Review Article

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Unusual systemic and nondental effects of maxillary expansion therapy: A comprehensive and updated review of literature

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Abstract

In dental practice, pediatric patients with a wide range of manifestations of malocclusion viz. crossbite, dental crowding, and skeletal Class III due to transverse discrepancy of the abnormally constricted maxilla or palate are found. However, the dental management of such kind of malocclusion with narrow palate needs a meticulous dental evaluation. Appliances used for treating such malocclusion conditions may include Slow-Maxillary Expansion (SME) or Rapid Maxillary Expansion (RME) orthodontic or orthopedic appliances. Considerable success has been described in the literature using the maxillary/palatal expansion modality. Unusual systemic and nondental effects of expansion appliances therapy have been described in some scientific studies. However, no comprehensive review article has been published describing the nondental and systemic effects of RME/SME therapy in Pediatric Dentistry. Considering the above scenarios, the updated and comprehensive review of the relevant literature is necessary for health professionals. Dental professionals including pediatric dentists and orthodontists need to consider such untoward or unexpected effects of RME/SME treatment modality. Hence, the current comprehensive review article has been written with the aim to meticulously describe the relevant scientific literature about nondental/extraoral and systemic effects of RME/SME appliances.

Keywords:

Adverse effects, alt-RAMEC, complications, maxillary expansion, nondental effects, palatal expansion, pediatric dentistry, rapid maxillary expansion, RME, slow maxillary expansion, SME, systemic effects, untoward effects

Introduction

In dental practice, pediatric patients presenting with a wide range of manifestations of malocclusion viz. crossbite, dental crowding, and skeletal Class III due to transverse discrepancy of the abnormally constricted maxilla or palate are found. However, the dental management of such kind of malocclusion with narrow palate needs a meticulous dental evaluation. Various orthodontic appliances for correcting such maxillary transverse deficiency of the palate have been reported with variable outcomes. Appliances used for treating such malocclusion conditions may include slow-maxillary expansion (SME) or rapid maxillary expansion (RME) orthodontic or orthopedic appliances. Success has been described in the literature using the maxillary/palatal expansion modality. However, several scientific studies have reported nondental or systemic effects of SME/RME appliances. Dental professionals including pediatric dentists and orthodontists need to consider such untoward or unexpected effects of RME/SME treatment modality. Hence, the current

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comprehensive review article has been written with the aim to meticulously describe the relevant scientific literature about nondental/extraoral and systemic effects of RME/SME appliances. This article will help medical and dental health professionals understand the unusual and unpredictable effects of RME/SME on different maxillofacial and systemic functions of pediatric dental patients.

Nondental or systemic effects of maxillary/palatal expansion

Effects on hearing disorders (otological disorders)

The recent scientific literature pertaining to RME for the correction of maxillary/palatal deficiency has highlighted one of the significant nondental effects, that is, hearing improvement in middle-ear disorders/conductive hearing loss disorders in children and adolescent patients.[1-3] Findings such as constricted maxilla/palate and hearing problems associated with Eustachian tubes, the middle ear, and mouth breathing have been previously described in the existing literature.[1-3] A link between conductive hearing loss and maxillary deficiency in patients with high palatal form and posterior crossbite has been reported in scientific literature. Resolution of the middle ear infection and hearing impairment/loss has been described in studies.[1-3] It has been reported that expansion of the constricted palate impacts the auditory anatomic area of the skull (Eustachian tube, i.e. tympanic cavity to the nasopharynx). In a study done by Timms, it was reported that soft tissues (muscles) of the anatomical structures of the palate and pharynx (by stretching the tensor veli palatine muscles and elevator muscles and thereby helping in restoring the appropriate function of the auditory system and tympanic membrane) are modified by the RME procedure, which leads to improvement in the drainage in the Eustachian tube.[4] In addition, a probable relation between palatal/maxillary expansion therapy and the attenuation of infectious processes was found.[1-3,5-7] Acoustic immittance measures also exhibit better integrity and functioning of the middle ear after maxillary expansion process.[1-3,5-7]

A systematic review (2017) evaluated the effect of palatal expansion therapy in improving or treating the hearing loss disorder in children and adolescents with pre-existing hypoacusis.[3] It was concluded that an improvement in hearing loss after maxillary expansion is observed in children and adolescents with hearing impairments. Several studies have reported an improvement in hearing levels (ranges from 2-19 decibel) after the retention/follow-up period or treatment with palatal expansion procedure.[1-3,7]

The additional outcomes of RME in terms of correction of hearing impairment in growing children have been reported to be helpful in improving the quality of life and school performances.[3]

Effects on nasal breathing/respiration

Maxillary expansion procedure has been reported in recent literature to rectify respiratory/breathing problems in growing patients including children and adolescents.[8] However, there have been some problems mentioned in the systematic review regarding the research methodology such as smaller sample size and shorter retention period.[8] Furthermore, along with rhinometry, the employment of computational fluid dynamics has been suggested to be considered for analyzing the influence/effects of RME on nasal breathing.[8] The relevant literature reveals beneficial effects of RME on nasal breathing or respiration by expanding the nasal cavity volume and reducing nasal airway resistance in growing patients. Also, apart from rhinometry, computational fluid dynamics should be taken into consideration to demonstrate more precise assessment of the RME effects.[8]

Scientific literature evidence demonstrated that RME affects the naso-maxillary complex by generating the skeletal transverse expansion significantly of the nasal region in growing pediatric patients.[9] However, no significant differences in nasal effects are predicted when the expansion appliance is anchored on the primary teeth either covering the palatal vault by the acrylic part of the expander.[9]

A systematic review concluded that a potentially positive influence on the nasal septum asymmetry during the phase of childhood; however, no remarkable changes were found in the adolescence phase from RME in individual with nasal septal defect.[10]

The results of the randomized clinical trial described the beneficial or positive effects of RME and alternating rapid maxillary expansion and constriction on the mucociliary clearance. However, alternating rapid maxillary expansion and constriction showed more beneficial outcomes on mucociliary clearance and nasal physiology.[11]

Effects on OSA

Obstructive Sleep Apnea (OSA) is a breathing disorder with mild to moderate symptoms with reported prevalence ranging from 1% to 5.7% in growing individuals, that is, children.[12-14] OSA is considered as a multifactorial disorder which impairs cranio-facial growth and also the general health of a growing child and consequently affects the quality of life.[12-14] Orthopedic treatment modalities for mild to moderate OSA include RME appliances and mandibular advancement appliances, which are treatment options

only when skeletal discrepancies have been reported in studies.[12-14] Presently, the scientific studies reveal that the aforementioned orthopedic therapies may relieve the signs and symptoms and the apnea-hypopnea index of OSA patients.[12-14] However, beneficial effects of RME in children with OSA have been described in several studies in terms of improvement in apnea-hypopnea index and oxygen saturation.[12-14]

Effects on head/cervical posture

Beside the maxillary/palatal expansion effects in transverse direction, the scientific literature about the RME's influence on head and cervical posture has not been substantially reported.[15,16] The studies investigating the changes in head and cervical posture due to RME therapy in individuals with narrow maxilla are required in considerable numbers for strong scientific evidence.[15,16] A systematic review described the beneficial outcomes of RME in terms of improvement of head and cervical position in growing individuals.[15,16] However, a reduction in cranio-cervical angle is observed (ranging from -5.1 to +1.58 degrees) for SN/OPT angle; from -4.36 to -4.07 for PP/OPT angle; while it ranges from 0.57 to +2.23 for CVT/NSL angle.[15,16] Moreover, weak evidence was reported to support a reduction in head elevation or flexion (ranging from -5.25 to -0.15 for NSL/Ver angle) and an increment in cervical lordosis (ranging from +0.26 to +0.43 for OPT/CVT angle) and also an inclination of the cervical spine was observed.[15,16]

Ophthalmologic effects and headache

Maxillary expansion procedure has been reported in literature recently to manifest ocular/ophthamological effects such as strabismus and diplopia.[17] Studies have described/hypothesized the reason of the abovementioned ocular effects, such that palatal expansion/increase in the width of the palatal vault following RPE/RME may incorporate other bony anatomical structures which contain blood vessels and nerves innervating the ocular cavity.[17] In a clinical case report of pediatric patients with constricted maxilla, class-III malocclusion and strabismus, the beneficial effects of maxillary expansion therapy in terms of vision were described. But six months later, relapse in vision defect was reported.[17] However, further clinical studies are necessary for ascertaining the ocular effects.[17] In a case report of RME appliance in pediatric with class III malocclusion with transverse maxillary deficiency and strabismus, it was concluded that the significant modification of the oculomotor system of the pediatric patient after RME therapy.[17]

The outcomes show that the effect of treatment on headache symptoms can be attributed to rapid palatal expansion. The innovative finding of this study is the possibility to remove neurovascular compression, stasis, and the tissue hypoxia, responsible for rhinogenous triggering in primary headaches. This noninvasive alternative can reduce the use of pharmacological and surgical therapies in growing patients.[18,19]

Influence on brain/intra-cranial effects

Recently, it has been reported in literature investigating the influence of RPE/RME on intra-cranial pressure in adolescent dental patients who undergoing MARPE (Miniscrew-Assisted Rapid Palatal Expansion) therapy for their maxillary transverse discrepancy. However, no significant changes were observed in their study. Thus, it was concluded that MARPE is presently a safer orthopedic therapy with no effects on intra-cranial pressure.[20]

Effects on pharyngeal dimensions

Maxillary/palatal expansion of the constricted maxilla or palatal vault along with protraction of retrognathic maxilla has been reported in scientific literature to be beneficial in improving the pharyngeal dimensions of the airway, including nasopharynx and oropharynx. But some limitations have also been mentioned in assessing the dimension by using 2D-cephalometric radiographs. Future scientific researches with the help of 3D imaging modalities should be carried out for determining the influence of RME on pharyngeal anatomy/morphology.[21]

Effects on TMJ and TMD

Several studies in the literature have reported the effects of RME/SME on temporomandibular joint and temporomandibular disorder (TMD). A recent study evaluated the influence of RME on TMD clinical manifestations using Hyrax appliance. A transient relief for initial 4 months from TMD's signs and symptoms by employing Hyrax appliance was found. However, the recurrence of signs and symptoms of TMD was observed after 10 months of initiation of RME therapy.[22]

Effects on speech

Owing to the hindrance potential in articulating the sounds (consonants and high-voiced vowels) by moving the tongue and thereby touching the palate, the RME has been described to be associated with speech problems in patients undergoing RME/RPE therapy. It has also been reported that a significant impairment of the first (F1) and second formants (F2) for the vowel (a) was found. However, RPE/RME has not reported to affect the resonance or vocal quality. Hence, a slight phonetic alteration in the acoustical parameters of both vowels and consonants has been illustrated in available literature.[19]

Facial or extraoral effects

Apart from the stomatognathic system, recently a case report has described the unexpected outcome/

complication viz. saddle nose with suborbital hematoma following maxillary expansion therapy.[23]

The aforementioned unintended or unusual effects of maxillary/palatal expansion therapy should be known to the associated health professional including pediatric dentist, orthodontist, ENT specialist, orthopedician, etc., for the early identification and appropriate intervention accordingly.

Maxillary expansion by slow-maxillary expansion appliances

The primary drawbacks of RME are the young patient's discomfort and pain as well as the need of compliance from both pediatric patient and parents to activate the appliance. As per literature, RME is one of the most painful early orthodontic procedures in terms of symptoms patients experienced (up to 98%).[24] The procedure of slow palatal expansion, also known as dentoalveolar expansion, entails the use of equipment to transversely widen the palate. Skeletal changes are still discernible even if the expansion is solely dental.[25] Structures surrounding the maxilla have less tissue resistance, and the midpalatine suture has more bone development. As a result, it lessens the negative effects of RME. Studies have demonstrated that great postexpansion stability is promoted by slow expansion procedure.[25] It consistently exerts a physiological force. The front teeth have very little or no tipping. Teeth that are anchored are barely stressed.[25] The gadget will be comfortable and lightweight in the patient's opinion. There are extremely few recurrent tendencies. The preservation of structural integrity comes with some trauma. The drawbacks include the need for a lengthy treatment duration compared to fast maxillary growth. In patients with a crossbite, SME is recommended to alleviate minor crowding by creating gaps.[25] It is indicated for patients with minor maxillary constriction and cleft lip and palate to undergo slow palatal expansion, which applies light, continuous stresses to the patient. However, it should not be used on patients whose growth is finished.[25]

SME with a nickel-titanium expander may also have orthopedic implications in deciduous or mixed dentition, according to several investigations, including that of Lanteri *et al*.[26] A SME appliance, that is, nickel-titanium (NiTi) expander can produce maxillary expansion while retaining tissue integrity by applying a smooth, mild, and continuous force during midpalate suture remodelling.

In other studies by Lanteri V *et al*., nasal cavity width and maxillary width both significantly expanded in all patients following treatment with the slow NiTi spring expander, with an average increase in nasal width of 1.79 mm.[27,28] There were no appreciable variations between the outcomes in the NiTi Leaf expander groups achieved with RME and SME therapy.[27,28]

An expansion that is calibrated and painless is produced by the SME (Leaf Expander appliance) activation approach as per a previous study by Cossellu G *et al*.[29] In reality, the mechanical stresses communicated to the bone and sutural complex are greatly reduced by this ongoing, gradual activation, which lowers the inflammatory response associated with the palate expansion protocol.[30]

The clinical activation strategy and screw size have an impact on the amount of pain experienced during rapid maxillary extension, as shown by Cossellu *et al*.[29] In comparison to patients treated with RPE, those who used the slow NiTi spring expander experienced much less pain during the first seven days of treatment. Periodontal effects and upper respiratory tract regarding the NiTi leaf spring expander's impact on the upper airways, research found no statistically significant difference between the device and RME in the volume expansion of the nasal cavity, nasopharynx, and maxillary sinus.[24,30]

In a study, Penn expander appliance was evaluated with RME and SME expansion protocols. The appliance was turned on by the SME group once every other day.[31] At any time point, there was no statistically significant difference in the headache scores between RME and SME. At t4, the RME group was found to have significantly higher scores for every measure, with the exception of headache and dizziness. Compared to rapid activation, slow activation produced a superior overall patient experience.[31]

A systematic review reported that during the first week of treatment for constricted palate, SME has significantly less pain than RME. There are no differences in discomfort between the two treatments in the weeks that followed.[32] Speaking, swallowing, hypersalivation, hygiene, and patient and parent satisfaction scores did not significantly differ between the RME and SME. Neither the significant differences found in hypersalivation, hygiene, or patient or parent satisfaction scores.[32]

Conclusion

After comprehensively and critically reviewing the relevant scientific literature pertaining to the various effects of maxillary/palatal expansion therapy in children, it can be concluded that medical as well as dental health professionals should consider the aforementioned effects if any signs and symptoms are suspected or reported by dental patients with RME/SME therapy. Hence, a multidisciplinary approach should be adopted prior to and during the palatal expansion therapy in growing children with transverse maxillary deficiency.

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Conflicts of interest

There are no conflicts of interest.

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