

Dentist's Role for Children and Adult with Sleep Disordered Breathing : Orthodontist Perspective

Audrey Yoon DDS MS

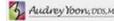
Clinical Professor
 Stanford University, Sleep Medicine Clinic
 Diplomate, American Board of Orthodontics
 Diplomate, American Board of Dental Sleep Medicine




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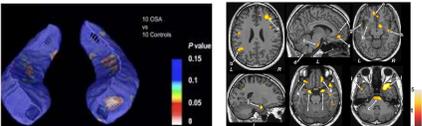
Conflict of Interest Disclosures

- Consultant - Sound Health
- KOL - Net 32, Diagnocat
- I do not have any conflict of interest with today presentation



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My Journey into the Sleep



Perinatal intermittent hypoxia alters γ -aminobutyric acid: a receptor levels in rat cerebellum

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 *USCA Neurobiology, Stanford University




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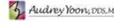
The Father of Sleep



Rapid Eye movement (REM)

“The paper I wrote on REM sleep was rejected five times before it was finally accepted for publication.”
 --William Dement, 1957s.

William Charles Dement
 (July 29, 1928 – June 17, 2020)
 World 1st sleep Clinic and Lab at Stanford
 Discovered 5 stages of Sleep
 Establish Full Sleep Study (Polysomnography)
 Invented AHI (Apnea-Hypopnea Index)
 Founder of American Academy of Sleep Medicine

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The Father of Sleep



Christian Guilleminault
 (1938–9 July 2019)
 Described " Obstructive Sleep Apnea Syndrome"
 Described " Pediatric Sleep Apnea"
 Described " Upper Airway Resistance Syndrome"
 Invented AHI (Apnea-Hypopnea Index)
 Founder of World Association Sleep Medicine




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Professional Experience

Clinical Professor
 Sleep Medicine division
 Department of Psychiatry and Behavioral Sciences
 Stanford University, School of Medicine

Now we have "dental sleep medicine specialty clinic"






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Professional Experience

Director : Dental Sleep Medicine Clinic
 Department of Orthodontics
 University of the Pacific, Arthur A. Doguni School of Dentistry

Now we have "dental sleep medicine clinic" under orthodontic department

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Professional Experience

Director : Dental Sleep Medicine Clinic
 Department of Orthodontics
 University of the Pacific, Arthur A. Doguni School of Dentistry

Now we have "dental sleep medicine clinic" under orthodontic department

Now we have "Sleep Disorder Screening" as part of a new pt exam for all university pt

Sleep Questionnaire is mandatory !

Sleep Disorder Course for Undergrad Dental Students as part of curriculums

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Pacific Dental Sleep Medicine Fellowship for orthodontist

Clinical Experience
 Experience/ learn clinical skills
 Oral appliance
 DOME/MMA Surgery
 Craniofacial development
 Growth Modification

Research
 Establish evidences
 Leading SDB researching centre

Education
 Class / Course
 How to read Sleep Study
 Understand pathophysiology
 Understand Sleep Study

Multidisciplinary Approach
 Work with Stanford Sleep Medicine and Sleep Surgery
 Establish network
 How to communicate and work as a team

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World DentoFacial Sleep Society

<https://dentofacialsleep.org/>

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Please Join Us !

SLEEP 2026

2026

WDSS 2026 June 14-15, 2026
Baltimore, MD, USA

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Why Sleep ?

- Increasing level of awareness of sleep apnea and related health issues
- Role of dental and orthodontic professionals in screening and treating sleep apnea patients

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Malocclusion can be a sign of other medical conditions

Orthodontic Treatment

Surface Meaning: Malocclusion
(Narrow, high arch maxilla
Retrognathic mandible
Vertical Growth Pattern,
Openbite)

Deeper Meaning: Nasal Obstruction
Mouth Breathing
Abnormal Tongue Postures
Sleep Disordered Breathing
TMJ dysfunction
Myofunctional Disfunctions

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Understanding Malocclusion

Airway affects development of malocclusion

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Dr. Audrey Yoon

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Zone of Equilibrium : Neutral Zone

The forces of tongue pressing outward are neutralized by the forces of the cheeks and lips
Chewing, speaking, swallowing and Breathing

Marc Geissberger. *Esthetic Dentistry in Clinical Practice*. John Wiley & Sons, 2013. ISBN 9781118694930.

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Zone of Equilibrium : Neutral Zone

Tongue Posture
Relates to Habits, Tongue Tie, Mouth breathing, Nasal Blockage, Adenoids and tonsils, Allergies and Asthma

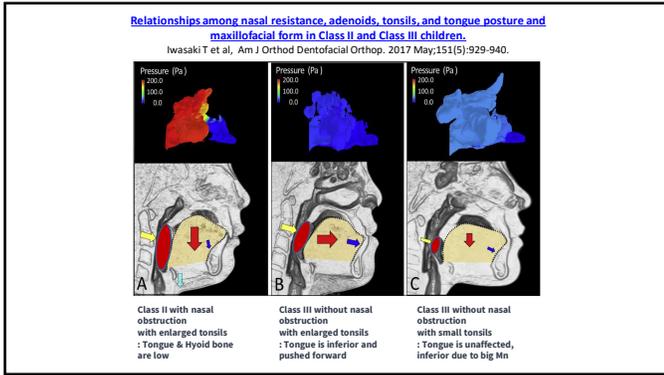
Narrow, high arch palate

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Tongue Posture

Anterior Class II / Open Class III

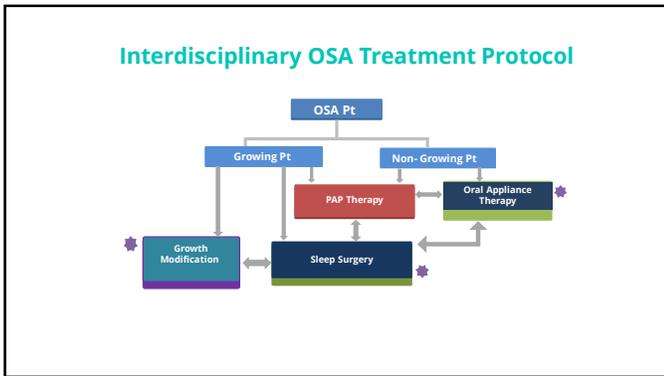
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Why Pediatric Sleep / Growth Modification ?

- Medical Treatment is not always successful or indicated for pediatric patient with OSA
- Dentists may provide valuable alternative and adjunctive treatment options for pediatric OSA

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Journal Article Snippet:

Sleep Medicine
 Editorial: Pediatric obstructive sleep apnea: beyond adenotonsillectomy

and, consequently, leading to airway collapse. At present, the treatment of choice worldwide for OSAS during childhood is adenotonsillectomy (AT). AT procedures account for 15% of all pediatric surgery carried out in the United States [1].

However, newer studies have shown that even after AT, 60%–70% of children experience residual OSAS. A recent meta-analysis showed that the short-term results from AT were divergent, and that AT did not provide any significant long-term benefit [3,4].

Therefore, the following minimally invasive coadjutant treatments have recently been proposed: (1) rapid maxillary expansion (RME), (2) use of oral appliances (OA) and (3) myofunctional therapy (MT) [7,10,12–14].

In conclusion, OSAS during childhood leads to physical and neuropsychomotor impairment. As such, it needs to be recognized and treated early, in order to avoid or mitigate its deleterious consequences and allow children to develop properly. Thus, it becomes the task of healthcare professionals to research and disseminate new forms of therapy for treating childhood OSAS.

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Journal Article Snippet:

Received: 31 May 2024 | Accepted: 24 October 2024
 DOI: 10.1111/jcpp.13984

ACPP AMERICAN COLLEGE OF PROSTHODONTISTS
 Their work. Our specialty.

REVIEW

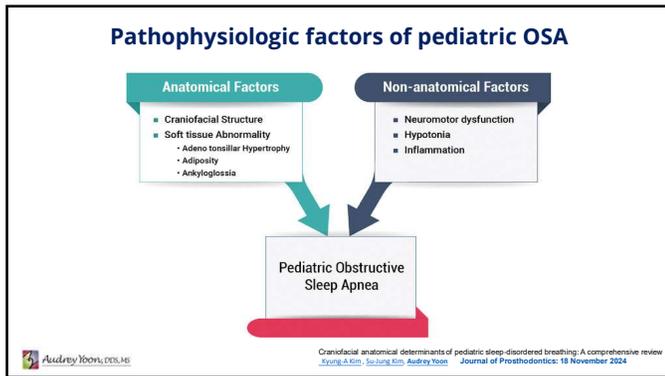
Craniofacial anatomical determinants of pediatric sleep-disordered breathing: A comprehensive review

Kyung-A Kim DDS, PhD¹ | Su-Jung Kim DDS, PhD¹ | Audrey Yoon DDS, MS^{2,3}

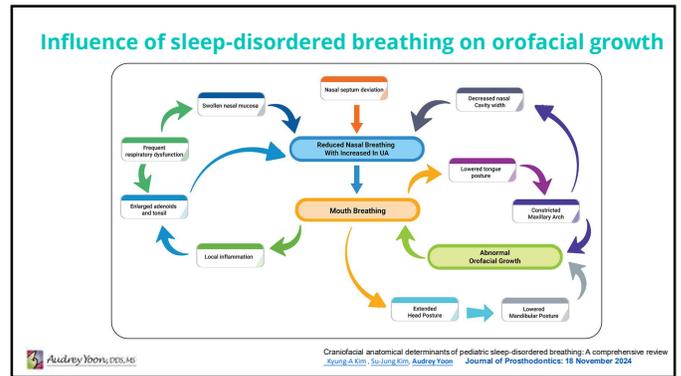
Conclusion: Early diagnosis and intervention are critical in managing PSDB. Dentists, through screening and early treatment, can significantly influence craniofacial growth and health outcomes. A multidisciplinary approach is essential for effective management, improving the quality of life and long-term health of affected children.

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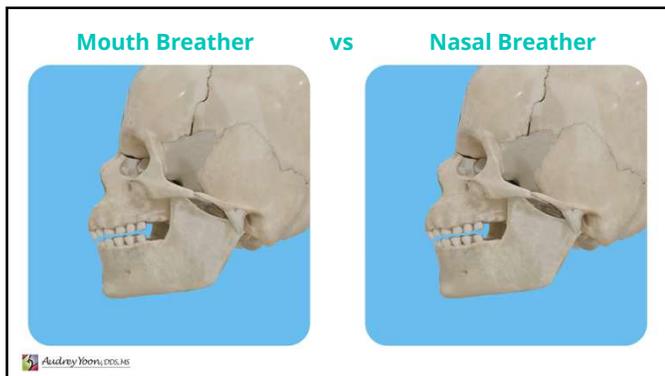
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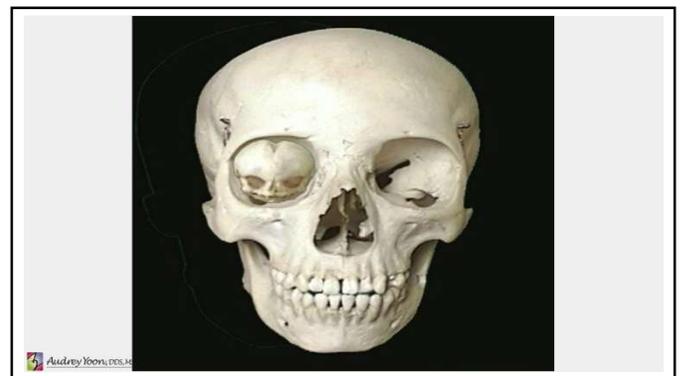
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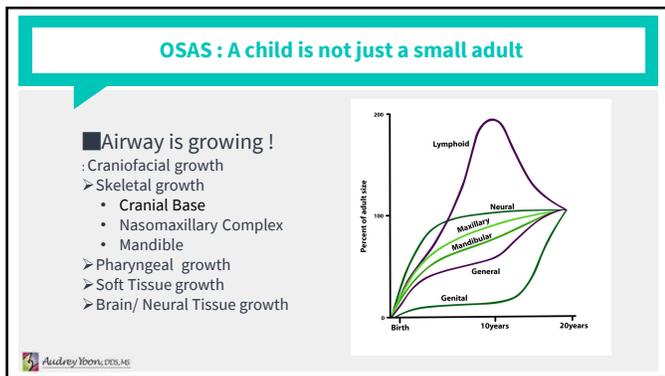
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Key to Pediatric SDB

- 1) Recognize risk factors **Early**
- 2) Treatment for a long Stability : **Structure and Function**
 - Maximize growth potential
 - Improve muscle tone and response
 - Orofacial growth modification

* **Ultimate goal of Pediatric SDB**
Nasal Breathing + Promote positive orofacial growth

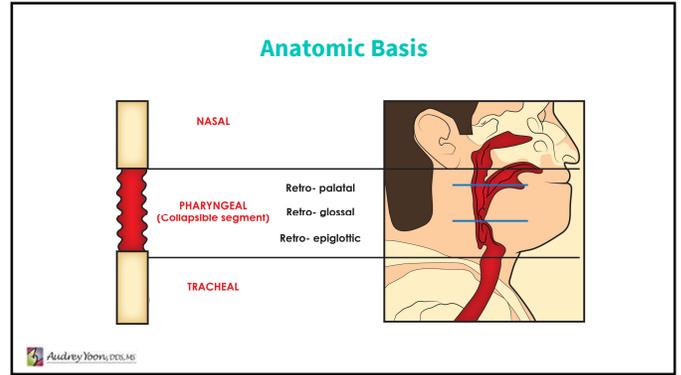
- Lip together, Tongue on the palate
- 100% Nasal Breathing → Promote positive orofacial growth

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Understanding Airway Anatomy

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Pharynx Anatomy

- **Nasopharynx:**
 - Base of the skull to soft palate
 - Adenoid tonsils
- **Oropharynx:**
 - Soft palate to superior border of the epiglottis.
 - Lingual tonsils, Palatine tonsil
 - Superior Pharyngeal Constrictor muscle.
- **Laryngopharynx:**
 - The superior border of the epiglottis and inferior border of the cricoid cartilage.
 - Middle and inferior Pharyngeal constrictors

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What is Origin of Pharyngeal Collapse?

Sleep Med. 2003 May;4(3):185-94.
The Great Leap Forward: the anatomic basis for the acquisition of speech and obstructive sleep apnea. Davidson TM.

- Other mammals and the infant human have velo-epiglottal Overlap
- The Oro-pharynx is **UNIQUE** to humans
- This open area of throat between soft palate and epiglottis non-intranarial airway is **unique to humans makes it possible to choke to death** on aspirated food

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Will show you endoscopy : know your anatomy !

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Fiberoptic Nasopharyngoscopy

- Determines level of obstruction
- Provides behavior of airway collapse
- Technique
 - supine (i.e., in a sleeping position)
 - snore maneuver
 - Jaw thrust maneuver
 - Mueller maneuver- inspire against a closed airway

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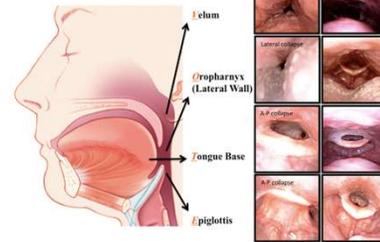
In Office Nasopharyngoscopy



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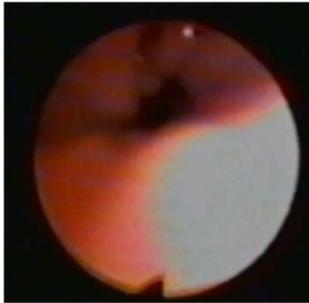
Sites of airway collapse (Drug Induced Sleep Endoscopy)



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Tonsil



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Pharyngeal wall collapse



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Velum



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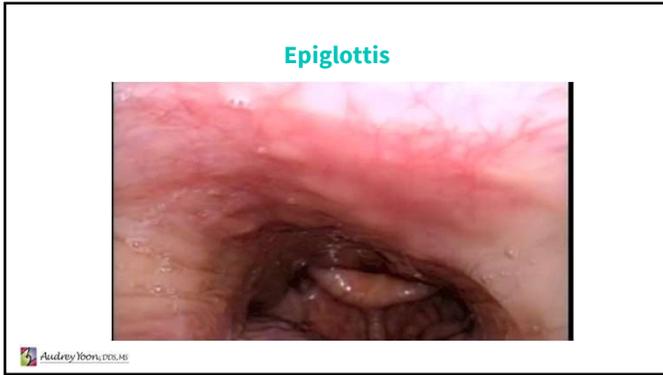
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Tongue Base (AP collapse)



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Case Report
Ankyloglossia in Children, a Cause of Obstructive Sleep Apnoea: Case Report of Paediatric Ankyloglossia and Sleep Apnoea: DISE Resolves the Mystery

Johanna Ximena Valdezama-Penagos ¹, Laura Rodriguez Alcalá ^{1,2}, Guillermo Plaza ^{3,4}, Peter Baptista ^{5,6}, Maria Teresa Garcia Iriarte ⁶, Eduardo J. Correa ⁶ and Carlos O'Connor-Reina ^{1,6*}

¹ Department of Otolaryngology, Hospital Quiron Salud Marbella, Av. Seven Ochos 22, 29630 Marbella, Spain
² Department of Otolaryngology, Hospital Fundación, Universidad Rey Juan Carlos I, 28032 Madrid, Spain
³ Department of Otolaryngology, Clínica Universitaria de Navarra, 31008 Pamplona, Spain
⁴ Department of Otolaryngology, Hospital Universitario Virgen de Valme, 41014 Sevilla, Spain
⁵ Department of Otolaryngology, Hospital La Lanza, 11300 La Lanza de la Concepción, Spain
⁶ Correspondence: carlos.oconnor@quiron.es

Abstract: Tongue mobility is an obstructive sleep apnoea (OSA) marker and myofunctional therapy (MFT) target. For this reason, all paediatric patients with sleep-disordered breathing should require a combined functional assessment from an ear, nose, and throat (ENT) specialist and a phonosociologist to confirm or rule out the presence of ankyloglossia. To our knowledge, this is the first case of a 13-year-old girl diagnosed with severe OSA and a significant decrease of 94% in her apnoea index (AI), requiring treatment with an immediate postoperative change in the tongue position. A drug-induced sleep endoscopy (DISE) was performed before and immediately postoperatively, and the anatomical changes provoked by this surgery during sleep were confirmed for the first time.

Check for updates
Children 2020, 8(12), 183



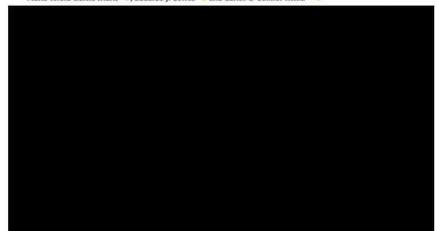
children.com

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Case Report
Ankyloglossia in Children, a Cause of Obstructive Sleep Apnoea: Case Report of Paediatric Ankyloglossia and Sleep Apnoea: DISE Resolves the Mystery

Johanna Ximena Valdezama-Penagos ¹, Laura Rodriguez Alcalá ^{1,2}, Guillermo Plaza ^{3,4}, Peter Baptista ^{5,6}, Maria Teresa Garcia Iriarte ⁶, Eduardo J. Correa ⁶ and Carlos O'Connor-Reina ^{1,6*}



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Open Access Article

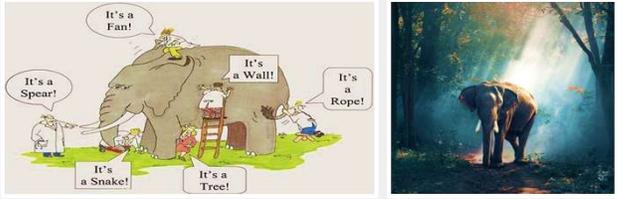
Does Frenotomy Modify Upper Airway Collapse in OSA Adult Patients? Case Report and Systematic Review

by Eduardo J. Correa¹, Carlos O'Connor-Reina¹, Laura Rodriguez-Alcala¹, Felipe Benjumea¹, Juan Carlos Casado-Morente¹, Peter M. Baptista², Manuele Casale², Antonio Moffa² and Guillermo Plaza⁴

* VOTE classification, 2 of 3 patients showed an improvement in their tongue level, from 2A-P (complete anteroposterior collapse) to 1ap (partial anteroposterior collapse). 3rd pt showed no changes

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Sleep Breathing Disorder: Where are we ?



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2018 ADA Policy Dentistry's Role in Sleep Related Breathing Disorders



- **Screen patients** for SRBD as part of a comprehensive medical and dental history
- **Recognize** symptoms such as sleepiness, choking, snoring or witnessed apneas and an evaluation for risk factors such as obesity, retrognathia, or hypertension
- **Refer** as needed to appropriate physicians for proper diagnosis.

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2018 ADA Policy Dentistry's Role in Sleep Related Breathing Disorders



- **In children**, screening through history and clinical examination may identify signs and symptoms of **deficient growth and development**, or other **risk factors** that may lead to **airway issues**. If risk for SRBD is determined, intervention through **medical/dental referral** or evidenced based **treatment may be appropriate** to help treat the SRBD and/or develop and optimal physiologic airway and breathing pattern.

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Policy on Obstructive Sleep Apnea (OSA)

Latest Revision 2021

How to Cite: American Academy of Pediatric Dentistry. Policy on obstructive sleep apnea (OSA). The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2021:13-14.



- AAPD Guideline - Policy Statements
 - **Screen patients** for snoring and sleep-related breathing disorders, OSA
 - Assess the **tonsillar pillar** area for hypertrophy
 - Assess **tongue** positioning
 - Recognize **obesity**
 - **Recognize craniofacial anomalies may be associated with OSA**
 - **Refer** to an appropriate medical provider (ENT, Sleep physician, pulmonologist)
 - **Consider non-surgical intraoral appliances** after a complete orthodontic/craniofacial assessment of the patient's growth and development **as part of a multi-disciplinary approach**

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AAO White Paper: Obstructive Sleep Apnea and Orthodontics

White Paper: Obstructive Sleep Apnea and Orthodontics

XIV. Executive Summary

1. It is strongly recommended that orthodontists be familiar with the signs and symptoms of OSA.
2. It is strongly recommended that orthodontists screen patients with regard to the signs and symptoms of OSA. A thorough history and clinical examination are critically important in that they establish the presence of pre-existing conditions, a basis for diagnosis, the need for referral, and a baseline for evaluating the effects of treatment.
3. It is strongly recommended that the orthodontist refer patients with risk factors for OSA to a physician for further evaluation and a definitive diagnosis. A sleep medicine physician is preferred.
4. It is recommended that the orthodontist refer pediatric patients with nasal obstruction or adenotonsillar hypertrophy to an otolaryngologist.
5. It is recommended that the orthodontist refer adult patients to an otolaryngologist when nasal obstruction or adenotonsillar hypertrophy is present.

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AAO White Paper: Obstructive Sleep Apnea and Orthodontics
 White Paper: Obstructive Sleep Apnea and Orthodontics
XIV. Executive Summary

- The decision for an orthodontist to participate in the treatment of OSA is a choice that should be made based on interest as well as training, skills, experience, laws, standards of care, and insurance coverages applicable to the orthodontist.
- If involved in the treatment of OSA, an orthodontist should monitor oral appliance treatment efficacy.
- An orthodontist may elect to manage adverse side effects of oral appliance therapy.
- No orthodontic treatments have been shown to cause or increase the likelihood of OSA. Rather, some forms of orthodontic treatment have been shown to be important in the treatment of OSA.
- Interdisciplinary treatment of OSA helps to serve the best interests of patients with OSA.



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AAO White Paper Update 2026
 SPECIAL OFFICE AJO-ODO
 Sleep-disordered breathing and orthodontics: An American Association of Orthodontists white paper update

- SDB encompasses a spectrum of breathing abnormalities, ranging from habitual snoring to OSA. SDBs can significantly impact the developing child and adults, and early detection is beneficial. Only a physician can diagnose SDB, and no SDB-related intervention is appropriate before proper diagnosis. Patients with SDB are ideally cared for with an interdisciplinary team.
- Current evidence does not support that any orthodontic intervention, such as maxillary expansion or functional appliances, can prevent the development of SDB. There is no evidence to support the prophylactic use of pediatric palatal expansion as a preventive measure for SDB at any age.
- Current evidence does not support that orthodontic tx is a stand-alone therapy for managing SDB.



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AAO White Paper Update

- No currently known craniofacial phenotypes can identify the presence of SDB.
- Imaging analysis of the upper airway, such as widths, volumes, and areas, using cephalograms or CBCTs, is not suitable for diagnosis, risk assessment, or outcome assessment of intervention in SDB. This finding differs from the 2019 white paper.
- The use of validated questionnaires is an effective method for assessing SDB risk. Once a risk is identified, a referral for a definite diagnosis by a physician is strongly recommended before any intervention.
- Current evidence does not support ankyloglossia as an SDB etiology. Routine frenectomy is not recommended for SDB prevention or treatment.
- Current evidence does not support that traditional orthodontic procedures and mechanics, such as extractions and distalizing mechanics, affect the etiology or increase the likelihood of any SDB.
- It is strongly recommended that the management and treatment of SDBs be an interdisciplinary collaboration between dental and medical health care professionals.



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Evaluation of Current Screening and Treatment Patterns for Pediatric Obstructive Sleep Apnea Among Practicing Pediatric Dentists in the United States: A Pilot Study
 Pediatric Dent 2016 Oct 15;38(5):393-397.

ASKED 6,017 active AAPD members (Pediatric Dentists) : 7 % response rate

RESULTS:

- 43.2% of respondents were uncomfortable or very uncomfortable screening for OSA/SDB
- 61.4% indicated no formal training in OSA/SDB during residency

CONCLUSIONS:

- While awareness of OSA and SDB is high among pediatric dental specialists, educational opportunities are limited, routine screening is not standard, and treatment is not commonly provided.




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The Prevalence of Pediatric Dentists Who Screen for OSA
 Journal of Dental Sleep Medicine 2017;4(1):5-10

RESULTS:

- 70 % of pediatric dentists do some form of screening for OSA
- Young Pediatric dentists (< 5 yrs practice) vs Old Pediatric Dentists (>30 yrs practice) = 82 % vs 60 %
- Western States vs Northeast States = 82 % vs 60 %
- 72 % pediatric dentist report lack of confidence regarding their capability for OSA screening.

CONCLUSIONS:

- The need for pediatric dentists to become more aware of OSA screening.
- The screening tools need to be improved more accurately and confidently.



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Seminars in Orthodontics 31 (2025) 490–503

Contents lists available at ScienceDirect
Seminars in Orthodontics
 Journal homepage:

Screening sleep-disordered breathing (SDB) in the everyday dental office – Pediatric and adult patients

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ARTICLE INFO **ABSTRACT**

Keywords: Sleep-disordered breathing (SDB), Obstructive sleep apnea (OSA), snoring, Sleep questionnaire

ABSTRACT: This paper discusses the growing role of dental professionals in screening for sleep-disordered breathing (SDB) in both pediatric and adult patients. It highlights etiology, risk factors, and clinical signs and symptoms, outlines effective screening methods, and emphasizes the importance of interdisciplinary collaboration in the management of SDB. By providing guidelines tailored to each age group, this paper aims to equip dental practitioners with the tools and knowledge to identify patients at risk for SDB, thereby supporting early intervention and improving patient outcomes.





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How can we Screen Sleep Disordered Breathing ?

History, Questionnaires, examination
are the keys to identifying patient at
risk for SDB

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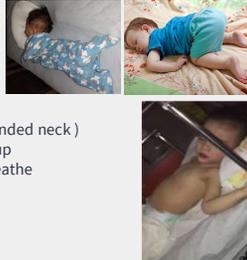
Screening

History	Questionnaires	Examination
<ul style="list-style-type: none"> • Snoring • Mouth breathing • ADHD • Bedwetting • Bruxism 	<ul style="list-style-type: none"> • Pediatric Sleep Questionnaire 	<ul style="list-style-type: none"> • Craniofacial Structure/ Malocclusion/ Tonsils • Wear facets • Speech • Tongue • Posture

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Nighttime Symptoms of Pediatric SDB

- Snoring (> 3 nights/wk), Noisy Breathing
- Breathing Pauses/ Gaspings
- Restless Sleep :toss & turn, position changes
- Paradoxical chest and abdominal motion
- Bruxism
- Sleeping in odd positions (such as hyperextended neck)
in order to open the airway or sleep sitting up
- Night Sweats - indicate increased effort to breathe
- Bed Wetting – Nocturnal Enuresis
- Recurrent Nightmares or night terrors



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Daytime Symptoms of Pediatric SDB

- Sleepiness and Fatigue
- Difficulty to wake up
- Mouth breathing – Dry mouth, inflamed gingiva
- Cognitive and Behavioral Issue— irritability, crankiness, frustration, mood changes, hyperactivity, and difficulty paying attention. ADHD ?
- Learning and Academic Challenges - poorly in school, labeled as “slow” or “lazy”
- Frequent tonsils, adenoids, ear infections, nasal obstruction
- Frequent headaches
- Stunted growth



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Nighttime Symptoms of Adult SDB

- Loud, Chronic Snoring
- Witnessed Apneas
- Gaspings, Choking, or snorting during sleep
- Restless, fragmented Sleep
- Bruxism
- Frequent Nocturia (nighttime urination)

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Daytime Symptoms of Adult SDB

- Excessive daytime sleepiness
- Morning headaches
- Fatigue and low energy
- Poor concentration
- Memory loss, or focus
- Mood changes — irritability, depression, anxiety
- Dry mouth

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Long Term Consequences of SDB

- **Cardiovascular Risks** ❤️
 - Hypertension (often resistant to medications), Atrial fibrillation, arrhythmias
 - Increased risk of myocardial infarction (heart attack)
 - Stroke and transient ischemic attacks (TIAs)
 - Heart failure progression (both systolic and diastolic)
 - Pulmonary hypertension
- **Metabolic & Endocrine Disorders** 🍬
 - Insulin resistance and impaired glucose tolerance, Increased risk of type 2 diabetes
 - Metabolic syndrome (obesity, dyslipidemia, hypertension, insulin resistance)
 - Weight gain and difficulty losing weight (due to hormonal dysregulation: leptin/ghrelin imbalance)

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Long Term Consequences of SDB

- **Neurocognitive & Mental Health** 🧠
 - Impaired memory, learning, and executive function
 - Poor concentration and decreased productivity
 - Depression, anxiety, and irritability
 - Increased risk of dementia and neurodegeneration (Alzheimer's, Parkinson's)
- **Accidents & Safety Risks** 🚗
 - Excessive daytime sleepiness → motor vehicle accidents
 - Higher risk of workplace accidents, reduced vigilance and reaction time
- **Other Systemic Effects** 🩺
 - Increased perioperative risks Association with chronic kidney disease
 - Worsening gastroesophageal reflux disease (GERD)
 - Reduced life expectancy overall

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COMMON SIGNS & SYMPTOMS OF SLEEP DISORDERED BREATHING

CHECK ALL THAT APPLY

<input type="checkbox"/> Teeth Grinding	<input type="checkbox"/> Mouth Breathing	<input type="checkbox"/> Tongue-tie	<input type="checkbox"/> Eye Shiner/ Dark Circle	<input type="checkbox"/> Learning Difficulties	<input type="checkbox"/> Snoring	<input type="checkbox"/> ADD / ADHD
<input type="checkbox"/> Bed Wetting	<input type="checkbox"/> Allergies	<input type="checkbox"/> Asthma	<input type="checkbox"/> Delayed Speech	<input type="checkbox"/> Night Sweats	<input type="checkbox"/> Aggression/ Delinquent Behavior	<input type="checkbox"/> Receding Chin
<input type="checkbox"/> Chronic Fatigue	<input type="checkbox"/> Restless Sleep	<input type="checkbox"/> Nightmares	<input type="checkbox"/> Anxiety Attacks	<input type="checkbox"/> Crooked Bite Crowded Teeth	<input type="checkbox"/> Swollen Tonsils	<input type="checkbox"/> Stunted Growth

Developed by Audrey Yboru, DDS, MS SMILE DESIGN & BEYOND

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★ Pediatric Sleep Questionnaire (PSQ) - Children

	Yes	No	Don't Know
Woke more than half the time?			
Always starts?			
Doesn't finish?			
Doesn't finish at that breathing?			
Doesn't finish breathing or struggle to breathe?			
Does your child stop breathing during the night?			
Does your child...?			
Tend to breathe through the mouth during the day?			
Does a dry mouth on waking up in the morning?			
Chatterbox wet the bed?			
Woke up feeling un-refreshed in the morning?			
Doesn't cooperate with teachers during the day?			
Is it hard to make your child up in the morning?			
Does your child wake up with headaches in the morning?			
Did your child stop growing at a normal rate at any time since birth?			
Is your child overweight?			
Does the child seem to have what is called a "climber"?			
Has difficulty organizing tasks.			
Doesn't seem to be attentive in class.			
Fidgets with hands or feet or squirms in seat.			
Has trouble getting started with school or other activities.			

If eight or more "Yes", consider referring for sleep evaluation

Chervine et al. Pediatric sleep questionnaire: Validity and Reliability of scales for sleep disordered breathing, snoring, sleepiness, and behavioral problems, SLEEP MEDICINE 2009; 12:1-32

70

Pediatric Epworth Sleepiness Scale (ESS- CHAD)

0 = Would never doze or sleep
 1 = Slight chance of dozing or sleeping
 2 = Moderate chance of dozing or sleeping
 3 = High chance of dozing or sleeping

1. Sitting and reading
2. Watching TV
3. Sitting inactive in a public place
4. Being a passenger in a motor vehicle without a break
5. Lying down in the afternoon when circumstances permit
6. Sitting and talking to someone
7. Sitting quietly after lunch
8. Doing homework or taking a test

Total score _____

A total score of 10 or more indicates that your child is sleepy. Please discuss this questionnaire with your child's health care provider.

Audin

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Epworth Sleepiness Scale (ESS)

0 = would never doze or sleep.
 1 = slight chance of dozing or sleeping
 2 = moderate chance of dozing or sleeping
 3 = high chance of dozing or sleeping

Print out this test, fill in your answers and see where you stand.

Situation	Chance of Dozing or Sleeping
Sitting and reading	_____
Watching TV	_____
Sitting inactive in a public place	_____
Being a passenger in a motor vehicle for an hour or more	_____
Lying down in the afternoon	_____
Sitting and talking to someone	_____
Sitting quietly after lunch (no alcohol)	_____
Stopped for a few minutes in traffic while driving	_____

Total score (add the scores up)
 (This is your Epworth score)

• ESS Scores increased with the severity of OSAS
 • A score of > 9 was found to correlate to an RDI of 30
 • Gottlieb, D et al. Am J Respir Crit Care Med. 1999 Feb;159(2):502-7
 • ESS Scores significantly distinguished primary snoring from OSAS
 • Johns, M. Sleep. 1991 Dec; 14(6):540-5

Interpretation
 0-7 : unlikely abnormally sleepy
 8-9 : Average daytime sleepiness
 10-15 : Excessively sleepy, may want to consider seeking medical attention
 16-24 : Excessively sleepy, should consider seeking medical attention

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STOPBANG - Adult

Scoring:	Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	Yes	No
Tiredness or fatigue:	Do you often feel tired, fatigued or sleepy during the daytime – even after a good night's sleep?		
Observed apnoea:	Has anyone ever observed you stop breathing during your sleep?		
Pressure:	Are you being treated for high blood pressure?		
Body mass index over 35:	Height (meters): _____ Weight (kg): _____ BMI: _____		
Age:	Are you older than 50 years?		
Neck size:	Does your neck measure more than 40 cm around? if yes, what is the measurement? _____ cm		
Gender:	Are you male?		

• If you have answered Yes to 3 or more, there is a likelihood of OSA

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Questionnaires

Pediatric Sleep Questionnaire

Parent Name: _____

Child Name: _____

Age: _____

Sex: Male Female

How often do you snore at night? Never Sometimes Often

Does your child ever wake up gasping or choking? No Yes

Does your child ever wake up with a wet mouth? No Yes

Does your child ever wake up with a sore throat? No Yes

Does your child ever wake up with a headache? No Yes

Does your child ever wake up with a dry mouth? No Yes

Does your child ever wake up with a cough? No Yes

Does your child ever wake up with a runny nose? No Yes

Does your child ever wake up with a sore? No Yes

Does your child ever wake up with a fever? No Yes

Does your child ever wake up with a rash? No Yes

Does your child ever wake up with a skin irritation? No Yes

Does your child ever wake up with a sore? No Yes

Does your child ever wake up with a fever? No Yes

Does your child ever wake up with a rash? No Yes

Does your child ever wake up with a skin irritation? No Yes

Nasal Obstruction and Snopliptin Effectiveness Score

Parent Name: _____

Child Name: _____

Age: _____

Sex: Male Female

How often do you snore at night? Never Sometimes Often

Does your child ever wake up gasping or choking? No Yes

Does your child ever wake up with a wet mouth? No Yes

Does your child ever wake up with a sore throat? No Yes

Does your child ever wake up with a headache? No Yes

Does your child ever wake up with a dry mouth? No Yes

Does your child ever wake up with a cough? No Yes

Does your child ever wake up with a runny nose? No Yes

Does your child ever wake up with a sore? No Yes

Does your child ever wake up with a fever? No Yes

Does your child ever wake up with a rash? No Yes

Does your child ever wake up with a skin irritation? No Yes

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Clinical Note / Forms

Clinical Note

Parent Name: _____

Child Name: _____

Age: _____

Sex: Male Female

How often do you snore at night? Never Sometimes Often

Does your child ever wake up gasping or choking? No Yes

Does your child ever wake up with a wet mouth? No Yes

Does your child ever wake up with a sore throat? No Yes

Does your child ever wake up with a headache? No Yes

Does your child ever wake up with a dry mouth? No Yes

Does your child ever wake up with a cough? No Yes

Does your child ever wake up with a runny nose? No Yes

Does your child ever wake up with a sore? No Yes

Does your child ever wake up with a fever? No Yes

Does your child ever wake up with a rash? No Yes

Does your child ever wake up with a skin irritation? No Yes

Assessment

Assessment	ICD
Obstructive Sleep Apnea	J34.0
Obstructive Sleep Apnea	J34.1
Obstructive Sleep Apnea	J34.2
Obstructive Sleep Apnea	J34.3
Obstructive Sleep Apnea	J34.4
Obstructive Sleep Apnea	J34.5
Obstructive Sleep Apnea	J34.6
Obstructive Sleep Apnea	J34.7
Obstructive Sleep Apnea	J34.8
Obstructive Sleep Apnea	J34.9
Obstructive Sleep Apnea	J34.0
Obstructive Sleep Apnea	J34.1
Obstructive Sleep Apnea	J34.2
Obstructive Sleep Apnea	J34.3
Obstructive Sleep Apnea	J34.4
Obstructive Sleep Apnea	J34.5
Obstructive Sleep Apnea	J34.6
Obstructive Sleep Apnea	J34.7
Obstructive Sleep Apnea	J34.8
Obstructive Sleep Apnea	J34.9

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Snoring in kids linked to behavioral problems

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smrv

ELSEVIER

Practice points

1. Sleep disordered breathing in children was associated with deficits across all cognitive domains: intelligence, attention/executive function, memory, language and visual spatial skills.
2. Children with primary snoring experience comparable and sometimes higher levels of cognitive deficits to children with obstructive sleep apnea.
3. Body mass index is a factor that increases poor cognitive outcomes in children with sleep disordered breathing. Hence, weight management may alleviate neurocognitive deficits.

Children with primary snoring has similar or higher level of cognitive deficits to children with OSA

Robust evidence of multiple neurocognitive impairments in children with Primary Snoring

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Snoring in kids linked to behavioral problems

ARTICLE | APRIL 01 2012

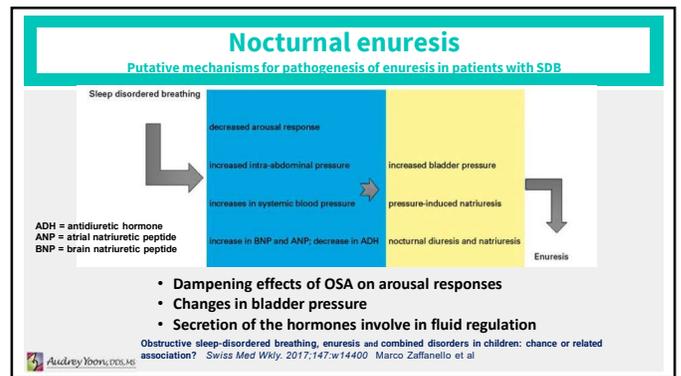
Sleep-Disordered Breathing in a Population-Based Cohort: Behavioral Outcomes at 4 and 7 Years

Karen Bonuck, PhD; Katherine Freeman, DrPH; Ronald D. Chervin, MD; Linzi Xu, PhD

- Longitudinal study with 11,000 children. Effects of sleep-disordered breathing (SDB) symptom trajectories from 6 mo to 7 yrs on subsequent behavior.
- Children with trouble breathing during sleep from 6 mo + were more likely to have behavioral or emotional problems by age 7
- Early-life SDB symptoms had strong, persistent statistical effects on subsequent behavior in childhood. Findings suggest that SDB symptoms may require attention as early as the first year of life.

Volume 129, Issue 4
April 2012

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Attention Deficit Hyperactivity Disorder and SDB

Sleep Medicine Reviews 18 (2014) 349–356

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smr

CLINICAL REVIEW

Attention deficit hyperactivity disorder and sleep disordered breathing in pediatric populations: A meta-analysis

Karim Sedky^{a,*}, David S. Bennett^b, Karen S. Carvalho^b

- ADHD symptoms are related SDB
- ADHD symptoms improve after adenotonsillectomy
- Patient with ADHD symptom should receive SDB screening
- Treatment of SDB should be considered before ADHD medication






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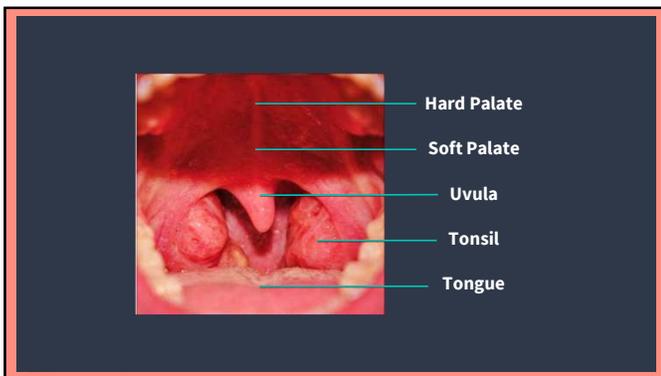
CLINICAL EXAMINATION

- Screener/ Questionnaire
- Mallampati Classification
- Brodsky Tonsil Grading
- Dental Conditions
- Skeletal Conditions
- Tongue / frenulum movement
- Radiography / CBCT

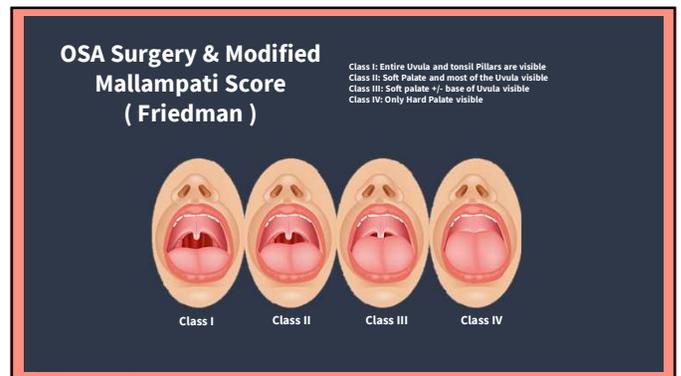
(not mandatory, but invaluable source of information)



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PEDIATRIC DENTISTRY V 43 | NO. 4 | JUL/AUG 21

CROSS-SECTIONAL STUDY

Determinants of Sleep-Disordered Breathing During the Mixed Dentition: Development of a Functional Airway Evaluation Screening Tool (FAIREST-6)

James S. Oh, DDS¹ • Soroush Zaghi, MD¹ • Cynthia Peterson¹ • Clarice S. Law, DMD, MS¹ • Daniela Silva, DDS, MS¹ • Audrey J. Yoon, DDS, MS¹

- The pediatric version of the **Functional Airway Evaluation Screening Tool (FAIREST-15)**
- The mean age :8.86 years (SD=1.88), Total 96 healthy children (46 males and 50 females), age 6-12 yrs old at UCLA Pediatric Dental Clinic, March 2018-March 2019
- Sleep Disturbance Scale for Children (SDSC)** by patient parents.

UCLA Dentistry Pediatric Dentistry

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Determinants of Sleep-Disordered Breathing During the Mixed Dentition : Development of a Functional Airway Evaluation Screening Tool

Pediatric Dentistry V 43 / No. 4 Jul/Aug 21
James Oh, Soroush Zaghi, Cynthia Peterson, Clarice S Law, Daniela Silva, Audrey J Yoon

6 RED FLAGS

Domain	Exam Finding	Clinical Threshold	95% Confidence Interval	P-value
Functional	Mouth breathing	through nose with lips retracted	2.5 – 21.2	p<0.0001
Extraoral	Mentalis strain	characterized as wrinkling of chin upon mouth	1.3 – 83.5	p=0.0086
Intraoral Soft Tissue	Tonsil hypertrophy	Tonsils occupy >50% of oropharynx	3.6 – 76.1	p<0.0001
Intraoral Hard Tissue	Ankyloglossia	measurement <16 mm	1.5 – 8.5	p=0.0029
	Dental wear	deterioration resulting in loss of incisal edge	4.6 – 77.4	p<0.0001
	Narrow palate	defined as intercanine (or intermolar distance) < 24 mm (adult cuspids)	3.2 – 22.6	p<0.0001

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Determinants of Sleep-Disordered Breathing During the Mixed Dentition: Development of a Functional Airway Evaluation Screening Tool

Pediatric Dentistry V 43 / No. 4 Jul/Aug 21
James Oh, Soroush Zaghi, Cynthia Peterson, Clarice S Law, Daniela Silva, Audrey J Yoon

Increased Risk of Sleep-Disturbance by Number of Red-Flags in Pediatric Patients
The score on the FAIREST-6 is equal to # of red-flags items present on the clinical exam.

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FAIREST-6

Six (6) Flags for Pediatric Sleep-Disordered Breathing (SDB)

- 1. MOUTH BREATHING**
through nose with lips retracted
- 2. MENTALIS STRAIN**
characterized as wrinkling of chin upon mouth
- 3. TONSIL HYPERTROPHY**
Tonsils occupy >50% of oropharynx
- 4. ANKYLOGLOSSIA**
measurement <16 mm
- 5. DENTAL WEAR**
deterioration resulting in loss of incisal edge
- 6. NARROW PALATE**
defined as intercanine (or intermolar distance) < 24 mm (adult cuspids)

Supplementary Clinical Classification and References:

- FUNCTIONAL CLASSIFICATION OF ANKYLOGLOSSIA (FAIC-15)**
- TRMR-TIP**
- TRMR-LPS**
- MEASURING MAXILLARY INTERMOLAR DISTANCE**
- ADULT MEASUREMENTS**
22 mm, 22-24 mm, 24-26 mm, 26-28 mm, 28-32 mm
- PEDIATRIC MEASUREMENTS**
Age = 24 mm

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PART III: EP MAGAZINE SLEEP SERIES

CLINICAL SIGNS OF SLEEP-DISORDERED BREATHING IN CHILDREN WITH DISABILITIES

BY DR. AUDREY YOON, DR. LINDA PHI, DR. JOOROK PARK, DR. HEESOO OH, DR. STEVE PERLMAN AND DR. ALLEN WONG

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VOICE FOR INCLUSIVE HEALTH

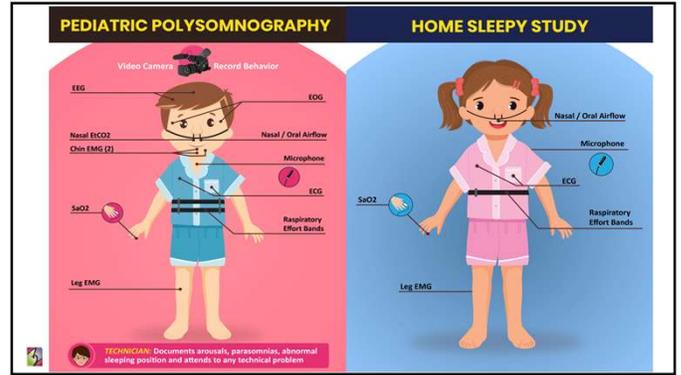
AADMD CONFERENCE ORLANDO 2022

SPECIAL OLYMPICS USA GAMES ORLANDO 2022

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Diagnosis for OSA - Sleep Study

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OSA Classification: Children vs Adult AHI- Apnea Hypopnea Index

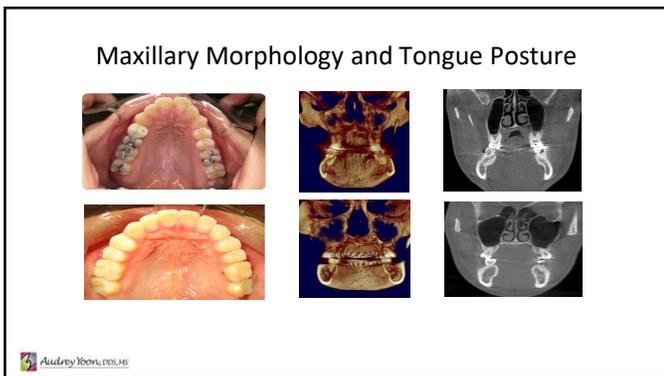
Severity	Children' AHI (Events/hour)	Adults' AHI (Events/hour)
Normal	< 1	< 5
Mild	1-5	5-15
Moderate	5-10	15-30
Severe	> 10	> 30

Audrey Yoon, DDS, MS

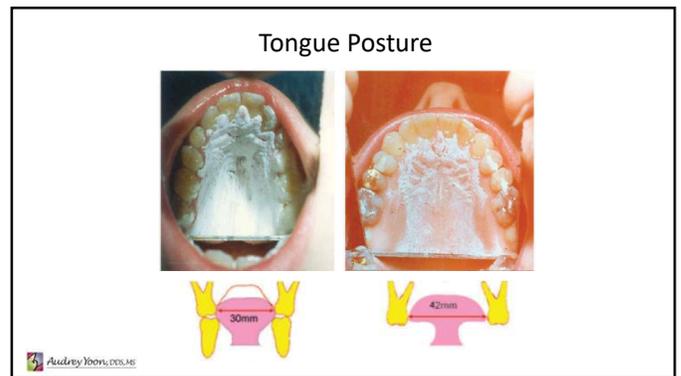
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Understanding Maxillary Morphology and Airway

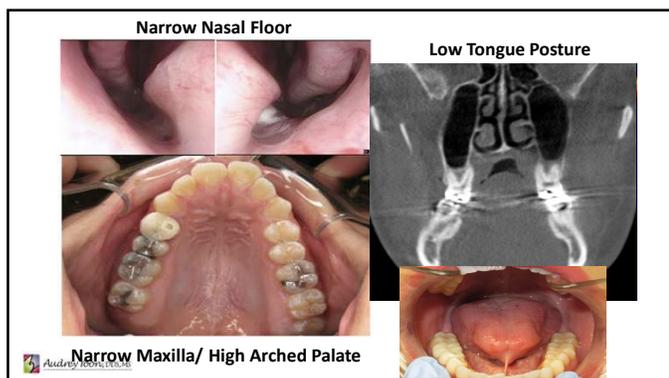
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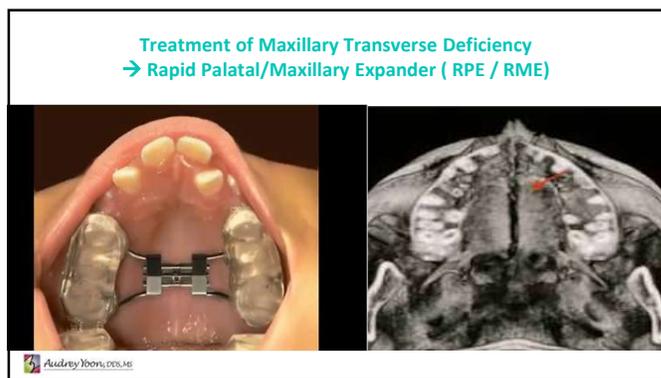
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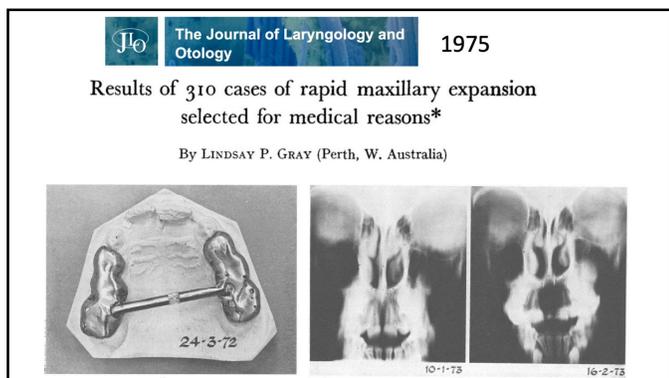
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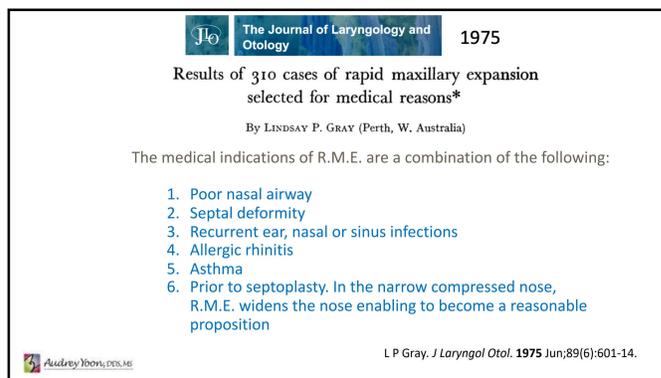
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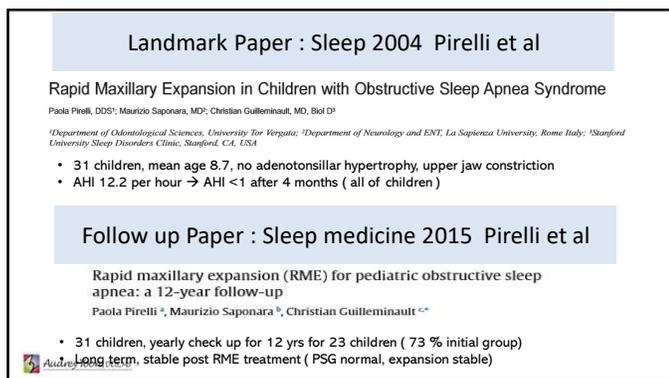
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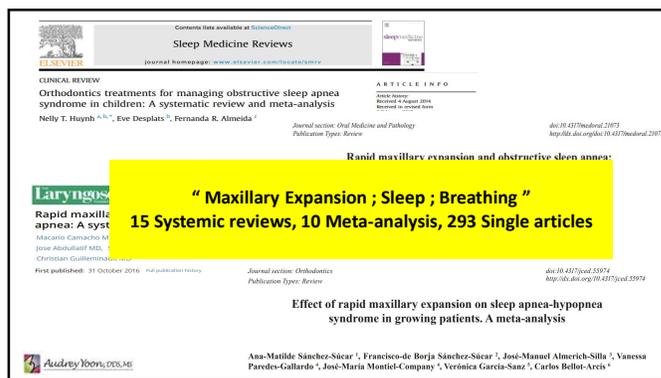
99



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Diagnosis and Orthodontic Treatment of Obstructive Sleep Apnea Syndrome Children—A Systematic Review

Conclusions: **An early orthodontic intervention may be effective in the management of pediatric OSAs.** Children with maxillary contraction and dental malocclusion have excellent results.

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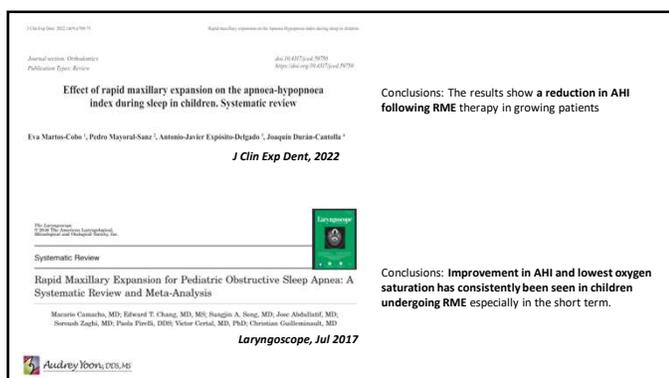
Effect of orthopedic and functional orthodontic treatment in children with obstructive sleep apnea: A systematic review and meta-analysis

Conclusions: **MAA with RME or RME with AT (not RME alone) may be associated with benefits for pediatric patients with OSA.**

Practice Points:

1. **Growing patients with obstructive sleep apnoea should perform regular consultation with an orthodontic specialist**
2. **In growing patients with constricted maxilla and obstructive sleep apnoea, rapid maxillary expansion may provide positive short-term effects on polysomnographic outcomes**
3. **No indications regarding orthodontic treatment to manage obstructive sleep apnoea in absence of malocclusion can be drawn**

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Effect of rapid maxillary expansion on the apnoea-hypopnoea index during sleep in children. Systematic review

Conclusions: **The results show a reduction in AHI following RME therapy in growing patients**

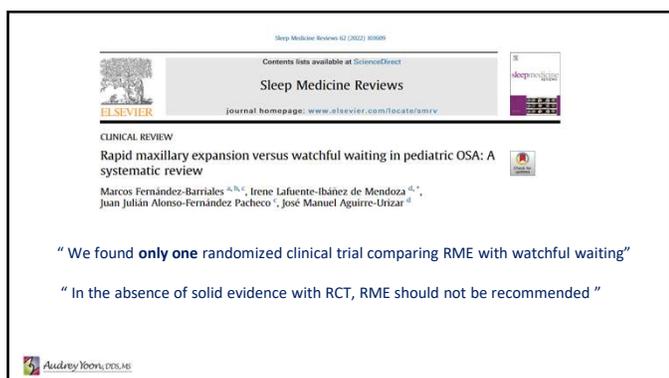
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Efficiency of Rapid Maxillary Expansion in the Treatment of Obstructive Sleep Apnoea Syndrome: A Systematic Review With Meta-analysis

Conclusions: **Increasingly the evidence indicates that RME devices reduce AHI in children with OSAs, making RME therapy an appropriate alternative treatment option for these patients.**

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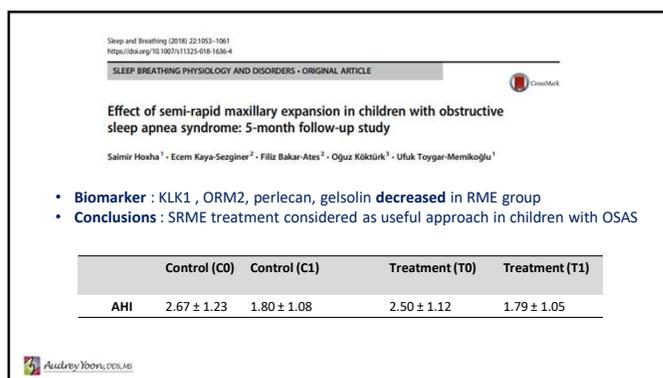
Rapid maxillary expansion versus watchful waiting in pediatric OSA: A systematic review

Conclusions: **Improvement in AHI and lowest oxygen saturation has consistently been seen in children undergoing RME especially in the short term.**

“We found **only one** randomized clinical trial comparing RME with watchful waiting”

“In the absence of solid evidence with RCT, RME should not be recommended”

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Effect of semi-rapid maxillary expansion in children with obstructive sleep apnea syndrome: 5-month follow-up study

Conclusions: **Biomarker : KLK1, ORM2, perlecan, gelsolin decreased in RME group**

Conclusions : **SRME treatment considered as useful approach in children with OSAs**

	Control (C0)	Control (C1)	Treatment (T0)	Treatment (T1)
AHI	2.67 ± 1.23	1.80 ± 1.08	2.50 ± 1.12	1.79 ± 1.05

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Sleep and Breathing (2016) 22:1003-1061
 https://doi.org/10.1007/s11325-016-1636-4

SLEEP BREATHING PHYSIOLOGY AND DISORDERS - ORIGINAL ARTICLE

Effect of semi-rapid maxillary expansion in children with obstructive sleep apnea syndrome: 5-month follow-up study

Saimir Hashta¹, Esem Kayo-Sezginer², Filiz Bakar-Ates², Oğuz Kikilirik³, Uluk Toygar-Memikoglu¹



ApneaLink portable device : Not Appropriate for Children



RPE for teens with OSA (Mean age: 12.27 ± 1.93) Less Effective than MARPE

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International Journal of Pediatric Otorhinolaryngology 171 (2020) 111633

Contents lists available at ScienceDirect
International Journal of Pediatric Otorhinolaryngology
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 journal homepage: www.elsevier.com/locate/ijporl

Rapid maxillary expansion and its consequences on the nasal and oropharyngeal anatomy and breathing function of children and adolescents: An umbrella review[®]

Arturo Garrocho-Rangel, Miguel Ángel Rosales-Berber, Adriana Ballesteros-Torres, Zaira Hernández-Rubio, Joselin Flores-Velázquez, Esthela Yáñez-González, Socorro Ruiz-Rodríguez, Amaury Pozos-Guillén

Pediatric Dentistry Postgraduate Program, Faculty of Dentistry, University of San Luis Potosí, Mexico

- 11 systematic reviews (5 meta-analysis, 132 single studies) was reviewed
- Conclusion**: Significant and Stable increases in the nasal and oropharyngeal space volumes and a decrease in airway resistance of growing children and adolescents, occur immediately after RME and at 3, 6 and 12 month follow-up

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Journal of Clinical Medicine

Systematic Review

The Role of Rapid Maxillary Expansion in the Management of Obstructive Sleep Apnoea: Monitoring Respiratory Parameters—A Systematic Review and Meta-Analysis

Aniruddh Hariharan¹, Susana Muwaquet Rodriguez² and Tawfiq Hijazi Alsadi^{3,*}

Conclusions:
 The systematic review and meta-analysis provided sufficient significant data in favor of the alternative hypothesis to indicate that RME is an effective treatment option in the management of obstructive sleep apnoea, in terms of the AHI reduction and SpO₂ increase.

Hijazi, T. et al. (2025). *Journal of Clinical Medicine*, 14(1), 20.

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Ask AI

Maxillary Expansion improve Sleep and Breathing?

Please based on only peer-reviewed journal, highest evidences

Consensus AI

Maxillary expansion improve sleep and breathing

56 Pro 1 month 28 Sources

Yes, maxillary expansion (especially rapid maxillary expansion, RME) can improve sleep and breathing in children and selected adults with maxillary constriction and sleep-disordered breathing.

Does maxillary expansion improve sleep and breathing?

Results	Recency	Methods	Journals	Citations
<ul style="list-style-type: none"> Yes 78% <input checked="" type="checkbox"/> <input type="checkbox"/> 16 papers — Multiple RCTs, meta-analyses, and large cohort studies in high impact journals consistently show significant improvements in sleep and breathing, especially in children. 	2019 avg.	5 for one studies	Q1:57 avg.	737 total
<ul style="list-style-type: none"> Probably 17% <input type="checkbox"/> <input checked="" type="checkbox"/> 7 papers — Systematic reviews and case-control studies suggest potential benefits but highlight limited sample sizes, short-term follow-up, or variable evidence quality. 	2020 avg.	2 for one studies	Q1:67 avg.	100 total
<ul style="list-style-type: none"> Mixed 0% <input type="checkbox"/> <input type="checkbox"/> 1 paper — A small-sized cohort study found nasal airway improvements in most but not all patients, indicating inconsistent individual outcomes. 	1987 avg.	0 for one studies	Q1: avg.	164 total
<ul style="list-style-type: none"> No 0% <input type="checkbox"/> <input type="checkbox"/> 	—	—	—	—

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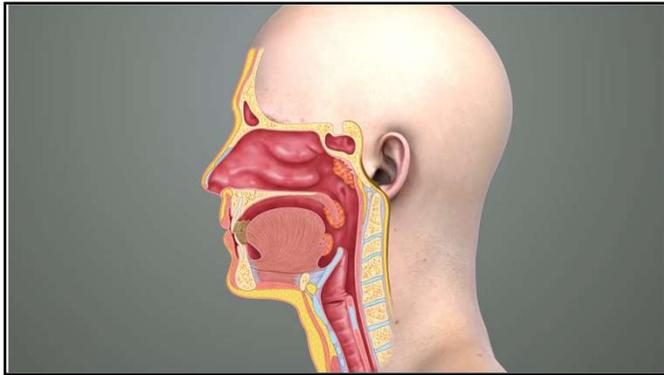
Pediatric SDB : What is Missing link ?

- Too much attention on AHI for treatment decision
 - **AHI not is perfect metric**
- Multiple Factors playing role at the same time
 - Anatomical, physiological, behavioral
- Poor Phenotyping and understanding all factors involved
- Offering similar treatment to all
 - One size fits all
 - Trial and Error method
 - RPE as an only standalone treatment

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How Does Palatal Expansion Improve Sleep Disordered Breathing ?

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How Does Palatal Expansions IMPROVE OSA?

1 . Nasopharynx

- : Expand nasal cavity
- Decrease resistance to airflow through the nose
- Improve nasal breathing

(Deeb et al. Am J Orthod Dentofacial Orthop 2010)
(Zeng et al. Sleep 2008)

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How Does Palatal Expansions IMPROVE OSA?

1 . Nasopharynx

- : Expand nasal cavity
- Expand nasal cavity volume
- Expand nasal floor
- Decrease resistance to airflow through the nose
- Improve nasal breathing

(Deeb et al. Am J Orthod Dentofacial Orthop 2010)
(Zeng et al. Sleep 2008)

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Internal Nasal Valve

The narrowest part of the nasal passageway
It represents 50% of the total airflow resistance

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SLEEP
Breathing

International Journal of the Science and Practice of Sleep Medicine

Sleep and Breathing
<https://doi.org/10.1007/s11325-020-02140-y>

ENT • ORIGINAL ARTICLE

Impact of rapid palatal expansion on the internal nasal valve and obstructive nasal symptoms in children

Audrey Yoon^{1,2} · Mohamed Abdelwahab^{3,4} · Stanley Liu³ · James Oh¹ · Heeyeon Suh² · Michael Trieu⁵ · Kevin Kang⁵ · Daniela Silva¹

Received: 23 March 2020 / Revised: 15 June 2020 / Accepted: 24 June 2020
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Otolaryngology—
Head and Neck Surgery

Original Research

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DOI: 10.1177/014599819842808
http://otojournal.org
SAGE

**Impact of Distraction Osteogenesis
Maxillary Expansion on the Internal Nasal
Valve in Obstructive Sleep Apnea**

Mohamed Abdelwahab, MD^{1,2}, Audrey Yoon, DDS, MS³,
Tyler Okland, MD¹, Sasikarn Poomkonsarn, MD^{1,4},
Chris Gouveia, MD^{1,3}, and Stanley Yung-Chuan Liu, MD, DDS¹

Audrey Yoon, DDS, MS

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How Does Palatal Expansions IMPROVE OSA?

2. Oral Cavity : Expand oral cavity
→ Create more tongue spaces (esp. roof of the mouth)
→ Pull Palatal muscles to tighten soft palate
(Nasopharynx)

Audrey Yoon, DDS, MS

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How Does Palatal Expansions IMPROVE OSA?

2. Oral Cavity : Expand oral cavity
→ Create more tongue spaces
(esp. roof of the mouth)
→ Improve tongue posture

Am J Orthod Dentofacial Orthop. 2013 Feb;143(2):235-45. doi: 10.1016/j.ajodo.2012.09.014.
Tongue posture improvement and pharyngeal airway enlargement as secondary effects of rapid maxillary expansion: a cone-beam computed tomography study.
Iwasaki T¹, Saitoh J, Takemoto Y, Inada E, Kahano E, Kanomi H, Hirasaki H, Yamasaki Y

Audrey Yoon, DDS, MS

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How Does Palatal Expansions IMPROVE OSA?

2. Oral Cavity : Expand oral cavity
→ Improve tongue posture (Advance and raise the tongue into the oral cavity) →
Expand posterior airway space

Am J Orthod Dentofacial Orthop. 2013 Feb;143(2):235-45. doi: 10.1016/j.ajodo.2012.09.014.
Tongue posture improvement and pharyngeal airway enlargement as secondary effects of rapid maxillary expansion: a cone-beam computed tomography study.
Iwasaki T¹, Saitoh J, Takemoto Y, Inada E, Kahano E, Kanomi H, Hirasaki H, Yamasaki Y

Fig 7. Improvement of low tongue posture and enlargement of the pharyngeal airway after RME in a patient: **A**, before RME, tongue posture is low (red arrow), and the oropharyngeal airway is narrow; **B**, after RME, tongue posture has improved (yellow arrow), and the pharyngeal airway has enlarged (blue arrows).

Audrey Yoon, DDS, MS

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How Does Palatal Expansions IMPROVE OSA?

2. Oral Cavity : Expand oral cavity
→ Improve tongue posture (Advance and raise the tongue into the oral cavity) →
Expand posterior airway space

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How Does Palatal Expansions IMPROVE OSA?

3. Pharynx (Collapsibility)

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RME not always changing pharyngeal volume ?

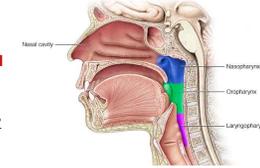
REVIEW ARTICLE | JDSM | <https://doi.org/10.1013/jds.2023.1154>

Rapid Maxillary Expansion Effects on the Upper Airway Dimensions and Function in Growing Patients: An Umbrella Review

Silvia Gianoni-Capenetas, DDS, MSc¹; Karla Carpio Horst, DDS, MSc, PhD¹; Carlos Flores-Mir, DDS, MSc, DSc, FRCD(C)¹; Manuel G. Laguarda, DDS, MSc, PhD, FRCD(C)¹; Camilla Pacheco-Pereira, PhD, MSc, MEd^{1,2}

Conclusions:

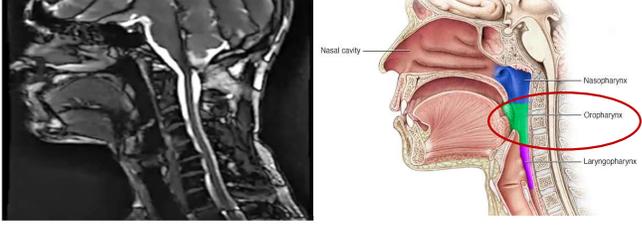
- The methodologic inconsistencies and disagreements especially on the **oropharyngeal dimensional changes after RME** lead to significant **uncertainties about the consistency of the effect of RME changes, especially on the oropharynx region dimensions.**



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Oropharynx Volume Measurement is not a good metric to determine the success



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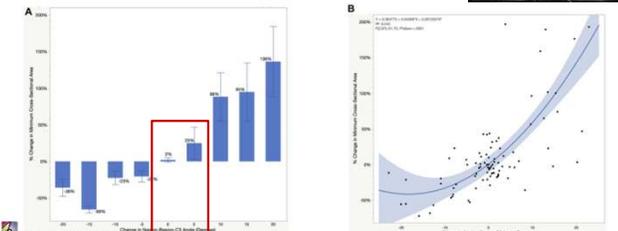
128

CRANIOMAXILLOFACIAL DEFORMITIES / SLEEPDISORDERS / COSMETIC SUR

Does Head and Neck Posture Affect Cone-Beam Computed Tomography Assessment of the Upper Airway?

Kerim Coppelson, MD, DDS,¹ Isabella Summersgill, BS,¹ David Hatchet, DDS, MSc,^{1,2,3} Gloria Nguyen, BS,¹ Hilary Patis, DMD,¹ Hal Stewart, DDS,¹ Tim Herre, DDS,¹ Michael Hamers, DDS,¹ and Steven Anshel, MD¹

J Oral Maxillofac Surg :1-13, 2023



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PROTOCOL FOR CBCT SCANS

- Natural head position.
- Horizontal visual axis.
- Close mouth, breathe through nose, place teeth together.
- Swallow once, then rest your tongue where it naturally goes.
- Avoid bite-registration and avoid reaching for chin rest.



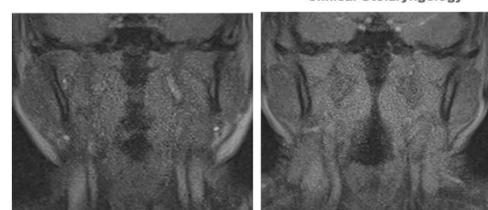
Coppelson at al, *J Oral Maxillofac Surg* :1-13, 2023

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Static Craniofacial Measurements and Dynamic Airway Collapse Patterns Associated with Severe Obstructive Sleep Apnea: A Sleep MRI Study

Stanley Yung-Chuan Liu MD, DDS^{1,2,4}; Leh-Kiong Huon MD^{2,3,4,9}; Men-Tzung Lo PhD^{5,10}; Yi-Chung Chang MS³; Robson Capasso MD¹; Yunn-Jy Chen DDS PhD⁶; Tiffany Ting-Fang Shih MD, PhD⁷; Pa-Chun Wang MD, MSc, MBA^{3,4,5,10}

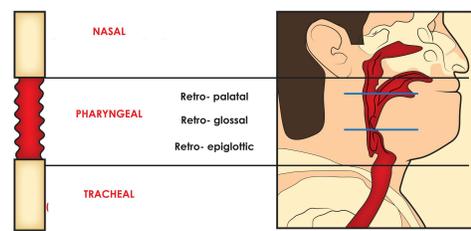
Clinical Otolaryngology



Slide credit: Stanley Liu MD, DDS

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Anatomic Basis



NASAL

PHARYNGEAL

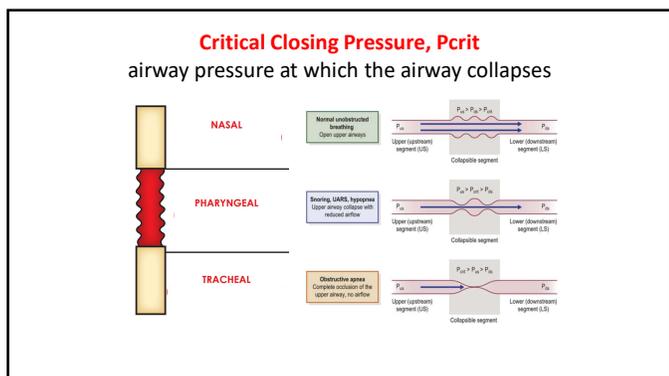
TRACHEAL

Retro- palatal

Retro- glossal

Retro- epiglottic

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Sleep and Breathing
<https://doi.org/10.1007/s11325-019-01948-7>

ENT - ORIGINAL ARTICLE

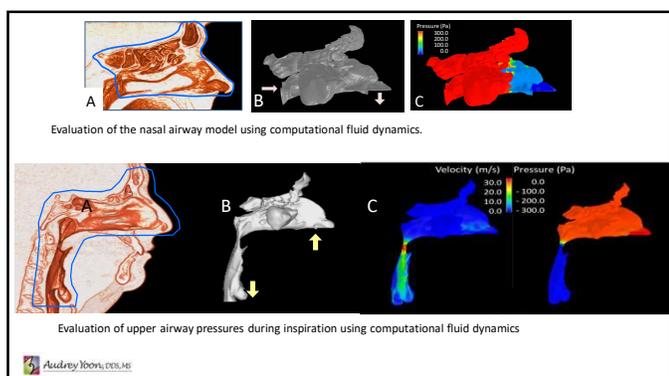
Check for updates

How does distraction osteogenesis maxillary expansion (DOME) reduce severity of obstructive sleep apnea?

Tomonori Iwasaki¹ · Audrey Yoon² · Christian Guilleminault³ · Youichi Yamasaki¹ · Stanley Yung Liu⁴

Received: 27 December 2018 / Revised: 30 August 2019 / Accepted: 18 September 2019
 © Springer Nature Switzerland AG 2019

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Table 1. Comparisons of PSG Parameters, intermaxillary molar width, nasal width, pharyngeal airway volume, intraoral airway volume and nasal airway model resistance before DOME and after DOME

	Before DOME			After DOME			Treatment change			P			
	mean	SD	95% CI	mean	SD	95% CI	mean	SD	95% CI				
AHI (events/hr)	17.81	17.56	9.59	26.02	7.82	7.11	4.49	11.14	-9.99	13.65	-16.38	-3.60	< 0.001
ODI (events/hr)	9.67	15.84	2.25	17.08	4.82	5.88	2.16	7.67	-4.75	11.91	-10.32	0.82	0.011
AI (events/hr)	5.30	17.53	-2.91	13.50	0.78	2.34	-0.32	1.87	-4.52	15.20	-11.64	2.60	0.012
LOS (%)	88.15	7.21	84.78	91.52	90.90	4.23	88.92	92.88	2.75	5.53	0.16	5.34	0.036
Intermaxillary molar width (mm)	34.97	3.53	33.32	36.63	42.24	3.28	40.70	43.78	7.27	2.45	6.12	8.41	< 0.001
Nasal width (mm)	22.41	2.34	21.31	23.51	26.68	2.33	25.59	27.77	4.27	1.46	3.59	4.96	< 0.001
Pharyngeal airway volume (cm ³)	16.00	5.57	13.39	18.00	16.20	6.19	15.30	21.10	2.21	3.50	0.37	3.84	0.011
Intraoral airway volume (cm ³)	2.41	4.54	0.29	4.53	1.08	3.08	-0.36	2.52	-1.33	2.64	-2.57	-0.09	0.036
Nasal airway model resistance (Pa/cm ³ /s)	0.53	0.38	0.35	0.71	0.16	0.10	0.12	0.21	-0.37	0.35	-0.53	-0.20	< 0.001

DOME, distraction osteogenesis maxillary expansion; AHI, apnea-hypopnea index; ODI, oxygen desaturation index; AI, apnea index; LOS, lowest oxygen saturation; 95% CI, 95% confidential interval.

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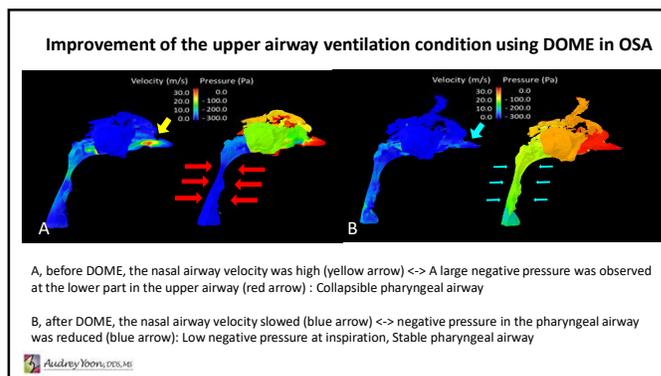
Table 4. Correlation between sleep data and upper airway ventilation condition before DOME, after DOME, and treatment change

	Pre DOME			Post DOME			Treatment change					
	AHI	ODI	AI	AHI	ODI	AI	AHI	ODI	AI	LOS		
nasal velocity (m/s)	r _s .665	.416	.496	-.336	.373	.333	.525	-.355	.479	.661	.284	-.368
P	.001**	.068	.026*	.147	.105	.152	.017*	.125	.033*	.002**	.225	.110
nasal pressure (Pa)	r _s -.373	-.371	-.413	.380	-.452	-.417	-.443	.431	-.437	-.535	-.478	-.428
P	.002**	.108	.071	.098	.045*	.067	.050	.058	.054	.003**	.033*	.060
RA velocity (m/s)	r _s .570	.330	.195	-.140	-.019	.081	-.031	-.073	.360	.308	.420	.048
P	.008*	.155	.411	.505	.936	.734	.888	.760	.119	.187	.065	.840
RA pressure (Pa)	r _s -.700	-.519	-.440	.429	-.501	-.482	-.454	.499	-.465	-.725	-.440	.506
P	.001**	.019*	.052	.059	.024*	.031*	.045*	.025*	.039*	.000**	.052	.023*
OA velocity (m/s)	r _s .485	.340	.093	-.372	.216	.020	.012	.067	-.365	.423	.368	-.360
P	.030*	.142	.896	.107	.361	.934	.959	.776	-.114	.063	.110	.119
OA pressure (Pa)	r _s -.678	-.498	-.412	.398	-.533	-.515	-.466	.514	-.425	-.688	-.370	.511
P	.001**	.025*	.071	.082	.015*	.020*	.038*	.020*	.062	.001**	.109	.021*
HA velocity (m/s)	r _s .313	.146	-.060	-.176	.370	.146	.178	-.080	-.158	-.265	-.121	-.204
P	.178	.540	.800	.458	.108	.538	.453	.737	.505	.259	.612	.389
HA pressure (Pa)	r _s -.714	-.510	-.459	.400	-.594	-.568	-.581	.556	-.419	-.638	-.376	.491
P	.001**	.022*	.042*	.081	.006**	.007**	.011*	.066	.002**	.102	.023*	.023*
nasal width (mm)	r _s -.126	.025	-.064	-.126	-.179	-.192	-.205	-.008	-.399	-.091	-.069	-.041
P	.597	.918	.787	.595	.450	.418	.384	.972	.082	.702	.677	.864
Intermaxillary first molar width (mm)	r _s .072	.179	-.216	-.383	.035	.042	-.218	-.158	-.002	.100	-.005	-.368
P	.762	.450	.360	.095	.885	.859	.356	.506	.995	.674	.983	.110

DOME, distraction osteogenesis maxillary expansion; RA, retropalatal airway; OA, oropharyngeal airway; HA, hypopharyngeal airway; AHI, apnea-hypopnea index; ODI, oxygen desaturation index; AI, apnea index; LOS, lowest oxygen saturation; **, Statistically significant at P < 0.01; *, Statistically significant at P < 0.05.

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DOME changes Airway Collapsibility (Pcrit)

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How Does Palatal Expansions IMPROVE OSA?

3. Pharynx (Collapsibility)

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How Does Palatal Expansions IMPROVE OSA?

4. Tonsils and Adenoids

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CHAT study

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Adenotonsillectomy for Childhood Sleep Apnea
N Eng J Med 2013

5 yrs old Snoring Restless Sleep Tonsil : Grade 3 Adenoid : 60 % occluded

- If Watchful waiting ->
 - 46%: normalization of the PSG
 - No improvement of symptoms (PSQ changes : 0)
 - 35 % : worsening of OSA
- If Early adenotonsillectomy->
 - 79%: normalization of the PSG
 - Symptoms, 2ndary Behavior, quality of life and PSG findings : **improvement**

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Research JAMA Pediatr. Published online March 17, 2025.

JAMA Pediatrics | Original Investigation

Adenotonsillectomy and Health Care Utilization in Children With Snoring and Mild Sleep Apnea

A Randomized Clinical Trial

Jessie P. Bakker, MS, PhD; Fang Zhang, PhD; Raouf Amin, MD; Cristina M. Baldassari, MD; Ronald D. Chervin, MS, MD; Susan L. Garetz, MD; Fauziya Hassan, MD; Sally Ibrahim, MD; Stacey L. Ishman, MD; Erin M. Kirkham, MD, MPH; Ariel Linden, DPH; Ron B. Mitchell, MD; Kamal Naqvi, MD; Carol L. Rosen, MD; Kristie Ross, MD; Ignacio E. Tapia, MD; Lisa R. Young, MD; Phoebe K. Yu, MD, MS; Susan Redline, MD, MPH; Rui Wang, PhD

•The study, which included 459 children, showed a 32% reduction in total health care encounters and a 48% reduction in prescriptions after adenotonsillectomy.

CONCLUSIONS AND RELEVANCE
This study found that adenotonsillectomy was associated with reduced all-cause HCU in children with mild SDB, supporting early intervention for children with mild SDB.

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Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision 2024

5 yrs old Pacifier until 3 yr -> lower lip sucking habit

Snoring Restless Sleep Narrow high arch palate Overjet : 9 mm Class II div 1 Adenoid : Tonsil : Grade 3 Adenoid : 60 % occluded ENT referral

- Primary dentition stage: Habits and crossbites should be diagnosed and **if predicted not likely to be self correcting, they should be addressed as early as feasible** to facilitate normal occlusal relationships.

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5 yrs old
Pacifier until 3 yr ->
lower lip sucking
habit

Sleeping
Restless Sleep
Narrow high arch
palate
Overjet : 9 mm
Class II div 1
Adenoid :
Tonsil : Grade 3
Adenoid : 60 %
occluded

ENT referral

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision
2021

• **Treatment Consideration : * Primary dentition stage**

- a. all anomalies of tooth number and size
- b. **anterior and posterior crossbites**
- c. **presence of habits** along with their dental and skeletal sequelae
- d. **openbite**
- e. **airway problems.**

Audrey Yoon^a, DDS, MS

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Sleep Medicine
Volume 92, April 2022, Pages 96-102

Original Article

Impact of rapid palatal expansion on the size of adenoids and tonsils in children

Audrey Yoon^a, Mohamed Abdelwahab^b, Rebecca Bockow^c, Ava Vakili^d, Katherine Lovell^d, Inwon Chang^e, Rumpa Ganguly^f, Stanley Liu^g, Clete Kushida^h, Christine Hong^{g, h}

Audrey Yoon^a, DDS, MS

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Sleep Medicine
Volume 92, April 2022, Pages 96-102

Original Article

Impact of rapid palatal expansion on the size of adenoids and tonsils in children

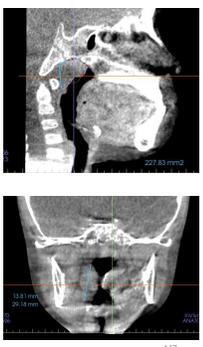
Audrey Yoon^a, Mohamed Abdelwahab^b, Rebecca Bockow^c, Ava Vakili^d, Katherine Lovell^d, Inwon Chang^e, Rumpa Ganguly^f, Stanley Liu^g, Clete Kushida^h, Christine Hong^{g, h}

Objectives

- To compare the size of adenoid and palatine tonsils with RPE using 3D volumetric analysis

Materials and Methods

- Total 60 pts: 40 RPE vs 20 Control
- Mean ages: 9.79 yrs old, range 5-15, 32 females, 28 males
- RPE was necessary orthodontically & Enlarged tonsils and Adenoids



Audrey Yoon^a, DDS, MS

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Sleep Medicine
Volume 92, April 2022, Pages 96-102

Original Article

Impact of rapid palatal expansion on the size of adenoids and tonsils in children

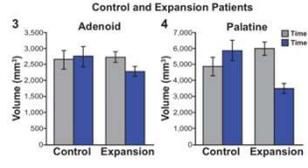
Audrey Yoon^a, Mohamed Abdelwahab^b, Rebecca Bockow^c, Ava Vakili^d, Katherine Lovell^d, Inwon Chang^e, Rumpa Ganguly^f, Stanley Liu^g, Clete Kushida^h, Christine Hong^{g, h}

Results

- RPE group: 97.5 % of pt tonsil shrinkage, 90% of pt adenoid reduction
- Average volume reduction : Adenoids 16.8 % & Tonsils 38.5%

Conclusion

- RPE significantly reduced the size of adenoid and tonsils
- **another long-term benefit of RPE**



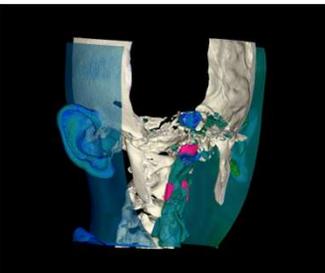
Group	Time 1 Volume (mm³)	Time 2 Volume (mm³)
Adenoid Control	~2500	~2200
Adenoid Expansion	~2500	~2200
Palatine Control	~5500	~4500
Palatine Expansion	~5500	~4500

Audrey Yoon^a, DDS, MS

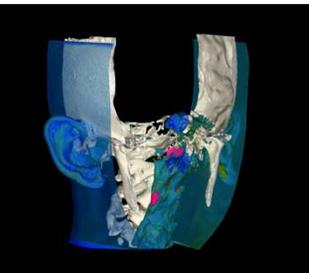
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Videos (Auto-play)

Before RPE



After RPE



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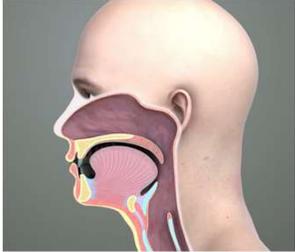
How does palatal expansion shrink the size of tonsils and adenoids?

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How Does Palatal Expansions shrink tonsils?

Less Irritation of lymphoid Tissue
Increase Nasal Volume
 (esp. internal nasal valve area)

- Decrease resistance to airflow through the nose
- Decrease Air Velocity & Decrease Air resistance &
- Lower Inspiratory Pressure & Improve collapsibility
- **Improving the irritation of lymphoid tissue**



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How Does Palatal Expansions shrink tonsils?

Nitric oxide (NO)

- One of the most important signal molecules in the body : selectively mediating cell signaling
- Involved in virtually every organ
- Keep blood vessels flexible
- Encourage vasodilation
- Lower blood pressure
- Improve mood & cognition
- **Support immune system *****
- **Defends against pathogens *****



The Nobel Prize in Physiology or Medicine 1998



The Nobel Prize in Physiology or Medicine 1998 was awarded jointly to Robert F. Foytgate, Louis J. Ignarro and Ferid Murad "for their discoveries concerning nitric oxide as a signalling molecule in the cardiovascular system".

Photo: Copyright © The Nobel Foundation

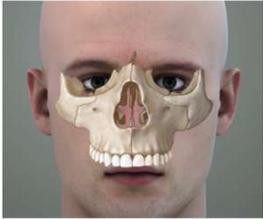
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How Does Palatal Expansions shrink tonsils?

Nitric oxide (NO)

- A strong neurotransmitter that increases ventilation-perfusion ratio
- **Produced in the nose and the paranasal sinuses**
- Plays a role in maintaining upper airway dilator muscles tone, regulation of spontaneous respiration, and neuromuscular control during sleep.
- **Helps in boosting immunity & rids of bacteria in airborne particles**



Haight JS, Djupesland PG. Nitric oxide (NO) and obstructive sleep apnea (OSA). *Sleep Breath.* Jun 2003

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How Does Palatal Expansions shrink tonsils?

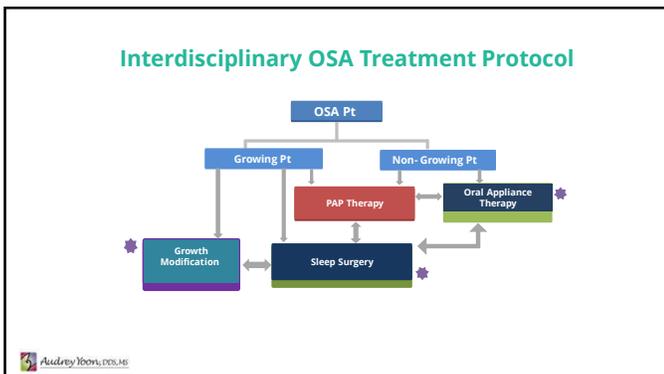
Nasal Breathing Restoration

- Nasal Breathing Restoration reverse the hypertrophic response of tonsils to antigen
- Reduce inflammation and irritation of lymphoid tissues



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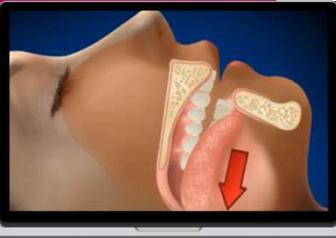
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Emerging Trends in Dental Sleep Medicine

- Smart Oral appliances
 - new emerging technologies
 - first-line alternatives to CPAP
- Craniofacial growth modification in children
- Anatomical airway Imaging for screening, diagnosis & monitoring
- Adult Nasomaxillary expansion
 - Non-Surgical Approach

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Oral Appliances



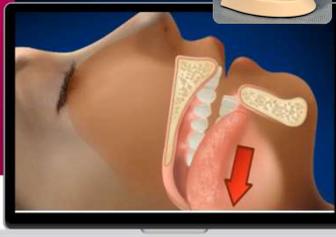
Oral appliances are **custom-made** mouthpieces intended to pull the jaw forward during sleep to help open upper airway.



Audrey Ibony, DDS, MS

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Oral Appliances



Good **alternative** to CPAP

- Primary snoring
- Mild to moderate OSA
- Severe OSA in case of CPAP intolerance

The American Academy of Sleep Medicine (1995)

↓

An effective **first-line** treatment

- Primary Snoring
- Mild to moderate OSA

The American Academy of Sleep Medicine (2006)

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Oral Appliances for Severe OSA



ProSomnus Severe OSA Study
Site Introduction/Training

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Research Reports: Clinical

Mandibular Advancement Device versus CPAP in Severe Obstructive Sleep Apnea

Journal of Dental Research
1-8
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DOI: 10.1177/00220345251361796
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J.T. Colpani¹, Y.-H. Ou², A.M. Kosasih², F.K.F. Lee¹, S.-P. Chan³, H.H. Tan¹, R.C.W. Wong⁴, C.W. Chin⁵, P.A. Cistulli^{6,7}, and C.-H. Lee^{2,7}

Randomized Trial 144 Severe OSA with hypertension
Comparing the effectiveness and adherence of mandibular advancement devices and CPAP

Audrey Ibony, DDS, MS

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Study Design



vs



- Randomized trial (CRESCENT substudy)
144 severe OSA patients (AHI ≥ 30) were enrolled
- Randomized to MAD (n=73) vs CPAP (n=71)
Patients were randomly assigned to MAD or CPAP treatment groups
- 12-month follow-up
Patients were followed for 12 months after treatment assignment
- Primary outcome: 24-h ambulatory BP
The primary outcome was 24-hour ambulatory blood pressure
- Secondary outcomes: sleepiness, QoL, cardiac MRI, biomarkers
Secondary outcomes included sleepiness, quality of life, cardiac imaging, and biomarkers

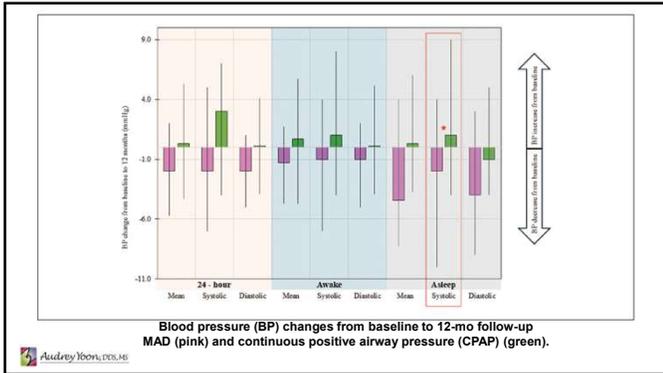
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Main Results

Outcome	MAD	CPAP
AHI (at 6 mos)	~21 (from 44)	~2 (from 50)
Adherence (≥6h/night)	56%	28%
Asleep mean BP reduction	~4 mmHg	No significant change
Sleepiness (ESS)	Improved	Slightly better improvement
Quality of Life	Improved	Improved

*Colpani et al. 2025

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Conclusion & Clinical Implications

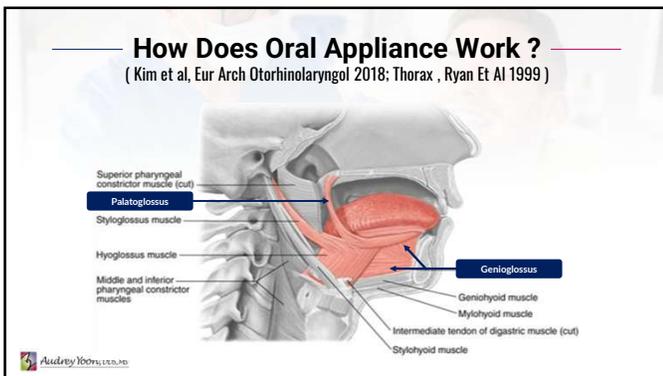
MAD is less effective than CPAP for AHI reduction
But MAD is better tolerated by patients

MAD improved asleep blood pressure
Asleep BP is a critical cardiovascular risk marker

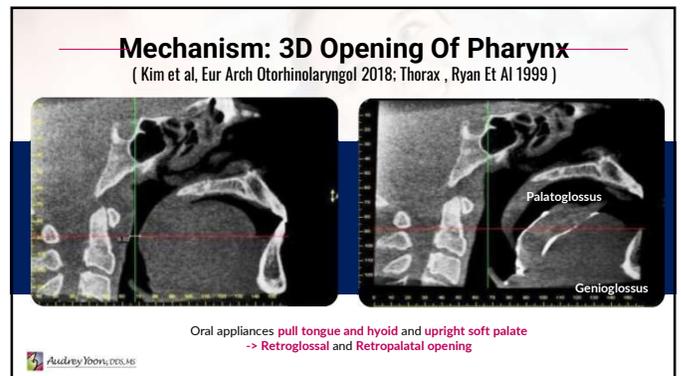
Both treatments improved quality of life
CPAP showed slightly better improvement in sleepiness scores

In severe OSA patients with hypertension, MAD may be a viable alternative to CPAP, particularly for those who cannot tolerate or adhere to CPAP therapy.

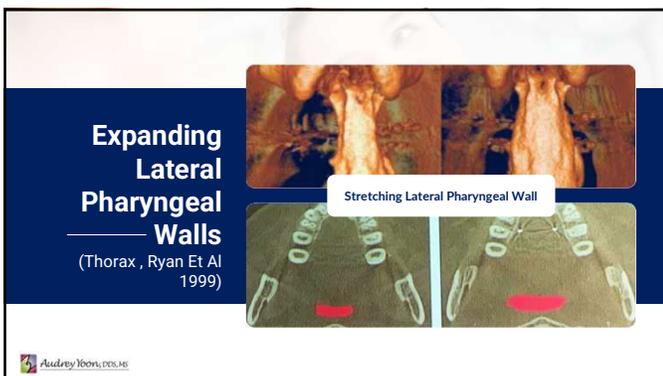
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DOSE DEPENDENT EFFECT OF Oral Appliance

Dose-Dependent Effects of Mandibular Advancement on Pharyngeal Mechanics and Nocturnal Oxygenation

	Control	OA2	OA4	OA8
ODI, h ⁻¹	26 (11.2 to 72.0)	17.21 (2.6 to 70.1)	14.71 (2.9 to 58.9)	10.51 (2.3 to 48.0)
CTaw, %	10 (1.2 to 58.7)	6.41 (0 to 46.1)	3.51 (0 to 35.4)	21 (0 to 31.2)
Mean nadir SaO ₂ , %	87.2 (78.0 to 91.8)	89.21 (80.0 to 92.6)	89.51 (78.1 to 93.4)	89.61 (81.5 to 92.6)

*Data are median (95% confidence intervals).
†p < 0.05 vs control.

Kato, J, S, Isono, A, Tanaka, T, Watanabe, D, Araki, H, Tanigawa and T, Nishino (2009), "Dose-dependent effects of mandibular advancement on pharyngeal mechanics and nocturnal oxygenation in patients with sleep-disordered breathing." Chest 117(4): 1065-1072.

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Predictors Of Oral Appliance Treatment Response

Awake Fiberoptic Nasopharyngoscopy



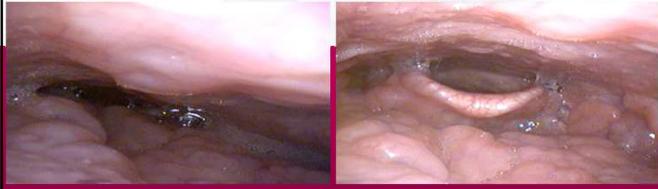
- Determines Level And Degree Of Obstruction**
- Behavior Of Muscle Collapse**
- Technique**
 - Supine (i.e., in a sleeping position)
 - Jaw Thrust Maneuver
 - Snore maneuver
 - Mueller maneuver- inspire against a closed airway

Audrey Yborra, DDS, MS 169

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Drug Induced Sleep Endoscopy

For Mandibular Advancement Devices



Open Mouth Jaw Thrust

Audrey Yborra, DDS, MS 170

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Journal of Clinical Medicine MDPI

Article

Optimizing Mandibular Advancement Maneuvers during Sleep Endoscopy with a Titratable Positioner: DISE-SAM Protocol

Patricia Fernández-Sanjuán ^{1,2}, Juan José Arrieta ³, Jaime Sanabria ⁴, Marta Alcaraz ⁵, Gabriela Bosco ^{5,6}, Nuria Pérez-Martín ^{5,6}, Adriana Pérez ⁷, Marina Carrasco-Llatas ⁸, Isabel Moreno-Hay ⁹, Marcos Rios-Lago ¹⁰, Rodolfo Lugo ¹¹, Carlos O'Connor-Reina ^{12,13}, Peter Baptista ¹⁴ and Guillermo Plaza ^{5,6,9,15}

Audrey Yborra, DDS, MS

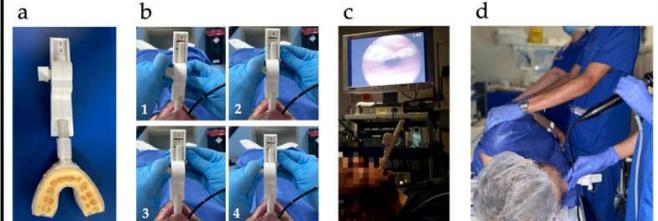
171

Journal of Clinical Medicine MDPI

Article

Optimizing Mandibular Advancement Maneuvers during Sleep Endoscopy with a Titratable Positioner: DISE-SAM Protocol

Patricia Fernández-Sanjuán ^{1,2}, Juan José Arrieta ³, Jaime Sanabria ⁴, Marta Alcaraz ⁵, Gabriela Bosco ^{5,6}, Nuria Pérez-Martín ^{5,6}, Adriana Pérez ⁷, Marina Carrasco-Llatas ⁸, Isabel Moreno-Hay ⁹, Marcos Rios-Lago ¹⁰, Rodolfo Lugo ¹¹, Carlos O'Connor-Reina ^{12,13}, Peter Baptista ¹⁴ and Guillermo Plaza ^{5,6,9,15}



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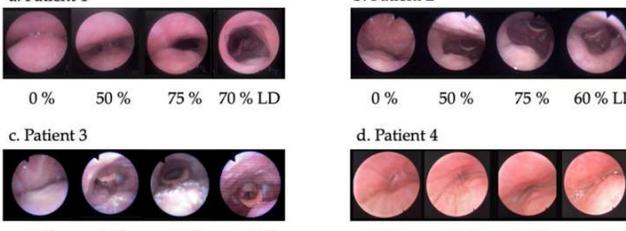
172

Journal of Clinical Medicine MDPI

Article

Optimizing Mandibular Advancement Maneuvers during Sleep Endoscopy with a Titratable Positioner: DISE-SAM Protocol

Patricia Fernández-Sanjuán ^{1,2}, Juan José Arrieta ³, Jaime Sanabria ⁴, Marta Alcaraz ⁵, Gabriela Bosco ^{5,6}, Nuria Pérez-Martín ^{5,6}, Adriana Pérez ⁷, Marina Carrasco-Llatas ⁸, Isabel Moreno-Hay ⁹, Marcos Rios-Lago ¹⁰, Rodolfo Lugo ¹¹, Carlos O'Connor-Reina ^{12,13}, Peter Baptista ¹⁴ and Guillermo Plaza ^{5,6,9,15}



a. Patient 1 b. Patient 2

0% 50% 75% 70% LD 0% 50% 75% 60% LD

c. Patient 3 d. Patient 4

0% 0% 50% 75% 0% 50% 75% 100%

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Efficient Calibration

Better monitoring and managing with Oral Appliance

Audrey Yborra, DDS, MS

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ORIGINAL RESEARCH

A Buccal Mucosal Oximeter Accurately Measures Arterial Oxyhemoglobin Saturation

Connor Snow¹⁻³, Shane Magnison-Benoit¹⁻³, Matiram Pun¹⁻³, Thomas R Tripp¹⁻³, Aimee Clarke¹⁻³, Sophie Berghmans¹⁻³, Bradley Hansen¹⁻³, Leo Transfiguracion⁴, Saleema Adatia⁵, Jean M Rawling⁶, Steven Roy^{7,8}, Giovanni Di Simone⁹, Ming-Lai Lai¹⁰, Erin V Mosca⁹, John E Remmers⁷, Marc J Poulin^{1-3,8,10,11}

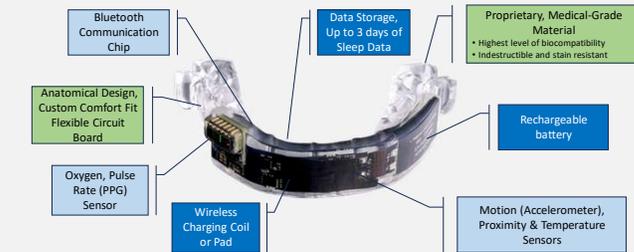


Figure 1 The buccal mucosal oximeter device. The photoplethysmography (PPG) unit is indicated by the green arrows.

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The Leading non-CPAP OSA Therapy

Buccal Mucosal Oximeter, Technology



- Bluetooth Communication Chip
- Data Storage, Up to 3 days of Sleep Data
- Proprietary, Medical-Grade Material
 - Highest level of biocompatibility
 - Indestructible and stain resistant
- Rechargeable battery
- Motion (Accelerometer), Proximity & Temperature Sensors
- Wireless Charging Coil or Pad
- Oxygen, Pulse Rate (PPG) Sensor
- Anatomical Design, Custom Comfort Fit Flexible Circuit Board

ProSomnus.com

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The Leading non-CPAP OSA Therapy

Docking Station, Daily Recharging



ProSomnus.com

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The Leading non-CPAP OSA Therapy

Introducing the ProSomnus HWO₂ Device

WEAR MONITOR OPTIMIZE



ProSomnus.com

Regression and Bland-Altman agreement versus arterial line and ECG (Snow et al. 2023)
 $r = .96$, SpO₂% (Device) vs SaO₂% (Co-oximeter); Bias = 0.72; n = 925
 $r = .99$, pulse rate vs ECG heart rate (bpm); Bias = 0.30; n = 346

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The Leading non-CPAP OSA Therapy

Oxymetrx™ Smartphone App

Daily Monitoring Reports and Communication



ProSomnus.com

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<https://doi.org/10.5864/jcsm.11736>

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SCIENTIFIC INVESTIGATIONS

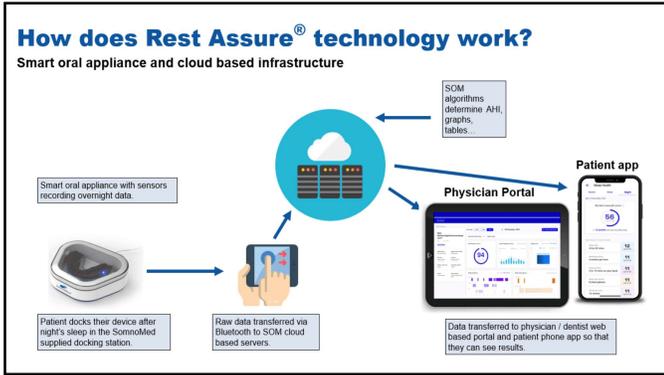
Evaluation of a novel smart mandibular advancement device for nightly monitoring of treatment

Anna M. Mohammed, BA, MBBS, FRACP, PhD^{1,2}; Benjamin K. Tong, BE, MBIomedE, PhD^{1,2}; Glenn M. Stewart, BExSc, PhD^{1,2}; Philip de Chazal, BE, MBIomedE, PhD^{1,2}; Peter A. Cistulli, MBBS, PhD, MBA, FRACP^{1,2}

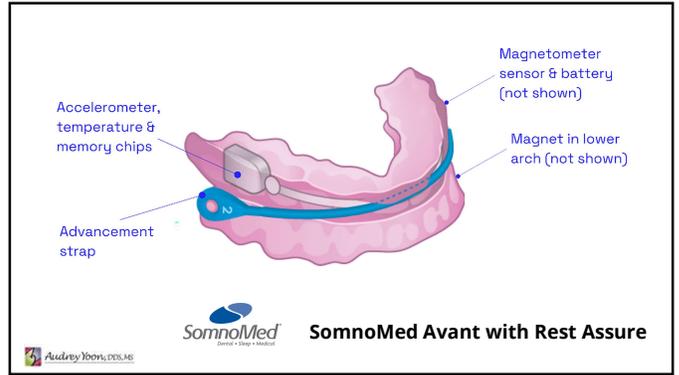
¹Charles Perkins Centre, Northern Clinical School, Faculty of Medicine and Health, The University of Sydney, Sydney, New South Wales, Australia; ²Department of Respiratory and Sleep Medicine, Royal North Shore Hospital, Sydney, New South Wales, Australia; ³School of Biomedical Engineering, The University of Sydney, Sydney, New South Wales, Australia

Audrey Ybarrondo, DDLMS

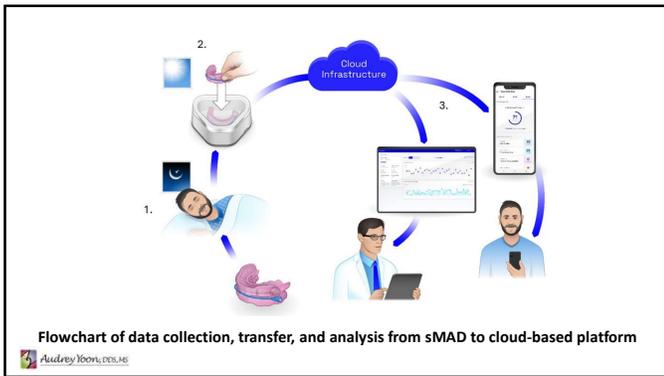
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Seminars in Orthodontics
Volume 27, Issue 3, September 2023, Pages 184-188

Be your own manufacturer: 3D printing intraoral appliances

Tom Shannon^{1,2}, Christian Grath³

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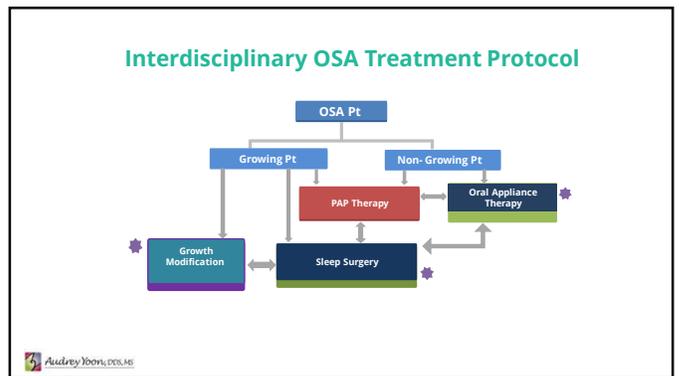
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Direct-Printed Aligners: A Clinical Status Report

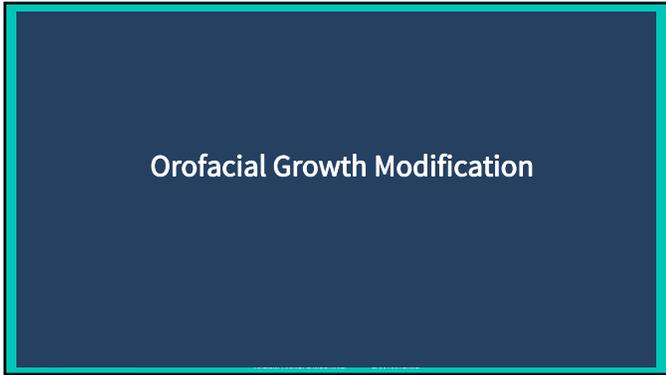
BLJORN LUDWIG, DMD, MSD, PhD
KENJI OJIMA, DMD
JONAS G. SCHMID, DMD
VANESSA KHODE, DMD
RAVINDRA NANDA, BDS, MSc, PhD

Shape Memory Material Tera Harz TC-85

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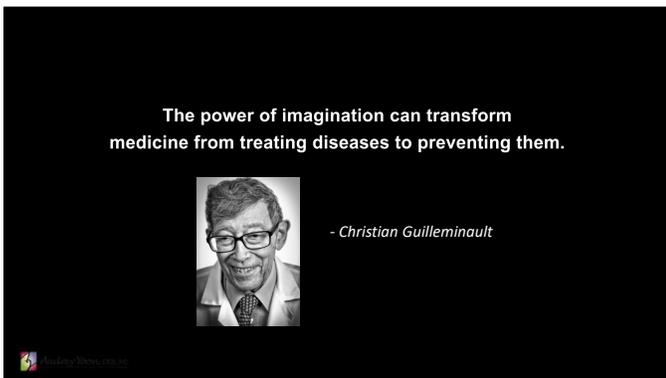
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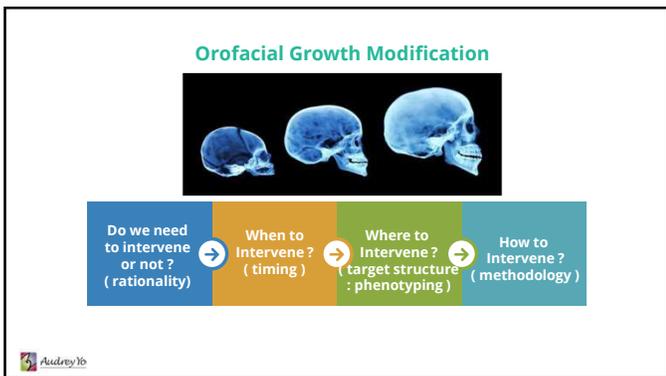
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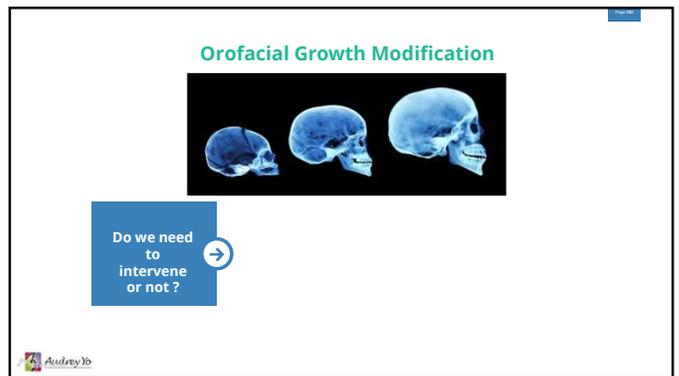
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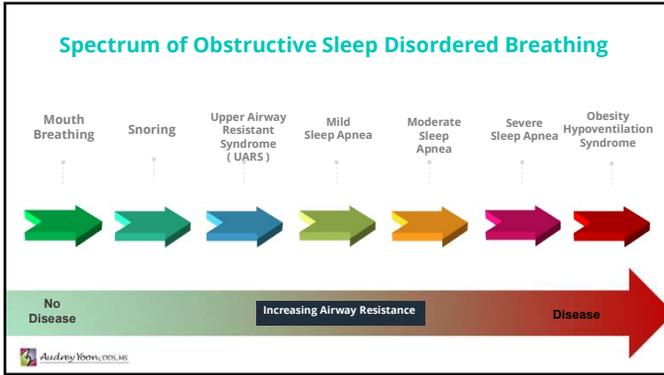
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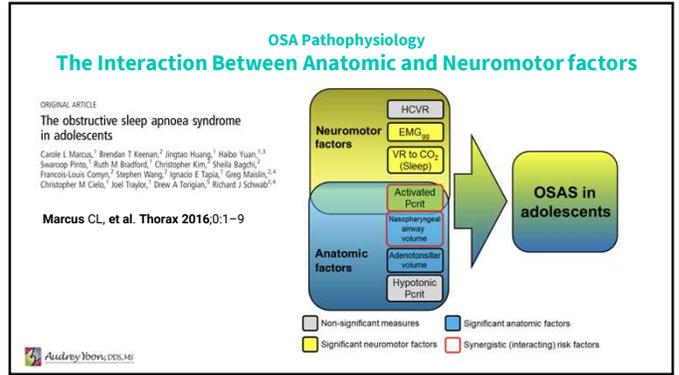
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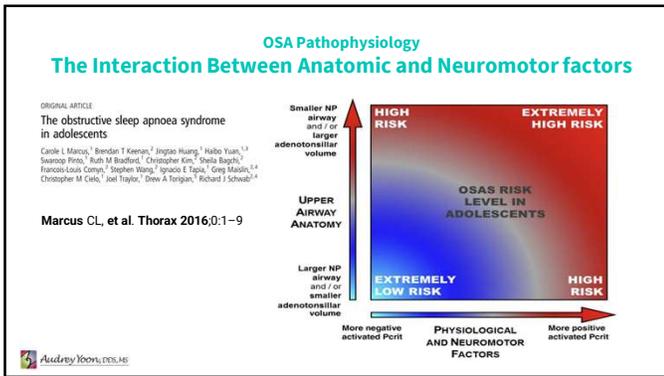
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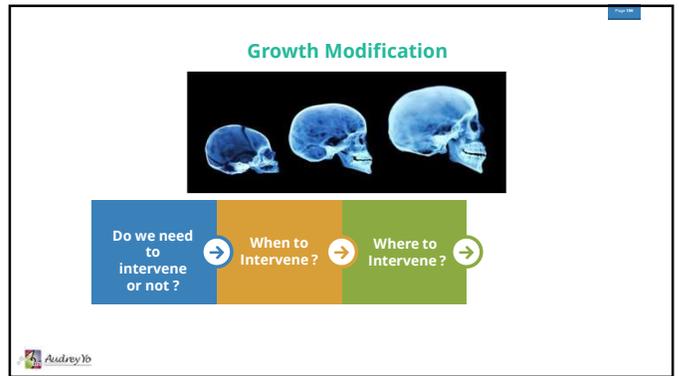
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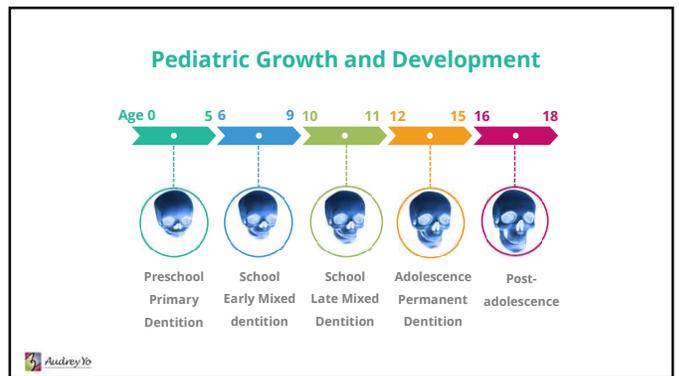
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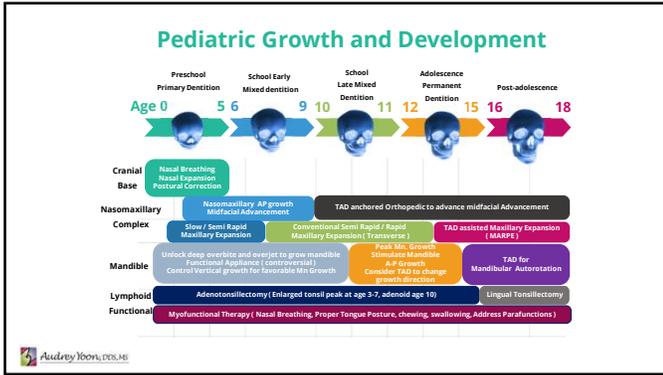
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Understanding Timing of Growth Modification

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A Roadmap of Craniofacial Growth Modification for Children with Sleep Disordered Breathing: A Multidisciplinary Proposal

Audrey Yoon¹, David Gozal², Clete Kushida¹, Rafael Pelayo¹, Stanley Liu³, Jasmine Faldu⁴, Christine Hong⁵

Acknowledgment

The authors would like to acknowledge Dr. Christian Guillemainault who inspired and encouraged us to start this growth modification guideline project. Also, the authors thank Ms. Licia Coccaeni Paskey for her insights and for helping develop the functional part of the growth modification roadmap.

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Sleep, Volume 46, Issue 8, August 2023, zsad095, <https://doi.org/10.1093/sleep/zsad095>

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Growth Modification Guidelines					
Chronological Age	Developmental Stages				
	0-5	6-9	10-11	12-15	16-18
Dental Stage	Primary Dentition	Early Mixed Dentition	Late Mixed Dentition	Adolescent Permanent Dentition	Permanent Dentition
Skeletal Stage: Cervical Vertebral Maturational Stage	CS 1	CS 1	CS 2-3	CS 4-5	CS 5-6
Characteristics of Skeletal Growth					
Cranial Base	Up to 80% cranial and neural growth occurs by age 8 yrs. Cranial Base Flexion determines the frame of facial growth pattern. Elongation at synchondrosis.	Anterior cranial base growth is complete. Posterior cranial base growth continues. S-N increases by 1 mm per year. N-S increases by 1.7 mm per year ages 6-16.	Anterior cranial base growth is complete. Posterior cranial base growth continues. S-N increases by 1 mm per year. N-S increases by 1.7 mm per year ages 6-16.	Most growth completed.	Most growth completed.
Nasomaxillary Complex	Development by anterior cranial base. Nasal cavity development.	Downward and forward growth. Nasal cavity development continues. Maxillary growth in horizontal direction.	Downward and forward growth. Nasal cavity development continues. Maxillary growth in vertical direction.	Downward and forward growth. Nasal cavity development continues. Maxillary growth in vertical direction.	Most growth completed.
Mandible	Body length and ramus development.	Increases in body length and ramus development.	Increases in body length and ramus development. My peak growth 11-13yr.	Increases in body length and ramus development. My peak growth 11-13yr.	Residual mandibular growth.
Lymphoid/Soft Tissues & Tongue	Enlarged adenoid/tonsil. Hyoid bone descends, moves slightly anteriorly. Tongue displacement. Lowest conchary affect mandibular development. Tongue strength increase rapidly from 3-4.5 yrs.	Enlarged adenoid/tonsil. Hyoid bone descends, moves slightly anteriorly. Increase tongue size. Tongue strength increases slowly.	Adenoid/tonsil size reduced. Tongue size growth complete. Tongue moves inferiorly and forward. Tongue strength increases slowly.	Tongue strength increases slowly.	Hypertrophy of lingual tonsils (after puberty). Tongue strength increases slowly until age 17.
Functional	Speech development. Transition from immature swallowing (50% age 6).	Transition from immature swallowing to mature swallowing.	Swallowing maturation complete.	Swallowing maturation complete.	Swallowing maturation complete.

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Growth Modification Guidelines					
Chronological Age	Developmental Stages				
	0-5	6-9	10-11	12-15	16-18
Dental Stage	Primary Dentition	Early Mixed Dentition	Late Mixed Dentition	Adolescent Permanent Dentition	Permanent Dentition
Skeletal Stage: Cervical Vertebral Maturational Stage	CS 1	CS 1	CS 2-3	CS 4-5	CS 5-6
Strategies for Targeted Therapy Goal: Establish nasal breathing and guide favorable growth pattern					
Cranial Base	Nasal Breathing Establishment. Postural Correction.	Nasal Breathing Establishment.			
Nasomaxillary Complex	Expansion and advancement. Consider slow maxillary expansion therapy.	Rapid maxillary expansion. Maxilla advancement with PPE and facemask therapy.	Rapid maxillary expansion. Maxilla advancement with TAD anchored RPE/MARPE and facemask therapy.	Enhance mandibular growth. Functional orthodontic appliances to influence Mx growth direction. Consider TAD for mandibular autostoration.	TAD anchored maxillary expansion (MARPE). Limited success Maxilla advancement with MARPE/facemask. Bolard mini-plates.
Mandible	Unlock sleep overbite/overjet to allow mandibular growth. Consider myofunctional appliance for tongue posture and forward mandibular growth.	Unlock sleep overbite/overjet to allow mandibular growth. Consider myofunctional appliance for tongue posture and forward mandibular growth.	Unlock sleep overbite/overjet to allow mandibular growth. Consider myofunctional appliance for tongue posture and forward mandibular growth.	Unlock sleep overbite/overjet to allow mandibular growth. Consider myofunctional appliance for tongue posture and forward mandibular growth.	Consider TAD for mandibular autostoration surgery.
Lymphoid/Soft Tissues & Tongue	Adenotonsillectomy. Consider myofunctional appliance for tongue.	Adenotonsillectomy. Consider myofunctional appliance for tongue.	Adenotonsillectomy after expansion.	Adenotonsillectomy after expansion.	Lingual tonsillectomy.
Functional	Myofunctional therapy.	Myofunctional therapy.	Myofunctional therapy.	Myofunctional therapy.	Myofunctional therapy.

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A Multidisciplinary Roadmap of Craniofacial Growth Modification for Children with Sleep Disordered Breathing

Timeline: Age 0 to 18. Dental stages: Preschool Primary Dentition (0-5), School Early Mixed Dentition (6-10), School Late Mixed Dentition (11-12), Adolescence Permanent Dentition (13-16), Post-adolescence (17-18).

Cranial Base: Nasal Breathing, Nasal Expansion, Postural Correction.

Nasomaxillary Complex: Nasomaxillary AP growth, Midfacial Advancement, TAD anchored Orthopedic to advance midfacial Advancement.

Mandible: Slow / Semi Rapid Maxillary Expansion, Conventional Semi Rapid / Rapid Maxillary Expansion (Transverse), TAD assisted Maxillary Expansion (MARPE), Peak Max. Growth, Stimulate Mandible AP Growth, Consider TAD to change growth direction, TAD for Mandibular Autostoration.

Lymphoid: Adenotonsillectomy (Enlarged tonsil peak at age 3-7, adenoid age 16), Lingual Tonsillectomy.

Functional: Myofunctional Therapy (Nasal Breathing, Proper Tongue Posture, chewing, swallowing, Address Parafunctions).

The appropriately targeted and patient-specific application of these orthodontic techniques provide an important therapeutic option for children and adolescents with symptomatic sleep disordered breathing and may help also mitigate or prevent its onset. Well-controlled longitudinal and long-term studies aimed at the effectiveness of treatment on the change of trajectory of growth and stability are necessary.

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EDITORIAL

<http://dx.doi.org/10.1533/jdsj.2020.7300>

Paradigm Shift for the DSM Dentist

Jean-François Masse, DMD, MSc, FACD, Diplomate, ABDSM

Editor-in-Chief Journal of Dental Sleep Medicine
Universite Laval, Quebec City, Quebec, Canada

Three months ago, Dr. Audrey Yoon and a team of distinguished researchers published a paper in *SLEEP* part of the book is devoted to sleep). This book is timely for us as there is already a sense in the general health community that our health system, which heavily rests on curing diseases, is broken and there should be more emphasis put on preventing illness. It is obvious that the

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JDSM

LETTER TO THE EDITOR <http://dx.doi.org/10.15331/jdslem.xxxx>

Embracing New Paradigms in Pediatric Dental Sleep Medicine: From Controversial to Universal

Audrey Yoon DDS, MS, ABO, D. ABDSM ^{1,2}

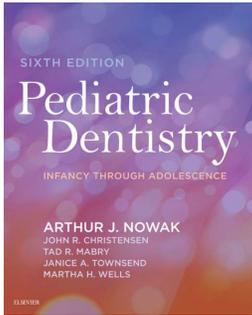
¹Clinical Professor, Division of Sleep Medicine, Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford, CA, USA; ²Clinical Assistant Professor, Department of Orthodontics, Arthur A. Dugoni School of Dentistry at the University of the Pacific, San Francisco, CA, USA

Dear Editor-in-Chief,

I greatly appreciate your editorial¹ regarding our paper "A Roadmap of Craniofacial Growth Modification for Children With Sleep-Disordered breathing: A healthy discussion will embrace the dentist's role of growth

Considering these developments, we are glad that AADSM proposed and offered a valid forum for discussion to define the future scope of DSM. It is our hope that this healthy discussion will embrace the dentist's role of growth

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Pediatric Dentistry Textbook

7th edition

Chapter 48. Sleep Disordered Breathing

Audrey Jung-Sun Yoon, Heesoo Oh

A Multidisciplinary Craniofacial Growth Modification Roadmap for Children with Sleep Disordered Breathing

	Preschool Primary Dentition	Early Mixed Dentition	Later Mixed Dentition	Adolescence Permanent Dentition	Post-adolescence
Age	0-5	6-9	10-12	13-16	16+
Cranial Base	None (Breathing, Habit, Crossbite)				
Maxillary Complex	Necessary for AP growth (Mandibular Extension)		Tab-assisted (Orthodontic for Medical Advancement)		
Mandible	Unlock deep overbite and overjet to give mandible functional space (crossbite)	Control vertical growth for favorable MB growth	Plan MB crossbite (Mandibular AP Growth) (Mandibular AP Growth)	Tab for Mandibular Advancement	
Lip/Tongue	Adaptability (Diagonal and Jaw Age 4-5, altered age 10) (Lipual Translatory)				
Functional	Multifunctional Therapy (Deep Breathing, Proper Tongue Posture, Heavy Swallowing, Address Posturocrania)				

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BEST PRACTICES: DEVELOPING DENTITION AND OCCLUSION

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision 2024

How to Cite: American Academy of Pediatric Dentistry. Management of the Developing Dentition and Occlusion in Pediatric Dentistry. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2024:475-51.

- Treatment objectives:** managing adverse growth, correcting dental and skeletal disharmonies, improving esthetics of the smile and the accompanying positive effects on self-image, and improving the occlusion.
 - Primary dentition stage:** **Habits and crossbites** should be diagnosed and **if predicted not likely to be self correcting, they should be addressed as early as feasible** to facilitate normal occlusal relationships.

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BEST PRACTICES: DEVELOPING DENTITION AND OCCLUSION

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision 2024

How to Cite: American Academy of Pediatric Dentistry. Management of the Developing Dentition and Occlusion in Pediatric Dentistry. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2024:475-51.

- Treatment Consideration : * Primary dentition stage**
The objectives of evaluation include identification of:
 - all anomalies of tooth number and size
 - anterior and posterior crossbites
 - presence of habits along with their dental and skeletal sequelae
 - openbite
 - airway problems.

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BEST PRACTICES: DEVELOPING DENTITION AND OCCLUSION

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision 2024

How to Cite: American Academy of Pediatric Dentistry. Management of the Developing Dentition and Occlusion in Pediatric Dentistry. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2024:475-51.

- Recommendations**
 - Oral habits :** Oral habits include, but are not limited to, nonnutritive sucking, bruxism, tongue thrust swallow and abnormal tongue position, self injurious/self-mutilating behavior, and obstructive sleep apnea (OSA).
 - Research on the relationship between malocclusion and mouth breathing suggests that **impaired nasal respiration may contribute to the development of increased facial height, anterior open bite, increased overjet, and narrow palate** but is not the sole or the major cause of these conditions.
 - Interdisciplinary care with medical colleagues or other dental specialists may be beneficial

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BEST PRACTICES: DEVELOPING DENTITION AND OCCLUSION

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision 2024

How to Cite: American Academy of Pediatric Dentistry. Management of the Developing Dentition and Occlusion in Pediatric Dentistry. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2024:475-51.

- Recommendations**
 - Oral habits :** Oral habits include **obstructive sleep apnea (OSA)**.
 - OSA may be associated with narrow maxilla, crossbite, low tongue position, vertical growth, increased overjet, and openbite.** History associated with OSA may include snoring, observed apnea, restless sleep, daytime neurobehavioral abnormalities or sleepiness, and bedwetting.
 - Physical findings may include growth abnormalities, signs of nasal obstruction, adenoidal facies, enlarged tonsils, hyponasal voice quality, and possible retrognathia, micrognathia, macroglossia, and hypoplasia of the midface.
 - OSA is more prevalent in, but not limited to, children with craniofacial anomalies,** neurologic disorders (e.g., cerebral palsy, muscular dystrophy), sickle cell disease, as well as a history of prematurity.

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BEST PRACTICES: DEVELOPING DENTITION AND OCCLUSION

Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Latest Revision
2024

How to Cite: American Academy of Pediatric Dentistry. Management of the developing dentition and occlusion in pediatric dentistry. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2024:92-93.

- Recommendations**
- Oral habits:** Oral habits include, but are not limited to, nonnutritive sucking, **bruxism**, **tongue thrust swallow** and abnormal tongue position, self injurious/self-mutilating behavior, and **obstructive sleep apnea (OSA)**.
- The identification of an abnormal habit and the assessment of **its potential immediate and long-term effects on the craniofacial complex and dentition should be made as early as possible**.
- The dentist should evaluate habit frequency, duration, and intensity in all patients with habits. Anticipatory guidance on long-term sequelae should be provided and intervention to terminate the habit should be initiated if indicated.



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Pediatric Growth and Development

Age 0 5



Preschool
Primary
Dentition



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Age 1-5 : Toddler & Preschool Primary Dentition



- Up to 80 % of Cranial development occurs by age 6 yrs
- Craniofacial growth is influenced by;
 - Genetics and epigenetics:** traits, prematurity, disorders, hormonal influence
 - Environment:** inflammatory diseases, trauma, etc

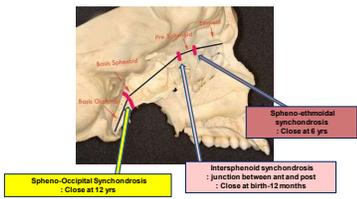
Aknin et al. 2007; Guillemainault et al. 2014; C Martinez-Maza et al. J Anat. 2013



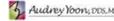
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Cranial Base Growth Mechanism

- Elongation:** Endochondral growth at synchondrosis
- Cortical Drift / Remodeling**
- Sutural Growth**



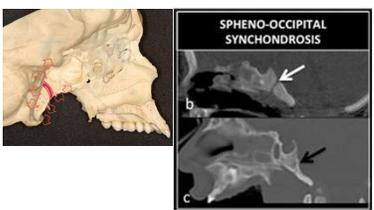
Function: Template / Frame for facial growth



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Cranial Base Growth : Lengthening

Function :
Displace Maxilla forward
Template / Frame for facial growth



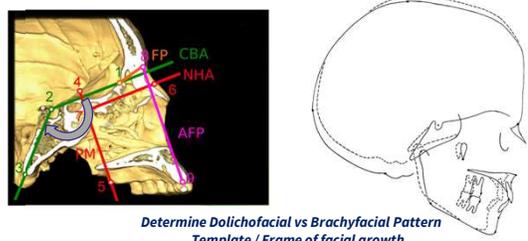
SPHENO-OCCIPITAL SYNCHONDROSIS



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Cranial Base Growth : Basiscranial Flexion

Function :
Affect Facial Depth, width, height



Determine Dolichofacial vs Brachyfacial Pattern
Template / Frame for facial growth

Relation of Cranial Base Flexure to Cranial Form and Mandibular Position
D. Anderson, F. Popovich. Am J Phys Anthropol 1983. June



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Age 1-5 : Toddler & Preschool Primary Dentition



- **Skeletal growth :**
 1. **Cranial Base : Flexing and lengthening**
 2. **Nasomaxillary Complex :**
Development by anterior cranial base lengthening
Nasal cavity development by nasal septal cartilage
 3. **Mandible:** During first postnatal year, mandible has the greatest growth to secure the pharyngeal airway.
AP growth (body length) > vertical growth (ramus)

Audrey Ybony, DDS, MS Aknin et al. 2007; Guilleminault et al. 2014; C Martinez-Maza et al. J Anat. 2013

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Age 1-5 : Toddler & Preschool Primary Dentition



- **Pharyngeal growth**
: Tonsillar hypertrophy peak age is 3-7 years old
- **Tongue**
: Backward and downward displacement toward oropharynx
: Tongue strength increase rapidly from 3-6.5 yrs
- **Hyoid bone** descends and moves slightly anteriorly
(low posterior tongue posture -> decent hyoid -> impairs Mn growth and affect symphysis growth by extended suprahyoid muscle)

Audrey Ybony, DDS, MS Aknin et al. 2007; Guilleminault et al. 2014; C Martinez-Maza et al. J Anat. 2013

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Age 1-5 : Toddler & Preschool Primary Dentition



- **Functional Development**
Tongue strength increase rapidly from 3-6.5 yrs
 - ✓ Breathing-sucking-swallowing coordination
 - ✓ Breathing-chewing-swallowing coordination
 - ✓ Breathing-voice-speech coordination
 - ✓ Dissociation and grading of movement of tongue, lips and jaws
 - ✓ Speech development
 - ✓ Stability at rest and during movement of tongue, lips and jaw

Audrey Ybony, DDS, MS Aknin et al. 2007; Guilleminault et al. 2014; C Martinez-Maza et al. J Anat. 2013

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Age 1-5 : Preschool Primary Dentition



➤ **Strategies**

- **Nasal Breathing Establishment** ★
: Developmental interplay between muscle function and the facial skeleton
: Suction, chewing, swallowing, and **nasal breathing Impairment has negative feedback on facial growth-> reduced airway size**
- Adenotonsillectomy
- Myofunctional therapy, Proper tongue posture
- Postural Correction
- **Nasomaxillary Complex Expansion and Advancement** ★
: Unlock deep overbite/overjet to unlock mandibular growth, Consider Slow Expansion
: Functional Appliance for tongue posture and forward mandibular growth

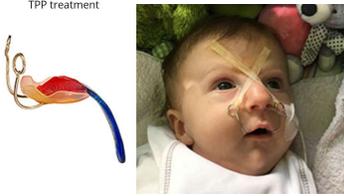
Audrey Ybony, DDS, MS Aknin et al. 2007; Guilleminault et al. 2014; C Martinez-Maza et al. J Anat. 2013

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Orthodontic Airway Plate for Pierre Robin Treatment

- **Custom-fabricated removable oral appliance**
 - : Pre-epiglottic baton plate, first described by Pielou (1967) in Northern Ireland
 - : TPP in Germany over 10 yrs
 - : Install and adjust under awake endoscopy
 - : Full time wear for 3-6 months depending on feeding and respiratory needs
 - : Parent clean and place once a day to clean

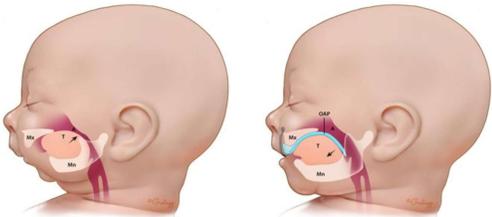
(Coquerelle et al.,2013; Inoue et al., 2019)



Audrey Ybony, DDS, MS

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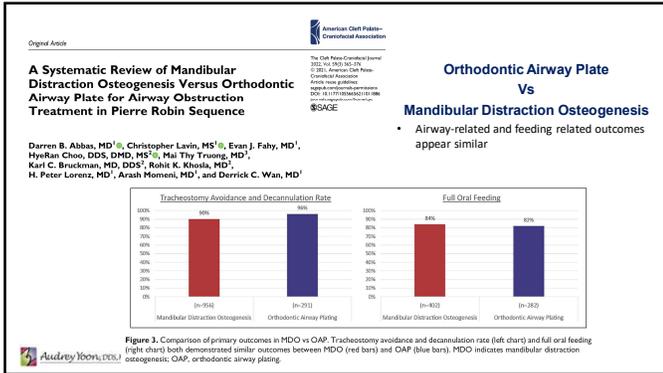
Pierre Robin Treatment : Orthodontic airway Plate (instead of Mandibular Distraction Osteogenesis)



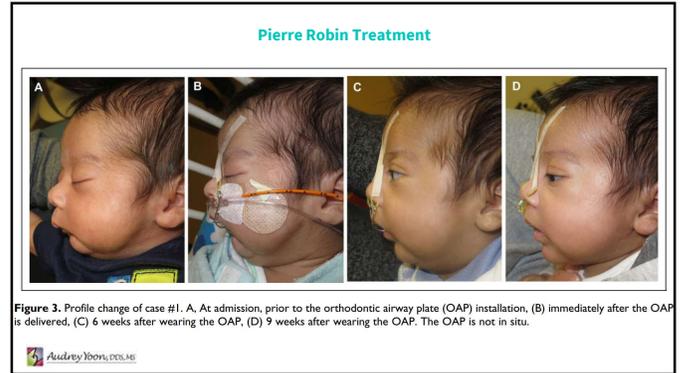
Orthodontic airway plate (OAP) before and after

Audrey Ybony, DDS, MS

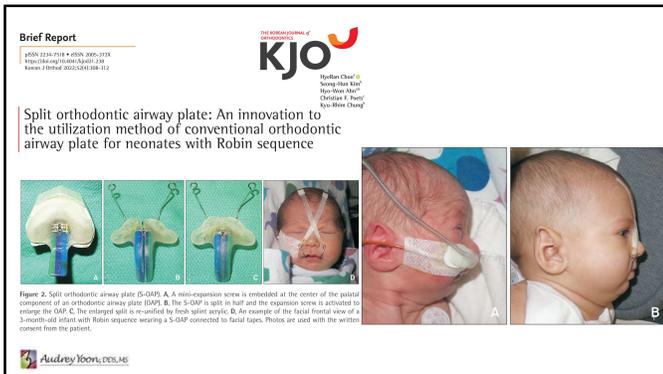
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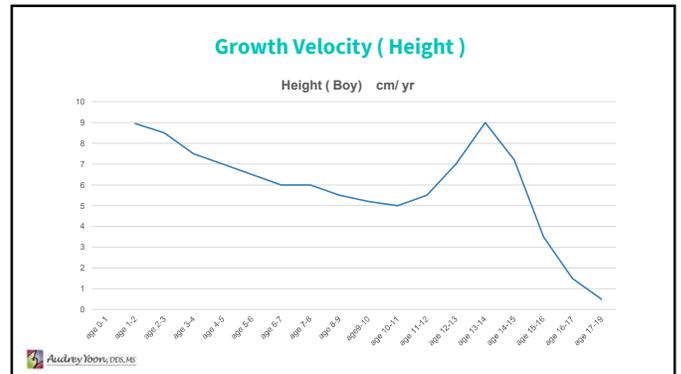
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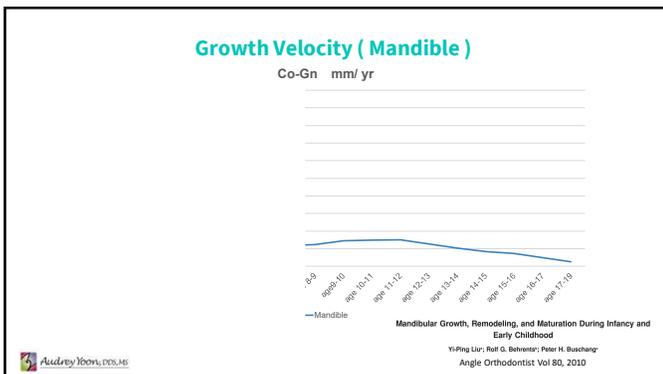
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Early Nasomaxillary Expansion Decisions

- 01** Habits and crossbites if predicted not likely to be self correcting
- 02** Medical Conditions : Sleep Disordered Breathing, Myofunctional Disorders

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Management of the Developing Dentition and Occlusion in Pediatric Dentistry

Treatment Consideration : * Primary dentition stage

- a. all anomalies of tooth number and size
- b. anterior and posterior crossbites
- c. presence of habits along with their dental and skeletal sequelae
- d. openbite
- e. airway problems.

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American Journal of Orthodontics and Dentofacial Orthopedics
Volume 117, Issue 6, June 2000, Pages 689-690

Sagittal changes after maxillary protraction with expansion in Class III patients in the primary, mixed, and late mixed dentitions: A longitudinal retrospective study

Marc Saadia, DDS, MS,* and Edgar Torres, DDS,*
Mexico City, Mexico

Earlier Treatment showed greater and faster skeletal results in less time

we recommend that **treatment be started as soon as the diagnosis is made** and cooperation allows for it.
Young patients show greater and faster results in less time.
Esthetics are greatly enhanced, compliance is improved, and the possible psycho-social scars can be greatly reduced.

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Dr. Audrey Yoon, DDS, MS
3400 Westre Blvd., #104, Los Angeles, CA

PSQ: 9 -> 4

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Nocturnal enuresis
Putative mechanisms for pathogenesis of enuresis in patients with SDB

Sleep disordered breathing leads to decreased arousal response, increased intra-abdominal pressure, and increases in systemic blood pressure. These factors lead to increased bladder pressure and pressure-induced natriuresis. This results in nocturnal diuresis and natriuresis, which leads to Enuresis.

ADH = antidiuretic hormone
ANP = atrial natriuretic peptide
BNP = brain natriuretic peptide

- Dampening effects of OSA on arousal responses
- Changes in bladder pressure
- Secretion of the hormones involve in fluid regulation

Obstructive sleep-disordered breathing, enuresis and combined disorders in children: chance or related association? *Swiss Med Wkly. 2017;147:w14400* Marco Zaffanello et al

232

Pediatric Growth and Development

Age 0 (Dentition) 5 6 (Mixed dentition) 9 10 (Late Mixed Dentition) 11 12 (Permanent Dentition) 15 16 (Post-adolescence) 18

Cranial Base: Ant. Cranial Base, Nasal Expansion

Nasomaxillary Complex: Nasomaxillary Adv., Midfacial Advancement, Conventional Maxillary Expansion (Transverse)

Mandible: Unlock Narrow Max., Deep OB for Mn growth, Functional Appl., Control Vertical by Mn. Rotation

CS1, CS2, CS3, CS4, CS5, CS6

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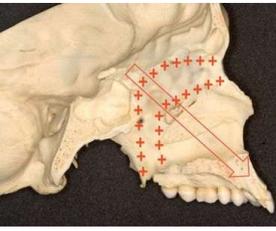
Pediatric Growth and Development

Age 0 (Dentition) 5 6 (Early Mixed dentition) 9 10 (Late Mixed Dentition) 11

Preschool Primary Dentition, School Early Mixed dentition, School Late Mixed Dentition

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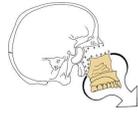
Nasomaxillary Complex Growth




Audrey Yoon, DDS, MS

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The maxilla is more responsive than the mandible to orthopedic force



Maxillary Growth

- 1) At the suture that connect the maxilla to the cranium and cranial base
- 2) By surface remodeling

The Maxilla can be Under Your Control



Mandibular Growth

- 1) In cartilage covering the mandibular condyle
- 2) direct surface apposition and remodeling

The Mandible has a mind of its own

Audrey Yoon, DDS, MS

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School Age Mixed Dentition (Age 6-11)

Early Mixed (Age 6-9)
Late Mixed (Age 10-11)

- **Skeletal Growth**
 - 1. Cranial Base :** Anterior cranial base growth is complete. Posterior cranial base grows (S-N increases by 1 mm per year , N-B increases by approximately 1.7 mm per year between 6 and 16 years of age)
 - 2. Nasomaxillary Complex :** Downward and forward, Nasal Cavity continue to grow together
(abnormal habit-> impaired palatal bone drift-> deep palatal vault, narrow high arch, narrow nasal cavity)
 - o Age 6-9 : Maxillary growth in horizontal direction
 - o Age 10-12 : Maxillary growth in more vertical direction



Audrey Yoon, DDS, MS

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School Age Mixed Dentition (Age 6-11)

Early Mixed (Age 6-9)
Late Mixed (Age 10-11)

- **Skeletal Growth**
 - 3. Mandible:** Increase body length and ramus
Juvenile growth spurt : mandibular internal rotation (gonial angle decrease -> determine Mn shape)
(mouth breathing-> poor internal rotation-> high angle, increases mandibular divergency)
- **Pharyngeal growth :**
 - : Enlarged adenoid (peak at 10-11 old)
 - : Enlarged tonsil (Peak at 3-7 yrs old) → Tonsil size reduced (age 10-11 yrs)



Audrey Yoon, DDS, MS

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School Age Mixed Dentition (Age 6-11)

Early Mixed (Age 6-9)
Late Mixed (Age 10-11)

- **Tongue**
 - age 6-9 : Increase in tongue size -> transient decrease retroglossal airway
 - age 10-11: Tongue size growth complete
Tongue strength increases slowly throughout
- **Functional**
 - : Transition from immature swallowing to mature swallowing through changes in dentition and palatal growth

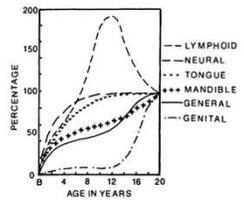



Figure 4. Main types of postnatal growth of the various parts and organs of the body. Lymphoid: neural, genital body, and genital types after Scammon (1920). Growth of the mandible and tongue extrapolated from data by Swain (1952, 1961, 1962), Turk (1963), and D. G. Woodside (unpublished materials from the Burlington Research Centre, Toronto, Canada, 1970).

Audrey Yoon, DDS, MS

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School Age Mixed Dentition (Age 6-11)

Early Mixed (Age 6-9)
Late Mixed (Age 10-11)

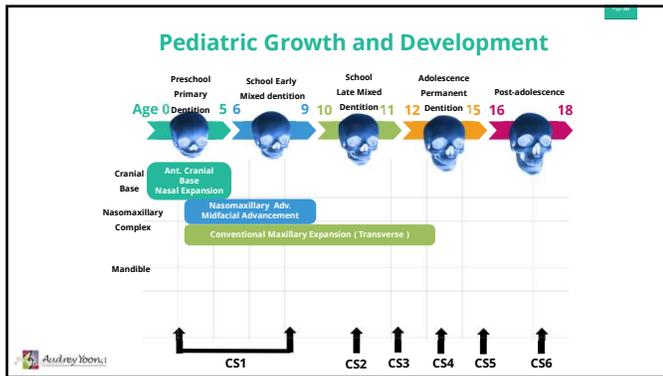
- **Strategies**
 - **Nasomaxillary Complex Expansion and Advancement**
 - Maxillary Expansion (Age 6-11) : Unlock deep overbite/overjet to unlock mandibular growth
 - Midfacial Advancement
 - Age 6-9 : RPE and Facemask
 - Age 10-12 : Consider TAD anchored RPE / MARPE and Facemask



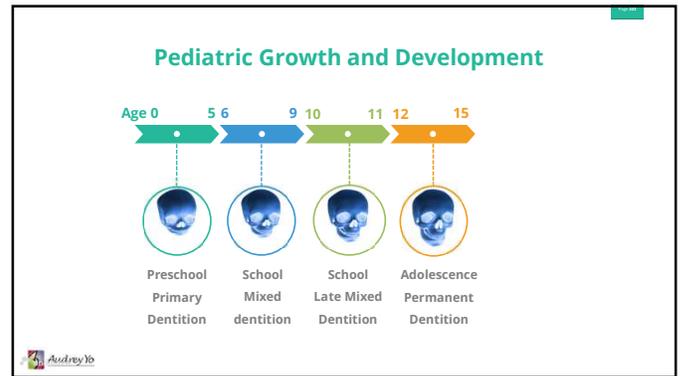
Adenotonsillectomy after expansion

Audrey Yoon, DDS, MS

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Adolescent Permanent Dentition (Age 12-15)

- **Skeletal Growth**
 1. **Cranial Base** : Most of growth is complete
 2. **Nasomaxillary Complex** : Downward and forward more vertical direction, Nasal Cavity continue grow together
 3. **Mandible: body length and ramus** : Mandibular growth peak at age 11-13 (Early Adolescent) : Vertical growth of condyle and ramus -> counterclockwise external rotation and surface modeling
 4. **Hyoid** : 2nd puberty of hyoid growth
- **Pharyngeal growth** : T & A reduction

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Adolescent Permanent Dentition (Age 12-15)

- **Strategies**
 - **Nasomaxillary Complex Expansion and Advancement**
 - **Maxillary Expansion**
 - **Consider TAD anchored RPE (MARPE)**
 - Unlock deep overbite/overjet to unlock mandibular growth
 - **Midfacial Advancement**
 - **MARPE with facemask or Tandem**
 - **Bollard mini-plates for a long term**

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Adolescent Permanent Dentition (Age 12-15)

- **Strategies**
 - **Enhance Mandibular Growth**
 - **Functional appliance to grow the mandible**
 - **Consider TAD to change growth direction (mandible autorotation & rotation)**
 - **Bollard Plate with Herbst (?)**
 - **Nasal Breathing Establishment** : Exclusive nasal breathing should be achieved
 - **Myofunctional therapy**: Swallowing maturation complete

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Limitation

RME
Rapid Maxillary Expansion

➔

SARME
Surgically Assisted Rapid Maxillary Expansion

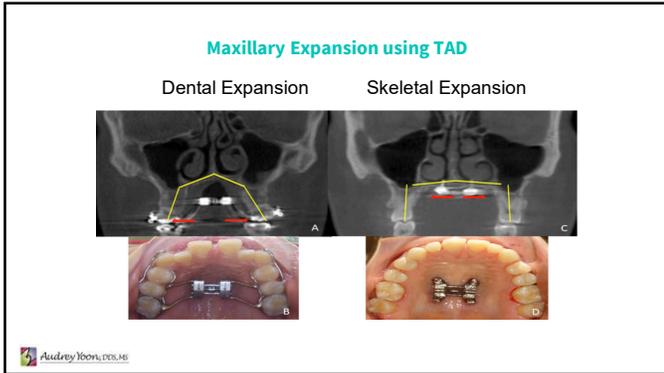
Suture matures at 11 ~ 15 yrs

Res Congr Eur Orthod Soc: 1964:40:131-42
MIDPALATAL SUTURE EXPANSION STUDIES BY THE IMPLANT METHOD OVER A SEVEN-YEAR PERIOD.
KREBS A.

In 1964, a study by Krebs on orthopedic expansion demonstrated that expansion is

- 50% skeletal and 50% dental in children
- 35 % skeletal and 65 % dental in adolescents

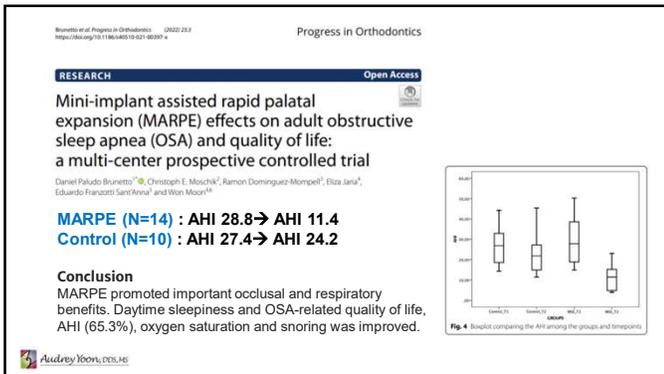
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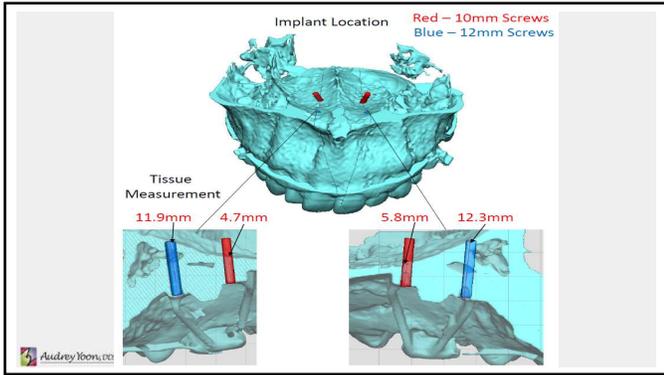
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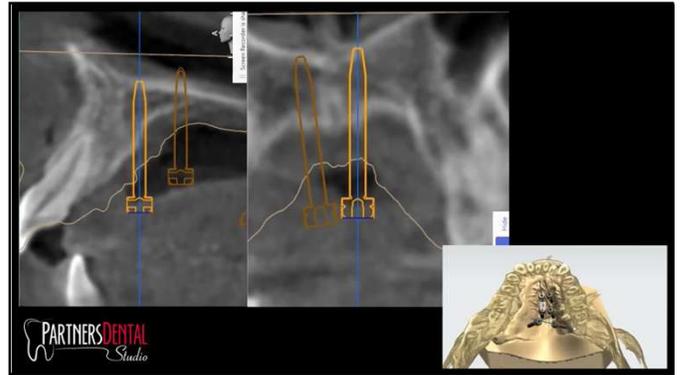
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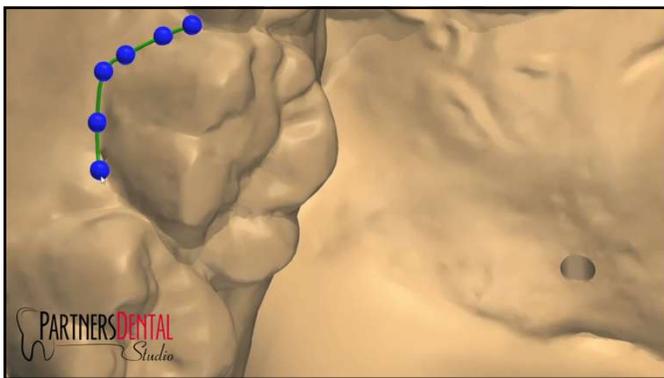
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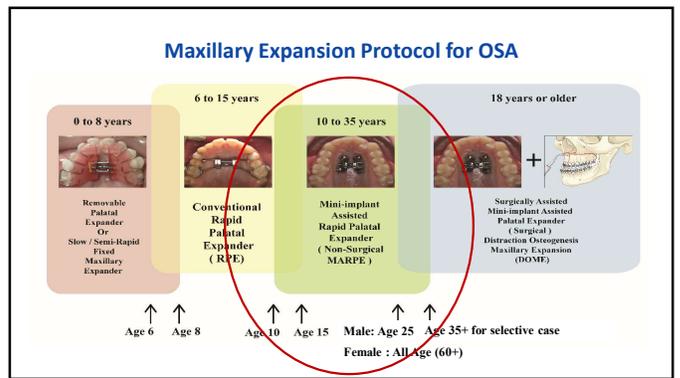
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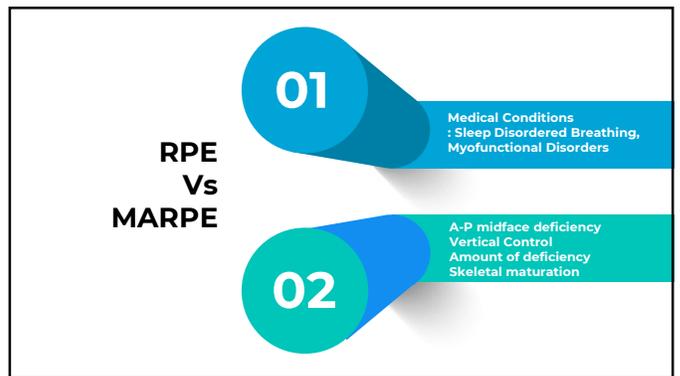
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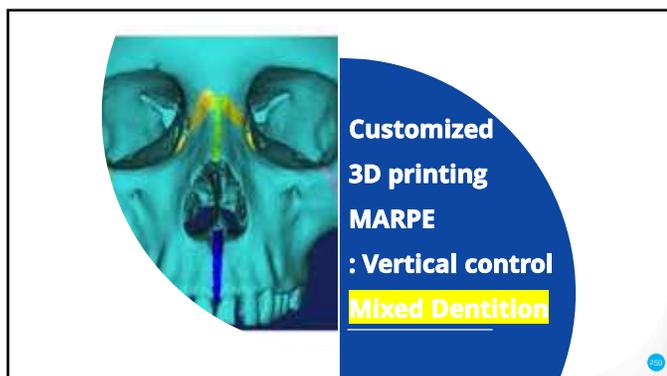
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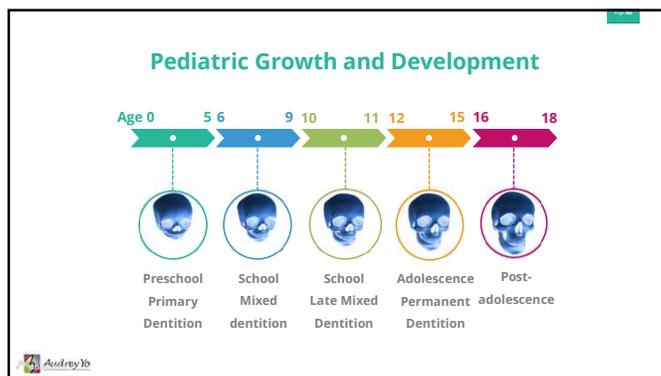
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Post-Adolescent (Age 16-18)

- Skeletal Growth
 1. Cranial Base : Most of growth is complete
 2. Nasomaxillary Complex : Most of growth is complete
 3. Mandible: body length and ramus : Substantial Mandibular growth is done
- Residual growth
 - Lymphoid Tissue: • Hypertrophy of lingual tonsils (after puberty)
 - Tongue strength increases slowly until age 17

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Check out Lingual Tonsil

Factors associated with hypertrophy of the lingual tonsils in adults with sleep-disordered breathing
 MW Sung, WH Lee, JH Wee, CH Lee, JAMA Otolaryngol Head Neck Surg. 2013

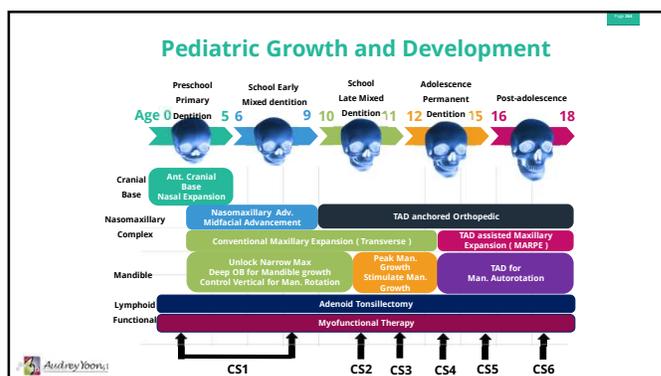
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Adolescent Permanent Dentition (Age 16-18)

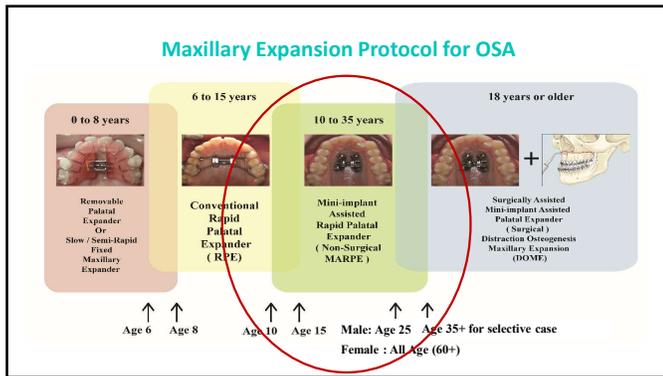
► Strategies

- Nasomaxillary Complex Expansion and Advancement
 - Maxillary Expansion
 - TAD anchored RPE (MARPE)
 - Midfacial Advancement : Not promising
 - MARPE with facemask or Tandem
 - Bollard mini-plates
- Residual Mandibular Growth
 - Consider TAD for mandible autorotation
 - Wait for Orthognathic Surgery
- Nasal Breathing Establishment
- Myofunctional therapy

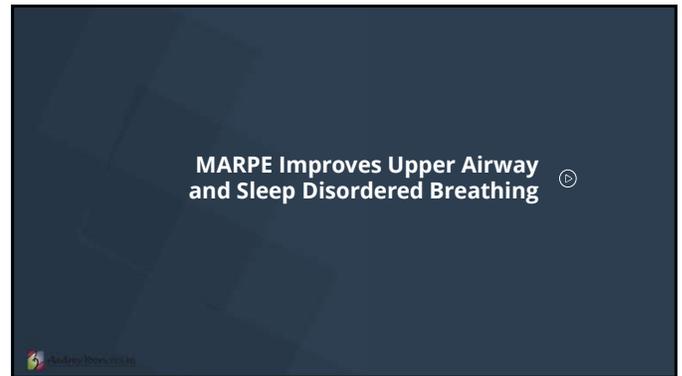
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Interest of miniscrew-assisted rapid palatal expansion on the upper airway in growing patients: A systematic review

Simon Prévê, Beatriz García Alcázar

Conclusions
 The short-term **airflow changes** after MARPE seems promising. MARPE is associated with greater skeletal maxillary expansion after retention, at various levels of the nasal cavity, compared to conventional RME.

International Orthodontics 2022; 20: 100657

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Liu et al. *BMC Oral Health* (2022) 22:820
<https://doi.org/10.1186/s12903-021-03344-w> BMC Oral Health

RESEARCH Open Access

The short- and long-term changes of upper airway and alar in nongrowing patients treated with Mini-Implant Assisted Rapid Palatal Expansion (MARPE): a systematic review and meta-analysis

Cuiyu Liu¹, Kaixin Wang¹, Chunmao Jiang^{1,2}, Yang Zhao^{1,2}, Yiyang Zhang¹, Qianwen Zhang¹, Chunhui Fan^{1,2} and Yang Liu^{1,2*}

- **Key Findings:**
 - **Increased nasal cavity width & volume** → Improved nasal airflow.
 - **Expanded nasopharyngeal & oropharyngeal volumes** → Potential airway ventilation benefits.
 - **Alar width & base width widened** → Possible soft tissue adaptation.
- **Clinical Insights:**
 - MARPE may enhance respiratory function and potentially aid in OSA symptom reduction.
 - Expansion effectiveness varies based on mini-screw length & activation frequency.

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Progress in Orthodontics

Bueno et al. *Progress in Orthodontics* (2022) 23:3
<https://doi.org/10.1186/s12903-021-03344-w>

RESEARCH Open Access

Mini-implant assisted rapid palatal expansion (MARPE) effects on adult obstructive sleep apnea (OSA) and quality of life: a multi-center prospective controlled trial

Daniel Paludo Brunetto^{1*}, Christoph E. Moschke¹, Ramon Domínguez-Mompeló¹, Eliza Jana¹, Eduardo Francisco Sarrhini¹ and Wilton Moon^{1,2}

MARPE (N=14) : AHI 28.8 → AHI 11.4
Control (N=10) : AHI 27.4 → AHI 24.2

- Significant improvements in daytime sleepiness, quality of life, AHI
- 85% success rate, improvements in oxygen saturation and snoring duration.

Fig. 4 Boxplot comparing the AHI among the groups and timepoints

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Review

Does Miniscrew-Assisted Rapid Palatal Expansion Influence Upper Airway in Adult Patients? A Scoping Review

Mariachiara Benetti¹, Luca Montresor^{1,*}, Daniele Cantarella², Nicoletta Zerman³ and Enrico Spinas^{1,4}

Dentistry Journal 2024 Mar 1;12(3):60. doi: [10.3390/dj12030060](https://doi.org/10.3390/dj12030060)

Key Findings:

- **Statistically significant airway increases**, especially in:
 - **Nasal cavity**: volume increased by **9.9%–31%**
 - **Nasopharynx**: volume increased by **6.4%–20.7%**
- **Improvements were observed immediately after expansion.**
- **MARPE affects upper airway anatomy favorably**, but its direct role in reducing OSA incidence remains unclear.

Conclusions: MARPE lead to a statistically significant increase in the upper airway, especially in the nasal cavity and nasopharynx immediately after expansion

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Chapter 57
MINI-SCREW ASSISTED MAXILLARY EXPANSION TECHNIQUES FOR TREATMENT OF OBSTRUCTIVE SLEEP APNEA
 Audrey Jung-Sun Yoon
 Management of Obstructive Sleep Apnea - A Multidisciplinary Textbook with Evidence-Based Guidelines Kim et al 2019 1st edition

DESIGN	ADVANTAGE	DISADVANTAGE
Hybrid Design: 2 Molar bands + 2 miniscrews • Hybrid Hyrax (Benedict Design)	<ul style="list-style-type: none"> Easy to insert and remove mini-screws Reduced inventory Can be custom-made to individual Easy refabrication for 2nd expander High success rate of midpalatal suture splits on young adults 	<ul style="list-style-type: none"> High cost of fabrication High cost of components Multiple piece fabrication Multiple appointment process Too bulky to insert into very narrow palate
Hybrid Design: 2 Molar Bands + 4 miniscrews • MSE (Maxillary Skeletal Expander) • KBE (Kee's Bone Expander)	<ul style="list-style-type: none"> Pre-fabricated design of jackscrew including miniscrew insertion holes Easy to insert and remove mini-screws Simple technique High success rate of midpalatal suture splits on young adults 	<ul style="list-style-type: none"> High cost of fabrication High cost of component Multiple appointment process Jackscrews are too big for very narrow palate Location of mini-screws insertion into bone are limited and dictated by the pre-fabricated holes of expander Once mini-screw anchorage fails, hard to change the location Mini-screws often penetrate through nasal cavity (oroantral fistula)

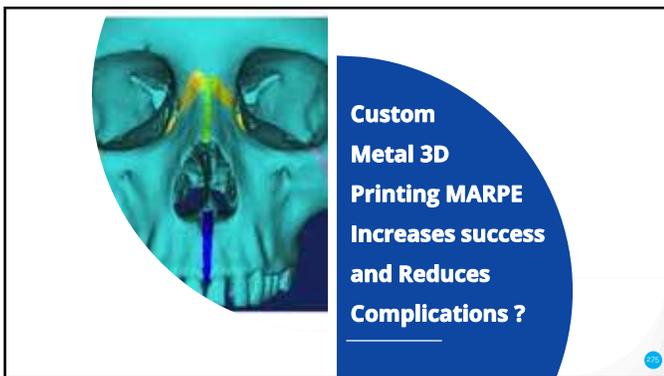
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DESIGN	ADVANTAGE	DISADVANTAGE
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Ready-made MARPE (MSE) → **Custom 3D Metal Printing MARPE**

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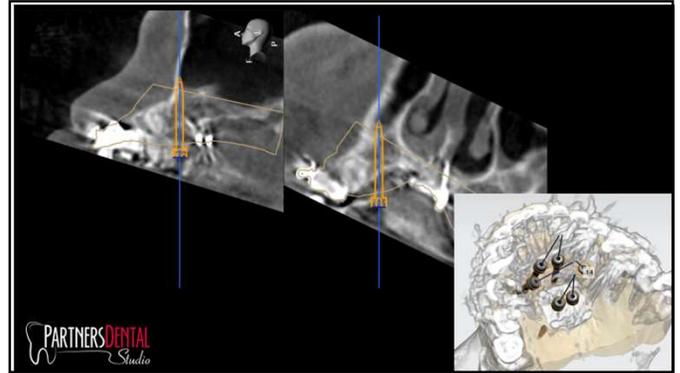
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Audrey Yoon, DDS, MS
Transfer Case
 38 yrs old Male
 Missing UR3, UL3, LL1
 Midfacial deficiency
 Sleep Disordered Breathing

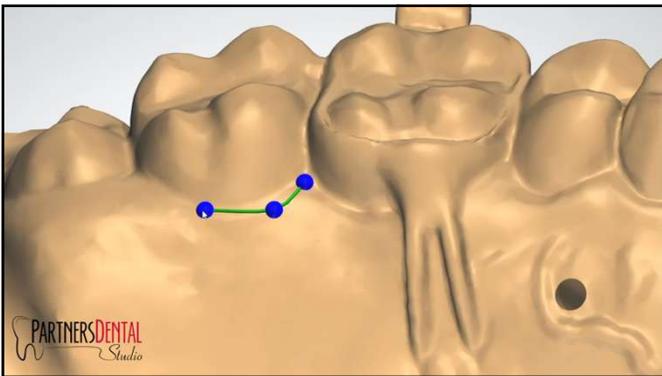
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**Adult MARPE : Custom 3D Metal Printing MARPE
(without cortipuncture or piezo)**

Retrospective Analysis of Success Rates and Complications in 100 Consecutive Adult Cases of Customized 3D-Printed Miniscrew-Assisted Palatal Expansion

Audrey Yoon , Eugene Y Kim , Heeyeon Suh
Unpublished, Under Review, In Submission, 2025

- Custom 3D-printed MAPE improves success in older patients by enhancing anchorage and fit, reducing pain and complications with a slower expansion protocol.
- 100 consecutive custom MARPE in adult : 99.9% success rate in females and 97% in males.
- These findings highlight the value of personalized design and precise mini-implant placement.

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Adult MARPE : Custom 3D Metal Printing MARPE (without cortipuncture or piezo)

Retrospective Analysis of Success Rates and Complications in 100 Consecutive Adult Cases of Customized 3D-Printed Miniscrew-Assisted Palatal Expansion

Audrey Yoon , Eugene Y Kim , Heeyeon Suh *Under Revision, In Submission, 2025*

ADULT non-surgical MARPE Success : 100 % Female, 97.3 % Male ALL AGES

Age Group	Male	Female
<18	~18	~18
18-25	~15	~15
>25-35	~12	~12
>35-45	~10	~10
>45	~8	~8

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Treatment outcomes of 3D-printed custom and conventional mini-implant assisted rapid palatal expanders (MARPE)

Yash Sharma¹, Heeyeon Suh^{1*}, Jonas Bianchi¹, Audrey Yoon^{1,2} and Heesoo Oh¹

Custom 3D Metal Printing MARPE
90 % skeletal
In adult expansion

Objective: Compare Conventional MARPE (MSE-II) vs. Custom 3D-printed MARPE in
Methods: CBCT analysis of 42 pt (16-35 years)
Results: MxW/SCRW 0.9 in custom MARPE group and 0.4 in MSE(P=0.0001)
Conclusion: Custom 3D-printed MARPE enhances maxillary expansion in adults with better design and implant placement.

Ready-made MARPE (MSE 2)
40 % skeletal
In adult expansion

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Treatment outcomes of 3D-printed custom and conventional mini-implant assisted rapid palatal expanders (MARPE)

Custom 3D Metal Printing MARPE
90 % skeletal
In adult expansion

Ready-made MARPE (MSE 2)
40 % skeletal
In adult expansion

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New MARPE Protocol : "No Diastema Protocol"

Esthetic Diastema Control (No-Diastema Protocol): Precision-Guided Slow Maxillary Skeletal Expansion with Clear Aligners

Thomas Roblee*, Richard Roblee*, James Roblee*, Eugene Y Kim*, Audrey Yoon^{hc}

Unpublished, Under Review, In Submission, 2025

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What is future ?
Action to Next level : Diagnosis and Phenotyping Precision Medicine

- Can we avoid expensive overnight polysomnography?
 - Can we avoid radiation or sedation?
- Easy, Affordable and non-invasive way to calibrate and measure ?
- Can we prevent OSA from developing in high-risk population?

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Screening and Diagnosis of Pediatric OSA : Beyond AHI What Is In The Future ?

EUROPEAN RESPIRATORY JOURNAL
ORIGINAL RESEARCH ARTICLE
R. CORTESE ET AL.

Single-cell RNA-seq uncovers cellular heterogeneity and provides a signature for paediatric sleep apnoea

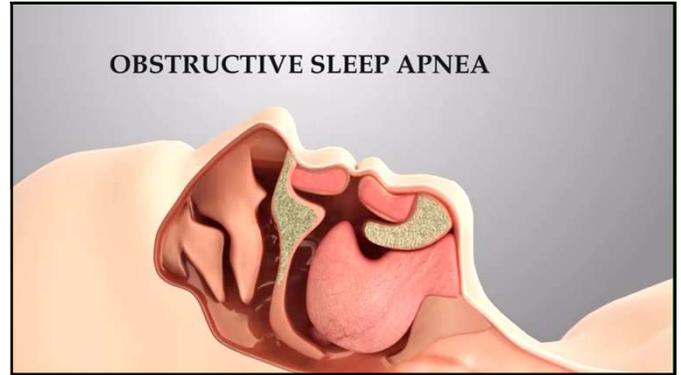
Rene Cortese¹, Taylor S. Adams², Kylie H. Cataldo³, Justin Hummel⁴, Naftali Kaminski⁵, Lella Khetrandish-Gozal⁶ and David Gozal⁶

96 % accuracy
Molecular signature for the diagnosis of paediatric sleep apnoea.
- Molecular signature consisting of 32 markers.

Rene Cortese et al. Eur Respir J 2023;61:2201465

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Research

JAMA Otolaryngology-Head & Neck Surgery | Original Investigation

Association of Backscattered Ultrasonographic Imaging of the Tongue With Severity of Obstructive Sleep Apnea in Adults

Stanley Y. C. Liu, MD, DDS; Pien F. N. Bosscheter, MD, PhD; Mohammed Abdelwahab, MD, PhD; Pei-Yu Chao, PhD; Argen Chen, PhD; Clete Kushida, MD, PhD

Figure 1. Ultrasonography Equipment and Upper Airway Diagram

Figure 2. Ultrasonographic Images

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Can voice quality accurately predict patient symptom severity of nasal congestion?

Mild congestion:

- High energy at lower frequencies and distinct energy bands

Moderate to severe congestion:

- Reduced energy at low frequencies due to limited nasal airflow

Audrey Youns, DDS, ME

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Using AI: Zero Radiation Smartphone Facial Scan with CT Level Accuracy

Real vs Estimated	Width	Height
Absolute Error	0.139 ± 0.084 cm	0.252 ± 0.191 cm
Percent Error	4.13 ± 2.44 %	6.38 ± 4.79 %

Meliadis et al. EMBS 2023

Audrey Youns, DDS, ME

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Using AI: Zero Radiation Smartphone Facial Scan

Close: SONU Airway Measure...

Measurements

- Nasal alar width | aL-aR | 3.605 cm
- Nasal base width | aCL-aCR | 3.375 cm
- Upper face height | p-sn | 5.107 cm
- Vertical philtrum height | sn-st (Mm) | 1.965 cm
- Intra eye distance | eUL-eUR | 3.619 cm
- Facial width | zYL-zYR | 15.622 cm
- Gonion width | gonL-gonR | 11.708 cm
- Mouth width | chl-eMR | 5.784 cm
- Intermental width | emL-emR | 6.638 cm
- Face height | T-ment | 9.289 cm

Angles

- Facial profile angle | n-sn-pB (°) | 99.02°
- Nasolabial angle | cm-sn-la (°) | 123.97°
- Nasal width angle | aCL-prn-aLR (°) | 71.69°
- ZYL-Gon-975 Angle | 70.60°
- ZYL-Gon-975 Angle | 70.62°
- gonL-pg-gonR (angle) | 86.79°

Measurements

- Nasal alar width | aL-aR | 3.605 cm
- Nasal base width | aCL-aCR | 3.375 cm

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AI Enabled Personalized Airway Management and Therapy

- Provide a clear **Therapeutic Pathway** with Experienceable and Measurable milestones
- Appliance Therapy
- Airway Autonomic Modulation
 - personalized vibrational therapy for sustained patency and clear congestion free nasal breathing
- Real Time health

Stay in Tune, Launching this year

295

Interdisciplinary OSA Treatment Protocol

296

Original Stanford Sleep Surgery Protocol

(Physical Examination, Cephalometric Analysis, Fiberoptic Pharyngoscopy)

Powell N, Riley R. A surgical protocol for sleep disordered breathing. Oral Maxillofac Surg Clin North Am. 1995 Aug;7(3):345-356.

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Updated Stanford sleep surgery algorithm

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Surgical Management of Obstructive Sleep Apnea: A Collaborative Approach to a Multidisciplinary Disease

Allen Huang,^{1,2} Felix Kyle Yip,^{1,3} Eugene Y Kim,⁴ Audrey Yoon, DDS, MS^{4,5}

Seminar in Orthodontics, In press 2025

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Surgical Management of Obstructive Sleep Apnea: A Collaborative Approach to a Multidisciplinary Disease

Allen Huang,^{1,2} Felix Kyle Yip,^{1,3} Eugene Y Kim,⁴ Audrey Yoon, DDS, MS^{4,5}

Seminar in Orthodontics, In press 2025

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MaxilloMandibular Advancement (MMA)

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Classic Maxillomandibular Advancement Surgery for OSA

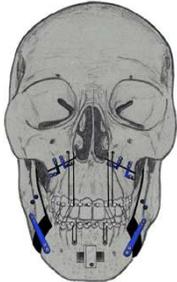
- Developed by Robert Riley, MD, DDS; Nelson Powell, MD, DDS; and Christian Guillemainault, MD at Stanford
- **Maxillary driven procedure** – greater success when maxilla is advanced 10 mm or more and mandible over 11 mm
- Designed to maximize soft tissue tension - allow for larger advancements.



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Classic Maxillomandibular Advancement Surgery for OSA

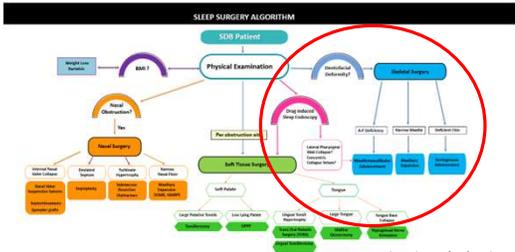
- Earliest indications:
 - (1) severe OSAS,
 - (2) morbid obesity,
 - (3) severe mandibular deficiency
 - (4) failure of other forms of therapy.
- Class 1 patients with or without bimaxillary hypoplasia.
 - Often seen when there is history of extractions during orthodontic treatment.



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Surgical Management of Obstructive Sleep Apnea: A Collaborative Approach to a Multidisciplinary Disease

Allen Huang,^{1,2} Felix Kyle Yip,^{1,3} Eugene Y Kim,⁴ Audrey Yoon, DDS, MS^{4,5}

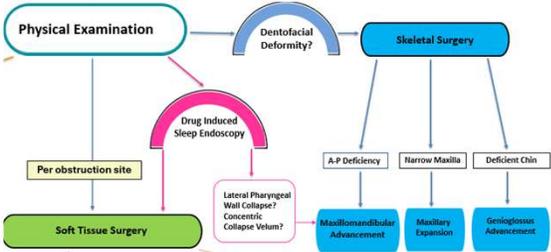


Seminar in Orthodontics, In press 2025

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Surgical Management of Obstructive Sleep Apnea: A Collaborative Approach to a Multidisciplinary Disease

Allen Huang,^{1,2} Felix Kyle Yip,^{1,3} Eugene Y Kim,⁴ Audrey Yoon, DDS, MS^{4,5}



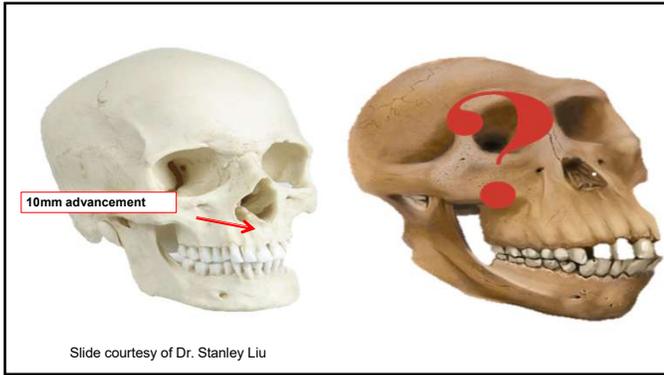
Audrey Yoon, DDS, MS

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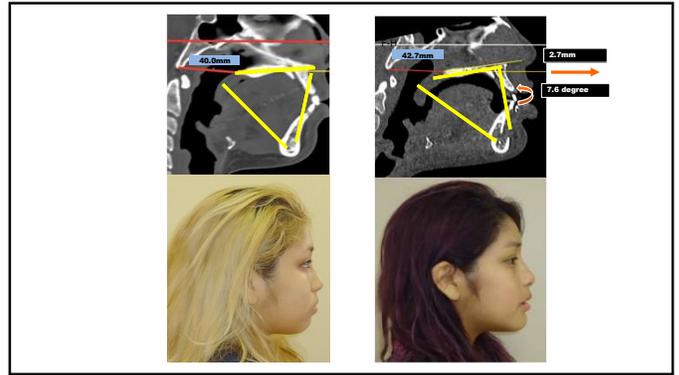
MMA for Bi Max Case




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308

Otolaryngology—
Head and Neck Surgery

An Accurate Method of Designing and Performing Individual-Specific Genioglossus Advancement

Chloromyrberg
Head and Neck Surgery
Fellow
American Academy of
Otolaryngology—Head and Neck
Surgery (Headline 2016)
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requests: www.sagepub.com/journalsPer-
mission.nav DOI: 10.1177/0022000715230366
http://jns.sagepub.com

Stanley Yung-Chuan Liu, MD, DDS¹, Leh-Kiong Huon, MD^{1,2,3},
Sorovush Zaghi, MD¹, Robert Riley, MD, DDS¹,
and Carlos Torre, MD¹

Long canine roots Mental Nerve Genial Tubercle

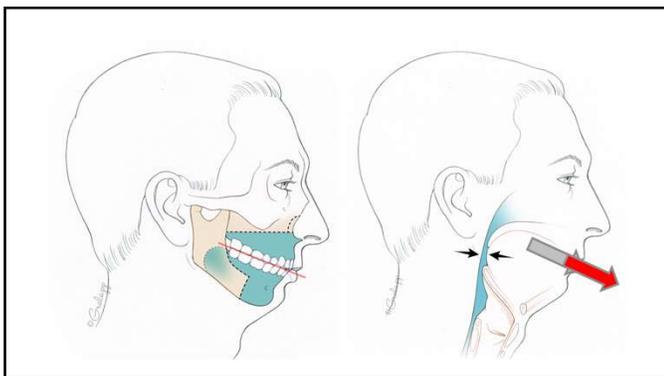
309

G.F.

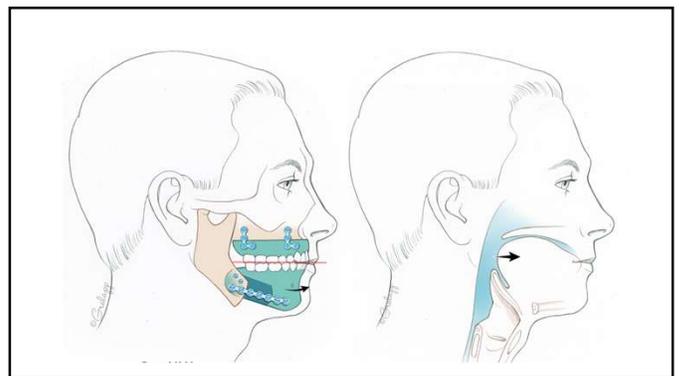
- 18 yrs old
- Had 6 years orthodontic treatment (phase I, phase II, orthotropic)
- AHI 45 at age 11
→ Tonsillectomy, adenoidectomy, RF turb
→ AHI improved 7.3, supine sleep AHI 9.5, REM sleep AHI 8.3, minimum O2 93% at age 13
- Excessive daytime fatigue, decrease attention and concentration
- Usually sleep 11 PM to 11 AM (12 hours), still waking up unrefreshed

Dr. Audrey Yoon

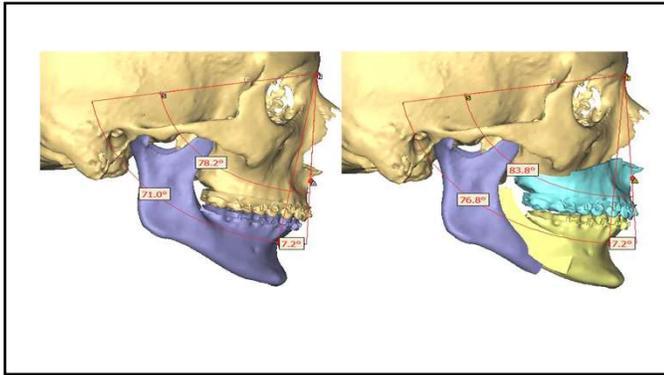
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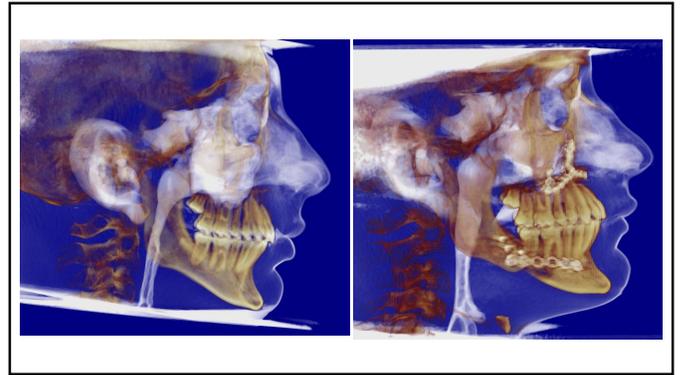
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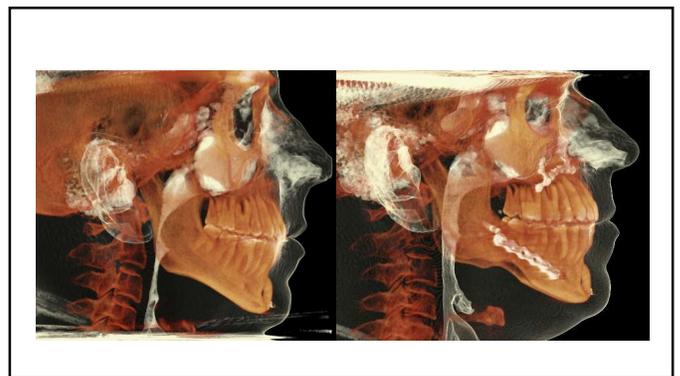
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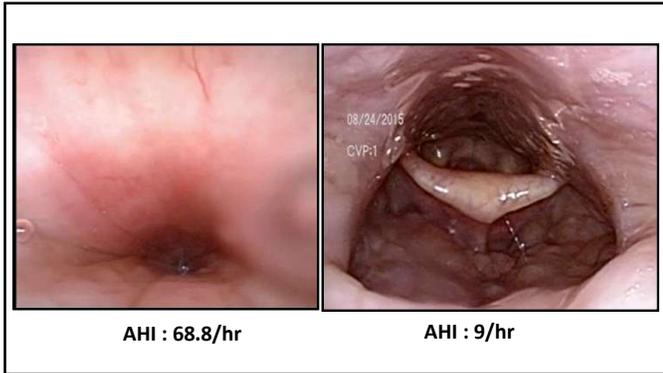
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317



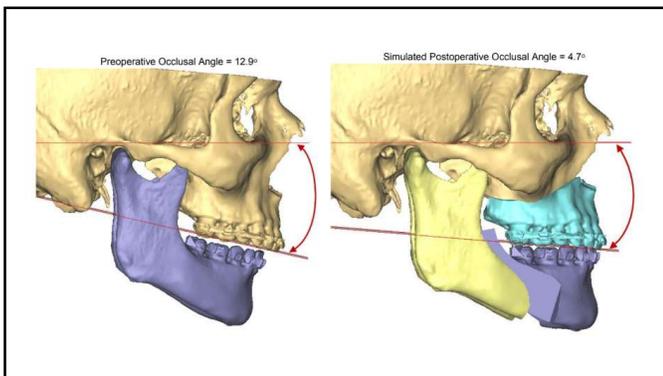
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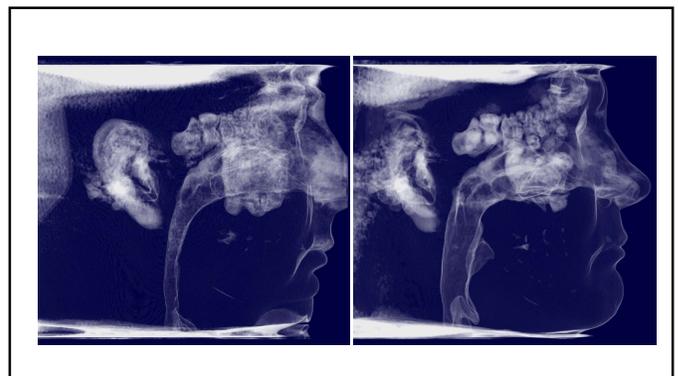
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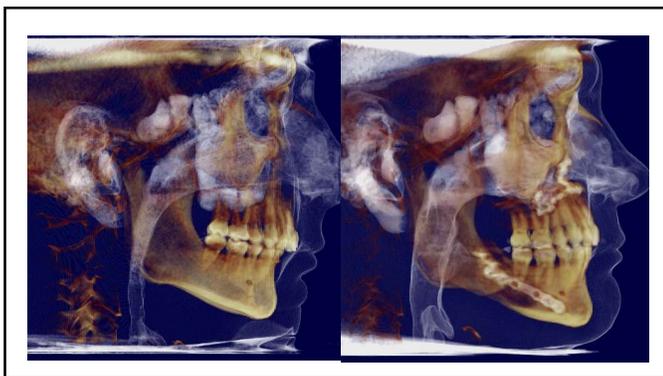
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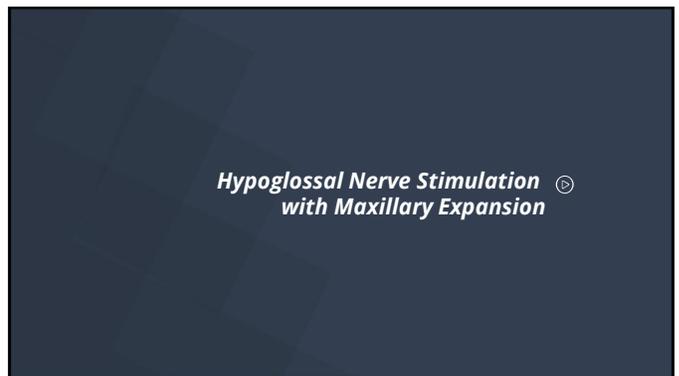
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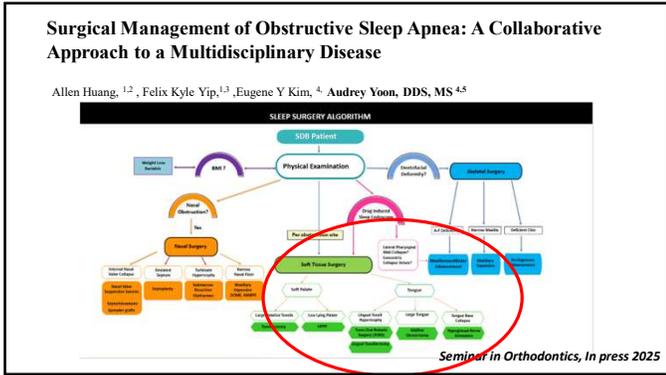
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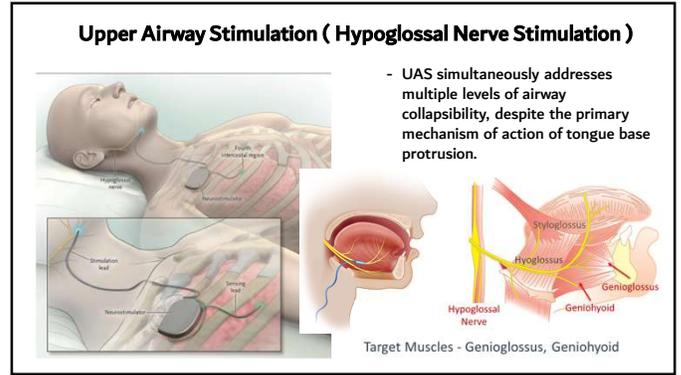
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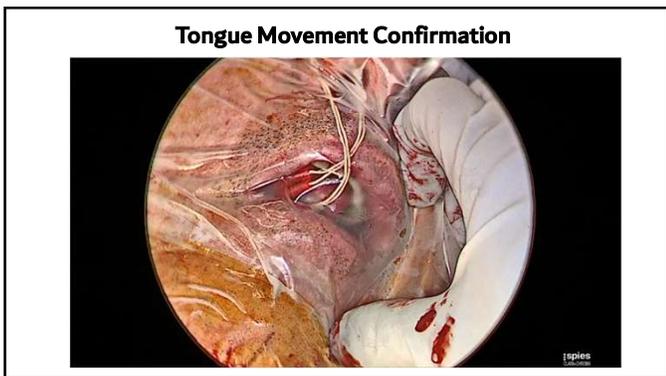
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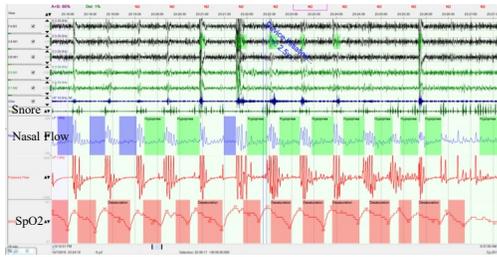


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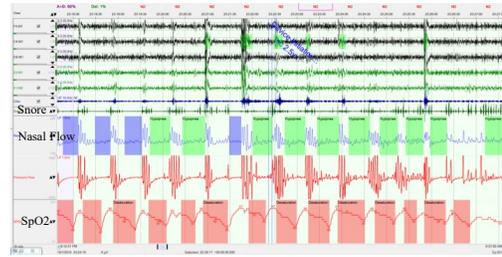
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Baseline



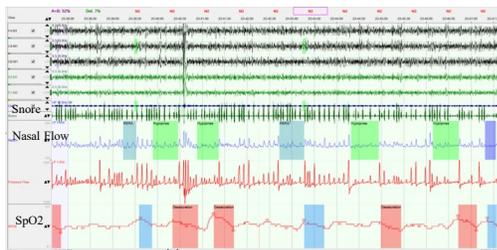
331

Functional Threshold



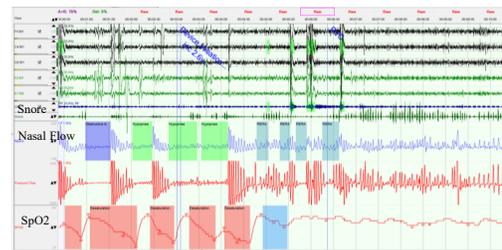
332

(2.5 Volts)



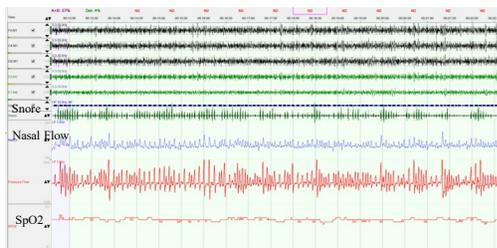
333

(2.6 Volts)



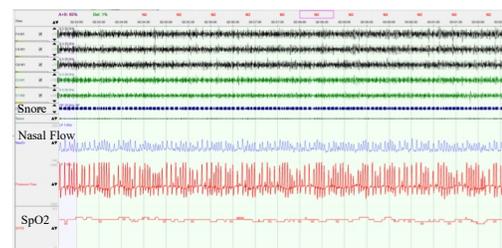
334

Minimum Therapeutic Amplitude (2.6 Volts)



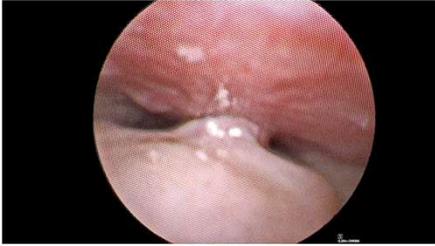
335

(2.8 Volts)

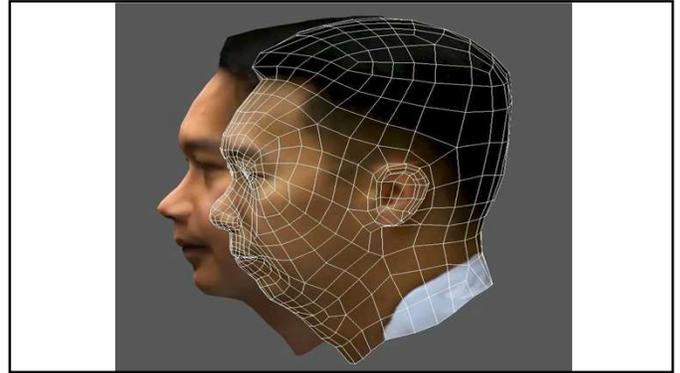


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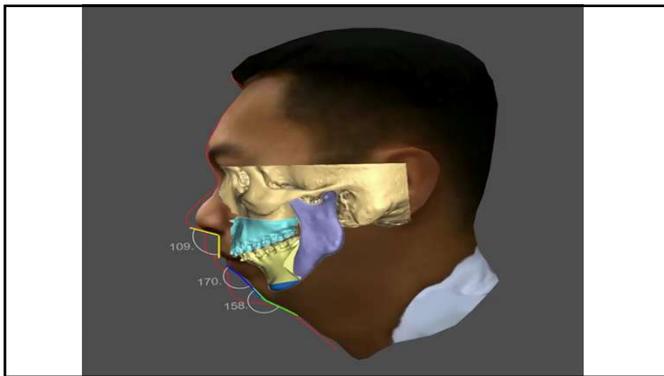
Upper Airway Stimulation for OSA



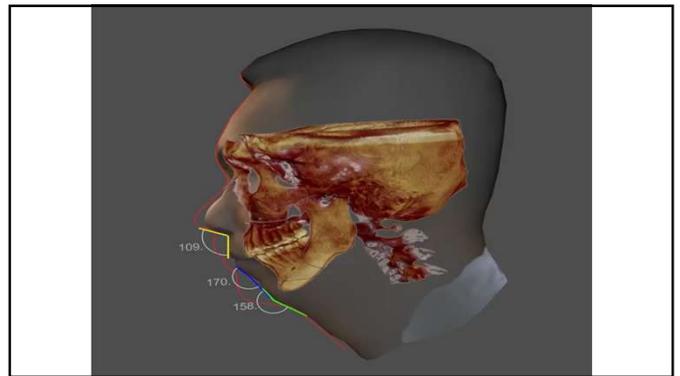
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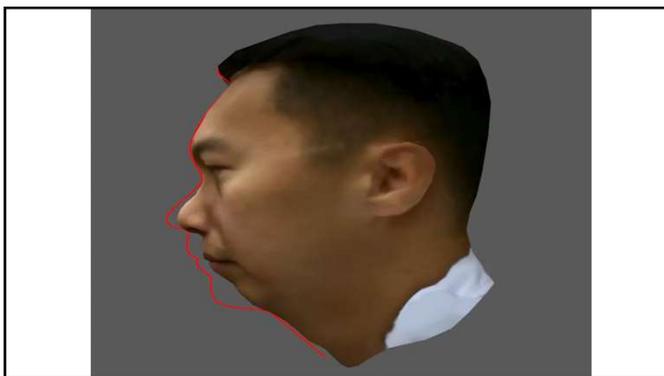
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Building the anatomical structure which lasts the lifetime



Patient Specific Airway Design from Children to Adult
The optimal esthetics and function

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Thank You

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