Effective Management of Transverse Problems in the Growing Patient: Evidence-based Approach

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“The transverse deficiency of the maxillary arch is the most common occlusal problem of the contemporary era”

Angle Orthod. 1985;55:190-6

Maxillary transverse deficiency

- Posterior crossbite
- Anterior openbite
- Class II malocclusion
- Class III malocclusion
- Dental crowding and protrusion

50-60% of our orthodontic patients present with clinical indications for maxillary expansion

ORTHOPEDIC EXPANSION

- In the maxilla only
- It occurs primarily through enhancement of sutural growth at the midpalatal suture
- It is possible only in growing subjects
- It is delivered by means of devices that produce heavy forces (1.5 to 4.5 kg) = rapid maxillary expansion: 0.2 to 0.5 mm/day
ORTHODONTIC EXPANSION

- Both maxillary and mandibular arches
- It occurs primarily through dental movement
- It is possible both in growing and adult subjects
- It is delivered by means of devices that produce lighter forces (400 to 900 g) = slow maxillary expansion: 0.2 to 1 mm/week

150 years of Rapid Maxillary Expansion (RME)

RAPID MAXILLARY EXPANSION (RME)
150 YEARS OLD AND STILL YOUNG....

Types of Expanders

Haas-Type

Hyrax-Type

HalfRax-Type

Butterfly-Type

HalfRax-Type

Types of Expanders

Haas AJ Angle Orthod 1961;31:73-90
Cozzani et al. Progr Orthod 2003;4:15-22

Types of Expanders

Acrylic Splint (Bonded)  
McNamara JA Jr, Brudon WL. Orthodontics and Dentofacial Orthopedics. 2001

Acrylic Splint (Bonded)  
Mini expander with orthogonal arms

How does RME work?

How does RME work?

When to use RME

When to use RME

Does RME produce adverse side effects?

Does RME produce adverse side effects?

Does RME produce favorable side effects?

Does RME produce favorable side effects?

Research collaboration

The University of Rome “Tor Vergata” Group
Paola Cozza
Ezio Fanucci
Manuela Mucedero
Fabiana Ballanti
Tiziano Baccetti

Treatmen,t and post-treatment skeletal effects of rapid maxillary expansion studied with low-dose computed tomography in growing subjects

Roberta Lione, Fabiana Ballanti, Lorenzo Fanucci, Tiziano Baccetti, and Paola Cozza


Original Article

Immediate and Post-Retention Effects of Rapid Maxillary Expansion Investigated by Computed Tomography in Growing Patients

Fabiana Ballanti, Roberta Lione, Ezio Fanucci, Lorenzo Fanucci, Tiziano Baccetti, Paola Cozza

Angle Orthod 2009;79:24-29
CONCLUSIONS

3D evaluation of the dentoskeletal effects produced by RME with low-dose CT on subjects before or at puberty (CS 1-4) revealed:

The increase in intermolar width was ~ 90% of the screw opening. The first molars moved bodily without damage to the periodontal bony support.

The increase in anterior sutural width was ~ 45% of the screw opening.

The increase in posterior sutural width was ~ 20% of the screw opening.

The least amount of opening of the midpalatal suture was observed in subjects at CS 4.

How does RME work?

When to use RME

Does RME produce adverse side effects?

Does RME produce favorable side effects?

42 SUBJECTS (25 f, 15 m) treated with Haas-type RME + fixed appliances

Posteroanterior and lateral cephalograms available at:

- Time 1: pre-treatment
- Time 2: immediate post-RME screw fixation
- Time 3: post-treatment (minimum 5 years)

Treatment Timing for Rapid Maxillary Expansion

| T3 = CS 6 |

Excellence in Orthodontic Research Award of The Angle Society, 2003

Treated Sample (Subjects treated with Haas-type RME followed by Fixed Appliances) (42 subjects)

- Early-Treated Group (ETG) *
  29 subjects
  Time1 = 11 y
  Time3 = 19 y 9 m
  Time3 - Time1 = 8 y 9 m

- Late-Treated Group (LTG) **
  13 subjects
  Time1 = 13 y 7 m
  Time3 = 21 y 9 m
  Time3 - Time1 = 8 y 2 m

(ETG) * = RME therapy was performed before the peak (CS 1, or 2, or 3)
(LTG) ** = RME therapy was performed after the peak (CS 4, or 5)

Control Sample (21 untreated subjects from the UMGS)

- Early Control Group (ECG) *
  11 subjects
  Time1 = 11 y 3 m
  Time3 = 17 y 5 m
  Time3 - Time1 = 6 y 2 m

- Late Control Group (LCG) **
  10 subjects
  Time1 = 12 y 9 m
  Time3 = 17 y 7 m
  Time3 - Time1 = 5 y 3 m

(ECG) * = CS 1, or 2, or 3 at Time 1
(LCG) ** = CS 4, or 5 at Time 1

T3 = CS 6

Significant increments in Early Tx Group

Skeletal Measurements

Dental Measurements

Long-term increase in the skeletal width of the maxilla.
Skeletal Measurements

Dental Measurements

Long-term changes in the dentoalveolar structures

NO increase in the skeletal width of the maxilla

Significant increments in Late Tx Group

Treatment Timing for Rapid Maxillary Expansion

Tiziano Baccetti, DDS, PhD; Lorenzo Franchi, DDS, PhD; Christopher G. Cameron, DDS, MS; J. A. McNamara Jr., DDS, PhD

(Angle Orthod 2001;71:343-50)

Pre-pubertal

Post-pubertal

Skeletal changes

Dento-alveolar changes

Critical Question

Will the midpalatal suture open in late adolescent and young adult patients?

Phases of the dentition for the assessment of skeletal maturity: a diagnostic performance study.

Franchi L., Baccetti T., De Toffol L., Polimeni A., Cozza P.


Maturational Stages of the Midpalatal Suture

Midpalatal suture maturation: Classification method for individual assessment before rapid maxillary expansion

Gender

Individual assessment of the midpalatal suture morphology;

140 subjects from 5.6y to 58.4y;

Initial CBCT images for clinical purposes;

Scan time – from 0.9 to 20s, resolution of 0.25 to 0.30mm.

<table>
<thead>
<tr>
<th>Gender</th>
<th>5.0-10.9y</th>
<th>11-15.9y</th>
<th>16-17.9y</th>
<th>18-18.4y</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>24</td>
<td>24</td>
<td>19</td>
<td>19</td>
<td>86</td>
</tr>
<tr>
<td>Male</td>
<td>04</td>
<td>24</td>
<td>13</td>
<td>13</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>48</td>
<td>32</td>
<td>32</td>
<td>140</td>
</tr>
</tbody>
</table>
Standardization of head position in the axial (A), sagittal (B) and coronal planes (C).

Classification of the midpalatal suture maturation

Stage A – midpalatal suture is almost straight high-density line

Stage B – one scalloped high-density line (A); or in some areas, two parallel, scalloped high-density lines (B)

Stage C – two parallel, scalloped, high-density lines close to each other and separated by small low-density spaces

Stage D – In the maxillary portion of the palate two scalloped, high-density lines. In the palatine bone, the midpalatal suture cannot be visualized and the parasutural bone density is increased.

Stage E – The midpalatal suture is not visible in at least a portion of maxilla.
CONCLUSIONS

The classification of midpalatal sutural fusion using CBCT is a reliable clinical method for individual assessment of midpalatal suture morphology before RME.

This method can be helpful in the clinical decision between conventional and surgically assisted RME for adolescent and young adult patients.

How does RME work?

When to use RME

Does RME produce adverse side effects?

Does RME produce favorable side effects?

A Systematic Review

Does rapid maxillary expansion induce adverse effects in growing subjects?

Roberto Lioner; Lorenzo Franchi; Pascoal Cazzar

Angle Orthod 2013;83:172-182

✓ RME is an effective procedure that is able to produce always transverse skeletal effects on the maxilla by opening the midpalatal suture in growing subjects regardless of the type of palatal expander.

✓ The vascular changes in the pulp of anchored teeth after RME are reversible. Active root resorption appeared along with increased filling of the reorptive defects with cellular cementum after 3 months.

Erverdi et al AJO-DO 1994;106:47-51

Langford and Sims AJO 1982;81:108-11
A Systematic Review

Does rapid maxillary expansion induce adverse effects in growing subjects?
Roberto Lione*, Lorenzo Franchi†, Paola Cozza‡
Angle Orthod. 2013;83:172-182

✓ Orthopedic forces in prepubertal subjects did not affect the alveolar bone palatal and buccal thickness after a 6-month retention period


Evaluation of alveolar bone loss following RME using CBCT
Baysal A, Uysal T, Veli I, Ozar T, Karadere I, Hekimoglu S.

RME during adolescence (14 yrs boys, 13.5 yrs in girls) may have detrimental effects on the supporting alveolar bone (dehiscences)

TREATMENT PROTOCOL

1. Haas expander activated for three weeks
2. Expansion 10.0 - 10.5 mm
3. 2+ months post-activation period
4. RME followed by fixed appliances

A Systematic Review

Does rapid maxillary expansion induce adverse effects in growing subjects?
Roberto Lione*, Lorenzo Franchi†, Paola Cozza‡
Angle Orthod. 2013;83:172-182

✓ The vertical changes found after RME treatment, although statistically significant, were small and probably transitory.

Effects of rapid maxillary expansion in hyperdivergent patients
Matthew W. Lindberg*, James A. McNamara†, Tiziana Baccetti‡, Thomas Herbst‡* and Lorenzo Franchi‡

Sample Size (N = 143)

<table>
<thead>
<tr>
<th>Group</th>
<th>Time</th>
<th>Age (yr) ± SD</th>
<th>Class (CS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>preTx</td>
<td>11.4 ± 1.2</td>
<td>1-3</td>
</tr>
<tr>
<td>T2</td>
<td>post RME+Fixed</td>
<td>14.3 ± 1.1</td>
<td>3-6</td>
</tr>
<tr>
<td>T3</td>
<td>long-term</td>
<td>20.1 ± 1.6</td>
<td>6</td>
</tr>
</tbody>
</table>

Baccetti T, Franchi L, McNamara JA Jr
Semin Orthod. 2005;11:119-129

Sample Size (N = 143)

Subjects were divided into 3 groups:

Normal (N=52): MPA greater than 20° and less than 27°
Moderately Hyperdivergent (N=62): MPA greater than or equal to 27° and less than 32°
Very Hyperdivergent (N=29): MPA greater than or equal to 32°
Conclusions

1. RME combined with full fixed appliances had no significant long-term skeletal effects in the vertical dimension in hyperdivergent subjects compared to patients with normal vertical relationships.

2. Rapid maxillary expansion can be used effectively in patients with increased vertical dimension without detrimental effects to the dental and skeletal structures.

How does RME work?

When to use RME

Does RME produce adverse side effects?

Does RME produce favorable side effects?

Favorable effects associated with RME

- Gain in arch perimeter
- Spontaneous improvement/eruption of impacted incisors and palatally displaced canines
- Spontaneous improvement of Class II malocclusion

Favorable effects associated with RME

- Gain in arch perimeter
- Spontaneous improvement/eruption of impacted incisors and palatally displaced canines
- Spontaneous improvement of Class II malocclusion
Long-Term Stability of Rapid Maxillary Expansion Concurrent with Schwarz Appliance Therapy in the Mixed Dentition

O’Grady PW, McNamara JA Jr, Franchi L, Baccetti T
Am J Orthod Dentofacial Orthop 2006;130:202-213

Schwarz app. followed by RME vs RME only vs Untreated controls

Age of Sample

<table>
<thead>
<tr>
<th>Group</th>
<th>T1 (Pre Tx)</th>
<th>T2 (Pre Phase II)</th>
<th>T3 (Post Tx)</th>
<th>T4 (Long term)</th>
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<tbody>
<tr>
<td>Sz-RME</td>
<td>9y 1m</td>
<td>12y 5m</td>
<td>14y 4m</td>
<td>21y 0m</td>
</tr>
<tr>
<td>RME only</td>
<td>8y 5m</td>
<td>11y 7m</td>
<td>13y 3m</td>
<td>19y 3m</td>
</tr>
<tr>
<td>Control</td>
<td>8y 0m</td>
<td>12y 3m</td>
<td>13y 4m</td>
<td>19y 0m</td>
</tr>
</tbody>
</table>

Maxillary Arch Perimeter (mm)

<table>
<thead>
<tr>
<th>Group</th>
<th>T1-T2</th>
<th>T3-T4</th>
<th>T5-T6</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sz-RME</td>
<td>2.9</td>
<td>-0.5</td>
<td>-1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>RME</td>
<td>2.6</td>
<td>-1.4</td>
<td>-1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Control</td>
<td>0.2</td>
<td>-1.5</td>
<td>-1.2</td>
<td>-2.5</td>
</tr>
</tbody>
</table>

C – EMR = +2.7 mm *
C – Sz/RME = +3.8 mm *

Mandibular Arch Perimeter (mm)

<table>
<thead>
<tr>
<th>Group</th>
<th>T1-T2</th>
<th>T3-T4</th>
<th>T5-T6</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sz-RME</td>
<td>0.0</td>
<td>-0.3</td>
<td>-1.7</td>
<td>-2.0</td>
</tr>
<tr>
<td>RME</td>
<td>-1.2</td>
<td>-1.2</td>
<td>-1.3</td>
<td>-3.6</td>
</tr>
<tr>
<td>Control</td>
<td>-2.8</td>
<td>-1.6</td>
<td>-1.3</td>
<td>-5.7</td>
</tr>
</tbody>
</table>

C – EMR = +2.1 mm ns
C – Sz/RME = +3.7 mm *

Conclusion

Over the long term, arch perimeter increases are in the amount of about 4 mm in both arches following an expansion protocol.
Favorable effects associated with RME

- Gain in arch perimeter
- Spontaneous improvement/eruption of impacted incisors and palatally displaced canines
- Spontaneous improvement of Class II malocclusion

Management of Impacted Incisors Following Surgery to Remove Obstacles to Eruption: A Prospective Clinical Trial
Pavoni C, Franchi L, Laganà G, Baccetti T, Cozza P. 

RME following surgical removal of the obstacles to the eruption of maxillary permanent incisors (supernumeraries/odontomas) appears to be an effective and efficient interceptive approach leading to spontaneous eruption of the incisors in 3 out of 4 patients within 7 months post-expansion.

Delayed eruption of 2.1 and 2.2
Over-retained 6.1 and 6.2 Matteo, 9 years
Constriction of the upper arch

Odontoma in the region of 2.1 located palatal and infracrestal

Surgical removal of the odontoma

After rapid maxillary expansion
Spontaneous eruption of 2.1 and 2.2 after 6 months after RME

Matteo, 14 years
After fixed appliances

Matteo, 14 years
After fixed appliances

Sample: 60 subjects (7.6 – 9.6 years) with Palatally Displaced Canines diagnosed on P-A cephalograms

Randomization:
• 35 subjects treated with RME (7 mm expansion, followed by Hawleys)
• 25 untreated subjects

Reevaluation: at 13.6 years (after CS4)
• Canine eruption in RME Group
• Canine eruption in Untreated Group

Always extract the deciduous canine ASAP

(P<.001)

Interceptive treatment of palatal impaction of maxillary canines with rapid maxillary expansion:
A randomized clinical trial

Baccetti T, Mucedero M, Leonardi M, Cozza P
Am J Orthod Dentofacial Orthop
2009;136:657-661

Over-retained 6.3 Alessandra, 12 years
Anterior transverse discrepancy
Rapid Maxillary Expansion

Before RME

7 months after RME

Alessandra, 14.5 years
After fixed appliances

Spontaneous eruption of 2.3 during fixed appliance therapy

<table>
<thead>
<tr>
<th>Bio-S-N°</th>
<th>Normal Values</th>
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<tbody>
<tr>
<td>130</td>
<td>150 ± 3°</td>
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<table>
<thead>
<tr>
<th>SNA°</th>
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<td>NMB°</td>
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<th>U1PF°</th>
<th>105-110°</th>
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<tr>
<td>OVB mm</td>
<td>3 ± 2.5 mm</td>
</tr>
<tr>
<td>OVJ mm</td>
<td>2 ± 2.5 mm</td>
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End of treatment

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<th>Normal Values</th>
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- Spontaneous improvement of Class II malocclusion

Spontaneous Improvement of Class II following Maxillary Expansion

Treatment Effects of RME: New studies

What evidence exists to support the concept of “Spontaneous Improvement”?

Spontaneous Improvement of Class II Malocclusion in Expansion Patients: A Prospective Clinical Study

Guest SS, McNamara JA Jr, Franchi L, Baccetti T
AJO-DO 2010;138:582-591

TREATMENT INTERVALS

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T₁–T₂</th>
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<tbody>
<tr>
<td>Treated</td>
<td>8.8 ±1.1 yr</td>
<td>12.8 ±1.1 yr</td>
<td>4.0 years</td>
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<tr>
<td>N=50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>8.9 ±0.9 yr</td>
<td>12.9 ±1.0 yr</td>
<td>4.1 years</td>
</tr>
<tr>
<td>N=50</td>
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</table>

Guest et al., 2010
Improving Class II malocclusion as a side-effect of rapid maxillary expansion: A prospective clinical study

This study suggests that the protocol described including treatment with a bonded rapid maxillary expander used in the early mixed dentition in Class II Division 1 patients can help to improve the Class II malocclusion as a side-effect, both skeletally and dentally:

Mol rel. 1.7 mm  Wits -1.2 mm

Conclusion

Spontaneous improvement in Class II relationship is a real phenomenon, with improvements of 2 mm or more seen in about half of the patients undergoing RME.

E.B., 8.9 ys  Class II malocclusion

E.B., 12.5 ys  3 years after RME
**Final Remarks**

In the growing patient RME is an effective, efficient, reliable, and predictable orthopedic procedure conditions associated with maxillary transverse deficiency

Optimal timing for RME is before puberty. Detrimental effects of RME like dehiscences or gingival recessions can be avoided if RME is performed with the right timing

An increased mandibular plane angle is not a contraindication to RME therapy in growing individuals

**Final Remarks**

The use of RME in the early mixed dentition is an effective procedure to increase the rate of eruption of palatally displaced maxillary canines

When combined with mandibular dentoalveolar decompensation, RME can produce arch perimeter increases of about 4 mm in both arches

In Class II patients RME can lead to spontaneous improvements of Class II relationships of 2 mm or more in about half of the patients