CASE REPORT

Sleep Science

Lip muscle training improves obstructive sleep apnea and objective sleep: a case report

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ABSTRACT

The present study assessed the potential of lip muscle training for improving sleep. A patient with heavy snoring, daytime sleepiness and dry mouth underwent lip muscle training. Lip closure force LCFmax increased by 67.3% and LCFmin by 152% post-training. AHI decreased from 12.2 to 3.9 events/h by reducing hypopneic episodes. TST, sleep stage N3 and REM sleep increased, and WASO, sleep stage N1, and AI decreased. The patient switched from mouth to nose breathing during sleep and stopped snoring. Improved LCF, by moving the tongue into the anterior-superior oral cavity, may increase upper airway space and reduce the hypopnea index.

Keywords: Myofunctional Therapy. Apnea. Mouth. Polysomnography.

INTRODUCTION

Dry mouth on awakening is associated with increased severity and risk of Obstructive Sleep Apnea (OSA) by 2.33 fold compared to primary snoring[1]. Continuous positive airway pressure (CPAP) is highly effective in preventing upper airway collapse, but patient acceptance and adherence is often low. Oral appliances designed to improve upper airway configuration prevent collapse by altering jaw and tongue positions, holding the lower jaw more anteriorly. A mandibular advancement device (MAD) fixes the mandible in a forward position, and is non-invasive compared to surgery and more convenient to use than CPAP. Such devices are unsuitable for individuals with few/no teeth; teeth are needed for fixation. Moreover, use of a MAD can cause tooth discomfort[2] and temporomandibular joint pain[3]. Long-term use results in changes to the bite[4].

Oral myofunctional therapy (OMFT) has proven beneficial in treating OSA. For example, oropharyngeal exercises that consisted of isometric and isotonic exercises involving the tongue, soft palate, and lateral pharyngeal wall significantly reduced subjective sleepiness, subjective sleep quality, snoring symptoms and neck circumference[5], and improved the quality of life whether applied alone or in association with CPAP[6]. Lip muscle training by way of a lip trainer mouth piece, as a form of OMFT, significantly decreases the AHI by strengthening the lip muscles and increasing lip closure force (LCF)[7]. However, the benefits of OMFT on objective sleep quality have not been investigated. We present a case report of a patient who showed improvements in objective sleep and sleep apnea after training.

Case report

A 20-year-old woman (body mass index, 18.6 kg/m^2) complaint of heavy snoring, daytime sleepiness and dry mouth following waking. Occlusion was normal without stomatognathic abnormalities or disorders in the maxillomandibular joint. The patient had a history of bacterial endocarditis, childhood asthma and allergic rhinitis. She was a mouth breather at night, but had no history of smoking or gastroesophageal tract problems.

A MAD was routinely applied, but was discontinued due to temporomandibular joint pain. Given the coexisting dry mouth and OSA[8], OMFT was implemented using an M-Patakara® lip trainer (Patakara, Tokyo, Japan) made from flexible, resilient plastic and rubber (Figure 1). LCF, LCFmax and LCFmin, obtained in a 10-s period, were reported as the mean of 3 measurements with a lip device (BHC-V01; Patakara Tokyo). In accordance with the supplied instructions for use of the Patakara® (Table 1), training involved 4 sessions/day, 5 min/session for 2 months. LCF data showed large improvements following training (Table 2).

Full diagnostic polysomnography (Alice PDx; Respironics, USA) was conducted once before (April 2015) and after OMFT (June 2015). Both tests were done under the same temperature condition (in the same hospital sleep laboratory) and the tests were run by the same clinical laboratory technician. Sleep data were scored according to AASM guidelines[9].

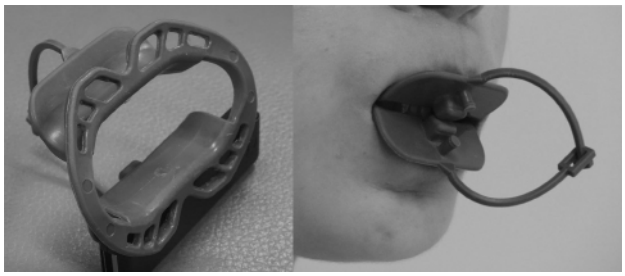

Figure 1. Lip muscle training with the Lip trainer Patakara® Insert the device between teeth and lips. Press lips on the mouthpiece without teeth contact.

Table 1. Instructiou.s for u sins Patakara.

1)	Close the mouthpiece and insert into the oral vestibule between the upper and lower lips.
(2)	When the lips are closed, they should be in contact with the projections on the upper and lower sides of Patakara.
(3)	At this time, it is best to close the lips without clenching the teeth for about 5 minutes.
(4)	The tip of the tongue touches inicisive papilla between the lip closed training.
(5)	With the lips closed, carry out stretching movements by pulling the plastic tabs on the front of the mouthpiece 10 times each to the front, upper and lower sides, and right and left sides.
(ó)	At this time, the hps should be kept firmly closed to prevent Pataleara from coming out of the mouth.
(7)	Each treatment session consists of these two actions (taking about 5 minutes); rehabilitation is carried out 4 times per day or more.

Table 2. Sleep data before and after training

	Before training	After training	% Change
Lip closure force max (N)	4.9	8.2	67.3
Lip closure force min (N)	2.5	6.3	152.0
Total sleep time (min)	338.0	476.0	40.8
WASO (min)	98.5	28.5	-71.1
Sleep latency (min)	0.0	0.0	0
stage REM (%TST)	19.4	19.9	2.6
stage N1 (%TST)	30.2	8.9	-70.5
stage N2 (%TST)	39.1	58.6	49.9
stage N3 (%TST)	11.4	12.6	10.5
Arousal index (times/h)	27.9	11.7	-27.9
Apnea hypopnea index (events.h^{1})	12.2	3.9	-68.0
Apnea index (times/h)	2.1	2.3	9.5
Hypopnea index (times/h)	10.1	1.6	-84.2
Sp02 90%>	90	92	2.2
Snoring rate (%TST)	29.4	19.5	-33.6

RESULTS

Mild OSA was diagnosed. Lip muscle training decreased the AHI and hypopnea index. Training decreased the snoring rate and improved sleep quality and quantity (Table 2). The patient spent more time sleeping (TST) due to decreased wake time after sleep onset (WASO), and experienced fewer arousals from sleep (arousal index). Improved sleep quality was reflected by

increased times spent in both REM sleep and stage N3. OMFT vastly reduced stage N1 and returned N1 to near-normal levels (from 30.2 to 8.9 %TST). N2 increased substantially to that of regular sleepers (Table 2). The patient changed from mouth to nose breathing during sleep and ceased snoring following OMFT, as reported by her partner.

DISCUSSION

In this case report of a patient with mild OSA, we showed that OMFT markedly decreased the AHI and hypopnea index, improved objective sleep and subjective symptoms of snoring and dry mouth.

OMFT increases LCFmax and LCFmin, suggesting improved lip muscle strength. The marked drop in the hypopnea index (10.1 to 1.6 events/h) but minimal change in apnea index (2.1 to 2.3 events/h) suggest an increased airway dimension/decreased airway resistance that may involve movement of the tongue into the anterior-superior oral cavity with lip closure, as the lip muscles are strengthened. Ishikawa et al.[10] showed that effective muscle strengthening was directly due to isometric training with the M-Patakara lip trainer that placed a direct load on the muscles especially the orbicularis oris and buccinator muscles.

In addition, Konishi[11] reported that strengthened mouth closure force along with coordinated contraction of the genioglossus and geniohyoid muscles reflexively moved the tongue forward during sleep. Lip muscle training prevented the base of the tongue from sagging which was expected to relieve snoring and OSA.

However, we have not recorded electromyogram or other indices from the orbicularis oris muscle to confirm our findings. We should investigate it based on this phenomenon in the future. It should be emphasized that regular lip muscle training is necessary, since muscle disuse will lead to detraining effects. Further research is also needed to demonstrate increases in airway dimensions or decreases in airway resistance.

The SpO_2 improvement was small, with a 2% increase. This small increment was not surprising, since the patient suffered from mild OSA. This improvement was unlikely to be influenced by changes in sleeping positions. The patient spent 63.9% of the sleep time in the supine position in the first PSG test and 58.2% following lip muscle training, whereas improvements in AHI and hypopneic index were 68% and 84% respectively (Table 2).

Importantly, the patient no longer experienced dry mouth on awakening. According to Oksenberg et al.[1], experiencing dry mouth upon awakening almost always was a common symptom in OSA patients referred for polysomnographic evaluation. In our opinion, the most plausible explanation for the increased frequency of dry mouth complaint was the sleep time spent with an open mouth. On the other hand, Izuhara et al.[12] reported that allergic rhinitis, a known risk factor for asthma onset, was often accompanied by mouth breathing and dry mouth. Mouth breathing may bypass the protective function of the nose and is anecdotally considered to increase asthma morbidity. However, it is unlikely that rhinitis caused the dry mouth in this patient, since she grew out of rhinitis at a young age. Thus dry mouth was no longer experienced following OMFT, which resulted in mouth closure during sleep.

A strong link between dry mouth and OSA has been noted. Hochberg et al., in an elderly population, found a prevalence of 11.5% complained of dry mouth most noticeable upon awakening[13]. Additionally, Kales et al.[14] reported complaints of dry throat on awakening in 37 of 50 patients (74%) with severe OSA. Sleep improvements observed in this study may be explained by an absence of dry mouth during the sleep period. Although it is known that sleep variability may occur from night to night[15], the consistent pattern of change with all sleep parameters (Table 2) suggested that sleep improvements were the results of lip muscle training. Notably, we observed an improvement in TST of 40.8%, whereas there was no reported significant first-night effect for the TST value[15,16].

The current findings suggest that OMFT may offer an alternative treatment in cases of mild OSA. Given that the results are those of a case report, future clinical trials to establish the efficacy of this modality may prove enormously beneficial, since OMFT (through regular lip muscle training) is cheap and easily implemented.

In conclusion, OMFT in this patient with mild OSA markedly decreased the AHI and hypopnea index, and improved objective sleep and subjective symptoms of snoring and dry mouth.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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