Excuse my while I

Stir + Shake

Things Up A bit

A Candid Look at the Muddled World of Orthodontics and OSA

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I have no commercial interests and no conflicts to disclose as related to this presentation to the Illinois Sleep Society.
Davidson, T. et al. The Anatomical Basis for the acquisition of speech and obstructive sleep apnea. Sleep 2005 Nov 6 (6)
Poor orthodontic treatment planning causes obstructive sleep apnea

No one should have teeth removed as it contributes to OSA and previously extracted bicuspids in ortho cases should have spaces reopened for implant

All children should be treated with expansion devices because they are each at risk for developing a SRBD

Children should be treated as soon as something is evident – 18 months is not too early

Orthotropics-Facial Growth Guidance
Accreditation Standards for Advanced Specialty Education Programs in Orthodontics and Dentofacial Orthopedics

Accreditation Standards for Advanced Specialty Education Programs in Pediatric Dentistry
** Some of us don’t understand the literature

** Evidence based means “it works in my hands”

** Associations imply a causal connection
Gadgets, Gizmos and Thingamajigs

How Myobrace straightens teeth naturally

The Myobrace System is a no-braces approach to straightening your teeth and jaws. Treatment uses myofunctional orthodontic techniques to address the poor oral habits (known as myofunctional habits) that are the real, underlying causes of crooked teeth, and uses light, intermittent forces to align the teeth. Myofunctional orthodontic techniques have been practiced by Orthodontists and Dentists around the world for over 50 years.

This is done through the use of a series of removable dental appliances that are worn for just 1-2 hours each day and overnight while sleeping.

Daily use of the Myobrace combined with regular activities (to improve breathing, muscle function and tongue posture) results in straighter teeth and improved function, leading to optimal facial development and a healthier smile.

The Benefits

While straight teeth are an awesome benefit, one of the coolest things about Myobrace treatment is that it corrects bad oral habits, which can be the underlying cause of crooked teeth and underdeveloped jaws. One such habit is mouth breathing. It encourages patients to breathe through their nose, which improves the airway helping with asthma and allergies and boosting your overall health.

Myobrace treatment can allow patients to avoid braces altogether, or in the small number of cases they're eventually required, individuals only have to wear them for a short time. Unlike traditional methods of teeth straightening, you won’t experience a relapse where stubborn teeth go back to their old positions and it’s more comfortable. Since the appliances are removable, you can keep up on your brushing and flossing and no one will know you’re undergoing treatment.
OUR GOALS FOR TODAY

* Role and Affect of RME in Pediatric SDB
* Literature surrounding orthodontics and SDB
* Upper Airway Imaging and Limitations
* Extraction of teeth as a risk factor for SDB
The effectiveness of AT in the treatment of pediatric OSA: A meta-analysis

• Fourteen studies
• Mean sample size was 28.
• Reduction of 13.92 events per hour.
• Success rate of T/A in normalizing PSG was 82.9%

Success of AT for OSA in children

- % of children who had normal PSG parameters after AT ranged from 69-83% depending upon the criteria used to define OSA
- But what about other outcomes?

Childhood adenoid and tonsillectomy Trial (chat)

Active Comparator: Watchful Waiting with Supportive Care
Experimental: Early Adenotonsillectomy (eAT)
Sleep Hygiene and Co Morbid Management of Disease RCT

Compared with watchful waiting, eAT did not improve attention or executive function.
AT did reduce symptoms and improve outcomes of behavior, Q of L, and polysomnographic findings.
Beneficial effects of early adenotonsillectomy.
**Refractory OSA in obesity

OSA is a heterogeneous disorder

- Anatomic
- Non Anatomic

Pcrit Anatomy is important but most of these OSA patients have significant nonanatomical issues contributing to disease
Anatomic vs Non Anatomic Phenotypes

* 36% decrease in UA dilator recruitment response to negative collapsing pressure

* 37% have a low arousal threshold. Waking up prematurely -- disrupts sleep continuity and limits the opportunity for adequate upper airway muscle recruitment to restore airflow during sleep

*36% high loop gain

70% have one or more nonanatomic traits
23% have two or more

Eckert, D et al; Defining Phenotypic Causes of Obstructive Sleep Apnea. Identification of Novel Therapeutic Targets AJRCCM 2013
Maxillary Transverse Hypoplasia
Dental Arch Dimensional Changes after Adenoidectomy or Tonsillectomy in Child with Airway Obstruction: Zhu, et al Medicine 2016 A Meta-Analysis

AT and Modifications (Meta Analysis)

*Post AT and up to one year NS changes in maxillary width

*Mode of respiration changes from oral to nasal

After one year greater normalization of arch is seen but it is not completely therapeutic
Maxillary Expansion

Rapid Palatal Expansion (Distraction) Weeks

Slow Expansion (Dental vs Skeletal) Months
Circumaxillary Sutural System

Courtesy Rosalia Leonardi
Midpalatal Suture Maturation

Distribution of the maturational stages of the midpalatal suture

<table>
<thead>
<tr>
<th>Stage</th>
<th>5-11 y</th>
<th>11-14 y</th>
<th>14-18 y</th>
<th>&gt;18 y</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>19</td>
<td>3</td>
<td>12</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>4</td>
<td>24</td>
<td>24</td>
<td>19</td>
</tr>
</tbody>
</table>

Angelieri et al AJODO 2013
How much is too much?

Over expansion: Maxillary occlusal surface buccal to mandibular teeth
Rapid Palatal Expansion
The Airway and Oxygen Levels

N = 22  Mean Age 8.3
PSG and CBCT taken Pre and Post Expansion

T0 → T1

SpO2 from 90.7% to 96.1%
AHI from 5.8 to 1.6

*** Total airway volume was not correlated with SP02 and AHI values**

Fastuca, et al Multimodal airway evaluation in growing patients after rapid maxillary expansion Eur J Paed Dent 2015
RME and SDB: Meta Analysis

Only 5 studies

Sample of 88 ranging from 6-13

Pre treatment crossbite

Measured outcome was AHI reduction

Huynh, N et al Sleep Med Review 2016
Malocclusion Prevalence and SDB (Associations)

* Retrognathic mandible
* Maxillary crossbite

Pliska, B et al J Dent Sleep Med 2017
Pediatric Cohort of 90

Mean Age 6.8

**Parent report of SDB signs and symptoms**

**Orthodontist examination of malocclusion**

**ENT assess airway**
### Associations and Prevalence

#### RESULTS:

Prevalence of mandibular retrognathia and maxillary transverse hypoplasia is similar to typical 6-9 years old.

<table>
<thead>
<tr>
<th>Category</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in yr (SD)</td>
<td>6.8 (1.29)</td>
</tr>
<tr>
<td>Female</td>
<td>46 (51%)</td>
</tr>
<tr>
<td>Parent report</td>
<td></td>
</tr>
<tr>
<td>Witnessed apneas</td>
<td>42 (47%)</td>
</tr>
<tr>
<td>Mouthbreathing</td>
<td>42 (47%)</td>
</tr>
<tr>
<td>Bruxism</td>
<td>22 (24%)</td>
</tr>
<tr>
<td>Class II Canines (n=63)</td>
<td>20 (32%)</td>
</tr>
<tr>
<td>Overjet &gt; 7 mm (n=63)</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>Anterior crossbite</td>
<td>5 (6%)</td>
</tr>
<tr>
<td>Posterior crossbite</td>
<td>14 (16%)</td>
</tr>
</tbody>
</table>
Are two better than one?  
Bimaxillary expansion for SDB

N=45  
PSG confirmed OSA prior to expansion  
No pretreatment crossbite were present  
No AT hypertrophy  No craniofacial anomalies

Quo et al, Sleep Medicine 30; 2017
### Bimaxillary Expansion

**AHI was elevated in 33% of the sample**

**OSA was never normalized in the sample**

**No cephalometric determinant associated with the BE response**

**Favorable responses were noted in the most severe**

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#### Table: AHI Distribution

<table>
<thead>
<tr>
<th>AHI</th>
<th>Mild OSA AHI &lt; 5 (n=12)</th>
<th>Moderate 5 &lt; AHI &lt; 10 (n=17)</th>
<th>Severe AHI &gt; 10 (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-BE</td>
<td>2.9</td>
<td>7.1</td>
<td>22.0</td>
</tr>
<tr>
<td>Post-BE</td>
<td>6.1</td>
<td>6.1</td>
<td>10.3</td>
</tr>
<tr>
<td>p-value</td>
<td><strong>0.03</strong></td>
<td>0.25</td>
<td><strong>0.001</strong></td>
</tr>
</tbody>
</table>

Data derived from Quo 2017 (median values)

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*Quo et al Sleep Med 30 2017*
RME and SARME increase nasal airway but do not necessarily result in change of breathing mode from oral to nasal.

Nasal Airway following maxillary expansion Warren, Hershey et al AJO DO 1987
RME and Nasal Changes

RME does not influence nasopharyngeal area or nasal airway resistance in long-term evaluation.

Effect of RME on nasal septal deviation (Systematic Review)

Only 2 studies

Both studies had significant methodology flaws

One positive change in NSD the other no change

**Potentially positive but not significant**
RME and Long Term Stability

* Plain film show some nasal cavity increases

* CBCT show NS increase in nasal cavity volume

* Rhinomanometry - reduction in nasal resistance
   Acoustical rhinometry - increases in nasal cavity volume

* Moderate evidence for improve conditions for nasal breathing for at least 11 months after therapy

Does rapid maxillary expansion have long term effects on airway dimensions and breathing? Baratieri et al AJO DO 2011
RPE and Airway Dimensions (Systematic Review)

Only four articles
Acoustic Rhinometry

Some increases in MCA and nasal volumes were noted but not a clinically significant indication for therapeutic maxillary expansion.

Gordon et al. RE effects on nasal airway dimensions as measured by acoustic rhinometry: a Systematic review. Angle Orthodontist 2009
RME and Upper Airway Changes

Controlled trial in 13-15 year old children

RME expansion creates significant increase in nasal airway volume but no significant change in oropharyngeal airway

Oropharyngeal Airway and RME

N = 24

CBCT in supine position

Only retropalatal airway volume changed significantly –

No significant change in mca

No evidence to support that RPE could enlarge the oropharyngeal airway volume

Zhao et al Oropharyngeal airway changes after RPE evaluated with CBCT AJODO 2010
Experimental N =28 Control N=20

Intra oral airway volume decreased significantly in the RME group. The increase in pharyngeal airway volume in the control was only 41% that of the RME group

RME not only reduces nasal obstruction but also raises tongue posture and enlarges the pharyngeal airway

Changes in hyoid bone position following rapid maxillary expansion in adolescents

Pre treatment, the hyoid to MP distance is greater in patients with narrow maxillae requiring RME.

Following treatment, the hyoid bone to MP distance increased in control group and decreased in subjects treated with RME.

RME treatment tends to normalize hyoid bone position.

Sleep Instability and RME

Small Sample
Pre tx and post tx PSG after RME

Longer duration TIB and TST

Reduction is stage shifts and AHI decreased

Children showed increased in CAP rate with an increase in A1 index

Miano, S., Rizzoli, A., Evangelisti, M., Bruni, O., Ferri, R., Pagani, J., & Villa, M. P. (2009). NREM sleep instability changes following rapid maxillary expansion in children with obstructive apnea sleep syndrome. Sleep Medicine, 10(4), 471-478
Maturational changes and the Airway

What is the normative data on the Airway?

Airway Growth and Development: A Computerized 3-Dimensional Analysis; Schendel et al
JOMS 2012
Total volume, length, area, and index all increase until age 20, then remain relatively flat until age 50, when they all begin to decrease dramatically.
Clinical guidelines regarding CBCT in Orthodontics: Position paper by AAOMR 2013

Despite the number of publications on the use of CBCT in specific orthodontic applications NO benefit has been demonstrated for airway assessment
Minimally Constricted Area

MCA correlates well to total airway volume

Airway area at different segments is more important than airway volume. Muscle tone?

Airway size decreases with age a factor related to the increase in OSA?
Volumetric and linear measurements performed using CBCT are highly accurate, but cross-sectional measurements at the level of the vallecula and minimum cross-sectional area were unreliable.

Comparing CBCT and Acoustic Reflection of UA Analysis

High correlation between CBCT and Pharyngometry when evaluating minimal cross sectional area of the pharyngeal space.

High correlation between CBCT and rhinometry when evaluating the minimal cross section of the nasal valve.

Poor correlation between CBCT and rhinometry when evaluating total nasal passage with CBCT showing higher volumes.

Moderately high correlation between CBCT and Pharyngometry when evaluating total pharyngeal volume with CBCT imaging showing higher volumes.

Tsolakis, et al AJODO October 2016 Vol 150 Issue 4
Positional Effects on the Airway

*Shape of oropharyngeal space decreases up to 27% in the supine position in healthy non OSA

*Shape of oropharyngeal airway space decreases up to 33% in OSA patients and the MCA may decrease up to 76%


Is the airway volume being correctly analyzed?

No established protocol for the threshold that must be used when airway volume is measured. Authors who evaluated airway volumes with the Dolphin software used different thresholds and others did not report it.

Effect of Head and Tongue Posture and Upper Pharyngeal Airway Dimensions in Three-Dimensional Imaging: Two Systematic Reviews

- No standardization exists for head and tongue position.
- Head rotation, CCE and mandibular position can each influence the airway when not standardized.
- Greater intra and inter examiner reliability when assessing total airway volume as compared to minimum cross-sectional area.
- No standardization for threshold.

- Gurani, et al J Oral Maxillofac Res 2016 (Jan-Mar) | vol. 7 | No 1
- Zimmerman, et al European J Ortho 2016 December
Systematic Assessment of Extractions

Very limited information available on the relationship between the presence of orthodontic premolar extractions, respiratory function and obstructive sleep apnea.

Even if premolar extractions and incisor retraction do decrease certain dimensions within the upper airway this does not provide evidence that the decrease predisposes the airway to collapse.
Extractions and OSA?

Controlled study using both cephalometry and CBCT

Extraction and non extraction trial

NO differences in oropharyngeal airway space from T0 – T1

Subjects with all premolars, 267 (9.56%) had received a diagnosis of OSA. Subjects with four missing premolars, 299 (10.71%) had received a diagnosis of OSA. The prevalence of OSA was not significantly different between the groups.

The absence of four premolars, a presumed indicator of past “extraction orthodontic treatment,” is not supported as a significant factor in the cause of OSA.
Upper Airway Changes After Extraction and Maximum Anchorage in Adults

- CBCT
- Small sample Class II Hyperdivergent
- Sagittal reductions in airway are noted
- Compensatory increase in transverse dimension

Zang, et al. PLOS Upper Airway Changes after Orthodontic Extraction Treatment in Adults PLOS 2015
Overall, no volumetric changes are noted.
Effect of orthodontic treatment on the UA volume of adults

- Orthodontic treatment in adults does not cause clinically significant changes to the volume or the minimally constricted area of the UA.

- Extractions in conjunction with orthodontic treatment have a negligible effect on the UA in adults.

Changes of pharyngeal airway size and hyoid bone position following orthodontic treatment of Class I bimaxillary protrusion

- Following retraction of incisors, the pharyngeal airway became narrower.
- Hyoid bone moves in a posterior and inferior direction.
- A significant relationship has been demonstrated between the reduction of the airway and the retraction distance of lower incisors.

Wang et al. Angle Orthodontist Volume 82, Issue 1 (January 2012)
Uvulo-glossopharyngeal dimensions in non-extraction, extraction with minimum anchorage, and extraction with maximum anchorage

Group 1 Superior and middle airway space increased significantly

Group 2 None of the parameters showed a significant change,

Group 3, Middle and Inferior airway space decreased

Eur J Ortho Derya Germec-Cakan, et al 30 November 2010
First premolar teeth extraction in non-growing patients with bimaxillary proclination

Upper and lower incisors were uprighted and retracted to reduce proclination

Hyoid bone position was also not affected significantly in this group.

*Upper and lower first premolar extraction for the treatment of bimaxillary proclination does not affect the upper airway dimensions.*

Maaitah et al; First premolar extraction effects on upper airway dimension in bimaxillary proclination patients Angle Orthodontist 2012
There is no compelling evidence correlating the overall size of the airway to physiological breathing or development of OSA.