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Obstructive Sleep Apnoea Syndrome and Obesity Hypoventilation Syndrome: comparison of ventilatory parameters and treatment adherence

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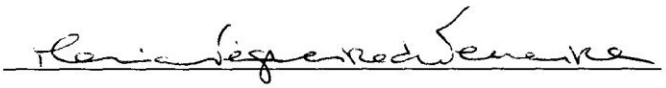
Assinatura: 

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Projeto de Opção do 6º ano – DECLARAÇÃO DE REPRODUÇÃO

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Título da Dissertação: Obstructive Sleep Apnoea Syndrome and Obesity Hypoventilation Syndrome: comparison of ventilatory parameters and treatment adherence

Orientador: Professora Marta Drummond

Ano de conclusão: 2013

Designação da área do projeto:

Pneumologia

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Assinatura: 

Abstract:

Purpose: Obstructive sleep apnoea syndrome (OSAS) and obesity hypoventilation syndrome (OHS) are two very similar, but independent conditions. The authors think that there may be significant differences between them, in what concerns treatment adherence and needed ventilatory parameters. The aim of this study is to evaluate and compare ventilatory parameters and treatment adherence in OHS patients and single OSAS patients treated with bi-level positive airway pressure (BiPAP), in order to clarify those differences. **Methods:** This is a real life retrospective study, in which 28 OHS patients and 33 single OSAS patients were enrolled. The data concerning adherence, ventilatory parameters and arterial blood gas analysis were recorded in two different moments: at the initial non-invasive ventilation (NIV) titration and 6 months later. **Results:** Expiratory positive airway pressure (EPAP) median values were the same for both groups (OHS: 10.0 (IQR=2.0) and OSAS: 10.0 (IQR=4.0)), while inspiratory positive airway pressure (IPAP) differed significantly (p=0.005), with a median value of 22.0 (IQR 7.0) to the OHS group and 18.0 (IQR 5.0) to the OSAS group. The treatment adherence was very good in both groups: the median percentage of days of BiPAP usage was 91.5% of days (IQR 31.8) for OHS patients and 88.6% (IQR 30.1) for OSAS patients. **Conclusion:** This study showed that OHS patients need higher IPAP to overcome the hypoventilation imposed by its pathophysiology. The absence of significant differences in which concerns treatment adherence may be due to their strong similarity and important correlation with obesity. Nonetheless, more studies are needed to confirm this hypothesis.

Keywords: Obstructive sleep apnoea, obesity hypoventilation syndrome, positive airway pressure, patient adherence

Resumo:

Objectivos: A síndrome de apneia obstrutiva do sono (SAOS) e a síndrome de hipoventilação-obesidade (SHO) são duas patologias muito semelhantes, mas mutuamente independentes. Os autores são da opinião de que poderão existir diferenças significativas entre elas, no que diz respeito à adesão terapêutica e aos parâmetros ventilatórios necessários. O objectivo deste estudo é precisamente avaliar e comparar os parâmetros ventilatórios e a adesão terapêutica em doentes com SHO e doentes com SAOS isolada tratados com BiPAP (*bi-level positive airway pressure*), de modo a esclarecer essas diferenças. **Métodos:** Este é um estudo retrospectivo da vida real, no qual 28 doentes com SHO e 33 doentes com SAOS isolado foram incluídos. Os dados relativos à adesão, parâmetros ventilatórios e gasometria arterial foram colhidos em dois momentos diferentes: no momento da titulação inicial da ventilação não-invasiva e 6 meses depois. **Resultados:** A mediana dos valores da pressão positiva expiratória (*expiratory positive airway pressure - EPAP*) foi a mesma em ambos os grupos (SHO: 10.0 (IQR=2.0) and SAOS: 10.0 (IQR=4.0)), enquanto a relativa à pressão positiva inspiratória (*inspiratory positive airway pressure - IPAP*) foi significativamente diferente entre os dois grupos (p=0.005), com uma mediana de 22.0 (IQR 7.0) no grupo de SHO e de 18.0 (IQR 5.0) no grupo de SAOS. A adesão ao tratamento foi muito boa em ambos os grupos: a percentagem mediana de dias de uso de BiPAP foi de 91,5% de dias (IQR 31,8) nos doentes com SHO e 88,6% (IQR 30,1) nos doentes com SAOS. **Conclusão:** Este estudo mostrou que os doentes com SHO precisam de valores de IPAP superiores para superar a hipoventilação imposta pela própria fisiopatologia da doença. A ausência de diferenças significativas no que diz respeito à adesão ao tratamento pode dever-se à forte semelhança e importante correlação com a obesidade de ambas as patologias. No entanto, são necessários mais estudos para confirmar esta hipótese.

Palavras-chave: apneia obstrutiva do sono, síndrome hipoventilação-obesidade, pressão positiva das vias aéreas, aderência ao tratamento

Obstructive Sleep Apnoea Syndrome and Obesity Hypoventilation Syndrome: comparison of ventilatory parameters and treatment adherence

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Abstract

Purpose: Obstructive sleep apnoea syndrome (OSAS) and obesity hypoventilation syndrome (OHS) are two very similar, but independent conditions. The authors think that there may be significant differences between them, in what concerns treatment adherence and needed ventilatory parameters. The aim of this study is to evaluate and compare ventilatory parameters and treatment adherence in OHS patients and single OSAS patients treated with bi-level positive airway pressure (BiPAP), in order to clarify those differences. **Methods:** This is a real life retrospective study, in which 28 OHS patients and 33 single OSAS patients were enrolled. The data concerning adherence, ventilatory parameters and arterial blood gas analysis were recorded in two different moments: at the initial non-invasive ventilation (NIV) titration and 6 months later. **Results:** Expiratory positive airway pressure (EPAP) median values were the same for both groups (OHS: 10.0 (IQR=2.0) and OSAS: 10.0 (IQR=4.0)), while inspiratory positive airway pressure (IPAP) differed significantly (p=0.005), with a median value of 22.0 (IQR=7.0) to the OHS group and 18.0 (IQR=5.0) to the OSAS group. The treatment adherence was very good in both groups: the median percentage of days of BiPAP usage was 91.5% of days (IQR=31.8) for OHS patients and 88.6% (IQR=30.1) for OSAS patients. **Conclusion:** This study showed that OHS patients need higher IPAP to overcome the hypoventilation imposed by its pathophysiology. The absence of significant differences in which concerns treatment adherence may be due to their strong similarity and important correlation with obesity. Nonetheless, more studies are needed to confirm this hypothesis.

Key words: Obstructive sleep apnoea, obesity hypoventilation syndrome, positive airway pressure, patient adherence

Introduction

Epidemiological studies have revealed a high prevalence of sleep-disordered breathing in the community (up to 20%) [1]. Obstructive sleep apnoea syndrome (OSAS) and obesity hypoventilation syndrome (OHS) are two different entities, which are both included in this group of disorders, being the former highly dependent on obesity and the latter directly related to it.

Accordingly to the World Health Organization, in 2008, obesity had already reached epidemic proportions with more than 1,4 billion overweight adults worldwide, of whom at least 400 million were obese. Despite the fact that major attention has been directed towards the metabolic and cardiovascular consequences of obesity, clinicians should remember that overweight imposes also a significant load on the respiratory system, by altering lung mechanics and increasing the work of breathing [2, 3]. A compensatory increase in ventilation drive enables most of obese individuals to maintain normal ventilation during wakefulness, despite the excessive weight and reduced lung volumes [2, 3]. However, there is a minority in which this compensatory mechanism fails, resulting in the development of alveolar hypoventilation [4] and chronic diurnal respiratory failure [2, 3]. This particular subgroup suffers from the so-called obesity hypoventilation syndrome (OHS).

OHS is defined as the combination of obesity (body mass index (BMI) $\geq$ 30Kg/m^2), daytime hypercapnia (arterial carbon dioxide partial pressure ($PaCO_2$) $\geq$ 45mmHg) and nocturnal hypoventilation without any other cause of hypoventilation such as severe obstructive or restrictive pulmonary diseases, chest wall disorders, neuromuscular diseases, severe hypothyroidism and congenital central hypoventilation syndrome [5]. Almost 90% of patients with OHS also exhibit OSAS [6, 7].

OSAS is characterized by repeated episodes of upper airway obstruction during sleep, associated with increasing respiratory efforts, intermittent arterial oxygen desaturation, systemic and pulmonary arterial blood pressure surges and sleep disruption [8]. It is defined as an apnoea-hypopnoea index (AHI) of 5 or greater with associated symptoms (excessive daytime sleepiness, fatigue, or impaired cognition, for example) or an AHI of 15 or greater, regardless of associated symptoms [9, 10]. Despite other established risk factors, this syndrome is also related with the excess of weight [11]. In fact, 70% of patients with OSAS are obese [12]. Given the increasing prevalence of obesity, there is no surprise in the fact that OSAS is fairly common in general population, affecting more than 2% of adult females and more than 4% of male [13].

OHS and OSAS have both concerning negative consequences, equally to the patient and the society. Untreated OSAS increases the risk of car accidents [14] and worsens the patients' quality of life [8, 15] and mood [8, 16]. Also importantly, it rises the hazard of acute cardiovascular events [17, 18] (i.e. stroke, myocardial infarction and nocturnal sudden death) and chronic conditions such as systemic hypertension [19], coronary artery disease [20] and heart failure [20]. Still, OHS patients display a worse prognosis than patients with single OSAS [21] and use more health care resources [3, 22]. Moreover, these patients are more likely to suffer from congestive heart failure [3], pulmonary hypertension [7] and diabetes mellitus [3, 23] than obese eucapnic OSAS patients. Hence, for both patient's health and public's safety, these syndromes' effective treatment should become a priority.

In both cases, treatment usually involves non-invasive positive airway pressure ventilation (NPPV) – continuous positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP) [6] – which requires a correct titration of the ventilation parameters and a high degree of treatment adherence [24] [25]to become effective. A satisfactory adherence to

the NPPV therapy has been defined as use of the ventilator for at least 4 hours per night for at least 70% of the nights per week [25].

Despite the treatment similarities, given that OHS and OSAS are two independent conditions, the authors considered that there may be important differences between them, concerning treatment adherence and needed ventilatory parameters, that should be clarified.

Therefore, in this study the authors aimed to evaluate and compare ventilation parameters and treatment adherence in OHS patients and single OSAS patients.

Methods

Study design

This is a real life retrospective study. Patients' informed consent to participate in the study wasn't required as the authors only collected data from routine procedures. The study protocol was approved by the São João Hospital Center's Ethics Committee.

Subjects

In this study, 28 OHS patients and 33 single OSAS consecutive patients needing BiPAP ventilatory treatment were enrolled. OSAS patients were titrated to BiPAP as they were not fully controlled with CPAP or intolerant to it. Patients were adapted to BiPAP between June 2010 and June 2012. All patients are followed in the Sleep Lab of Pulmonology Department of São João's Hospital Center. Those who presented with obstructive pulmonary diseases, chest wall disorders, neuromuscular diseases, neoplastic diseases, interstitial lung diseases or asthma/bronchial hyperresponsiveness were excluded.

Study procedures

The patients were divided into two groups, accordingly to their diagnosis: group 1 – OHS patients; group 2 – OSAS patients.

The ventilatory titration was performed in an ambulatory basis in the Sleep lab for 2 to 4 hours, according to the severity of the disease. The equipment used was a *Phlips Respironics BiPAP Synchrony II ST*® ventilator, a *Tina4*® CO2 radiometer and a *Masimo: LNCS DC-I*® oximeter. The procedures were all monitored by a clinician and a respiratory physiotherapist, with the help of *Philips Alice 5 Diagnostic Sleep System software*®.

Baseline demographic and clinical data were collected from patients' medical records. The data concerning adherence (percentage of days during which the patients used the ventilator, the mean number of hours of use per day, percentage of days during which the patients used the ventilator for at least 4 hours) and ventilation parameters (leaks, residual AHI, time of oxygen saturation below 90%) were obtained from ventilators' memory cards. Inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP), mask, heated humidifier, supplemental oxygen and follow up arterial blood gas analysis were recorded. There were two evaluation moments: initial non-invasive ventilation (NIV) titration and 6 months follow up appointment.

Statistical Analysis

Sample characteristics are presented as counts and proportions for categorical variables and median and interquartile range for continuous variables (non-normally

distributed variables). Comparison of categorical variables was performed using a chi-square test and Fisher's exact test whenever appropriate. Spearman correlations coefficients were computed to estimate the association between participants' age, BMI and initial AHI and IPAP and EPAP levels.

All the statistical analyses were conducted using Statistical Package for Social Sciences (SPSS) for Windows, version 20.0 (IBM Corp., New York, USA).

Results

Overall studied population demographic and clinical characteristics at baseline and the comparison between OHS and OSAS groups are presented in Table 1. Of the whole sample, 57.4% were female. This tendency to a feminine predominance was verified also in the OHS group, in which 67.9% of the participants were female, but not in the OSAS group, which was formed by 48.5% women and 51.5% men. The median age of the patients in both groups was very similar: 66.0 (IQR=19.0) and 63.0 (IQR=21.0) years of age, for OHS and OSAS, respectively. The median BMI was 38.7 Kg/m^2 (IQR=11.3) for OHS and 34.2 Kg/m^2 (IQR=13.4) for OSAS. No difference was found in the initial IAH between groups of patients (OHS: 15.3 events/hour (IQR=48.9) and OSAS: 16.9 events/hour (IQR=20.7)). Regarding smoking habits, no differences were found between groups (14.3% of smokers in OHS group and 12.1% in OSAS group).

Regarding the treatment compliance, as showed in Table 2, it was observed that both groups' participants had a similar median percentage of days of BiPAP usage, with 91.5% of days (IQR=31.8) for OHS patients and 88.6% (IQR=30.1) for OSAS patients. Nonetheless,

the median percentage of days in which the ventilator was used for at least 4 hours was greater in OSAS group, with 75.4 (IQR=82.3) against 56.4 (IQR=56.5) from OHS.

Concerning treatment characteristics (Table 3), it was possible to observe that the majority of participants wore a facial mask rather than a nasal one (85.7% and 78.8% of patients wearing a facial mask in OHS and OSAS group, respectively). Regarding the ventilatory pressures, EPAP median values were similar for both groups (OHS: 10.0 (IQR=2.0) and OSAS: 10.0 (IQR=4.0)), while IPAP differed significantly between them, with a median value of 22.0 (IQR=7.0) to the OHS group and 18.0 (IQR=5.0) to the OSAS group (p=0.005). Significant correlations between patients' age, BMI and initial AHI with the ventilatory pressures (IPAP and EPAP) in either of the groups were not observed, with the exception of EPAP, which showed a moderate positive correlation with the initial AHI in OHS group, as seen in Table 4.

In which concerns the residual AHI, OSAS patients presented a higher median value than OHS patients (8.4 events/hour (IQR=10.9) *versus* 5.5 events/hour (IQR=10.4), respectively), although there was not observed a statistical significant difference. Respecting the mean time with SpO_2<90% (min), OHS patients presented a higher median (17.7 (IQR=26.3)) than OSAS patients (3.5 (IQR=13.3)).

In relation to the follow up arterial blood gas analysis, the registered values for each group did not reveal notable differences. The $PaCO_2$ (mm/Hg) median value was slightly higher in OHS group (45.5 (IQR=9.8)) against (42.1 (IQR=9.4)) from OSAS group.

It was not observed statistical significant correlations between patients' age, BMI, initial AHI, ventilatory pressures (IPAP and EPAP) or mask model with the treatment adherence in either of the groups. However, EPAP seems to be negatively correlated with the adherence evaluation parameters.

Due to missing information, results concerning the association between the smoking status, the utilization of heated humidifier or the treatment with O_2 complement and the treatment adherence are not computed. Nevertheless, it seems to exist a bigger tendency to the treatment compliance in the non-smoker/former smokers' group (data not shown).

Discussion

Concerning the population characteristics, the high BMI verified in both groups was already expected, since, as previously stated, they are both very related to obesity. The fact that there are almost no smokers in this sample was also expectable, since usually smoking patients have other diseases concomitantly, making them unfit for this study. About the predominance of female participants, mostly in OHS group , it is probably due to the higher prevalence of obesity in the female population, observed in Portugal [26]. Finally, the similar initial IAH of both groups was surely influenced by the fact that OSAS patients were titrated to BiPAP because they were not fully controlled with CPAP or were intolerant to it, which means that there had already been a period of ventilation treatment, probably reducing (even if not satisfactorily), the initial IAH of these patients.

With regard to the treatment, it was verified that the great majority of the patients wore facial masks, which may be related to their more efficient control of the leaks, although, accordingly to some studies, they may be also associated with less treatment compliance [27]. Importantly, this study demonstrated that the IPAP needed are significantly higher in OHS, when compared to OSAS. This goes accordingly to its pathophysiologic process, in which the obesity has a greater impact, making it necessary to recur to a higher IPAP to overcome the hypoventilation. Conversely, no significant differences were found between EPAP values of both groups. This is probably related to the high percentage of SHO patients who

concomitantly presented with OSAS (78.6%). Lastly, the positive correlation between initial IAH and EPAP found in OHS group was not surprising, since this is the pressure responsible for the maintenance of the airways' patency at the end of the expiration period, correcting de respiratory events (apnoeas/hypopnoeas). The inexistence of this correlation in the OSAS group is most likely related to the fact that the initial IAH of these patients had already been reduced by the previous CPAP ventilation treatment. Probably, if we considered the pre-CPAP IAH value, this correlation would also be present in this group.

In relation to the ventilatory and gasimetric characteristics at follow up, no significant differences were observed between the two groups. It was evidenced a higher $PaCO_2$ in OHS group, which was already expected, as it stems from the definition of the disease itself. Also observed was the higher mean time with SpO_2<90% in OHS group, which reinforces the idea of the magnitude of the obesity related alveolar hypoventilation in its pathophysiology.

Finally, there were not found significant differences in which concerns the treatment adherence. Both groups showed a very good adherence, which, given the high severity of the enrolled patients, is most likely associated with the important symptomatic relief provided by the treatment. Nevertheless, the fact that the median percentage of days in which the ventilator was used for at least 4 hours was inferior in OHS group, even if not statistically significant, may be a reflex of a worse treatment tolerance and, therefore, worse compliance in this group. The higher IPAP values may perhaps be one of the facts that contribute to this poorer tolerance.

As seen, no major demographic and clinical differences were found between both groups. There may be a few explanations for this fact. First of all, we are dealing with two groups of patients who are very similar. Despite the pathophysiologic differences between them, they are both closely related to obesity. Also, the studied OSAS population was a more

severe subgroup than the usual OSAS ones, as these patients had to be titrated to NIV because of their intolerance to CPAP or partial disease control with it. Furthermore, as stated earlier, nearly 90% of patients with OHS also exhibit OSAS [6, 7], bringing both groups even closer and making the absence of significant ventilatory and treatment adherence differences between them very probable. On the other hand, study limitations did not allow finding differences between groups.

One of the biggest limitations was the small number of patients in each group. This was due to two major factors: the exclusion criteria (most patients of the initial study sample had other concomitant respiratory pathologies that made them unfit for this study) and the high number of drop outs. Nevertheless, the greatest obstacle found by the authors was the lack of information about each patient. Most of the clinical records (digital and paper version) were very incomplete, which constituted an important deterrent factor for performing a good statistical analysis and possibly contributed to the final results.

In spite of the considered limitations, to the best of our knowledge, this is the first study to compare ventilatory parameters and treatment adherence in OHS patients and single OSAS patients. Due to the fact that the characteristics of both pathologies are not completely clarified, and given the rising prevalence and important negative consequences of the two, more studies to evaluate their similarity and idiosyncrasies would be useful for clinical practice. For that reason, a future prospective study, with larger sample size, should be attempted.

Conflict of interest

None of the authors has any conflict of interests that could inappropriately influence this study.

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Table 1. Baseline demographic and clinical characteristics of both groups: obesity hypoventilation syndrome (OHS) and obstructive sleep apnoea syndrome (OSAS).

	Total n=61	**OHS n=28**	**OSAS n=33**	***p*-value**
Age (years), median (IQR)	63.0 (21.0)	66.0 (19.0)	63.0 (21.0)	0.373
Gender, n (%)				
Female	35 (57.4)	19 (67.9)	16 (48.5)	0.127
Male	26 (42.6)	9 (32.1)	17 (51.5)	
Smoking status, n (%)				
Non-smoker/former smoker	53 (86.9)	24 (85.7)	29 (87.9)	0.999
Current smoker	8 (13.1)	4 (14.3)	4 (12.1)	
BMI (Kg/m^2), median (IQR)	37.2 (12.4)	38.7 (11.3)	34.2 (13.4)	0.676
Initial AHI (events/hour), median (IQR)	16.8 (25.6)	15.3 (48.9)	16.9 (20.7)	0.686

OHS, obesity hypoventilation syndrome; OSAS, obstructive sleep apnea syndrome; BMI, body mass index; AHI, apnoea-hypopnea index; IQR, interquartile range.
Note: in each variable, the total may not add to 61 due to missing data.

Table 2. Treatment compliance data of both groups: obesity hypoventilation syndrome (OHS) and obstructive sleep apnoea syndrome (OSAS) diagnosis.

	Total n=42 Median (IQR)	**OHS n=19** Median (IQR)	**OSAS n=23** Median (IQR)	***p*-value**
% days of BiPAP usage	90.1 (31.5)	91.5(31.8)	88.6 (30.1)	0.909
% days with >4 hours per night of BiPAP usage	61.9 (78.7)	56.4 (56.5)	75.4 (82.3)	0.263
Hours per night of BiPAP usage	5.6 (3.3)	5.1 (2.8)	6.5 (3.6)	0.604

OHS, obesity hypoventilation syndrome; OSAS, obstructive sleep apnoea syndrome; BiPAP, bi-level positive airway pressure; IQR, interquartile range.

Table 3. Ventilatory and gasimetric characteristics of both groups: obesity hypoventilation syndrome (HOS) and obstructive sleep apnoea syndrome (OSAS).

	Total n=61	**OHS n=28**	**OSAS n=33**	***p*-value**
IPAP (cm/H_2O), median (IQR)	20.0 (8.0)	22.0 (7.0)	18.0 (5.0)	**0.005**
EPAP (cm/H_2O), median (IQR)	10.0 (3.0)	10.0 (2.0)	10.0 (4.0)	0.458
BiPAP mask, n (%)				
Nasal	11 (18.0)	4 (14.3)	7 (21.2)	0.483
Facial	50 (82.0)	24 (85.7)	26 (78.8)	
BiPAP with heated humidifier, n (%)				
No	41 (67.2)	20 (71.4)	21 (63.6)	0.518
Yes	20 (32.8)	8 (28.6)	12 (36.4)	
BiPAP with O_2 Complement, n (%)				
No	54 (88.5)	23 (82.1)	31 (93.9)	0.231
Yes	7 (11.5)	5 (17.9)	2 (6.1)	
Residual AHI (events/hour), median (IQR)	6.8 (11.8)	5.5 (10.4)	8.4 (10.9)	0.378
Mean time with SpO_2 <90%, median (IQR) (min)	5.6 (22.4)	17.7 (26.3)	3.5 (13.3)	0.131
pH, median (IQR)	7.41 (0.07)	7.42 (0.08)	7.41 (0.08)	0.791
PaO_2 (mm/Hg), median (IQR)	71.9 (11.9)	71.9 (16.7)	72.3 (9.0)	0.661
$PaCO_2$ (mm/Hg), median (IQR)	42.8 (10.1)	45.5 (9.8)	42.1 (9.4)	0.335
SpO_2 (mm/Hg), median (IQR)	93.8 (3.4)	93.4 (4.5)	94.5 (3.3)	0.826

OHS, obesity hypoventilation syndrome; OSAS, obstructive sleep apnoea syndrome; IQR, interquartile range; BiPAP, bi-level positive airway pressure; AHI, apnea-hypopnea index; PaO_2, partial pressure of arterial oxygen; $PaCO_2$, partial pressure of arterial carbon dioxide; SpO_2, oxygen peripheral saturation;
Note: in each variable, the total may not add to 61 due to missing data.

Table 4. Associations between participants' characteristics and inspiratory and expiratory positive airway pressures in both groups: obesity hypoventilation syndrome (OHS) and obstructive sleep apnoea syndrome (OSAS).

	IPAP levels				**EPAP levels**			
	OHS n=28		**OSAS n=33**		**OHS n=28**		**OSAS n=33**	
	Median (IQR)	p-value	Median (IQR)	p-value	Median (IQR)	p-value	Median (IQR)	p-value
Gender								
Female	22.0 (5.0)	0.585	17.0 (8.0)	0.758	10.0 (2.0)	0.505	8.5 (3.0)	0.296
Male	20.0 (13.0)		18.0 (6.0)		8.0 (6.0)		10.0 (5.0)	
	r*	p-value	r*	p-value	r*	p-value	r*	p-value
Age (years)	0.147	0.454	0.022	0.905	0.116	0.558	-0.111	0.540
BMI(Kg/m^2)	0.116	0.607	0.189	0.439	-0.007	0.976	-0.039	0.876
Initial AHI (events/hour)	0.038	0.858	0.244	0.185	**0.656**	**<0.001**	-0.085	0.651

OHS, obesity hypoventilation syndrome; OSAS, obstructive sleep apnoea syndrome; IPAP, inspiratory positive airway pressure; EPAP, expiratory positive airway pressure; BMI, body mass index; AHI, apnoea-hypopnea index; IQR, interquartile range.

*for quantitative variables Spearman's correlation test was applied.

Anexos

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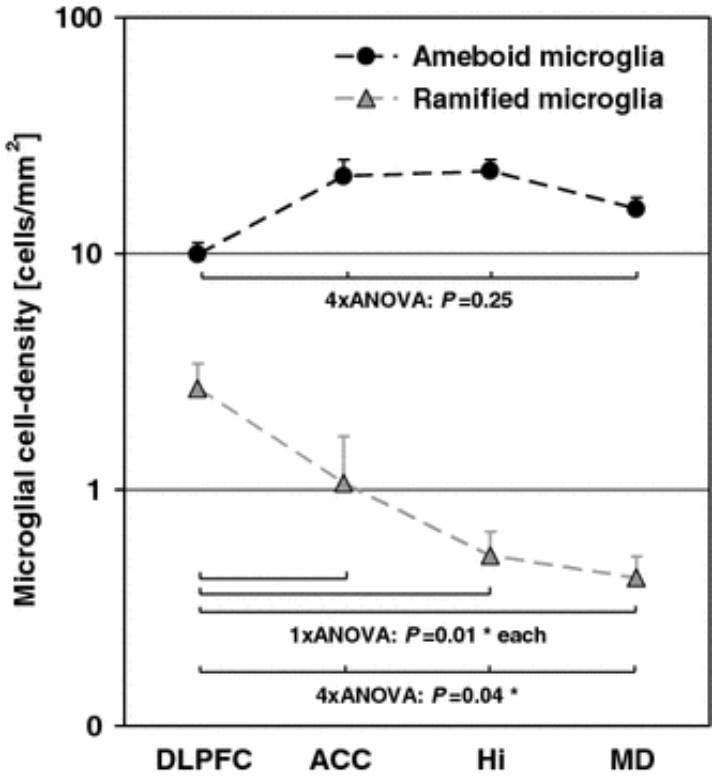

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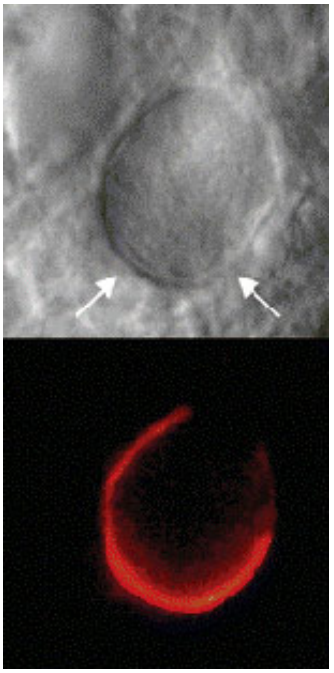

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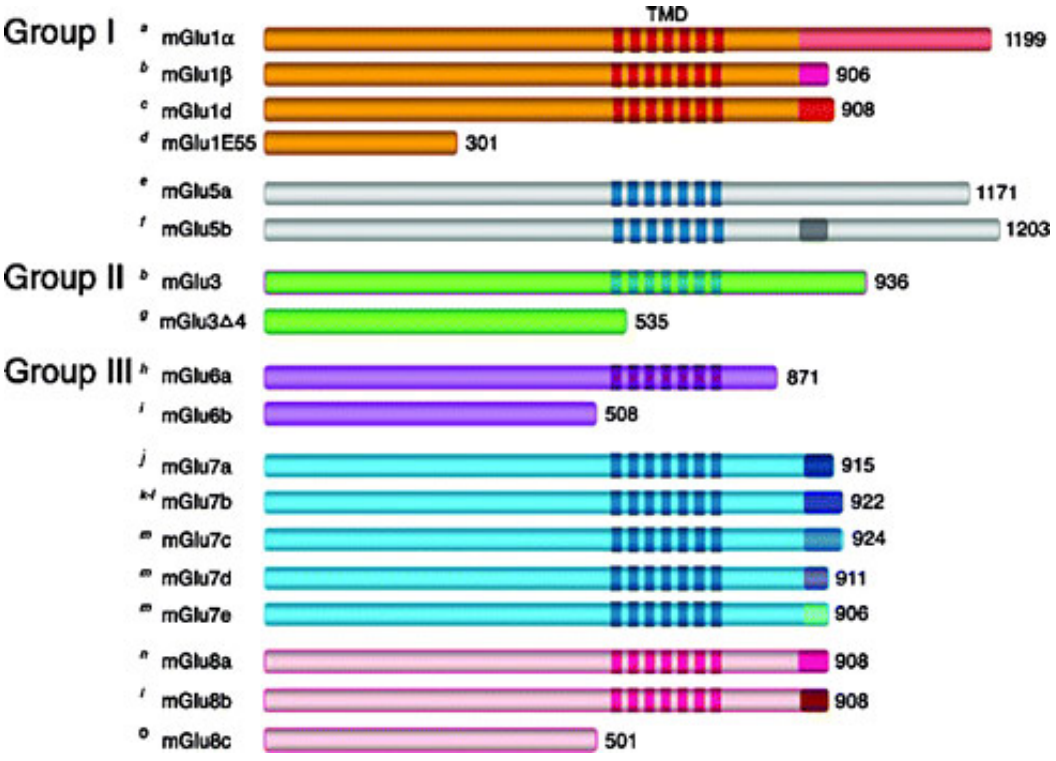

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