Treatment of Snoring with a Mandibular Advancement Device and Laser Photo-stimulation. Narrative Review *

Tratamiento del ronquido con dispositivo de avance mandibular y laser de fotoestimulación. Revisión Narrativa

Tratamento do Ronco com Aparelho de Avanço Mandibular e Fotoestimulação a Laser. Revisão Narrativa

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ABSTRACT

Background: Snoring is an annoying noise that affects the coexistence, health and quality of life of those who suffer from it and those around them. There are treatment alternatives that can individually improve the patient's situation but often do not completely solve the problem. The possibility then arises of combining two or more alternatives to be able to effectively treat snoring. **Purpose**: To describe the existing evidence on the use of Nightlase photo-stimulation laser treatment and Mandibular Advancement Devices (MAD) to treat snoring, and the positive synergy of using them together. **Methods**: This study consisted of a narrative review of the literature. The search was conducted using PubMed with keywords and articles published after 2010 were selected. **Results**: The combination of both approaches offers synergies in the treatment of snoring. MADs act physically to expand airway space, while photo-stimulation laser therapy works at the cellular level to improve the resistance and tone of affected tissues. **Conclusions**: The combined treatment of snoring with a device and laser addresses the problem of snoring with two different approaches that, combined, can be a promising option.
Keywords: dentistry; mandibular advancement device; narrative review; photostimulation laser; sleep disorders; snore

RESUMEN

Antecedentes: El ronquido es un ruido molesto que afecta la convivencia, la salud y la calidad de vida de quien lo padece y de los que están en su entorno. Existen alternativas de tratamiento que de forma individual pueden mejorar la situación del paciente pero que muchas veces no resuelven por completo el problema. Surge entonces la posibilidad de combinar dos o más alternativas para poder tratar de forma eficaz el ronquido. **Objetivo**: Describir la evidencia existente sobre el uso del tratamiento laser de foto-estimulación Nightlase y de los Dispositivos de Avance Mandibular (DAM) para tratar los ronquidos, y de la sinergia positiva que supone utilizarlos de forma conjunta. **Métodos**: Este estudio consistió en una revisión narrativa de la literatura. La búsqueda se realizó por PubMed con palabras clave y se seleccionaron los artículos publicados a partir de 2010 **Resultados**: La combinación de ambos enfoques ofrece sinergias en el tratamiento del ronquido. Los DAM actúan físicamente para ampliar el espacio de las vías respiratorias, mientras que la terapia láser de fotoestimulación trabaja a nivel celular para mejorar la resistencia y la tonicidad de los tejidos afectados. **Conclusiones**: El tratamiento combinado del ronquido con dispositivo y laser aborda el problema del ronquido con dos enfoques diferentes que combinados pueden ser una opción prometedora.

Palabras clave: desórdenes del sueño; dispositivo de avance mandibular; láser de fotoestimulación; odontología; revisión narrativa; ronquido

RESUMO

Antecedentes: O ronco é um ruído incômodo que afeta a convivência, a saúde e a qualidade de vida de quem o sofre e de quem o rodeia. Existem alternativas de tratamento que podem melhorar individualmente a situação do paciente, mas muitas vezes não resolvem completamente o problema. Surge então a possibilidade de combinar duas ou mais alternativas para poder tratar eficazmente o ronco. **Objetivo**: Descrever as evidências existentes sobre o uso do tratamento a laser de fotoestimulação Nightlase e dos Dispositivos de Avanço Mandibular (MAD) para tratar o ronco, e a sinergia positiva de usá-los juntos. **Métodos**: Este estudo consistiu em uma revisão narrativa da literatura. A busca foi realizada no PubMed com palavras-chave e foram selecionados artigos publicados após 2010. **Resultados**: A combinação das duas abordagens oferece sinergias no tratamento do ronco. Os MADs atuam fisicamente para expandir o espaço das vias aéreas, enquanto a terapia a laser de fotoestimulação atua no nível celular para melhorar a resistência e o tônus dos tecidos afetados. **Conclusões**: O tratamento combinado do ronco com aparelho e laser aborda o problema do ronco com duas abordagens diferentes que, combinadas, podem ser uma opção promissora.
Palavras-chave: dispositivo de avanço mandibular; distúrbios do sono; laser de fotoestimulação; odontologia; revisão narrativa; ronco

INTRODUCTION

Snoring is an acoustic phenomenon that occurs during sleep due to vibration of the tissues of the upper airway (1). Although it is usually considered only an annoying but harmless problem, it can have consequences on the health and quality of life of the subject, it can be a sign or symptom of sleep apnea and in some cases, it can cause progressive deterioration to more severe stages of apnea (2).

Snoring affects people of all ages around the world. It is estimated that about 40% of adults snore occasionally, while approximately 25% snore habitually (3). The prevalence of snoring tends to increase with age, being more common in people over 60 years of age (3). Snoring is more common in men than women. Additionally, factors such as obesity, excessive alcohol consumption, smoking, and upper airway anatomy can influence the likelihood of snoring (3).

Snoring, apart from being a social problem, is associated with a greater prevalence of a large number of diseases, such as metabolic and cardiovascular disorders, among others (2). Likewise, the constant vibration of the soft tissues of the pharynx that causes chronic snoring can cause tissue deterioration due to continued trauma (1).

There is a wide range of treatment alternatives for snoring such as intraoral devices, positional devices, continuous air pressure machines, non-surgical laser photostimulation treatment, and various types of surgery (1). The goal of treatment is to reduce or eliminate snoring, as well as the possible consequences on the tissues, reduce the risks to the patient's health and improve quality of life (2). Some of these treatment alternatives individually can reduce the problem, but many times they do not solve it completely. Combining two or more alternatives is, in these cases, the effective solution to treat snoring.

In January 2023, the first clinical case of a patient treated with the Erbium:YAG photostimulation device and laser was published, as part of the necessary process to begin a multicenter prospective clinical study (4). The objective of this Narrative Review is to show the existing evidence on the use of the Nightlase Laser photo-stimulation protocol and advance devices in the treatment of snoring. Likewise, we present an analysis of the bases of the physiology of breathing during sleep and the pathophysiology necessary to understand the phenomenon of snoring, its consequences and therapeutic alternatives.

MATERIALS AND METHODS

This narrative review describes the main characteristics of the research works published in recent years on the treatment of snoring with Lasers and Intraoral Devices. The search was conducted through PubMed with keywords and articles published from 2010 onwards with relevant content on snoring treatment with Devices and Laser were selected.

RESULTS AND DISCUSSION

Physiology of Breathing During Sleep

The upper airway is a dynamic structure that allows respiratory functions, which change during the respiratory cycle, between wakefulness and sleep, and between stages of sleep (5). The patency of the upper airways depends on a delicate balance between pressure in the upper airways and dilatory forces in the surrounding tissues thanks to the action of neural control and the mechanical behavior of soft tissues (5). There are passive (anatomical balance of hard and soft tissues) and active (muscle activity and tissue deformation produced by changes in airway pressure) components that keep the airways open during sleep (5). The balance of intraluminal (inside the duct) and extraluminal (outside the duct) pressure in the pharynx is essential to maintain an open airway and allow fluid breathing during sleep (5).

The mandible acts as a lever to stabilize the pharynx. Proper position and movements of the jaw during breathing contribute to the patency of the upper airway (6). Mandibular movements, just a few tenths of a millisecond before diaphragm contraction counteract the negative pressure within the walls of the upper airways (6). The hyoid bone is displaced anteriorly and caudally by muscles and acts as an anchor for the tongue musculature, widening the airways (6, 7). The proper position of the jaw and hyoid bone favors pharyngeal patency and the configuration of the upper airway (7).

Pathophysiology of Snoring

Snoring is caused by partial obstruction of the upper airways (1). Extraluminal pressures and changes in airflow dynamics, as well as neural control of the dilator muscles, can alter this balance (5). During sleep, muscle tone decreases, the muscles of the throat and tongue tend to relax and can produce a loss of wall tension and consequently lead to narrowing of the airways (8). This is especially noticeable in the REM (rapid eye movement) sleep phase, when muscles are more relaxed, and snoring may be louder (8).

One of the key factors in the pathophysiology of snoring is the anatomy of the upper airways (8). People with a smaller jaw, larger tongue, or enlarged tonsils and adenoids are at higher risk of snoring due to airflow obstruction (5). Additionally, obesity can also contribute to snoring, as excess fatty tissue around the neck can put pressure on the airways and narrow them (1).

Consequences of Snoring

Snoring is considered an annoying inconvenience in cohabitation and relationships that can have consequences beyond simple nocturnal noise (9). In some people, snoring may be associated with more serious health problems (10,11).

Snoring is an important social problem that especially affects people who sleep in the same room, who frequently suffer from poor sleep quality and fatigue during the day (10). Snoring causes relationship problems, requiring you to sleep in separate rooms or use sleeping pills and earplugs (9).

Snoring also affects the snorer, as it has been linked to waking up feeling unrefreshed, excessive daytime sleepiness, and tiredness (10, 11). In addition, snoring is associated with a higher prevalence of metabolic diseases, increases the risk of hypertension and heart problems (12-15).

Some of the potential consequences of snoring include:

- Daytime fatigue: Snoring can consistently disrupt sleep, leading to fragmented, poor-quality sleep (10). As a result, people who snore may experience daytime fatigue, drowsiness, and poor concentration during the day (11). This can negatively affect your performance at work, school, and other daily activities (10).
- Cognitive impairment: Lack of adequate sleep due to snoring and sleep disruption can impact cognitive functions (10). Concentration, memory, and overall cognitive function can be negatively affected by a lack of consistent sleep.
- Weight gain: Some studies suggest that there is a relationship between snoring and weight gain (12). Obesity can increase the likelihood of snoring, as excess fatty tissue around the neck can put pressure on the airways. In turn, snoring can contribute to weight gain since a lack of quality sleep can alter metabolism and eating habits (12,14-15).
- Cardiovascular risk: Chronic snoring may be associated with an increased risk of developing cardiovascular problems (13). Disruptions in breathing during sleep can lead to decreased blood oxygen levels and stress on the cardiovascular system, which could contribute to the development of heart disease (14,15).
- Problems in interpersonal relationships: The noise of snoring can affect bed and roommates, leading to sleep disturbances and tensions in personal relationships (9). Constant snoring can create frustration and stress in couples, which can affect overall quality of life (10).
- Sleep apnea: In some cases, snoring can be a symptom of sleep apnea, a condition in which the airways become repeatedly obstructed during sleep, resulting in pauses in breathing (11). Sleep apnea can have serious health consequences, including an increased risk of cardiovascular disease, hypertension, and metabolic problems (12).

Consequences of Snoring on the Palate and Soft Tissues

The constant vibration of the soft tissues of the pharynx produced by chronic snoring can cause continued trauma with the consequent deterioration of collagen fibers (2, 16). Collagen is one of the essential components of connective tissue that provides support and structure to many parts of the body (1). Morphometric and histological studies have demonstrated diffuse inflammatory changes, muscular changes, and neural alterations of the soft palate in snoring and OSA patients (16). The soft palate and uvula of patients who snore have a higher proportion of type IIA fibers, suggesting an adaptive physiological transformation of fatigue-resistant muscles (Type I) and fatigue-prone muscles (Type IIA) (16).

This muscular alteration results in adaptive compensation in these patients. Furthermore, as gravity increases, muscle tissue will be unable to resist pharyngeal collapse despite adaptive changes in muscle fiber physiology (16). Finally, internal changes in muscle fibers can cause a decrease in the electromyographic (EMG) activity of the soft palate muscles during sleep (16). The above findings may explain why patients with snoring and mild/moderate obstructive sleep apnea have a consistent increase in AHI over time (2). This highlights the importance of treating snoring and mild OSA to avoid the consequences of ongoing trauma to the pharyngeal tissue, in addition to the need to address the actual problem.

Importance of Treating Snoring

Treating snoring goes beyond simply addressing annoying nighttime noise. Persistent snoring can have significant effects on a person's quality of life, health, and overall well-being (11). Recognizing these consequences, it is crucial to understand the importance of appropriately addressing and treating snoring (14). Some reasons to consider snoring treatment are as follows:

- Improve sleep quality, which in turn benefits overall health and well-being and a better quality of life.
- Reduce associated risk factors and improve health.
- Improve social and couple relationships by creating a calmer and more comfortable sleeping environment.
- Prevent progression to more severe stages of sleep apnea.
- Prevention of long-term health complications such as type 2 diabetes, heart disease and metabolic problems.

Snoring treatment is not only about eliminating nighttime noise, but also about improving quality of life, preventing long-term health problems and strengthening interpersonal relationships (2). Snoring should be treated from a psychosocial, medical and preventive perspective to avoid progression to more serious diseases, all of which could have a significant social, medical and economic impact (2).

Snoring Treatment Alternatives

There is a whole range of treatment options for snoring, starting with behavioral options such as diet and exercise (weight reduction, alcohol and sedatives), stopping smoking, changing sleeping position (back to side), and a few others. lifestyle changes (such as exercising your throat with singing lessons or playing some wind instruments) (17). The main problem associated with lifestyle changes is patient motivation, which is usually exceptionally low unless the problem is life-threatening (17).

Nonsurgical snoring therapies include MADs, continuous positive airway pressure (CPAP), nonsurgical laser, and pharmacological treatment (18) (Figure 1). MADs are used to advance the jaw, thereby opening the upper airways to reduce or eliminate snoring (19). CPAP treatment provides a constant flow of air to the mouth and nose, keeping the airways open so the patient can breathe more easily during sleep (20). CPAP devices are effective in treating sleep apnea, reducing snoring, improving breathing during sleep, reducing daytime sleepiness, and lowering blood pressure (21).

FIGURE 1
MAD mechanical effect, Nightlase laser photostimulation effect

However, many patients find it uncomfortable and cannot wear it for prolonged periods, with the most common complaints being dry mouth, nasal congestion, skin irritation and nightmares (17). For its part, the non-surgical laser produces tissue remodeling thanks to its photostimulation effect (4). Among other non-surgical therapies for snoring, there are also pharmaceutical products such as decongestants, administered orally or as a nasal spray, although these medications are not recommended for routine use due to side effects (such as rhinorrhea) and because these agents lose effectiveness after a few days of use (17).

Most severe cases of snoring and apnea are treated with one or more surgical methods, mainly involving the uvula and soft palate and sometimes also the posterior wall of the pharynx (18). Among the most commonly used less invasive surgical procedures are the abutment procedure, the injection snoreplasty procedure, and various radiofrequency procedures (17). Finally, there are some variants of surgical treatment for snoring, including uvulopalatopharyngoplasty (UPPP), laser-assisted uvulopalatoplasty (LAUP) and radiofrequency tissue volume reduction (17). All surgical procedures have many potential postoperative side effects in addition to prolonged pain, such as problems with smell and taste, pharyngeal dryness, bloated sensations, vocal changes, and reflux (22).

Mandibular Advancement Devices

Mandibular advancement devices (MADs) are an effective, non-invasive treatment option for snoring and mild, moderate, and severe sleep apnea (19). These devices work by modifying the position of the jaw and tongue during sleep, which helps keep the airways open and reduces the obstruction that causes snoring (21) (Figure 2).

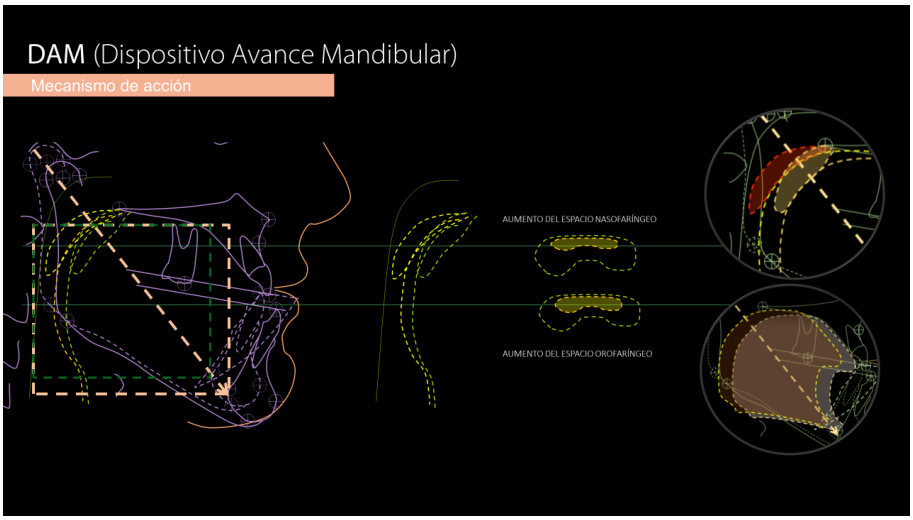

FIGURE 2
Mechanism of action of MAD: mechanical action

The predominant effect of jaw repositioning is anatomical, and its most favorable action is on the pharyngeal airways (23). This is found in particular in the increase in the velopharyngeal lateral diameter, which improves airway patency, reduces collapsibility and the appearance of obstructive respiratory events (24).

Anteroinferior repositioning of the mandible results in an increase in the size of the box volume, providing more space for the soft tissues. This anteroinferior displacement causes the chin and tongue to move in the same direction (24). Jaw and tongue movements cause the soft palate to move downward and forward through the connection of the palatoglossus muscle laterally from the base of the tongue to

the soft palate and uvula (2,24). This puts more tension on the tissue of the tongue and palate, making them less likely to block the airway (25,26).

The superior pharyngeal constrictor muscle inserts into the mandible through the pterygomandibular raphe (27, 28). Repositioning of the mandible laterally displaces the superior constrictor muscle and the lateral pharyngeal wall, widening the airway. (28). Anteroinferior repositioning of the mandible in turn changes the position of the hyoid bone with respect to the maxilla in a more anterior and superior position (29). The distance between the mandible and the hyoid decreases, indicating that the MAD pulls the hyoid muscles forward improving the tension and space of the pharyngeal airways (23). There is also an impact on the Epiglottis, since the hyoid moves anterosuperiorly, and through the hyoepiglottic ligament directly to the epiglottis, changing its position and inclination (30). Furthermore, MAD reduces collapse at upper levels by reducing negative intraluminal pressure, all of which could directly or indirectly neutralize epiglottic collapse (30).

Displacement of the tongue and soft palate increases the anteroposterior diameter and area of the airways in the oropharynx and velopharynx (25, 31). The increase in lateral diameter is one of the most important changes, through the connections between the mandible in the retromolar region and the muscles of the lateral airway wall, particularly in the velopharyngeal region (28, 32). The total volume of the upper respiratory tract increases as a result of all the mechanisms explained above. Increased volume, area, and diameter have been documented using 3D videofluoroscopy, computed tomography, computational fluid dynamics analysis, magnetic resonance imaging (MRI), and drug-induced sleep endoscopy (DISE) (26, 28, 30).

Repositioning of the jaw returns the upper airway to a normal pattern of muscle function and soft tissue configuration (33). A larger, less collapsible upper airway improves airflow dynamics, therefore requiring less dilator muscle activity to maintain upper airway patency (23, 32, 33). Furthermore, the repositioning of soft and hard tissues contributes to a better position of the muscles, with the direction and length of the muscle fibers appropriate to fulfill their function (34).

The increase in upper airway space/volume and permeability of the pharyngeal walls explain the functional changes observed with MADs (24). A reduction in resistance at the velopharyngeal level, a decrease in negative intraluminal pressure, as well as an increase in inspiratory flow have been observed (25, 30). Critical closure pressures are reduced with MAD from supra-atmospheric to subatmospheric pressures, which determine a less collapsible airway (30).

It is vitally important to stabilize the jaw in the new position during sleep. If the patient opens his mouth during sleep, the jaw will subsequently rotate, and all the benefits of repositioning will be reversed (35). This will cause the jaw to recede, pushing on the tongue and palate, narrowing the maxillomandibular space and collapsing the upper airway. The MAD should hold the mandible in this new forward and downward position relative to the maxilla (32).

The process of obtaining and using a MAD generally involves the following stages:

- Evaluation and diagnosis: Before prescribing a MAD, a healthcare professional will evaluate the severity of the patient's snoring or sleep apnea. Sleep studies may be performed to determine the appropriateness of a MAD as a treatment.
- Custom Fit: If a MAD is determined to be appropriate, measurements and molds will be taken of the patient's jaw and teeth. These molds are used to make a device that fits customarily and comfortably in your mouth.
- Use and adaptation: At first, the patient may require a period of adaptation to the MAD, as they may experience slight discomfort or increased saliva during the first few days. However, over time, most people get used to the device.
- Medical follow-up: It is important to have regular medical follow-up while using a MAD to ensure that it is working effectively and that there are no problems or adjustments necessary.

- Efficacy and benefits: MADs have been shown to be effective in reducing snoring and improving sleep apnea symptoms in many patients. In addition to relieving snoring, these devices can improve sleep quality and nighttime breathing, which in turn can have a positive impact on daytime energy and overall health.

It is important to note that not all patients are suitable candidates for MADs (35). For example, those with jaw problems, severe periodontal disease, or who cannot tolerate devices in their mouth may not be ideal candidates. Therefore, it is crucial to consult a healthcare professional before starting any treatment with MAD (19).

MADs are an effective, non-invasive option for the treatment of snoring and mild to moderate sleep apnea (19). By modifying the position of the jaw and tongue, these devices help keep the airways open during sleep, thereby reducing the obstruction that causes snoring and improving sleep quality (26). However, it is essential to seek medical advice before starting any treatment to ensure it is suitable for individual needs (19).

Nightlase Photostimulation Laser

Photostimulation laser is a therapy considered among new technologies that has important scientific evidence for the treatment of snoring and mild, moderate and severe sleep apnea (36-43). This method uses laser energy to stimulate collagen in the soft tissue of the palate, uvula and tonsillar pillars in order to improve the quality of the upper airways, thus reducing snoring and associated symptoms (43). In the Nightlase protocol, the Er:YAG laser is used in a specific mode called Smooth Mode, which produces incrementally controlled heating of the tissue (4, 40, 42). It is the photothermal effect that immediately contracts the collagen fibers and produces a delayed stimulation of new collagen production (collagenosis) (36, 42). It is because of this last effect that some publications speak generically of photobiomodulation (PBM), although it is correct to speak of photostimulation (4, 36-43) because the wavelength of Erbium:Yag is 2940 nanometers.

The treatment is performed with a pixelated, collimated beam handpiece, performing area irradiation with temperature control in the tissues, managing the deposition of laser energy between the thermal effect and the thermal relaxation of the tissues (4, 40). The procedure is based on the fact that laser energy can induce changes in collagen and other connective tissue components in the pharynx (41). Its effect on collagen tissue produces an immediate shortening of approximately one third of the length of the fibers and a neoformation of collagen fibers from the first 15 days (42, 45). All of this leads to a retraction, tightening and strengthening of the soft tissue (41, 44), with a hardening and elevation of the soft palate (Figure 3) (44). The therapy is conducted in several sessions, in which the laser is applied by sweeping from the soft palate towards the peripharyngeal tissues (40, 46). Laser energy is non-invasive and does not cause thermal damage to tissues, making it a safe and tolerable procedure for all patients (41).

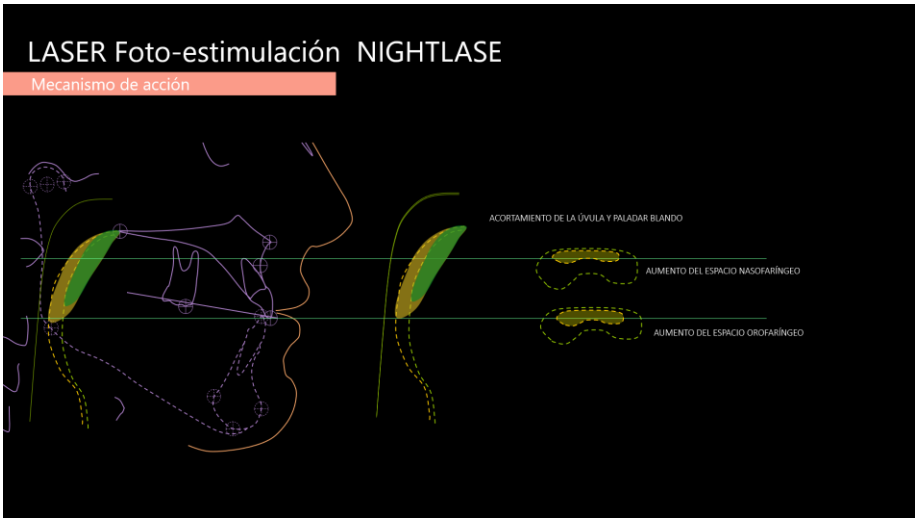

FIGURE 3
Mechanism of action of the Nightlase laser: photostimulation of the internal structure of tissues

The benefits of photostimulation laser treatment for snoring include:

- Non-invasive technique: Unlike other treatments that may require surgery or uncomfortable devices, it is a non-invasive approach that requires no cuts or incisions.
- Painless, fast and with no downtime: Each treatment session usually lasts between 30 to 45 minutes, and patients can resume their normal activities after the session, since no anesthesia or recovery time is needed (43).
- It does not require any preparation, it is performed on an outpatient basis, and without the need for post-treatment care (41).
- Gradual improvement: As more treatment sessions are performed, the effects of Nightlase often accumulate, which can lead to gradual and sustained improvement in snoring and sleep quality (Figure 4) (4, 47).
- Personalization: Each patient is unique, and laser photostimulation treatment can be tailored to the specific needs of each individual. Clinical examination is important to evaluate the indication and favorable anatomical factors for treatment (43).
- No side effects: Compared to some other treatment options, there are no side effects or discomfort after the procedure (41, 43).

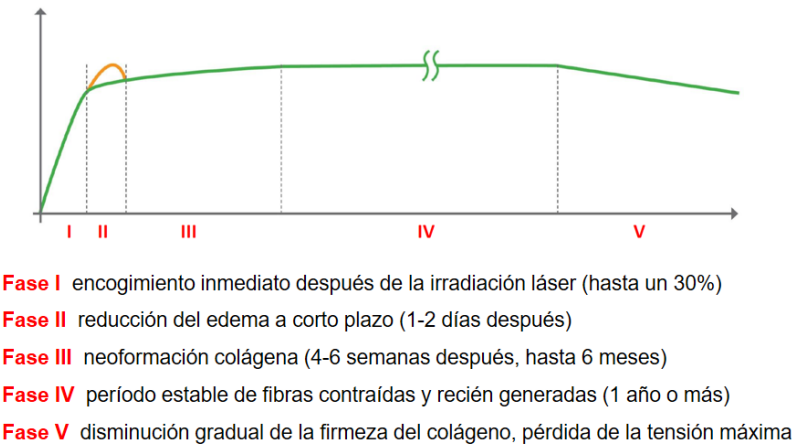

FIGURE 4
Phases of the Nightlase laser effect over time

Scientific evidence in this field is growing, and numerous studies have provided relevant information on the effectiveness of photostimulation in the treatment of snoring. Clinical studies have evaluated the effects of laser therapy in reducing the intensity and frequency of snoring, as well as improving associated symptoms (4, 36-49). To illustrate the action and effectiveness of laser photostimulation treatment, we show a clinical case in which tissue retraction can be seen after applying the laser (Figure 5).

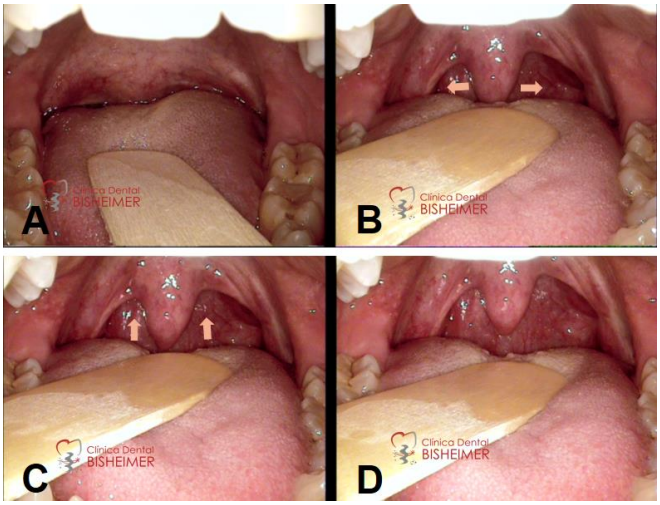

FIGURE 5
Clinical case treatment with Laser Nightlase. A. Initial. B. After first. session. C. After second session. D. After third session.

Lee, et al. (37) examined the effects of a non-ablative Erbium YAG (Er:YAG) laser procedure on increasing oropharyngeal airway volume. The study included 22 participants with a history of snoring or mild obstructive sleep apnea and was applied to specific areas of the soft palate and uvula. Airway dimensions were evaluated by cone beam computed tomography (CBCT) before and after laser treatment. The results of the study showed a significant increase in oropharyngeal airway volume after the laser procedure suggesting an improvement in airflow dynamics and contributing to reducing airway collapse during sleep.

Kakkar, et al. (43) reviewed the existing scientific literature on the efficacy and safety of laser use in the treatment of snoring and sleep apnea, specifically low-intensity laser uvulopalatoplasty, and its impact on improving symptoms and sleep quality. The authors highlight that the Nightlase protocol is considered a less invasive alternative to other surgical procedures and may be suitable for patients with snoring or mild to moderate sleep apnea. The technique involves applying laser to the soft palate and uvula to reshape and tighten the tissues, with the goal of reducing airway obstruction and improving airflow during sleep.

For their part, Liu, et al. (48) examined the efficacy of Erbium YAG (Er:YAG) laser treatments in patients with obstructive sleep apnea hypopnea syndrome (OSAS). The study evaluated how laser therapy can influence the reduction of apnea events and improve sleep quality in these patients. The results of the study showed that Er:YAG laser treatments led to a significant decrease in the apnea-hypopnea index, indicating a reduction in the severity of sleep apnea. Additionally, patients reported improvement in daytime sleepiness and subjectively perceived sleep quality. The authors concluded that Er:YAG laser therapy can be effective in the treatment of sleep apnea and improve quality of life in patients with OSAHS.

However, it is important to note that laser photostimulation treatment may not be equally effective in all patients (41). Response to treatment may vary depending on individual anatomy, snoring severity, and other factors (43). Some people may experience a significant reduction in snoring, while for others the results may be more modest (41).

Combined MAD and Photostimulation Laser Treatment

The combination of both approaches offers synergies in the treatment of snoring. MADs act physically to expand airway space, while photostimulation laser therapy works at the cellular level to improve the resistance and tone of affected tissues (19, 41). The result is a comprehensive approach that addresses both structural obstruction and contributing factors in the pathophysiology of snoring (Figure 6).

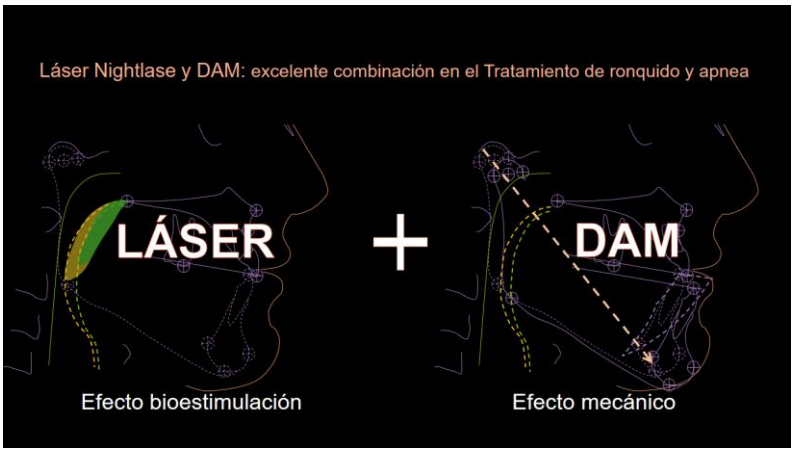

FIGURE 6
Laser Nightlase and MAD treatment combination

Mandibular advancement devices perform their action mechanically by modifying the position of the jaw and tongue during sleep, with the aim of increasing the diameter and tension of the muscles and walls of the upper airway (19).

Photostimulation laser therapy, for its part, conducts its action by modifying the internal structure of the tissues (41). In the context of snoring, laser therapy seeks to strengthen the connective tissue in the pharynx and reduce sagging and consequent excessive vibration that leads to the characteristic noise of snoring (38).

To date, only one article has been published demonstrating the effectiveness of the combination of these two therapies (4). If the combination of laser with CPAP has been suggested for the treatment of apnea (43), there are studies combining MAD with CPAP (49), in addition to other combinations such as MAD with positional therapy (50), MAD and myofunctional therapy. The evidence highlights the importance of combining treatments to resolve the problem of snoring and apnea more effectively, hence the synergy of Laser photostimulation and MAD can be an excellent combination.

CONCLUSIONS

Snoring is a respiratory problem that has consequences and must be treated.

MAD treatment mechanically repositions the jaw with the aim of increasing airway patency.

Laser treatment uses energy to stimulate collagen in the soft tissue of the palate, uvula, tonsillar pillars and walls of the pharynx in order to improve the quality of the upper airways, thus reducing snoring.

Combined treatment with MAD and Laser addresses the problem of snoring with two different approaches that, combined, are a promising option.

RECOMMENDATIONS

Controlled clinical studies are needed to evaluate the synergy in the combined treatment of snoring with MAD and laser.

References

1. Pevernagie D, Aarts R and De Meyer M The acoustics of snoring Sleep Med. Rev. 2010:14;131–44. https://doi.org/10.1016/j.smrv.2009.06.002
2. De Meyer MMD, Vanderveken OM, De Weerdt S, Marks LAM, Carcamo BA, Chavez AM, et al. Use of mandibular advancement devices for the treatment of primary snoring with or without obstructive sleep apnea (OSA): a systematic review. Sleep Med Rev. 2021;56:101407. https://doi.org/10.1016/j.smrv.2020.101407
3. Heinzer R, Vat S, Marques-Vidal P, et al. Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. Lancet Respir Med. 2015;3(4):310-318. https://doi.org/10.1016/S2213- 2600(15)00043-0
4. Bisheimer M, Ng ET, Lagravere MO, Mayoral P. Combined oral appliance therapy and adjunctive minimally invasive Er:YAG laser therapy for complete resolution of severe obstructive sleep apnea: A clinical case report. J Dent Sleep Med. 2022;10(1). http://dx.doi.org/10.15331/jdsm.xx
5. Bilston LE, Gandevia SC. Biomechanical properties of the human upper airway and their effect on its behavior during breathing and in obstructive sleep apnea. J Appl Physiol 2014;116:314–324. https://doi.org/10.1152/japplphysiol.00539.2013
6. Martinot J-B and Pépin J-L (2023) Mandibular jaw movements as a non-invasive measure of respiratory effort during sleep: application in clinical practice. Front. Sleep 2:1145620. https://doi.org/10.3389/frsle.2023.114562
7. Jo JH, Park JW, Jang JH, Chung JW. Hyoid bone position as an indicator of severe obstructive sleep apnea. BMC Pulm Med. 2022;22(1):1–10. https://doi.org/10.1186/s12890-022-02146-0.
8. Edwards B, White DP. Control of the pharyngeal musculature during wakefulness and sleep: Implications in normal controls and sleep apnea. Head Neck 2011;33:Suppl. 1, S37–S45. https://doi.org/10.1002/hed.21841
9. Cazan D, Mehrmann U, Wenzel A, Maurer JT. The effect on snoring of using a pillow to change the head position. Sleep Breath 2017;1(3):615e21. https://doi.org/10.1007/s11325-017-1461-1
10. Orjatsalo M, Toppila J, Heimola M, et al. Snoring was related to self-reported daytime sleepiness and tiredness in young adults performing compulsory conscript service. J Clin Sleep Med. 2023;19(2):243–251. https://doi.org/10.5664/jcsm.10294
11. Brown LK. Mild obstructive sleep apnea syndrome should be treated: pro. J Clin Sleep Med 2007;3:259–262.
12. Niu Y, Sui X, He Y, Xi H, Zhu R, Xu H, et al. Association between self-reported snoring and hypertension: a systematic review and meta-analysis. Sleep Med. 2021;88:140–8. https://doi.org/10.1016/j.sleep.2021.10.016
13. Wei Y, Lv J, Guo Y, et al. Age-specific associations between habitual snoring and cardiovascular diseases in China: a 10-year cohort study. Chest. 2021;160:1053-1063. https://doi.org/10.1016/j.chest.2021.04.070
14. Wang J, Campos AI, Rentería ME, Xu L. Causal associations of sleep apnea, snoring with cardiovascular diseases, and the role of body mass index: a two-sample Mendelian randomization study. European Journal of Preventive Cardiology. 2023:30(7);552-560. https://doi.org/10.1093/eurjpc/zwad005
15. Wang X, Fan J, Guo R, Hao W, Gong W, Yan Y, Zheng W, Ai H, Que B, Hu D, et al. Association of OSA with cardiovascular events in women and men with acute coronary syndrome. Eur Respir J. 2022. https://doi.org/10.1183/13993003.01110-2022.
16. Patel JA, Ray BJ, Fernandez-Salvador C, Gouveia C, Zaghi S, Camacho M. Neuromuscular function of the soft palate and uvula in snoring and obstructive sleep apnea: a systematic review. Am J Otolaryngol. 2018;39:327-337. https://doi.org/10.1016/j.amjoto.2018.03.006
17. Miracki K, Vizinti Z. Nonsurgical Minimally Invasive Er:YAG Laser Snoring Treatment. J LA&HA, J Laser and Health Academy 2013(1):36-42
18. Picavet VA, Dellian M, Gehrking E, Sauter A, Hasselbacher K. Treatment of snoring using a non-invasive Er: YAG laser with SMOOTH mode (NightLase): a randomized controlled trial. Eur Arch Otorhinolaryngol. 2023;280:307–312. https://doi.org/10.1007/s00405-022-0
19. Gianoni-Capenakas S, Kim DI, Mayoral P, Lagravère Vich. Mandibular advancement device effects on the upper airway anatomy and function: An umbrella review. J Dent Sleep Med. 2023;10(2). http://dx.doi.org/10.15331/jdsm.7290
20. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, Chervin RD. Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: an update for 2015. J Clin Sleep Med 2015;11(7):773–827. https://doi.org/10.5664/jcsm.4858
21. Sutherland K, Takaya H, Qian J, Petocz P, Ng AT, Cistulli PA. Oral appliance treatment response and polysomnographic phenotypes of obstructive sleep apnea. J Clin Sleep Med 2015;11(8):861–868. F, Ahlberg J, Raphael KG, et al.

International consensus on the assessment of bruxism: Report of a work in progress. J Oral Rehabil. 2018;45:837-844. https://doi.org/10.1111/joor.12663
22. Rombaux P, Hamoir M, Bertrand B, Aubert G, Liistro G, Rodenstein D. Postoperative Pain and Side Effects After Uvulopalatopharyngoplasty, Laser-Assisted Uvulopalatoplasty, and Radiofrequency Tissue Volume Reduction in Primary Snoring, Article first published online: 3 JAN 2009 https://doi.org/10.1097/00005537-200312000-00023.
23. Pae E-K, Harper RM. Elevated Hyoid Bone Position in Response to Mandibular Advancing Appliance Predicts Effectiveness of the Appliance for Obstructive Sleep Apnea. Front Dent Med 2021;2:1-9. https://doi.org/10.3389/fdmed.2021.672936
24. Ogawa T, Long J, Sutherland K, et al. Effect of mandibular advancement splint treatment on tongue shape in obstructive sleep apnea. Sleep Breath 2015;19:857–863. https://doi.org/10.1007/s11325-014-1101-y
25. Van Holsbeke C, De Backer J, Vos W, et al. Anatomical and functional changes in the upper airways of sleep apnea patients due to mandibular repositioning: a large scale study. J Biomech 2011;44:442–9. https://doi.org/10.1016/j.jbiomech.2010.09.026
26. Sutherland K, Chan AS, Cistulli PA. Three-dimensional assessment of anatomical balance and oral appliance treatment outcome in obstructive sleep apnea. Sleep Breath. 2016;20:903–10. https://doi.org/10.1007/s11325-015-1304-x.
27. Wojda M, Kostrzewa-Janicka J. Influence of MAD Application on Episodes of Obstructive Apnea and Bruxism during Sleep—A Prospective Study. J Clin Med 2022;11:5809. https://doi.org/10.3390/jcm11195809
28. Brown EC, Jugé L, Knapman FL, Burke PGR, Ngiam J, Sutherland K, Butler JE, Eckert DJ, Cistulli PA, Bilston LE. Mandibular advancement splint response is associated with the pterygomandibular raphe. Sleep 2021:44(4):zsaa222. https://doi.org/10.1093/sleep/zsaa222
29. Kim DI, Lagravère Vich M, Mayoral, P, Miguez M. Three-Dimensional Changes in Skeletal/ Dental Landmarks With Use of Mandibular Advancement Devices. J Dent Sleep Med. 2020;7(2). http://dx.doi.org/10.15331/jdsm.7120
30. Van de Perck E, Dieltjens M, Vroegop AV, Verbraecken J, Braem M, Vanderveken OM. Mandibular advancement device therapy in patients with epiglottic collapse. Sleep Breath 2022;26:1915–1920. https://doi.org/10.1007/s11325-021-02532-8
31. Okuno K, et al. Endoscopy evaluation to predict oral appliance outcomes in obstructive sleep apnoea. Eur Respir J. 2016;47(5):1410–1419. https://doi.org/10.1183/13993003.01088-2015
32. Sutherland K, Cistulli PA. Oral appliance therapy for obstructive sleep apnoea: state of the art. J Clin Med 2019;8:2121. https://doi.org/10.3390/jcm8122121
33. Tsuiki S, Ryan CF, Lowe AA, Inoue Y. Functional contribution of mandibular advancement to awake upper airway patency in obstructive sleep apnea. Sleep Breath 2007;11:245-51. https://doi.org/10.1007/s11325-007-0119-9
34. Juge L, et al. Regional respiratory movement of the tongue is coordinated during wakefulness and is larger in severe obstructive sleep apnoea. J Physiol. 2020;598(3):581–597. https://doi.org/10.1113/JP279382
35. Mogell K, Blumenstock N, Mason E, Rohatgi R, Shah S, Schwartz D. Definition of an Effective Oral Appliance for the Treatment of Obstructive Sleep Apnea and Snoring: An Update for 2019. J Dent Sleep Med. 2019;6(3) http://dx.doi.org/10.15331/jdsm.7090
36. Cetinkaya EA, Turker M, Kiraz K, Gulkesen HK. Er: Yag Laser Treatment of Simple Snorers in an Outpatient Setting. ORL J Otorhinolaryngol Relat Spec. 2016;78(2):70–76
37. Lee 2015 Lee CYS, Lee CCY. Evaluation of a non-ablative Er: YAG laser procedure to increase the oropharyngeal airway volume: a pilot study. Dental Oral Craniofacial Res. 2015;1(3):56–59
38. Storchi IF, Parker S, Bovis F, Benedicenti S, Amaroli A. Outpatient erbium:YAG (2940 nm) laser treatment for snoring: a prospective study on 40 patients [published correction appears in Lasers Med Sci. 2019 Mar;34(2):431]. Lasers Med Sci. 2018;33(2):399–406
39. Frelich H, Ścierski W, Marków M, Frelich J, Frelich H, Maciej M. Minimally invasive erbium laser treatment for selected snorers. Lasers Med Sci. 2019;34(7):1413–1420. https://doi.org/10. 1007/s10103-019-02731-6
40. Monteiro L, Macedo A, Corte-Real L, Salazar F, Pacheco JJ. Treatment of snoring disorder with a non-ablactive Er:YAG laser dual mode protocol. An interventional study. J Clin Exp Dent. 2020;12(6):e561–e567. https://doi.org/10.4317/jced.56953
41. Neruntarat C, Khuancharee K, Shoowit P. Er:YAG laser for snoring: a systemic review and meta-analysis. Lasers Med Sci. 2020;35(6):1231–1238. https://doi.org/10.1007/s10103-020-02987-3
42. Unver T, Aytugar E, Ozturan O, Kıran T, Ademci E, Usumez A. Histological Effects of Er:YAG Laser Irradiation with Snoring Handpiece in the Rat Soft Palate. Photomed Laser Surg. 2016;34(8):321–325. https://doi.org/10.1089/pho.2015.4044
43. Kakkar M, Malik S, Gupta B, Vaid N, George R, Singh S. Use of Laser in Sleep Disorders: A review on low laser uvulopalatoplasty. Sleep Disord. 2021;2021:8821073. https://doi.org/10.1155/2021/8821073
44. Wang Z, Rebeiz EE, Shapshay S. Laser soft palate “stiffening”: An alternative to uvulopalatopharyngoplasty. Lasers Surg Med. 2002;30: 40–43.

45. Badreddine AH, Couitt S, Kerbage C. Histopathological and biomechanical changes in soft palate in response to non-ablative 93-mum CO2 laser irradiation: an in vivo study. Lasers Med Sci 2021;36:413–420 https://doi.org/10.1007/s10103-020-03087-y.
46. Miracki K, Vizintin Z. Nonsurgical minimally invasive Er: YAG laser snoring treatment. J Laser Heal Acad 2013;1(1):36–41.
47. Frelich H, Marków M, Tażbirek M, Frelich-Truchel H, Misiołek M, Ścierski W. Erbium: Yttrium Aluminum Garnet (Er: YAG) Laser: A Minimally Invasive Treatment Method in Selected Patients with Impaired Breathing During Sleep—The Assessment of Treatment Effectiveness After 4 Years. Photomed. Laser Surg. 2023;*41*(8), 415-421.
48. Liu J, Yang J, Zhang M, Chen Y, Li Q. Clinical Efficacy Evaluation of Er: YAG Laser Treatments for Obstructive Sleep Apnea Hypopnea Syndrome. Biomed J Sci & Tech Res 2019;20(3):15010-15016. https://doi.org/10.26717/BJSTR.2019.20.003447
49. Liu 2017 20Liu H-W, Chen Y-J, Lai Y-C, Huang C-Y, Huang Y-L, Lin M-T. Combining MAD and CPAP as an effective strategy for treating patients with severe sleep apnea intolerant to high-pressure PAP and unresponsive to MAD. PLoS ONE 2017;12(10): e0187032. https://doi.org/10.1371/ journal.pone.0187032
50. 2015 Dieltjens Dieltjens M, Vroegop A V, Verbruggen AE, et al. (2015) A promising concept of combination therapy for positional obstructive sleep apnea. Sleep Breath 19:673–44. https://doi.org/10.1007/s11325-014-1068- 8.

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