Pulmonary rehabilitation: A novel adjunct in management of obstructive sleep apnea

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Abstract

Pulmonary rehabilitation (PR) is being used in the routine management of patients of obstructive sleep apnea (OSA) at some centers. However, the studies documenting benefits of PR in OSA lack standardization in terms of outcome measures. A study was hence planned to determine the efficacy of PR on exercise capacity, health related quality of life (HRQOL), daytime sleepiness and sleep-quality of life (QOL) in patients of OSA. As a part of comprehensive therapy, patients diagnosed with OSA are managed with continuous positive airway pressure (CPAP), 8 weeks thrice weekly outpatient hospital-based PR and medical treatment at the Pulmonary Medicine Department, Government Medical College and Hospital, Chandigarh. However, some patients refuse for PR because of time constraints and travel issues. Patients with newly diagnosed OSA without co-existing respiratory disease, who agreed for the CPAP, PR and medical management were enrolled in group A. The patients who refused for PR but were ready for CPAP and medical management were enrolled in Group B; 30 patients were taken in each group. Exercise capacity, HRQOL, daytime sleepiness and sleep-QOL were determined at baseline and at 8-weeks follow-up by 6-minute walk distance (6MWD), St. George's Respiratory Questionnaire (SGRQ), Epworth Sleepiness Scale (ESS) and Functional Outcomes of Sleep Questionnaire (FOSQ) and compared amongst the two groups. Four patients from group A were excluded as they did not complete PR; 26 patients from group A and 30 patients from group B were finally analyzed. At baseline, both groups were matched with respect to age, gender, apnea-hypopnea index (AHI), body mass index (BMI), FEV_1%predicted, 6MWD, SGRQ, ESS and FOSQ. At follow up at 8 weeks, BMI, 6MWD, SGRQ, ESS and FOSQ improved significantly from baseline in group A ($p<0.001$). FEV_1%predicted also improved but non significantly. In group B, FEV_1%predicted, BMI, 6MWD, SGRQ, ESS and FOSQ score did not improve significantly from baseline. Mean improvement from baseline in BMI, 6MWD, SGRQ, ESS and FOSQ was significantly more in group A than group B ($p<0.001$, $p<0.001$, $p=0.041$, $p<0.001$ and $p<0.001$, respectively). PR, being beneficial, should be incorporated in standard management of OSA.

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Introduction

Obstructive sleep apnea (OSA) is a common but under diagnosed disorder encountered in everyday practice. It is characterized by recurrent episodes of apnea and hypopnea due to repetitive partial or complete closure of the upper airway during sleep that results in hypoxemia and hypercapnia and is frequently associated with arousals and sleep fragmentation [1]. Left untreated, it is a significant burden on the healthcare system [2]. Continuous positive air-

way pressure (CPAP) is the gold standard treatment for OSA [3]. It is highly effective, but its usefulness is limited because of cost and poor adherence [4].

Pulmonary rehabilitation (PR) aims to reduce symptoms, decrease disability, increase participation in physical-social activities, and improve overall quality of life (QOL) through education, exercise training, psychological rehabilitation and nutritional counselling. The intervention is geared towards the unique problems and needs of each patient [5]. Treatment via PR, which is used for conditions such as chronic obstructive pulmonary disease (COPD), is increasingly being studied and used in OSA. Few studies in the past have proposed the use of PR as a part of routine care in management of OSA, however there is no uniformity in the duration and type of PR used. They lack standardization in terms of outcome measures and have used limited number of patients [6,7]. Moreover, till date no such study has been undertaken in Indian population. Hence the present study was undertaken with the objective to evaluate efficiency of regular 8 week thrice weekly PR program on respiratory parameters, BMI, exercise capacity, HRQOL and sleep quality of life in patients with OSA.

Materials and Methods

This prospective longitudinal study carried was out from January 2018 to July 2019. Patients of 18-65 years of age, newly diagnosed with OSA after two nights level 1 polysomnography (PSG), and not suffering from any co-existing respiratory illness were enrolled in the study after informed consent (Figure 1).

OSA was defined according to the third edition of the International Classification of Sleep Disorders (ICSD-3) as a PSG-determined obstructive respiratory disturbance index (RDI) ≥5 events/h associated with the typical symptoms (e.g., unrefreshing sleep, daytime sleepiness, fatigue or insomnia, awakening with a gasping or choking sensation, loud snoring, or witnessed apneas), or an obstructive RDI ≥15 events/h (even in the absence of symptoms) [8]. In addition to apneas and hypopneas that are included in the AHI, the RDI includes respiratory effort-related arousals (RERAs). The scoring of respiratory events was done as per the definitions in the AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology

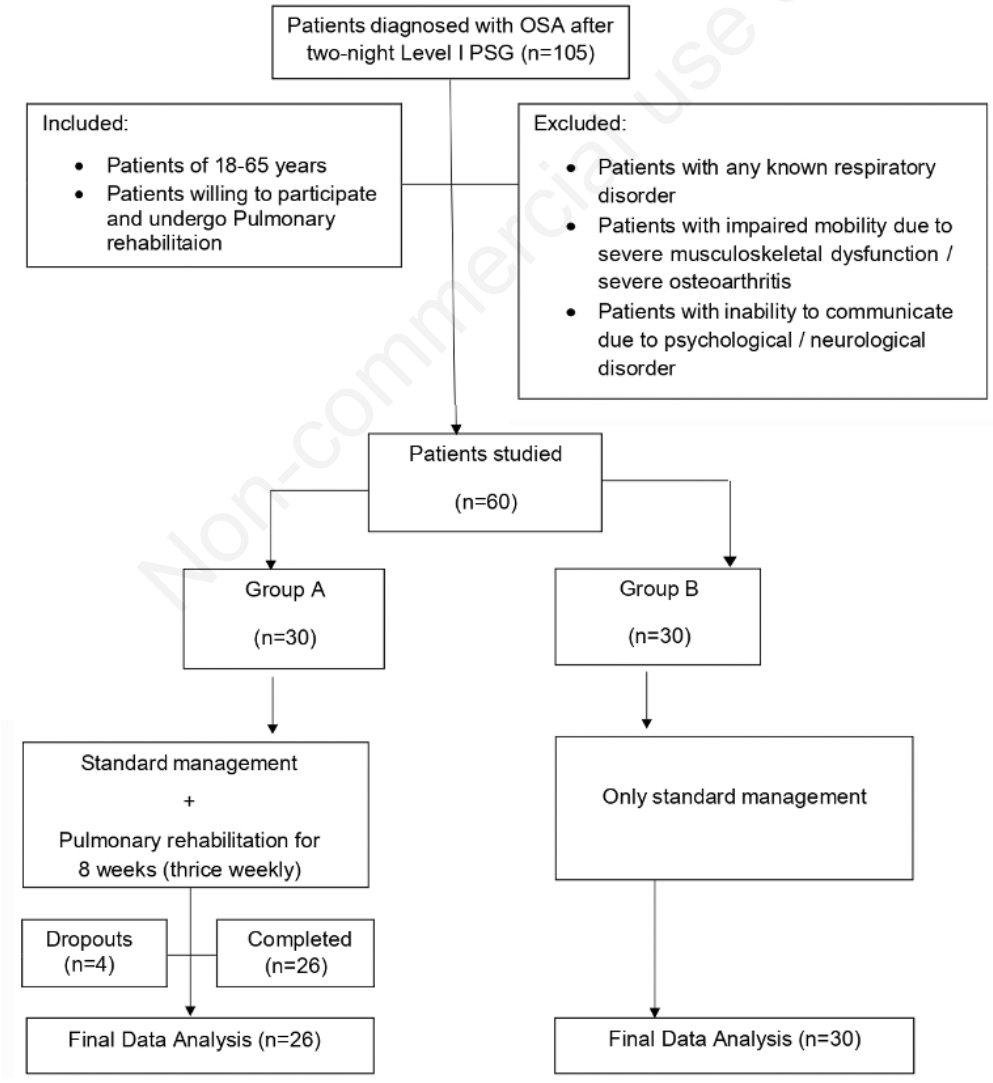

Figure 1. Patients' enrollment criteria. OSA, obstructive sleep apnea; PSG, polysomnography.

and Technical Specifications, Version 2.3 (AASM Scoring Manual) [9].

The patients who agreed for CPAP, 8-week thrice weekly PR Programme and medical management as a part of comprehensive therapy for OSA were enrolled in group A. The patients who refused for PR but were ready for CPAP and medical management were enrolled in group B. 30 patients were taken in each group. Each patient was subjected to detailed medical history, general physical and systemic examination, routine blood investigations, arterial blood gas analysis, chest radiograph, spirometry (performed using Spirometer make-Spiro Analyzer, RMS HELIOS) and electrocardiograph (ECG) at baseline.

Exclusion criteria

Patients having impaired mobility due to severe musculoskeletal disorders, patients having inability to communicate due to psychological/neurological disorders and patients with any known respiratory disorder.

Pulmonary rehabilitation program included two components. The first one was education and nutritional advice. Patients were given basic information about OSA and its consequences and were educated about breathing techniques, exercise techniques, use of home care equipment, self-administration of exercise and medical therapy. Patients were also encouraged to lose weight and advised a low-fat and low-carbohydrate diet. The other component included exercise prescription which the patients received in the Departmental Pulmonary Rehabilitation Centre. It consisted of 3 supervised exercise sessions per week, each of 1-hour duration, for a total period of 8 weeks. Exercise sessions included upper and lower extremity aerobic exercises, resistance exercises, oropharyngeal exercises and ventilatory muscle training exercises. All the sessions were conducted under supervision of a respiratory physiotherapist. During the exercise, supplemental oxygen was administered to the patients so as to maintain oxy-hemoglobin saturation (SpO_2) >90% on as and when required basis. The use of oxygen during the exercise was standardized and exercise was stopped if SpO_2 fell below 85%. Patients were also instructed to record their home exercises in a diary, which was reviewed weekly at the Pulmonary Rehabilitation Centre. Patients were considered to be compliant if they completed at least 70% or more of the sessions. Patients who could not complete the PR were not considered for final evaluation.

Besides body mass index (BMI) and percentage predicted forced expiratory volume in first second (FEV_1% predicted); exercise capacity, health related quality of life (HRQOL), day time sleepiness and sleep-QOL were measured at baseline and at 8 weeks follow up by 6 Minute Walk distance (6MWD), St. George's Respiratory Questionnaire (SGRQ), Epworth Sleepiness Scale (ESS) and Functional Outcomes of Sleep Questionnaire (FOSQ), respectively [10-13]. A change of 4 points in the SGRQ score was shown to represent the minimum clinically significant change [14].

The study was approved by the institute's Ethics committee.

Statistical analysis

Categorical variables were reported as counts and percentages. Group comparisons were made with the Chi-Square test/Fisher's exact test. Continuous data was given as mean ± SD and range or median and interquartile range, as appropriate. Normality of quantitative data was checked by measures of Kolmogorov Smirnov tests of normality. For skewed data, comparisons for two groups were made by Mann-Whitney test. For normally distributed data, Student t-test was applied to compare two groups. Paired *t*-test or Wilcoxon signed rank test was applied for time related calculations. A p-value <0.05 was considered significant. Analysis was conducted using IBM SPSS STATISTICS (version 22.0).

Results

After screening of 105 patients of suspected OSA, 60 consecutive patients meeting the inclusion and exclusion criteria were finally enrolled in the study. 38 were males and 18 were females, aged from 32 to 64 years with a mean age of 48 years. All the patients were diagnosed with moderate/severe OSA. Four patients in group A were excluded as they did not complete the PR program. 26 patients from group A and 30 patients from group B were finally analyzed (Figure 1). Although CPAP was advised in all the patients, only 2 patients in group A and 2 patients in group B took CPAP during the period of study. Both the groups were matched with respect to age, gender and AHI. Baseline FEV_1% predicted, BMI, 6MWD, SGRQ, ESS and FOSQ scores were also similar in the two groups (Table 1). In group A at follow up at 8 weeks, FEV_1% predicted

Table 1. Baseline patient characteristics.

Parameters		Group A (n=26)	Group B (n=30)	p-value
Age (years)		47.50±8.99	48.13±8.96	0.856
Gender	Males	18	20	0.838
	Females	8	10	
AHI (/hr)		33.12±12.81	35.17±12.64	0.388
FEV_1% predicted		93.15±9.88	93.77±10.19	0.821
BMI (Kg/m^2)		33.52±5.57	31.56±4.36	0.416
6MWD (meters)		414.5±34.75	422.47±34.69	0.253
SGRQ score		10.61±5.80	9.58±4.37	0.532
ESS score		15.5±2.79	14.6±2.75	0.226
FOSQ score		15.85±2.35	16.1±2.37	0.576

AHI, Apnea-hypopnea index; FEV_1% predicted, Forced expiratory volume in first second; BMI, body mass index; 6MWD, 6 minute walk distance; SGRQ, St. George's respiratory questionnaire; ESS, Epworth sleepiness scale; FOSQ, functional outcomes of sleep questionnaire.

improved but non significantly (p=0.185). BMI, 6MWD, SGRQ, ESS and FOSQ scores improved significantly from baseline (p<0.001) with a significant decrease in BMI, ESS and SGRQ scores and a significant increase in 6MWD and FOSQ score. In group B, at follow up at 8 weeks, FEV_1% predicted, BMI, 6MWD, SGRQ, ESS and FOSQ scores did not improve significantly from baseline (p=0.852, 0.086, 0.666, 0.365, 0.752 and 0.661, respectively) (Table 2). Mean improvement from baseline in BMI, 6MWD, ESS and FOSQ scores was significantly more in group A than group B (p<0.001). 4 patients in group A had a decrease of mean SGRQ by ≥4 units, but none of the patients in group B had such a change, the differences being statistically significant (p=0.041). However, there was no statistical difference between mean improvement in FEV_1% predicted between the two groups (p=0.443) (Table 3).

Discussion

There is emerging literature on the use of PR in OSA. We aimed to evaluate the efficacy of PR in the management of OSA in the Indian population using discrete outcome measures.

With a total of 56 patients (26 patients in group A and 30 patients in group B) who completed the study and were finally analyzed, it was seen that only 2 patients from group A and 2 from patients from group B could use CPAP even after advice, due to financial and/or compliance issues. Since the equipment is costly, and the patients may be awaiting some financial aid from one or the other source which may take some time, majority of the patients were not on CPAP at follow up evaluation which was at 8 weeks immediately after diagnosis and baseline assessment. Hence, in such patients awaiting definitive therapy, alternative treatments in the meantime become all the more important and need to be explored.

The patients in group A and B in our study were matched at baseline with respect to age, gender, AHI, FEV_1% predicted, BMI, 6MWD, SGRQ, ESS and FOSQ, thus eliminating any bias which could have arisen because of differences, if any. Our results were similar to other studies in the past which also had matched baseline characteristics [6,15,16].

In patients of group A, at follow up at 8 weeks, BMI and ESS score decreased significantly and 6MWD and FOSQ score increased significantly from baseline, the results being similar to the already available literature. However, in most of the previous studies, there was a concomitant use of CPAP or upper airway surgery and hence it was difficult to separate the effect of CPAP or surgery induced improvement from PR *per se* [6,17]. Since majority of our patients did not use CPAP during the study period, it would be more judicious to say that PR primarily was responsible for the significant improvements seen in our study. Another important finding was the improvement in HRQOL as evidenced by a significant decrease in SGRQ. Ours is the only study evaluating the impact of PR on HRQOL in OSA patients.

Various aerobic and resistance exercises employed in PR increase the physical activity and baseline metabolic rate of the patients which along with caloric restriction enhances weight loss and weight maintenance [18,19]. Moreover, physiological changes due to physical exercise led to increase in upper airway muscle tone, decrease in neck circumference, reduction in systemic inflammation and loss of weight. An interplay of all these factors could be responsible for a significant reduction in BMI and increase in 6MWD. This also leads to an ultimate improvement in snoring and relief of upper airway obstruction during sleep, thus alleviating the symptoms of OSA.

Apart from physical impairment due to OSA, patients are also mentally burdened resulting in psychological issues and disabilities leading to a lower QOL. Improvement in SGRQ score reflects substantial improvement in psychological disabilities and disease perception by the patient. Regular and effective aerobic exercises have

Table 2. Patient characteristics at baseline and after 8 weeks in Cases and Controls.

Parameters	Group A		p-value	Group B		p-value
	Baseline	After 8-weeks		Baseline	After 8-weeks	
FEV_1% predicted	93.15±9.88	94.5±10.18	0.185	93.77±10.19	93.9±10.15	0.852
BMI (Kg/m^2)	33.52±5.57	32.01±5.18	<0.001	31.56±4.36	31.91±4.36	0.086
6MWD (meters)	414.5±34.75	449.38±43.84	<0.001	422.47±34.69	423.8±33.37	0.666
SGRQ score	10.61±5.80	9.01±4.88	<0.001	9.58±4.37	9.42±4.42	0.365
ESS score	15.5±2.79	11.69±2.48	<0.001	14.6±2.75	14.67±2.66	0.752
FOSQ score	15.85±2.35	17.47±1.87	<0.001	16.1±2.37	16.09±2.44	0.661

FEV_1% predicted, forced expiratory volume in first second; BMI, body mass index; 6MWD, 6 minute walk distance; SGRQ, St. George respiratory questionnaire; ESS, Epworth sleepiness scale; FOSQ, functional outcomes of sleep questionnaire.

Table 3. Mean change in characteristics after 8 weeks of intervention.

Parameters	Group A	Group B	p-value
Mean change in FEV_1% predicted	1.35±5.04	0.01±3.88	0.443
Mean change in BMI	-1.51±0.99	0.35±0.93	<0.001
Mean change in 6MWD	34.88±22.59	1.40±13.91	<0.001
Mean change in ESS Score	-3.81±2.04	0.07±1.34	<0.001
Mean change in FOSQ Score	1.62±1.63	-0.003±0.48	<0.001
No. of subjects with improvement in SGRQ by ≥4 units	4	0	0.041

FEV_1% predicted, forced expiratory volume in first second; BMI, body mass index; 6MWD, 6 minute walk distance; SGRQ, St. George's respiratory questionnaire; ESS, Epworth sleepiness scale; FOSQ, functional outcomes of sleep questionnaire.

short term positive effects on various other organ systems in the form of decreased peripheral vascular resistance, reduction in sympathetic activity, heart rate and blood pressure, and long-term effects in the form of a reduction in the risk of co-morbidities [20]. This contributes to an increased sense of well-being. Moreover, PR promotes active participation of the patient in the treatment and increased awareness of the disease which has a positive influence on psychosocial status further improving the quality of life of the individual, a resultant decrease in ESS score, and an increase in FOSQ score.

The lack of robust improvement in FEV_1% predicted in our study is also consistent with previous research [7]. Even for a disease like COPD, where the role of PR is well established, there is conflicting evidence regarding its contribution towards functional improvement [21,22]. Also, the patients in our study had normal lung function at baseline and were not suffering from any other lung disease, hence, major improvement was not even expected.

The significant improvement in the various parameters as discussed above in patients of Group A was not seen in patients in Group B, thus signifying the highly important role of the PR. Our study hence proposes that PR can be used as an adjunctive treatment for OSA patients as it improves the physical and functional disabilities associated with the disease. It is an easy and cheap method for providing symptomatic relief to OSA patients who otherwise could not afford it or are not compliant on CPAP. Moreover, 6MWD, SGRQ, ESS and FOSQ scores can serve as useful tools for predicting the response to treatment after PR and for devising strategies for optimization of treatment in patients on PR.

To the best of our knowledge, this is one of the studies of its kind evaluating the role of PR in patients of OSA, with the use of multiple discrete outcome measures. Patients in our study belonged to the moderate/ severe OSA category whereas the few existing studies which are available had evaluated mild to moderate OSA patients primarily. Hence, in addition to the findings already discussed, another beauty of our study is that it adds to the benefits of PR in severe OSA patients too, for whom even lesser data is available.

Limitations of the study

Since majority of our patients in both the groups did not use CPAP, advantages of PR when used in conjunction with CPAP therapy could not be studied.

Conclusion

The present study showed that PR decreases BMI, improves exercise capacity, HRQOL and sleep QOL in OSA patients. Hence, multidisciplinary PR, as we did, should be incorporated in the standard management of OSA, and also as an initial management in those patients awaiting definitive therapy.

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