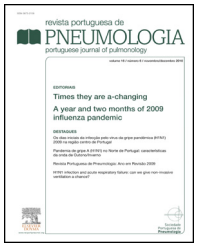
Rev Port Pneumol. 2015;21(2):55–60

revista portuguesa de PNEUMOLOGIA
portuguese journal of pulmonology
www.revportpneumol.org



ORIGINAL ARTICLE

Obstructive sleep apnea and diabetes mellitus

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Received 10 October 2013; accepted 12 July 2014
Available online 7 February 2015

KEYWORDS
Obstructive sleep apnea syndrome;
Diabetes mellitus;
Glycemic control

Abstract
Background: There is convincing evidence that obstructive sleep apnea (OSA) is highly associated with impaired glucose metabolism.
Objectives: Analyze the prevalence of OSA in type 1 and type 2 diabetes mellitus (DM) patients. Evaluate the influence of OSA on glycemic control.
Methods: The adult patients with diabetes mellitus (DM) followed in the department of internal medicine were referred to our Sleep Unit. A home respiratory polygraphy was then performed on all patients with body mass index (BMI) < 40 kg/m^2. The glycemic control was assessed by the value of glycated hemoglobin (Hba1c) in the previous 3 months.
Results: A total of 46 patients were studied (20 men and 26 women), the mean age was 50 ± 15 years and mean BMI was 28.6 ± 4.9 kg/m^2. The mean Hba1c was 8.3 ± 1.2. Twenty three patients had type 2 DM and 23 patients had type 1 DM. Twenty nine patients (63.0%) had OSA and 8.7% had severe OSA (AHI > 30/h). The mean CT90 was 5.3 ± 12.5 and the mean AHI was 13.6 ± 18.3. The mean AHI was similar between type 1 and type 2 DM (15.7 ± 24.5 Vs 11.6 ± 8.9; $p = 0.46$). The AHI was not correlated with the BMI. Type 2 DM patients with poor glycemic control (HbA1c > 7.5%) had a significantly higher mean AHI (14.3 ± 9.0 vs 6.4 ± 6.2; $p = 0.038$). This difference did not remain significant after adjustment for BMI ($p = 0.151$).
Conclusions: The prevalence of OSA in type 1 DM is similar to that found in type 2 DM. We note the high prevalence of OSA in younger patients with type 1 DM.

Introduction

Obstructive sleep apnea (OSA) is a treatable sleep disorder characterized by repetitive upper airway collapse, leading to oxygen desaturation and sleep fragmentation.[1,2]

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http://dx.doi.org/10.1016/j.rppnen.2014.07.005

Diabetes mellitus (DM) and obstructive sleep apnea (OSA) are common disorders that often coexist. One explanation for this overlap is the presence of shared risk factors such as obesity. There may also be a more complex relationship between these conditions in which an underlying metabolic disorder predisposes for both or in which metabolic and autonomic abnormalities associated with one influence the development of the other. Because both diabetes and OSA are associated with increased cardiovascular morbidity and mortality, it is possible that the presence of both conditions results in added or even synergistic health risks. OSA has been identified as a highly prevalent comorbidity of type 2 diabetes mellitus (DM),[3–5] in particular, among obese patients with type 2 DM, which represent the vast majority of individuals with type 2 DM. Multiple epidemiologic and clinical studies have revealed that individuals without diabetes suffering from OSA show alterations in glucose metabolism, including insulin resistance and impaired glucose tolerance, independent of adiposity.[6–9]

Previous studies on the relationship between sleep characteristics and diabetes have mainly focused on patients with type 2 diabetes. Only a few studies have assessed sleep characteristics in patients with type 1 diabetes mellitus. Those studies investigated mainly children with type 1 diabetes, with shorter duration of diabetes. Previous studies showed that reduction of sleep duration and/or decreased sleep quality impair glucose tolerance and reduce insulin sensitivity in healthy controls.[10] Sleep disturbances might have a similar negative effect on glucose metabolism in patients with type 1 diabetes, resulting in worse glucose control.[11] Borel et al.[12] observed a prevalence of 40% in 37 non-obese adult patients with type 1 diabetes mellitus.

In the present study, we therefore evaluated the prevalence of OSA in type 1 and type 2 diabetes mellitus (DM) patients and the influence of OSA on glycemic control.

Methods

We included patients (over 18 years old and under 80) with diabetes followed in the Diabetes Unity of our Hospital, from January 2012 to December 2013. All participants had been on stable medications for diabetes and other comorbidities for the preceding 3 months. Subjects were excluded if they: had unstable cardiopulmonary, neurological, or psychiatric disease; morbid obesity (BMI $\geq$ 40 kg/m^2); or used nocturnal oxygen or positive airway pressure therapy. Height, weight and waist circumference were measured in all patients. HbA1c values (defined as the proportion of hemoglobin that is glycosylated) were obtained from the patient's chart if assessed during the previous 3 months. The following tests were also collected: electrocardiogram, echocardiogram, renal function, cholesterol levels and thyroid function. Sleep complaints or symptoms of OSA were not used as selection criteria. During this period a total of 1520 patients were observed in the Diabetes Unit, of which 178 patients had type 1 DM. The patients were referred successively to the Sleep Unit if they met the criteria mentioned above. Three patients refused to undergo respiratory polygraphy. These were type 1 diabetic patients, not obese and without symptoms of OSAS.

Table 1 Demographic characteristics.

	Mean $\pm$ SD
Age	50.7 $\pm$ 15.1
BMI, kg/m^2	28.6 $\pm$ 4.9
Waist circumference, cm	97.8 $\pm$ 13.2
Neck circumference, cm	37.3 $\pm$ 10.2
ESS	7.7 $\pm$ 4.7
Diabetes diagnosis, years	17.3 $\pm$ 11.7
HbA1c, %	8.3 $\pm$ 1.2

Respiratory polygraphy (RP)

The sleep study equipment measured body position, air flow via nasal cannula, oximetry, pulse rate, and respiratory effort via thoracic and abdominal bands (Embletta PDS 3.0, Flaga Medical, Iceland).

Total cessation of airflow for at least 10 s was defined as apnea (obstructive if respiratory efforts were present and central if respiratory efforts were absent). Hypopneas were defined as at least 30% reduction in thoraco-abdominal movement or airflow lasting at least 10 s which was associated with at least a 3% drop in oxygen saturation. The apnea–hypopnea index (AHI) was defined as the total number of obstructive apneas and obstructive hypopneas per hour of sleep. OSA severity categories were defined according to commonly used clinical cutoffs as follows: no OSA (AHI < 5); mild OSA (AHI $\geq$ 5 but <15); moderate OSA (AHI $\geq$ 15 but <30); and severe OSA (AHI $\geq$ 30). OSA was defined by AHI $\geq$ 5/h, excluding those with central apnea predominance, which was defined by a central apnea index/AHI $\geq$ 50%. All patients got more than 4 h of total sleep time during the RP.

Data analysis

Statistical analysis was performed with SPSS for Windows 20.0 software package (SPSS, Inc; Chicago, IL). Mean and SD were used to express the central tendency and dispersion of continuous variables in normal distribution, and median and interquartile ranges are otherwise used. Comparisons between groups were performed with Student t tests or χ^2 tests when appropriate. Pair-wise comparisons of continuous variables in patients with and without OSA were examined by t test and confirmed by the nonparametric Mann–Whitney test. A p-value $\leq$0.05 was considered to indicate statistical significance.

Results

Forty six patients were included (20 men and 26 women). The mean age was 51 $\pm$ 15 years and mean BMI was 29.0 $\pm$ 4.9 kg/m^2. The mean Hba1c was 8.3 $\pm$ 1.2. Twenty three patients had type 2 DM and 23 patients had type 1 DM. Table 1 summarizes the demographic characteristics of the cohort. The sample included 10 lean, 16 overweight, and 20 obese patients. Snoring was the most frequently reported symptom; it was present in 20 patients (43.5%). Ten patients did not present any symptoms of OSAS. Regarding