

Rapid Maxillary Expansion: A Unique Treatment Modality in Dentistry

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ABSTRACT

Rapid Maxillary expansion or palatal expansion as it is sometimes called, occupies unique niche in dentofacial therapy. Rapid Maxillary expansion is a skeletal type of expansion that involves the separation of the mid-palatal suture and movement of the maxillary shelves away from each other. An objective approach to the design of a suitable appliance should be made by preparing

a list of criteria based on the biomechanical requirements of RME. RME effects the maxillary complex, palatal vaults, maxillary anterior and posterior teeth, adjacent periodontal structures to bring about an expansion in the maxillary arch. The majority of dental transverse measurements changed significantly as a result of RME.

Key Words: Rapid maxillary expansion, Nasal obstruction, Maxillofacial complex

INTRODUCTION

Rapid maxillary expansion (RME) is a dramatic procedure with a long history. Rapid Maxillary expansion or palatal expansion as it is sometimes called, occupies unique niche in dentofacial therapy. Rapid Maxillary expansion or Split palate is a skeletal type of expansion that involves the separation of the mid-palatal suture and movement of the maxillary shelves away from each other.

ANATOMY

The tenacity of circummaxillary attachments due to buttressing is strong postero-supero-medially and postero supero laterally. A palatine bone forms an intimate relationship with maxilla to form complete hard palate (or) floor of nose and greater part of lateral wall of nasal cavity.

It articulates anteriorly with maxilla through transverse palatal sutures and posteriorly through pterygoid process of the sphenoid bone. The interpalatine suture joins the two palatine bones at their horizontal plates and continuous as inter maxillary sutures. These sutures forms the junction of three opposing pairs of bones: the premaxillae, maxilla, and the palatine. The entire forms mid-palatal suture [Table/Fig 1], [Table/Fig 2].

SUTURES

Mid Palatine Suture plays a key role in R.M.E [1].

- i. Infancy - Y-shape [Table\Fig 3]
- ii. Juvenile - T-shape
- iii. Adolescence - Jigsaw puzzle [Table\Fig 4]

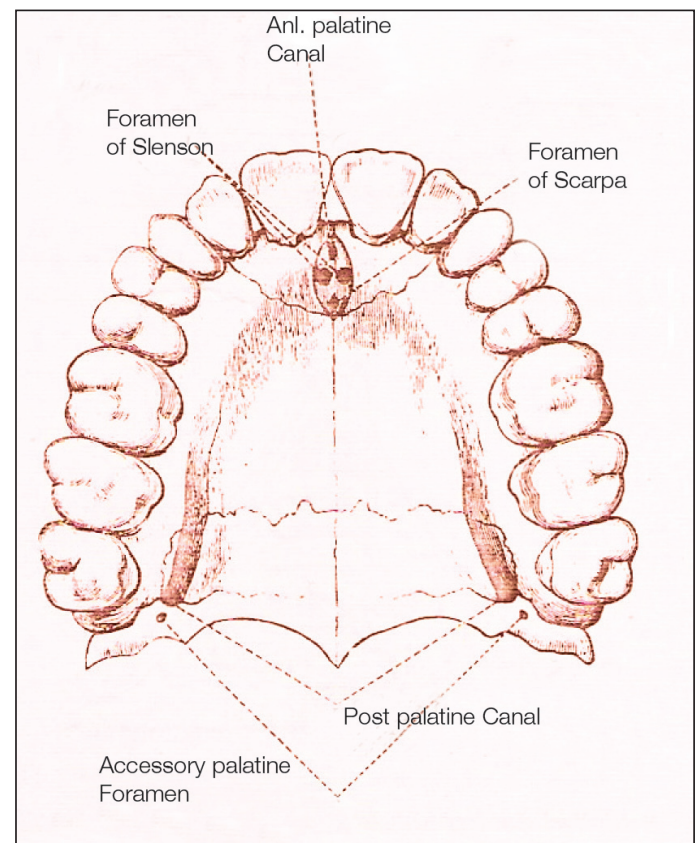
As sutural patency is vital to R.M.E, it is important to know when does the suture closes by synostosis [2] and on an average 5% of suture in closed by age 25 yrs. Earliest closure occurs in girls aged 15 yrs. Greater degree of obliteration occurs posteriorly than anteriorly.

Ossification comes very late anterior to incisive foramen – this is important when planning surgical freeing in late instances of RME [3].

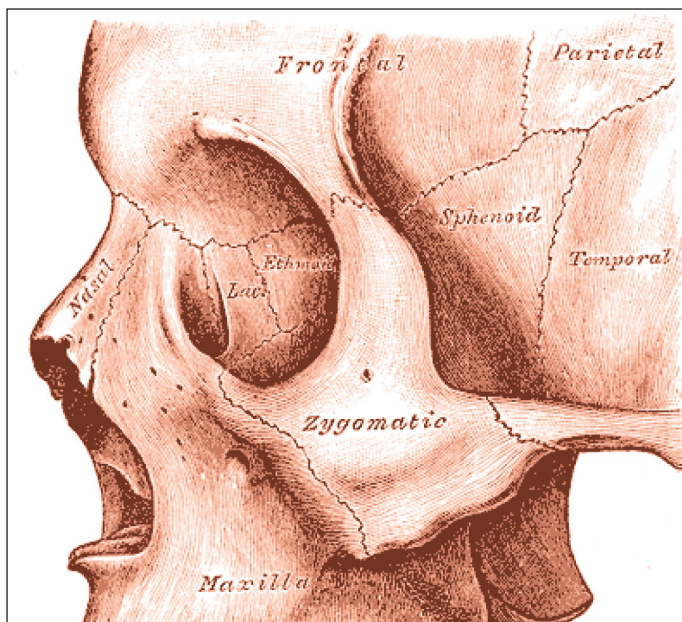
FACTORS TO BE CONSIDERED PRIOR TO EXPANSION

Important factors to be considered in Rapid Maxillary Expansion:

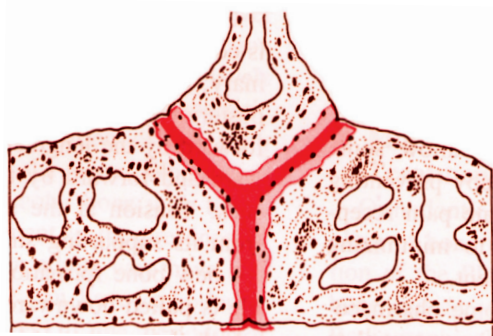
1. **Rate of Expansion:** By expanding at the rates of 0.3-0.5mm per day, active expansion is completed in 2-4 weeks, leaving little time for the cellular response of osteoclasts and osteoblasts seen in slow expansion.
2. **Form of Appliance:** As the thrust is delivered to the teeth at the inferior free borders of the maxilla, expansion must



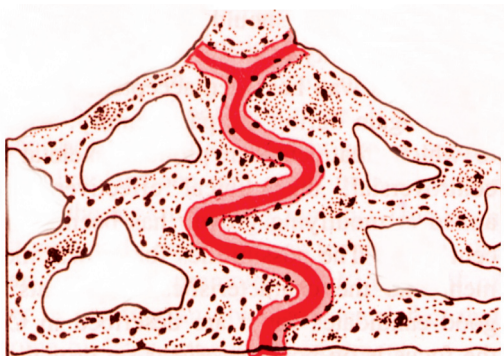
[Table/Fig-1]: Anatomy of maxilla (adopted)



[Table/Fig-2]: Sutures in the maxillofacial region



[Table/Fig-3]: Mid palatine suture in infancy (adopted)



[Table/Fig-4]: Mid palatine suture in early adolescence (adopted)

reach to the basal portions. The form of appliance will play an important role in this effort, according to its rigidity or flexibility, i.e. anchorage or control of tipping.

- Age and Sex of the patient:** The increasing rigidity of the facial skeleton with advancing age restricts bony movements remote from the appliance of expansion, which differs in both sexes.
- Discrepancy between maxillary and mandibular first molars & bicuspid width** is 4mm or more RME indicated.
- Severity of cross bite** i.e number of teeth involved.
- Initial angulation of molars or premolars:** When the maxillary molars are buccally inclined, conventional expansion will tip them further into the buccal musculature and if the

mandibular molars are lingually inclined, the buccal movement to upright them will increase the need to widen the upper arch.

- Assessment of roots of deciduous tooth**
- Physical availability of space for expansion.
- Nasal Obstruction:** All patients considered for RME should be examined for nasal obstruction and, if obstruction is found, they should be referred to an otolaryngologist before orthodontic treatment.
- Medical history:** Since the efficacy of maxillary expansion depends on suture patency and the flexibility of craniofacial complex to adapt to mechanical changes hence medical conditions altering these should be considered.
- Metabolic disorders:** Many metabolic disorders are found associated with suture synostoses which include hyperthyroidism, hypophosphatemic vitamin D-resistant rickets, and mucopolysaccharidoses and mucopolipidoses. These disorders are mostly associated with bone metabolism. Maxillary expansion would be futile even in young patients if they are suffering from any of these diseases.
- Periodontal Type:** It is essential to record the thickness of the gingival tissues during clinical evaluation of the periodontium. This is especially important because a thin and delicate gingiva might be prone to recession after traumatic, surgical, or inflammatory injuries [4].
- Mucogingival Health:** Orthodontic tooth movement has significant effect on the mucogingival tissues and hence it is important to assess the periodontal health of the patient before performing OME.

INDICATIONS FOR RME [5]

Patients who have lateral discrepancies that result in either unilateral or bilateral posterior crossbites involving several teeth are candidates for RME.

Anteroposterior discrepancies are cited as reasons to consider RME. For example, patients with skeletal Class II, Division 1 malocclusions with or without a posterior crossbite, patients with Class III malocclusions, and patients with borderline skeletal and pseudo Class III problems are candidates if they have maxillary constriction or posterior crossbite.

[Table/Fig-5] shows the various factors responsible for constricted maxillary arches.

1.	Habits-thumb sucking
2.	Obstructive sleep apnea
3.	Iatrogenic (cleft repair)
4.	Palatal dimensions and inheritance
5.	Muscular
6.	Syndromes
7.	Klippel-Feil syndrome
8.	Cleft lip and palate
9.	Congenital nasal pyriform aperture stenosis
10.	Marfan syndrome
11.	Craniosynostosis (Apert's, Crouzon's disease, Carpenter's)
12.	Osteopatia striata
13.	Treacher Collins
14.	Duchenne muscular dystrophy
15.	Nonsyndromic palatal synostosis

[Table/Fig 5]: Etiology for maxillary constriction indicating RME

CONTRAINDICATIONS OF RME

Patients who have anterior open bites, steep mandibular planes, and convex profiles are generally not well suited to RME.

Patients who have skeletal asymmetry of the maxilla or mandible, and adults with severe anteroposterior and vertical skeletal discrepancy.

HAZARDS OF RME

- Oral hygiene
- Length of fixation
- Dislodgement and breakage
- Tissue damage
- Infection
- Failure of suture to open

Rapid maxillary expansion can be of two types

1. **Tissue borne:** Haas type expansion.
2. **Tooth borne :** Banded – Hyrax or Biedermann type.
Bonded maxillary expansion.
Minne Expander or Isaacson type.

Diagnostic Aids

Case History, Clinical examination, study models, radiographs - maxillary occlusal, P.A. cephalogram.

1. A radiologically visible midpalatal suture corresponds histologically to a predominantly straight running oronasal suture, which projects largely into the sagittal X-ray path
2. Radiological invisible suture corresponds histologically to a relatively large area of interdigitation, an oblique running suture course in relation to X-ray path or bone structures projecting above the suture course. Percentage of suture obliteration to be expected is also low in this group.
3. A radiologically invisible suture is not histologically equivalent of fused suture.

DESIGN

An objective approach to the design of a suitable appliance should be made by preparing a list of criteria based on the biomechanical requirements of RME.

1. **Rigidity (Resistance to Rotation):** An RME is most likely to be "applied to the permanent dentition when there is considerable resistance to maxillary separation, the resistance is found mainly in those very areas where expansion is required, i.e., in the basal portion of the maxillae, yet the force is applied remotely, to teeth at the free lower border.
2. **Tooth Utilization: (No. of teeth included in appliance)**
 - (a) **Load distribution:** As the entire lower portions of the maxilla are to be moved laterally, it would be best to incorporate as many teeth as possible & thus spread the load over the entire alveolar length instead of applying it only at a few isolated points
3. **Expansion: (Dilating unit & action):** The dilating mechanism can be a spring (or) a screw but a spring reduces the rigidity & control. A screw is far better but should have a thread of sufficient length to complete the expansion without interruption.
4. **Economy:**
 - (a). **Time:** The use of cap splints keep the clinical time to a minimum with good laboratory backup. Chairside work is limited to taking of impressions & bite registration.

- b. **Material:** The appliance which makes the least intrusion into the oral space will be best tolerated by patient. Here the banded appliances have a distinct advantage over the bulky capsplints
5. **Hygiene:** The form which produces the minimal covering of the dental and palatal mucosal tissues consists of bands and less amount of interconnecting material. But this design as the inherent disadvantage of too much flexibility.

Cap splints should be fixation of choice, especially where rigidity is important & bands have their place, where there are difficulties in retention.

In order to simplify instructions patients have been classified into 3 age groups [6].

1. **Upto age 15 years**
 - 180° daily rotation can be met with turn of 90° both morning & evening.
 - Patient recalled after one week.
2. **Age 15 to 20years**
 - Increasing resistance for maxillary separation may cause a force buildup & pain to patients in this age group with turns of 90°.
 - Patients are asked to return after one week.
3. **Over age 25 years**
 - The mid palatal suture often is opened surgically which relieves much of the tension. Here it may not be necessary to reduce the overall rate of expansion in these patients.
 - Revisit within 3-4 days.
 - Pain to be reviewed during active RME, before continuing with patient management during subsequent visits.
4. **Pain during RME:** Completion of the desired expansion in the short time allotted requires strong forces which often produce painful effects. The clinician monitoring treatment by rate of expansion has only the modality of pain as a monitor and indication of excessive force buildup that may lead to possible tissue damage.
5. **Instructions: (Subsequent)**
 - First ask the patient & person turning the screw if there were any difficulties. This information may be volunteered as any persistent pain certainly will be.
 - Then check the central incisors for diastema.
 - Then examine the screw to see how much thread is exposed, which indicates regularity in turning.
 - The patients who complaints of pain when the screw is turned should be asked how long it lasts; it generally disappears if the suture is open. Advice that 2nd 45° turn of screw not be made before the pain generated by the first has dissipated.
 - With patients overage 20 years it is difficult to differentiate b/w the pain from on unopened suture & that from skeletal rigidity. In event of non opening of suture, surgical freeing should be considered.
 - Should difficulties (or) minor illnesses arise during the active expansion phase, it may be stopped & resumed later.
6. **How much to expand:** Expansion should stop when the maxillary palatal cusps are level with the buccal cusps of the mandibular teeth [6-7]. Young growing patients – two turns each day for the first 4 to 5 days, one turn each day for the remainder of RME treatment. In adult (non-growing) patients – because of increased skeletal resistance, two turns each day for the first 2 days, one turn each day for the next 5 to 7

days, and one turn every other day for the remainder of RME treatment.

7. Integration:

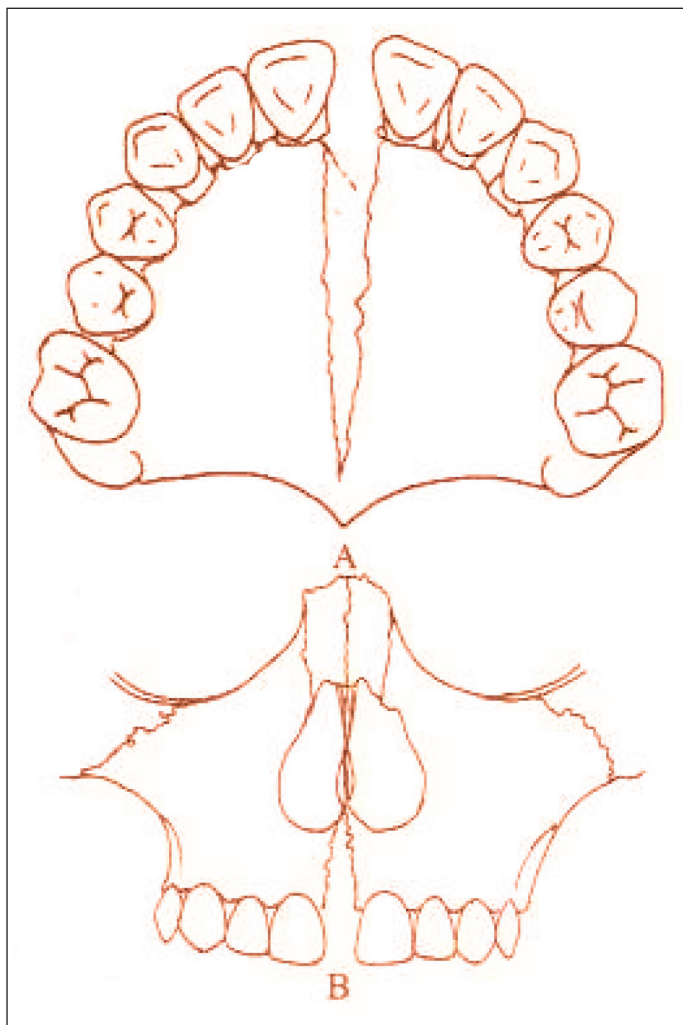
- Malocclusion often has a different appearance & its easier to treat after RME as result of changed maxillo-mandibular relationship.
- Extractions also should be left until after RME, not that much relief will gained from crowding & will eliminate extractions only in mild cases but expansion may help in better clarification of this issue.
- A palate covering retainer is satisfactory but may be some what awkward in combination with a fixed appliance to align the teeth as 1st stage of treatment proceeds.
- When functional appliances are to be used, the clinician must be sure that it has been fully accepted before discarding the retention plate.
- With fixed appliances, the palatal arch must be used.

EFFECTS OF RME ON THE MAXILLARY COMPLEX

Rapid maxillary expansion occurs when the force applied to the teeth and the maxillary alveolar processes exceed the limits needed for orthodontic tooth movement.. The appliance compresses the periodontal ligament, bends the alveolar processes, tips the anchor teeth, and gradually opens the mid-palatal suture [Table/Fig 6].

MAXILLARY HALVES

It is seen that the two halves of the maxilla rotated in both the sagittal and frontal planes. The maxilla was found to be more frequently



[Table/Fig-6]: Effects of RME on mid palatine suture (adopted)

displaced downward and forward [8]. Haas suggested when the midpalatal suture opens, the maxilla always moves forward and downward. Skeletal changes in vertical and anterior displacement of maxilla with bonded rapid palatal expansion appliances using the lateral cephalograms showed that downward and anterior displacement of the maxilla may be minimized or negated with the use of the bonded appliance.

PALATAL VAULT

The palatine processes of the maxilla were lowered as a result of the outward tilting of the maxillary halves, also the palatal vault height decreased significantly during RME. Palatal height returned to pretreatment values one year after expansion and increased an average of 0.5mm two years after treatment.

ALVEOLAR PROCESS

It has been seen in studies that since bone is resilient, lateral bending of the alveolar processes occurs early during RME [6].

BIOLOGIC RESPONSE OF MID-PALATAL SUTURE TO MAXILLARY EXPANSION

The immediate effect of applying force to the suture results in trauma. Small, localized tears occurred within the suture from the localized blood vessels. These small defects were filled with exudate, a few extravasated red blood cells, scattered filaments of fibrin and a few fine collagen fibrils [9]. A transient polymorph response was noted in the region of the defects in the first 12 hours and thereafter was not seen again. Following the polymorph response, an influx of macrophages and pioneer fibroblasts into the defect occurred by 24 hours.

Within 3 to 4 days, bone formation had begun at the margins of the suture achieved by the pre-existing and undamaged osteoblasts. These formed successive lamellae along the suture margin. The collagen fibers and cells were aligned transversely across the suture corresponding to levels of tension. New bone formation now occurred along the same axis as trabeculae formed at right angles to the lamellae deposited initially at the suture margins.

With diminution and cessation of the expansion force (2 to 3 weeks), remodeling of both the bone and the suture occurred by the osteocytic and fibrocytic cell series until normal sutural dimensions were achieved..

The mineral content within the suture rose rapidly during the first month after the completion of suture opening. The mineral content in the bone beside the suture decreased rapidly in the first month but returned to its initial level within 3 months [10].

MAXILLARY ANTERIOR TEETH

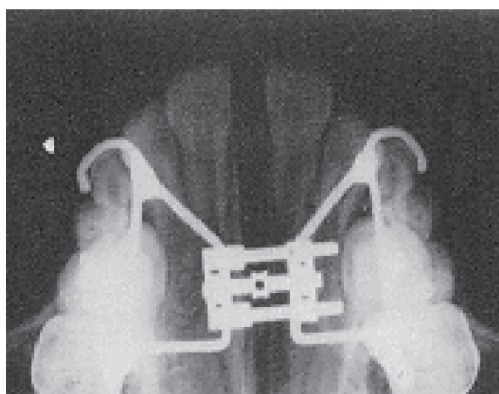
From the patient's point of view, one of the most spectacular changes accompanying RME is the opening of a diastema between the maxillary central incisors. It is estimated that during active suture opening, the incisors separate approximately half the distance the expansion screw has been opened. Following this separation, the incisor crowns converge and establish proximal contact. If a diastema is present before treatment, the original space is either maintained or slightly reduced. The mesial tipping of the crowns is due to the elastic recoil of the transseptal fibers. Once the crowns contact, the continued pull of the fibers causes the roots to converge toward their original axial inclinations. This cycle generally takes about 4 months [Table/Fig-7, 8, 9].



[Table/Fig-7]: Effects of RME on anterior teeth (adopted)



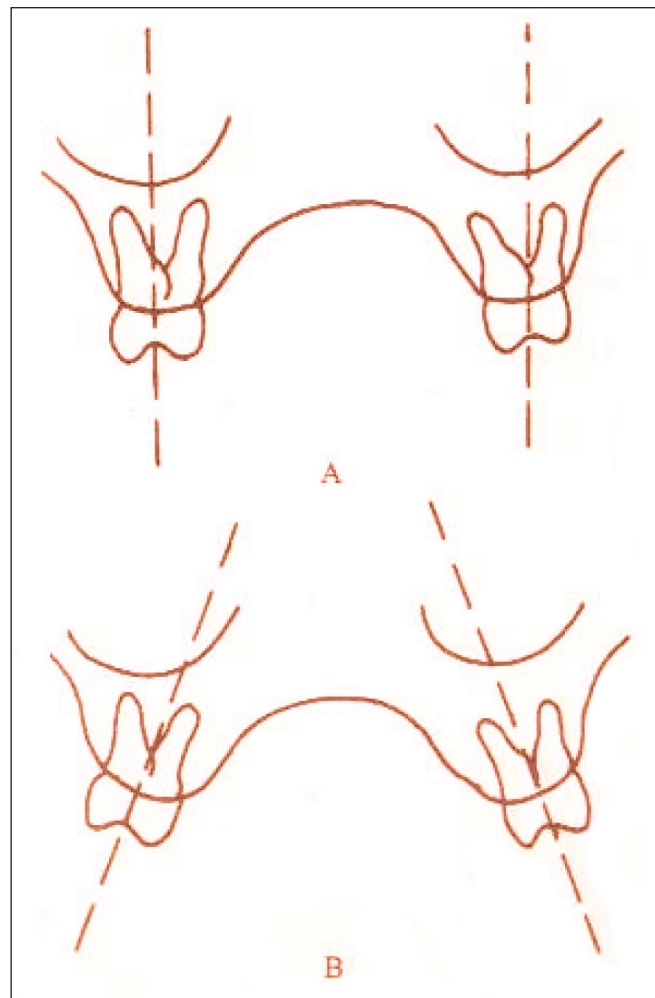
[Table/Fig-8]: Effects of appliance on midline diastema (adopted)



[Table/Fig-9]: Radiograph showing appliance for RME (adopted)

MAXILLARY POSTERIOR TEETH

With the initial alveolar bending and compression of the periodontal ligament, there is a definite change in the long axis of the posterior teeth. Teeth show buccal tipping and believed to extrude to a limited extent [11] [Table/Fig-10].



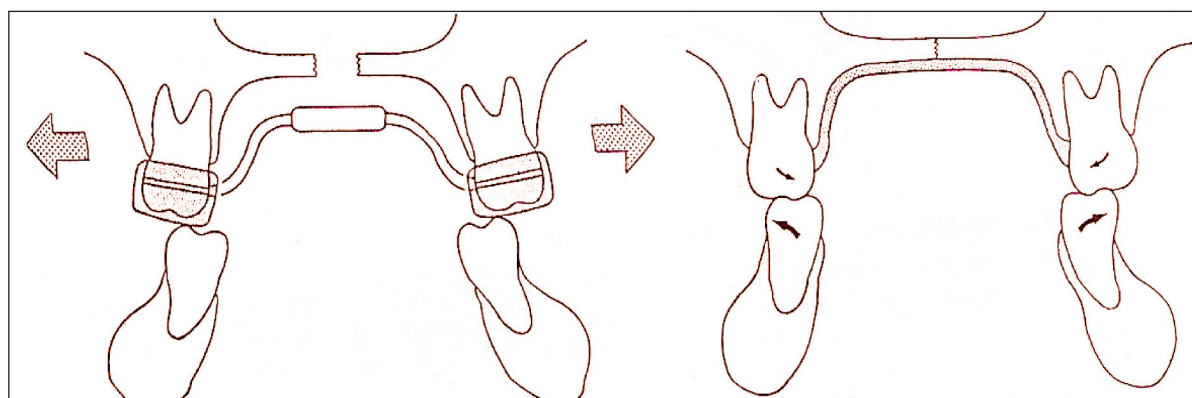
[Table/Fig-10]: Effect of RME on maxillary posterior teeth (adopted)

EFFECTS OF RME ON THE MANDIBLE

The greatest increase in uprighting of the buccal segments was in the bonded RME case for the lower arch. RME could lead to a concurrent expansion of the lower arch as much as 4 mm in inter-canine width and 6 mm in inter-molar width [12] [Table/Fig-11] (figure to be inserted after this line i.e 11)].

EFFECTS OF THE RME ON ADJACENT FACIAL STRUCTURES

All craniofacial bones directly articulating with the maxilla were displaced except the sphenoid bone. The cranial base angle remained constant. Displacement of the maxillary halves was asymmetric, the sphenoid bone, and not the zygomatic arch, was the main buttress against maxillary expansion.



[Table/Fig-11]: Effect of RME on mandibular teeth (adopted)

EFFECTS OF RME ON NASAL VOLUME CHANGES

The use of maxillary expansion has been extended to nasal obstruction, as it has been suggested that nasal width and volume increases by RME [13]. A 5.1 percent increase in nasal volume has been reported in patients after RME according to a study by Deeb W in Pubmed.

EFFECT OF RME ON SOFT TISSUE

According to a study by, the effect of RME on soft tissues, the nose tip and soft tissue Point A followed the anterior movement of the maxilla and maxillary incisors. Nihat Kilic and et al, concluded in their study that the soft tissue facial angle decreases and the H angle and profile convexity increases after RME. Also the H angle and profile convexity were statistically significant for their study [14].

ADVANCEMENTS IN TREATMENT

The most recent method used in the treatment of maxillary transverse deficiency (MTD) is Surgically Assisted Rapid Palatal Expansion (SARPE). Orthopedic Maxillary expansion (OME), in mature patient has been found associated with laterally tipping of teeth, extrusion, periodontal membrane compression, buccal root resorption, alveolar bone bending, fenestration of buccal cortex, palatal tissue necrosis, pain and instability of expansion. Because of the complications of OME SARPE has been recommended as a treatment of choice

Recent advances in molecular biology has identified the underlying mechanism in suture fusion which is an important criteria for successful long term maxillary expansion. Increased rate of cell numbers and cell differentiation can cause the formation of a bony obliteration in between the sutures.

ROLE OF LITHIUM

Effect of Lithium has also been studied related to RME by Tang H and et al, they found out that lithium treatment could aid to improve stability of ortho treatment like RME because beta catenin formation enhances new bone formation.

RETENTION AND RELAPSE OF RME

Expansion through maxillary suture widening by rapid maxillary expanders has been claimed to promote stability after retention. Stability has been attributed to the skeletal component of arch enlargement obtained by the expansion appliance as opposed to dental expansion as a result of edgewise appliance mechanotherapy.

The causes of Relapse are:

- High stress accumulated between the articulations of the craniofacial complex.
- Tension produced in the palatal mucosa.
- Imbalance between the buccal and lingual pressures, which is created as a result of maxillary expansion.
- The application of a fixed retainer immediately and subsequent to rapid maxillary expansion, then followed by an intermittent removable retention appliance is highly recommended..

CONCLUSION

The majority of dental transverse measurements changed significantly as a result of RME. The maturity of the maxilla-facial structures determine the time and success rate of the treatment with RME.

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