Online supplement

Adenotonsillectomy for childhood obstructive sleep apnea reduces thoraco-abdominal asynchrony but spontaneous apnea-hypopnea index normalisation does not

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Analysis of thoraco-abdominal asynchrony

PSG recordings of ribcage (RC) abdominal (ABD) inductance belts were considered for thoraco-abdominal asynchrony analysis in this study. All recordings were resampled at 64 Hz and subsequently filtered with a finite impulse response band pass filter (0.1 - 5 Hz). Instantaneous TAA was computed within a sliding window. The length of the window was set to three times the average respiratory period. It was estimated based on the fundamental frequencies of the RC and ABD signals of the entire recording, by using the Welch power spectral density estimation method with 50% window overlap. The step size of the sliding window was set to a quarter of the average respiratory period.

TAA was calculated by applying the Hilbert transform [1, 2] to the RC and ABD signals $(x_1(t), x_2(t))$ contained in the sliding window, after subjecting both signals to a frequency selective filter that was set to the fundamental frequency. The Hilbert transform creates analytic signals of RC and ABD $(\zeta_1(t), \zeta_2(t))$ that allow calculating of the instantaneous phase. The analytic signal of $x(t)$ is

$$\zeta(t) = x(t) + j\tilde{x}(t) = Ae^{i\varphi(t)}, \quad (1)$$

where $\tilde{x}(t)$ is the Hilbert transform $x(t)$, A and φ are the instantaneous amplitude and phase of the analytic signal. Hence, the relative phase difference between two signals is obtained as follows:

$$\varphi_1(t) - \varphi_2(t) = \arctan\left[\frac{x_1(t)\,\tilde{x}_2(t) - x_2(t)\,\tilde{x}_1(t)}{x_1(t)\,x_2(t) + \tilde{x}_1(t)\,\tilde{x}_2(t)}\right]. \quad (2)$$

Each calculated TAA value was subsequently automatically checked for validity and excluded if:

1) signals were noisy (defined as the ratio of spectral power within the frequency band of interest to total power < 0.65),
2) breathing frequencies lie outside the physiological range for children (i.e. 0.12 - 0.585 Hz or, respectively, 7.2 - 35.1 breaths/min), or
3) disparity between RC and ABD fundamental frequencies existed (defined by a difference > 20%)

Importantly, all episodes of discretely scored events were excluded from analysis. All TAA results therefore represent periods of breathing that were free of frank respiratory events. The total amount of sleep included in the analysis summarized in Table S1.

Neurophysiological tests and surveys

The following neurophysiological outcomes were measured as part of the original CHAT study [3] and included in our analysis:

1) Behaviour, by the parent rating on the *Conners' Parent Rating Scale-Revised: Long version Global Index* (CGI T score), a two-factor score comprising the Restless Impulsive and Emotional-Lability factor sets, and by the *Behaviour Rating Inventory of Executive Function (BRIEF) Global Executive Composite (GEC)* T score, comprising summary measures of behavioural regulation and metacognition. Teacher ratings from parallel instruments (the CGI short version and BRIEF Teacher Report Form) were also evaluated.

2) Symptoms of OSAS, by the total score of the *Paediatric Sleep Questionnaire (PSQ) Sleep Related Breathing Disorder Scale (SRBD)*. A higher score indicates more symptoms of SDB.

3) Sleepiness, by the *Epworth Sleepiness Scale* modified for children. The higher the score the more sleepy the individual.

4) Global quality of life, by the parental total score from the *Paediatric Quality of Life Inventory (PedsQL)*, and disease-specific quality of life, assessed by the total score of the *OSA-18*, a composite of OSAS-related symptoms and quality of life. The higher the score the less the impact.

5) Generalized intellectual functioning, by the *Differential Ability Scales II*.

Table S1: Amount of sleep included in the TAA analysis, expressed in minutes and percentage of total time spent in each stage of sleep. (N2 – stage 2 non-rapid eye movement sleep, N3 – stage 3 non-rapid eye movement sleep, R – rapid eye movement sleep). Data are expressed as mean values and standard deviations.

	Early adenotonsillectomy (N =182)		**Watchful waiting with supportive care (N =171)**	
Sleep stage	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**
total	352 ± 76.3 min (76.8 ± 12.9 %)	400 ± 57.4 min (86.5 ± 7.68 %)	354 ± 71.3 min (77.8 ± 11.9 %)	370 ± 70.9 min (80.4 ± 12.3 %)
N2	152 ± 47.5 min (80.4 ± 14.1 %)	184 ± 41.8 min (89.0 ± 7.55 %)	155 ± 48.2 min (81.5 ± 13.1 %)	166 ± 42.8 min (83.3 ± 13.2 %)
N3	125 ± 35.1 min (87.3 ± 13.5 %)	128 ± 32.6 min (92.9 ± 8.44 %)	125 ± 35.8 min (87.0 ± 11.6 %)	126 ± 38.3 min (89.0 ± 11.3 %)
R	55.7 ± 23.6 min (64.6 ± 19.6 %)	67.3 ± 21.2 min (78.6 ± 14.6 %)	54.4 ± 23.9 min (65.4 ± 19.3 %)	55.9 ± 23.6 min (68.6 ± 20.9 %)

References

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3. Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, Mitchell RB, Amin R, Katz ES, Arens R, Paruthi S, Muzumdar H, Gozal D, Thomas NH, Ware J, Beebe D, Snyder K, Elden L, Sprecher RC, Willging P, Jones D, Bent JP, Hoban T, Chervin RD, Ellenberg SS, Redline S, Childhood Adenotonsillectomy T. A randomized trial of adenotonsillectomy for childhood sleep apnea. *The New England journal of medicine* 2013: 368(25): 2366-2376.