Prevalence of Obstructive Sleep Apnoea in Patients with Hypertension: Study from a tertiary care hospital

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Research article

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Abstract

Background: Obstructive Sleep Apnoea (OSA), a condition characterized by a complete or partial cessation of airflow during sleep, can cause various cardiovascular disorders including hypertension. The aim of the study was to determine the prevalence of OSA in patients with hypertension. Methods: A cross-sectional prospective cohort study of 504 patients (253 males and 251 females) with hypertension was undertaken at Shri-Maharaja Hari Singh (SMHS) Hospital of Srinagar, India for a period of six months. OSA was evaluated using Berlin questionnaire and Epworth Sleepiness scale. Data analysis was done using SPSS v. 20. Results: High risk of OSA was identified in 120 (23.8%) patients and the prevalence of sleepiness (Epworth Sleepiness score ≥16) was found to be 32.5% (95% CI, P≤0.001) in these patients. The mean neck circumference, waist circumference and waist-to-hip ratio for high-risk OSA group was 14.75 ± 1.338 inches, 105.90 ± 11.28 cm and 1.01 ± 0.065 respectively while for the low-risk group, these parameters were 13.97 ± 1.045 inches, 98.75 ± 10.87 cm and 0.99 ± 0.080 respectively (95% CI, P≤0.001). The mean blood pressure (BP) ≥133.52/84.37 mm Hg was recorded in patients with high risk of OSA (95% CI, P<0.05) and resistant hypertension (3.3%) was significantly associated with the risk of OSA (95% CI, P<0.05). Conclusion: In the tertiary health care setting, the prevalence of high-risk of OSA in patients with hypertension is high. Screening for OSA should be a part of the hypertensive medical investigation and patients may benefit from proper evaluation of OSA.

Background

Obstructive Sleep Apnoea (OSA) is a sleep-related breathing disorder that involves complete or partial halt in airflow due to the collapse of the upper airway, despite an ongoing effort to breathe [1]. The obstruction of the upper airway occurs because of the inadequate motor tone of the tongue and/or airway dilator muscles [2], which is associated with fragmented sleep pattern, arousals from sleep and fall in oxygen saturation [3]. Nocturnal oxygen desaturation causes sympathetic surges conducive to the development of acute cardiovascular events (i.e., stroke, myocardial infarction and nocturnal sudden death) and chronic conditions such as systemic hypertension, coronary artery disease and heart failure [4]–[6]. Hypertension is an important public health challenge worldwide because of its high frequency and concomitant risk of cardiovascular (CV)/cerebrovascular morbidity and mortality [7], [8]. It is estimated to cause 7.5 million deaths that is 12.8% of the total number of deaths worldwide [9].

Globally, various epidemiological studies report that about 30% of patients with OSA have hypertension [10]–[13], while in patients with resistant hypertension the prevalence of OSA is reported to be 80% [14], [15].

Epidemiological studies from Asia have shown that the prevalence of OSA in patients with hypertension varies from 14-75% [16]–[19]. A number of studies from India have garnered data regarding the overall prevalence of OSA in general population [20]–[23], however, there is insufficient data to determine the prevalence of OSA in patients with hypertension. This lack of epidemiological aspects confirming relation, if any, of hypertension with OSA has remained an unmet research need. The current study

investigates the prevalence of OSA in confirmed hypertensive cases and correlates the severity of hypertension and OSA in terms of Berlin and Epworth scores.

Methods

This prospective cross-sectional study was conducted at the Department of General Medicine, *Shri Maharaja Hari Singh* (SMHS) Hospital, Karanagar, Srinagar, J&K, India, a tertiary care hospital. The participants were prospectively selected for a period of six months. A flow diagram depicting the number of subjects recruited at each step is shown in Figure 1. The ethical clearance for the study was obtained from the institutional review board of Government Medical College/SMHS under the investigation vide number: 108/ETH/GMC/ICM, Dated 28/10/2017. After a proper statistical confirmation, 504 patients were selected with a mean age of 56 ± 11 years. Patients 18 years and older, of both sexes, who came for consultation/treatment at the Department of General Medicine, with a known case of hypertension were enrolled for the study and a well-informed consent was taken from all the patients before enrollment in the study.

Exclusion criteria included pregnancy/lactation, stroke/functional impairment, uncontrolled hypertension (≥ 170/100 mm Hg), pre-eclampsia, uncontrolled diabetes (HbA1c > 9.0%), other uncontrolled medical problems (impaired renal, liver functions) and subjects who had been receiving treatment for OSA. Participants were also excluded if they were reluctant to give consent or were younger than 18 years.

Study Measures: All patients, who consented to participate, were recruited by one attending physician. The patients were invited to complete a standardized questionnaire surveying the information regarding demographics and lifestyle factors [Table 1]. They were then subjected to the Berlin Questionnaire and the Epworth Sleepiness Scale. After the completion of questionnaires, measurement of BP, height, weight, waist circumference (WC), neck circumference (NC) and hip circumference were taken. BP measurement was recorded using a mercury sphygmomanometer (Speider & Keller, Jungingen, Germany), according to the recommendations of the American Heart Association Council on High Blood Pressure Research. Hypertension was categorized as stage 1 (140-159/90-99 mm Hg) and stage 2 (≥160/100 mm Hg) based on the guidelines by the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure [24]. Resistant Hypertension was defined as the failure to control clinic BP levels, despite the use of ≥3 antihypertensive drugs in optimal dosages, ideally including a diuretic, or achieving it with ≥4 drugs [25], while uncontrolled hypertension was defined as an office BP ≥140/90 mm Hg at the day of consultation [26]. The risk of OSA was assessed using Berlin Questionnaire [27]. The questionnaire is divided into three categories related to the risk of having sleep apnoea. Category 1 is about the nature of snoring; category 2, about patient's complaint of fatigue, tiredness and daytime sleepiness and category 3 evaluates the presence of obesity or hypertension. The subjects were categorized into "high-risk group" if two or more Berlin categories were positive and "low-risk group" in case one or no category was positive [28]. The daytime sleep tendency was evaluated using Epworth Sleepiness Scale (ESS) which classifies the subjects into five groups on the basis of the score: 0-5, Lower Normal Daytime Sleepiness; 6-10, Higher Normal Daytime Sleepiness; 11-12, Mild Excessive Daytime

Sleepiness; 13-15, Moderate Excessive Daytime Sleepiness; 16-24, Severe Excessive Daytime Sleepiness. [29] Lastly, a standardized interview specifying baseline demographic data was collected which included age, sex, Medical Records Department (MRD) number and marital status. Lifestyle factors evaluated were smoking history, exercise level and occupation. A baseline clinical data that is medical history was also obtained. Height and weight measurements were obtained to calculate BMI and to categorize underweight (BMI 18 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), class 1 obesity (30–34.9 kg/m^2), class 2 obesity (35–39.9 kg/m^2), and class 3 extreme obesity (≥40 kg/m^2) [30]. The normal cut-off value for NC was taken as 35.5 cm (14 in.) for men and 32 cm (12.5 in.) for women [31]. WC was defined using the new International Diabetes Federation criteria for Asians: WC ≥ 90cm for men and ≥ 80cm for women [32].

Statistical Analysis

The statistical analysis was done using IBM SPSS (Statistical Package for the Social Sciences), V.20.0. (Armonk, NY: IBM Corp) software. Factors associated with high risk of OSA and excessive daytime sleepiness (EDS) were identified using the χ2 test in the univariate analysis. A *p*-value of 0.05 was considered statistically significant.

Results

Over a period of six months, 737 subjects were surveyed, of which 504 (69%) responded and completed the study. In this sample, men and women were nearly equally distributed (male 253 and female 251). The mean age of the sample was 56±11 years. The high risk of OSA, as per the Berlin Questionnaire, was present in 23.8% (n = 120) of the population and the severe excessive daytime sleepiness, according to the Epworth Sleepiness Scale, was present in 32.5% (n = 39) participants of the high-risk group.

On anthropometric evaluation, 37.5% of high-risk OSA patients had a BMI ≥30 kg/m^2 and about 85.1% of low-risk OSA patients had a BMI <30 kg/m^2. The mean BMI for high-risk OSA group was 28.75 ± 5.4 kg/m^2 and 25.51 ± 4.5 kg/m^2 ($p < 0.001$; 95% CI) for low-risk group. The mean neck circumference for high-risk OSA group was 14.75 ± 1.338 inches and 13.97 ± 1.045 inches for the low-risk group. About 88% of high-risk subjects had abnormal neck circumference and 34.9% of the low-risk group had normal neck circumference ($p < 0.001$; 95% CI). Mean waist circumference for high-risk group was 105.90 ± 11.28 cm and for the low-risk group was 98.75 ± 10.87 cm. Ninety percent of subjects in the high-risk group had abnormal waist circumference and only ten percent in the low-risk group had abnormal waist circumference ($p < 0.001$; 95% CI). Mean waist-to-hip ratio (WHR) in high-risk group was 1.01 ± 0.065 and only 0.99 ± 0.080 in the low-risk group. About 97% of patients in the high-risk group had abnormal WHR while only 4.7% of the low-risk group had normal WHR ($p = 0.295$; 95% CI). The descriptive statistical analysis of various anthropometric parameters in study patients is given in Table 2.

The mean systolic and diastolic BP for the high-risk group was 133.52 ± 17.503 and 84.37 ± 7.425 mm Hg whereas for the low-risk group the mean BP was 130.21 ± 17.244/82.69 ± 9.531 mm Hg ($p<0.05$; 95%

CI). Uncontrolled hypertension was present in 50% (n=60) of patients with high-risk for OSA while 57.6% (n=221) of patients had controlled hypertension in low-risk group (p=0.146; 95% CI). Resistant hypertension was present in 3.3% (n=4) subjects in high-risk OSA category while 99.5% (n=382) subjects in low-risk group had non-resistant hypertension (p<0.05; 95% CI). The Epworth score of >10 was found in 62.5% (n=75) patients with high-risk for OSA and <10 was found in 86.1% (n = 331) among low-risk group (p<0.001; 95% CI). The patients with high-risk for OSA utilized more number of medications than the low-risk group with 7.5% of patients in the former group using three drugs simultaneously and only 2.08% in the latter group using triple therapy (p < 0.05; 95% CI).

The most notable clinical features associated with high-risk of OSA were BP, sleepiness, hypertension control-status, resistant hypertension, diabetes and obesity. Table 3 summarizes the clinical parameters of study patients. The most common co-morbidities associated with hypertension were type 2 diabetes mellitus (23.2%), subclinical hypothyroidism (9.5%), dyslipidemia (4%), obesity (4%) and non-alcoholic fatty liver disease (2.4%) (Table 1). The high-risk group presented with disturbed sleep (29.2%), high daytime somnolence (32.5%), high fatigue/lethargy (46.7%) and loud snoring (84.2%) while these parameters were relatively normal in the low-risk group (p < 0.001; 95% CI).

Discussion

The present study is the first large data set furnishing information regarding the prevalence of obstructive sleep apnoea in patients with hypertension from this part of the world. The target population was identified on the basis of physician detected hypertension and the patient data was collected by a standardized protocol on snoring, daytime sleepiness, BP and other features associated with OSA.

Our study demonstrates that OSA is widely prevalent in patients with hypertension. On the basis of standard Berlin Questionnaire, 24% of the test population was found to be at high risk for OSA (i.e., 1 in every 4 hypertensive individuals). This is in accordance with the studies by Peppard and colleagues who identified 24-28% prevalence of OSA in hypertension [33].

The prevalence of daytime sleepiness in this sample was 62.5% by the Epworth Scale result above 10 points. This prevalence in our sample is in agreement with the prevalence identified in a previous report of patients with hypertension [62.78% (95% CI 58.08 to 67.47)] [34].

The overall mean age of the high risk for OSA respondents was 53.4 ± 9.02 years. The prevalence of OSA was highest between 51-60 years of age and this risk increased exponentially from 0.8% at ≤ 30 years of age to 41.7% at 51-60 years of age (p 0.001) (Figure 2). This finding is in agreement with the previous studies demonstrating the effect of age on OSA status [19], [35].

The seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure identifies the independent role of OSA in the development of hypertension and its association with obesity [24]. In our study, patients with high-risk of OSA had significantly higher BMI, WC, WHR and NC values compared to the patients with low-risk of OSA (Figure 3). All of the anthropometric

indices (NC, WC, and BMI) were significantly correlated with the risk of OSA. These results are supported by similar findings by Kang and colleagues, who reported that NC [95% CI; $p < 0.001$], WC (95% CI; $p < 0.001$), and BMI (95% CI; $p < 0.001$) were significantly associated with the presence of OSA [36]. Hiestand et al. reported that among obese subjects (BMI ≥ 30kg/m^2), 59% of subjects were at high-risk of OSA [37]. In our study, only 37.5% of subjects were at high-risk of OSA among obese patients (BMI ≥ 30 kg/m^2).

In a study by Endeshaw and colleagues the mean BP values among older adults with sleep-disordered breathing were 133±16 and 71±8 mm Hg for systolic and diastolic BP, respectively ($p < 0.001$) [38]. In our study, the average systolic and diastolic BP was 133.52 ± 17.503 and 84.37 ± 7.425 mm Hg (Figure 4).

In our study, OSA was found to be strongly associated with resistant hypertension. Though our sample size was not large enough to justify a meaningful conclusion on this, another case-control study by Gonçalves et al. reported that OSA is a strong independent risk factor for resistant hypertension [39].

Strength of the Study

This is the first population-based, cross-sectional study to determine the prevalence of high-risk of OSA in patients with hypertension from the state of Jammu and Kashmir. This study represents an advanced approach in the understanding of the risk-factors of hypertension and gives an insight into the prevalence of high-risk of OSA in patients with hypertension. The Berlin Questionnaire, used in our study, is a validated instrument that has been used widely to identify individuals who are at risk for OSA [40]. Our assessment of excessive daytime sleepiness was based on the ESS score, which is a well-tested international instrument for the evaluation of daytime sleepiness [41]. With the increasing problem of hypertension, the impact of undetected or under-diagnosed OSA as a healthcare burden cannot be undermined. Therefore, this study can help reduce CV outcomes and healthcare costs of rigorous anti-hypertensive regimen by treating the underlying cause.

Limitations of the Study

The limited number of patients and less time duration are the limitations of this study. Also, we only used the Berlin Questionnaire to identify high risk for OSA. Although polysomnography is the gold-standard test for the diagnosis of OSA in clinical settings [42], it is complex, expensive, time consuming and uneconomical for the general population. Further studies using overnight polysomnography are needed to exhaustively elucidate the bidirectional association between OSA and hypertension and also to determine the magnitude of prevalence of the two disorders together from different healthcare facilities of the state.

Conclusions

OSA is one of the most underdiagnosed and overlooked conditions in the healthcare system. The screening of OSA must be done in every suspected case, such as uncontrolled BP, unexplained

hypertension, resistant hypertension and obese patients. Our study concludes that nearly one in every four hypertensive patients are at high risk of OSA and most of them are obese and have a large neck circumference. Therefore, patients who feel very dizzy, fatigued and lethargic during the day should consult the physician, while the healthcare personnel involved in the management of hypertensive patients should screen OSA and EDS and consider lifestyle modifications in patients who are at high risk of developing OSA. The current study strengthens the acceptance of OSA as a risk factor for hypertension, in terms of essential hypertension and resistant hypertension and provides an estimate of the worsening situation of hypertension due to undiagnosed underlying causes.

Abbreviations

BMI: Body Mass Index

BP: Blood Pressure

ESS: Epworth Sleepiness Scale

HC: Hip Circumference

mm Hg: millimeters of Mercury

NC: Neck Circumference

OSA: Obstructive Sleep Apnoea

SPSS: Statistical Package for the Social Sciences

WC: Waist Circumference

WHR: Waist-to-hip ratio

Declarations

Ethical approval

Ethical approval was obtained from the Institutional Ethics Committee of Government Medical College/Shri Maharaja Hari Singh (IEC-GMC/SMHS), in accordance with Indian Council of Medical Research (ICMR) guidelines. Institutional Ethical Registration Number: 108/ETH/GMC/ICM Dated 28/10/2017.

Consent to participate

A well informed written as well as verbal consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests

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This research did not receive grant of any sort from any funding agencies in the public, commercial, or not-for-profit sectors to ensure that there is no bias in collection or interpretation of data, so any role by them in the study design or data collection or analysis does not arise.

Author's Contribution

GNB and MT initiated the idea and designed the study protocol. OK performed the research at the hospital under the active involvement of MT. GNB and MT supervised the overall work. GNB and OK drafted the manuscript. All authors contributed to the writing of the final manuscript and approved the final version.

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