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Transverse discrepancies? Solutions with RME

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Abstract
Rapid Maxillary Expansion (RME) is a dramatic procedure with a long history. Emerson C. Angell reported on the procedure in 1860 (known as Father of RME), and since then it has gone through periods of popularity and decline.
Rapid Maxillary Expansion or Palatal Expansion occupies a unique niche in dentofacial therapy. By its tooth movements and mechanic's, it must basically come within the field of orthodontics, yet its ramification takes it into such other surgical disciplines as oral surgery, ENT and plastic surgery.
R.M.E. is comparatively simple and conservative method indicated for mainly maxillary transverse deficiency, bilateral crossbite, Class III prognathic malocclusion, cleft palate and medical problems like poor nasal airway due to anterior nasal stenosis, septal deformity, recurrent ear or nasal infection, allergic rhinitis, asthma and prior to septoplasty.

Keywords: RME, transverse discrepancy, crossbite

Introduction
Rapid Maxillary Expansion (RME) is a dramatic procedure with a long history. Emerson C. Angell reported on the procedure in 1860 (known as Father of RME), and since then it has gone through periods of popularity and decline.
Rapid Maxillary Expansion or Palatal Expansion occupies a unique niche in dentofacial therapy. By its tooth movements and mechanic's, it must basically come within the field of orthodontics, yet its ramification takes it into such other surgical disciplines as oral surgery, ENT and plastic surgery. However, through some strange touch of irony, many of those who work in the field most closely involve with RME find it difficult to accept because of the inculcation of two orthodontic dogmata that:

1. All expansions are bound to relapse
2. Changes in basal bone cannot be influenced by orthodontic treatment

Failure to recognize the fundamental difference between RME and other conventional techniques prevent them from accepting the philosophy of a success and useful tool in our treatment armamentarium.

Factors which regulate expansion mechanics are

1. Rate or Expansion
2. Form or appliance
3. Age of Patient

1) Rate of Expansion
Treatment time is fast as by expanding at rate of 0.3 - 0.5mm per day, active expansion is achieved in 2 to 4 weeks with little time for the characteristic osteoclastic and osteoblastic activity seen in slow expansion. The expansion of the maxillary dental arch is a result of dento-alveolar movement as well as splitting of the midpalatal suture and moving the maxillae apart. Therefore, rate of expansion is directly proportional to effect of expansion on the dental arch.

2) Form of Appliance
Force is applied to the basal bone via the anchor teeth, or anchor teeth and palatal vault (as in the Haas type appliance), and therefore the amount of skeletal changes depends on rigidity of

appliance i.e. anchorage control. The effect of expansion of the dental arch on the maxillary base increases as appliance rigidity increases. Even in some forms of slow expansion, basal width increases slightly by stimulating (or not?) growth at the midpalatal suture.

3) Age of Patient

The increasing rigidity of the facial skeleton with advancing age restricts bony movement remote from the appliance of expansion. There is an exception to this general rule just before and during the pubertal growth spurt when response is heightened. As this occurs at slightly different ages in girls and boys, a sex differential might be argued. In general, the effect of expansion of the dental arc on the maxillary bases diminishes as age advances.

A fundamental difference in the treatment effects of R.M.E and slow expansion is that in R.M.E. there is substantial increase in maxillary basal width, which is not lost despite partial dental relapse, whereas in slow expansion, there is more of dentoalveolar movement and a minimal basal effect. The role of R.M.E in the treatment requires of certain rhinologic conditions is of immense value as the relief attained is rapid. This is a consequence of widening of nasal air passages and improving the nasal respiration as a result of rapid basal bone expansion, which is not attainable by slow expansion. Therefore, the patient should be assessed from both a dental and medical aspect and the usefulness of R.M.E. considered.

Indications for R.M.E.

1. Cases of real and relative maxillary deficiency with posterior cross bite.
2. All type of Class III cases i.e. Pseudo Dental and skeletal Class III.
3. Cases of nasal stenosis - (Usually Characterized by full time mouth breathing and a constricted nasal aperture with the conchae laterally compressed against the septum).
4. Mature Cleft lip and Cleft palate patients with collapsed maxilla.
5. Antero-Posterior maxillary deficiency cases (These are cases with negative ANB angles, a negative point A to facial plane, or a negative wits analysis, which would benefit from maxillary protraction. A prerequisite to such activity would be R.M.E. to loosen the maxilla to facilitate protraction).
6. Selected arch length problems in a mature good morphogenetic skeletal pattern especially some patients of 14 - 16 yrs where extraction could lead to flattening of profile.

Contraindications for R.M.E.

1) Poor patient Co-operation.
2) Single tooth in crossbite.
3) Patient who have anterior open-bites, steep mandibular planes, and convex profile.
4) Patient with skeletal asymmetry of maxilla or mandible and adults with severe antero-posterior and unilateral skeletal discrepancies. R.M.E can be done if it is to be followed with orthognathic surgery.
5) Some operators set an upper age limit i.e. the age when synostosis has occurred. But with adjunctive surgery this is surmounted.
6) Normal buccal occlusion. However if there are overriding medical reasons of a respiratory nature for R M E., we have to give priority to this and correct. If there is a medical reason for RME but with "Cover Bite" (i.e. Maxillary teeth completely outside mandibular teeth) then it is a definite contradiction.
7) Periodontally weak teeth.

The following factors need to be considered during treatment planning to determine whether to expand the dental arches conventionally or with R.M.E.

1) The magnitude of the discrepancy between the maxillary and mandibular first molar and premolar widths; if the discrepancy is 4 mm or more, one should consider R.M.E.
2) The severity of the crossbite i.e. more the number of teeth involved, we consider R.M.E.
3) The initial angulations of the molars and 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.

Etiology

The causes of bucco-lingual discrepancies could be either genetic or environmental. According to Graber and Harvold, Cherici and Vargevik, many constricted maxillary dental arches are the result of abnormal function. Harvold in his experimental work created narrow maxillary dental arches in rhesus monkeys by converting them from nasal to obligatory oral respiration. All patients considered for R.M.E. should be examined for nasal obstruction and if obstruction is found, they should be referred to an otolaryngologist before orthodontic treatment for examination and treatment of the problem.

The Appliance used for R.M.E.

Design

Timms has listed criteria based on the biomechanical requirement of R.M.E. by which an appliance design may be attempted by an objective approach. The components that best satisfy these criteria are selected and the appliance pieced together. The list is in a descending order of importance.

1) Rigidity (Resistance to rotation)
2) Tooth utilization (No. of teeth included in appliance)
3) Expansion (dilating unit and action)
4) Economy of
a) Time &
b) Material
5) Hygiene

Types of Appliances (Construction)

1. Removable
2. Fixed

a) Tooth Borne	b) Tooth and Tissue Borne
i.) Banded	i) Banded
ii) Splints	ii) Splints

1) Removable Expansion Plates

Removable expansion plates are not recommended if significant skeletal changes are required. Midpalatal

splitting with such appliances is possible, but not predictable. For these appliances to be effective, they must be used in the deciduous or early mixed dentition and must have sufficient retention to be stable during the expansion phase (Ivanovsky). Retention is often difficult and the forces created tend to dislodge the appliance before sufficient force is created to cause a palatal split.
Though, fabrication and maintenance of oral hygiene is much easier, removable R.M.E. appliances are not recommended. Various designs of removable R.M.E. appliances have been tried.

Examples
1. Expansion screw with palatal acrylic coverage and retentive clasp components.
2. Acrylic embedding the screw and covering the palate and extending onto the anchor teeth up to facial aspect designed by Ivanovsky.

2) Fixed Type of R.M.E. Appliances
The appliance is attached to the teeth with bands cemented on the anchor teeth or by means of bonded splints.
Splints are basically of 2 types;
1. Cast Cap Splints
2. Acrylic Splints

Cap Splints are usually cast in silver/copper alloy and incorporate palatal extensions to receive the acrylic components.
Acrylic Splints are made using polymethyl methacrylate with or without a wire support framework adapted around the cervical third of the anchor teeth. The expansion screw can be spring-loaded or non-spring loaded jackscrew.

A) Fixed Tooth Borne Appliance
i) Isaacson Type
This appliance uses a special spring-loaded screw called a Minne Expander, which is adapted and soldered direct to the bands without the use of acrylic. The screw may be reduced in length to suit narrow arches by shortening the spring, tube and rod.

ii) Biedermann Type
Here special screws like the Hyrax (Dentaurum 602 – 813, leone 620; or Unitek 440 – 160) are used. These have extensions of heavy gauge wire from the screw or splints.

B) Fixed Tooth and Tissue borne appliance
Here the screw is embedded in acrylic which appraises the palatal vault and the alveolar ridges. Usually the first premolars and first permanent molars are banded with bands of a slightly loose fit as it is extremely difficult to seat four tightly fitting bands simultaneously. Wires (1mm diameter) can be soldered to the buccal aspects of the bands to increase rigidity; or brackets may be welded and used to attach arch wires for connection of teeth not covered by the R.M.E. device.

i) Derichsweiler Type
Wire lags are welded and soldered to the palatal aspect or the bands to facilitate attachment for the acrylic, which is extended to the palatal aspect of all non-banded teeth except incisors.

ii) Haas Type
A length of 0.045 inches (1.15mm) stainless steel wire is welded and soldered along the buccal and palatal aspects of the bands. The free ends are turned back and embedded in the acrylic base, which stops short of the bands and teeth. A proprietary screw is set in the midline of the split acrylic base.
Whatever the type of appliance, the screw should be mounted high in the palatal vault as possible to minimize intrusion into the tongue space. Also, because moment of rotation of the appliance during expansion is opposite to that of the tissues, it helps to keep the screw as high as possible.
The screw is mounted in the midline of the vault with the thread axis in line with the anterior border of the first permanent molars. The thread axis must be at right angles to the sagittal plane if there is mesial migration of one of the molars.
To facilitate easier turning of the screw by the patient, it is mounted so that the thread is rotated from front to back for expansion.

Orthopedic Forces during R.M.E.
The idea of influencing the mobile maxillae during and after expansion has been explored. Haas applied mesially and distally directed forces to the maxillae following R.M.E. and suggested that the orthopedic response in many patients was increased. On the other hand in a study on R.M.E. in 20 monkeys, Henry found that it did not enhance the susceptibility of the maxilla to posterior orthopedic movement following application of heavy distal forces.

R.M.E. and its role in Cleft Lip/Palate Patient Rehabilitation
Complete unilateral or bilateral clefts of the osseous premaxilla destroy the continuity of the dental arch, alveolar arch and the basal maxillary bone with varying degree of buccal crossbites and collapsed arches.
The rationales for using R.M.E. in the rehabilitation of cleft patients are:
1. It is better to place the maxilla nearer to their normal position in order to correct the basal and dentoalveolar defects viz. to achieve a proper occlusion.
2. By basally moving the maxilla laterally, the anterior nasal airway is enlarged leading to decrease in airway resistance to facilitate easier breathing.

Timms advocates the use of an appliance design for differential expansion in order to restrict posterior expansion, as in cleft cases there is more anterior collapse with the posterior most tooth quite wide. He advises that the left and right portions of the appliance be teethered at the posterior limit by using a hinge or omega spring. An articulated screw would be ideal but few such screws are available and have the drawback of limited strength and length to fully accomplish treatment goals.
Clinically one problem is the narrow confine of the palate limits the selection of a screw with adequate expansion. And secondly, limited availability of clinical crown both in quality & quantity.
These problems are overcome by;
1. Using the latest screws with expansion of up to 18 mm and mounted at the level of the crowns.
2. Using combination of bands along with Cast Cap Splints on the short clinical crowns, which cannot retain bands.

Surgical Midpalatal Splitting & Osteotomy as an Adjunct to R.M.E.
Non-Surgical R.M.E. has been for the most part, limited to

growing patients. Because the results of R.M.E. in adults are unpredictable, different surgical approaches are used to help correct maxillary constrictions. Palatal expansion can be accomplished by surgically moving the maxillae or by surgically undermining the maxillae to facilitate expansion using an R.M.E. appliance.
Kennedy et al concluded that "true movement of basal bone of maxilla by R.M.E. may be accomplished by reducing the resistance to lateral movement by osteotomies through the zygomatic buttress, nasomaxillary and pterygomaxillary areas". They have tried;
a) Horizontal Subapical Osteotomy
b) Bilateral Parasagittal Palatal Osteotomy
c) Combination

Palatal osteotomies can be parasagittal or midline to free an ossified suture.
Though many researchers reports of success, results of long-term studies on the stability are as yet not available. Several questions remain to be answered and future studies will undoubtedly produced more questions & answers.

Force Involved in R.M.E.
Isaacson et al using force dyamometers reported that a single activation expansion screw produced 3-10 pounds of force. Cumulative loads of 20 pounds and above have been recorded after multiple daily turns of the screw. Residual loads were demonstrated at the termination of appliance activation, which dissipated by about 6 weeks.
Forces of Relapse
a) Genetic
b) Environmental
c) Expansion generated

Relation and Relapse
Hicks observed that the amount of relapse is related to the method of retention after expansion. With no retention, the relapse can amount to 45% as compared with 10% to 23% with fixed retention and 22% to 25% with removable retention.
Krebs found that after fixed retention was discontinued, there was a substantial reduction in dental arch width. This tendency continued for up to 5 years.
After a review of the literature, Bell concluded that expansion is less disruptive to the sutural systems.
Slow expansion that maintains tissue integrity apparently needs 1 to 3 months of retention.

Length of Retention Phase with R.M.E.
Most researchers advocate a retention phase of no less than 3-6 months.
Mew advocates a total retention period of 1½ to 4 years depending on the extent of expansion.
Haas recommends 2 years full time followed by 1½ - 2 years - part time.

The length of time required for skeletal readjustment during retention is dependant upon the amount of residual load remaining at the termination of active treatment. Thus length of retention must allow for load decay to occur.
Fixed as well as removable appliance are not available.

Management
The appliance is luted with plain zinc phosphate cement or a zinc phosphate cement containing copper salts. The latter has the advantage of antibacteria activity (Ames black copper cement is best).
Acrylic cap splint appliances can be bonded using composite resins.
The screw must be turned only after sufficient time for setting of cement has lapsed.
All posterior teeth expansion must be positioned until expansion has been achieved for often we use these teeth as abutments for the appliance.
Orthodontic treatment prior to R.M.E. should be avoided as these teeth might tip faster.

Activation Schedule (Jackscrew turn schedules)
Most expansionists advocate a 180^{O} rotation/day which provides about 10mm expansion in 4 weeks. The regimen must be prescribed suitable to the patient age and expected degree of resistance to maxillary separation.

Timms
1. Up to age 15 years
   90^{O} turn at morning
   180^{O} daily rotation
   90^{O} turn at evening
2. Age 15 – 20 years (Increased resistance to maxillary separation)
   180^{O} daily rotation - is broken into 4 turns of 45^{O} with ideally 4 equal time intervals.
3. Age over 20 years

Most patients tolerate 4 turns of 45^{O} per day with adequate intervals. But in some cases, after an initial 90^{O} turns, only 45^{O} mornings and at night is advisable.
If the mid palatal suture is opened surgically, then it is not necessary to reduce the overall rate of expansion.

By Zimring and Isaacson
1. **Young growing patients:** 2 turns each day for the first 4 to 5 days, 1 turn each day for the remainder or R.M.E. treatment.
2. **Adult (non-growing) patients:** Because of increased skeletal resistance 2 turns each day for the first two days, 1 turn each day for the next 5-7 days and 1 turn every other day for the remainder of R.M.E. treatment.

Hazards of R.M.E. (and their management)
1. Oral Hygiene
2. Length of fixation
3. Dislodgment and breaking of appliance
4. Tissue damage
5. Infection
6. Failure of suture to open

Clinical Advice for R.M.E. Patients
1. Postpone extraction or first premolars until palatal expansion is completed because these teeth, together with the first molars, are often used as abutment teeth for anchoring the appliance. If premolars have not erupted, second deciduous molars with adequate root structures can be used. Howe suggested a bonded appliance that would incorporate deciduous teeth.
2. When possible, avoid orthodontic movement of the maxillary posterior teeth prior to R.M.E. Mobile teeth may tip faster during expansion.

3. The vertical positioning of the expansion screw is a function of the width of the palate and the size of the screw. For patient comfort and for mechanical advantage, position the screw as superiorly as possible in the palatal vault.
4. Start turning the jackscrew 15 to 30 minutes after the appliance is inserted to allow sufficient setting time for the cementing medium. Each turn of the screw opens the appliance ¼ mm. Provide the patient with an instruction sheet listing the turn schedule and possible symptoms that might accompany R.M.E. Ask the patient to report to you any unusual symptoms such as pain or dizziness. If these symptoms persist, either decrease or discontinue the turn schedule.
5. Tie a string or dental floss to the turnkey to prevent it from being swallowed. Solder the key handle closed to avoid slippage of the floss.
6. See the patient at regular intervals during the expansion phase of treatment. Measure the distance between the two halves of the expansion screw to determine how much the screw has been turned. Discuss discrepancies between this measurement and the turn schedule with the patient.
7. Monitor the midpalatal suture with weekly maxillary occlusal films. The suture will open within 7 to 10 days in most patients. If the suture does not split within 2 weeks, the lack of skeletal response may result in tipping of the teeth and possible fracture of the alveolar plates.
8. After the expansion is completed and the screw is immobilized, the appliance acts as a fixed retainer for a period of 3 to 6 months to allow the tissues to reorganize in their new positions and also allow the forces created by the expanding appliance to dissipate. The greater the magnitude of expansion, the longer the period of fixed retention.
9. After removing the R.M.E. appliance, place a transpalatal holding arch between the maxillary first molars to minimize relapse tendencies.
10. At the end of the expansion stage and during fixation, the maxillary posterior segments are usually overexpanded. During the orthodontic treatment phase, incorporate some expansion in the maxillary arch wire. Avoid lingual crown torque or the maxillary molars and/or buccal crown torque of the mandibular molars because such forces may reintroduce the crossbite problem.
11. In a patient with a severely constricted palate, the clinician might consider some of the following options;
    a) Expand the palate in two phases
    b) Initiate expansion as early as possible
    c) Prolong the period of fixed retention
    d) Consider extraction of teeth in one or both jaws to facilitate constriction of the dental arches
    e) Over expand the maxillary arch and
    f) Use an expander that will maximize skeletal movements For patients with narrow palates, clinicians may choose a telescopic screw, an interchangeable screw, or construct two appliances with progressively larger screws.
12. Possible immediate effects of premature appliance removal include dizziness and a feeling of heavy pressure at the bridge of the nose, under the eyes, and generally throughout the face. Blanching of the soft tissues overlying these areas and blanching between the central incisors has been reported. Some of these symptoms continued over a period of 19 hours during which the appliance was out of the mouth. In that period the measured relapse was only 1.5mm in transpalatal dimension. Similar symptoms occur if the appliance is removed for repairs or recementation during the expansion phase or if the force is deactivated rapidly. Therefore, perform any appliance manipulation while the patient is seated securely in a dental chair. Avoid making the patient stand immediately after appliance removal.

The usual program for R.M.E. in patients other than infants and juveniles in whom the fixed retention is extended for 6 months (The time is not to scale).

Summary and Conclusion

Since the first recorded work on R.M.E. by Angell in 1860, there have been many reports on R.M.E., its effects and associated medical results. These results have generally been very good and quite challenging and so it is amazing that R.M.E. can evoke so much controversy.

R.M.E. is comparatively simple and conservative method indicated for mainly maxillary transverse deficiency, bilateral crossbite, Class III prognathoid malocclusion, cleft palate and medical problems like poor nasal airway due to anterior nasal stenosis, septal deformity, recurrent ear or nasal infection, allergic rhinitis, asthma and prior to septoplasty.

It is only by expanding at about 2.5mm per week that sufficient maxillary translation and transformation can be achieved at a level high enough to ensure:

1. A wider apical base to support a wider dental arch and
2. A dilation of the nasal air passages to reduce the nasal resistance

E.C. Angell's reply to his detractors should be borne in mind

"For our mode of treating irregularities, we not only claim the separation of the maxillary bones, but we also assert without fear of contradiction, that this is a fact of highest importance in this branch of dental surgery. More particularly that it renders the treatment of a large majority of cases hitherto complex, comparatively simple, while it saves an immense amount of time to the operator and an immense amount of suffering to the patient".

The proof of pudding is in the eating. Let the results, the many satisfied patients who have derived benefit from R.M.E. speak for themselves.

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