Prevalence and characteristics of positional OSA, a retrospective study

Original Article

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Abstract

Objectives: To compare the prevalence of Positional Obstructive Sleep Apnea (P-OSA) based on different definitions and to identify the main factors independently associated with P-OSA and exclusive POSA (Pe-OSA).
Study Design: Retrospective study.
Material and Methods: Analysis of the type 3 polysomnography (PSG) recordings of adult patients performed between 2020 and 2021 at the Otorhinolaryngology Department of Hospital Garcia de Orta. P-OSA was defined by APOC criteria and Pe-OSA was defined as APOC I.
Results: 245 PSG were evaluated, with a mean age of 57 years and 64.9% of male patients. The prevalence of P-OSA was 55.5%, 38% of whom had Pe-OSA. Patients with P-OSA were younger (OR=0.971), slept mostly in the supine position (OR=1.031), had lower Body Mass Index (BMI) (OR=0.882), Apnea/Hypopnea Index (AHI), oxygen desaturation index (OR=0.964), mean desaturation drop, and shorter snoring time ($p<0.05$). The most significant predictors of Pe-OSA were a lower oxygen desaturation index (OR=0.879) and longer time in the supine position (OR=1.031).
Conclusions: Patients with P-OSA and Pe-OSA are younger, less obese and have less severe conditions, being respectively candidates for improvement or resolution of their disease using positioners.
Keywords: Obstructive sleep apnea; OSA; Positional;

Introduction

Positional obstructive sleep apnea syndrome (P-OSAS) is a subtype of OSAS that includes patients whose apnea and hypopnea tend to occur more frequently in certain sleep positions, mainly in the supine position[1]. Several definitions of P-OSAS have been proposed since 1984, although none are widely accepted in the scientific community. The first author to characterize P-OSAS more extensively was Cartwright, who defined it as OSAS patients who had at least twice the

apnea/hypopnea index (AHI) in the supine position relative to the non-supine position[2]. Although it is one of the earliest definitions, it continues to be one of the most widely used in several centers. More recently, Levendowski *et al*. introduced the definition of P-OSAS as an AHI in the supine position which is at least 1.5 times higher than the AHI in the non-supine position[3]. In 2015, Frank *et al*., in an attempt to better identify candidates for positional therapy, developed the Amsterdam Positional OSA Classification (APOC), which recommends the diagnosis of OSAS by the American Academy of Sleep Medicine (AASM) criteria and at least 10% of time in the best and worst sleep positions. P-OSAS includes three categories: APOC I when the AHI in the best sleep position is less than 5; APOC II when the AHI in the best sleep position is of less severity than in the worst sleep position; and APOC III when the AHI is at least 40 and there is at least a 25% reduction in the best sleep position[4,5].
The prevalence of P-OSAS is estimated to be between 53% and 77.4% among all OSAS patients, and the variability may be due to the study design, patient ethnicity, and use of different definitions of P-OSAS. Patients with P-OSAS have predominantly mild to moderate OSAS and are mostly younger men, with a lower body mass index (BMI), fewer symptoms, fewer comorbidities, smaller neck and abdominal circumference, and lower scores in the Berlin, STOP-BANG and Epworth Sleepiness Scale questionnaires compared to patients with non-positional OSAS[1,6]. The main mechanism underlying P-OSAS is probably a combination of inadequate upper airway geometry, with an increased likelihood of collapse, reduced lung volume, and failure of compensation by the airway dilator muscles[7].
Although continuous positive airway pressure (CPAP) therapy remains the gold standard of treatment for OSAS, patient compliance remains relatively low[8]. In this context, the identification of patients with P-OSAS is of decisive clinical importance because they can benefit from therapy with the new generation of positioners[9].

The present study aimed to systematically compare the prevalence of P-OSAS in adult patients diagnosed with OSAS based on the different definitions and to identify the main factors independently associated with P-OSAS and exclusive P-OSAS (eP-OSAS).

Materials and Methods

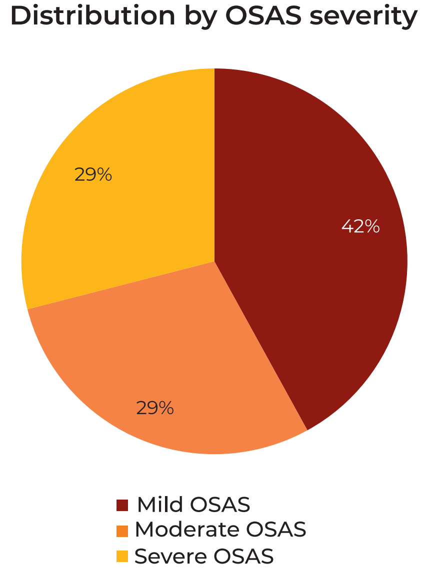
This retrospective study was conducted by analyzing the records of type 3 polysomnography (PSG) between January 2020 and December 2021 in the Otorhinolaryngology Department of the Garcia de Orta Hospital - Integrated Responsibility Center.
PSG records of patients aged 18 years or older, with total recording time greater than 4 hours and AHI greater than or equal to 5 were evaluated. Patients with a nasal flow signal of less than 85% of the total time or with position sensor failures were excluded.
A NOX T3® device with six channels was used for all PSGs: nasal flow sensor, pulse oximetry, thoracic and abdominal bands, position sensor, and microphone. The tracings obtained were automatically analyzed using the Noxturnal software from Nox Medical® and manually reviewed according to the 2018 AASM criteria[10]. Apnea was defined as a decrease of at least 90% in the nasal flow sensor and hypopnea was defined as a decrease of at least 30% in the nasal flow sensor associated with oxygen desaturation of at least 3%, both lasting 10 seconds or longer. The following variables were analyzed: age, sex, BMI , time in the supine and non-supine positions, AHI, AHI in the supine and non-supine positions, oxygen desaturation index (ODI), ODI in the supine and non-supine positions, total mean desaturation drop (MDD) in the supine and non-supine positions, snoring, and snoring in the supine and non-supine positions. P-OSAS was characterized using the APOC criteria, and eP-OSAS was defined as APOC I. This is because according to Cartwright's criteria, the lack of indication of minimum time in the various sleep positions can easily generate false positives, i.e., patients who sleep more than 90% of the night in the supine position, with

an AHI above 5 events/h, and have a very low AHI in the remaining time in the non-supine position, which is very short, can easily fulfill the criterion of an AHI in the supine position that is twice the AHI in the non-supine position. Quantitative data were described as medians and interquartile ranges, and categorical data as frequencies and percentages. Statistical analysis was performed using the SPSS® software (Statistical Package for the Social Sciences - IBM Corp. Released 2017, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) for Microsoft Windows®. The Mann-Whitney U test and the chi-square test were used for comparing the data. Binomial logistic regression was also performed to determine the most significant predictors of positional dependence. A value of $p \leq 0.05$ was considered statistically significant.

Results

Of the 372 patients who underwent type 3 PSG between 2020 and 2021, 245 were included in the study, while the remaining 127 were excluded after applying the exclusion criteria. The mean age was 57(±20) years and 159 patients (64.9%) were men. The majority were overweight or obese (median BMI 29.4±6.3 kg/m^2), and as shown in Graph 1, were mostly classified as mild OSAS (median AHI of 17.8 events/h ± 21.3, with a range from 5.1 to 110.8).
The median ODI was 19 ± 21.5 events/h and the median MDD was 4.6% ± 1.6. When adjusted for the patient position, AHI, ODI, and MDD were higher in the supine position (Table 2), although the median time in the supine position was shorter (65.8% ± 37.3).
Snoring was present for 14.3% ± 29 of the examination duration and mainly in the non-supine position (13.7% ± 35).
Of the 245 patients included, 136 (55.5%) were classified as P-OSAS according to the APOC criteria and 52 (21.2%) were classified as eP-OSAS, which accounted for 38% of the P-OSAS cases according to the APOC criteria. The prevalence of P-OSAS and eP-OSAS according to the severity of OSAS is shown in Graph 2. The prevalence of P-OSAS decreased from

Graph 1
Distribution of the included cases by OSAS severity according to the 2018 AASM criteria



Abbreviations: OSAS, obstructive sleep apnea syndrome; AASM, American Academy of Sleep Medicine.

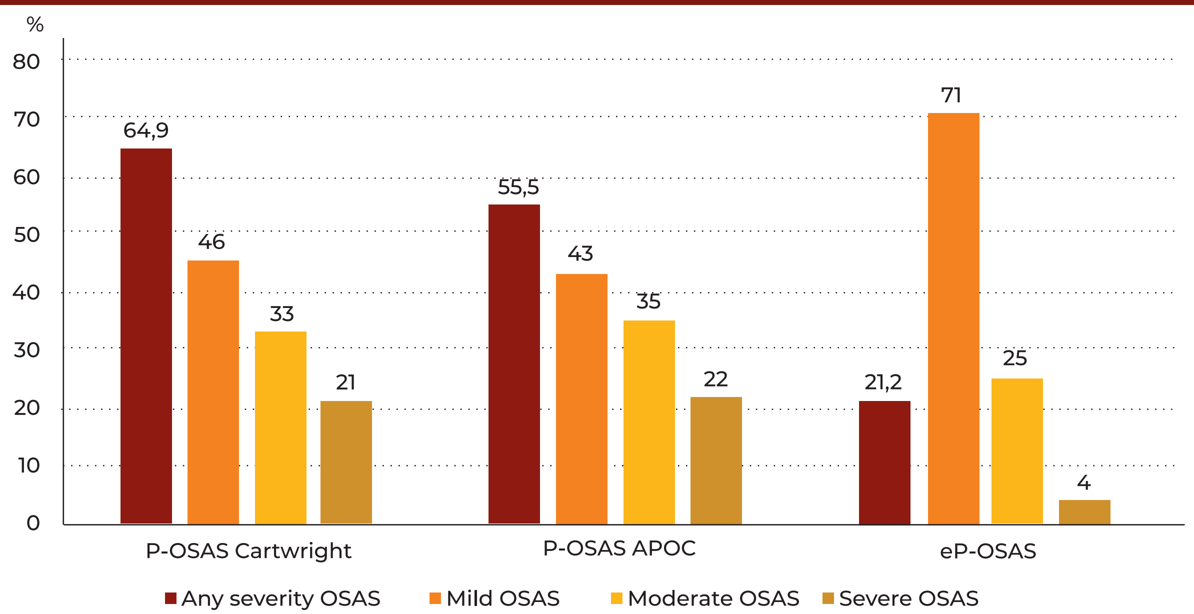
43% in mild OSAS to 22% in severe OSAS, while the prevalence of eP-OSAS decreased from 71% in mild OSAS to 4% in severe OSAS.
When compared to patients with non-positional OSAS (NP-OSAS), patients with P-OSAS demonstrated a lower BMI, less sleep time in the non-supine position, and had lower AHI, ODI, and snoring time. On the other hand, they exhibited a higher MDD in the supine position and slept longer in the supine position (Table 1). When compared to patients with exclusive non-positional OSAS (eNP-OSAS), patients with eP-OSAS had lower ages, lower BMI, slept longer in the supine position, and exhibited a lower AHI, ODI, MDD, and snoring time (Table 2).
The binomial logistic regression model showed that the predictors with statistical significance were BMI (β=-0.073, p=0.02), time in the supine position (β=0.022, p=0.001), and ODI (β=-0.037, p<0.001) for P-OSAS (Table 3). This binomial logistic regression model (including BMI, time in the supine position, and ODI) correctly classified 71% of the patients. Sensitivity, specificity, positive predictive value, and negative predictive value were 83.1%, 56%, 70.2%, and 72.6%, respectively.

Table 1
Demographic and sleep data (median) of the study sample

	Median (IQR)	Min-max
Men (n(%))	159 (64,9%)	-
Age (years)	57 ± 20	20-91
BMI (kg/m2)	29.4 ± 6,3	20.5 – 58.7
Supine time (%)	34.2 ± 37.5	0.2 – 100
Non-supine time (%)	65.8 ± 37.3	0 – 99.7
AHI	17.8 ± 21.3	5.1 – 110.8
AHI supine	30.9 ± 36.2	0 – 122.4
AHI non-supine	9.9 ± 16	0 – 109.5
ODI	19 ± 21.5	5 – 129.3
ODI supine	31.2 ± 33.7	0 – 126.1
ODI non-supine	12.4 ± 19.6	0 – 129.7
Mean desaturation drop (%)	4.6 ± 1.6	3.2 – 18.7
Mean desaturation drop supine (%)	4.2 ± 2.2	0 – 17.1
Mean desaturation drop non-supine (%)	3.9 ± 1.1	0 – 19.9
Snoring (%)	14.3 ± 29	0 – 74.7
Snoring supine (%)	8.7 ± 22.8	0 – 74.9
Snoring non-supine (%)	13.7 ± 35	0 – 82.6

Abbreviations: BMI, body mass index; AHI, apnea/hypopnea index; ODI, oxygen desaturation index, IQR, interquartile range.

Graph 2
Prevalence of P-OSAS (Cartwright and APOC definition) and total eP-OSAS according to the OSAS severity.



Abbreviations: P-OSAS, positional obstructive sleep apnea syndrome; eP-OSAS, exclusive P-OSAS; APOC, Amsterdam Positional OSA Classification

With regard to eP-OSAS, the most significant predictors were time in the supine position (β=0.031, p<0.001) and ODI (β=-0.129, p<0.001) (Table 4). This binomial logistic regression model (including time in the supine position and ODI) correctly classified 80.8% of the

Table 2
Characteristics of P-OSAS patients compared to NP-OSAS patients

	P-OSAS (Cartwright)	NP-OSAS	P-value	P-OSAS (APOC)	NP-OSAS	P Value
N	159	86		136	109	
Men (n(%))	110 (69.2%)	49 (57%)	0.056	91 (66.9%)	68 (62.4%)	0.056
Age (years)	55 ± 21	60 ± 18	0.011	56 ± 20	58 ± 20	0.559
BMI (kg/m2)	28.4 ± 5.3	32.4 ± 8.4	<0.001	28.15 ± 5.8	31 ± 7.3	<0.001
Supine time (%)	39.7 ± 37.4	27.85 ± 39.5	0.12	42.7 ± 30.2	21.6 ± 44.9	<0.001
Non-supine time (%)	60.3 ± 37.4	72.15 ± 39.5	0.011	57.3 ± 30.2	77.2 ± 44.8	<0.001
AHI	15.9 ± 15.1	24.25 ± 41.1	0.001	16.85 ± 14.3	20.2 ± 37.4	0.026
AHI supine	32.2 ± 32	20.1 ± 39.7	0.001	31.2 ± 23.6	30 ± 53	0.575
AHI non-supine	7.1 ± 9	25 ± 31.7	<0.001	7.1 ± 9.2	17.5 ± 31	<0.001
ODI	16.6 ± 15.8	26.05 ± 39.2	<0.001	17.35 ± 14.4	24.4 ± 37.3	0.001
ODI supine	32.3 ± 30.5	26.55 ± 40.8	0.084	31.05 ± 24.4	31.2 ± 51.6	0.753
ODI non-supine	9 ± 10.4	26.45 ± 36.1	<0.001	9.3 ± 10.1	21.2 ± 31.9	<0.001
Mean desaturation drop (%)	4.6 ± 1.4	4.6 ± 1.6	0.02	4.6 ± 1.6	4.6 ± 2	0.415
Mean desaturation drop supine (%)	4.6 ± 2	4.2 ± 2.2	0.028	4.75 ± 1.7	4.2 ± 3	0.017
Mean desaturation drop non-supine (%)	3.7 ± 0.8	3.9 ± 1.1	<0.001	3.8 ± 0.9	4.3 ± 1.4	<0.001
Snoring (%)	14.3 ± 31.1	14.4 ± 27	0.919	12.55 ± 24.4	18 ± 34.2	0.037
Snoring supine (%)	9.2 ± 21.9	6.75 ± 23.3	0.052	11.25 ± 23.6	5.4 ± 19.4	0.001
Snoring non-supine (%)	11.5 ± 35.5	16.4 ± 33.9	0.128	8.2 ± 26	17.9 ± 39.7	0.002

Abbreviations: P-OSAS, positional obstructive sleep apnea syndrome; NP-OSAS, non-positional OSAS; APOC, Amsterdam Positional OSA Classification; BMI, body mass index; AHI, apnea/hypopnea index; ODI, oxygen desaturation index.

patients. Sensitivity, specificity, positive predictive value, and negative predictive value were 32.7%, 93.8%, 58.6%, and 83.8%, respectively.

Discussion

P-OSAS has been gaining attention as a subtype of OSAS in the scientific community in recent decades, mainly due to the technological development in positioners. The growing number of publications on the topic and the search for better P-OSAS criteria to select candidates for positional therapy to attest to this fact.

In the present study, the prevalence of P-OSAS and eP-OSAS in patients diagnosed with OSAS was 55.5% and 21.2%, respectively. These findings are in agreement with those described in the reviewed literature. In 2016, Lee *et al*. reported a P-OSAS prevalence of 75.6% with the Cartwright criteria and an eP-OSAS prevalence of 39.9% in a sample of 1052 Korean adults, which was defined as subtype I, with the AHI in the non-supine position inferior to 5 events/h[11]. This was slightly higher than the prevalence found in the present study, especially of eP-OSAS, which may be related to the physiognomic features of the Asian population, namely a short skull base and retrognathia. In 2018, Levendowski *et al*. reported a P-OSAS prevalence of 64.8% and 50.7% in a sample of 142 patients, using the Cartwright and APOC criteria, respectively[9]. More recently, in one of the largest studies on the characteristics and prevalence of P-OSAS and eP-OSAS, Sabil *et al*. found a prevalence of 53.5% and 20.1% respectively, among 6437 French patients [7].

Table 3
Characteristics of eP-OSAS patients compared to eNP-OSAS patients

	SAOS-Pe (APOC I)	SAOS-NPe	Valor P
N	52	193	
Men (n(%))	35 (67.3%)	124 (64.2%)	0.682
Age (years)	53 ± 24	58 ± 29	0.014
BMI (kg/m2)	27.65 ± 5	30.4 ± 6.2	0.002
Supine time (%)	46.05 ± 25.7	28 ± 40.6	<0.001
Non-supine time (%)	53.9 ± 25.7	72 ± 40.3	<0.001
AHI	10.9 ± 9.7	21.1 ± 25	<0.001
AHI supine	23.4 ± 19.5	34.4 ± 39.9	<0.001
AHI non-supine	2.5 ± 2.5	13 ± 19.3	<0.001
ODI	11.45 ± 7.2	23.2 ± 26.9	<0.001
ODI supine	22.65 ± 17.8	36.1 ± 36.8	<0.001
ODI non-supine	3.4 ± 3	15.8 ± 20.8	<0.001
Mean desaturation drop (%)	4.1 ± 1	4.7 ± 2	<0.001
Mean desaturation drop supine (%)	4.25 ± 1.1	4.6 ± 2.5	0.149
Mean desaturation drop non-supine (%)	3.4 ± 0.6	4.1 ± 1.3	<0.001
Snoring (%)	8.2 ± 21.9	16.7 ± 32.6	0.003
Snoring supine (%)	12.2 ± 29.2	8.1 ± 20.5	0.071
Snoring non-supine (%)	2.75 ± 14.9	17.9 ± 38	<0.001

Abbreviations: eP-OSAS, exclusive positional obstructive sleep apnea syndrome; eNP-OSAS, exclusive non-positional OSAS; BMI, body mass index; AHI, apnea/hypopnea index; AHI, apnea/hypopnea index; ODI, oxygen desaturation index.

Table 4
Binomial logistic regression model for the most significant predictive factors of P-OSAS and eP-OSAS

	Parameters	β	SE	Wald	Df	OR (95% CI)	P-value
P-OSAS Cartwright criteria	Age (years)	-0.029	0.012	5.608	1	0.971 (0.948 – 0.995)	0.018
	BMI (kg/m2)	-0.125	0.035	12.862	1	0.882 (0.824 – 0.945)	<0.001
	ODI (events/h)	-0.031	0.009	11.667	1	0.969 (0.952 – 0.987)	0.001
	Supine time (%)	0.014	0.007	4.343	1	1.014 (1.001 – 1.027)	0.037
P-OSAS APOC criteria	BMI (kg/m2)	-0.073	0.031	5.397	1	0.930 (0.874 – 0.989)	0.02
	Supine time (%)	0.022	0.006	11.914	1	1.022 (1.009 – 1.035)	0.001
	ODI (events/h)	-0.037	0.009	16.094	1	0.964 (0.946 – 0.981)	0.007
eP-OSAS	ODI (events/h)	-0.129	0.026	24.636	1	0.879 (0.835 – 0.925)	<0.001
	Supine time (%)	0.031	0.008	16.380	1	1.031 (1.016 – 1.047)	<0.001

Abbreviations: P-OSAS, positional obstructive sleep apnea syndrome; eP-OSAS, exclusive P-OSAS; APOC, Amsterdam Positional OSA Classification; BMI, body mass index; ODI, oxygen desaturation index; OR, odds ratio; CI, confidence interval.

The lower severity of OSAS in patients with P-OSAS or eP-OSAS is evident in the percentage of severe OSAS among P-OSAS (22%), and eP-OSAS (4%) patients. These data are in agreement with those reported in previous studies[9]. Similar to other studies[7,8,9], we observed that the group of patients classified as P-OSAS slept longer in the supine position, were younger, had a lower BMI, ODI, and AHI. However, on using a binomial logistic regression model, we observed that the most significant predictors of P-OSAS were BMI, ODI, and supine position time. Thus, as the BMI and ODI increase, the probability of the patient presenting with P-OSAS decreases. Conversely, when the supine position time increases, the likelihood that the patient will have P-OSAS also increases.

With regard to eP-OSAS, we observed that patients in this group slept longer in the supine position, were younger, and had a lower BMI, AHI, ODI, MDD, and duration of snoring, which indicate the lower severity of these cases. Applying the same principle as for P-OSAS, using a binomial logistic regression model, we found that the most significant predictors of eP-OSAS were ODI and time in the supine position. Thus, the probability of an eP-OSAS diagnosis decreases with increasing ODI and conversely increases with increasing time in the supine position.

Contrary to some studies in the literature, the predominance of male patients in the P-OSAS and eP-OSAS groups was not statistically significant in the present study[12]. We think that this difference may be related to the predominance of male patients in the initial sample. One of the limitations of this study was the use of PSG type 3 in an outpatient setting instead of PSG type 1 in a sleep laboratory, as only with the latter it is possible to monitor the patient's sleep stages. Additionally, the video feedback allows the correction of the position of the equipment on the patient. Another limitation was the fact that PSG was performed for only one night per patient, which may not account for the intra-individual variability of OSAS patients[13].

To our knowledge, this is the first study of its kind conducted in the Portuguese population.

Conclusion

Our results suggest that P-OSAS is relatively frequent in patients with OSAS. Patients with P-OSAS tend to be younger, less obese, and have less severe presentations of the disease than patients with NP-OSAS. The identification of patients with P-OSAS and eP-OSAS, with the latter corresponding to about 1/3 of the former, is extremely important given the potential for improvement or resolution of the disease with the use of positioners.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

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Availability of scientific data

There are no datasets available, publicly related to this work.

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