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# Lack of reliable clinical predictors to identify obstructive sleep apnea in patients with hypertrophic cardiomyopathy

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**OBJECTIVE:** Obstructive sleep apnea is common among patients with hypertrophic cardiomyopathy and may contribute to poor cardiovascular outcomes. However, obstructive sleep apnea is largely unrecognized in this population. We sought to identify the clinical predictors of obstructive sleep apnea among patients with hypertrophic cardiomyopathy.

**METHODS:** Consecutive patients with hypertrophic cardiomyopathy were recruited from a tertiary University Hospital and were evaluated using validated sleep questionnaires (Berlin and Epworth) and overnight portable monitoring. Ninety patients (males, 51%; age, 46 ± 15 years; body mass index, 26.6 ± 4.9 kg/m$^2$) were included, and obstructive sleep apnea (respiratory disturbance index ≥15 events/h) was present in 37 patients (41%).

**RESULTS:** Compared with the patients without obstructive sleep apnea, patients with obstructive sleep apnea were older and had higher body mass index, larger waist circumference, larger neck circumference, and higher prevalence of atrial fibrillation. Excessive daytime sleepiness (Epworth scale) was low and similar in the patients with and without obstructive sleep apnea, respectively. The only predictors of obstructive sleep apnea (using a logistic regression analysis) were age ≥45 years (odds ratio [OR], 4.46; 95% confidence interval [CI 95%], 1.47–13.54; $p = 0.008$) and the presence of atrial fibrillation [OR, 5.37; CI 95%, 1.43–20.12; $p = 0.013$].

**CONCLUSION:** Consistent clinical predictors of obstructive sleep apnea are lacking for patients with hypertrophic cardiomyopathy, which suggests that objective sleep evaluations should be considered in this population, particularly among elderly patients with atrial fibrillation.

**KEYWORDS:** Hypertrophic Cardiomyopathy; Obstructive Sleep Apnea; Atrial Fibrillation.

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## INTRODUCTION

Hypertrophic cardiomyopathy (HCM) is a common genetic cardiac disease that is characterized by left ventricular (LV) hypertrophy associated with non-dilated ventricular chambers in the absence of another cardiac or systemic disease capable of producing this hypertrophy (1). HCM is a potentially devastating disease; it occurs in all age groups (1) and is a significant cause of disability, including heart failure, atrial fibrillation (AF), and sudden death (2). Despite all efforts, the sudden death rate in HCM patients is approximately 1% per year, and this disease primarily affects patients older than 55 years (3–5).

Obstructive sleep apnea (OSA) is characterized by recurrent episodes of either partial or complete upper airway obstruction during sleep, leading to fragmented sleep and intermittent hypoxia (6). Growing evidence shows that OSA triggers a cascade of deleterious effects to the cardiovascular system, including increased sympathetic activity, oxidative stress, systemic inflammation, insulin resistance, endothelial dysfunction, atherosclerosis, and heart remodeling (7,8). OSA is considered to be a risk factor for hypertension and is independently associated with poor cardiovascular outcomes in the general population (9,10). The typical features of OSA patients who are referred to sleep laboratories include male, obese, loud snoring, and symptoms of excessive daytime sleepiness.

Novel evidence shows that OSA is surprisingly common among patients with HCM, with prevalences ranging from

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32% to 71%, depending on the diagnostic criteria (11–15). Because HCM is commonly diagnosed at young ages, the presence of OSA among HCM patients has been largely ignored. Moreover, for reasons that are not completely understood, evidence indicates that the patients with HCM and OSA are typically less obese than the patients with OSA observed in sleep clinics (13,15). However, cross-sectional data suggest that similarly to what has been well established in other populations, the presence of OSA may contribute to poor cardiovascular outcomes in HCM patients (16). For instance, in HCM patients, OSA has been independently associated with left atrial enlargement and AF (13,14), which is a risk factor for sudden death in these patients.

We have previously reported a high prevalence of OSA among HCM patients (13). Though the previous study conveyed novel and important findings, the clinical characteristics and predictors of OSA were not described. Therefore, the objective of the present study was to identify the predictors of OSA that may help to increase the awareness and diagnosis of OSA in HCM patients.

## METHODS

### Study design

This cross-sectional observational study evaluated consecutive HCM patients who were previously diagnosed according to the standard criteria described below. All patients were recruited from the Cardiomyopathy Clinical Unit, (Clinical Unit of Cardiomyopathies) at the Heart Institute (InCor), University of São Paulo School of Medicine, São Paulo, Brazil, between March 2008 and October 2011. Each patient had been diagnosed with HCM with asymmetric septal hypertrophy, with septal thickness ≥15 mm in the absence of other known causes of left ventricular hypertrophy, such as hypertension and aortic stenosis (17). We included patients of both genders who were older than 18 years. Patients with another cardiac diseases and clinical instability, as defined by a recent hospital admission (the previous 6 months), were excluded.

### Clinical evaluation

All HCM patients underwent a detailed history and physical examination, including anthropometric and clinical data. We used two questionnaires, the Berlin questionnaire and the Epworth Sleepiness Scale, to evaluate the risk of having OSA and the level of excessive daytime sleepiness, respectively, as described below:

Berlin Questionnaire - This questionnaire classifies patients at low and high risk for OSA based on responses in three symptom categories regarding: 1) snoring, 2) tiredness, and 3) the presence of obesity (BMI ≥30 kg/m$^2$) or hypertension. Patients positive for at least two symptom categories were considered at high risk for OSA (18). Because none of the patients with HCM had hypertension, the third domain of the Berlin questionnaire was restricted to obesity.

Epworth Sleepiness Scale (ESS) - The ESS is used to evaluate subjective excessive daytime sleepiness. Briefly, the patient rates the probability of dozing (0 to 3) in eight different situations. A score above 10 is considered positive for the presence of excessive daytime sleepiness (19).

### Sleeps study

All participants underwent an overnight study with a standard 4-channel recording device (Stardust II, Respironics Inc., Murrysville, Pennsylvania, USA). This device records nasal pressure, thoracic excursion (as measured using a piezoelectric crystal), body position, pulse oxymetry, and heart rate. The device is classified as a type 3 monitor in accordance with the AASM recommendations (20). The portable monitoring sleep study was unattended and performed at home. Hypopnea was defined as a ≥50% discernible decrement in airflow lasting ≥10 s with a 3% reduction in oxygen saturation. Apnea was defined when cessation of airflow lasted ≥10 s and was further classified as central, obstructive, or mixed based on the presence of respiratory effort (21). The total recording time was used as the denominator to calculate the respiratory-disordered index (RDI) (6). The RDI was calculated as the total number of respiratory events per hour of record. The classification of OSA severity was defined according to RDI as mild (5–14.9 events/h), moderate (15–29.9 events/h), or severe (≥30 events/h) (6). In this study, we considered moderate to severe OSA (≥15 events/h) as the cut-off for OSA.

### Statistical analysis

Quantitative variables are expressed as means ± SD or medians (interquartile ranges [IQRs]) or in percentages, when appropriate. The Kolmogorov-Smirnov test was used to assess the normal distribution of continuous variables. The Students t-test for independent samples and the Mann-Whitney U-test were used to compare continuous variables when appropriate. The chi-squared test was used for categorical variables. A univariate binary logistic regression analysis was used to evaluate variables associated with the presence of OSA, considering an RDI ≥15 events/h. The tested variables were age (≥45 years), BMI (≥27 kg/m$^2$), neck circumference (≥43 cm and ≥41 cm for males and females, respectively) (22), waist circumference (≥102 cm and ≥88 cm for males and females, respectively) (23), snoring, and a high risk for OSA, as assessed by the Berlin questionnaire. The cut-offs used for age and BMI were obtained using ROC curve analysis as the best values for sensitivity and specificity. Variables with a $p$-value <0.1 upon univariate analysis were entered into a multivariate binary logistic regression. Because snoring was one of the Berlin questionnaire domains, it was not included as an independent variable. In addition, sensitivity, specificity, and positive and negative predictive values of relevant variables were also calculated. Data were analyzed with SPSS 17.0 statistical software (SPSS Inc., Chicago, Illinois, USA). A $p$-value ≤0.05 was considered significant.

### Ethics

The institutional ethics committee approved this study (SDC 3252/09/003), which was performed in accordance with the Helsinki Declaration of 1975 (revised in 1983).

## RESULTS

We evaluated 90 HCM patients who were consecutively recruited from the Cardiomyopathy Clinical Unit at a tertiary University Hospital. None of the patients were referred to the sleep laboratory because of sleep complaints or had a previous diagnosis of OSA. Table 1 summarizes the



**Table 1 –** General and clinical characteristics of the entire population of patients with hypertrophic cardiomyopathy and the patients with and without obstructive sleep apnea.

| | Total population (n = 90) | No OSA (n = 53) | OSA (n = 37) | *p*-value |
|---|---|---|---|---|
| Age, years | 46±15 | 41±14 | 53±13* | <0.001 |
| Male, n (%) | 46 (51) | 26 (49) | 21 (57) | 0.742 |
| Caucasians, n (%) | 67 (74) | 40 (75) | 27 (72) | 0.983 |
| Body Mass Index, kg/m$^2$ | 26.6±4.9 | 25.3±5.0 | 28.5±4.0* | 0.003 |
| Neck, cm | 37.4±4.2 | 36.4±3.2 | 39.0±5.0* | 0.002 |
| Waist, cm | 94.1±12.1 | 91.0±11.0 | 98.6±11.7* | 0.003 |
| NYHA 2 and 3, n (%) | 44 (49) | 23 (43) | 20 (54) | 0.434 |
| Atrial fibrillation, n (%) | 18 (20) | 5 (9) | 13 (35)* | 0.003 |
| Antihypertensive, n (%) | | | | |
| Diuretics, n (%) | 19 (23) | 10 (20) | 9 (27) | 0.718 |
| Beta-blockers, n (%) | 61 (68) | 34 (64) | 26 (70) | 0.705 |
| Angiotensin-converting enzyme inhibitor, n (%) | 4 (5) | 1 (2) | 3 (8) | 0.302 |
| Calcium channel blockers, n (%) | 18 (22) | 9 (17) | 10 (27) | 0.375 |
| Angiotensin receptor blocker, n (%) | 14 (17) | 7 (13) | 7 (19) | 0.660 |
| Hypnotics, n (%) | 5 (6) | 2 (4) | 3 (8) | 0.398 |
| Antidepressants, n (%) | 13 (16) | 6 (11) | 7 (29) | 0.481 |

Values are presented as percentages, means±SD or medians (interquartile ranges) for the variables, as appropriate. OSA: obstructive sleep apnea.
*$p \leq 0.05$.

patient demographics and the medications of the entire population and divides the patients according to the absence or presence of OSA. The vast majority of patients were taking at least one cardiovascular medication (88%) (Table 1). Consistent with recent studies of HCM patients, moderate to severe OSA (Apnea-Hypopnea Index> 15 events/h) was extremely common and was present in 41% of our population (13–15). The OSA patients were predominantly older males with higher BMIs, higher neck and waist circumferences, and higher prevalences of AF compared to the patients without OSA. However, in contrast to the typical patient with OSA referred to the sleep laboratory, the patients with HCM+OSA were not particularly obese (Table 1).

The sleep characteristics and sleep-related questionnaires of the entire population are summarized in Table 2 according to the presence or absence of OSA. A high OSA risk, as evaluated by the Berlin questionnaire, was more common among the patients with OSA than among the patients without OSA (Table 2). The frequencies of positive answers to the three categories of the Berlin questionnaire (snoring, tiredness, and obesity) are also shown in Table 2. Snoring and high BMI were more common in the OSA patients. In contrast, tiredness did not differ significantly among the patients with and without OSA. Moreover, complaints of excessive daytime sleepiness, as assessed by the Epworth Sleepiness Scale, were relatively low in the entire population and were similar among patients with and without OSA (Table 2).

We performed a binary logistic regression to evaluate the predictors for OSA: the only variables that were independently associated with OSA were age ≥45 years and the presence of AF (Table 3). To translate our findings into clinically meaningful data, we determined the sensitivity, specificity, and positive and negative predictive values of the main traits, including demographics and OSA-associated complaints (Table 4). In general, all analyzed variables performed poorly in the analysis, which highlights the fact that several HCM patients are minimally symptomatic for OSA and do not have the typical features that helps to identify OSA.

## DISCUSSION

In this study, the prevalence of OSA among consecutive HCM patients was particularly high (41%), which aligned with data from previous studies (13–15). Our study was designed to determine the clinical characteristics that may help to identify OSA among HCM patients. The main

**Table 2 -** Respiratory parameters derived from portable monitoring and sleep questionnaires for the entire population and for patients with and without obstructive sleep apnea.

| | Total population (n = 90) | No OSA (n = 53) | OSA (n = 37) | *p*-value |
|---|---|---|---|---|
| **RDI, e/h** | 10.2 (4.5–24.8) | 5 (2.7–8.1) | 30.3 (21.2–39.3)* | <0.001 |
| **Lowest $SpO_2$, %** | 84 (78–88) | 87 (83–89.5) | 80 (75.7–82.5)* | <0.001 |
| **Berlin high risk, n (%)** | 36 (40) | 13 (25) | 23 (66)* | <0.001 |
| **Snoring, n (%)** | 47 (52) | 13 (35) | 24 (65) | 0.056 |
| **Tiredness, n (%)** | 35 (39) | 18 (34) | 19 (51) | 0.152 |
| **BMI ≥30 kg/m$^2$, n (%)** | 22 (24) | 9 (16) | 13 (35) | 0.080 |
| **Epworth** | 7 (3–11) | 7.5 (3.5–11) | 7 (3–12.2) | 0.924 |

Values are presented as percentages, means±SD or medians (interquartile ranges) for the variables with skewed distribution. OSA: obstructive sleep apnea. RDI: respiratory-disordered index; BMI: body mass index.
*$p \leq 0.05$.

**Table 3 -** Binary logistic regression with the predictors of obstructive sleep apnea among patients with hypertrophic cardiomyopathy.

| | Univariate | | Multivariate | |
|---|---|---|---|---|
| | OR (CI 95%) | *p*-value | OR (CI 95%) | *p*-value |
| Age ≥45 years | 3.76 (1.55–9.13) | 0.003 | 4.46 (1.47–13.54) | 0.008 |
| BMI ≥27 kg/m$^2$ | 2.62 (1.10–6.24) | 0.029 | 0.842 (0.25–2.88) | 0.843 |
| Large neck | 2.18 (0.83–5.71) | 0.067 | 2.48 (0.64–9.49) | 0.185 |
| Large waist | 2.07 (0.87–4.92) | 0.097 | 2.07 (0.67–6.43) | 0.207 |
| Atrial fibrillation | 5.20 (1.65–16.36) | 0.005 | 5.37 (1.43–20.12) | 0.013 |
| Snoring | 4.40 (1.59–12.18) | 0.004 | | |
| Berlin high risk | 3.39 (1.41–8.18) | 0.007 | 2.46 (0.83–7.28) | 0.103 |
| Constant | | | 0.086 | 0.000 |

OR: odds ratio; CI: confidence interval; BMI: body mass index.

findings were as follows: 1) the patients with HCM+OSA did not complain of excessive daytime sleepiness; 2) the patients with HCM+OSA were significantly older and had higher BMI and neck and waist circumferences, but on average, the patients with HCM+OSA were overweight and typically not obese; 3) the Berlin questionnaire, which has been previously validated to recognize patients with OSA in other populations (18,24,25), was not useful in recognizing OSA among HCM patients and 4) age ≥45 years and the presence of AF were the only variables that were independently associated with OSA. However, age ≥45 years had a low sensitivity and specificity to predict OSA. Conversely, the presence of AF presented a relatively high sensitivity (0.72, 95% confidence interval [CI 95%], 0.46–0.89). Altogether, our results suggest a lack of reliable clinical predictors to identify OSA among HCM patients.

OSA is common in the general population (26,27) and is independently associated with increased cardiovascular risk (9,10). In HCM patients, evidence also shows that the presence of OSA may be associated with worse structural and functional impairment of the heart, including atrial and aortic enlargement, worse New York Heart Association functional class, and worse quality of life (13–15,28). In HCM patients, AF is an independent marker of mortality (29), and its prevalence is significantly higher (~5 times) in the presence of OSA (13,14). Consistent with these previous observations, in the present study, AF was ~3 to 4 times more common among patients with HCM+OSA than in patients with HCM but not OSA. Moreover, in the multivariate analysis, when all possible clinical predictors were considered, only age and the presence of AF remained statistically significant. These findings are worrisome and indicate the necessity to test the hypothesis in future studies that OSA may contribute to the genesis of heart remodeling and AF among HCM patients. Despite this evidence, the clinical suspicion of OSA among HCM patients remains uncommon. There are several potential explanations for the lack of OSA recognition among these patients. First, cardiologists are not systematically trained in sleep medicine. Second, because HCM is a genetic disease, it is often diagnosed at young ages (when OSA is not frequent). Third, HCM patients frequently do not exhibit the typical features of OSA patients, such as obesity. Fourth, OSA has only recently been shown to be extremely common in this population. Finally, in contrast to the patient population referred to the sleep laboratory (30), patients with HCM+OSA frequently do not have typical clinical symptoms, such as tiredness and excessive daytime sleepiness. The lack of excessive daytime sleepiness in patients with OSA has also been observed in consecutive patients with established cardiovascular disease, including hypertension (24,25), metabolic syndrome (31), stroke (32), atrial fibrillation (33), and coronary artery disease (34). In our study, regarding the sensitivity and specificity to predict OSA, the Epworth Sleepiness Scale and Berlin questionnaire returned low values for all of the tested variables; therefore, these tools are not useful in clinical practice (Table 4). All of these findings are important and emphasize that cardiologists should take the responsibility to actively search for OSA among patients with HCM.

**Table 4** - Performance of clinical and sleep-related characteristics of the HCM patients.

| | Sensitivity (CI 95%) | Specificity (CI 95%) | PPV (CI 95%) | NPV (CI 95%) |
|---|---|---|---|---|
| Age ≥45 years | 0.26 (0.15–0.42) | 0.42 (0.28–0.57) | 0.31 (0.18–0.49) | 0.36 (0.23–0.51) |
| Gender | 0.38 (0.24–0.54) | 0.54 (0.39–0.69) | 0.44 (0.28–0.61) | 0.48 (0.34–0.62) |
| BMI ≥27 kg/m$^2$ | 0.53 (0.38–0.67) | 0.69 (0.53–0.82) | 0.65 (0.48–0.79) | 0.57 (0.43–0.71) |
| BMI ≥30 kg/m$^2$ | 0.59 (0.36–0.78) | 0.63 (0.50–0.74) | 0.34 (0.20–0.51) | 0.82 (0.69–0.91) |
| Large neck | 0.56 (0.34–0.76) | 0.62 (0.50–0.73) | 0.34 (0.20–0.51) | 0.80 (0.67–0.90) |
| Large waist | 0.50 (0.35–0.64) | 0.67 (0.50–0.81) | 0.65 (0.48–0.79) | 0.51 (0.37–0.65) |
| AF | 0.72 (0.46–0.89) | 0.66 (0.54–0.72) | 0.36 (0.21–0.53) | 0.90 (0.77–0.96) |
| Snoring | 0.56 (0.41–0.70) | 0.77 (0.58–0.89) | 0.79 (0.61–0.90) | 0.53 (0.38–0.68) |
| Berlin | 0.40 (0.25–0.57) | 0.30 (0.18–0.44) | 0.28 (0.17–0.43) | 0.42 (0.26–0.59) |
| Epworth >10 | 0.46 (0.28–0.65) | 0.60 (0.46–0.72) | 0.36 (0.22–0.54) | 0.69 (0.54–0.80) |

PPV: positive predictive value; NPV: negative predictive value; AF: atrial fibrillation.

Our study has some limitations that should be addressed. First, because of the specific nature of the underlying disease, the external validity of our data should be analyzed carefully. Second, our sleep study was performed using a portable monitor. However, portable monitors have also been confirmed as a useful alternative to overnight polysomnography for the diagnosis of sleep-disordered breathing in a series of patients with cardiovascular disease (34–36).

In conclusion, our study confirms that OSA is common in HCM patients. In this population, using clinical characteristics or validated questionnaires to identify OSA does not accurately identify the patients at high risk for OSA. Our results indicate the necessity for more accurate screening strategies for identifying OSA in HCM patients. Considering the high prevalence of OSA and its potential cardiovascular consequences, sleep studies should be widely considered for diagnosing OSA in patients with HCM, particularly among elderly patients with AF.

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## AUTHOR CONTRIBUTIONS

Nerbass FB participated in the study design, data collection, statistical analysis, and manuscript development. Pedrosa RP participated in the study design, data collection, and manuscript development. Genta PR performed the statistical analysis. Antunes MO participated in the data collection. Arteaga-Fernández E contributed to the manuscript development. Drager LF and Lorenzi-Filho G participated in the study design, statistical analysis, and manuscript development.

## REFERENCES

1. Gersh BJ, Maron BJ, Bonow RO, Dearani JA, Fifer MA, Link MS, et al. 2011 ACCF/AHA guideline for the diagnosis and treatment of hypertrophic cardiomyopathy: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Thorac Cardiovasc Surg. 2011;142(6):e153-203, http://dx.doi.org/10.1016/j.jtcvs.2011.10.020.
2. Maron BJ. The 2009 international hypertrophic cardiomyopathy summit. Am J Cardiol. 2010;105(8):1164-8, http://dx.doi.org/10.1016/j.amjcard.2009.12.021.
3. Elliott PM, Gimeno JR, Thaman R, Shah J, Ward D, Dickie S, et al. Historical trends in reported survival rates in patients with hypertrophic cardiomyopathy. Heart. 2006;92(6):785-91.
4. Wald DS, Law M, Morris JK. Mortality from hypertrophic cardiomyopathy in England and Wales: clinical and screening implications. Int J Cardiol. 2004;97(3):479-84.
5. Arteaga E, Ianni BM, Fernandes F, Mady C. Benign outcome in a long-term follow-up of patients with hypertrophic cardiomyopathy in Brazil. Am Heart J. 2005;149(6):1099-105, http://dx.doi.org/10.1016/j.ahj.2004.09.049.
6. Flemons WW, Buysse D, Redline S, Strohl K, Wheatley J, Douglas N, et al. Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. Sleep. 1999;22(5):667-89.
7. Bradley TD, Floras JS. Obstructive sleep apnoea and its cardiovascular consequences. Lancet. 2009;373(9657):82-93, http://dx.doi.org/10.1016/S0140-6736(08)61622-0.
8. Drager LF, Polotsky VY, Lorenzi-Filho G. Obstructive sleep apnea: an emerging risk factor for atherosclerosis. Chest. 2011;140(2):534-42, http://dx.doi.org/10.1378/chest.10-2223.
9. Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. Lancet. 2005;365(9464):1046-53.
10. Punjabi NM, Caffo BS, Goodwin JL, Gottlieb DJ, Newman AB, O'Connor GT, et al. Sleep-disordered breathing and mortality: a prospective cohort study. PLoS Med. 2009;6(8):e1000132, http://dx.doi.org/10.1371/journal.pmed.1000132.
11. Banno K, Shiomi T, Sasanabe R, Otake K, Hasegawa R, Maekawa M, et al. Sleep-disordered breathing in patients with idiopathic cardiomyopathy. Circ J. 2004;68(4):338-42, http://dx.doi.org/10.1253/circj.68.338.
12. Eleid MF, Konecny T, Orban M, Sengupta PP, Somers VK, Parish JM, et al. High prevalence of abnormal nocturnal oximetry in patients with hypertrophic cardiomyopathy. Am Coll Cardiol. 2009;54(19):1805-9, http://dx.doi.org/10.1016/j.jacc.2009.07.030.
13. Pedrosa RP, Drager LF, Genta PR, Amaro AC, Antunes MO, Matsumoto AY, et al. Obstructive sleep apnea is common and independently associated with atrial fibrillation in patients with hypertrophic cardiomyopathy. Chest. 2010;137(5):1078-84, http://dx.doi.org/10.1378/chest.09-2335.
14. Konecny T, Brady PA, Orban M, Lin G, Pressman GS, Lehar F, et al. Interactions between sleep disordered breathing and atrial fibrillation in patients with hypertrophic cardiomyopathy. Am J Cardiol. 2010;105(11):1597-602, http://dx.doi.org/10.1016/j.amjcard.2010.01.023.
15. Prinz C, Bitter T, Oldenburg O, Horstkotte D, Faber L. Incidence of obstructive sleep apnea in patients with hypertrophic cardiomyopathy. Congest Heart Fail. 2011;17(1):19-24, http://dx.doi.org/10.1111/j.1751-7133.2010.00196.x.
16. Nerbass FB, Pedrosa RP, Danzi-Soares J, Drager LF, Arteaga-Fernandez E, Lorenzi-Filho G. Obstructive sleep apnea and hypertrophic cardiomyopathy: a common and potential harmful combination. Sleep Med Rev. 2013;17(3):201-6, http://dx.doi.org/10.1016/j.smrv.2012.06.006.
17. Maron BJ, Gardin JM, Flack JM, Gidding SS, Kurosaki TT, Bild DE. Prevalence of hypertrophic cardiomyopathy in a general population of young adults. Echocardiographic analysis of 4111 subjects in the CARDIA Study. Coronary Artery Risk Development in (Young) Adults. Circulation. 1995;92(4):785-9.
18. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med. 1999;131(7):485-91, http://dx.doi.org/10.7326/0003-4819-131-7-199910050-00002.
19. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991;14(6):540-5.
20. Collop NA, Anderson WM, Boehlecke B, Claman D, Goldberg R, Gottlieb DJ, et al. Portable Monitoring Task Force of the American Academy of Sleep Medicine. Clinical guidelines for the use of unattended portable monitors in the diagnosis of obstructive sleep apnea in adult patients. Portable Monitoring Task Force of the American Academy of Sleep Medicine. J Clin Sleep Med. 2007;3(7):737-47.
21. Iber C, Ancoli-Israel S, Chesson AL, Quan SF. The AASM Manual for the Scoring of Sleep and Associated Events, Rules, Terminology and technical Specifications, American Academy of Sleep Medicine. Westchester, IL: AASM Manual for Scoring Sleep; 2007.
22. Epstein LJ, Kristo D, Strollo PJ, Friedman N, Malhotra A, Patil SP, et al. Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med. 2009;5(3):263-76.
23. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. American Heart Association; National Heart, Lung, and Blood Institute. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005;112(17):2735-52.
24. Drager LF, Genta PR, Pedrosa RP, Nerbass FB, Gonzaga CC, Krieger EM, et al. Characteristics and predictors of obstructive sleep apnea in patients with systemic hypertension. Am J Cardiol. 2010;105(8):1135-9, http://dx.doi.org/10.1016/j.amjcard.2009.12.017.
25. Pedrosa RP, Drager LF, Gonzaga CC, Sousa MG, de Paula LK, Amaro AC, et al. Obstructive sleep apnea: the most common secondary cause of hypertension associated with resistant hypertension. Hypertension. 2011;58(5):811-7, http://dx.doi.org/10.1161/HYPERTENSIONAHA.111.179788.
26. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med. 1993;328(17):1230-5.
27. Tufik S, Santos-Silva R, Taddei JA, Bittencourt LR. Obstructive sleep apnea syndrome in the São Paulo Epidemiologic Sleep Study. Sleep Med. 2010;11(5):441-6, http://dx.doi.org/10.1016/j.sleep.2009.10.005.
28. Pedrosa RP, Lima SG, Drager LF, Genta PR, Amaro AC, Antunes MO, et al. Sleep quality and quality of life in patients with hypertrophic cardiomyopathy. Cardiology. 2010;117(3):200-6, http://dx.doi.org/10.1159/000321718.
29. Olivotto I, Cecchi F, Casey SA, Dolara A, Traverse JH, Maron BJ. Impact of atrial fibrillation on the clinical course of hypertrophic cardiomyopathy. Circulation. 2001;104(21):2517-24, http://dx.doi.org/10.1161/hc4601.097997.
30. Roure N, Gomez S, Mediano O, Duran J, Peña Mde L, Capote F, et al. Daytime sleepiness and polysomnography in obstructive sleep apnea patients. Sleep Med. 2008;9(7):727-31, http://dx.doi.org/10.1016/j.sleep.2008.02.006.
31. Drager LF, Lopes HF, Maki-Nunes C, Trombetta IC, Toschi-Dias E, Alves MJ, et al. The impact of obstructive sleep apnea on metabolic and inflammatory markers in consecutive patients with metabolic syndrome. PLoS One 2010;5(8):e12065, http://dx.doi.org/10.1371/journal.pone.0012065.
32. Arzt M, Young T, Peppard PE, Finn L, Ryan CM, Bayley M, et al. Dissociation of obstructive sleep apnea from hypersomnolence and obesity in patients with stroke. Stroke. 2010;41(3):e129-e34, http://dx.doi.org/10.1161/STROKEAHA.109.566463.
33. Albuquerque FN, Calvin AD, Sert Kuniyoshi FH, Konecny T, Lopez-Jimenez F, Pressman GS, et al. Sleep-disordered breathing and excessive daytime sleepiness in patients with atrial fibrillation. Chest. 2012;141(4):967-73, http://dx.doi.org/10.1378/chest.11-0975.
34. Danzi-Soares NJ, Genta PR, Nerbass FB, Pedrosa RP, Soares FS, César LA, et al. Obstructive sleep apnea is common among patients referred for coronary artery bypass grafting and can be diagnosed by portable monitoring. Coron Artery Dis. 2012;23(1):31-8.
35. Quintana-Gallego E, Villa-Gil M, Carmona-Bernal C, Botebol-Benhamou G, Martinez-Martinez A, Sanchez-Armengol A, et al. Home respiratory polygraphy for diagnosis of sleep-disordered breathing in heart failure. Eur Respir J. 2004;24(3):443-8, http://dx.doi.org/10.1183/09031936.04.00140603.
36. Prinz C, Bitter T, Piper C, Horstkotte D, Faber L, Oldenburg O. Sleep apnea is common in patients with coronary artery disease. Wien Med Wochenschr. 2010;160(13-14):349-55, http://dx.doi.org/10.1007/s10354-009-0737-x.