Shi, 1:4
http://dx.doi.org/10.4172/scientificreports.233

Open Access Scientific Reports

Research Article Open Access

Pulse Oxyhemoglobin Desaturation Index for the Screening of Obstructive Sleep Apnea Syndrome

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Abstract

Introduction: To investigate the diagnosis value of Pulse Oxyhemoglobin Desaturation Index (PODI) in patients with Sleep Apnea/Hypopnea Syndrome (SAS).

Materials and methods: 178 patients with suspected SAS has to be overnight polysomnography monitoring and pulse oxygen saturation, and sleep Apnea/Hypopnea Index (AHI) the Mean time for sleep apnea/hypopnea (TIME-mean) the longest time for sleep apnea/hypopnea (TIME-max) the Mean Spo2 (Spo2-Mean) the lowest Spo2 (Spo2-Min) and PODI were calculated.

Results: There were a significant correlation(rs=0.959, p=0.000) between PODI and AHI. Multiple stepwise regression analysis found that the impact factor PODI is AHI, Spo2-min, BMI, and standard regression coefficients were 0.79, -0.188, and 0.053, respectively. ROC analysis of the PODI, 4.75 is the best standard to judge whether or not patients with SAS (sensitivity of 97.4% and specificity was 100%), divided into mild and moderate SAS value of 14 (sensitivity of 92.0%, specificity was 90.3%), classified as moderate to severe 25.6 (sensitivity of 89.4% and specificity was 90.3%). PODI values smaller than AHI in criteria for the classification of SAS, therefore relatively more sensitive.

Conclusions: The result of the present work implied that PODI is an objective ideal target for the diagnosis of SAS.

Keywords: Oxyhemoglobin/Blood oxygen desaturation index; Sleep apnea syndrome; Screening

Introduction

Has been clear about the sleep apnea syndrome since 1956, the European and American countries conduct the massive research to the sleep apnea, the research had indicated that the obstructive sleep apnea syndrome is most common sleep disorder disease [1,2]. SAS is due to upper respiratory tract during sleep over the surrounding muscle to relax excessively [3,4], anatomical abnormalities, resulting in inspiratory airway obstruction or partial obstruction [5,6], so that increased resistance to breathing [7], slow or shallow breathing caused by suspension of recurrent hypoxia, Hypercapnia disease and acidosis, and intra thoracic pressure changes and sympathetic and parasympathetic imbalance [8], leading to body heart, brain and kidney damage and other system functions, and even sudden death. Incidence rate among men is 4%, 2% of women [9], the epidemiology investigates the middle-aged women the incidence rate is 5%, men is 15% [10]. It estimates that 93% of women and 82% of men with moderate to severe SAS have not been clinically diagnosed [11]. SAS is currently the diagnostic gold standard is still in the sleep laboratory for more than 7 hours a nocturnal polysomnography, but not all patients are able to PSG monitoring, and there are drawbacks such as cumbersome to operate, analyze long time-consuming, inconvenient to carry, more expensive, etc. so the application has been limited.

The SAS diagnosis technology changes with each new day, forward simplification, family, wireless development. As the blood oxygen saturation monitoring data easy to analyze and objectivity, and also we had found that the oxyhemoglobin desaturation index and AHI have a good correlation in the clinical work, so this study, 178 cases of snoring through the analysis of the monitoring results of night polysomnography to explore the night-time oxygen saturation index by sleep apnea-hypopnea syndrome patients and to determine the diagnostic value. Trying to find a more convenient and more appropriate indicators for the diagnosis of SAS.

Materials and methods

Study population

Select from April 2007 to February 2009, because of snoring, daytime sleepiness, or discover the existence of the phenomenon of sleep apnea so to our sleep center for nocturnal polysomnography examination in patients with 178 cases, 166 male, 12 female among them. Exclusion criteria for persons aged less than 18 years of age; have a history of neuromuscular diseases; severe pulmonary disease (FEV1 less than the expected value of 50%); severe hypoxia during the day; chronic insomnia; uremia; more than level III cardiac function, restless legs syndrome, etc.

Sleep studies

American Embla N7000 60-lead multi-functional analysis of sleep monitoring device and pulse oxygen saturation LS-100 to monitor sleep at night for more than 7h, simultaneous recording

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Received December 14, 2011; **Published** August 22, 2012

Citation: Shi Z, Jin G, Li T (2012) Pulse Oxyhemoglobin Desaturation Index for the Screening of Obstructive Sleep Apnea Syndrome. 1: 233. doi:10.4172/scientificreports.233

of Electroencephalography (EEG), Electromyography (EMG), Electrocardiography (ECG), snoring, nasal airflow, thoraco-abdominal movements, oxygen saturation parameters, etc. 24 hours before the inspection service ban alcohol, caffeine, sedatives or hypnotics. Used Somnologica STUDIO Version 3.3.1 l software, computer automatic analysis, and then manual adjustment artificially.

Polysomnography (PSG) monitoring and diagnosis, in accordance with American Society of Sleep Medicine (ASSM) standards [12]. Apnea was classified as a cessation of airflow for at least 10 s. hypopnoea was defined as 50% reduction in airflow accompanied by ≥4% desaturation. Sleep apnea-hypopnea index (AHI) refers to the average apnea and hypopnea episodes per hour slept [13].

Statistical analysis

SPSS 10.0 statistical package used for statistical analysis. Data were expressed as mean ± Standard Deviation (SD). The same indicator in difference was assessed with Analysis of Variance (ANOVA) followed by Bonferroni or Fisher LSD posthoc tests. Correlations between PODI and AHI were calculated the Spearson correlation analysis. Multiple stepwise regression analysis was used between PODI and a number of indicators, and diagnostic sensitivity and specificity by Receiver operating characteristic (ROC) analysis. $p<0.05$ was considered statistically significant.

Results

Summary of clinical data, according to night polysomnography results of the monitoring by American Society of Sleep Medicine (ASSM) standard[12] , according to apnea-hypopnea index AHI (mild 5 ≤ AHI ≤ 15, moderate 15<AHI≤30,severe AHI>30), the information will be divided into four groups of cases, of which 24 cases of non-, 29 cases of mild, 31 cases of moderate, 94 cases of severe. Table 1.

Grouping according to AHI, night polysomnography monitoring results collected in Table 2.

Correlation between AHI and PODI. Because each group AHI and PODI did not fully comply with the normal distribution, so uses Spearson correlation analysis to evaluate close degree and the related direction. After analysis Spearson correlation coefficient $r_s = 0.959$, p = 0.000, that the existence of a positive correlation between them.

The PODI multiple stepwise regression analysis (Table 3)

The PODI multiple stepwise regression analysis, PODI to be dependent variable, age, height, weight, Body Mass Index (BMI), neck circumference, AHI, TIME-mean, TIME-max, Spo_2-mean, Spo_2-min as independent variables carries on the multiple stepwise regression analysis (entry probability of less than 0.05, removal probability of greater than 0.1), found that the PODI impact factor is AHI, Spo_2-min, BMI, but age, height, weight, neck circumference, TIME-mean, TIME-max, Spo_2-mean and so on are removed, the PODI influence's size was in turn: AHI, Spo_2-min, and BMI. Three regression equations can be drawn through multiple regression analysis in Table 3. On the comparison of the three regression equations, since only the AHI of the equation variables preferable because fewer variables to facilitate the practical application, and the standard regression coefficient value is biger, has not been short of the two independent variables on the dependent variable obvious reduced the regress contributions to the dependent variable (R^2 only from 0.925 reduces to 0.905).

ROC analysis PODI equal to 4.75 is the best standard for judge whether to be SAS or not, with a sensitivity of 97.4% and specificity was 100, and find the right mild, moderate and severe criteria for the classification. Its diagnostic value of statistics in Table 4.

Discussion

In this study, an analysis of 178 cases in our hospital medical center sleep nocturnal polysomnography monitoring patients, in accordance with the ASSM standards, according to AHI index patients were divided into four groups. Through the relevant analysis, PODI and AHI there is a positive correlation and multiple stepwise regression analysis found that the impact factor PODI is AHI, Spo_2-min, BMI, and AHI greatest contribution to the PODI.

In this study, grouped according to AHI, the multiple stepwise regression analysis, AHI as dependent variable, but age, height, weight, BMI, neck circumference, AHI, TIME-mean, TIME-max, Spo_2-mean, Spo_2-min as independent variables, found that the PODI impact factor is AHI, and the age, height, weight, neck circumference, Spo_2-mean, Spo_2-min, BMI, TIME-mean, TIME-max and other factors are removed. Moreover, AHI as grouped variable, only PODI correlated with AHI in the detected indicators.

groups	number	age	height	weight	BMI	neck circumference
non	24	39.13 ± 11.56	166.79 ± 6.26	70.83 ± 16.97	25.28 ± 4.92	41.54 ± 7.40
mild	29	45.17 ± 12.85	169.45 ± 8.21	79.00 ± 13.25	27.33 ± 3.08	45.38 ± 7.60
moderate	31	46.87 ± 11.32	166.42 ± 8.91	72.16 ± 8.66	26.05 ± 2.58	46.92 ± 8.56
severe	94	43.39 ± 11.48	170.12 ± 5.65	82.24 ± 14.66	28.35 ± 4.45	45.70 ± 7.71

Table 1: Summary of clinical data.

Group	number	AHI	TIME-mean	TIME-max	Spo_2-mean	Spo_2-min	PODI
non	24	2.16 ± 1.47	19.13 ± 6.91	35.76 ± 18.11	96.79 ± 1.25	89.58 ± 4.14	1.88 ± 1.57
mild	29	8.48 ± 2.10*	20.46 ± 3.72	48.23 ± 18.66	96.07 ± 1.10	84.38 ± 4.31*	9.98 ± 10.48*
moderate	31	22.66 ± 4.37*	23.1 ± 5.65	69.37 ± 32.99*	95.52 ± 1.34*	80.94 ± 7.69*	18.01 ± 7.04*
severe	94	58.89 ± 18.33*	27.61 ± 6.92*	77.26 ± 25.79*	91.28 ± 5.27*	69.69 ± 11.07*	51.16 ± 19.48*

*p<0.05 vs. non groups

Table 2: Summary of polysomnography monitoring results.

model	Variables entered	R	R Square	Standardized regress coefficients	Regression equation
1	AHI	0.951	0.905	0.951	0.879AHI - 0.232
2	AHI Spo_2-min	0.960	0.922	0.798 - 0.202	0.738AHI - 0.436Sp+38.42
3	AHI Spo_2-min BMI	0.962	0.925	0.79 - 0.188 0.053	0.73AHI-0.406Sp+0.322BMI+27.579

Table 3: PODI as the dependent variable of the multiple stepwise regression analysis.

PODI group	ROC curve				sensitivity	specificity
	Area	Confidence interval		P		
		Lower bound	Upper bound			
4.75	0.993	0.983	1.002	0.000	97.4%	100%
14	0.95	0.895	1.004	0.000	92.0%	93.1%
25.6	0.956	0.925	0.988	0.000	89.4%	90.3%

Table 4: PODI grouped diagnostic sensitivity and specificity, and ROC indicators.

ROC curve for PODI sensitivity and specificity analysis, and got different degrees PODI for the diagnosis of SAS, 4.75 is the best standards to determine whether the SAS or not, 14 is for divided mild or moderate, 25.6 is for distinction moderate or server compared with the AHI, its value smaller, so it has relatively higher sensitivity. Taking into account the PSG analysis, the complexity of EEG, the accuracy for sleep staging and diagnosis of SAS, both were affected. However, the analysis of oxygen saturation and the division of blood oxygen desaturation are simple and easy, so more accurate, and there is no EEG, electro-oculogram lead lines. Moreover, the first night effect will be weakened, thus more accurately reflects the situation in patients with normal sleep.

Although night polysomnography is a multi-functional monitoring and a variety of data access methods, and still is the industry's recognized gold standard for diagnosis of SAS, but its shortcomings are obvious. So the doctors involved in sleep medicine have been trying to find a more simple, convenient and more accurate methods and diagnostic criteria, making the diagnosis of SAS more popular.

So far, screening methods are questionnaire, scale [14,15], 24h electrocardiography [16], physical examination [17,18], and oxygen saturation monitoring.etc [19,21]. By oxygen saturation monitoring, we can arrive at a number of indicators, including the minimum oxygen saturation, the average oxygen saturation, the minimum duration of oxygen saturation [22], to minimize deoxygen and oxygen desaturation index (the number of per hour of sleep in the oxygen desaturation of more than 4) and so on. In accordance with obstructive sleep apnea-hypopnea syndrome medical guidelines, the current national minimum Spo_2 to determine its severity of the hypoxic, but the index only reflects the oxygen desaturation degree, not related frequency and time and so on, there are certain limitations. In this study, we compared and analyzed the results of each group, the oxygen desaturation index was found is another objective indicator., and has certain correspondence with the AHI into sub-degrees, is more sensitive than the AHI. Sleep medicine doctors and researchers should concern it, and its has certain value on clinical, therefore is worth the basic hospital promotion.

Acknowledgement

We would like to thank Yuan Fen, Chun Li and colleagues, Southern Medical University, Nanfang Hospital, Southern Sleep Medicine Center, Guangzhou, Guangdong, Peoples R China for helping us in sleep monitoring and sleep analysis.

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