

NONINVASIVE VENTILATION CONFERENCE

Which therapeutic option when CPAP fails?

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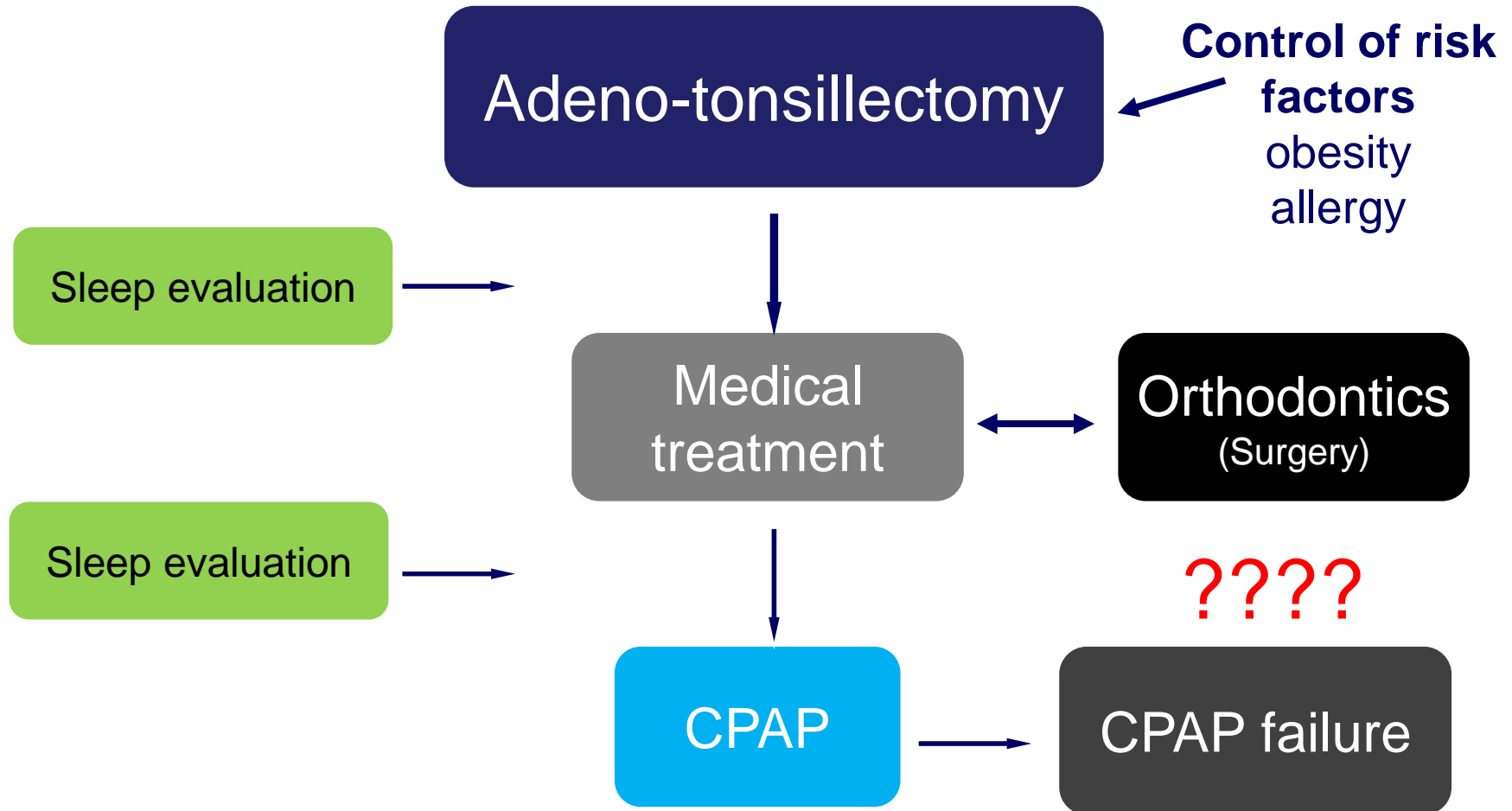


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Stepwise treatment approach



Other options?

- *Revise previous therapeutic options*
 - *weight loss*
 - *mandibular advancement devices or rapid maxillary expansion*
- *Discuss surgery (selected patients)*
 - *mandibular distraction osteogenesis*
 - *craniofacial surgery*
- *High flow nasal cannula*
- *Tracheotomy*

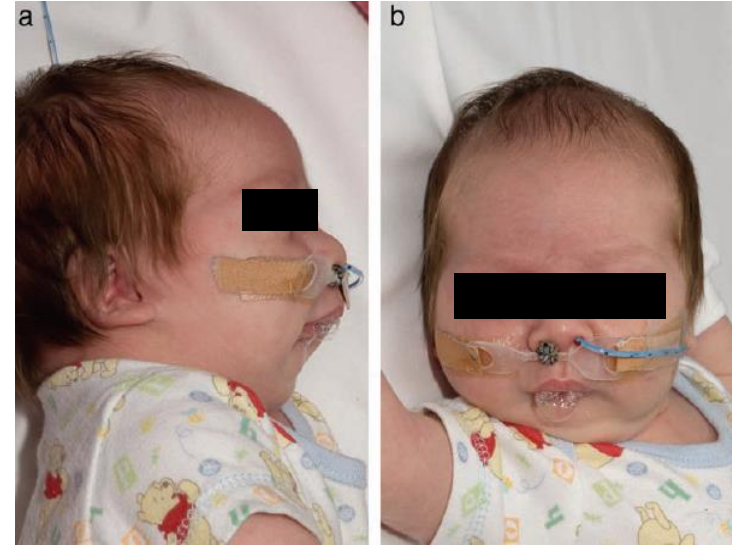
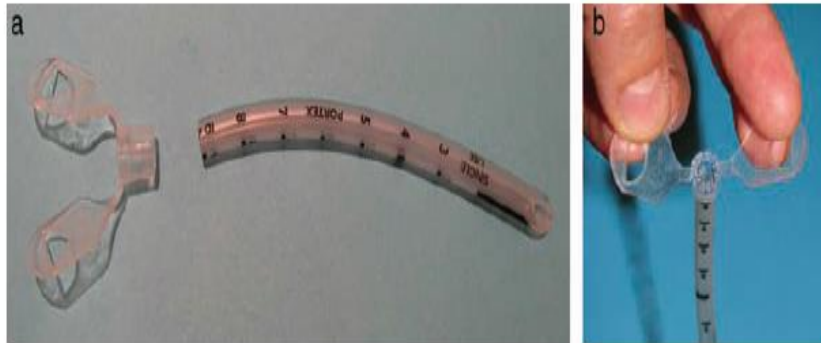
Additional specific options?

- Nasopharyngeal airway
- Hypoglossal nerve stimulation
- Uvulopalatal plates
- Myofunctional therapy
- Diaphragmatic pacing (as an alternative to NIV)
- ? Pharmacotherapy

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Nasopharyngeal airway (NPA) in PRS



- Modified endotracheal tube placed intranasally and positioned in distal oropharynx beyond the area of glossoptosis
- Breaks seal between tongue and posterior pharynx and child can breathe through tube and contralateral nostril

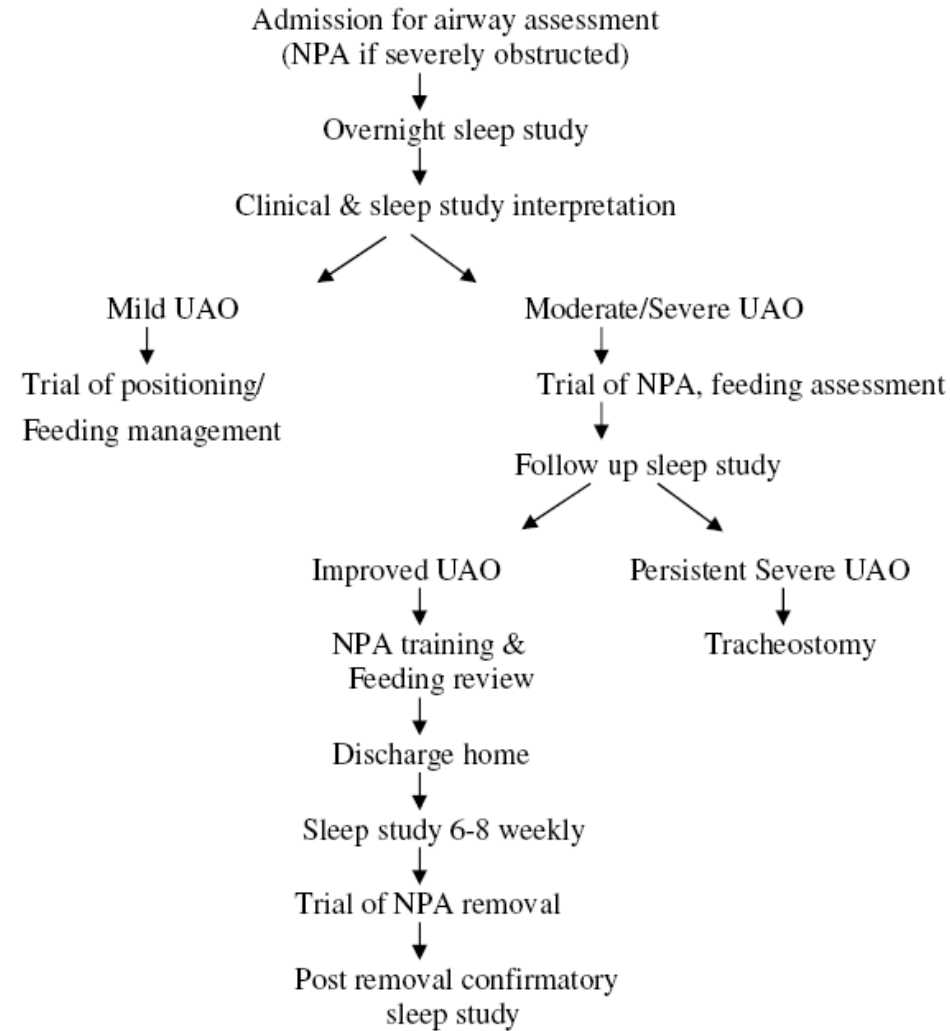
NPA: Advantages

- Non invasive management
- Efficient in hospitalised infant for weight gain, UAO relief and normalisation of oximetry^{1-2, 5}
- Transition home is possible after training³⁻⁵
- Minimal adverse effects if training done well
- Safe and effective option in many institutions

1. Parhizkar N et al. Cleft Palate Craniofac J. 2011 Jul; 48: 478-82
2. Wagener S et al. Cleft Palate Craniofac J. 2003 Mar; 40: 180-5
3. Olson TS et al. Int J Pediatr Otorhinolaryngol. 1990 Sep; 20: 45-9
4. Anderson KD et al. Cleft Palate Craniofac J. 2007 May; 44: 269-73
5. Abel F et al. Arch Dis Child. 2012 Apr; 97: 331-4

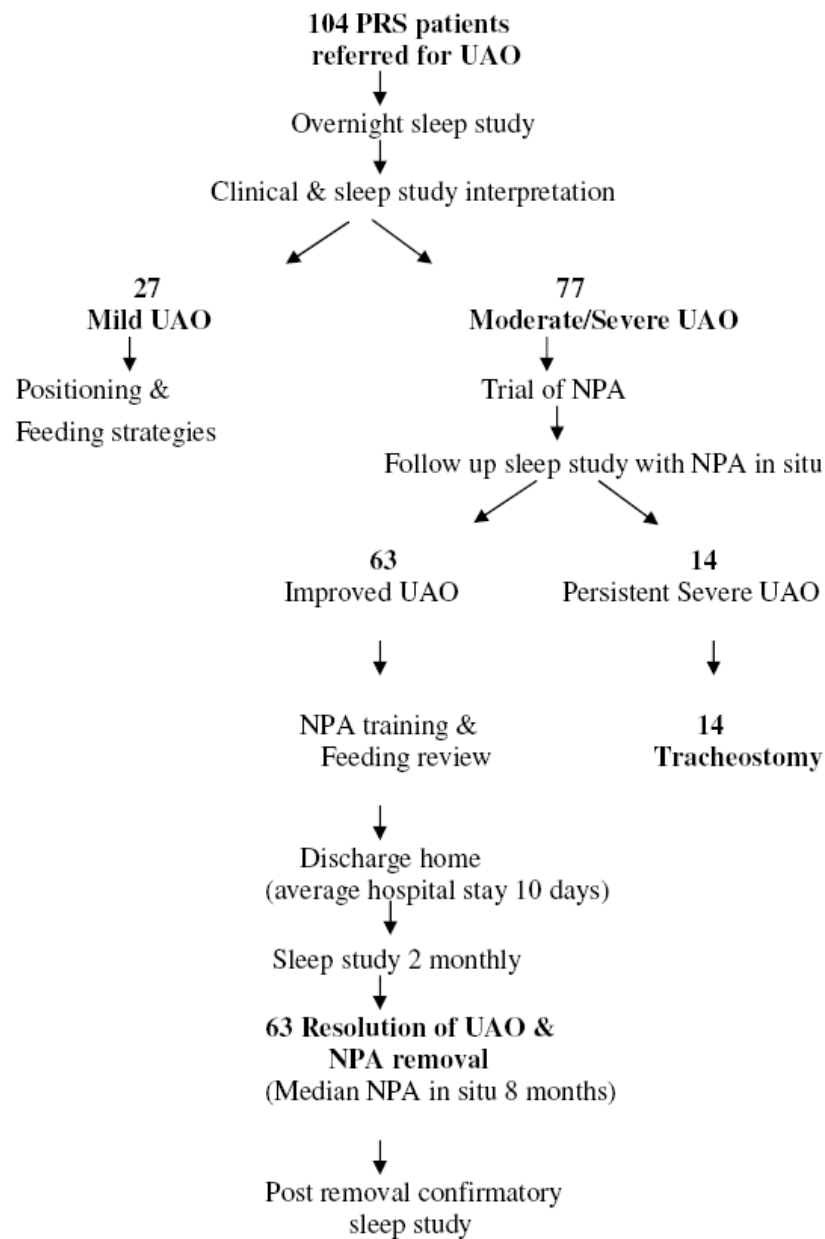
The successful use of the nasopharyngeal airway in Pierre Robin sequence: an 11-year experience

Francois Abel,¹ Yogesh Bajaj,² Michelle Wyatt,² Colin Wallis¹



The successful use of the nasopharyngeal airway in Pierre Robin sequence: an 11-year experience

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Results

- Median age at time of insertion : 30 days old (1 day – 330 days)
- Median length of hospital stay (including training): 10 days (6-28 days)
- Median use of NPA: 8 months (6 weeks – 27 months)
- 63 out of 77 patients (81%) had resolution of UAO with NPA management.
- 14 out of 77 patients (19%) required tracheostomy – 90 % syndromic PRS
- 2 had mandibular distraction osteogenesis and are still tracheostomy dependent.
- There were no nasal injuries, no fatalities, no untoward incidents at home and no other complications related to the use of NPA.

Other indications of NPA

Craniosynostosis-associated OSA

- Bypassing midface obstruction with a nasopharyngeal airway
- Study in 27 children with syndromic craniosynostosis
 - 17 severe OSA pre-insertion
 - 10 moderate OSA pre insertion
 - Mean age at NPA insertion was 12.3 months (0.5-48)
 - Improvement in OSA severity scores in 96% of patients
 - 3 moderate OSA
 - 24 mild OSA
- NPA well tolerated with 24/27 children retaining it for >6 weeks

Other indications of NPA – OSA in patients with cerebral palsy

- Different factors contributing to upper airway obstruction in patients with CP (including awake)
 - Maxillary hypoplasia
 - Hypotonia of palate and constrictor muscles
 - Glossoptosis
 - Retrognathia
 - Inspiratory airway collapse
 - Redundant aryepiglottic folds
 - GORD leading to upper airway inflammation
 - Laryngeal dystonia
- Anecdotal evidence that NPA helps in these situations but dedicated studies needed

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Hypoglossal nerve stimulation in Down syndrome

- Novel therapy for OSA in adults
- Efficacy and safety in adolescent with Down syndrome (DS) with persistent OSA
- Recent study where 20 non-obese children (10- 21 yo) with DS and severe OSA (AHI >10 and <50 events/hr) despite prior adenotonsillectomy and failed CPAP trial were enrolled. All patients had drug induced sleep endoscopy to confirm eligibility for HNS
 - All children were implanted with no long term complications
 - Median reduction in AHI of 85% at PSG 2 months post implantation
 - Median change in OSA-18 score of 1.15 – well tolerated – median hours of use 9.21 hrs/night

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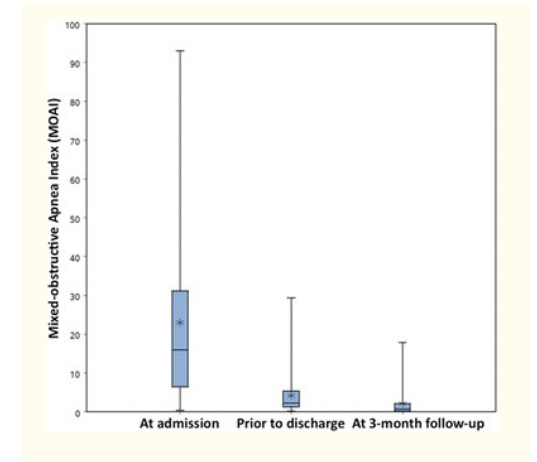
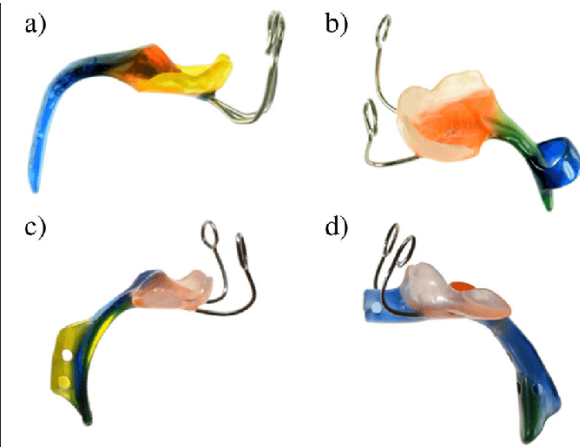
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Palatal plates (PP)



- Used since 1960's in infants with PRS
- Effect mediated by improved tongue function and stimulation of mandibular growth
- Butow et al²⁷:
 - single centre 188 PRS patients
 - PP (suction and drinking plate) used in 134 with resolution of glossoptosis in 122 (91%)
 - feeding problems persist in 26%
 - no objective assessment of UAO
 - 9 % required invasive management

- More severe UAO – modified acrylic palatal plate with velar extension shifting base of tongue forward
- PEPB: pre-epiglottic baton plate – correct length and angle controlled endoscopically – corrects anatomical abnormalities and allows for mandibular catch up growth
- Initial small studies showed benefits but requires a good interdisciplinary team used to this device¹⁻²
- Recent prospective multicentre cohort study confirms efficacy even in syndromic patients³



1. Buchenau et al. *J Pediatr.* 2007 Aug; 15:145-9
2. Bacher M et al. *Cleft Palate Craniofac J.* 2011 May; 48:331-6
3. Poets CF et al. *Orphanet J Rare Dis.* 2017 Mar; 12:46

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Myofunctional therapy

- Oropharyngeal exercises aimed at improving labial seal and lip tone, facilitating nasal breathing rehabilitation and improving tongue posture
- Exercises to be performed daily with the aim of strengthening the tongue and orofacial muscles and realigning them in the correct position



Myofunctional therapy

- To date, studies have been small and larger prospective and controlled studies will be required
- Retrospective study of 24 children (3.6- 6.6 yo) post adenotonsillectomy¹
 - 11 received myofunctional re-education for 24 months – no recurrence of OSA
 - recurrence of symptoms OSA at 50 months in all patients who did not receive re-education (mean AHI 5.3 +/- 1.5)
- Retrospective study of 14 subjects with residual OSA post AT improved AHI by 58% after being treated with oropharyngeal exercises for 2 months compared with 7% in control group²
 - reduction in oral breathing, increased labial seal, lip tone, ...

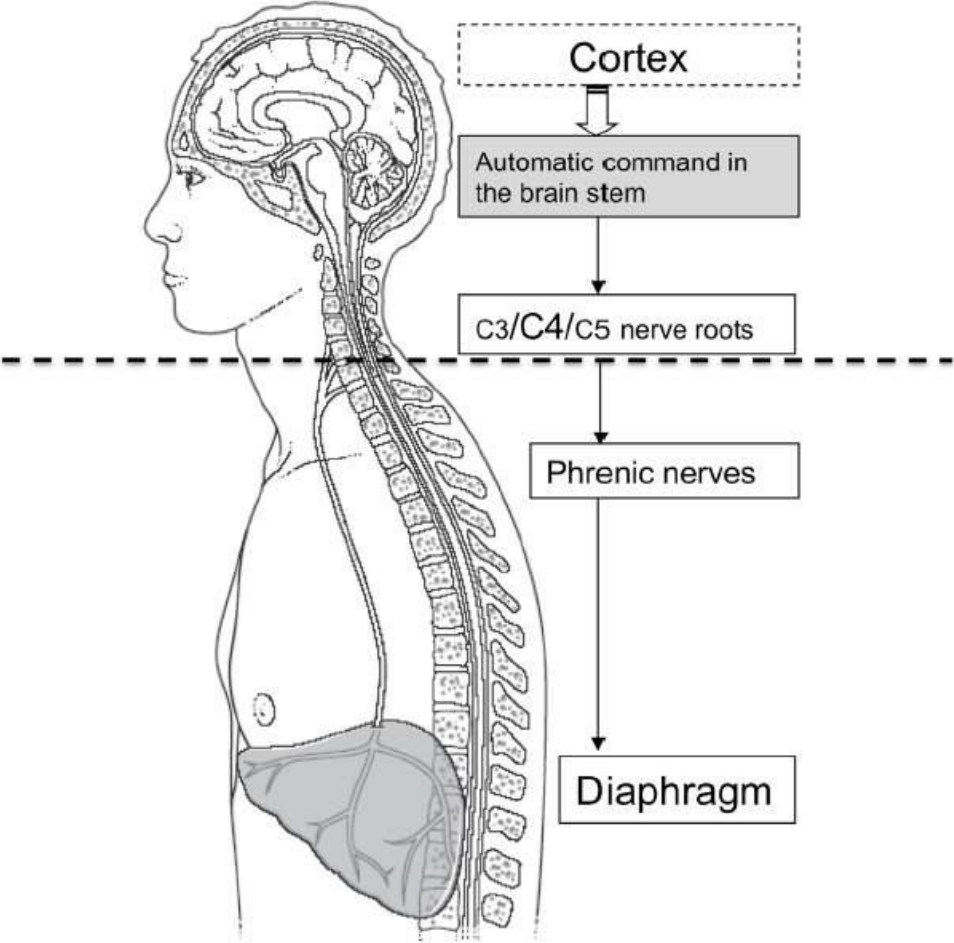
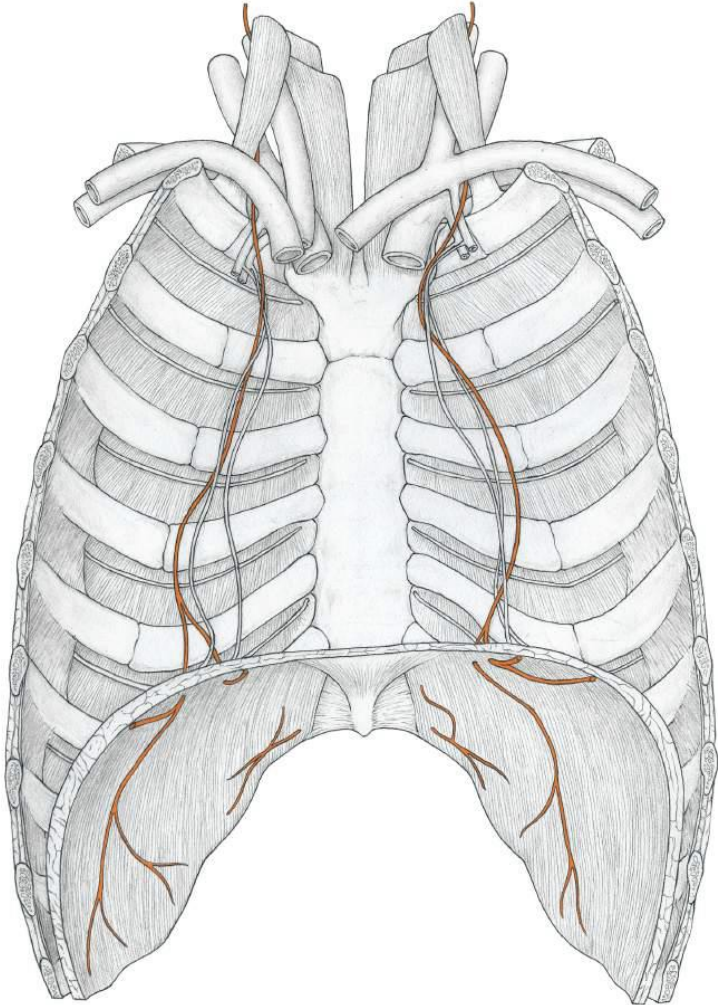
1. Guilleminault C et al. *Sleep Med.* 2013 Jun; 14:518-25

2. Villa MP et al. *Sleep Breath.* 2015 Mar; 19:281-9

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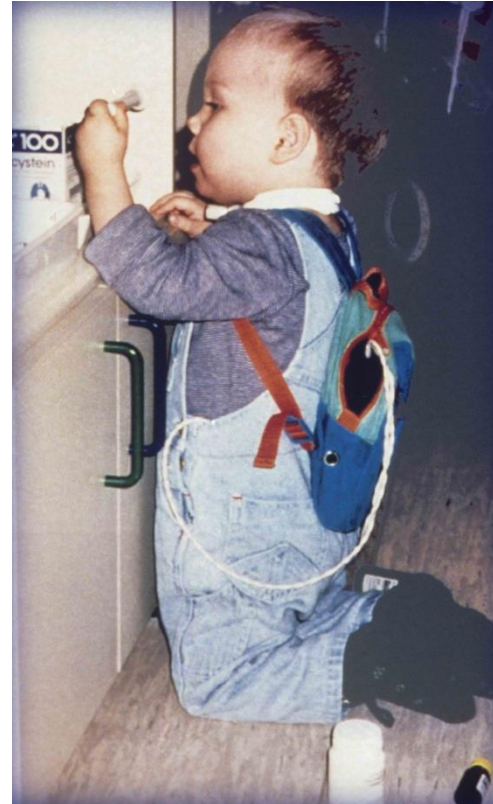
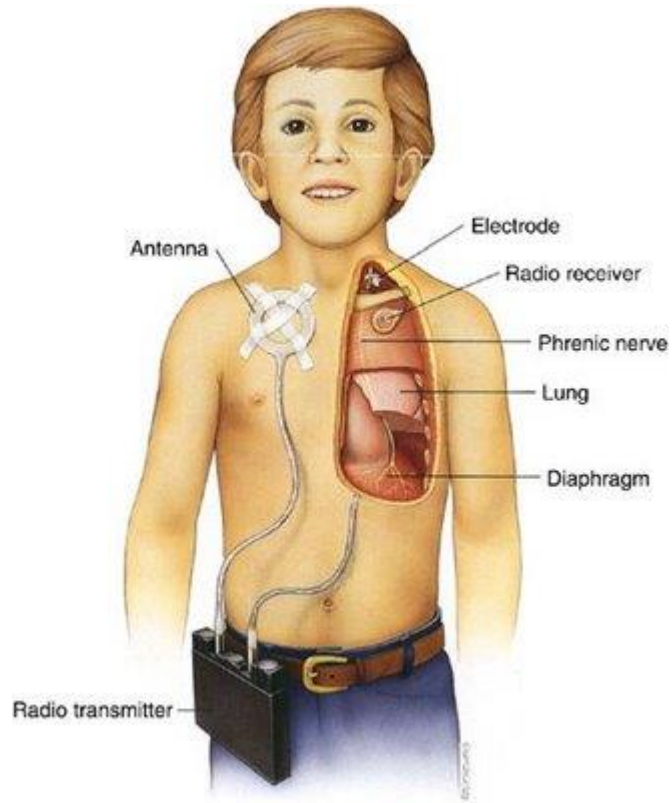
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Diaphragmatic pacing



Diaphragmatic pacing

- Bilateral implantation of phrenic nerve electrodes (either cervical or thoracic approach)
- Radiofrequency signal converted in electrical current transmitted to electrodes via stainless steel wires
- Electrical stimulation causes diaphragmatic contraction



Advantages/Disadvantages

- Advantages

- Optimal for patients requiring daytime ventilation – often used in combination with NIPPV at night
- For older patient on night time ventilation only – possibility to wean from tracheostomy¹
- Indications: Central sleep apnoea (including CCHS), quadriplegia/tetraplegia, diaphragm paralysis
- Safe and efficient in CCHS patient as an alternative to positive pressure ventilation²

- Disadvantages

- OSA : synchronous upper airway skeletal muscle contraction does not occur with paced inspiration
- Back up diaphragm pacer required/NIPPV backup
- Expertise centre required (ability to set pacers with digital oscilloscopes and surface EMG recordings)

1. Diep B et al. *Respiration*. 2015 ; 89:534-8

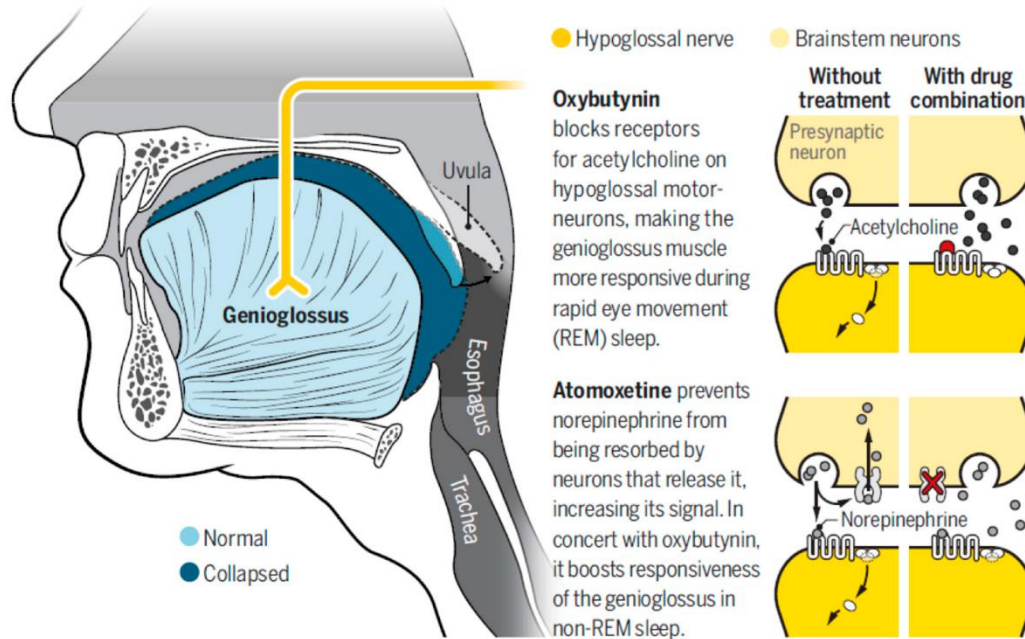
2. Nicholson KJ et al. *J Pediatr Surg*. 2015 Jan; 50:78-81

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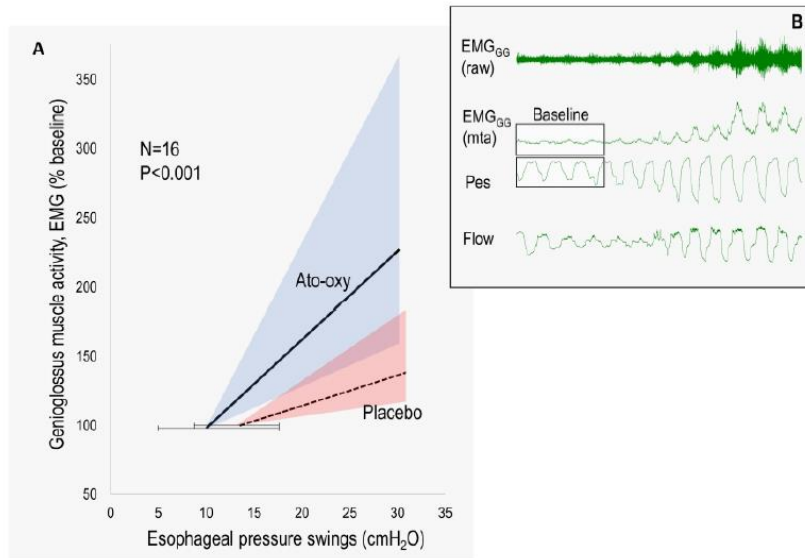
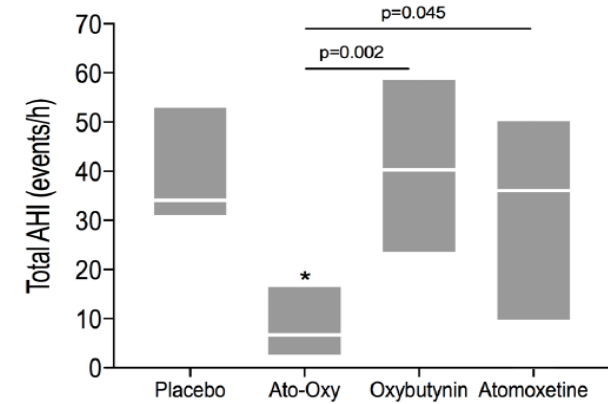
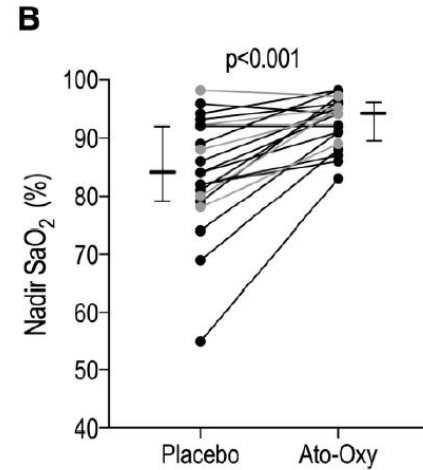
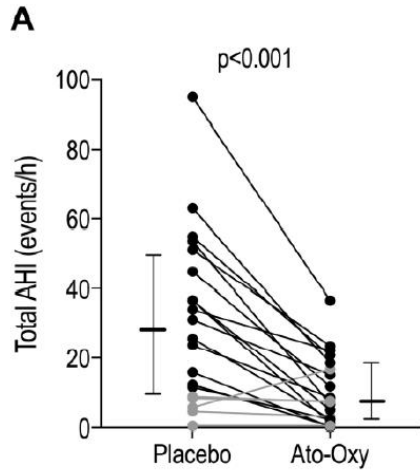
The Combination of Atomoxetine and Oxybutynin Greatly Reduces Obstructive Sleep Apnea Severity. A Randomized, Placebo-controlled, Double-Blind Crossover Trial

Luigi Taranto-Montemurro ¹, Ludovico Messineo ^{1,2}, Scott A. Sands ¹, Ali Azarbarzin ¹, Melania Marques ^{1,3}, Bradley A. Edwards ^{4,5}, Danny J. Eckert ⁶, David P. White ¹, and Andrew Wellman ¹



- Oxybutynin is FDA approved drug for treatment of overactive bladder in adult and children
- Atomoxetine is FDA approved drug for treatment of ADHD in adult and children

- Proof of concept physiological trial
- Randomised placebo-controlled double blind cross-over trial to evaluate effectiveness of combination of Atomoxetine/Oxybutynin on OSA severity and genioglossus activity in subjects with OSA
- 20 adult patients randomised to either placebo or combination 30 min before lights out
- Subgroup of 9 patients were drugs were given separately
- 16/20 male, mean age 53 yo and mean BMI 34.8kg/m²



- AHI reduced by 74% (62-88%)
- Genioglossus responsiveness increased 3 fold (from 2.2 [1.1-4.7]/cmH₂O on placebo to 6.3 [3-18.3]/cmH₂O on combination therapy)
- Combination is believed to have synergistic effects on upper airway dilator muscles
- Neither oxybutynin nor atomoxetine reduced the AHI when administered separately
- No significant changes in sleep architecture and arousal index between the groups
- Proof of concept trial of usefulness of pharmacotherapy in adult
- Clinical trials are being started in adults
- No applicability for paediatric yet but interesting concept with relatively safe combination therapy although long term risk and adverse effects will need to be established

Conclusions

- Multiple alternative possible if CPAP fails
- These options are however condition and patient specific
- Importance of phenotypical approach to identify which patient would benefit from which intervention

Thank you for you attention
Any questions?

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