ARTICLE IN PRESS

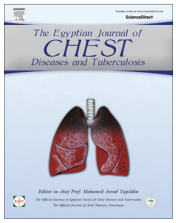
Egyptian Journal of Chest Diseases and Tuberculosis (2016) xxx, xxx–xxx

HOSTED BY

The Egyptian Society of Chest Diseases and Tuberculosis

Egyptian Journal of Chest Diseases and Tuberculosis

www.elsevier.com/locate/ejcdt
www.sciencedirect.com



ORIGINAL ARTICLE

Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome

Ahmed Sh. Mohamed [a], **Ragia S. Sharshar** [a,*], **Reham M. Elkolaly** [a], **Shaimaa M. Serageldin** [b]

[a] *Chest Department, Faculty of Medicine, Tanta University, Egypt*
[b] *Phoniatrics Unit, ENT Department, Faculty of Medicine, Tanta University, Egypt*

Received 11 August 2016; accepted 30 August 2016

KEYWORDS

OSAS;
Pharyngeal exercises;
Polysomnography

Abstract *Background:* Obstructive sleep apnea syndrome (OSAS) is an important disease that represent a challenge for both patients and physicians to reach optimum choice for treatment mostly because genesis of OSAS is multifactorial. Upper airway muscle function plays a major role in maintenance of the upper airway patency especially during sleep. Oropharyngeal exercises may be an effective treatment option for OSAS.

Objective: Aim of this study was to evaluate upper airway muscle exercise as method to treat OSAS.

Patients and methods: 30 patients divided into 2 groups; Group I moderate OSAS and Group II: severe OSAS patients. Follow up, as regard ESS, AHI, oxygen saturation and snoring was done after 3 months of oropharyngeal exercises.

Results: After end of study, daytime sleepiness and AHI improved significantly in group I (moderate OSA) 13 out of 15 patients shifted from moderate to mild OSAS. There was significant decrease in oxygen desaturation and snoring index. As for group II, there was decrease but not significant change in same parameters. Only for moderate OSAS, there was, significant decrease in neck circumference, which inversely correlated with changes in AHI ($r = 0.582$; $P < 0.001$).

Conclusion: Upper airways exercises can be a novel easy non invasive technique to improve AHI, O2 saturation and snoring thus used in treatment of OSAS patients mainly moderate type.

Introduction

Obstructive sleep apnea syndrome (OSAS) is an important problem facing many physicians because of its symptoms, complications and difficult management. That syndrome is characterized by repetitive episodes of upper airway collapse

* Corresponding author.
E-mail address: ragia_sharshar@yahoo.com (R.S. Sharshar).
Peer review under responsibility of The Egyptian Society of Chest Diseases and Tuberculosis.

http://dx.doi.org/10.1016/j.ejcdt.2016.08.014

Please cite this article in press as: A.S. Mohamed et al., Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome, Egypt. J. Chest Dis. Tuberc. (2016), http://dx.doi.org/10.1016/j.ejcdt.2016.08.014

and occlusion during sleep associated with sleep fragmentation, hypoxemia and daytime hypersomnolence [1].

The etiology of OSAS is not sharply known to physicians; they studied neuromuscular abnormalities of upper airway in addition abnormal anatomical factors (e.g., tongue volume, tonsils enlargement, soft palate length, position of mandible and maxilla) which all contribute in the pathogenesis of OSAS [2,3].

Physicians tried to treat OSA to reduce patients suffering and ameliorate their quality of life; they used invasive and non-invasive maneuvers, e.g., most appropriate one is continuous positive airway pressure that is used usually because of it is easy, available and effective particularly in moderate and severe cases of OSAS especially if associated with snoring and hypoxemia [4]. Inspite of long history of CPAP usage, many patients don't prefer it because of noise, uncomfortableness, air leak and irritation of eyes and nose [4].

Other modalities for treating OSA include intra-oral appliances, mandibular advanced splint sand tongue retainer, to keep upper airway patent during sleep, they are usually preserved for mild to moderate OSAS [5].

Although decreasing body weight by either by diet or surgery usually contribute to decrease severity of sleep apnea, it needs relatively long time to reach ideal weight and also OSA relapse again in some patients regardless weightgain [6].

Uvulopalatopharyngplasty, maxillomandibular advancement, radiofrequency ablation of palate and tracheotomy are examples of surgical techniques used for management of OSA, they are used for patients after precise detection of site where obstruction occurs [7–10].

Surgery is effective, improves apnea and snoring, but it needs long time follow up, has many complications Unfortunately, the effectiveness of these surgeries decrease by age [11].

Most of previously mentioned methods not curing the disease itself, in addition, patients compliance to them is poor because of ignorance, side effects or high cost [12].

More than muscle group are responsible for patency of airways; tonicity of dilator muscles of upper airway counteract the collapsibility caused by negative transmural pressure, so they play important role in maintaining the upper airway open especially during sleep [13].

The muscles of pharyngeal wall, tongue and soft palate are the main structures that enrolled in these exercises and they are responsible for chewing, speech, breathing and swallowing. Protocol of these exercises emerged from that of speech muscle therapy that improve the function and performance of upper respiratory tract through repetitive isotonic and isometric exercise, aiming to increase movability and tension (tonicity) of these muscles to prevent airway closure particularly during sleep [12,14].

Therefore, it is important to search for other method that accurately treat OSAS especially moderate type that contribute to a high percentage of patients suffering from sleep apnea[12]. So Physicians tried previously to study efficacy of upper airway muscles exercise as method for treating moderate OSA and snoring [2].

Aim of the study

The aim of this study is to evaluate the effect of upper airway muscle exercise and rehabilitation as a new and simple technique to treat OSAS mainly moderate type.

Patients

After fulfilling entry criteria, from 36 patients, recruited from Chest Department in Tanta University Hospital in period from April 2015 to October 2015 only 30 patients completed the study. Patients were divided into 2 groups;

1- Group I: 15 moderate degree OSAS adult patients.
2- Group II: 15 severe degree OSAS adult patients.

Follow up of 2 groups after 3 months of oropharyngeal exercises.

Inclusion criteria

Patients with OSA (apnea hypopnea index 15–30 for group 1, AHI > 30 events/hour for group 2, together with at least two symptoms of OSA:(snoring, fragmented sleep, witnessed apneas, morning headache and daytime sleepiness).

Exclusion criteria

One or more of the following conditions:

- Age more than 50 years old.
- Obesity BMI 40 kg/m^2 or greater.
- Current or planned intervention for weight reduction.
- Craniofacial malformations, physical obstruction in nose or throat, abnormally large tonsils, uncorrected deviated septum.
- The presence of any neurological or psychiatric diseases.
- Regular use of alcohol/drugs known to affect sleep or daytime sleepiness as antidepressants, hypnotics.
- Hypothyroidism, previous stroke, neuromuscular disease, heart failure, coronary disease.

All patients gave written informed consent.
For all patients, the following was done:

1. Detailed personal and medical history with special emphasis on symptoms of OSAS as snoring, witnessed apneas, and excessive daytime sleepiness.
2. Subjective evaluation of daytime sleepiness, subjects was evaluated using Epworth Sleeping Scale (ESS) [15].
3. Thorough clinical evaluation including: height and weight to measure body mass index (BMI), neck circumference, and upper airway examination to exclude space occupying lesions in nose and mouth and dental examination (teeth and gum).
4. Complete overnight polysomnography for objective diagnosis of OSA and repeated after 3 months of oropharyngeal exercises.
5. Upper Airways exercises including variety of training strategies.

Polysomnography

All patients were evaluated by full polysomnography using (SOMNO screen™ plus PSG+, Germany) which was performed at the sleep laboratory of Tanta University Hospital.

Please cite this article in press as: A.S. Mohamed et al., Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome, Egypt. J. Chest Dis. Tuberc. (2016), http://dx.doi.org/10.1016/j.ejcdt.2016.08.014

PSG included electroencephalogram (EEG), was performed using four-channel EEG (C3, C4, O1, and O2) referred to linked earlobes. (C3-A2, C4-A1, O1-A2, O2-A1); Right and left electrooculogram (EOG), Submental chin electromyogram (EMG), heart rate and electrocardiogram (ECG). Thoracic and abdominal belt with body position sensor inbetween, Nasal canula, snoring microphone were used to monitor respiration, finger pulse oximeter was used to measure oxygen saturation.

PSGs were scored manually for sleep stages according to criteria of the American Academy of Sleep Medicine (AASM) [16].

Apnea-hypopnea index (AHI) was calculated by apneas and hypopneas per hour of sleep. Patients were classified as: moderate OSAS: AHI between 15–30 events per hour sleep. While severe OSAS: AHI $\geqslant$ 30event per hour sleep [16].

Questionnaire

Subjective daytime sleepiness was evaluated with Epworth questionnaire that evaluates the propensity to sleep from no (0) to intense (3) in eight different situations. Total score $\geqslant$ 12 considered excessive daytime sleepiness.

Polysomnography and questionnaires were performed at the beginning and end of study. The primary outcome was AHI. Secondary outcomes: oxygen saturation and snoring.

Oropharyngeal exercises

Oropharyngeal exercises included tongue, soft palate, and facial muscle exercises as well as stomatognathic function exercises. The patients were instructed by one single speech pathologist to perform the following tasks.

The exercises were given to patients on 3 months period. All patients were evaluated once a week for 30 min. All patients had to fill a diary recording compliance to exercises (yes or no). Exercises regularly at home 3–5 times per day with minimum 10 min for each time.

Adequate compliance was defined by performance of 85% or more of exercises. Patients who failed to return for 3 consecutive weeks or failed to comply with exercises at home were excluded from the study.

The oropharyngeal exercises included:

1- Push tip of tongue against hard palate and slide tongue backward (20 times);
2- Suck the tongue upward against palate, pressing entire tongue against palate (20 times);
3- Force tongue back against mouth floor while keeping tongue tip in contact with inferior incisive teeth (20 times);
4- Elevation of soft palate and uvula while intermittently saying vowel "A" (20 times). After gaining control and coordination of movement (after 3–5 weeks), elevation done without vocalization for 5 s;
5- Recruitment of buccinator muscle against the finger that is introduced in oral cavity, pressing buccinator muscle outward (10 times each side);
6- Alternate bilateral chewing and deglutition using tongue in palate, without perioral contraction, whenever feeding. The patients were instructed to incorporate this mastication pattern whenever they were eating.

Statistical analysis

- All Data were statistical analyzed using SPSS (Statistical Package for Social Sciences) version 10.
- Normally distributed data was presented as mean ± SD.
- Baseline characteristics of patients with OSAS and differences between baseline and follow-up between groups were compared by using a two sample *t* tests.
- In addition, we performed Pearson correlations between changes in AHI with changes in neck circumference.
- $P < 0.05$ was considered to be statistically significant.

Results

After fulfilling inclusion criteria, from 36 OSAS patients, six patients were excluded due to low adherence.

30 patients included in final analysis were predominantly men, aged 46.39 ± 2.04 and 47.5 ± 9 years old in groups I, II respectively, overweight or obese. They had excessive daytime sleepiness (mean Epworth scores 14 ± 6 in group I and 20.9 ± 6.2 in group II). They had average AHI of 22.51 ± 5.03, 46.1 ± 21.1 in group I and II respectively (Table 1).

Patients treated with oropharyngeal exercises in group I (moderate OSA) had significant decrease in neck circumference after 3 ms (Table 2). In group II, there was decrease but not significant change in neck circumference (Tables 2 and 3).

The primary outcome (daytime sleepiness as measured by ESS) improved significantly in group I (moderate OSA), also a significant decrease in AHI occured in group I. In this group, 13 out of 15 patients shifted from moderate to mild OSAS. (Table 2).

There was significant decrease in desaturation index and TST% $SaO_2 < 90$, and significant improvement of minimal oxygen saturation, %, in group I after ttt, also there was significant decrease in Snoring index and TST% loud snoring (snorie episodic %TST) in group I, after ttt (Table 2).

As for group II, after oropharyngeal exercises, there was decrease but not significant change in ESS and AHI (Table 3).

As regard, minimal oxygen saturation, desaturation index and TST% $SaO_2 < 90\%$,also Snoring index and TST% loud snoring (snorie episodic %TST). In group II, there was decrease but not significant change after oropharyngeal exercises, (Table 3).

After 3 months, Changes in neck circumference correlated inversely with changes in AHI in group I ($r = 0.582$; $P < 0.001$). (Table 4).

Table 1 Demographic characteristics of participants, and baseline values of outcomes.

Variable	Group I (mean ± SD)	Group II (mean ± SD)
Age	46.39 ± 2.04	47.5 ± 9
Sex (m/f)	12/15	13/15
BMI	28.62 ± 1.86	27.2 ± 2.03
Neck circumference (cm)	39.65 ± 3.52	43.02 ± 2.06
ESS	14 ± 6	20.9 ± 6.2
AHI	22.51 ± 5.03	46.1 ± 21.1

Please cite this article in press as: A.S. Mohamed et al., Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome, Egypt. J. Chest Dis. Tuberc. (2016), http://dx.doi.org/10.1016/j.ejcdt.2016.08.014

Table 2 Anthropometric, questionnaires, polysomnographic characteristics at baseline and after oropharyngeal exercises in group I.

Variable	Group I (baseline)	Group I (after ttt)	*P* value
Neck circumference (cm)	39.65 ± 3.52	38.92 ± 2.92	< 0.001
ESS	14 ± 6	9.5 ± 4.9	< 0.001
AHI	22.51 ± 5.03	12.4 ± 5.12	< 0.001
Lowest SaO_2%	83 ± 4	86 ± 5	< 0.001
Desaturat. Index	24.6 ± 3.9	16.7 ± 4.7	< 0.001
%TST SaO_2 < 90%	10.7 ± 5	6.4 ± 3.9	< 0.001
Snoring index	312 ± 8.8	237.8 ± 27.4	< 0.001
%TST loud Snoring (snore episodic %TST)	20.5 ± 1.27	13 ± 1.53	< 0.001

Table 3 Anthropometric, questionnaires, polysomnographic characteristics at baseline and after oropharyngeal exercises in group II.

Variable	Group II (baseline)	Group II (after ttt)	*P* Value
Neck circumference (cm)	43.02 ± 2.06	42.86 ± 1.87	> 0.05
ESS	20.9 ± 6.2	18.91 ± 5.1	> 0.05
AHI	46.1 ± 21.1	42.8 ± 15.65	> 0.05
Lowest SaO_2%	75 ± 5.8	78 ± 4.9	> 0.05
Desaturat. Index	77 ± 6	71 ± 5.1	> 0.05
%TST SaO_2 < 90%	69 ± 4.9	58 ± 4.1	> 0.05
Snoring index	615 ± 96.8	554.6 ± 81.43	> 0.05
%TST loud snoring (snorie episodic%TST)	56.5 ± 9.67	51.5 ± 8.96	> 0.05

Table 4 Correlation of changes of AHI with changes of neck circumference.

	Changes in AHI	
	R	P
Changes in neck circumference (cm)	0.582	< 0.001

Discussion

Pathogenesis of OSA is multifactorial both anatomical and physiological factors affecting it [2]. Pharyngeal patency during breathing mainly achieved by synchronized action of upper airway and thoracic respiratory muscles together. The tendency for pharyngeal lumen to collapse during inspiration by effect of thoracic negativity is opposed by upper airway muscles contraction (dilatorsandharyngeal lumen regulators, [17].

The goal of OSAS treatment is to restore optimal breathing during night improve symptoms and decreasing complications [12,18]. Myofunctional therapy includes functional exercises (respiratory, suction, swallowing and chewing), aim is to improve tonus and mobility of oral and cervical structures [12,14].

At the end of study we found, there was decrease in neck circumference which was significant only in moderate OSA (group I) not for in severe OSA (group II). These changes in neck circumference can be due to effect of exercises on upper airway remodeling. This results was in accordance with the study of Guimaraes, who concluded that use of group oropharyngeal exercises for OSA reduced AHI by 39% and significantly reduced neck circumference also [12].

After Oropharyngeal exercises the primary outcome of study: daytime sleepiness (ESS) improved significantly in moderate OSA (group I), also there was significantly reduced severity of OSAS evaluated by AHI in group I only. In this group, 13 out of 15 patients shifted from moderate to mild OSAS. For severe OSA (group II) there was decrease but not significant change in ESS and AHI.

The significant OSAS severity improvement by Oropharyngeal exercises in moderate OSAS was accompanied by reduction in desaturation index and TST% SaO_2 < 90, and minimal oxygen saturation, %, and also significant Snoring index and TST% loud snoring (snorie episodic%TST)in moderate OSA (group I) after ttt.

The same occurred in severe OSA (group II) but the decrease in minimal oxygen saturation, desaturation index and TST% SaO_2 < 90%, Snoring index and TST% loud snoring (snorie episodic%TST)was not significant.

These results was in accordance with many other studies, whose confirmed that upper airway exercises can achieve subjective and objective improvement of symptoms, daytime sleepiness, sleep quality and PSG abnormalities in mild to moderate [12,14].

The explanation of this effect of oropharyngeal exercises on improving OSA may be due to decrease upper airway edema and collapsibility that also improved tongue position and overcome the bad action of long floppy soft palate and uvula mostly present in OSA. Also exercises has positive effect on facial muscles contractility during chewing and training muscles to elevate mandibule and hyoid bone to avoid mouth opening [14,19].

Many authors supported same explanations such as Puhan et al. who explained that reduction of in AHI ($P = 0.05$) by using didgeridoo playing for 4 months indicated that collapsibility of the upper airways decreased [20]. Also Carrera et al. reported that snoring and OSA patients have a prevalence of type 11 muscle fiber, due to inflammatory trauma promoted by vibration, affecting and decreasing the myofunction of upper airway [21,22]. Blottner et al. stated that, main methods to increase upper airway muscle tone was to gain both endurance and strength. So improvement in OSA manifestation was due to improvement of muscle tone by exercises as manifested by increase in type 1 muscle fibers (type 1 having endurance) and in size of type 11 muscle fibers (type 11 having speed capability) [23,24].

Please cite this article in press as: A.S. Mohamed et al., Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome, Egypt. J. Chest Dis. Tuberc. (2016), http://dx.doi.org/10.1016/j.ejcdt.2016.08.014

The limitation of our study is the small number of study population also exercises depended on patients compliance at home without direct observation by speech pathologist. Another 2nd part study with much longer time (another 3 months) of exercises may be beneficial, adding better results and much improvement of OSAS degree especially in severe cases group.

In conclusion, in our case series, we reported that myofunctional therapy includes upper airways exercises is a new and simple technique to improve ESS, AHI, O2 saturation and snoring which has good both subjective and objective effect on OSAS patients mainly moderate type.

Conflict of interest

There is no conflict interest.

References

[1] J.M. Marin, S.J. Carrizo, E. Vicente, A.G. Agusti, Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: observational study, Lancet 365 (2005) 1046–1053.
[2] A.R. Schwartz, S.P. Patil, A.M. Laffan, V. Polotsky, H. Schneider, P.L. Smith, Obesity and obstructive sleep apnea: pathogenic mechanisms and therapeutic approaches, Proc. Am. Thorac. Soc. 5 (2008) 185–192.
[3] D.P. White, The pathogenesis of obstructive sleep apnea: advances in the past 100 years, Am. J. Respir. Cell Mol. Biol. 34 (2006) 1–6.
[4] D.B. Pitta, A.F. Pessoa, A.L. Sampaio, R.N. Rodrigues, M.G. Tavares, P. Tavares, Oral myofunctional therapy applied on two cases of severe obstructive sleep apnea syndrome, Int. Arch. Otorhinolaryngol 11 (2007).
[5] A.S. Chan, K. Sutherland, R.J. Schwab, B. Zeng, P. Petocz, R. W. Lee, M.A. Darendeliler, P.A. Cistulli, The effect of mandibular advancement on upper airway structure in obstructive sleep apnoea, Thorax 65 (2010) 726–732.
[6] D.C. Cowan, E. Livingston, Obstructive sleep apnoea syndrome and weight loss: review, Sleep Disord. 2012 (2012) 163296.
[7] J.R. Prinsell, Maxillomandibular advancement surgery for obstructive sleep apnea syndrome, J. Am. Dent. Assoc. 133 (2002) 1489–1497, quiz 1539–1440.
[8] L.J. Epstein, D. Kristo, P.J. Strollo, et al, Adult obstructive sleep apnea task force of the American Academy of Sleep, Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults, J. Clin. Sleep Med. 5 (2009) 263–276.
[9] R.N. Aurora, K.R. Casey, D. Kristo, S. Auerbach, et al, American Academy of Sleep, Practice parameters for surgical modifications of the upper airway for obstructive sleep apnea in adults, Sleep 33 (2010) 1408–1413.
[10] W. Carroll, C.S. Wilhoit, J. Intaphan, S.A. Nguyen, M.B. Gillespie, Snoring management with nasal surgery and upper airway radiofrequency ablation, Otolaryngol. Head Neck Surg. 146 (2012) 1023–1027.
[11] L. Spicuzza, D. Caruso, G. Di Maria, Obstructive sleep apnoea syndrome and its management, Ther. Adv. Chronic Dis. 6 (2015) 273–285.
[12] K.C. Guimaraes, L.F. Drager, P.R. Genta, B.F. Marcondes, G. Lorenzi-Filho, Effects of oropharyngeal exercises on patients with moderate obstructive sleep apnea syndrome, Am. J. Respir. Crit. Care Med. 179 (2009) 962–966.
[13] J.S. Valbuza, M.M. Oliveira, C.F. Conti, L.B. Prado, L.B. Carvalho, G.F. Prado, Methods to increase muscle tonus of upper airway to treat snoring: systematic review, Arq. Neuropsiquiatr. 66 (2008) 773–776.
[14] C. Guilleminault, Y.S. Huang, P.J. Monteyrol, R. Sato, S. Quo, C.H. Lin, Critical role of myofascial reeducation in pediatric sleep-disordered breathing, Sleep Med. 14 (2013) 518–525.
[15] M.W. Johns, A new method for measuring daytime sleepiness: the Epworth sleepiness scale, Sleep 14 (1991) 540–545.
[16] C. Iber, S. Ancoli-Israel, A. Chesson, et al, The AASM Manual for Scoring of Sleep and Associated Events: Rules, Terminology, Technical Specifications, American Academy of Sleep Medicine, Westchester, IL, 2007, pp. 17–18.
[17] R. Tauman, D. Gozal, Obstructive sleep apnea syndrome in children, Exp. Rev. Respir. Med. 3 (2011) 425–440.
[18] S.L. Marcus, Diagnosis and management of childhood obstructive sleep apnea syndrome. Clinical practise guideline, Pediatrics 130 (2012) 576–584.
[19] L. Kheirandish-Gozal, D. Gozal, Sleep Disordered Breathing in Children. A Comprehensive Clinical Guide to Evaluation and Treatment, Humana Press, 2012.
[20] M.A. Puhan, A. Suarez, cl Cascio, et al, Didgeridoo playing as alternative treatment for obstructive sleep apnea syndrome, BMJ 332 (2005) 266–270.
[21] A.R. Schwartz, L. Patil, A.M. Laffan, et al, Obesity and QSA: pathogenic mechanism and therapeutic approaches, Proc. Am. Thorac. Soc. 5 (2008) 185–192.
[22] M. Carrera, E. Babe, J. Sauleda, Effect of obesity upon genioglossus structure and function in obstructive sleep apnea, Eur. Respir. J. 23 (2004) 425–429.
[23] K.L. Chiu, C.M. Ryan, S. Shiota, et al, Fluid shift by lower body positive pressure increases pharyngeal resistence in healthy subjects, Am. J. Respir. Crit. Care Med. 174 (2006) 1378–1383.
[24] D. Blottner, A. Salavnova, B. Butmarin, Human skeletal muscle structure and function preserved by vibration muscle exercises following 55 days of bed rest, Eur. J. Appl. Physiol. 97 (2006) 261–271.

Please cite this article in press as: A.S. Mohamed et al., Upper airway muscle exercises outcome in patients with obstructive sleep apnea syndrome, Egypt. J. Chest Dis. Tuberc. (2016), http://dx.doi.org/10.1016/j.ejcdt.2016.08.014