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

Hiroshi Suzuki 1
Mayuko Yoshimiura 1
Yoshihiro Iwata 1
Sumito Oguchi 2
Misao Kawara 1
Chin-Moi Chow 3

1 Nihon University School of Dentistry at Matsudo, Department of Oral Function and Rehabilitation, Matsudo, Japan.
2 Nihon University School of Dentistry at Matsudo, Department of Internal Medicine - Matsudo, Japan.
3 Faculty of Health Sciences, The University of Sydney, Discipline of Exercise and Sport Science - Sydney, Australia.

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.

Corresponding author: Hiroshi Suzuki. Department of Oral Function and Rehabilitation, Nihon University School of Dentistry at Matsudo, 2-870-1 Sakaecho- nishi, Chiba 271-8587, Japan. E-mail: suzuki.hiroshi91@nihon-u.ac.jp
Received: February 16, 2017; Accepted: March 10, 2017.

DOI: 10.5935/1984-0063.20170022
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. 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 and temporomandibular joint pain. Long-term use results in changes to the bite.

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, and improved the quality of life whether applied alone or in association with CPAP. 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). 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/m²) complained 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, OMFT was implemented using an M-Patakara® lip trainer (Patakara, Tokyo, Japan) made from flexible, resilient plastic and rubber. 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). 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.

Table 1. Instructions for use Patakara.

| Step | Instruction |
|------|-------------|
| 1    | Close the mouthpiece and insert into the oral vestibule between the upper and lower lips. |
| 2    | When the lips are closed, press the mouthpiece without teeth contact. |
| 3    | At this time, close the lips without clenching the teeth for about 5 minutes. |
| 4    | The tip of the tongue touches incisive papilla between the lips 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. |
| 6    | At this time, the lips should be kept firmly closed to prevent Patakara 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) | 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    |
| SpO2 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...
Lip muscle training improves obstructive sleep apnea and objective sleep: a case report

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, Konishi11 reported that strengthened mouth closure force along with coordinated contraction of the genioglossus and geniobhyoid 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 SpO2 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. Hoehberg et al., in an elderly population, found a prevalence of 11.5% complained of dry mouth most noticeable upon awakening13. 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 night15, 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 value16,17.

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.

ACKNOWLEDGEMENTS

This study was supported by a Grant-in-Aid for Scientific Research (15K11200) from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

CONFICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES

1. Oksenberg A, Froom P, Melamed S. Dry mouth upon awakening in obstructive sleep apnea. J Sleep Res. 2006;15(3):317-20.
2. Aarab G, Lobbezoo F, Heymans MW, Hamburger HL, Naeije M. Long-term follow-up of a randomized controlled trial of oral appliance therapy in obstructive sleep apnea. Respiration. 2011;82(2):162-8.
3. de Almeida FR, Lowe AA, Tsuki S, Osuka R, Wong M, Fastlicht S, et al. Long-term compliance and side effects of oral appliances used for the treatment of snoring and obstructive sleep apnea syndrome. See comment in PubMed Commons belowJ Clin Sleep Med. 2005;1(2):143-52.
4. Marklund M, Sahlin G, Stenlund H, Persson M, Franklin KA. Mandibular advancement device in patients with obstructive sleep apnea: long-term effects on apnea and sleep. Chest. 2001;120(1):162-9.
5. Guimarães KC, Drager LF, Genta PR, Marcondes BF, Lorenzi-Filho G. Effects of oropharyngeal exercises on patients with moderate obstructive sleep apnea syndrome. Am J Respir Crit Care Med. 2009;179(10):962-6.
6. Duféria G, Badele L, Santos-Silva R, Bommarito S, Tufik S, Bittencourt L. Effect of speech therapy as adjunct to continuous positive airway pressure on the quality of life of patients with obstructive sleep apnea. Sleep Med. 2013;14(7):628-35.
7. Suzuki H, Watanabe A, Akihiro Y, Takao M, Ikematsu T, Kimoto S, et al. Pilot study to assess the potential of oral myofunctional therapy for improving respiration during sleep. J Prosthodont Res. 2013;57(3):195-9.
8. Yoshimura M, Suzuki H, Tanaka H, Asakawa R, Chow CM, Kawara M. Lip muscle training improves halitosis and obstructive sleep apnea syndrome: a case report. J Dent Sleep Med. 2016;3(1):31-2.
9. Iber C, Ancoli-Israel S, Chessen A, Quan S. The AASM manual for the scoring of sleep and associated events: rules, terminology and technical specifications. Westchester: American Academy of Sleep Medicine; 2007. p. 45-7.

10. Ishikawa M, Ishikawa S, Kamata H, Akihiro Y, Hamada U, Yonei Y. Efficacy of a health program with facial mimetic muscle training in residents of a medical care facility for the elderly. Anti-Aging Med. 2010;7(11):120-8.

11. Konishi Y. The effect of stimulation of facial expression muscles via on oral muscle function using a training device on the relief of stress. Esthetic Dent. 2005;18:18-22.

12. Izuhara Y, Matsumoto H, Nagasaki T, Kanemitsu Y, Murase K, Ito I, et al.; Nagahama Study Group. Mouth breathing, another risk factor for asthma: the Nagahama Study. Allergy. 2016;71(7):1031-6.

13. Hochberg MC, Tielsch J, Munoz B, Bandeen-Roche K, West SK, Schein OD. Prevalence of symptoms of dry mouth and their relationship to saliva production in community dwelling elderly: the SEE project. Salisbury Eye Evaluation. J Rheumatol. 1998;25(3):486-91.

14. Kales A, Cadieux RJ, Bixler EO, Soldatos CR, Vela-Bueno A, Misoul CA, et al. Severe obstructive sleep apnea–I: Onset, clinical course, and characteristics. J Chronic Dis. 1985;38(5):419-25.

15. Newell J, Mairesse O, Verbanck P, Neu D. Is a one-night stay in the lab really enough to conclude? First-night effect and night-to-night variability in polysomnographic recordings among different clinical population samples. Psychiatry Res. 2012;200(2-3):795-801.

16. Le Bon O, Minner P, Van Moorsel C, Hoffmann G, Gallego S, Lambrecht L, et al. First-night effect in the chronic fatigue syndrome. Psychiatry Res. 2003;120(2):191-9.