Quality of Sleep in Bronchial Asthma and Factors Influencing It - A Cross-Sectional Study from a Tertiary Care Centre in West Rajasthan, India

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ABSTRACT

BACKGROUND

Several studies showed that quality of sleep is reduced in asthma, but majority of the studies have used subjective methods for assessment of quality of sleep. This study was carried out to objectively measure quality of sleep using various sleep parameters by polysomnography in asthmatics and compare these sleep parameters with level of asthma control and with severity of airway limitation.

METHODS

This is a cross sectional study conducted among 50 adult asthma patients. History of the patients was taken. Patients included in the study were assessed clinically for asthma control, spirometry and each one of them was subjected to overnight level 1 polysomnography. Level of asthma symptom control was done depending on the daytime symptoms, reliever usage, night awakenings and activity limitation. Level of asthma control and airway limitation, forced expiratory volume in 1 second (FEV1) were compared with various sleep parameters. Tukey's post hoc test was performed to check as to which specific independent variable level significantly differs from the other.

RESULTS

Among 50 patients, 32 were men, mean age of the study population was 46.04 years. Mean sleep efficiency of study population was 76 ± 10.34 %. Average apnoea-hypopnea index (AHI) of the population was 7.86 / hr. Arousal index was 13.22 / hr. and desaturation index was 11.46 / hr. in asthmatics. Uncontrolled asthma patients had lower sleep efficiency (67.05 ± 8.19 % vs. 83 ± 5.5 %), longer sleep onset latency (29.11 ± 5.48 min vs. 23.25 ± 6.2 min), higher AHI (15.03 ± 10.1 / hr. vs. 1.57 ± 0.6 / hr.), more frequent arousals (23.32 ± 13.4 / hr. vs. 3.31 ± 2.42 / hr.) and more desaturations (18.72 ± 7.76 / hr. vs. 1.66 ± 1.53 / hr.) compared to well controlled asthma patients. Similar correlation was found with severe airway limitation.

CONCLUSIONS

Sleep quality is reduced in asthmatics. Optimal management targeting good asthma control and preventing the airway limitation is the key to achieve good quality of sleep and good quality of life. Subjective assessment in the form of questionnaires can be used as screening tools to evaluate the sleep; polysomnography can be used for confirmation.

KEYWORDS

Bronchial Asthma, Quality of Sleep, Asthma Control, Polysomnography

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BACKGROUND

Asthma is one of the most common chronic diseases in the world. Approximately 300 million individuals are currently suffering from asthma worldwide. It is an important public health problem in India with significant morbidity. In India, the prevalence of asthma is about 2 % affecting around 17 million people.[1] Global Initiative for Asthma (GINA) 2020 defines asthma as a heterogeneous disease, usually characterised by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary in intensity over time together with variable expiratory airflow limitation.[2] The main goal in the management of asthma is to achieve good control of asthma. But many patients remain symptomatic despite optimal treatment.[3] Apart from associated obstructive sleep apnoea (OSA), asthma will also affect quality of sleep. Patients with asthma frequently report sleep disturbances like insomnia which includes either difficulty in initiating and maintaining sleep or both, early morning awakenings, frequent arousals etc.[4] Some of the well-controlled asthma patients also report disturbed or poor sleep independent of nocturnal asthma symptoms.[5]

Sleep is an important aspect of health. Good health cannot be achieved without good Sleep. Sleep disorder can often be a symptom of a disease. Hence, sleep assessment is an essential component of any health check. Sleep assessment methods can be classified according to different criteria like objective (polysomnography, actigraphy) vs. subjective (sleep questionnaires, diaries...), contact vs. contactless devices etc. There are different tests that can be performed in a sleep laboratory. All of the tests have their own advantages and disadvantages. These tests are technology sensitive and cannot be used at home, they can be extremely precise and can be discreate. Hence they are often used as the gold standard for sleep evaluation. In order of accuracy, sleep detection methods may be arranged as follows: questionnaire < sleep diary < contactless devices < contact devices < polysomnography.

In this study we compare variables of polysomnography to assess quality of sleep with various levels of asthma control and with airflow limitation, forced expiratory volume in one second (FEV1).

METHODS

This study is a cross sectional study conducted to assess quality of sleep in bronchial asthma and to correlate quality of sleep with level of asthma control and airway limitation (FEV1). RMS Helios 401 PFT machine was used. This study was conducted between August 2014 to September 2015. All adult asthmatic patients visiting the hospital who were willing to participate in the study were enrolled. Patients with uncontrolled other system diseases and respiratory diseases other than asthma were excluded. Total 50 patients were included. After detailed history and detailed demographic details were obtained, they were subjected for spirometry pre and post bronchodilator according to protocols. Level of asthma symptom control was assessed according to Global Initiative for Asthma (GINA) guidelines 2014[2] and divided into well, partially and un-controlled depending on symptoms in last 4 weeks as mentioned below:

1. Daytime symptoms more than twice / week?
2. Any night waking due to asthma?
3. Reliever needed more than twice / week?
4. Any activity limitation due to asthma?

None of these = asthma symptoms well-controlled
1 – 2 of these = asthma symptoms partly-controlled
3 – 4 of these = asthma symptoms uncontrolled

Each patient underwent level 1 overnight polysomnography and manually scored according to Indian initiative on obstructive sleep apnoea (INOSA) guidelines.[7] Objective assessment of quality of sleep was done by parameters like sleep efficiency (percentage of sleep of the total time in bed), sleep onset latency (time taken to fall asleep initially), percentage of stages of sleep, REM stage, AHI (total number of apnoea events and hypopnea events per hour of total sleep time), desaturation index (number of significant desaturations i.e. > 3 % per hour of sleep), arousal index (number of arousals and awakenings per hour of sleep), total body movements per hour were tabulated.

Sample Size Calculation

Sample size was calculated based on one-way analysis of variance (ANOVA) using G Power 3.1. Software in which effect size f = 0.25, α error probability = 0.05, power (1-β error probability) = 0.30 with number of groups = 3 and critical F = 3.204. Therefore total (minimum) sample size = 48.

Statistical Analysis

Data was entered and analysed using Microsoft excel 2013 and Statistical Package for the Social Sciences (SPSS) 20 software. Categorial values were expressed as proportion and percentages, comparison was done using chi-square test. Continuous variables were expressed as mean with standard deviation, compared using one way ANOVA. P-value < 0.05 was considered as statistically significant. Demographic variables, comorbidities and polysomnographic variables were compared with different levels of asthma control and with FEV1 %.

RESULTS

50 patients with asthma were subjected to sleep study and results were tabulated and analysed. Mean age of the study population was 46.04 years, 32 out of 50 were men among whom 12 were smokers. 20 patients had gastroesophageal reflux disease (GERD), 23 had rhinitis and 13 had post nasal drip (PND). Mean sleep efficiency of study population was 76 ± 10.34 %. Average AHI of the population was 7.86 / hr., arousal index was 13.22 / hr. and desaturation index was 11.46 / hr. (Table 1). 17 out of 50 subjects had

bronchodilator reversibility (more than 12 % and 200 ml). Since it was cross sectional study, known cases of asthma who were already receiving treatment were included in the study, most of them have not showed bronchodilator reversibility. Most of the patient were on medium dose inhaled corticosteroids (ICS) plus long acting β agonist (LABA) or ICS according to stepwise guidelines of treatment by GINA. Most of the patients were on formoterol 6mcg + budesonide 200 mcg twice daily.

Baseline variables and comorbidities were compared between the level of asthma symptom control are tabulated in Table 2. Mean age of uncontrolled asthma group was more when compared to other group, but not statistically significant (P = 0.293). There was no significant correlation of gender and smoking status between the groups. Mean BMI of patients with un-controlled asthma was more than the partially controlled asthma, which is more than the well-controlled asthma. Most of the un-controlled asthma patients were snorers, 18 / 19 (94.7 %) vs. 5 / 23 (21.74 %) in partially controlled vs. 2 / 8 (25 %) in well controlled asthma. Nocturnal asthma symptoms were more common in uncontrolled asthma when compared to partially-controlled and nil in well controlled patients. Patients with uncontrolled asthma had a greater number of exacerbations (4.53 ± 1.22) when compared to partially (2.26 ± 1.01) and well controlled (0.75 ± 0.88) (P < 0.001). None of the patients with well controlled asthma had GERD / rhinitis / PND. Uncontrolled asthma group had a greater number of GERD (P = 0.035) and rhinitis (P = 0.001) than the partially controlled group. There was no significant changes for PND.

Various polysomnographic variables indicating quality of sleep were compared between the different levels of asthma control and tabulated in Table 3. Sleep efficiency was decreased (P < 0.001) and sleep onset latency (P = 0.003) was increased significantly in patients with uncontrolled asthma. Sleep stages showed no significant correlation with level of asthma control except stage 1 (P = 0.003) which was significantly increased in uncontrolled asthma. Patients with uncontrolled asthma were significantly associated with increase in AHI (P < 0.001), arousal index (P < 0.001), snoring events (P < 0.001), desaturation index (P < 0.001) than partially and uncontrolled asthma. 17 out of 50 people had obstructive sleep apnoea (AHI ≥ 5 / hr). Average oxygen saturation was low in uncontrolled asthma than partially controlled, which is further lower than the well-controlled asthma (P = 0.002). Body movements were more frequent in patients with uncontrolled asthma.

Study population was divided depending on degree of airway limitation using FEV1 % into mild (FEV1 % ≥ 80), moderate (80 > FEV1 ≥ 50) and severe (FEV1 < 50) which was compared with sleep study variables (objective assessment of sleep quality) were tabulated in Table 4. Sleep efficiency was significantly decreased in patients with low FEV1 (0.001). Sleep onset was delayed in patients with moderate to severe airway limitation. AHI (P = 0.016), arousal index (P = 0.042), snoring events (P = 0.038) and desaturation index (P < 0.001) was increased significantly as the airflow limitation increased (i.e. FEV1 decreased). There was no significant variation in stages of sleep except stage 2.

Variables (N = 50)	Count (%) Mean ± SD
Age, years	46.04 ± 12.76
Men	32 (64)
BMI, Kg / m2	27.83 ± 6.36
Smoking	12 (24)
No. of exacerbations in last year	2.88 ± 1.75
GERD	20 (40)
Rhinitis	23 (46)
Post nasal drip	13 (26)
FEV1 %	60.86 ± 18.91
Sleep efficiency %	76 ± 10.34
Sleep onset latency, min	25.06 ± 6.87
Awake %	6.01 ± 2.68
NREM stage 1 %	12.04 ± 9.19
NREM stage 2 %	52.53 ± 7.92
NREM stage 3 %	15.8 ± 4.15
REM %	11.16 ± 6.21
AHI, per hour	7.86 ± 8.69
Arousal index, per hour	13.22 ± 12.47
Snoring events, per hour	6.9 ± 7.79
Desaturation index, per hour	11.46 ± 9.12
Average saturation %	94.92 ± 2.26
Body movements, per hour	8.40 ± 3.06

Table 1. Baseline Demographic, Clinical, Spirometry and Polysomnographic Characteristics of the Study Population

SD: Standard Deviation; BMI: Body Mass Index; GERD: Gastro Esophageal Reflux Diseases; FEV1: Forced Expiratory volume in One second; NREM: Non Rapid Eye Movement; REM: Rapid Eye Movement; AHI: Apnea-Hypopnea Index.

Variables (n)	Well Controlled (n = 8) n (%)	Partially Controlled (n = 23), n (%)	Un-Controlled (n = 19), n (%)	P Value
Age, years	39.75 ± 10.48	46.48 ± 14.26	48.16 ± 11.37	0.293
Men	6 (75)	14 (60.87)	12 (63.16)	0.77
BMI, Kg / m2	23.92 ± 5.02	26.62 ± 5.16	30.96 ± 6.97	0.012*
Smoking	0 (0)	9 (39.13)	3 (15.79)	0.252
No. of exacerbations in last year	0.75 ± 0.88	2.26 ± 1.01	4.53 ± 1.22	< 0.001*
GERD	0 (0)	10 (43.48)	10 (52.63)	0.035*
Rhinitis	0 (0)	9 (39.13)	14 (73.68)	0.001*
Post nasal drip	0 (0)	8 (34.78)	5 (26.31)	0.155

Table 2. Comparison of Baseline Variables in Various Levels of Asthma Control

*P value < 0.05 is considered statistically significant

SD: Standard Deviation; BMI: Body Mass Index; GERD: Gastro Esophageal Reflux Diseases

Variables (n)		Well Controlled (n = 8) (mean ± SD)	Partially Controlled (n = 23) (mean ± SD)	Un Controlled (n = 19) (mean ± SD)	P Value
Sleep efficiency %		83 ± 5.5	80.96 ± 7.8	67.05 ± 8.19	< 0.001*
Sleep onset latency, min		23.25 ± 6.2	22.35 ± 6.73	29.11 ± 5.48	0.003*
Sleep stages	Awake %	6.34 ± 1.52	5.25 ± 2.81	6.79 ± 2.76	0.166
	NREM stage 1 %	6.97 ± 1.79	10.77 ± 6.09	15.71 ± 12.48	0.003*
	NREM stage 2 %	54.74 ± 3.95	54.02 ± 4.53	49.81 ± 11.26	0.27
	NREM stage 3 %	15.57 ± 2.85	15.99 ± 4.06	15.66 ± 4.85	0.954
	REM %	14.13 ± 5.29	11.09 ± 6.28	10 ± 6.38	0.293
AHI, per hour		1.57 ± 0.6	4.12 ± 3.33	15.03 ± 10.1	< 0.001*
Arousal index, per hour		3.31 ± 2.42	8.32 ± 6.97	23.32 ± 13.4	< 0.001*
Snoring events, per hour		0.5 ± 0.92	4.57 ± 4.97	12.42 ± 8.8	< 0.001*
Desaturation index, per hour		1.66 ± 1.53	8.86 ± 6.91	18.72 ± 7.76	< 0.001*
Average saturation %		96.25 ± 0.46	95.57 ± 1.67	93.58 ± 2.67	0.002*
Body movements, per hour		6.57 ± 1.45	6.43 ± 6.57	11.49 ± 11.46	0.019*

Table 3. Comparison of Polysomnography Variables in Various Levels of Asthma Control

*P value < 0.05 is considered statistically significant

SD: Standard Deviation; NREM: Non Rapid Eye Movement; REM: Rapid Eye Movement; AHI: Apnea-Hypopnea Index.

Average saturation was significantly low in patients with low FEV1 (P < 0.001). As the airflow limitation increased, total body movements also increased (P = 0.001).

Variables (n)		FEV1 % ≥80 % (n = 8) (mean ± SD)	FEV1 ≥50 < 80 % (n = 27) (mean ± SD)	FEV1 < 50 % (n = 15) (mean ± SD)	P Value
Sleep efficiency %		84.5 ± 4.34	77.74 ± 9.27	68.33 ± 9.74	< 0.001*
Sleep onset latency, min		17 ± 2.07	26.89 ± 6.09	26.07 ± 7.03	0.001*
Sleep stages	Awake %	5.55 ± 0.79	6.46 ± 2.65	5.45 ± 3.32	0.447
	NREM stage 1 %	9.57 ± 3.79	14.33 ± 10.7	9.23± 7.32	0.162
	NREM stage 2 %	53.14 ± 3.86	49.98 ± 8.56	56.82 ±6.62	0.023*
	NREM stage 3 %	15.99 ± 1.51	15.93 ± 4.85	15.45 ± 3.91	0.931
	REM %	12.67 ± 5.2	10.99 ± 6.28	10.66 ± 6.84	0.753
AHI, per hour		1.98 ± 1.19	7.1 ± 6.79	12.36 ± 11.64	0.016*
Arousal index, per hour		4.68 ± 2.6	12.95 ± 12.06	18.25 ± 14.21	0.042*
Snoring events, per hour		0.75 ± 1.03	7.48 ± 7.02	9.13 ± 9.63	0.038*
Desaturation index, per hour		1.66 ± 1.73	11.25 ± 8.88	17.05 ± 7.39	< 0.001*
Average saturation %		97 ± 0.53	95.29 ± 1.54	93.13 ± 2.67	< 0.001*
Body movements, per hour		3.45 ± 0.83	8.28 ± 3.38	11.27 ± 6.42	0.001*

Table 4. Comparison of Polysomnography Variables with FEV1

*P value < 0.05 is considered statistically significant

SD: Standard Deviation; BMI: Body Mass Index; GERD: Gastro Esophageal Reflux Diseases; FEV1: Forced Expiratory Volume in One second; NREM: Non Rapid Eye Movement; REM: Rapid Eye Movement; AHI: Apnea-Hypopnea Index

Variables (n)	Well Controlled (n = 8) (mean ± SD)	Partially Controlled (n = 23) (mean ± SD)	Un Controlled (n = 19) (mean ± SD)	P Value	Partial η^2
Sleep efficiency %	83 ± 5.5	80.96 ± 7.8	67.05 ± 8.19	< 0.001*	0.356
AHI, per Hour	1.57 ± 0.6	4.12 ± 3.33	15.03 ± 10.1	< 0.001*	0.274
Desaturation index, per hour	1.66 ± 1.53	8.86 ± 6.91	18.72 ± 7.76	< 0.001*	0.387
Variables(n)	FEV1 % ≥80 % (N = 8) (mean ± SD)	FEV1 ≥50 < 80 % (N = 27) (mean ± SD)	FEV1 < 50 % (N = 15) (mean ± SD)	P Value	Partial η^2
Sleep efficiency %	84.5 ± 4.34	77.74 ± 9.27	68.33 ± 9.74	< 0.001*	0.340
AHI, per hour	1.98 ± 1.19	7.1 ± 6.79	12.36 ± 11.64	0.016*	0.176
Desaturation index, per hour	1.66 ± 1.73	11.25 ± 8.88	17.05 ± 7.39	< 0.001*	0.318

Table 5. Results of Multivariate Analysis of Variance (MANOVA) for Continuous Outcome Variables

Dependent Variable	Asthma Control Level	Asthma Control Level	P Value
Sleep Efficiency	well controlled	partially controlled	.651
	well controlled	Uncontrolled	.000*
	partially controlled	Uncontrolled	.000*
AHI	well controlled	partially controlled	.419
	well controlled	Uncontrolled	.002*
	partially controlled	Uncontrolled	.005*
Desaturation index	well controlled	partially controlled	.026*
	well controlled	Uncontrolled	.000
	partially controlled	uncontrolled	.003

Table 6. Post Hoc Multiple Comparison Test Using Tukey HSD Method for Sleeping Efficiency, AHI, Desaturation Index in Asthma Control Level

*P < 0.05 is considered statistically significant

Dependent Variable	FEV1 %	FEV1 %	P Value
Sleep efficiency	FEV1 < 50 %	FEV > 50 < 80 %	.001*
	FEV1 < 50 %	FEV1 > 80 %	.000*
	FEV1 > 50 < 80 %	FEV1 > 80 %	.171
AHI	FEV1 < 50 %	FEV1 > 50 < 80 %	.076
	FEV1 < 50 %	FEV1 > 80 %	.011*
	FEV1 > 50 < 80 %	FEV1 > 80 %	.291
Desaturation index	FEV1 < 50 %	FEV1 > 50 < 80 %	.038*
	FEV1 < 50 %	FEV1 >80 %	.000*
	FEV1 > 50 < 80 %	FEV1 > 80 %	.011*

Table 7. Post Hoc Multiple Comparison Test Using Tukey HSD Method for Sleeping Efficiency, AHI, Desaturation Index in FEV1 %

*P < 0.05 is considered statistically significant

Group differences across polysomnography variables were examined with a MANOVA performed on the three prime sleep parameters: sleep efficiency, oxygen desaturation index and AHI. Table 5 presents the mean, standard deviation and results for the two MANOVA for all the continuous outcome variables by group to all the samples. Using an alpha level of 0.001 to evaluate homogeneity of covariances (P > 0.001) and Levene's homogeneity test (P .0.001) were not statistically significant. For the MANOVA analyses using Wilks criterion λ as the appropriate test statistic, there was statistically significant difference based on various levels of asthma control F (6,90) = 5.080, P < .05; Wilks λ = 0.525 partial $\eta 2$ = 0.275, sleep efficiency [F (2, 47) = 13.005; P < .05; partial η2 = .356], AHI [F (2, 47) = 8.87; P < .05; partial η2 = .274], desaturation index [F (2, 47) = 14.82; P < .05; partial η2 = .387].

Tukey's post hoc test was performed to check which specific independent variable level significantly differs from another. The multiple comparison results (Table 6) showed that mean sleep efficiency was statistically significantly different between well controlled asthma level and uncontrolled asthma level (P < .05), and also partially controlled asthma level and uncontrolled asthma level (P < .05), but there was no statistically significant difference between well controlled asthma level and partially controlled asthma level (P = .651). Mean AHI was statistically significantly different between well controlled asthma level and uncontrolled asthma level (P < .05), and partially controlled asthma level and uncontrolled asthma level (P < .05), but there was no statistically significant difference between well controlled asthma level and partially controlled asthma level (P = .419). Mean oxygen desaturation was statistically significant between all the three groups, i.e., well controlled asthma level and uncontrolled asthma level (P < .05), and partially controlled asthma level and uncontrolled asthma level (P < .003) and well controlled asthma level and partially controlled asthma level (P = 0.026).

Similarly, considering various levels of FEV %, there was statistically significant difference based on various levels of FEV1 % F (6, 90) = 4.82, P < .05; Wilks λ = 0.573, partial $\eta 2$ = 0.243. Various levels of FEV1 % has a statistically significant effect on sleep efficiency (F (2, 47) = 12.119; P < .05; partial η2 = .340), AHI (F (2, 47) = 5.03; P < .05; partial η2 = .176), desaturation index (F (2, 47) = 10.951; P < .05; partial η2 = .318).

Tukey's post hoc test was performed to check which specific independent variable level significantly differs from another. The multiple comparison results from Table 7 shows that mean sleep efficiency was statistically significantly different between FEV1 < 50 % and FEV1 < 50 > 80 (P < .05), FEV1 < 50 % and FEV1 > 80 % (P < .05), but there was no statistical significant difference between FEV1 < 50 > 80 and FEV1 > 80 % (P = .171). Mean AHI was statistically significantly different between FEV1 < 50 % and FEV1 > 80 % (P < .05), and there was no statistical significant difference between FEV1 < 50 % and FEV1 < 50 > 80 (P < .076) and FEV1 < 50 > 80 and FEV1 > 80 % (P < .291). Mean oxygen desaturation was statistically significant between all the three groups FEV1 <

50 % and FEV1 < 50 > 80 (P < .05), FEV1 < 50 > 80 and FEV1 > 80 % (P < 0.05), FEV1 < 50 > 80 and FEV1 > 80 % (P < .05).

DISCUSSION

Asthma is one of the most common disease worldwide. Our study demonstrated high prevalence of sleep related breathing disorders in asthmatics. OSA and asthma are highly prevalent respiratory disorders that share several risk factors and are frequently comorbid. Multiple mechanisms have been postulated to explain this frequent coexistence, which is recently referred to as the "alternative overlap syndrome". The pathophysiology of these two conditions seems to overlap significantly, as airway obstruction, inflammation, obesity and several other factors are implicated in the development of both diseases.

A high index of suspicion is warranted for the overlap of OSA and asthma, particularly in the presence of obesity, longer duration of asthma, severe airway obstruction, frequent exacerbations and in patients with uncontrolled asthma.

Sleep quality is decreased in patients with asthma and significantly decreased in patients with poor asthma control and in severe airflow limitation. Many previous studies they have assessed quality of sleep using subjective methods. As indicated, objective methods that too polysomnography offers various indices to assess quality of sleep and hence is superior to subjective methods (questionnaires).

The present study was conducted in Kamala Nehru Chest Hospital, Dr S N Medical College, Jodhpur, Rajasthan to know the sleep disordered breathing in asthma patients. This was a cross sectional descriptive type of study in 30 patients of asthma. Patients diagnosed with asthma were subjected for polysomnography study.

In the present study, mean age of the study population was 46.04 ± 12.76 years. Mean age reported in other studies was 49.12 ± 3.43 years, (9) 64 years (10) and 33 ± 7 years (10). 64 % of our study population were men, where as other studies reported as 49.8 % (10), 43.33 % (9) and 45 % (11) of their study were men. Mean BMI of our study was 27.84 ± 6.36 kg / m2, whereas other studies reported 28.13 ± 4.22 Kg / m2 (9) and 29.5 Kg / m 2 (10). Demographic variables are comparable to our study.

Number of exacerbations were 2.88 ± 1.75 (mean) and increased as the level of asthma control increased. In our study population, 40 % had GERD, 46 % had rhinitis and 26 % had post nasal drip. M. Zidan et al.[8] Egypt reported GERD in 40 % and rhinitis / sinusitis in 67 % more than that of controls. Daboussi et al.[9] in their study showed GERD in 46.66 % of patients with asthma and rhinitis in 53.3 % asthmatics. C. Janson et al.[10] reported high incidence of rhinitis in their study (71 %). Study by Dixit R et al.[11] showed GERD and rhinitis in 60 % and 42 % respectively.

When we enlisted sleep variables to assess sleep quality, sleep efficiency (76 ± 10.34 %) was decreased, sleep onset latency (25.06 ± 6.87 min) was more, Mean AHI (7.86 ± 8.69 / hr.) was high, arousal index (13.22 ± 12.47 / hr.) was high, desaturation index (11.46 ± 9.12) was high and total body movements (8.4 / hr.) were high in asthmatics (our study population) compared to normal values of these sleep variables. These variables indicate the objective assessment of quality of sleep in an individual, which was done on asthmatics, in this study, indicate poor sleep quality in asthmatics.

A study by B. Shrestha et al.[12] compared polysomnographic variables with asthmatics and controls, showed decreased AHI (11.34 / hr.) and decreased arousal index (18.53) in asthmatics compared to that of non-asthmatics. When compared to our study, AHI was high, arousal index was high, sleep efficiency was better and sleep latency was low in asthmatics in the study by B. Shrestha et al.

M. Zidan et al[8] published a study of overlap of OSA and asthma, showed increased AHI (19.5 ± 12.2), desaturation index (6.48 ± 7.8) was increased and average saturation (92.4 ± 2.6) was low significantly in patients with asthma when compared to controls (non-asthmatics), which was comparable with our study.

C. Janson et al. in their study compared subjective assessment of sleep quality by using sleep questionnaire and sleep dairy stated that asthmatics had decreased quality of sleep compared to normal people.

In our study, OSA was present in 17 (34 %) out of 50 patients. OSA was present in 50 % of the females with asthma and 25 % of males. Dixit et al. showed OSA of 46 % in asthmatics in their study, whereas M. Zidan et al.[12] showed OSA in asthmatics as high as 60 %. Sleep stages have not shown any significant changes when compared to asthma control.

In this study when we compared sleep study variables indicating quality of sleep in various levels of asthma control like sleep efficiency, sleep onset latency, AHI, arousal index, desaturation index, average saturation was significantly varied in poorly controlled asthmatics indicating decrease in sleep quality, as the level of asthma control worsened as depicted in Table 3. An Indian Study by Dixit R et al.[13] done to see impact of obstructive sleep apnoea and sleep parameters on level of asthma control showed very significant increase in AHI and desaturation index as level of asthma control worsened; which was consistent with our study.

In our study, we compared airway limitation (FEV1 %) with different sleep parameters. As FEV1 decreased, sleep efficiency was decreased and AHI, desaturation index and arousal index were increased depicting poor quality of sleep as the airway limitation increased. To the best of our knowledge we didn't get any study which correlates objective measurement of quality of sleep by polysomnographic variables with airflow limitation (FEV1) in adults.

The strength of this study is we have demonstrated that sleep quality was decreased in asthmatics by using multiple polysomnographic variables. We have demonstrated that there were significant changes in polysomnographic variables when it was compared with level of asthma control. We have included patients with all ages.

CONCLUSIONS

OSA and asthma are harmful to each other. Quality of sleep is reduced in asthmatics; hence, quality of life is also reduced. Optimal treatment of asthma should target achieving good symptom control and prevent fixed airway obstruction as they have significant influence on sleep quality.

Evaluation of sleep is a must in all asthmatics, especially in uncontrolled asthma patients and in patients with severe airway limitation. Subjective assessment in the form of questionnaires can be used as screening tools to evaluate the sleep, polysomnography can be used for confirmation. Both OSA & asthma control should be addressed simultaneously for the better outcome, as both are related to each other.

Limitations

Most of the patients were not willing for overnight sleep study, so sample size was low. Assessment of asthma phenotypes relation to quality of sleep would have fetched more information. Large number multicentre study is needed to explore further correlations. In spite of these limitations, our study highlights that sleep quality is decreased in asthma and it will further worsen with poor control and severe airflow limitation.

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