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The role of oxygen saturation measurement and body mass index in distinguishing between non-apnoeic snorers and patients with obstructive sleep apnoea syndrome

M. ÜNAL,* L. ÖZTÜRK† & A. KANIK‡

**University of Mersin, School of Medicine, Department of Otorhinolaryngology, Mersin, †University of Kadir Has, School of Medicine, Department of Physiology and Sleep Laboratory, İstanbul, Turkey, and ‡University of Mersin, School of Medicine, Department of Biostatistics, Mersin, Turkey*

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The aim of this study was to examine the role of oxygen saturation (SaO_2) measurement in identifying apnoeic snorers from non-apnoeic snorers and in the assessment of the severity of obstructive sleep apnoea. Ninety-two patients with clinically suspected obstructive sleep apnoea syndrome (OSAS) were assessed, using overnight polysomnography. The patients were classified as follows: 14 patients were non-apnoeic snorers, 27 patients had mild OSAS, 31 patients had moderate OSAS and 20 patients had severe OSAS. Minimum SaO_2 level, mean SaO_2, time below 85% of SaO_2, the ratio between the time SaO_2 and total sleep time and body mass index (BMI) were assessed retrospectively. There was a statistically significant difference between the non-apnoeic group and OSAS patients in Min SaO_2 ($P = 0.03$). Patients who had Min SaO_2 above 85% could be evaluated as non-apnoeic snorers; however, SaO_2 and BMI were not found to be useful in the assessment of the severity of OSAS.

Keywords *obstructive sleep apnoea syndrome polysomnography oxygen saturation diagnosis*

The obstructive sleep apnoea syndrome (OSAS) is characterized by snoring, frequent apnoea and hypopnoea, oxygen desaturation during sleep and excessive daytime sleepiness.[1] OSAS is remarkably common in the middle-aged adult population (2–4%) and has been demonstrated to cause an increased mortality and morbidity probably due to cardiovascular diseases and stroke.[2,3] Also several studies have demonstrated that OSAS is a progressive disease, it is therefore of great importance that these individuals be identified and treated.[4] Polysomnography is the only widely accepted diagnostic method for OSAS but a complete overnight study is very time consuming, labour intensive and expensive.[3,4] This situation is especially important in view of the cost; we need some cheap and accurate methods to differentiate apnoeic snorers from non-apnoeic snorers. The aim of this study is to examine the role of oxygen saturation (SaO_2) in identifying apnoeic snorers and assessing the severity of the disease.

Correspondence: Dr Murat Ünal, Mersin Universitesi Tip Fakultesi Hastanesi, Kulak Burun Bogaz Anabilim Dali, Zeytinlibahce cad., 33070, Mersin, İÇEL, Turkey (e-mail: muunal@hotmail.com).

Patients and methods

Ninety-two men with clinically suspected sleep apnoea participated in the study. The mean age of the patients was 47.8 years (range 33–60). All the patients were asked to answer a questionnaire that included questions about symptoms of OSAS, medical history and social habits. The criteria for exclusion were the existence of neurological disease and regular use of central nervous system active drugs, a recent upper airway disease, and significant abnormalities of the facial skeleton or the upper airway. Clinical assessment included measurement of body height and weight for body mass index (BMI) calculation, and a complete ear nose and throat examination.

Overnight polysomnographic recording (EMBLA, Flaga) included central and occipital electroencephalogram, submental

Table 1. Descriptive data of the study group

Parameter	Group A	Group B	Group C	Group D
Min SaO_2	87.07 ± 4.6	80.7 ± 8.01	80.7 ± 9.65	82.6 ± 10.8
Mean SaO_2	95.2 ± 1.35	93.75 ± 2.94	94.17 ± 2.74	94.9 ± 4.15
R SaO_2	0.1 (0–0.7)*	6.7(0–56.8)*	5.3 (0–66.7)*	5.6(0–55.6)*
Subgroups				
0	11 (79%)	11 (41%)	13 (42%)	10 (50%)
1	3 (21%)	10 (37%)	13 (42%)	8 (40%)
2	0	6 (22%)	5 (16%)	2 (10%)
BMI	28.1 ± 2.15	28.9 ± 4.34	28.72 ± 3.9	30.2 ± 6.5

*Standard deviation was not given because of high range value.

electromyogram, electrooculogram, and electrocardiogram; left and right leg movements (EMG) and respiratory parameters, such as oro-nasal flow, thoracic and abdominal movements, were recorded, respectively, by thermistor and strain gauges. Arterial oxygen saturation was monitored by pulse oximetry.

Apnoea is a cessation of airflow for longer than 10 s and hypopnoea is a 50% reduction in airflow for longer than 10 s. The diagnostic criteria for OSAS on overnight polysomnography was an Apnoea–Hypopnoea Index (AHI) of at least 5 episodes/h. According to AHI, the patients were divided into four subgroups: non-apnoenic snorers AHI < 5 (Group A), mild OSAS AHI $= 5$–20 (Group B), moderate OSAS AHI $= 21$–40 (Group C) and severe OSAS AHI > 40 (Group D).[5] The factors associated with SaO_2 were determined as minimum SaO_2 (min SaO_2; the lowest recorded SaO_2 value during sleep), mean SaO_2 (the mean level of SaO_2 during sleep), time below 85% of SaO_2 [T SaO_2; total time (hours) below the level of 85% SaO_2] and this parameter was used for calculation of the ratio between the T SaO_2 and total sleep time (R SaO_2). These measurements were made by the overnight polysomnographic investigation and then checked manually by the same investigator. SaO_2 evaluation was done retrospectively after this complete sleep examination in order to compare the data. R SaO_2 was evaluated in three subgroups: (0) 0 ($n = 45$), (1) 0–0.09% ($n = 34$) and (2) $\geq 0.1\%$ ($n = 13$). One-way ANOVA and the Z approximation test for two independent proportions were used to compare the results between the groups, and Spearman's rank correlation test was used to assess the correlation between SaO_2, BMI and polysomnographic results. Differences and correlations were considered statistically significant at $P < 0.05$.

Results

Fourteen patients were diagnosed as non-apnoeic snorers (Group A), 27 patients had mild OSAS (Group B), 31 patients had moderate OSAS (Group C) and 20 patients had severe OSAS (Group D). The average BMI was 29 kg/m^2 (range 21.5–53). Average Min SaO_2 was 87.1% (range 80–94) in Group A, 80.9% (range 55–88) in Group B, 80.7% (range 55–90) in Group C and 82.6% (range 51–94) in Group D respectively. Group A value was significantly different from the other groups. Mean SaO_2 was 95.2% in Group A, 93.75% in Group B, 94.1% in Group C and 94.9% in Group D respectively. The difference between the groups was not statistically significant. Average R SaO_2 was found 0.1% in Group A, 6.7% in Group B, 5.3% in Group C and 5.6% in Group D respectively. Group A values were significantly different from the other groups in subgroup 0. Table 1 summarized the descriptive data. Statistically significant correlations between the parameters are shown in Table 2.

Table 2. Correlation of the parameters with each other

	P-value			
Parameter	Group A	Group B	Group C	Group D
Min SaO_2-BMI	0.952	0.045	0.330	0.019
Min SaO_2-Mean SaO_2	0.378	0.001	0.006	0.001
Min SaO_2- R SaO_2	0.005	0.001	0.001	0.001
Mean SaO_2-R SaO_2	0.916	0.001	0.001	0.001
Mean SaO_2-BMI	0.139	0.073	0.103	0.001
R SaO_2-BMI	0.876	0.005	0.311	0.001

Discussion

This study confirmed that SaO_2 is not a useful method for the distinction of the severity of the OSAS. However, minimum SaO_2 may be used for the selection of non-apnoeic snorers from apnoeic snorers; the patient who has SaO_2 above 85% can probably be evaluated as a non-apnoeic snorer.

Overnight polysomnography is the most reliable diagnostic method for the evaluation of patients with suspected OSAS and provides information about the severity of the disease.[6] However, it is time consuming, expensive and the routine use of EEG, EMG and EOG to rule out OSAS is probably unnecessary.[7] Also, a single night recording does not always reflect the usual sleep characteristics and obstructive events. Differences in sleep position, degree of relaxation, changes in nasal resistance, unfamiliar surroundings and recording equipment may affect the results.[6] In addition to these negative effects, the attached equipment forces the patient to sleep flat on the back and this leads to an increased number of apnoeic events.[6] However, according to a recent study, a pragmatic trial of polysomnography was found superior to polysomnography under telesurveillance.[8] The aim of the present study was not to suggest an alternative to polysomnography but evaluate the role of pulse oximetry in the diagnosis of OSAS. Pulse oximeters are found to be relatively accurate in measuring SaO_2 but there are individual differences in both accuracy and response characteristics in different oximeters and oximeter probes.[9] According to Svanborg *et al.*, recording of SaO_2 only is not satisfactory as a screening procedure because of the difficulties in estimation of the sleep time and short apnoeas and artefacts due to body movements, and the use of SaO_2 monitoring alone has a high risk of both false-negative and false-positive results. They developed a limited diagnostic investigation, consisting of a static charge sensitive bed and oximetry for OSAS.[3] Also, Talmi *et al.* suggested that automatic analysis of static charge sensitive bed and SaO_2 signals can be used as a simple quantitative descriptor of SaO_2 distribution in the evaluation and follow-up of OSAS patients.[4] Other disadvantages of oximetry are detecting the upper airway resistance syndrome and other forms of sleep apnoea (central apnoea, etc.).[10] Gould *et al.*[11] examined the value of SaO_2 and thoracoabdominal movement in determining disturbed breathing during sleep, and concluded that overnight oximetry detects most but not all (especially hypopnoeas) patients with abnormal breathing during sleep. George *et al.*[10] investigated the identification and quantification of apnoeas by computer-based analysis of SaO_2 and suggested that this method appears to be accurate and reliable with very low false-positive and false-negative rates, and has the advantage of speed. According to the SaO_2 levels, Lalakea *et al.*[12] classified obstructive apnoea as follows: SaO_2 over 85% as mild, between 65% and 84% as moderate, and below 65% as severe. We used this classification for determination of the 85% SaO_2 level. Meanwhile, it was demonstrated that if the percentage of time spent with SaO_2 below 90% was less than 1% of the sleep time, clinically significant apnoea practically can be excluded, but we did not observe such a relation in our study group.[13] In another study, we found nocturnal pulse oximetry very useful for the detection of OSAS in children.[14] In several studies, the correlation between BMI and OSAS severity has been reported, but our study did not confirm this. High correlation with BMI and other parameters led us to think that BMI is not a leading cause for severity of OSAS but an important contributor especially in severe forms of the disease. This interesting result needs new comprehensive community-based studies. In conclusion, our results suggest that:

1 OSAS is a complex disease of which the aetiology is not well understood.
2 Several studies have still many discrepancies, probably due to an insufficient number of subjects or different population.
3 SaO_2 and BMI are not useful indicators for OSAS severity.
4 Non-apnoeic snorers may be recognized by Min SaO_2 (above 85% SaO_2).
5 Non-apnoeic snorers must be assessed from the aspect of upper airway resistance syndrome.
6 New ambulatory devices for sleep studies are needed (accelerometer actigraph, RhinoSleep, measurement of airway pressure and flow, etc.).

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