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Oropharyngeal exercises in the treatment of obstructive sleep apnoea: our experience

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Abstract

Introduction Oropharyngeal exercises are new, non-invasive, cost effective treatment modality for the treatment of mild to moderate obstructive sleep apnoea. It acts by increasing the tone of pharyngeal muscles, is more physiological, and effects are long lasting.

Aim of the study The aim of our present study was to evaluate the effect of oropharyngeal exercises in the treatment of mild to moderate obstructive sleep apnoea.

Method Twenty patients of mild to moderate obstructive sleep apnoea syndrome (OSAS) were given oropharyngeal exercise therapy for 3 months divided into three phases in graded level of difficulty. Each exercise had to be repeated 10 times, 5 sets per day at their home. Oropharyngeal exercises were derived from speech–language pathology and included soft palate, tongue, and facial muscle exercises. Anthropometric measurements, snoring frequency, intensity, Epworth daytime sleepiness and Berlin sleep questionnaire, and full polysomnography were performed at baseline and at study conclusion.

Results Body mass index (25.6 ± 3.1) did not change significantly at the end of the study period. There was significant reduction in the neck circumference (38.4 ± 1.3 to 37.8 ± 1.6) at the end of the study. Significant improvement was seen in symptoms of daytime sleepiness, witnessed apnoea, and snoring intensity. Significant improvement was also seen in sleep indices like minimum oxygen saturation, time duration of Sao2 < 90 %, sleep efficiency, arousal index, and total sleep time N3 stage of sleep at the end of study.

Conclusion Graded oropharyngeal exercise therapy increases the compliance and also reduces the severity of mild to moderate OSAS.

Keywords Obstructive sleep apnoea · Oropharyngeal exercise therapy · Polysomnography · Effectiveness

This material has never been published and is not currently under evaluation in any other peer-reviewed publication.

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Introduction

Guilleminault et al. coined the term obstructive sleep apnoea syndrome (OSAS) to describe patients with disrupted nocturnal breathing [1]. American Academy of Sleep Medicine defines OSAS by occurrence of daytime sleepiness, loud snoring, and witnessed breathing interruptions or awakenings due to gasping or choking in the presence of at least five obstructive respiratory events (apnoea, hypopnoea, and respiratory effort-related arousals) per hour of sleep [2]. OSAS is a significant public health problem and has been implicated in systemic hypertension, pulmonary hypertension, arrhythmia, cerebrovascular accident (CVA), and polycythemia [3, 4]. Compromised sleep has also been identified as a risk

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factor for driving accidents, neurocognitive dysfunction and depression, deteriorated quality of life, and increased health-care costs. Prevalence of OSAS is approximately 4 % for adult men and 2 % for adult women in the general population [4].

The pathogenesis of OSA is multifactorial [1, 3]. Research indicates that both anatomical and neuromuscular factors play a role in genesis of OSAS [3, 5]. Anatomical factors causing OSAS includes enlarged tonsils, increased bulk of the tongue, increased length of the soft palate, abnormal positioning of the maxilla and mandible, and lax lateral pharyngeal walls [3]. Upper airway dilator muscles play a crucial role in the maintenance of pharyngeal patency and may contribute to the genesis of OSAS [5].

There is no single treatment for OSAS that is universally accepted and that has long-lasting effects. CPAP is considered to be a gold standard treatment option for treating sleep apnoea for moderate to severe OSAS [6]. But a substantial proportion of patients still remain ineffectively treated by it [7]. It is also associated with device-related complications like mask discomfort, rejection of partner, and cutaneous allergies which lead to low compliance of the patients for CPAP [8]. Weight reduction by diet or surgery does cause improvement in AHI but symptoms tend to reoccur on resumption of normal diet [9]. Intra-oral devices like lingual retainers and jaw petitioners do improve sleep disturbances in OSAS temporarily [10]. However, it is associated with problems like use of extensive dental prosthesis, periodontal problems, and intense temporomandibular joint dysfunction (TMJ) [11]. Various surgical procedures like septoplasty, tonsillectomy, uvulopalatopharyngoplasty (UPPP), and tongue base reductions do provide benefits in OSAS but their efficiency is only 40–50 % and symptoms tend to recur after 1–2 years [12, 13]. Maxillomandibular advancement is a treatment option only for severe OSAS patients with significant retrognathia [13].

The abovementioned treatment modality for OSAS focus on increasing the airway space or on increasing the airway pressure but they do not address the basic cause of OSAS (decreased tension of pharyngeal muscles during sleep). Oropharyngeal exercises are a new, non-invasive, cost-effective treatment which acts by increasing the tone of pharyngeal muscles. It aims at correcting the posture adequacy, the sensibility and proprioception, and the tonus and mobility of the orofacial and pharyngeal musculature. Oropharyngeal exercises reinforce the oropharyngeal muscles and increase their tone, thereby dilating the upper airways during sleep [14]. It is more physiological and may bring long-lasting benefits to the patients. The aim of our present study was to evaluate the effect of oropharyngeal exercises in graded level of difficulty for mild to moderate obstructive sleep apnoea.

Material and methods

Material

This was a prospective experimental cohort study done in the Department of Otolaryngology and Head & Neck surgery, Department of Audiology and Speech Therapy and Neurology during a 1-year period (July 2013–November 2014). Twenty OSAS patients who had AHI 5–30 per hour of sleep on polysomnography and who gave written informed consent for oropharyngeal exercise therapy were included in study. Patients having conditions like body mass index (BMI) 40 kg/m2 or greater, craniofacial malformations, regular use of hypnotic medications, hypothyroidism, previous stroke, neuromuscular disease, heart failure, coronary disease, and severe obstructive nasal disease were excluded from the study.

Methods

All patients complaining of snoring and daytime sleepiness were evaluated with detailed history and Berlin questionnaire and Epworth Sleepiness Scale, followed by general examination and detailed head and neck examination including nasal endoscopy. BMI and neck circumference measurement was done in all patients. Polysomnography (Nicolet one) was done in all patients at baseline and follow-up. The following sleep parameters were calculated: total sleep time (TST) in minutes; sleep efficiency; percentage of TST spent in stages 1,2, and 3; minimum oxygen saturation; arousal index; desaturation index; average duration of Spo2 < 90 %; apnoea-hypopnoea index(AHI); heart rate; pulse; and ECG. Sleep staging and scoring, sleep-relative breathing disorders, and sleep-related movement disorders were also assessed.

Exercise therapy and regimen

Oropharyngeal exercises were derived from speech–language pathology and include soft palate, tongue, and facial muscle exercises as well as stomatognathic function exercises.

Oropharyngeal exercises regime was divided into three phases:

Phase 1 included 4 lip exercises, 5 tongue exercises, 2 jaw exercises, and 2 soft palate exercises.

Phase 2 included 2 lip exercises, 2 tongue exercises, 2 jaw exercises, 5 soft palate exercises, and 2 cheek exercises.

Phase 3 included 2 lip exercises, 2 tongue exercises, 1 jaw exercises, and 2 soft palate exercises.

Phase 1

- Slowly open and close your mouth to its full extent, making sure the lips meet when closing: orbicularis oris

Pucker your lips (as if about to kiss). Hold for a count of 10. Relax.

Pucker your lips (as if about to kiss). Hold for a count of 10. Relax.

- Spread your lips into a big, exaggerated smile. Hold. Relax: levator

Tongue exercises

- Brushing the superior and lateral surfaces of the tongue while the tongue is positioned in the floor of the mouth
- Placing the tip of the tongue against the front of the palate and sliding the tongue backward
- Open your mouth and stick out your tongue. Be sure your tongue comes straight out of your mouth and does not go off the side. Hold, relax, and repeat several times. Work toward sticking your tongue out farther each day, but still pointing straight ahead
- Repeatedly stick your tongue in and out as fast as you can.
- Flick your tongue from corner to corner as quickly as you can. Move tongue all around your lips in a circle as quickly as you can, making sure you stay in constant contact.

Jaw muscles exercises

- Open and close mouth as quickly as you can, making sure your lips close each time.
- Say “Ma-Ma-Ma-Ma” as quickly as possible, ensuring there is an “em” and an “ah” sound each time. Repeat with “La-La-La-La.”
- Swallowing and chewing: Alternate bilateral chewing and deglutition, using the tongue in the palate, closed teeth, without per oral contraction, whenever feeding

Phase 2

Lip exercises

- Mix exercises 2 and 3: Pucker-hold-smile-hold.
- Close your lips and press them tightly together.

Tongue exercises

- Stick out your tongue and try to reach your chin with the tongue tip.
- Hold at the farthest extension.

Jaw exercises

- Repeat with “Ka-Ka-Ka-Ka” as quickly and accurately as you can.
- Repeat with “Kala-Kala-Kala-Kala”

Palatal exercises

- Palatal elevation with and without yawn (to feel the soft palatal lift). Pronounce an oral vowel intermittently (isotonic exercise) and continuously (isometric exercise).

Buccinator muscle

- Suction movements contracting only the buccinator. These exercises were performed with repetitions (isotonic) and holding position (isometric). Recruitment of the buccinator muscle against the finger that is introduced in the oral cavity, pressing the buccinator muscle outward.

Pterygoid muscles

- Lateral jaw movements with alternating elevation of the mouth angle muscle
- Forced nasal inspiration and oral expiration in conjunction with phonation of open vowels, while sitting.

Phase 3

Buccinator muscle

Balloon inflation with prolonged nasal inspiration and then forced blowing, repeated five times without taking the balloon out of the mouth.

Pterygoid muscles

- Alternated elevation of the jaw muscle forwards and sideways with repetitions
- Sing through the vowel sounds (A-E-I-O-U) as loudly as you can (or dare)

Tongue muscle

- Stick out your tongue. Hold a spoon upright against the tip of your extended tongue and try to push it away while your hand holds the spoon in place
- Forced tongue sucking upward against the palate, pressing the entire tongue against the palate

Lip exercises

- Try to pucker with your mouth wide open, without closing your jaws together. Hold and relax
- Close your lips firmly, and then make a "slurping" noise, as if sipping a drink

All patients underwent oropharyngeal exercise therapy for a period of 3 months.

The oropharyngeal exercises were divided into three phases in a graded level of difficulty. Each phase comprised of a set of exercises which had to be practiced for 1 month. We also recorded the responses of patients after each phase of exercise based on the percentage of improvement in the overall symptoms. This was to give an idea about which set of exercise regime is more satisfactory for the patient in relieving both symptoms and in terms of compliance.

Each patient was given a CD and manual which described the proper way to do these exercises. (Video 1). The proper way to exercise was demonstrated to each patient by a qualified speech pathologist at the start of each phase. Each exercise included in each phase had to be repeated 10 times, 5 sets per day at their home. All the patients were called to the Outpatient Department once a week, were asked to perform the exercise under supervision, and were monitored by two clinicians to ensure an adequate effort. Patients were also followed up in-between their visits telephonically to offer support and provide technical solutions regarding the exercises.

Epworth sleepiness score assesment was done after completion of each phase of oropharyngeal exercise by two independent clinicians. Follow-up polysomnography was done after completion of 3 months of oropharyngeal exercise therapy.

Statistical analysis

All analyses were conducted using SPSS for Windows (version 17.0; SPSS Inc., Chicago, IL, USA). Discrete categorical data was presented as *n* (%); continuous data as mean ± SD or median and interquartile range. Gender differences were calculated using Mann-Whitney *U* test for skewed continuous variables and ordered categorical variables. For normally distributed data, *t* test was applied. Categorical data comparisons were made by Pearson chi-square test and Fisher's exact test as appropriate. For time-related variables (2-times), paired *t* test or Wilcoxon signed rank test was applied. *To see* relationship between different variables, Pearson or Spearman correlation coefficient was used.

Results

During the study period, 100 suspected cases of obstructive sleep apnoea were screened. Fifty patients had AHI between 5 and 30/h of sleep on polysomnography and were included in the study. Out of 50 patients, 40 gave informed consent for oropharyngeal exercise therapy. Three had h/o cardiac event, two had craniofacial abnormalities, and one had hypothyroidisms so they were excluded. Only 34 patients received oropharyngeal exercise therapy. Out of these 34 patients, 8 were lost to follow-up after 1 month and 6 after 2 months of oropharyngeal exercise therapy, so they were excluded from the study. Only 20 patients completed 3 months of oropharyngeal exercise therapy and underwent follow-up polysomnography. The data of these 20 patients were included in further analysis.

The mean age of the patients was 41.1 ± 10.6 years (26–61). Out of 20 patients, 15 (75 %) were males, 5 (25 %) were females. The mean body mass index at the time of starting therapy was 25.6 ± 3.1 (21.4–32.7). After 3 months oropharyngeal exercise therapy, the mean BMI was 25.4 ± 3.2 (20.2–33.1). This decrease in the BMI was found to be statistically non-significant (*p* value 0.072). The mean neck circumference was 38.4 ± 1.3 (36–41). After 3 months of oropharyngeal exercise therapy, mean neck circumference reduced to 37.8 ± 1.6 (40–34.9) which was statistically significant (*p* value 0.004) (Table 1).

There was significant improvement in symptoms of daytime sleepiness, witnessed apnoea, and snoring intensity following 3 months of oropharyngeal exercise therapy. Fourteen out of 16 patients (70 %) who complained of daytime sleepiness were relieved of the symptom post-exercise therapy. This was statistically significant (*p* value <0.001). Thirteen out of 20 patients (65 %) were suffering from witnessed apnoea at the start of therapy. Nine out of 13 patients (65 %) were relieved of the symptom after the oropharyngeal exercise therapy which was found to be statistically significant (*p* value <0.004). Seven patients complained of morning headache at the start of therapy. Only three out of seven were relived of morning headache following 3 months of exercise therapy which was statistically non-significant (*p* value 0.289). The mean snoring intensity before starting oropharyngeal exercises was 2.8 ± 0.5 [2–4]. Snoring intensity reduced to 1.7 ± 0.6 [1–3] after 3 months of oropharyngeal exercise therapy which was statistically significant (*p* value <0.001) (Table 2) (Fig 1).

Epworth sleepiness score was administered after the completion of each phase of oropharyngeal exercise. The mean

Table 1 Changes in clinical parameters before and after oropharyngeal exercise therapy

Mean BMI	Before 25.6 ± 3.1	After 25.4 ± 3.2	% increase or decrease	*p* value 0.072
Mean neck circumference	38.4 ± 1.3	37.8 ± 1.6		0.004
Daytime sleepiness (*n*)	16	2	87.5 % decrease	<0.001
Morning headache (*n*)	7	3	40 % decrease	0.289
Witnessed apnoea (*n*)	13	4	52.9 %	<0.004
Improvement in ESS score (*n*)	20	17	85 % improved	*p* value <0.001
Snoring intensity	2.8 ± 0.5	1.7 ± 0.6		<0.001

n no of patients

ESS score before initiation of therapy was 15.4 ± 2.3 [10–18], and after 3 months of oropharyngeal exercise, therapy ESS score reduced to 13.6 ± 3.1 [7–18] which was statistically significant(*p* value <0.001). We also noted that the decrease in the ESS score was more in the males (15 to 12.3) as compared to females (16.8 to 15.8) which was statistically significant (*p* value 0.002) (Table 1).

Patients were also asked regarding the percentage of improvement in their overall symptoms after each phase of oropharyngeal exercise therapy, and their values were assessed. Perception of improvement in phase 1 was 10–15 %, phase 2 was 15–20 %, and in phase 3 was 40–45 %. Maximum improvement was seen after the completion of phase 3 (Fig 2).

On polysomnographic analysis, we found significant improvement in arousal index, minimum Sa02, time duration SaO2 < 90 %, sleep efficiency, and total sleep time in N3 stage. The mean AHI of patients at the start of the therapy was 20.1 ± 9.1 (8.4–28.2) which reduced to 19.7 ± 9.4 (5.6–27.8) after 3 months of oropharyngeal exercise therapy which was statistically non-significant (*p* value 0.291). Reduction in AHI was found to be similar in both males and females (*p* value 0.156). The mean desaturation index at the start of the therapy was 10.9 ± 4.9 (3.1–22.1) which reduced to 10.3 ± 5.3 (2.6–21.9) after 3 months which was statistically non-significant (*p* value 0.075). The mean arousal index at the start of the therapy was 15.6 ± 9.5 (3.5–44.6) which reduced to 12.8 ± 7.1 (2.1–32.5) after 3 months of oropharyngeal exercise therapy. This decrease in the arousal index was found to be statistically significant (*p* value 0.013). The decrease of arousal index was found to be more in females (21.8 to 17.9) as compared to males (12.7 to 11.1) which was also statistically significant (*p* value 0.043). The mean minimum oxygen saturation at the start of the therapy was 87.6 ± 1.1 (86–90). It increased to 88.5 ± 1.6 (87–90) after 3 months which was statistically significant (*p* value 0.006). The increase of minimum oxygen saturation was significantly more in males (87.8 to 88.7) as compared to females (87.2 to 87.8) (*p* value 0.017).

Table 2 Changes in polysomnography analysis before and after oropharyngeal exercise therapy

	Before	After	*p* value
AHI	20.1 ± 9.1	19.7 ± 9.4	0.291
Desaturation index	10.9 ± 4.9	10.3 ± 5.3	0.075
% Total sleep time stage N3	0.97 ± 1.1	1.6 ± 1.5	0.009
Sleep efficiency (%)	87.3 ± 2.6	88.6 ± 3.1	0.003
MMS score	3	2	0.001
Sao2 < 90 %(min)	6.7 ± 6.6	5.1 ± 6.1	0.007
Arousal index	15.6 ± 9.5	12.8 ± 7.1	0.013

The mean value of time duration of oxygen saturation <90 % at the start of the therapy was 6.7 ± 6.6 min. It decreased to 5.1 ± 6.1 min at the end of 3 months of therapy which was a statistically significant value (*p* value 0.007). We also noted that the decrease in duration of oxygen saturation <90 % was more in males (6.5 to 4.4 min) compared to females (7.4 to 7.2) which was statistically significant (*p* value 0.004) (Fig 3, Table 2).

We also assessed for sleep parameters like sleep efficiency and total sleep time in the N3 stage of sleep. The mean sleep efficiency was calculated as the percentage of total sleep time to total bed time. The mean sleep efficiency was 87.3 ± 2.6 (78.5–90.2) at the start of therapy. It increased to 88.6 ± 3.1 (81–93) after 3 months of therapy which was statistically significant. An interesting finding noted was that the increase in sleep efficiency after oropharyngeal exercise therapy was significantly more in males (87.3 to 88.4) as compared to females (87.4 to 89)(*p* value 0.027).

The mean value of total sleep time in the N3 stage of sleep at the start of therapy was 0.97 ± 1.1 h, and it increased to 1.6 ± 1.5 h after 3 months of oropharyngeal therapy. This was statistically significant (*p* value 0.009). The increase in the total sleep time in the N3 stage of sleep was found to be more in males (1.0 to 1.5 h) as compared to females (0.86 to 1.64), and this was found to be statistically significant (*p* value 0.047) (Table 3, Fig 2).

We compared the parameters between males and females. Parameters which improved significantly more in males as compared to females were snoring intensity, witnessed apnoea, minimum oxygen saturation, SaO2 <90 %, sleep efficiency, and total sleep time stage N3. Parameters which

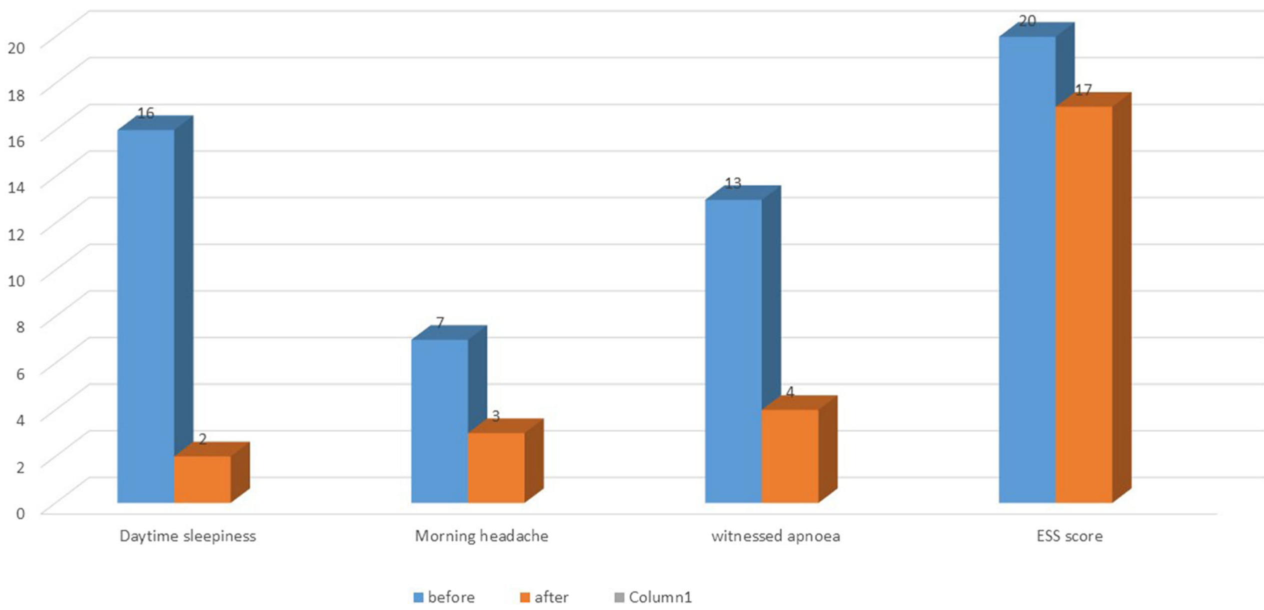

Fig 1 Clinical symptoms before and after 3 months of oropharyngeal excercise therapy

improved significantly more in females were neck circumference, arousal index, and snoring intensity.

Discussion

An oropharyngeal exercise is the new modality of treatment for OSAS which addresses the actual physiological cause of OSA. It has low risk and is cost-effective for the society. In the present study, we studied the effect of 3 months of oropharyngeal exercise therapy on OSAS patients. Among 100 suspected cases of OSAS who attended our outpatient department, only 20 patients completed 3 months of oropharyngeal exercise therapy and were included in the study.

The mean body mass index decreased after 3 months of oropharyngeal exercise therapy but was found statistically non-significant (p value 0.072). Guimaraes et al. also reported a similar result [16]. In contrast, there was significant decrease in neck circumference after 3 months of oropharyngeal exercise therapy (p value 0.004). We conclude that oropharyngeal exercise therapy has no effect on body mass index but does significantly reduce the neck circumference significantly.

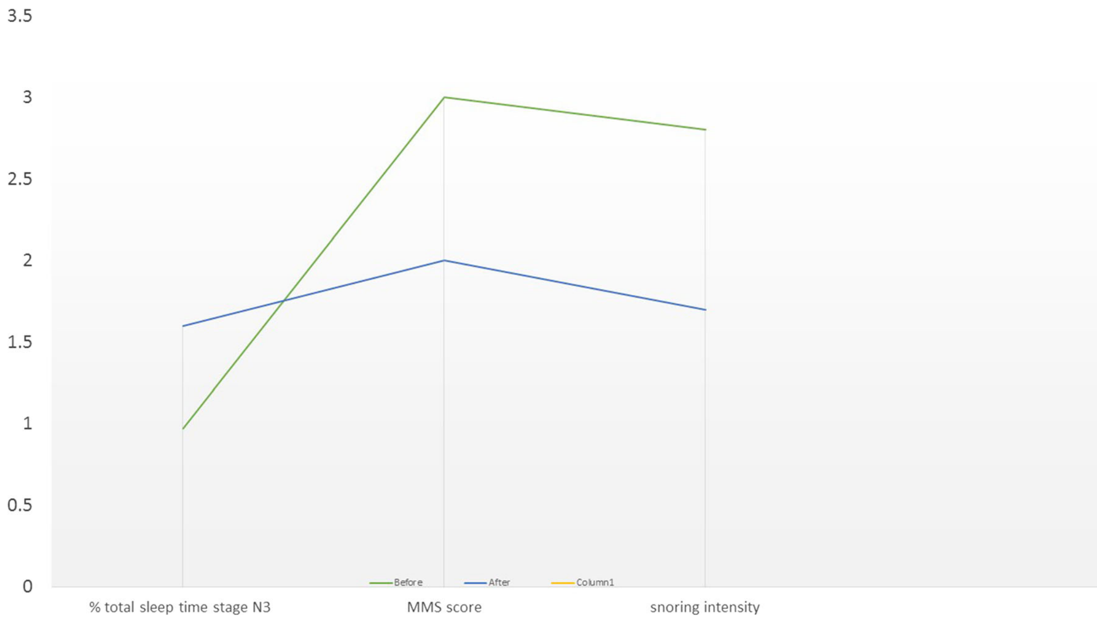

Fig 2 Sleep parameters before and after oropharyngeal exercise therapy

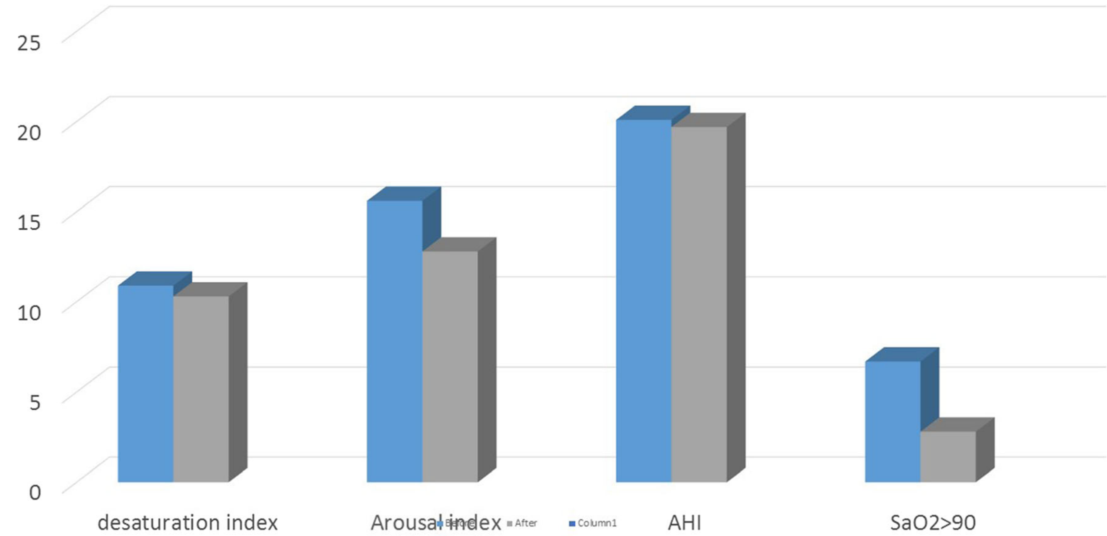

Fig 3 Polysomnographic findings before and after oropharyngeal exercise therapy

The symptom of daytime sleepiness, witnessed apnea, and morning headache improved after completion of 3 months of exercise therapy. This is in concordance with other studies in literature [16–18]. Thus, oropharyngeal exercise therapy leads to lesser sleep disturbance in the night, improving sleep efficiency which result in overall improvement in the quality of life. Oropharyngeal exercise therapy will help in reducing the impact of the OSAS on the ability to carry out daily activities efficiently.

Mean snoring intensity was also decreased after 3 months of oropharyngeal exercise therapy which was found to be statistically significant (*p* value 0.001). We also found reduction in the time and duration of nighttime snoring in OSAS patients. Other studies have also reported on significant reduction in snoring intensity in their studies [16–18]. Oropharyngeal exercises are effective in reducing not only the intensity of snoring significantly but also reduces the duration of nighttime snoring thus making it useful for co-partners in bed.

Table 3 Gender differences in parameters between males and females

Parameters	*p* value
Males	
Minimum oxygen saturation	0.017
Sao2 < 90 %	0.004
Snoring intensity	0.001
Sleep efficiency	0.027
Total sleep time stage N3	0.047
Witnessed apnoea	0.031
Eppworth score	0.002
Females	
Neck circumference	0.038
Arousal index	0.043

There was a statistically significant reduction in the mean Eppworth sleepiness score after completion of exercise at the end of 3 months in our study (*p* value <0.001). Similar results have also been reported in other studies [16, 18, 19]. However, an interesting finding noted in our study was that the reduction in the ESS score was found to be more in males as compared to females and this difference was found to be statistically significant (*p* value 0.002). This gender difference could be due to the fact that women generally have a milder sleep disorder compared to males in spite of having smaller airways [18].

In polysomnographic analysis, there was marginal decrease in AHI (*p* value 0.291) but we found significant reduction in mean arousal index (*p* value 0.013) after completion of oropharyngeal exercise therapy. Our result contradicts with the results from other studies reported in the literature who have reported statistically significant reduction in AHI after oropharyngeal exercise therapy [16, 18]. Another interesting observation we noted in our study was that the decrease in arousal index was found to be more in females as compared to males which was statistically significant (*p* value 0.043).

There was statistically significant increase in the mean minimum oxygen saturation after 3 months of therapy (*p* value 0.006). Significant improvement in mean value of time duration of oxygen saturation <90 % at the end of 3 months of therapy was also seen (*p* value 0.007). This correlates with results of a similar study done by Younis et al. [19].

We found statistically significant increase in sleep efficiency after three months of exercise therapy in OSAS (pvalue-0.003). This is in concordance with study by Guimaraesetal [16]. The increase in the percentage of sleep efficiency was found to be more in males as compared to females (*p* value 0.027). On review of literature, we found no study that has reported gender differences in sleep efficiency after oropharyngeal exercise therapy as we have reported in our study. The improvement in sleep efficiency would improve the quality of life and would also alter various psychological issues seen in patients of OSAS. It would also improve various hormonal disturbances which occur in OSAS.

Statistically significant increase in the percentage of total sleep time in the N3 stage of sleep was seen after 3 months of oropharyngeal exercise therapy (p value 0.009). Iber C et al. [20] has described that obstructive sleep apnea affects both REM and non-REM sleep. The increase in percentage of total sleep time in the N3 stage of sleep would correct neuroendocrine dysfunction of OSAS. On searching the world literature, we did not find any study on OSAS reporting on the percentage of sleep spent in the N3 stage of NREM after intervention.

Marginal decrease in mean desaturation index after 3 months of oropharyngeal exercise therapy was seen (p value 0.075). This is contradictory to the result by Younis et al. [19]who reported statistically significant decrease in mean desaturation index oropharyngeal exercise therapy (p value <0.001). We also assessed for the size of oral cavity by recording modified Mallampatti score. The Mallampatti score increased from grade 3 to grade 2 after 3 months of oropharyngeal exercise therapy. This was found to be statistically significant (p value 0.001).

One of the demerits of the Guimaraes et al. [16] study was that they were not able to conclude which set of exercises resulted in maximum benefit for the patients. In our study, since we categorized the exercises into three phases (phase 1, phase 2, phase 3) with graded level of difficulty and we administered questionnaires after each phase to denote which set of exercises yielded maximum benefit. We also recorded the responses of patients after each phase of exercise based on the percentage of improvement in the overall symptoms. This was to give an idea about which set of exercise regime is more satisfactory for the patient in relieving both symptoms and in terms of compliance. We found maximum improvement in phase 3 (40–45 %). We also found that males showed improvement in all the phases with phase 3 showing 40–45 % improvement. This could be due to fact that phase 3 exercises was more effective in increasing tone of oropharyngeal muscles and moreover after 2 months of oropharyngeal exercise therapy patients became more compliant with exercise regimen. But females perceived maximum benefit only after phase 1 and phase 3 exercises and not from phase 2. No study in the literature has standardized the exercises into phases as we have done in our study. In this way, we increased the patients understanding and compliance of the oropharyngeal exercises.

Thus, in our study, we conclude that oropharyngeal exercise is a promising option to treat mild and moderate OSA patients which are more economical, compliant, and may provide benefits.

Conclusion

The results of our study revealed that oropharyngeal exercises causes various effects in the treatment of mild to moderate obstructive sleep apnoea syndrome. They are the following:

- They reduced neck circumference of the patients significantly.
- They improved symptoms like daytime sleepiness, witnessed apnoea, and snoring intensity
- They caused significant improvement in sleep indices like minimum oxygen saturation, Sao2 < 90 %, sleep efficiency, arousal index, and total sleep time N3 stage of sleep.
- Percentage of subjective satisfaction was more after the completion of phase 3 exercises.

We can conclude from this study that oropharyngeal exercises can achieve subjective improvement in OSAS symptoms and their polysomnographic abnormalities in patients with mild to moderate OSAS and so can be considered as an alternative method of treatment of mild to moderate OSAS.

Compliance with ethical standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria, educational grants, participation in speakers' bureaus, membership, employment, consultancies, stock ownership or other equity interest, and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript.

Disclosures There is no conflict of interest or financial disclosure to be made.

Informed consent Informed consent was obtained from all individual participants included in the study.

Human and animal rights This article does not contain any studies with animals performed by any of the authors.

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