MANAGEMENT OF SLEEP RELATED BREATHING DISORDERS IN PEDIATRIC AND ADOLESCENT PATIENTS

BANGKOK
NOVEMBER 8, 2017

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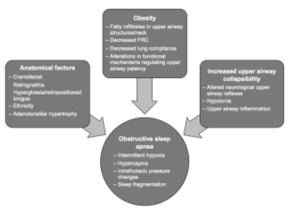


Figure 1 Pathophysiological factors involved in pediatric OSA.
Abbreviations: FRC, functional residual capacity; OSA, obstructive sleep apnea.

Tan HL, Gozal D, kheirandish-Gozal L. OSA in children: a critical update. Nature and science of sleep.2013

TONSILLARY HYPERTROPHY

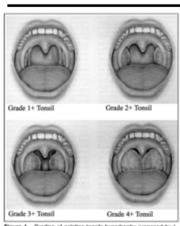
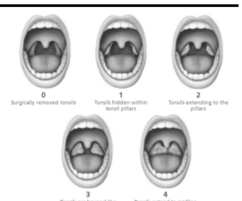


Figure 1 – Grading of palatine tonsils hypertrophy proposed by L. Brodsky.



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Adenotonsillectomy for Childhood Sleep Apnea

Carole L. Marcus, M.B., B.Ch., Reneé H. Moore, Ph.D., Carol L. Rosen, M.D., Bruno Giordani, Ph.D., Susan L. Garetz, M.D., H. Gerry Taylor, Ph.D., Ron B. Mitchell, M.D., Raouf Amin, M.D., Eliot S. Katz, M.D., Raanan Arens, M.D., Shalini Paruthi, M.D., Hiren Muzumdar, M.D., David Gozal, M.D., Nina Hattiangadi Thomas, Ph.D., Janice Ware, Ph.D., Dean Beebe, Ph.D., Karen Snyder, M.S., Lisa Elden, M.D., Robert C. Sprecher, M.D., Paul Willging, M.D., Dwight Jones, M.D., John P. Bent, M.D., Timothy Hoban, M.D., Ronald D. Chervin, M.D., Susan S. Ellenberg, Ph.D., and Susan Redline, M.D., M.P.H., for the Childhood Adenotonsillectomy Trial (CHAT)

Figure 1. **Study Enrollment and Randomization.**
A total of 464 children underwent randomization, with 226 children assigned to early adenotonsillectomy and 227 to a strategy of watchful waiting with supportive care. A total of 194 children in the early-adenotonsillectomy group and 203 in the watchful-waiting group were included in the analysis of the primary outcome, the attention and executive-function score on the Developmental Neuropsychological Assessment (NEPSY).

RESULTS

The average baseline value for the primary outcome, the attention and executive-function score on the Developmental Neuropsychological Assessment (with scores ranging from 50 to 150 and higher scores indicating better functioning), was close to the population mean of 100, and the change from baseline to follow-up did not differ significantly according to study group (mean [±SD] improvement, 7.1±13.9 in the early-adenotonsillectomy group and 5.1±13.4 in the watchful-waiting group; P=0.16). In contrast, there were significantly greater improvements in behavioral, quality-of-life, and polysomnographic findings and significantly greater reduction in symptoms in the early-adenotonsillectomy group than in the watchful-waiting group. Normalization of polysomnographic findings was observed in a larger proportion of children in the early-adenotonsillectomy group than in the watchful-waiting group (79% vs. 46%).

CONCLUSIONS

As compared with a strategy of watchful waiting, surgical treatment for the obstructive sleep apnea syndrome in school-age children did not significantly improve attention or executive function as measured by neuropsychological testing but did reduce symptoms and improve secondary outcomes of behavior, quality of life, and polysomnographic findings, thus providing evidence of beneficial effects of early adenotonsillectomy. (Funded by the National Institutes of Health; CHAT ClinicalTrials.gov number, NCT00560859.)

Table 2. **Outcome Measures.***

Outcome	Normative Mean	Watchful Waiting		Early Adenotonsillectomy		Effect Size†	P Value
		Baseline	Change from Baseline to 7 Mo	Baseline	Change from Baseline to 7 Mo		
Primary outcome							
NEPSY attention and executive-function score‡	100±15	101.1±14.6	5.1±13.4	101.5±15.9	7.1±13.9	0.15	0.16
Secondary outcomes							
Conners' Rating Scale score§	50±10						
Caregiver rating		52.6±11.7	−0.2±9.4	52.5±11.6	−2.9±9.9	0.28	0.01
Teacher rating		55.1±12.8	−1.5±10.7	56.4±14.4	−4.9±12.9	0.29	0.04
BRIEF score¶	50±10						
Caregiver rating		50.1±11.5	0.4±8.8	50.1±11.2	−3.3±8.5	0.28	<0.001
Teacher rating		56.4±11.7	−1.0±11.2	57.2±14.1	−3.1±12.6	0.18	0.22
PSQ-SRBD score‖	0.2±0.1	0.5±0.2	−0.0±0.2	0.5±0.2	−0.3±0.2	1.50	<0.001
PedsQL score**	78±16	76.5±15.7	0.9±13.3	77.3±15.3	5.9±13.6	0.37	<0.001
Apnea–hypopnea index — no. of events/hr††	NA						
Median		4.5	−1.6	4.8	−3.5	0.57	<0.001‡‡
Interquartile range		2.5 to 8.9	−3.7 to 0.5	2.7 to 8.8	−7.1 to −1.8		

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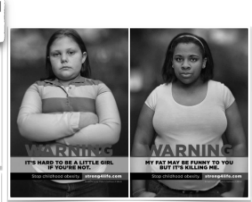
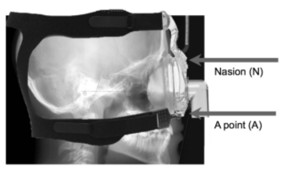


Weight loss canreduce OSA severity:
-dietetic reccommendation
-physical activity

CPAP

CPAP

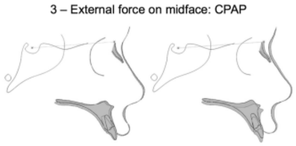
3 – External force on midface: CPAP



1 – Roberts SR et al., 2016.

CPAP

3 – External force on midface: CPAP



Based on cephalometric analysis, pediatric patients compliant with PAP for 2.5 years show overall maxillary retrusion, counterclockwise tipping of the palatal plane, and flaring of the maxillary incisors.

1 – Roberts SR et al., 2016.

frontiers in NEUROLOGY
HYPOTHESIS AND THEORY ARTICLE
published: 22 January 2013
doi: 10.3389/fneur.2012.00184

Pediatric obstructive sleep apnea and the critical role of oral-facial growth: evidences

Yu-Shu Huang[1] *and Christian Guilleminault*[2]*
[1] Department of Child Psychiatry and Sleep Center, Chang Gung Memorial Hospital and University, Taiwan, China
[2] Sleep Medicine Division, Stanford University, Redwood City, CA, USA

Review of evidence in support of an oral-facial growth impairment in the development of pediatric sleep apnea in non-obese children

Non Obese

Am J Orthod. 1981 Apr;79(4):359-72.
Primate experiments on oral respiration.
Harvold EP, Tomer BS, Vargervik K, Chierici G.

Mouth-breathing
was developed
in monkeys
by obstruction
of the nasal passages
with silicon nose plugs

Volume 79 Number 4 — Primate experiments on oral respiration 365

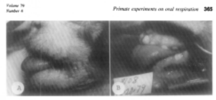


Fig. 4. The animal lowered the mandible and protruded the tongue. Eighteen months of mouth breathing produced a notch in the upper lip **(A)** and a severe open-bite **(B)**.

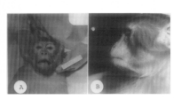
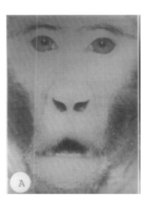


Fig. 5. This animal developed a notch in the lip and an open-mouth posture **(A)**. Mouth breathing continued 1 year after the nose was reopened, and the facial features were retained **(B)**.

changes in the function
of the masticatory muscles

All experimental animals
gradually acquired a facial
appearance and dental
occlusion different from those of
the control animals



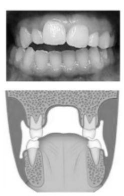
CHRONIC MOUTH BREATHING

- Clockwise rotation of mandible
  - Molar supraeruption
  - Long lower facial height
  - Retrognathic appearance

Roberts SL. AADSM 2016

CHRONIC MOUTH BREATHING

- Low tongue posture
  - Constricted maxillary arch
    - High arch palate
    - Posterior crossbite
    - Maxillary dental crowding
  - Wide mandibular arch
  - Proclined mandibular incisors
  - Tongue thrust
  - Speech complications



Roberts SL. AADSM 2016

CLINICAL PRACTICE | SYSTEMATIC REVIEW

Craniofacial morphological characteristics in children with obstructive sleep apnea syndrome

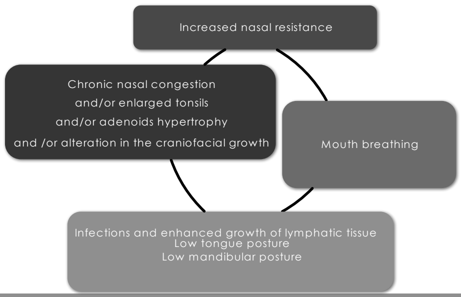
A systematic review and meta-analysis

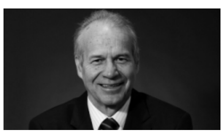
Carlos Flores-Mir, DDS, DSc, FRCD(C); Mohamed Korayem, DDS, MSc, FRCD(C); Giseon Heo, PhD; Manisha Witmans, MD, FRCPC; Michael P. Major, DMD; Paul W. Major, DDS, MSc, FRCD(C)

JADA 2013;144(3):269-277

Common reported findings across studies.

- Narrow maxillary dental arch with high palatal vault and posterior crossbites
- Longer lower anterior face height
- Steeper (more obtuse) gonial angle (vertical growth pattern)
- Posterior-inferior (clockwise) rotation of the mandible (mandibular plane angle)
- Retrusive chin
- Tendency toward anterior open bite and lip incompetence
- Smaller nasopharyngeal airway spaces





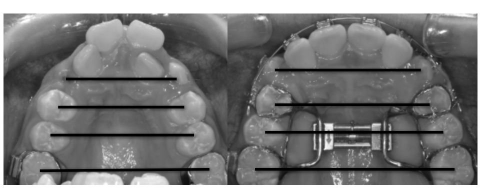
DGZS
DEUTSCHE GESELLSCHAFT ZAHNÄRZTLICHE SCHLAFMEDIZIN

The Emerging Role of Dental Sleep Medicine in SDB
Prof. C. Sullivan, 2010

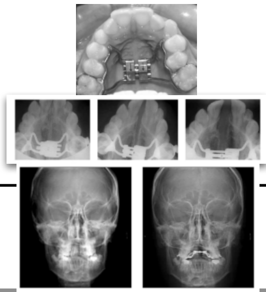
DENTISTS SHOULD PLAY
A CRITICAL ROLE IN:

1. Intercepting OSAS patients
2. Recognising the need for MF treatment
3. Treating adult OSAS patients
4. Treating children with RME

RME: rapid maxillary expansion



Several studies have demonstrated the effectiveness of RME in children even if they present adenotonsillar hypertrophy



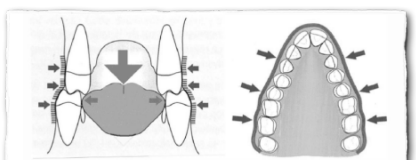


Fig . Position basse de la langue. Insuffisance de développement transversal du maxillaire supérieur provoquant un encombrement dentaire (d'aprés A.Patti)

Rollet D. L'ORTHODONTIE FONCTIONNELLE ET LES EDUCATEURS COMPORTEMENTO-FONCTIONNELS SOUPLES: EVOLUTIONS OU REVOLUTIONS ?
http://selarl-dr-rollet-daniel.chirurgiens-dentistes.fr

The purpose of maxillary expansion is to **normalize the diameter of maxillary bone** and to achieve a significative **decrease of nasal resistances**

T Baccetti et al.
American Journal of Orthodontics & Dentofacial Orthopedics 2010
C Enoki et al.
International Journal of Pediatric Otorhinolaryngology, 2006
KF Christie e al.
American Journal of Orthodontics & Dentofacial Orthopedics, 2010

IWASAKI et al. Am J Orthod Dentofacial Orthop. 2012, 2013
SOKUCU et al, Angle 2009
GRACCO et al. Angle 2010

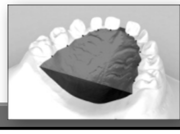
Improved nasal airway ventilation

Improved tongue posture

Enlargement of pharyngeal airway

Significant increase of palatal volume,

with insignificant relapse after 2,5 years



Rapid Maxillary Expansion in Children with Obstructive Sleep Apnea Syndrome

Paola Pirelli, DDS[1]; Maurizio Saponara, MD[2]; Christian Guilleminault, MD, Biol D[3]

[1]Department of Odontological Sciences, University Tor Vergata; [2]Department of Neurology and ENT, La Sapienza University, Rome Italy; [3]Stanford University Sleep Disorders Clinic, Stanford, CA, USA

Objective: To evaluate the effect of rapid maxillary expansion on children with nasal breathing and obstructive sleep apnea syndrome.
Method: Recruitment of children with maxillary contraction, without of adenoid hypertrophy, with a body mass index < 24 kg/m2, with obstructive sleep apnea syndrome demonstrated by polysomnography, and whose parents signed informed consent. Otolaryngologic and orthognathic-odontologic evaluation with clinical evaluation, anterior rhinometry and nasal fibroscopy, panoramic radiographs, anteroposterior and laterolateral telecephalometry were performed at entry and follow-up.
Intervention: Rapid maxillary expansion (ie, active phase of treatment) was performed for 10 to 20 days; maintenance of device (for consolidation) and orthodontic treatment on teeth lasted 6 to 12 months.
Results: 31 children (19 boys), mean age 8.7 years, participated in the study. The mean apnea-hypopnea index was 12.2 events per hour. At the 4-month follow-up, the anterior rhinometry was normal, and all children had an apnea-hypopnea index < 1 event per hour. The mean cross-sectional expansion of the maxilla was 4.32 ± 0.7 mm. There was a mean increase of the pyriform opening of 1.3 ± 0.3 mm.
Conclusion: Rapid maxillary expansion may be a useful approach in dealing with abnormal breathing during sleep.
Key Words: Rapid maxillary expansion, obstructive sleep apnea syndrome, children, nasal opening, maxilla
Citation: Pirelli P; Saponara M; Guilleminault C. Rapid maxillary expansion in children with obstructive sleep apnea syndrome. *SLEEP* 2004; 27(4):761-6.

Original Article

Airway compartments volume and oxygen saturation changes after rapid maxillary expansion:
A longitudinal correlation study

Rosamaria Fastuca[a]; Giuseppe Perinetti[b]; Piero Antonio Zecca[c]; Riccardo Nucera[d]; Alberto Caprioglio[e]

Angle Orthodontist, Vol 85, No 6, 2015

Table 1. Airway Compartment Volumes and Respiratory Functional Parameters Recorded at Each Time Point (n = 15)[a]

Parameter	Time Point: Baseline	Time Point: 12 Mo	Changes
Total airway volume (mm^3)	16,995 ± 5163	22,389 ± 7610	5394 ± 2317*
Upper airway volume (mm^3)	7716 ± 3324	10,021 ± 3946	2305 ± 1014*
Middle airway volume (mm^3)	5856 ± 2371	7001 ± 2890	1144 ± 835*
Lower airway volume (mm^3)	3451 ± 1613	5366 ± 2685	1915 ± 662***
SpO_2 (%)	90.7 ± 5.1	96.1 ± 4.5	5.3 ± 0.6***
AHI (events/h)	5.8 ± 1.1	1.6 ± 0.9	−4.2 ± 1.5***

[a] Data are shown as mean ± SD for time points, and as mean ± SE for changes over time.
SpO_2, oxygen saturation; AHI, apnea/hypopnea index.
Levels of significance: * $P < .05$; *** $P < .001$.

Original Article

Rapid maxillary expansion (RME) for pediatric obstructive sleep apnea: a 12-year follow-up

Paola Pirelli [a], Maurizio Saponara [b], Christian Guilleminault [c,*]

[a] Department of Clinical Sciences and Translational Medicine, University of Tor Vergata, Rome, Italy
[b] Department of Otolaryngology and Neurology, La Sapienza University, Rome, Italy
[c] Stanford University Sleep Disorders Clinic, Redwood City, CA, USA

Objective: The objective of this study was to prospectively evaluate the long-term efficacy of rapid maxillary expansion (RME) in a group of children with obstructive sleep apnea (OSA).
Material and method: Thirty-one children diagnosed with OSA were involved in the study. These children had isolated maxillary narrowing and absence of enlarged adenotonsils at baseline. Twenty-three individuals (73% of the initial group) were followed up annually over a mean of 12 years after the completion of orthodontic treatment at a mean age of 8.68 years. Eight children dropped out over time due to either moving out of the area (*n* = 6) or refusal to submit to regular follow-up (*n* = 2). Subjects underwent clinical reevaluation over time and repeat polysomnography (PSG) in the late teenage years or in their early 20s. During the follow-up period, eight children dropped out and 23 individuals (including 10 girls) underwent a final clinical investigation with PSG (mean age of 20.9 years). The final evaluation also included computerized tomographic (CT) imaging that was compared with pre- and post-initial treatment findings.
Results: Yearly clinical evaluations, including orthodontic and otolaryngological examinations and questionnaire scores, were consistently normal over time, and PSG findings remained normal at the 12-year follow-up period. The stability and maintenance of the expansion over time was demonstrated by the maxillary base width and the distance of the pterygoid processes measured using CT imaging.
Conclusion: A subgroup of OSA children with isolated maxillary narrowing initially and followed up into adulthood present stable, long-term results post RME treatment for pediatric OSA.

Original Article

Rapid maxillary expansion (RME) for pediatric obstructive sleep apnea: a 12-year follow-up

Paola Pirelli [a], Maurizio Saponara [b], Christian Guilleminault [c,*]

[a] Department of Clinical Sciences and Translational Medicine, University of Tor Vergata, Rome, Italy
[b] Department of Otolaryngology and Neurology, La Sapienza University, Rome, Italy
[c] Stanford University Sleep Disorders Clinic, Redwood City, CA, USA

Table 1
Polysomnographic results immediately post treatment and at long-term (12 years) follow-up.

	Results after completion of initial RME (n = 31)	Results at long term follow-up (n = 23)	p-value
PSG parameters			
AHI	0.4 ± 1.1	0.3 ± 0.9	NS
range	0–2.1	0–1.8	NS
Nadir SpO2 (%)	95.3 ± 1.7	97.2 ± 1.5	NS
% sleep time with SpO2< 92%	1.3 ± 1.1	1.1 ± 1.0	NS
Sleep efficiency (%)	89.2 ± 7.7	90.1 ± 6.5	NS

Legend: AHÍ: apnea-hypopnea-index % sleep time with SpO2< 92%: percentage of sleep-time spent below 92%.

Systematic Review

Rapid Maxillary Expansion for Pediatric Obstructive Sleep Apnea: A Systematic Review and Meta-Analysis

Macario Camacho, MD; Edward T. Chang, MD, MS; Sungjin A. Song, MD; Jose Abdullatif, MD; Soroush Zaghi, MD; Paola Pirelli, DDS; Victor Certal, MD, PhD; Christian Guilleminault, MD

Objectives/Hypothesis: To perform a systematic review with meta-analysis for sleep study outcomes in children who have undergone rapid maxillary expansion (RME) as treatment for obstructive sleep apnea (OSA).
Data Sources: PubMed/MEDLINE and eight additional databases.
Review Methods: Three authors independently and systematically reviewed the international literature through February 21, 2016.
Results: Seventeen studies reported outcomes for 314 children (7.6 ± 2.0 years old) with high-arched and/or narrow hard palates (transverse maxillary deficiency) and OSA. Data were analyzed based on follow-up duration: ≤3 years (314 patients) and >3 years (52 patients). For ≤3-year follow-up, the pre- and post-RME apnea–hypopnea index (AHI) decreased from a mean ± standard deviation (M ± SD) of 8.9 ± 7.0/hr to 2.7 ± 3.3/hr (70% reduction). The cure rate (AHI <1/hr) for 90 patients for whom it could be calculated was 25.6%. Random effects modeling for AHI standardized mean difference (SMD) is −1.54 (large effect). Lowest oxygen saturation (LSAT) improved from 87.0 ± 9.1% to 96.0 ± 2.7%. Random effects modeling for LSAT SMD is 1.74 (large effect). AHI improved more in children with previous adenotonsillectomy or small tonsils (73–95% reduction) than in children with large tonsils (61% reduction). For >3-year follow-up (range = 6.5–12 years), the AHI was reduced from an M ± SD of 7.1 ± 5.7/hr to 1.5 ± 1.8/hr (79% reduction).
Conclusions: Improvement in AHI and lowest oxygen saturation has consistently been seen in children undergoing RME, especially in the short term (<3-year follow-up). Randomized trials and more studies reporting long-term data (≥3-year follow-up) would help determine the effect of growth and spontaneous resolution of OSA.
Key Words: Obstructive sleep apnea, sleep medicine, sleep apnea, systematic review, meta-analysis.
***Laryngoscope*, 127:1712–1719, 2017**

In the long term

Baratieri C, Alves MJr, de Souza MM, de Souza Araujo MT, Maia LC. Does rapid maxillary expansion have long-term effects on airway dimensions and breathing? Am J Orthod Dentofacial Orthop. 2011 Aug;140(2):146-56.

SYSTEMATIC REVIEW

Moderate evidence that in growing children improves nasal breathing and that the result is stable for at least 11 months after therapy

European Journal of Paediatric Dentistry 2015

M. Eichenberger, S. Baumgartner

Department of Orthodontics and Paediatric Dentistry University of Zürich, Switzerland

The impact of rapid palatal expansion on children's general health: a literature review

	Positive side effect of RPE			Level of evidence		
	Yes	Unclear	No	High	Moderate	Low
Obstructive sleep apnea syndrome (OSAS)						
Cistulli et al. 1998	x					x
Pirelli et al. 2004	x				x	
Villa et al. 2007&2011	x					x

What is the role of tratment **timing** in the determinatior of craniofacial modification following RME therapy?

- Patients treated before pubertal peak show significantly greater short-term increase in the width of the nasal cavities
- In the long term (minimum 5 years) maxillary skeletal width was greater in the early-treated patients
- RME treatment before pubertal peak is able to induce more pronounced transverse craniofacial changes at the skeletal level

Baccetti et al. Angle Orthod. 2001

Is maxillary constriction the only predisposing factor to OSAS?

GUILLEMINAULT et al. Orthodontic expansion treatment and adenosillectomy in the treatment of OSAS in prepubertal children. SLEEP 2008

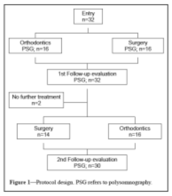


Figure 1—Protocol design. PSG refers to polysomnography.

A significative difference has been detected when the patient underwent to a combined treatment: surgery + RME

…Miofunctional therapy may increase stability

Breath in through the nose and breath out through the mouth strongly enough to displace a balloon	A
Breath in through the nose and breath out through the mouth using a straw placed in a glass of water and making bubbles for as long as possible	A
Breath in through one nostril and breath out through the other, using the thumb to close the other nostril	A
Lower the upper lip over the incisors in such a way as to hamper the contemporary relaxation of the chin muscle	B
Place a button tied to 15-20 cm of thread inside the mouth vestibule and pull it perpendicularly forward	B
Press one lip against the other keeping the teeth closed	B
Vibrate the lips blowing out noisily	B
Place the tongue on the incisor taste bud and move from right to left using a movement resembling that of a windscreen wiper	C

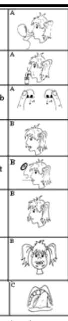


Fig. 2 Examples of some oropharyngeal exercises. **a** Nasal breathing rehabilitation, **b** labial seal and lip tone exercises, and **c** tongue posture exercises

Villa et al. Oropharyngeal exercises to reduce symptoms of OSA after AT. Sleep Breath 2015 19: 281-9

Bimaxillary expansion therapy for pediatric sleep-disordered breathing

Stacey D. Quo [a], Nelly Hyunh [b], Christian Guilleminault [c,*]

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[b] Faculty of Dentistry, Université de Montréal, Montréal, Canada
[c] Sleep Medicine Division, Stanford University School of Medicine, Stanford, CA, USA

Sleep Medicine 30 (2017) 45–51

46 S.D. Quo et al. / Sleep Medicine 30 (2017) 45–51

Fig.1. Depiction of inward lingual tipping of the upper and lower dentition. Legend: Black lines indicate the lingual inclination of the upper and lower teeth.

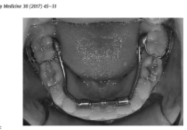


Fig. 2. Lower expander anchored to the permanent lower first molars.

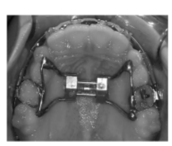


Fig. 3. Design of upper expander in the mixed dentition.

Table 2
Polysomnography results by OSA severity group (n = 45).

	Mild AHI < 5 (n = 12)			Moderate AHI between 5 and 10 (n = 17)			Severe AHI > 10 (n = 16)		
	Pre-BE	Post-BE	p-value	Pre-BE	Post-BE	p-value	Pre-BE	Post-BE	p-value
Total Sleep Time (min)	450.5(204.5–515.5)	448.2(372.0–519.5)	0.75	468.4(368.1–554.0)	446.0(93.2–539.0)	0.06	498.5(322.5–543.4)	468.5(224.0–583.4)	0.12
Sleep Efficiency(%)	89.9(76.5–95.9)	87.8(71.1–93.8)	0.94	90.0(72.5–97.4)	88.6(49.0–98.3)	0.16	89.5(64.9–97.5)	90.1(40.9–96.6)	0.90
Sleep-Onset Latency(min)	20.0(0.0–43.0)	16.3(1.9–47.5)	0.88	13.2(0.0–44.6)	18.8(2.9–49.8)	0.57	13.9(1.7–67.0)	14.5(2.2–95.6)	0.93
AHI	2.9(0.1–0.4)	6.1(0.0–30.8)	**0.03**	7.1(5.2–10.0)	6.1(0.0–20.2)	0.25	22.0(10.4–32.5)	10.3(3.7–25.3)	**0.001**
SPO_2 Mean Desaturation(%)	97.6(96.2–99.5)	97.7(96.2–99.4)	0.80	97.8(94.9–99.4)	97.2(96.0–98.0)	0.17	97.2(94.5–98.9)	97.2(92.3–99.3)	0.38

Data presented as median(min–max). Wilcoxon signed-rank tests were performed.

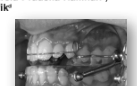
Sagittal correction
of a short or **retropositioned mandible**
can increase the oropharyngeal space
and significantly decrease AHI

American Journal of Respiratory and Critical Care Medicine
2002 MP Villa et al.

Original Article

Class II correction improves nocturnal breathing in adolescents

Teresa Cristina Barros Schütz[a]; Gladys Cristina Dominguez[b]; Marcia Pradella Hallinan[a];
Thays Crosara Abrahão Cunha[c]; Sergio Tufik[d]



12 months Herbst appliance:

- length of the mandible was increased
- antero-posterior position of the maxilla remained stable
- posterior airway space was increased
- length of the tongue was preserved
- hyoid bone was moved to a more anterior position
- increase in airway volume
- decrease in numbers of obstructive events in PSG

Original Article

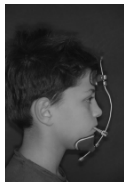
Correlation between skeletal changes by maxillary protraction and upper airway dimensions

Ji-Won Lee[a]; Ki-Ho Park[b]; Seong-Hun Kim[c]; Young-Guk Park[d]; Su-Jung Kim[e]

Sagittal correction of an **underdeveloped maxillary**

9-12 months Delaire Mask 6-8 years:

- significant increase in maxillary forward displacement
- increase in nasopharyngeal space rather than that of oropharyngeal space
- improve tongue posture due to the increased space in the oral cavity caused by the forward growth of maxilla



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Intervention Review

Oral appliances and functional orthopaedic appliances for obstructive sleep apnoea in children

Fernando R Carvalho[1,*], Débora A Lentini-Oliveira[1], Marco Antonio C Machado[2], Humberto Saconato[3], Lucila BF Prado[1], Gilmar F Prado[4]

Editorial Group: Cochrane Oral Health Group
Published Online: 18 APR 2007
Assessed as up-to-date: 14 FEB 2007
DOI: 10.1002/14651858.CD005520.pub2

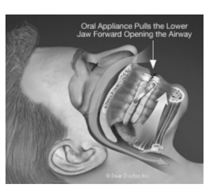
Authors' conclusions

At present there is no sufficient evidence to state that oral appliances or functional orthopaedic appliances are effective in the treatment of OSAS in children . Oral appliances or functional orthopaedic appliances may be helpful in the treatment of children with craniofacial anomalies which are risk factors for apnoea

ORAL APPLIANCES (ADULT PATIENTS)

Reposition and maintain the mandible and tongue anteriorly, increasing upper airway volume and thus decreasing resistance to airflow.

Increase the resting tonicity in the genioglossus and palatoglossus muscles.



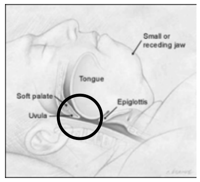
Sites of Obstruction

Rama, A: Chest 2002; 122

Medline review of articles from

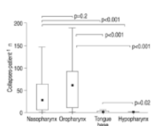
1980-2002 to determine the most the common sites of obstruction in studies of OSA

Although there was considerable variability in techniques and results, the most common site of obstruction detected by these studies was at the level of the oropharynx (retropalatal and retroglossal)



SITES OF OBSTRUCTIONS

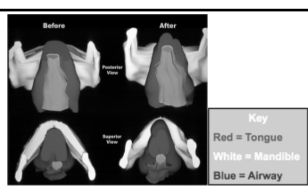
Pt n	Site of UA obstruction			
	Nasopharynx	Oropharynx	Tongue base	Hypopharynx
1	x			
1		x		
15	x	x		
2		x	x	
7	x	x	x	
2	x	x	x	x



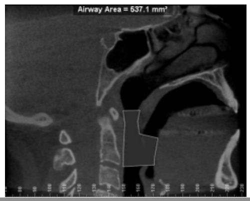
- Combination of the different sites of upper airway (UA) obstruction
- Total number of obstructions at a given site of the upper airway for each patient

Courtesy of Dr. Ulrich Sommer-Mannheim

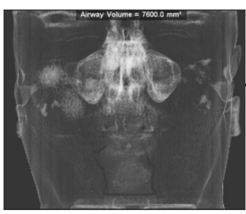
AIRWAY VOLUME IS EXPANDED



Three Dimensional reconstructions courtesy of Alan A. Lowe, DMD, FRCD (C) , FACD



Courtesy of Dr. Ghabi Kaspo. Detroit, MI



Courtesy of Dr. Ghabi Kaspo. Detroit, MI

Courtesy of Dr. Ghabi Kaspo. Detroit, MI

AMERICAN ACADEMY OF SLEEP MEDICINE
Setting Standards & Promoting Excellence in Sleep Medicine

Indications for Oral Appliances

Sleep 2006;29(2):240-243

- Primary snoring
- Mild to moderate OSA who:
  - Prefer OAs to CPAP
  - Do not respond to CPAP
  - Are not appropriate candidates for CPAP
  - Fail treatment attempts with CPAP or behavioral changes
- Patients with **severe OSA** who have **failed an initial trial of nasal CPAP** [before considering OAs]
- Upper airway surgery may also supersede the use of OAs in patients for whom these operations are predicted to be highly effective in treating sleep apnea

Types of Oral Appliances

There are more than 100 different OAs commercially available; only few have been approved by the FDA for the management of obstructive sleep apnea

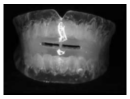
Two basic types:

- Mandibular repositioners; reposition and maintain the mandible and tongue in a forward position
  - There are also variations in which a CPAP connector can be combined with an oral appliance, eliminating the need for head straps
- Tongue retainers; engage and hold only the tongue in a forward position without affecting the mandible or teeth (not FDA approved for OSA)

Oral appliances

- Material
- Cost
- Retention
- Mechanism of titration
- Range of protrusion\advancement
- Lateral movement
- Comfort

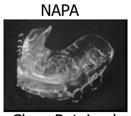
Non-adjustable Appliances


Elastomeric


NAPA


Snore Guard


OSAP


Clasp Retained


Snore-Aid

Adjustable Appliances


Klearway


Adjustable PM Positioner


TAP


TAP-T

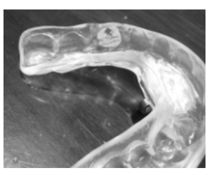

Herbst

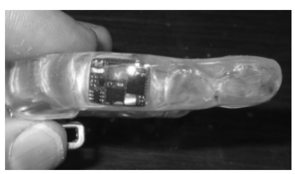
Adjustable Appliances

SOMNODENT

DREAM TAP

Compliance Monitoring





Effect of nasal or oral breathing route on upper airway resistance during sleep

M.F. Fitzpatrick*, H. McLean*, A.M. Urton*, A. Tan#, D. O'Donnell*, H.S. Driver¶

Eur Respir J 2003; 22: 827–832.

Upper airway resistance during sleep and the propensity to obstructive sleep apnoea are significantly lower while breathing nasally rather than orally. This mechanical advantage may explain the preponderance of nasal breathing during sleep in normal subjects.

J Physiol 574.3 (2006) pp 859–866

Influence of breathing route on upper airway lining liquid surface tension in humans

Manisha Verma[1,3], Margaret Seto-Poon[1,3], John R. Wheatley[1,2], Terence C. Amis[1,2] and Jason P. Kirkness[1,2,3]

$P < 0.001$; linear regression). We conclude that oral breathing increases and nasal breathing decreases the γ of UAL in healthy subjects during wakefulness. We speculate that nasal breathing in OSAHS patients during sleep may promote a low γ of UAL that may contribute to reducing the severity of sleep-disordered breathing.

Dream Tap with Mouth Shield





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TRIAL ORAL APPLIANCES

- ***MY TAP***



MyTap with Mouth Shield

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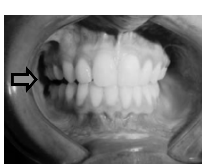
Side Effects of Oral Appliances

Very common, but most often are minor and transient and quickly resolve upon removal of the appliance

- Excessive salivation
- Dry mouth
- Tooth discomfort
- Jaw or muscle pain
- Dislodgement or damage of restorations
- Changes in occlusion

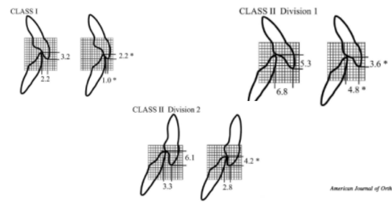
OCCLUSAL CHANGES

- **Posterior open bite** is commonly experienced upon removal of the appliance in the morning
- Characterized by persistence of the jaw in a forward position resulting in….
  - Heavy contact on the front teeth (incisors)
  - Little or no contact on the back teeth (molars)
- Usually returns to normal within a few seconds or minutes after removal of the appliance
- Can be accelerated by attempting to squeeze together on the molars (may be facilitated by use of a leaf gauge)



Long-term sequellae of oral appliance therapy in obstructive sleep apnea patients: Part 2. Study-model analysis

Fernanda Ribeiro de Almeida,[a] Alan A. Lowe,[b] Ryo Otsuka,[c] Sandra Fastlicht,[d] Maryam Farbood,[e] and Satoru Tsuiki[f]
Vancouver, British Columbia, Canada, Tokyo, Japan, and Tehran, Iran



American Journal of Orthodontics and Dentofacial Orthopedics
February 2006

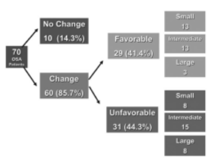
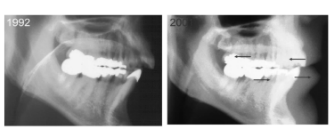


Fig. 2. The occlusal changes in 70 patients after an average of 7.4 years of MAS use.



- Retroclination of the maxillary incisors
- Distal tipping of the maxillary molars
- Proclination of the mandibular incisors
- Mesial tipping of the mandibular molars
- NO Changes in condyle position

Fig. 3. Dentoalveolar changes after 9 years of MAS use.

LONG TERM SIDE EFFECTS

Table 4. Long-term side-effects of mandibular advancement stent on occlusal measurements

First author [Ref.]	Year of study	Patients n	Interval years	Change in OB mm	Change in OJ mm
Marklund [66]	2001	75	2.5	-0.5	-0.6
Robertson [111]	2001	100	2.5	-1.02	-1.06
Rose [112]	2002	34	2.5	-1.1	-1.3
Ghazal [113]	2008	24	2.5	3.2	2.5
Almeida [109, 110]	2006	70	7.6	-1.9/-2.8	-1.2/-2.6
Marklund [108]	2006	450	5.4	-0.6	-0.6
Hammond [114]	2007	64	2.1	-0.3	-0.2

OB: overbite, vertical overlapping of upper teeth over lower teeth. OJ: overjet, horizontal projection of upper teeth beyond the lower teeth.

From European Respiratory monograph. December 2010

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