Title:

Combined oral appliance therapy and adjunctive minimally invasive Er:YAG laser therapy for complete resolution of severe obstructive sleep apnea: a clinical case report

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Erbium-doped yttrium aluminium garnet laser = Er:YAG

Obstructive sleep apnea = OSA

Positive airway pressure = PAP

Respiratory event index = REI

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Abstract

This case report describes the use of laser therapy from an Er:YAG laser in conjunction with a custom fit titratable dental sleep appliance for the resolution of a patient's severe obstructive sleep apnea, daytime sleepiness, snoring and breathing sounds when sleeping.

Keywords: laser, dentistry, sleep appliance, obstructive sleep apnea

Introduction

Obstructive sleep apnea (OSA) is a type of sleep breathing disorder that affects between 9-38% of the population[1-3]. OSA occurs when the upper airway in the oropharynx collapses during sleep, resulting in difficulties with breathing during sleep. OSA is well associated with other medical conditions including diabetes and cardiovascular disease. Depending on its severity, OSA is most frequently treated with positive airway pressure (PAP) machines, dental sleep appliances, positional therapy, and weight loss.

Over the last few years, non-surgical laser therapy for snoring has gained popularity within medicine and dentistry. As early as 2011, dentists were using erbium-doped yttrium aluminium garnet lasers (Er:YAG) in a non-surgical fashion to decrease snoring to improve patient quality of life.[4] The use of non-surgical lasers for treating snoring has become very popular, with two lasers dominating the market: the Lightwalker AT-S by Fotona (specific protocol for snoring: Nightlase) and the Solea by Convergent (specific laser protocol for snoring: Solea Sleep).[5,6] However, as of 2020, research still showed that while non-surgical laser therapy was able to significantly decrease snoring, it is not an effective treatment for OSA.[7]

This case report will demonstrate the use of combining a dental sleep appliance with non-surgical laser therapy to manage a patient's severe OSA, without the required use of the dental sleep appliance for maintenance of the resolution. One year follow-up will show maintained complete resolution of the patient's OSA.

Case Report

A 71 year old female presented to a multidisciplinary sleep centre with primary concerns of loud snoring with observed apneas. The patient's medical history was significant for vascular stenosis and bilateral cataracts, for which she had undergone phakectomy (cataract surgery). The patient reported no allergies and is currently not taking any medications. Clinical assessment of the patient noted a height of 161cm, weight of 57kg, and body mass index of 22. The patient scored 9 on the Epworth Sleepiness Scale, 4 on the STOP-BANG assessment, and 9 on a visual analog scale of 0-10 for snoring volume. Review of disturbed sleep symptoms with the patient revealed self-reported loud continuous snoring with worsening over the last five years, observed apneas by bedpartner, poor sleep quality, unrefreshing sleep, difficulty with waking up in the mornings, and tiredness throughout the day. The patient noted she did not experience dry mouth, headaches, or nocturia (having to wake up to go to the bathroom). Based on this initial assessment, a home sleep apnea test (BTI APNiA, Biotechnology Institute, Vitoria, Spain) was provided to the patient with instructions for appropriate wear and use.

The sleep test results were scored and reviewed by a sleep physician, who diagnosed the patient with severe OSA. The patient's respiratory event index (REI) was 37.1, though a postural component was noted as the supine REI was 51.8. The average oxygen saturation recorded throughout the night was 93%, with the lowest oxygen saturation during the study night of 88%. A table of sleep study results is attached in Appendix A. The patient returned to the multidisciplinary sleep centre to review the results after which the sleep physician discussed and reviewed appropriate treatment options with the sleep physician. Due to the severity of the patient's OSA, the first line of treatment recommended to the

patient was PAP therapy. However, the patient was not interested in PAP therapy and requested other treatment options. After review with a multidisciplinary team on other treatment options including a custom fit dental sleep appliance, laser therapy, combination of both, and surgical options, the patient opted for combined dental sleep appliance with laser therapy.

A custom fit dental appliance (SomnoDent, Barcelona, Spain) was provided to the patient at a dental sleep medicine clinic with an initial mandibular position set at 50% of maximum mandibular protrusion. (Figure 1) The patient was shown how to appropriately insert and remove the appliance, then demonstrated her ability to do so before leaving her appointment. Appropriate homecare instructions for the use and maintenance of the appliance were reviewed and also provided to the patient in writing. The patient was shown the SnoreLab app, which she downloaded onto her phone and was instructed to use to record her snoring volume while sleeping, with the purpose being to objectively monitor her snoring for comparison before, during, and after treatment.

The first laser therapy session was provided two months later at an outpatient laser clinic. The patient's oropharynx was irradiated with an Er:YAG laser (Lightwalker AT-S, Fotona) under settings previously described by Monterio et al (Figure 1).[8]

> *The patients were all treated… with a 2940nm wavelength Er:YAG laser (Lightwalker AT-S, Fotona®, Slovenia) with a non-contact irradiation of connective and muscle tissue of oropharynx (soft palate including uvula, anterior and posterior pillar's, and rest of oropharynx) using a PS04 handpiece with 7-mm spot size. The parameters were set as a combination of a long pulse (LP0 with a fluence of 2J/cm^2 with 12Hz in a brushing technique with 6 passes in a well-defined overlays and a smooth mode with a fluence of 10-8J/cm^2 with 2Hz performing 4-6 smooth pulses with 6 passes, with an overlap around 50%, with total pulses ranging between 10,000 and 12,000 pulses per sessions. Usual safety precautions related with the instrument for protecting the operator, patient, and assistant were followed. (e562)* [8]

The patient reported no ill effects and no discomfort during the procedure. The patient was then scheduled for three additional laser therapy sessions set apart biweekly, then an additional two sessions three months apart. A table outlining the dates of the laser therapy sessions is attached as Appendix B. The patient was also scheduled for her one- year sleep study follow up. Clinical photos were taken of the patient's oropharynx before the initial laser therapy and after each laser therapy session (Figure 2). The patient was instructed to continue to use her dental appliance and the patient's SnoreLab results were also recorded at each session. The results indicated that the patient's snoring volume was decreasing.

After the third laser session, the patient discontinued use of her dental sleep appliance. Her stated reasons were due to improved symptoms and no longer wanting to wear the appliance. Even after discussions with the dental and sleep physician members of the multidisciplinary sleep team, the patient continued to refuse to wear her dental sleep appliance but wanted to continue with the laser therapy. The decision was made to continue to provide the laser therapy portion of her treatment and to re-evaluate her through a follow up sleep study as originally scheduled. At her annual follow up, the patient was provided with the follow-up sleep study as scheduled to evaluate the management of her

severe OSA. The results of the sleep study, without a dental sleep appliance, were a REI of 5.2 and a supine REI of 5.9. (Appendix A)

One year later the patient underwent standard annual follow up with a sleep study to confirm appropriately maintained management of her OSA. The results of the sleep study were an REI of 3.5 and a supine REI of 4.2. (Appendix A) Review of the patient's medical history revealed no reported changes to weight, sleep position, general medical status, medications, or any other medical interventions since the patient's last sleep study at her last visit.

Discussion

Currently, the first line treatment for severe OSA is the use of PAP machines. While these have been shown to be efficacious, there are significant difficulties with the use of PAP machines in terms of comfort and compliance for patients with the long term use of PAPs significantly lacking. For this reason, the use of custom fit dental sleep appliances are also considered an effective treatment due to greater patient compliance when compared to use of PAPs. However, though patient compliance and comfort are improved with dental sleep appliances, side effects (such as facial pain/soreness and occlusal/bite changes) are still common and can be problematic with long term use.

Non-surgical laser therapy has been used in multiple fields for the treatment of different diseases and conditions including wound healing, scar reduction, nerve injuries, to improve cognitive function, and to decrease inflammation in chronic pain patients. More recently, non-surgical laser therapy has also gained popularity within medicine and dentistry for the treatment of snoring, though there has still been little research to show its effectiveness in the treatment of OSA.[7-11] However, interest in the use of lasers for the treatment of snoring and eventually for sleep breathing disorders is growing.

This case report shows that the combined use of a dental sleep appliance with non-surgical laser therapy may be considered a treatment option for patients with severe OSA. While a dental sleep appliance may be used for initial immediate management, we speculate that laser therapy appropriately applied at the oropharynx over multiple sessions may help with improving oropharyngeal patency. Over time, this may result in the maintenance of oropharyngeal patency without the continued need for a dental sleep appliance. This would eliminate the risks associated with long term use of dental sleep appliances and any compliance concerns surrounding the use of the appliance while still providing complete therapeutic benefit in the treatment of patients with severe OSA.

Conclusion

This case report shows the successful combined use of non-surgical laser therapy with the transitional use of a dental sleep appliance for the resolution of severe OSA in a single patient. Further research into this combination of treatment through efficacy studies as well as through blinded randomized controlled trials with placebo control groups with long term sleep testing and clinical photography documentation of the oropharynx to assess changes to pharyngeal tissues are necessary to determine the

generalizability of this therapy modality and the development of appropriate patient selection criteria for its use.

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Appendix A

Table of home sleep test results pre-treatment, post-treatment, and at one year follow up

	Total REI	Non-Supine REI	Supine REI	TST	Baseline $[O_2]$	Mean $[O_2]$	$[O_2]$ Nadir	$[O_2]$ Time below 90%
Pre-Tx	37.1	58.1	51.8	359 min	93%	93%	88%	0.7 min
Post-Tx	5.2	4.5	5.9	426 min	93.9%	91.3%	86%	32.4 min
1Y Post-Tx	3.5	4.2	3.3	463 min	97%	93.5%	88%	0.5 min

Appendix B

Timeline of low level laser therapy applied to the soft palate for the patient. Note that Snore Lab Data was taken from the SnoreLab app (https://www.snorelab.com/) and is not a validated sleep testing method.

Date	Laser Therapy Session	Snore Lab Data					
		Time in Bed	Time Snoring	Quiet	Light	Loud	Epic
April 30, 2019	Laser therapy consult						
May 3, 2019		7h 44min	3h 27min (47%)	53%	27%	19%	0%
May 17, 2019		8h 16min	1h 47min (23%)	77%	15%	7%	0%
May 20, 2019	Laser therapy session 1						
June 4, 2019		7h 58min	1h 29min (19%)	81%	13%	7%	0%
June 5, 2019	Laser therapy session 2						
June 9, 2019		7h 32min	3h 2min (42%)	58%	28%	14%	0%
June 17, 2019		8h 24min	2h 9min (27%)	73%	24%	3%	0%
June 19, 2019	Laser therapy session 3						
Patient discontinued use of oral appliance between Sessions 3 and 4							
July 1, 2019		7h 14min	2h 37min (38%)	62%	23%	15%	0%
July 4, 2019	Laser therapy session 4						
July 8, 2019		7h 25min	2h 58min (42%)	58%	43%	8%	1%
July 13, 2019		5h 49min	2h 16min (41%)	59%	31%	10%	0%
August 17, 2019	Laser therapy session 5						
September 17, 2019		7h 45min	1h 17min (17%)	83%	14%	3%	0%
September 18, 2019		7h 51min	1h 3min (14%)	86%	13%	1%	0%
October 7, 2019		7h 58min	45min (10%)	90%	9%	1%	0%
October 8, 2019	Laser therapy session 6						
November 22, 2019		7h 52min	1h 28min (19%)	81%	16%	3%	0%

Figure Legend

Figure 1: Treatment interventions provided to the patient. (A) Somnodent dental appliance for OSA. (B) Minimally invasive Er:YAG laser irradiating the oropharynx.

Figure 2: Clinical photos of the patient before and after non-surgical laser therapy of the oropharynx following Er:YAG exposure.[5] Prior to (A) and after laser therapy: (B) initial; (C) second; (D) third; (E) fourth ; (F) sixth (final); (G) at one year follow up. Note that variations to the visualization of the oropharynx can be influenced by pressure depression of the tongue and/or patient contraction of the palatal muscles.

Figure 1

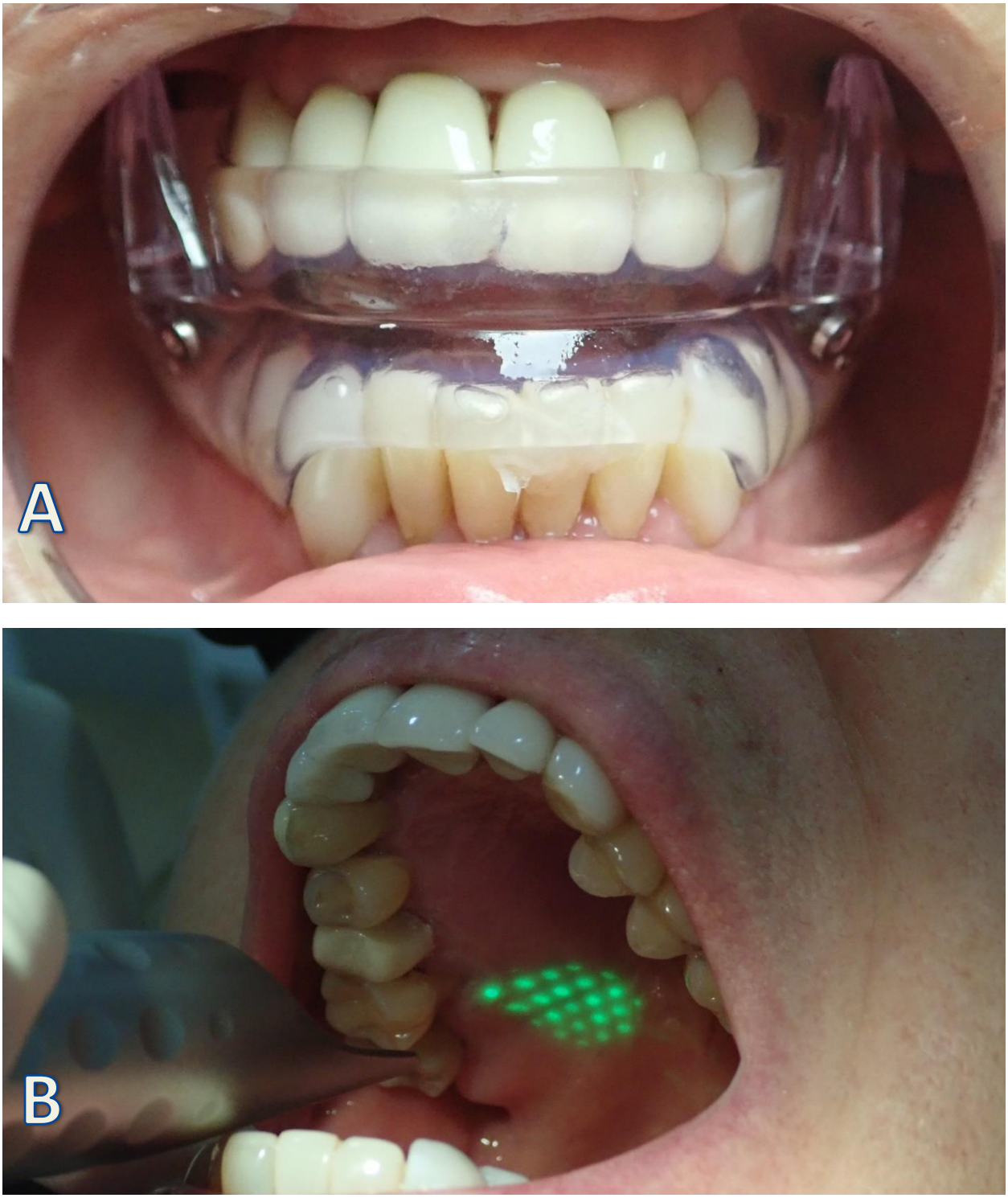

Figure 2