

Pulse Wave Photo-plethysmogram analysis, calculation and distribution of a reactivity index over 2285 polysomnographic recordings

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Introduction :

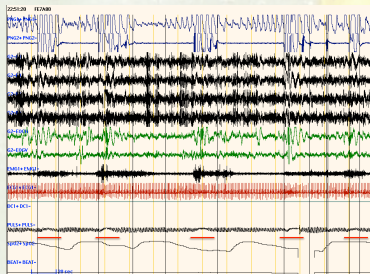
Pulse Wave photoplethysmography uses light absorbance technology to detect waves produced by heart pulsation. This technique associated with absorption spectrophotometry is at origin of SpO2 measure. Photoplethysmogram is frequently a part of signals recorded during polysomnography. For Brosh and al this signal can be considered as good indicator of coronary pathology. For Kirichenko and al normalization of the pulse photoplethysmogram amplitude can be used as indicator of anti-hypertensive efficiency. Clinical observation allows easy individualization of the photoplethysmography signal amplitude in touch with events arising during sleep. We attempted to develop an algorithm to analyse amplitude variations of pulse photoplethysmogram, we apply it to the database of our polysomnography recordings database and analyse distribution according to sleep parameters parameters and subjective scales (Epworth, ADA PICHOT, Q2DA Pichot).



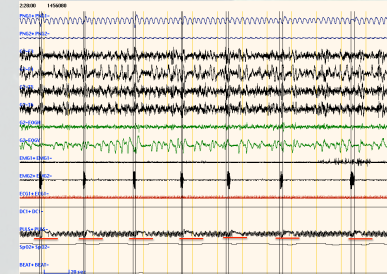
Karl Von Vierordt - 1876
Met en évidence les variations d'absorption spectrales en rapport avec la circulation.



Takuo Aoyagi - 1972
Inventeur de l'oxymètre rouge/infra-rouge



Fluctuations in the amplitude of the pulse wave plethysmography (Pulses signal).
Figure 1 at left from a patient suffering from Obstructive Sleep Apnoea (OSAS), Figure 2 to the right at a patient suffering from periodic limb movement (PLMS)



Pulse Wave Plethysmography
Underlined in red: pulse wave reactivity synchronous with respiratory events or periodic limb movement.

Material and Methods :

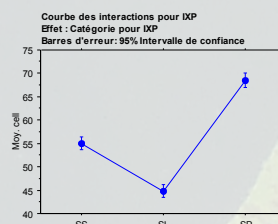
Amplitude variations of the photoplethysmogram are calculated from a baseline elaborated on slippery average of signal amplitude and filtered. Amplitude variations superior to 50 % of basic line are deducted and associated with the current period. This allow to calculate an index of reactivity of pulse wave (Pulse Wave Reactivity:PWR). This algorithm was applied to our database of 2285 polysomnography recordings made between 2002 and 2012. Results were visually validated.

Pulse Waves:
- Automatic detection of reactivity in orange
- Désaturations in red
- Calcul parameters

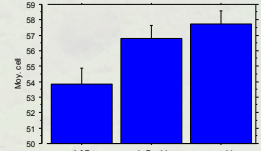


Résultats :

Average of PWR index reported to the total sleep time is 56/h \pm 37/h. There are significant differences of index reported to sleep stage (SS: 55/h \pm 33/h, SW: 45/h \pm 32/h, REM: 69/h \pm 43/h; $p < 0.001$), sex ($p < 0.001$), age ($p < 0.001$). There is significant correlations ($p < 0.05$) between the index and Epworth Sleepiness Score (ESS), Pichot asthenia scale (ADA) and Pichot depression scale (Q2DA).



Pulse wave reactivity index reported to Epworth Sleepiness Score



CLASSE/SS	dof	Somme des carrés	Carré moyen	Valeur de F	Valeur de p	Lambda	Puissance
2	10393,320	5196,660	4,296	0,141	8,532	750	
Résidu	4593	5596259,901	1218,215				

Conclusion :

Because of relations between Pulse Wave Reactivity and others sleep elements it seems necessary to introduce this new parameter in polygraphy and polysomnography analysis. An analysis of the reference distribution in normal population must be made.

Bibliography :

- (1) Kirk H. Shelley, Photoplethysmography: beyond the calculation of arterial oxygen saturation and heart rate, Anesth Analg. 2007 Dec;105(6 Suppl):S31-6
- (2) Brosh D, Assali A, Greenberg D, Kornowski R. Pulse wave analysis during instructed breathing as an indicator of significant coronary artery disease. EuroIntervention. 2010 Feb;5(7):847-52.
- (3) Kirichenko & al, Antihypertensive efficacy and tolerability of nebivolol, Kardiologia. 2002;42(12):35-7.