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- Diplomate – American Board of Orthodontics
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  Orthodontic Program Director (retired 2013)
- American Academy of Dental Sleep Medicine
  - Board of Directors
  - Associate editor – Journal of Dental Sleep Medicine

Topics
- Impact of positive airway pressure to manage sleep disordered breathing (SDB) on craniofacial growth
- Orthodontic procedures to manage pediatric SDB
  - Rapid maxillary expansion
  - Mandibular advancement devices
  - Controversy regarding orthodontic premolar extractions and development of SDB

Pediatric Sleep Disordered Breathing and Orthodontic Implications
Rose D. Sheats, DMD, MPH
University of North Carolina (Retired)
Chapel Hill, NC

Positive Airway Pressure (PAP) and Craniofacial Growth
Case reports and small case series of CPAP suggest adverse impact on craniofacial growth in children
16 yr 11 mos male
BiPap x 10 yrs

- Medical history: Achondroplasia
- Age 6 yr: adenotonsillectomy for OSA
- BiPAP initiated for residual OSA
- Pressure increased over time until titrated to max of 28 cm H2O (age 16 yrs)
- Severe maxillary retrusion

**Positive Airway Pressure (PAP) and Pediatric Craniofacial Growth**

- 2014: SD Roberts, University of Washington orthodontic residency thesis
- N = 100 children, Seattle Children’s Hospital Craniofacial Center and Sleep Disorders Center
- nPAP > 2.5 yrs
  - Compliant (>20 hrs/week, > 6 mos): n = 50, mean age = 10.4 yrs
  - Non-compliant: n = 50, mean age = 8.5 yrs


**PAP and Craniofacial Growth & Development**

**Non-compliant PAP**

T1 (dark), T2 (light)


**Positive Airway Pressure and Pediatric Craniofacial Growth: Summary**

- SDB children compliant with PAP demonstrate impaired craniofacial growth, notably deficient maxillary development
- Sleep physicians who prescribe PAP are encouraged to collaborate with orthodontists to monitor growth and development
- Discuss alternative treatment options
- Have frank discussions about jaw surgery in future

**RME & Pediatric Obstructive Sleep Apnea (OSA)**

- 31 children (8.7 yr) with OSA and crossbite
- AHI* Pre-tx = 12.2 (severe)
- Rapid maxillary expansion for 3 weeks
- At 4 months: AHI < 1 (normal) in 100% of patients
- No long-term outcomes

*Apnea-hypopnea index


**Maxillary Anatomy**

Midpalatal Suture

Maxillary Bone

Bartleby.com: Gray’s Anatomy Plates 160 and 190. Licensed under Public Domain via Wikimedia Commons.

https://commons.wikimedia.org/wiki/File:Gray160.png?fbclid=IwAR0fFh5J100.png
RME Effect on Airway

- Nasal cavity: Increase in width of lower third of nasal cavity
- Nasopharynx: No change in volume, cross-sectional area, or AP width
- Oropharynx: Increase in all dimensions


RME: Airway and O2

- N = 22, mean age = 8.3 ± 0.9 years
- Baseline and 12 mos post-expansion (at removal of expander):
  - CBCT
  - PSG
- Baseline to follow-up: increase in airway volume and SpO2 (90.7% to 96.1%) and decrease in AHI (5.8 to 1.6) (p<.001)
- Total airway volume was not correlated with SpO2 or AHI values


RME and Pediatric OSA Studies

- 2016 meta-analysis identified 5 studies:
  - Pirelli et al., NRS 2004 (Italy)
  - Villa et al., NRS 2007 (Italy)
  - Guilleminault et al., RCT 2011 (US)
  - Marino et al., RCT 2012 (Italy)
  - Pirelli et al., NRS 2012 (Italy)


RME and Pediatric SDB Studies

- 5 studies:
  - N = 88 patients
  - Age range: 6-13 yrs
  - Presence of posterior crossbite
  - Primary outcome: AHI scores pre- and post-tx
  - Follow-up: 6-18 mos


RME and Pediatric SDB Studies

Malocclusion Prevalence and Pediatric SDB

- Two specific malocclusion traits thought to be associated with pediatric SDB
  - Mandibular retrognathia
  - Maxillary constriction
- Early orthodontic treatment has demonstrated improvement in OSA
- Is prevalence of maxillary constriction and mandibular retrognathia higher in pediatric SDB patients?

- Cohort of children consecutively referred to sleep center for SDB
- N = 90 (5-10 yrs old; mean age = 6.8 yrs)
- Otolaryngology to assess airway
- Orthodontics to identify need for early treatment
- Parent report of SDB signs and symptoms

Findings (Total Sample = 90)

<table>
<thead>
<tr>
<th>n (%)</th>
<th>Age in yr (SD)</th>
<th>Female</th>
<th>Parent report</th>
<th>Class II Canine (n=63)</th>
<th>Overjet &gt; 7 mm (n=63)</th>
<th>Anterior crossbite</th>
<th>Posterior crossbite</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>6.8 (1.29)</td>
<td>46 (51%)</td>
<td>Witnessed apneas</td>
<td>42 (47%)</td>
<td>42 (47%)</td>
<td>22 (24%)</td>
<td>14 (16%)</td>
</tr>
</tbody>
</table>

- In pediatric SDB sample, prevalence of mandibular retrognathia and maxillary constriction similar to that of a typical orthodontic population of 6-9 year olds
- Referral to orthodontist for early treatment may not be beneficial for majority of pediatric SDB patients evaluated in regional sleep center

Study Limitations

- SDB not confirmed by PSG
- Criteria for early orthodontic treatment may have been too restrictive:
  - OJ > 7 mm
  - Presence of posterior crossbite

Bimaxillary Expansion (BE) for SDB

- Retrospective study (2001-2011)
- N=45 children (age: 3-14 yrs)
- Inclusion criteria:
  - PSG confirmed OSA pre-BE
  - Treated with maxillary and mandibular expansion
  - Complete records (including lateral cephs and PSGs)
  - No other co-therapy
  - Post-BE PSG (3-6 mos)
- Exclusion criteria:
  - Previous adenotonsillectomy
  - Syndromic craniofacial anomalies

Bimaxillary Expansion

Maxilla: Skeletal Expansion (Rapid maxillary expansion)
- Mandible: Dentoalveolar Expansion

<table>
<thead>
<tr>
<th>AHI</th>
<th>Mild OSA (AHI &lt; 5 (n=22)</th>
<th>Moderate 5-10 (n=17)</th>
<th>Severe AHI &gt; 10 (n=16)</th>
</tr>
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<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>
</tbody>
</table>

Data derived from Quo 2017 and presented as median values

- AHI increased in 15/45 patients
- No cephalometric findings associated with BE response
- Favorable BE response significantly associated with OSA severity
- OSA was not eliminated in any case
RME and Vomer

- Beware of intervening with rapid maxillary expansion in children < 8 yrs old
- Anecdotal reports of nasal distortion
- Caused by "vomer drop"?
- 10-20 lbs force

RME and Vomer “Drop”

- Rapid maxillary expansion in children < 8 yrs may lead to drop in vomer, causing nasal deformities
- No studies have examined behavior of vomer or nose during maxillary expansion

Vomer Anatomy

- Paired bone in utero
- Fuses prior to birth
- Articulates with crest of maxilla and crest of palatine bone

Vomer Anatomy

Gray’s Anatomy (2015, April 13). Wikimedia Commons, the free media repository. Retrieved 02:46, October 20, 2015 from https://commons.wikimedia.org/wiki/File:Vomer.jpg

RME for Pediatric SDB: Summary

- Physician colleagues need to be educated on limitations of RME
- RME is promising tool in select orthodontic cases but insufficient data exist to recommend its use more generally at this time as a treatment option for pediatric sleep disordered breathing
- Research efforts are underway to investigate this treatment modality in young children
- Slow expansion in management of pediatric SDB has not been described to date

Mandibular Advancement Devices

Methods

- "Quasi-randomized" controlled clinical trial
- N=32, mean age 7.2 yrs
- Treatment: Mono-bloc removable mandibular advancement device to correct Class II malocclusion x 6 mo (tx)
- Controls: no tx (n=15)
- Daytime and nighttime symptom questionnaires in all subjects
- Pre- and post-PSG in treated children only

Results

- 9 dropouts (5 tx/4 control)
- AHI significantly improved from 7.1 to 2.6 (p<.001) in tx group
- Questionnaire results suggest decrease in symptoms in treated group

Mandibular Advancement Devices (MAD)

2002-2013: systematic review of MAD for pediatric SDB
- Only 4 (of 1759) studies met criteria for inclusion
  - Randomized or non-randomized, prospective or retrospective clinical trials
  - Children and adolescents (< 16 yrs)
  - Dx = SDB, Treated with MAD
  - Treatment and control groups or pre- and post-treatment outcomes (AHI)
- Available evidence is scarce and of poor quality


Mandibular Advancement Devices: Summary

- Currently insufficient research to judge feasibility and effectiveness of oral appliance therapy (OAT) for pediatric OSA
- Practical considerations have limited use of OAT in children
- Long-term outcomes have not been assessed
  - Respiratory
  - Behavioral
  - Cognitive
  - Cardiovascular

Ortho Extractions and “Tongue Space”

- Studies conflict with regard to association between extractions and posterior airway dimensions
- Poor correlation between posterior airway dimensions and SDB

Airway Volume and AHI

- No significant relationship between airway size and treatment efficacy with either mandibular advancement device or tongue stabilizing device

Missing Link

- Assessment of airway size after treatment not most useful outcome
- Need data on association between premolar extractions and SDB confirmed by PSG

Premolar Extractions & OSA

- Review of electronic medical and dental health records of HealthPartners in MN
- N=5,584
  - Cases: 50% (2,792) - missing one premolar/quadrant
  - Controls: 50% - no missing premolars
  - Matched 1:1 on age, gender, BMI categories (normal, overweight, obese, unknown)
  - Age groups: 40-49 yrs, 50-59 yrs, 60-70 yrs
- Outcome: prevalence of OSA (confirmed by PSG)

Premolar Extractions & OSA: Results

| Matched | 1:1 on age, gender, BMI categories (normal, overweight, obese, unknown) | Case: 10.71% | Control: 9.56%
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<tr>
<td></td>
<td>Prevalence of OSA not significantly different between groups (OR = 1.14, p = .144)</td>
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Due to 1:1 matching, subject characteristics identical between Cases and Controls

Premolar Extractions & OSA: Conclusion

- Extraction of premolars is not a risk factor in development of OSA

Conclusions

- Orthodontic treatment modalities have been described to manage pediatric SDB
- Much research is still needed to clarify
  - Appropriate procedures
  - Optimal age
  - Outcomes: Cognitive, behavioral, cardiovascular, effect on airway and craniofacial growth and development
- Treatment protocols need to be established
Introduced in 2009, the DOS program provides access to care for children in need. Access to quality orthodontic care is missing in many children’s lives.

The DOS program mission is to serve indigent children without insurance coverage or that do not qualify for other assistance in their state of residence. The program has expanded and offers care to children nationwide in addition to the recognized state programs in Illinois, Indiana, Kansas, Michigan, New Jersey, North Carolina, Rhode Island, Tennessee, Texas and Virginia.

In order to expand further, we need you to help by volunteering to serve as a provider orthodontist or help identify orthodontists willing to lead efforts to establish a DOS chapter in your state.

Stop by the DOS booth here in San Diego to learn more about the program or contact Ann Sebaugh at asebaugh@aaoortho.org with questions.