Prevalence and Risk Factors of Obstructive Sleep Apnea in Hypertensive Patients

Easwaramangalath Venugopal Krishnakumar[1], Ponneduthamkuzhy Thomas James[2]

ABSTRACT

Introduction: Hypertensive patients have a higher incidence of obstructive sleep apnea (OSA). The prevalence and risk factors of OSA among the hypertensives with OSA symptoms, of this geographical region was not yet been studied. Therefore, the prevalence and risk factors of OSA among the hypertensive patients with OSA symptoms was described in this study.

Materials and Methods: All adult hypertensives patients (blood pressure > 140/90) with OSA symptoms were subjected to overnight polysomnography. Patients with secondary hypertension were excluded. Factors such as age, gender, BMI, other co morbidities like diabetes, asthma, cardiovascular diseases etc. were collected. The risk factors associated with OSA were subjected to a multivariate logistic regression analysis and calculated the odds ratios with 95% confidence intervals.

Results: Sixty five patients were included in the study, 40 were obese and 25 were non-obese. The prevalence of OSA among the hypertensives with OSA symptoms was 80%. Among the obese patients, 36 (90%) had OSA. Among the non-obese patients, only 16 (64%) had OSA. The comorbidities most commonly seen in hypertensive OSA patients were dyslipidaemia, diabetes mellitus and coronary artery disease. Obesity was found to be the independent risk factor (P value = 0.041, Odds ratio 4.313) than any other co morbidities for the incidence of OSA.

Conclusions: There is a high proportion of OSA patients among the hypertensives with OSA symptoms. Obesity is one of the independent risk factor for OSA. Single centre and small sample size were the limitations of this study. A generalized multicentre study is warranted for the appropriate preventive strategies.

Key words: Apnea; Hypopnea; Hypertension; Obesity; Polysomnography

INTRODUCTION

Sleep is a universal phenomenon exhibited by all organisms. Sleep disordered breathing is said to be present when there are recurrent episodes of cessation of respiration (apneas), decrements in airflow (hypopneas) or Respiratory Event Related Arousals (RERAS). Obstructive sleep apnea (OSA) is one of the most common sleep disorders. Population studies using sleep recordings show that OSA affects about 25% of adult males and 10% of adult females.[1] Male sex and obesity were strongly associated with the presence of sleep-disordered breathing. Significant sleep apnea is present in 40% of obese individuals and 70% of OSA patients are obese.[2] While obesity increases the risk for OSA, sleep apnea may predispose to weight gain and obesity. Indeed, patients with newly diagnosed OSA have a history of excessive recent weight gain in the period preceding the diagnosis.[3,4] In addition, chronic *Continuous Positive Airway Pressure*(CPAP) therapy has been shown to decrease body fat and visceral fat accumulation in patients with OSA which further strengthen the evidence for an etiologic link between OSA and body mass.[5] The reported prevalence of systemic hypertension (HT) in those with OSA ranges from 15 to 56%.[6] There is experimental evidence to support a causal link as blood pressure (BP) has been shown to rise acutely with each apnea during the night.[7] Also associated with apneas are repetitive arousals, hypoxia, and rises in catecholamines and sympathetic nervous system activity, all of which can lead to daytime HT.

The coexistence of OSA and obesity may have more widespread implications for cardiovascular control and dysfunction in obese individuals and may contribute to some of the clustering of abnormalities broadly defined as the metabolic syndrome. The presence of resistant hypertension and the absence of a nocturnal decrease in BP in obese individuals should prompt the clinician to consider the diagnosis of OSA, especially if clinical symptoms suggestive of OSA are also present. Although much research has been undertaken in the area of association between OSA, systemic hypertension and obesity, till date there are no studies which compare between obese and non-obese hypertensives to estimate the proportion of OSA patients among them. Many patients with vague symptoms are misdiagnosed as OSA without any objective evidence from polysomnography (PSG). The prevalence and risk factors of OSA among the hypertensives with OSA symptoms, of this geographical region was not yet been studied. Hence, this study was aimed to estimate the prevalence of OSA among hypertensives patients as well as to assess the risk factors for OSA in such patients in order to select the most appropriate preventive strategies.

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MATERIALS AND METHODS

Patients' selection

In this cross sectional study, patients who attended the outpatient department of Institute of Chest Diseases, Government Medical College, Kozhikode from August 2007 to July 2009 with a diagnosis of essential hypertension (BP > 140/90 mm of Hg in supine position from an average of at least two measurements or the use of antihypertensives) with symptoms of OSA were included.[8] Symptoms of OSA included snoring, excessive daytime sleepiness, nocturnal choking episodes, recurrent awakenings from sleep, unrefreshing sleep, daytime headache and impaired concentration.

Patients who did not give consent, who could not sleep during the procedure, patients with secondary hypertension, or cases in which any technical errors occurred during the procedure were excluded from the study

Study procedure

A consent form was signed by each study subject and approval for the study was obtained from the Institutional Scientific and Ethics Committees. Hypertensive subjects with symptoms suggestive of OSA were sought through a detailed interview involving the patient and also the partner. Detailed history regarding the type of occupation and various comorbidities were taken. A thorough history, followed by a complete physical examination including anthropometry (body mass index calculated from height in m and weight in kg) was done. All patients were subjected to routine blood investigations, chest X-ray, ECG, fasting lipid profile and thyroid function tests.

Each patient underwent an attended overnight polysomnography (PSG) in the sleep laboratory. PSG included the following recordings: electroencephalogram, chin electromyography, electro-oculography, chest and abdominal movements and body position measured by inductance plethysmography, airflow and snores detected via a nasal pressure sensors, oxygen saturation (SpO_2) by a pulse oximeter, and heart rate monitored by ECG electrodes. Results were analyzed by software and are also scored manually. Apneas were defined as complete cessation of airflow for >10 seconds. Hypopneas were defined as reduction of >50% in one of three respiratory signals - airflow signal or either respiratory or abdominal signals of respiratory inductance plethysmography, with an associated fall of at least 4% in oxygen saturation with or without an arousal.

OSA is diagnosed if a patient has a cumulative apnea hypopnea index (AHI) of ≥5. Those with OSA are further grouped based on AHI into three classes of severity as mild OSA (AHI: 5 to 14.9), moderate OSA (AHI: 15 to 29.9), and severe OSA (AHI ≥ 30), as per American Sleep Disorders Association (ASDA) criteria.[9]

The subjects were also stratified based on age, gender, occupational status, severity of OSA and comorbidities. The comorbidities analyzed were diabetes mellitus (DM), dyslipidaemia (DLP), coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), asthma and hypothyroidism. Those comorbid conditions (including obesity) which are independent risk factors for OSA were identified with the help of statistical analysis.

STATISTICAL ANALYSIS

Analysis was done using SPSS software version 16. Pearson Chi Square test was done. P value and Odds Ratio were calculated. p value <0.05 was considered as significant. Multivariate logistic regression was also done to nullify the effects of confounding variables.

RESULTS

A total of 68 patients were initially enrolled in the study out of which 3 patients were excluded based on exclusion criteria. 80% of symptomatic hypertensives in this study have objective evidence of OSA. Majority of the subjects included in the study were obese (P < 0.05) (Figure 1). There were 40 (62%) subjects obese and 25 (38%) subjects were non-obese. The proportion of patients with objective evidence of OSA was estimated in both the groups with the help of overnight PSG. Thirty six subjects (90%) in the obese group and 16 (64%) subjects in the non-obese group had objective evidence of OSA. Thus the proportion of OSA patients in the obese group was distinctly high (p = 0.041 with odds ratio of 4.313) (Figure 2). Taking into account both the groups as a whole 80% of the subjects had objective evidence of OSA. In both the groups, the subjects were stratified depending on the severity of OSA. In the obese group 22% had mild OSA, 25% had moderate OSA and 53% had severe OSA. In the non-obese group this was 25%, 37.5% and 37.5% respectively (Figure 3).

Patients were also stratified based on age. In the obese group majority of the patients were in the 50 - 59 year age group (42%). This was followed by the 40 - 49 year age group (25%) and 60 - 69 year age group (19%). In the non-obese group majority of the patients were in the 50 - 59 year age group (75%). This was followed by the 60 - 69 year age group (19%) (Table 1).

Both in the obese group as well as in the non-obese group majority of the patients were males. Males constituted 69% of the OSA patients in the obese group and 94% of the OSA

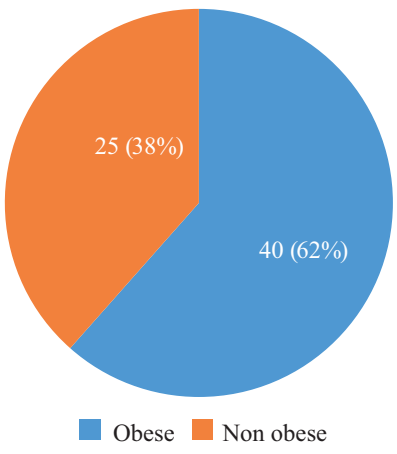

Figure-1: Distribution of subjects with obese and non-obese group

patients in the non – obese group (Figure 4). In both the obese as well as non – obese group majority of the subjects were leading a sedentary type of life. Most of them were businessmen, drivers or office staff etc. 97% of the subjects in the obese group and 94% of the subjects in the non – obese group were leading a sedentary life.

The various comorbid conditions in both the obese and non-obese groups were analyzed. The most common comorbidities seen were DLP, DM and CAD. The other comorbid conditions seen were hypothyroidism, COPD and asthma. In the obese group 63% had DLP, 51% had DM and 38% had CAD. In the non-obese group 44% had DLP, 31% had DM and 19% had CAD (Figure 5). None of them was found to be independent risk factor for the incidence of OSA as evident from the multivariate regression analysis.

Statistical analysis reveals a significant association between OSA and obesity, DM and CAD as revealed by significant P values and Odds Ratios. In the case of DM and CAD the P value loses significance after multivariate logistic regression. But the Odds Ratio is still high in the case of DM. In the case of CAD the loss of significance can be attributed to the fact the number of subjects included in the study is very less (Table 2).

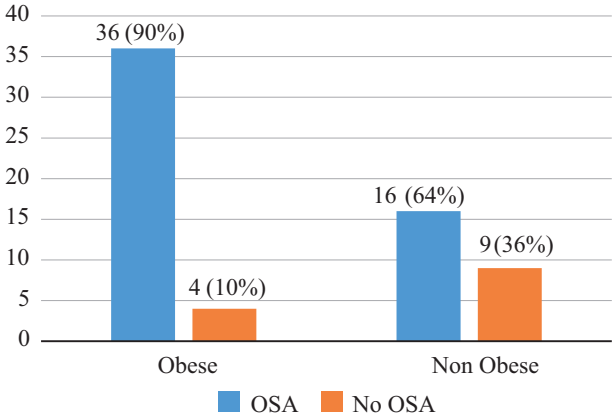

Figure-2: Proportion of patients with objective evidence of OSA among the obese and non obese groups.

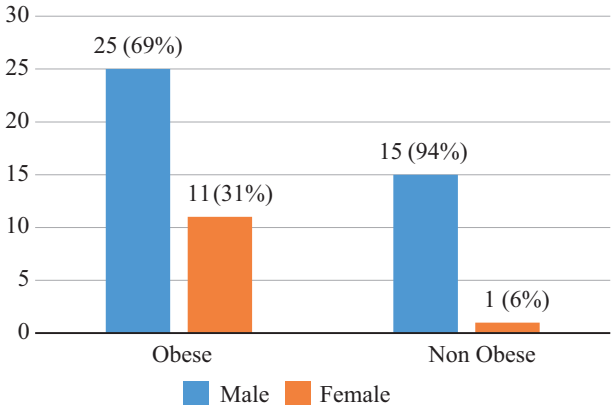

Figure-4: Distribution of patients on gender basis

DISCUSSION

Results of this study revealed that the prevalence of OSA among the study population with HT, having OSA symptoms was 80%. The Sleep Heart Health Study of >6000 patients, showed a linear relationship between systolic and diastolic blood pressures and severity of OSA.[10] The recurrent ap-

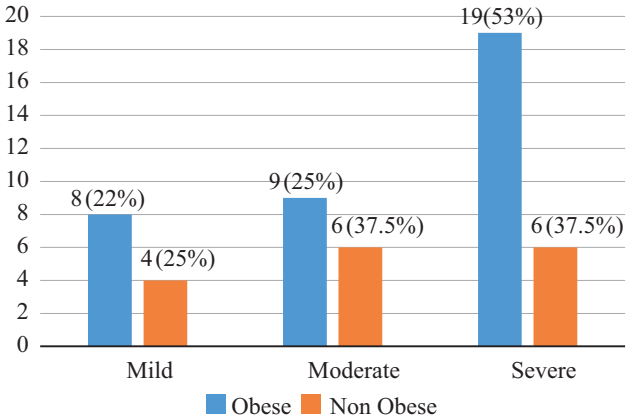

Figure-3: Distribution of subjects depending on the severity of OSA.

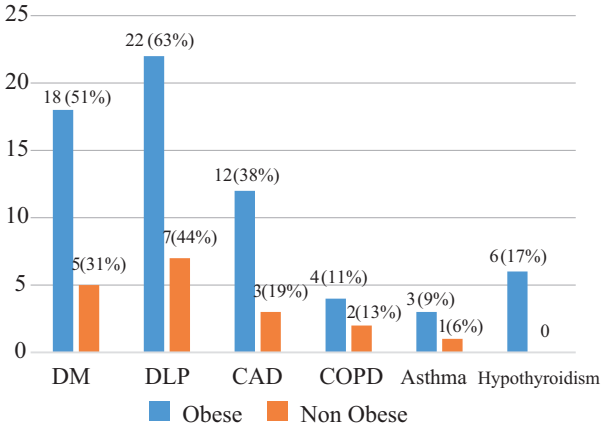

Figure-5: Various comorbid conditions in both the obese and non-obese groups

Age group (yrs)	Obese			Non obese		
	OSA	No OSA	Total	OSA	No OSA	Total
20-29	1 (100%)	-	1 (100%)	-	-	-
30-39	3 (75%)	1 (25%)	4 (100%)	1 (25%)	3 (75%)	4 (100%)
40-49	9 (81.8%)	2 (18.2%)	11 (100%)	-	2 (100%)	2 (100%)
50-59	15 (93.8%)	1 (6.3%)	16 (100%)	12 (85.7%)	2 (14.3%)	14 (100%)
60-69	7 (100%)	-	7 (100%)	3 (60%)	2 (40%)	5 (100%)
70-79	1 (100%)	-	1 (100%)	-	-	-
Total	36 (90%)	4 (10%)	40 (100%)	16 (64%)	9 (36%)	25 (100%)

Table-1: Age wise distribution of patients with OSA

Comorbidity	P Value (univariate)	P value (multivariate)	Odds Ratio
Obesity	0.011	0.041	4.313
DM	0.056	0.115	3.943
DLP	0.534	-	1.471
CAD	0.027	0.822	0.932
Hypothyroidism	0.706	-	0.717
COPD	0.706	-	0.717
Asthma	1	-	1
Any comorbidity	0.278	-	2.123

Table-2: Summary of statistical analysis

noeic episodes due to OSA and consequent transient rise in nocturnal BP has been implicated in the development of sustained systemic hypertension.[11] The seventh report of the Joint Committee on Prevention, Detection, Evaluation and Treatment of High BP lists sleep apnea as an important cause of secondary hypertension.[12]

Four important facts need consideration regarding OSA and hypertension. First, clinicians should seek for OSA symptoms and consider a PSG in patients with resistant hypertension.[13] Second, treatment of OSA in hypertensive (HTs) OSA patients may improve control of blood pressure but without large reductions, while snoring and quality of life should improve. Third, CPAP is not a replacement for pharmacological treatment. Fourth, obesity is a unifying factor and, so, weight loss measures should be the primary objective for clinicians.[14]

Lavie et al.[15] screened 50 patients with HT and found that 26% had an apnea index greater than 5 per hour. Kales and coworkers[16] used PSG to diagnose OSA in patients receiving treatment from a HT clinic and found that 30% had an apnea index greater than 30, 64% had an apnea index greater than 3, compared with zero in a control group of normotensive (NT) subjects. Fletcher and coworkers[17] compared 46 male HTs taken off medication with 34 male NTs and found that 30% of the HTs and 9% of the NTs had an apnea index greater than 10 determined with PSG. The two groups were matched for age and weight.

The result of our study is more towards the higher range among the published figures. This can be attributed to the fact that our study has been done in a group of HT patients who are suffering from the symptoms of sleep disordered breathing. Minai et al[18] found no significant differences were observed between the pulmonary hypertension (PH) and no PH groups regarding age or apnea-hypopnea index, although generally mild to moderate, severe PH can occur in patients with OSA. The investigators found that the subjects with mild, moderate and severe OSA were 47%, 34% and 19% respectively. These results are slightly different from the results of our study. In our study majority of the subjects fall in the 'severe OSA' group. This may be because of the fact that our study is done on a group of OSA symptomatics with systemic hypertension, and not pulmonary hypertension. Moreover, our study has stratified the subjects based on OSA severity in the obese and non – obese groups separately.

John et al[19] studied the prevalence of OSA in untreated and treated hypertensive patients in Australia by comparing them with normotensive subjects, taking into account the possible confounding variables body mass index, age, sex, and alcohol consumption. 38% of the 34 untreated and 38% of the 34 treated hypertensives, and 4% of the 25 normotensives had apnea hypopnea index greater than 5. In this study, the mean age of the untreated hypertensives was 58 years and that of the treated hypertensives was 60.9 years. This finding almost closely matches with our study also.

Our study classifies hypertensive OSA patients based on their gender too. Both in the obese group as well as in the non-obese group majority of the patients were males. Males constituted 69% of the OSA patients in the obese group (M:F ratio of 69:31) and 94% of the OSA patients in the non - obese group (M:F ratio of 47:3). Study by John et al[19] also found majority of the patients were males. The male:female ratio in the treated and untreated hypertensives were 26:8 and 33:1 respectively. This is also in accordance with the results of our study.

Studies demonstrate that as little as 10 % weight reduction is associated with a more than 50% reduction in the severity of OSA.[20] A prospective epidemiological study reported that a 10% weight gain led to a six-fold increase in the odds of developing moderate to severe OSA.[21] In our study, the majority of the subjects were obese (obese : non – obese = 62:38). In the previously mentioned study by John et al[19] also, majority of the patients were obese. The study of John et al[19] demonstrated that the mean BMI of the treated and untreated hypertensives were 28.9 and 28.7. This is very close to the cut – off value of 30 kg / m^2 selected in our study Our study also found a statistically significant relationship between OSA and obesity.

Treatment of OSA in diabetic patients may be a potential therapeutic option to improve macro, but not microvascular outcomes.[22] Insulin resistance and visceral obesity are the core risk factors that define the metabolic syndrome.[23] OSA exhibits pathophysiologic mechanisms that may potentially contribute to the development of insulin resistance.[23] Recent studies have more consistently demonstrated an independent association between OSA and insulin resistance in adults.[24]

Diabetes has been associated with complaints related to sleep.[25] There is substantial evidence that glucose tolerance is impaired in patients with OSA.[26] However, there are other studies[27] that have not supported an independent association with sleep-disordered breathing but attribute the glucose intolerance to the presence of obesity. The 'metabolic syndrome' is a term used to describe the grouping of several risk factors for cardiovascular disease: obesity, hypertension, insulin resistance, and dyslipidemia. These metabolic abnormalities are often observed in patients with OSA, and some[28] have proposed that OSA is probably another manifestation of the metabolic syndrome. However, since obesity and OSA are so closely associated, it is difficult to distinguish the metabolic effects of obesity and OSA. Visceral fat is known to be metabolically active, producing a variety of inflammatory and metabolic substances that have been implicated in the pathogenesis of insulin resistance and atherosclerosis.[29]

The symptoms of hypothyroidism overlap with those of OSA and are difficult to distinguish with certainty. Obesity is a common factor. Pelttari et al[30] found that 50% of hypothyroid patients had some degree of sleep-disordered breathing compared with 29% of a euthyroid control group. Whether thyroid function tests should be ordered in all patients with suspected OSA is controversial. It seems reasonable, however, to perform thyroid function testing in patients who have other reasons to consider hypothyroidism, such as in postmenopausal women or patients with dyslipidemia. In hypothyroid patients with OSA, thyroid replacement has been shown to improve sleep disordered breathing in some studies.[31,32]

It is a well recognized fact that systemic HT as well as obesity predispose to the development of OSA. But our study highlights the added influence of obesity over hypertension in the pathogenesis of sleep disordered breathing. No similar study has been undertaken so far. Moreover majority of the research work on OSA has been from the developed nations where the prevalence of obesity is much more. Very limited study has been done in India and especially from Kerala. It is in this context that our study assumes importance.

Our study is conducted in subjects who are suffering from the symptoms of OSA. Though this may be attributed as a limitation of the study it has significance too. In our part of the world the facility and accessibility to a sleep study centre is very much restricted. Many of the practicing physicians are tempted to make a vague diagnosis of obstructive sleep apnea whenever they meet an obese patient with the symptom of snoring. But from our experience with the work we realized that all those who snore are not suffering from OSA. All those patients with OSA symptoms should be subjected to an attended PSG in sleep lab before labeling them as OSA. Awareness has to be created among doctors as well as patients in this regard. Single centre and small sample size were the limitations of this study. A generalized multicentre study is warranted for the appropriate preventive strategies.

CONCLUSIONS

Among the hypertensives with symptoms suggestive of OSA, 80% are having abnormal Apnea Hypopnea Index. Obesity is an independent risk factor for OSA (P value = 0.041, Odds Ratio = 4.313). Comorbid illnesses are commoner in obese hypertensives when compared to non-obese hypertensives. The most significant association was found with diabetes mellitus and coronary artery disease. Single centre and small sample size were the limitations of this study. A generalized multicentre study is warranted for the appropriate preventive strategies.

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REFERENCES

1. Mansfield DR, Hillman DR, Antic NA, McEvoy RD, Rajaratnam SMW. Sleep loss and sleep disorders. MJA. 2013;199:S5–S6.
2. Vgontzas AN, Tan TL, Bixler EO, Martin LF, Shubert D, Kales A. Sleep apnea and sleep disruption in obese patients. Arch Intern Med. 1994;154:1705–1711.
3. Phillips BG, Hisel TM, Kato M, Pesek CA, Dyken ME, Narkiewicz K, et al. Recent weight gain in patients with newly diagnosed obstructive sleep apnea. J Hypertens. 1999;17:1297–1300.
4. Phillips BG, Kato M, Narkiewicz K, Choe I, Somers VK. Increases in leptin levels, sympathetic drive, and weight gain in obstructive sleep apnea. Am J Physiol. 2000;279:H234–H237.
5. Chin K, Shimizu K, Nakamura T, Narai N, Masuzaki H, Ogawa Y, Mishima M, Nakao K, Ohi M. Changes in intra-abdominal visceral fat and serum leptin levels in patients with obstructive sleep apnea syndrome following nasal continuous positive airway pressure therapy. Circulation. 1999; 100: 706–712.
6. Rauscher H, Popp W, Zwick H. Systemic hypertension in snorers with and without sleep apnea. Chest 1992;102:367–371.
7. Stoohs R, Guilleminault C. Cardiovascular changes associated with obstructive sleep apnea syndrome. J. Appl. Physiol. 1992;72:583– 589.
8. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. JAMA. 2003;289:2560–2572.
9. The Report of an American Academy of Sleep Medicine Task Force. Sleep related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. Sleep 1999; 22: 667-689.
10. Lavie L. Obstructive Sleep Apnea Syndrome: an oxidative stress disorder. Sleep Med Review 2003;7:35- 51
11. Lorell BH, Carabello B. Left Ventricular hypertrophy: Pathogenesis, detection and prognosis. Ciculation. 2000;102:470-9.
12. Mehra R, Storfer-Isser A, Kirchner HL. Soluble interleukin 6 receptor: a novel marker of moderate to severe sleeprelated breathing disorder. Arch Intern Med. 2006;166: 1725—1731.
13. Lévy P, McNicholas WT. Sleep apnoea and hypertension: time for recommendations. Eur Respir. J 2013; 41: 505-506.
14. Garun S Hamilton, Matthew T Naughton. Impact of obstructive sleep apnoea on diabetes and cardiovascular disease. MJA. 2013;199:S27–S30.
15. Lavie P, Ben-Yosef R, Rubin AE. Prevalence of sleep apnea syndrome among patients with essential hypertension. Am Heart J. 1984;108:373–376.
16. Kales A, Bixler EO, Cadieux RJ, Schneck DW, Shaw LC, Locke TW, Vela-Bueno A, Soldatos CR. Sleep apnoea in a hypertensive population. Lancet. 1984; 1005–1008.
17. Fletcher EC, DeBehnke RD, Lovoi MS, Gorin AB. Undiagnosed sleep apnea in patients with essential hypertension. Ann. Intern. Med. 1985;103:190–195.

18. Minai OA, Ricaurte B, Kaw R, Ricaurte B, Kaw R. Frequency and impact of pulmonary hypertension in patients with obstructive sleep apnea syndrome Am J Cardiol. 2009;104:1300 –1306.
19. John Worsnop CJ, Naughton MT. The Prevalence of obstructive sleep apnea in hypertensives. Am J Respir Critic Care Med. 1998;157:111–115.
20. Rubinstein I, Colapinto N, Rotstein LE, Brown IG, Hoffstein V. Improvement in upper airway function after weight loss in patients with obstructive sleep apnea. Am Rev Respir Dis. 1988;138:1192-1195.
21. Peppard PE, Young T, Palta M, Dempsey J, Skatrud J. Longitudinal study of moderate weight change and sleep-disordered breathing. JAMA. 2000;284:3015-3021.
22. Suratt PM, McTier RF, Findley LJ, Pohl SL, Wilhoit SC. Effect of very low-calorie diets with weight loss on obstructive sleep apnea. Am J Clin Nutr. 1992; 56:182S-184S.
23. Susie YY, Rahangdale S,Anh TS, Karen ES, Victor N, Aristidis V and Mahlotra A. Vascular Dysfunction in obstructive sleep apnea and type 2 Diabetes mellitus. Obesity. 2011;191:17-22.
24. Iiyori N, Alonso LC, Li J. Intermittent hypoxia causes insulin resistance in lean mice independent of autonomic activity. Am J Respir Crit Care Med. 2007;175:851-857.
25. Seicean S, Kirchner HL, Gottlieb DJ, Punjabi NM, Resnick H, Sanders M, et al. Sleep disordered breathing and impaired glucose metabolism in normal weight and overweight/obese individuals: the Sleep Heart Health Study. Diabetes Care. 2008;31:1001-1006.
26. Sharma SK, Kumpawat S, Goel A, Banga A, Ramakrishnan L, Chaturvedi P. Obesity, and not obstructive sleep apnea, is responsible for metabolic abnormalities in a cohort with sleep-disordered breathing. Sleep Med. 2007;8:12-17.
27. Tasali E, Ip MSM: Obstructive sleep apnea and metabolic syndrome: alterations in glucose metabolism and inflammation. Proc Am Thorac Soc. 2008;5:207-217.
28. Fantuzzi G: Adipose tissue, adipokines, and inflammation. J Allergy Clin Immunol. 2005;115:911-919.
29. Pelttari L, Rauhala E, Polo O, Hyyppä MT, Kronholm E, Viikari J, et al. Upper airway obstruction in hypothyroidism. J Intern Med. 1994;236:177-181.
30. Skjodt NM, Atkar R, Easton PA: Screening for hypothyroidism in sleep apnea. Am J Respir Crit Care Med. 1999;160:732-735.
31. Jha A, Sharma SK, Tandon N, Lakshmy R, Kadhiravan T, Handa KK, et al: Thyroxine replacement therapy reverses sleep-disordered breathing in patients with primary hypothyroidism. Sleep Med. 2006;7:55-61.

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