECHANISM

The purpose of this article is to make the clinician aware that in some cases of conductive hearing loss where the above-listed features of maxillary deficiency syndrome are present, a relationship may exist. Rapid maxillary expansion may improve the oral and nasopharyngeal anatomic environment so as to result in improved hearing.[45]

MECHANISM

The middle ear is connected by the eustachian tube to the nasopharnyx, which in turn communicates with the nasal cavities and the oropharynx. Oropharnyx and palate may both influence the functioning of the eustachian tube. RME has certain effects on the nasal cavity and palate. In addition, tensor veli palatini may affect hearing improvements.

This muscle has its origin at or near the Eustachian tube orifice and inserts into the soft palate and plays a role in the opening of eustachian tube orifice.

After RME, this muscle may extend and open the eustachain tube orifice. As a result, air passes through the tube, and ossicular chain function normally.[42]

RATIONALE:

RME is one of the treatment modalities for the correction of maxillary constriction with posterior crossbites. RME increases the width of the nasal passages and improves respiration.[22-24, 33] Braun[37] indicated that maxillary constriction is one of the causes of nasal stenosis, which may be associated with mouth breathing, can affect the Eustachian tubes and the middle ear, and result in hearing loss.

The maxilla articulates with nearly 10 other bones of the face and cranium. Because of their relative rigidity, skeletal tissues offer immediate resistance to the expansion force. The main resistance to mid-palatal suture opening is not in the suture itself but mainly in the surrounding structures, particularly the sphenoid and zygomatic bone.[25, 26] There are two distinct stages in palatal expansion, active adjustment of the screw and the passive retention to allow healing. These stages are mediated by the stabilization of the appliance.[24]

A number of authors[32,34,44] suggested that a three- to six month retention period is sufficient for the ossification of the midpalatal suture and reorganization and stabilization of the other maxillary sutures. Other authors[24,34,47] suggest that a longer retention period is needed. In animal studies, RME resulted in cranioskeletal dis placements further from the site of actual expansion. [48, 49]

The skeletal changes that occur in the mouth, oropharynx, nasal cavity, and nasopharynx tend to modify the soft tissue architecture overlying these bony structures.[21,50] In addition, the soft tissue response plays an important role vis-a-vis the stability of the results.[21,50,51] Some patients affected with hearing loss also have a history of recurrent upper respiratory tract infections.[37,52,53] The general improvement in nasal physiology as a result of RME minimizes the drying of the pharyngeal mucosa and decreases the upper respiratory tract infections and otitis media. The latter is a common cause of conductive hearing loss.[29,52,54,55]

Progressive deafness occurs through an increase in the tympanic membrane concavity as a result of pressure loss. Chronic otitis media is an example of conduction deafness because in this disorder air conduction is impaired.[52,53,56]

With RME, palatal and pharyngeal soft tissues can be modified and tubal ostia may function more normally.[51,55] 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.[52,55]

Pure-tone air- and bone-conduction threshold testing provides a good profile of an individual's hearing.[31] Conductive hearing loss due to middle ear stiffness primarily affects low frequencies[57] Hence, the thresholds at high frequencies of 4000 and 8000 Hz affected by middle ear mass or by inner ear nerve damage were excluded from this study.

In Taspinar's study, significant improvements in both hearing levels and air-bone gaps were achieved at the completion of the active expansion period. These findings are similar to the observations by Laptook,[51] Timms,[54] and Hazar et al[39] as well as the study by Ceylan et al.[31] Although Laptook, [51] Timms,[54] and Hazar et al[39] reported that the results were not transient, Ceylan et al[31] found that at the end of the 4.5-month retention period, some of the improvement was lost but not at a significant level. In addition, they stated that the decrease in air-bone gap measurements affected hearing positively. In Taspinar's study, 26 of 35 patients (74%) demonstrated clinically significant and stable improvement in their hearing. The improvements in hearing levels and air-bone gaps appeared to be evident at the third and fourth recordings, ie, two years after expansion.

According to long-term studies evaluating the stability of RME, most authors[21,22,33] observed that some relapse occurred during the retention period, whereas others[33,40,47] did not. The non significant reversal in the hearing level observed in the third recording in Taspinar's study could be related to the relapse tendency of the hard and soft tissues.

On the other hand, the stability of the hearing improvements in Taspinar's study could be attributed to the rigid retention device used and the longer retention period when compared with the other RME and conductive hearing loss studies. According to Timms[58] 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.[27] Improvement in conductive hearing loss is considered as a possible additional benefit of RME treatment. It does not indicate that people with conductive hearing loss should consider this a treatment approach without an accompanying maxillary constriction.

CONCLUSION

It has been observed that RME has a positive and statistically significant ($P<0.05$) effect, dur-ing the active widening period,(According to Ceylon and Taspinar) on the hearing levels of subjects with conductive hearing loss. At the end of the retention period, the improve-ment reversed in 2 studies at a non significant level, causing the change in hearing levels to become non sig-nificant. The decrease in air-bone gap measure-ments between the first and third records could be considered to positively affect hearing.

The fact that a significant improvement was observed in the hearing levels of some subjects, but was not supported by statistical analysis of the entire sample, denotes the need to investi-gate this topic using a larger sample and a longer investigation period. All audiological records should be included, and researchers should try to determine why some subjects show improve-ment and others do not.

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