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[ORIGINAL ARTICLE]

Effect of Oropharyngeal Exercises and Respiratory Muscle Strengthening in Obese Patients with Obstructive Sleep Apnoea- An Experimental Study

Mahajan Pradnya[1], Patil Prajakta[2], Nagulkar Jaywant[3], Saini Vikas[4]

[1]Assistant Professor, [2]BPTh Intern, Jalgaon, [3]Principal, [4]Assistant Professor,
Dept. of Musculoskeletal physiotherapy, Dr. Ulhas Patil College of Physiotherapy, Jalgaon, India

ABSTRACT :

Aim- To determine the effect of oropharyngeal exercise and respiratory muscle strengthening in obese patients with obstructive sleep apnoea.

Relevance of study - Obstructive sleep apnoea syndrome (OSAS) is a significant public health problem It is necessary to treat OSA so that obese patients should not always go for non-invasive CPAP ventilation or surgical need as it becomes severe there is a need for surgery.

Methodology- In this experimental study, 34 obese (BMI >30) subjects with mild or moderate obstructive sleep apnoea (AHI>5) were selected according to inclusion & exclusion criteria. pre- and post-OSA analyses were done using the Epworth sleepiness scale (ESS), the Scale of subjective snoring (Stanford), and neck circumference. The oropharyngeal exercises & respiratory muscle strengthening exercises were given to patients for 6 weeks, 5 days per week.

Result- On intra-group using paired t-test, the pre-intervention mean neck circumference was 34.946+3.173. The obtained p-value after the intervention is <0.0001 with a post mean of 34.263+3.022, which implies a significant difference between pre-post comparisons for the Stanford scale was 6.257+0.980. The obtained p-value after the intervention is <0.0001 with post mean 4.714+ 0.957, which implies the significant difference between pre-post comparison and ESS was 11.941+1.071. The obtained p-value after the intervention is <0.0001 with post mean 10.000+ 0.816, which implies a significant difference between pre-post comparison.

Conclusion - Oropharyngeal exercises and respiratory strengthening exercises are effective in obese patients with mild or moderate obstructive sleep apnoea.

Keywords- Obstructive Sleep Apnoea, Oropharyngeal & Respiratory muscle strengthening exercises)

Introduction

Obstructive sleep apnoea (OSA) is a prevalent sleep-related breathing disorder distinguished by a complete or partial upper airway obstruction, resulting in apnoea and hypopnea during sleep. The clinical symptoms and signs included nocturnal snoring, choking and fragmented sleep, daytime sleepiness, fatigue, and problems with memory and concentration[1].

Obstructive sleep apnoea syndrome (OSAS) is a significant public health problem characterized by repetitive episodes of upper airway occlusion during sleep associated with sleep fragmentation, daytime hypersomnolence, and increased cardiovascular risk[2]. The etiology of OSAS is not sharply known to physicians; they studied neuromuscular abnormalities of the upper airway in addition to abnormal anatomical factors (e.g., tongue volume, tonsil enlargement, soft palate length, the position of mandible and maxilla), which all contribute to the pathogenesis of OSAS[3]. Obstructive sleep apnoea syndrome (OSAS) is a common disorder with prevalence rates of at least 4% among middle-aged male Caucasians and Hong Kong Chinese populations. Intermittent hypoxia and sympathetic

*Corresponding author
Dr. Mahajan Pradnya (PT)
Email : pprad1816@gmail.com
Dept. of Musculoskeletal physiotherapy, Dr. Ulhas Patil College of Physiotherapy, Jalgaon, India

surges, which characterize OSAS, can lead to oxidative stress, systemic inflammation, and endothelial dysfunction and result in sleep fragmentation, daytime sleepiness, impaired cognitive function, and poor health status. OSAS patients are at increased risk of cardiovascular morbidity and mortality, including sudden death, and are more prone to traffic accidents4. The prevalence of sleep-disordered breathing (SDB) has been reported to be 20–81% in the elderly Caucasian populations. In a French study, OSAS was diagnosed in 57% of the community dwellers aged 68 years, with 34% having a mild form with an apnoea-hypopnea index[4].

Obesity and particularly central adiposity are potent risk factors for sleep apnea[5]. They can increase pharyngeal collapsibility through mechanical effects on pharyngeal soft tissues and lung volume and through the central nervous system–acting signaling proteins (adipokines) that may affect airway neuromuscular contro[15]. Specific molecular signaling pathways encode differences in distribution and metabolic activity in adipose tissue. These differences can alter the mechanical and neural control of upper airway collapsibility, which determines sleep apnoea susceptibility5. Although weight loss reduces upper airway collapsibility during sleep, it is not known whether its effects are mediated primarily by improvement in upper airway mechanical properties or neuromuscular control5. Physicians tried to treat OSA to reduce patients' suffering and lessen their quality of life; they used invasive and non-invasive maneuvers, e.g., the most appropriate one is continuous positive airway pressure, which is usually used because it is easy, available, and effective particularly in moderate and severe cases of OSAS primarily if associated with snoring and hypoxemia. Despite a long history of CPAP usage, many patients don’t prefer it because of noise, uncomfortableness, air leaks, and irritation of the eyes and nose[3].

The body's response to obstructed breathing leads to brain arousal, sympathetic activation, and oxygen desaturation in the blood. Repeated episodes of upper airway obstruction during sleep may result in sleep fragmentation and non-restorative sleep. Those who have OSA may complain of tiredness, excessive day-time sleepiness, insomnia, or morning headaches, but many are asymptomatic. The primary metric for diagnosing OSA is the apnoea hypopnea index (AHI). This reflects the average number of significant breathing disturbances per hour6.OSA is critically determined by anatomic impairment of the upper airway, including nasal septum deviation, nasal turbinate hypertrophy, tonsil hypertrophy, macroglossia, retrognathia, high arch palate, etc.

Upper airway muscle strengthening comprised the retropalatal level, the retroglossal level, the hypopharyngeal level, the facial level, and the temporomandibular joint level, indicated for patients with mild and moderate OSA only. Respiratory muscle strengthening can be considered one kind of pulmonary rehabilitation, which can improve pulmonary function by training both inspiratory and expiratory muscles. It is essential to treat or manage OSA so that obese patients do not always go for non-invasive CPAP ventilation or surgical needs. As it becomes severe, there is a need for surgery, so it is essential to prevent it at a minimum or moderate level. As oropharyngeal exercises & upper respiratory strengthening exercise is non-invasive & cost-effective, this study will help obese patient deal with OSA and improve their quality of life. Hence, the present study is conducted to determine the effect of oropharyngeal exercise and upper respiratory strengthening exercises in obese patients with moderate obstructive sleep apnoea.

Methodology

Study Type- Pre-Post Experimental study. Study set up - Dr. Ulhas Patil College of Physiotherapy, Jalgaon.

Study duration- 6 months. CTRI Registration no.- CTRI/2023/07/055712.

Subjects included in this study were: Obese subjects with moderate obstructive sleep apnoea. The sample size was calculated using the formula of minimum sample size to estimate the population's mean formula. The minimum sample size was 37. Convenient sampling was done. from which 3 were excluded due to lack of follow-up.

Subjects included in the study were: 1. Obese subjects, 2. Both gender 3. Patients with OSA (apnoea hypopnea index 15–30) together with at least two symptoms of OSA:(snoring, fragmented sleep, witnessed apnoeas, morning headache, and daytime sleepiness). Subjects excluded were subjects 1. who were not willing to participate. 2. Subject who could not perform exercise or follow Complete protocol. 3. Subjects have a BMI of more than 32. 4.

Neuromuscular or restrictive pulmonary disease. Craniofacial malformations, physical obstruction in nose or throat, abnormally large tonsils, uncorrected deviated septum. 5. Persistent unstable hypertension post medication. 6. Hypothyroidism 7. Active psychiatric disease. 8. Severe upper airway anatomical abnormalities. Outcome measures- were 1. Stanford scale 2. Epworth sleepiness scale (0.88) 3. with reliability and validity of (0.88) 3. Neck circumference.

Procedure

Ethical clearance was obtained from the Institutional Ethical Committee of Dr. Ulhas Patil College of Physiotherapy. A written informed consent form was obtained from those willing to participate. The subject was screened according to inclusion and exclusion criteria. The aim of the study and its objective was explained to willing participants. Selected participant's demographic details & outcome measures were recorded as follows:

The BMI of each subject was calculated subject having a BMI more than 25 (pre obese or obese) were selected for the study.

The screening was done using the Apnoea Hypopnea Index (AHI) in which episodes of snoring in 1 Hr were noted by asking the subject's spouse or relative, which is named as a hypopnea episode, and for apnoea, the subject was asked how many times the subject got awake during sleeping hours and calculated using formula.

CALCULATION=APNEA+HYPOPNEA

NO. OF SLEEPING HOURS

The subjects with an AHI score >5 and mild or moderate OSA were included.

Neck circumference- Neck circumference is measured of each subject using measuring tape in centimeters (cm) to check the girth of the neck in obese patients.

Epworth sleepiness scale (with validity and reliability of 0.88)- Subjects were asked to answer the questions in the questionnaire, and a score was noted. This questionnaire was developed to determine the level of daytime sleepiness.

Stanford Scale- This scale assigns patients grades from 0 to 10 based on the extent to which snoring affects their family relationship

Intervention

Exercises regularly at home 3–5 times per day with a minimum of 10 min for each time. Patients who failed to return for 3 consecutive weeks or failed to comply with exercises at home were excluded from the study.

Oropharyngeal Exercise

oropharyngeal exercises included tongue, soft palate, and facial muscle exercises.

The oropharyngeal exercises included:

1)	Push the tip of the tongue against the hard palate and slide the tongue backward	20 times
2)	Suck the tongue upward against the palate, pressing the entire tongue against the palate	20 times
3)	Elevation of the soft palate and uvula while intermittently saying the vowel "A". After gaining control and coordination of movement (after 3–5 weeks), elevation done without vocalization	20 times
4)	Recruitment of buccinator muscle against the finger that is introduced in the oral cavity, pressing buccinator muscle outward	10 times
5)	Alternate bilateral chewing and deglutition using the tongue in the palate, without perioral contraction, whenever feeding	
6)	Practice gargling without water.	200X

Upper Airway Muscle Strengthening & Respiratory Muscle Strengthening.

Upper airway muscle strengthening was based on an anatomically multilevel approach. 20-min program of upper airway muscle strengthening included retropalatal level, retroglossal level, hypopharyngeal level, facial level, and temporomandibular (TMJ) level, followed by 30-s rest interval between exercise

1. Retroglossal level- sticking the tongue out straight forwardly and then deviating laterally, and finally curling upward and downward , slowly rotating the tongue as a circle between the teeth and the mouth and as farther as possible.	2 sets of 10 repetitions
2. Hypopharyngeal level: - Respiration: inspiratory and expiratory muscle strengthening with quantified resistance was instructed.	5 breaths/cycle 5 cycles/ day
3. Facial level: - Buccinators and orbicularis oris: recruitment of the buccinators and orbicularis oris when puffing out one's cheeks as fully as possible while keeping lips closed for 15	2 sets of 10 repetitions
4. TMJ level- It is involved with muscle balance between supra -hyoid and infra -hyoid muscles. Jaw movement was introduced with resisted loading, especially while opening/ closing the mouth and protruding/ retruding the jaw.	2 sets of 10 repetitions

Statistical Analysis

A total of 31 participants were included in this study, of which 11 were men and 20 were women. The data obtained from the participants was statistically analyzed. Mean was calculated for all the needed variables. Statistical analysis was performed with In-Stat. The paired t-test was used for calculating intra-group values.

Table 1- Age-wise distribution of study subjects

Age Group	No. Of Subjects	Mean
40-45	14	47
46-50	13	
51-55	7	

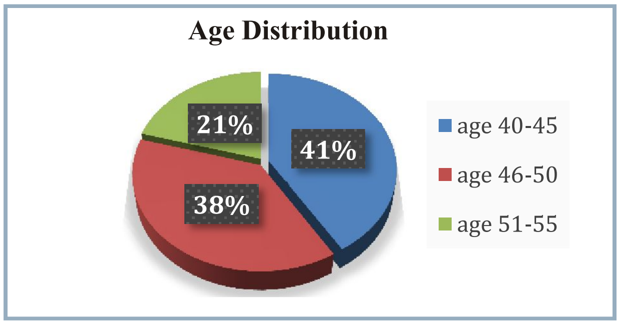


Table 2- Gender wise distribution of study subject

Gender	No. Of Subjects	Percentage
Male	12	35%
Female	22	65%

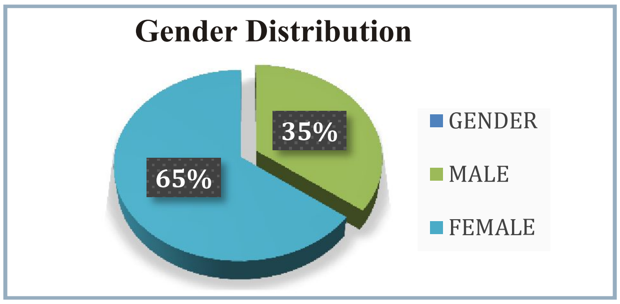
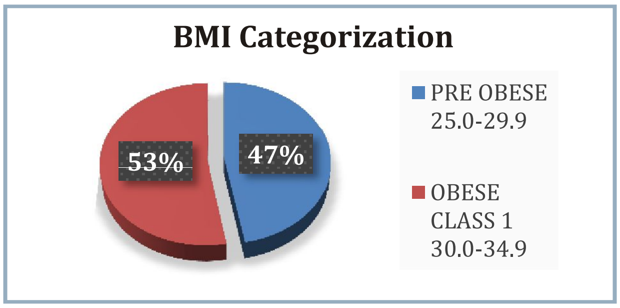


Table 3- BMI Categorization of study subject.

BMI	Kg/m^2	No. of subjects	mean
Normal	18.5-24.9	0	29.73
Pre obese	25- 29.9	16	
Obese Class 1	30-32	18	



As shown in graph 1, In the group using paired t-test the pre-intervention mean of neck circumference was 34.946+3.173. The obtained p-value after the intervention is <0.0001 with a post-mean of 34.263+3.022, implying a significant difference between pre-post comparisons. As shown in graph 2, On intra-group comparison of the group using paired t-test, the pre-intervention mean of the Stanford scale was 6.257+0.980. The obtained p-value after the intervention is <0.0001 with a post mean 4.714+ 0.957, which implies a significant difference between pre-post comparison. As shown in graph 3, intra-group comparison of the group using paired t-test, the pre-intervention mean of ESS was 11.941+1.071. Obtained p-value after the intervention is <0.0001 with post mean 10.000+ 0.816, which implies a significant difference between pre-post comparisons. oropharyngeal exercises & upper respiratory strengthening exercises were effective in reducing para pharyngeal fat by reducing neck circumference, Stanford score, which indicates the intensity of snoring the ESS

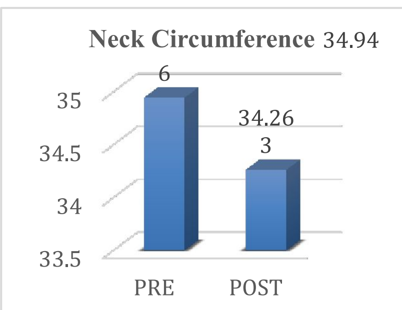
score, which shows a reduction in daytime sleepiness.

Discussion

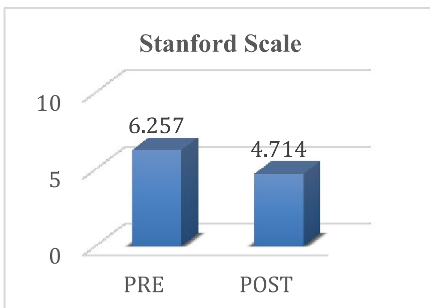
Obstructive sleep apnoea (OSA), characterized by repeated pharyngeal collapse during sleep, is associated with excessive daytime sleepiness, resulting in a decline in the patient's quality of life. Oropharyngeal exercises are a new, non-invasive, cost-effective treatment modality for the treatment of mild to moderate obstructive sleep apnoea. Increasing the tone of pharyngeal muscles is more physiological, and its effects are long-lasting. Respiratory muscle strengthening can be considered one kind of pulmonary rehabilitation that can improve pulmonary function by training both inspiratory and expiratory muscles. This study was conducted to see the effectiveness of oropharyngeal and upper respiratory strengthening exercises on obese patients with obstructive sleep apnoea.

Table 4

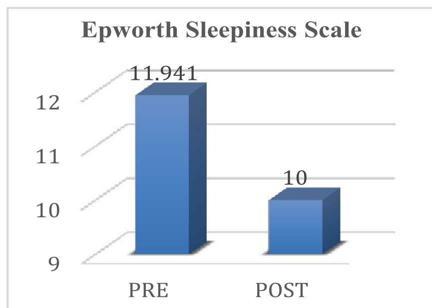
OUTCOME MEASURES	PRE (MEAN+SD)	POST (MEAN+SD)	t value	P value	significance
Neck circumference	34.946±3.173	34.263±3.022	6.687	<0.0001	Extremely significance
Stanford score	6.257±0.980	4.714± 0.957	9.608	<0.0001	Extremely significance
ESS score	11.941±1.071	10.000± 0.816	11.171	<0.0001	Extremely significance



Graph 1



Graph 2



Graph 3

The total number of subjects included in the study was 37, of which 3 were dropouts due to lack of follow-up, so the total number of subjects who participated in the study was 34, of which 12 were males and 22 were females.

Variable 1-Neck Circumference

Neck circumference is measured before and after the oropharyngeal and upper respiratory strengthening exercises. Results showed that neck circumference was reduced after the intervention. The pre-intervention mean neck circumference was 34.943+3.46. The obtained p-value after the intervention is <0.0001 with a post-mean of 34.280 + 3.194, implying that oropharyngeal and upper respiratory strengthening exercises effectively reduce neck circumference. This could be due to reduced parapharyngeal fat tissue, as this tissue may cause narrowing of the upper airway. During sleep, muscles get relaxed, and pharyngeal muscle relaxation causes narrowing. At the same time, due to the force of gravity, the tongue slides downward, which leads to obstruction and provides less oxygen to the lungs, resulting in hypoventilation, which causes an increase in respiratory rate, results in hypopnea, and an increase in hypoventilation, leads to arousal which means apnoea which leads to daytime sleepiness.

Oropharyngeal exercises increase the metabolism of fat and reduce the fat, releasing the narrowing of the upper airway, which results in a reduction in neck circumference.

This result of our study is in accordance with Dr.

Anujot Kaur et al. (2021)18 The rationale behind using OMSE for sleep apnoea is that strengthening would increase the upper airway dilator muscle tone. This increase in muscle tone helps maintain the pharyngeal airway's patency. In turn, this prevents airway collapse by counteracting the negative transmural pressure, thus reducing the number of apnoea/hypopneas during sleep.

Variable 2- Epworth sleepiness scale

Epworth sleepiness scale evaluates the daytime sleepiness in patients. Results showed that the ESS score was reduced after the intervention. the pre-intervention mean of ESS was 11.969+1.092. The obtained p-value after the intervention is <0.0001 with post-mean.

9.906+0.777. The body's response to obstructed breathing leads to brain arousal, sympathetic activation, and oxygen desaturation in the blood. Repeated episodes of upper airway obstruction during sleep may result in sleep fragmentation and non-restorative sleep. So, a reduction in the narrowing of the upper airway leads to less gasping of air by the subject, which causes less fragmented sleep, resulting in reduced daytime sleepiness.

This result of our study is in accordance with Ahmed Sh. Mohamed et al. (2017)3 After Oropharyngeal exercises, the primary outcome of the study was daytime sleepiness (ESS) improved significantly in moderate OSA (group I); also, there was significantly reduced severity of OSAS.

Variable 3- Stanford Scale

On inter-group using paired t-test, the pre-intervention mean Stanford scale was 6.187 +0.965. The obtained p-value after the intervention is <0.0001 with a post mean of 4.593 +0.910, implying a significant difference between pre-post comparisons. This could be due to decreased snoring intensity because a reduction in leptin resistance causes synchronized breathing with less chance of hypoventilation.

This result of our study is in accordance with Marcos Marques Rodrigues et al. (2010)17. who found a positive correlation between snoring intensity and OSAS severity. The study's authors assessed snoring subjectively with the Severity of Snoring Scale. As a measure of snoring severity, this questionnaire can provide a fast and easy indication of the severity of OSAS.

Conclusion

This study concludes that the oropharyngeal exercises and upper respiratory strengthening exercises are effective in reducing obstructive sleep apnoea among obese patients between the age group of 40 to 55.

Limitations

AHI scale was taken subjectively, Unequal gender distribution, Protocol is given for less duration

Future Scope

AHI can be calculated using devise polysomnography. The protocol can be increased up to 12 weeks. Subjects with severe OSA can be included with proper safety measures.

Clinical Implication

The oropharyngeal exercise and upper respiratory strengthening exercises are effective in reducing the severity of obstructive sleep apnoea among obese patients between the age group 40 to 55. It is a non-invasive and cost-effective treatment for OSA.

Acknowledgment

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