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Content

Er:Yag Laser Treatmentof Simple Snorers in an Outpatient Setting

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Abstract

Objective*:* Snoring occurs as a result of soft tissue vibration caused by a partial upper airway collapse during sleep. This study evaluated the effectiveness and potential adverse side effects associated with the use of a nonsurgical, erbium-doped yttrium aluminum garnet (Er:YAG) laser treatment for patients with snoring conditions. Materials and Methods: In total, 33 patients with different degrees of snoring were analyzed retrospectively. All patients received three NightLase™ Er:YAG laser treatments. Results were measured using a follow-up questionnaire and then statistically analyzed. Any effects that occurred during the first year after treatment (i.e., short-term effects) were followed up with interviews. Results: Laser treatment effectively reduced patients' snoring and achieved a 65% satisfaction rate after three treatments. The greatest improvement and satisfaction were experienced by patients aged ≥ 50 years. Patients reported additional benefits from this treatment including easier breathing, higher alertness, and increased focus. Conclusion: Nonsurgical Er:YAG laser treatment is an effective and minimally invasive procedure to reduce patient snoring and other sleep-disordered breathing symptoms. Patients reported minimal disadvantages including minor discomfort and a low risk of side effects.

Introduction: Snoring occurs as a result of soft tissue vibration caused by a partial upper airway collapse during sleep. It can be loud, unpleasant, and a societal problem that occurs in both males and females [1]. On average, 45% of healthy adults snore occasionally and 25% are habitual snorers. Snoring is more frequent in males and overweight individuals and progresses with age. Because snoring is an indication of obstructed breathing, it is a medical condition that should be taken seriously [2, 3]. Snoring can cause sleep deprivation for both the snorers and those around them as well as daytime drowsiness, irritability, lack of focus, and decreased libido. Furthermore, patients can suffer from more severe issues including morning headaches, automatic behavior, mood alterations, short-term memory loss, and hypnogenic hallucinations. Studies have revealed a positive correlation between loud snoring and the risk of heart attack and stroke [1, 3, 4]. These symptoms alone are reason to seek medical assistance.

The erbium-doped yttrium aluminum garnet (Er:YAG) laser produces excellent energy absorption in water, making it an ideal laser for intraoral use and superficial skin resurfacing [5]. Therefore, the goal of this study was to evaluate the effectiveness of Er:YAG laser treatment in reducing snoring and to assess patient satisfaction following treatment.

Fig. 1. Er:YAG laser application.

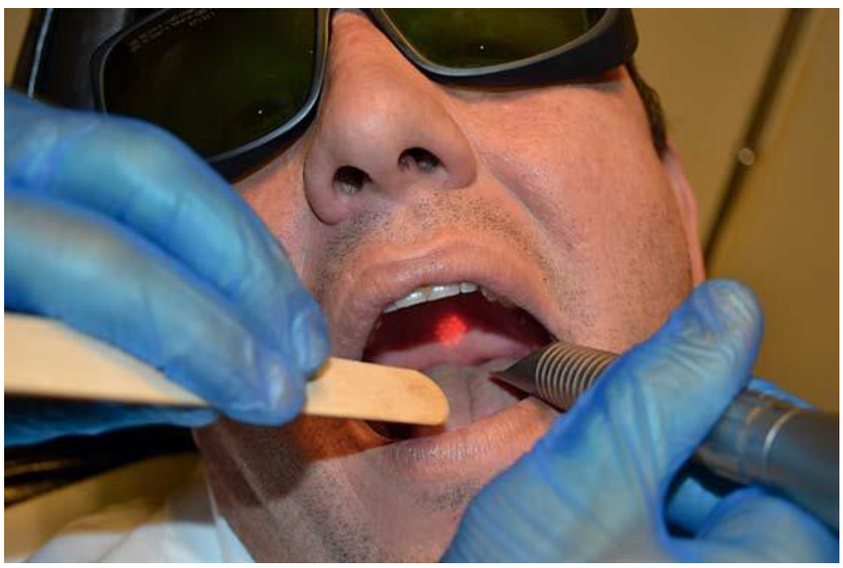

Fig. 2. Scanning of the treated areas with a high-definition handheld thermal camera.

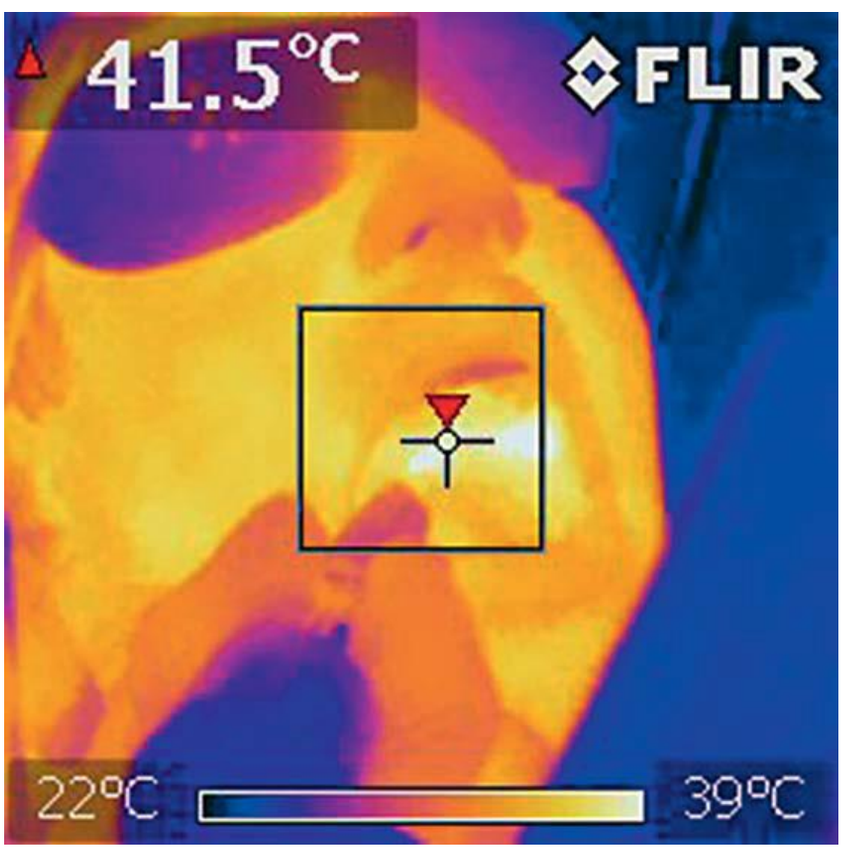

Table 1. Pre- and post-laser treatment snoring questionnaire (parts 1 and 2, respectively) and pain assessment (part 3)

	1	2	3	4	5	Score
Part 1 How often do you snore?	Never or almost never	1–2 times a month	1–2 times a week	3–4 times a week	Almost every day	
Evaluate the loudness level of your snoring	Slightly louder than breathing	Occasional soft snoring – not bothersome to bed partner	Persistent snoring – bothersome to bed partner	Persistent loud snoring – annoying bed partner	Heroic snoring – continuous, not tolerated by bed partner	
Evaluate your morning alertness or wakefulness	Very alert, almost every day	Alert 3–4 times a week	Alert 1–2 times a week	Alert 1–2 times a month	Never alert, very hard to get up	
Part 2 Evaluate the effect of your snoring problem on your personal life	No problem	Mild problem	Moderate problem	Severe problem	Extremely severe problem	
Awakens how often at night by snoring	Never or almost never	1–2 times a month	1–2 times a week	3–4 times a week	Almost every day	
Wake up with sore throat	Never or almost never	1–2 times a month	1–2 times a week	3–4 times a week	Almost every day	
Wake up with dry mouth	Never or almost never	1–2 times a month	1–2 times a week	3–4 times a week	Almost every day	
Part 3 Evaluate your pain during and after laser application	No pain	Mild pain – no need for painkiller	Moderate pain – need one dose p.o. painkiller	Severe pain – need multiple dose p.o. painkiller	Extreme pain – need parenteral painkiller	

p.o. = Peroral.

Materials and Methods: We retrospectively reviewed patients who had undergone NightLase™ Er:YAG laser (Fotona, Slovenia) treatment for snoring. Patients with snoring problems visited our clinic for a period of 1 year. Data were obtained upon admission and from follow-up records and questionnaires. The protocol was approved by the Ethics Committee of the Antalya Training Research Hospital. Er:YAG laser treatment and alternative therapies were presented to all patients, and explanations were given regarding the potential risks and benefits. Patients were included in the study if they were ≥ 18 years of age and were considered simple snorers (i.e., underwent polysomnography) with an Apnea-Hypopnea Index of <5. The exclusion criteria were photosensitive drugs, pregnancy, any other simultaneous surgical treatment that may affect snoring (e.g., tonsillectomy or nasal surgery), nasal cavity obstruction (e.g., obvious deviation, polyps, adenoids, or turbinate hypertrophy), a neck size of >17 in (man) or 16 in (woman), and a body mass index of >25. All patients signed informed consent forms. An otolaryngologist performed Er:YAG laser application without the use of anesthetics or premedication (fig. 1). The thermal nonablative heating of the treated areas was scanned with a high-definition handheld thermal camera (fig. 2). During consultation, patients' throats were examined and characterized as type 2 or 3 according to Mallampati's classification. Prior to treatment, patients were grouped according to age (25–34, 35–49, and 50–70 years).

All patients were treated at the onset of treatment as well as 2 and 6 weeks after treatment. A specially patterned laser beam was used at the minimally invasive setting and repetitively fired at the soft intraoral tissue. Nonablative tightening was performed on the anterior pillar, soft palate, uvula

with the lower part of the hard palate, posterior pillars, tonsils, lateral tongue, and bottom of the tongue. The beam was manually delivered across the target. All applications were performed using an Er:YAG laser with a PS03 handpiece and patterned beam in noncontact mode. The number of delivered treatment pulses per patient was dependent on the anatomy of the person, varying between 12,000 and 17,000. The procedure was stopped when shrinking of the mucosa was observed.

Table 2. Post-Er:YAG laser treatment improvement and satisfaction assessment

	1	2	3	4	5	Score
Part 4 Evaluate the condition of your snoring problem following treatment	Worse	No change	Somewhat improved	Improved	Much improved	
Evaluate your satisfaction with the snoring treatment you received thus far	Dissatisfied	Neutral	Somewhat satisfied	Satisfied	Much satisfied	

Treatment effectiveness was evaluated with a clinical assessment and using a previously designed snoring questionnaire (table 1) comprising seven questions selected from the current and valid Epworth Sleepiness Scale and the Berlin Questionnaire.
A simple questionnaire was created to assess the severity of snoring and other problems associated with sleep-disordered breathing. There were four main parts of the questionnaire with answers graded on a 5-point scale. The first section concerning the bed/bedroom partner was particularly important. Following treatment, patients were asked to complete the questionnaire, which was then compared to patients' questionnaires scores prior to treatment (parts 1 and 2).
All patients were evaluated for pain after the treatment (part 3). After the last treatment session, 6–10 months following the initial treatment, patients and their bed/bedroom partners were asked to complete questionnaires (part 4; table 2).
Statistical analyses were performed using SPSS 18.0 software (SPSS Inc., Chicago, Ill., USA). Normality of the groups was tested using the Shapiro-Wilk test. Pre- and post-treatment scores were compared using a paired t test. Post-treatment scores were compared by the Kruskal-Wallis and Mann-Whitney tests with Bonferroni correction. P values of <0.05 were considered statistically significant.

Results: In total, 33 patients met the inclusion criteria and were included in the study. Of these 33 patients, 8 (25%) were female and 25 (75%) were male. All patients were aged 28–70 years (mean, 44.3 years). The majority of patients presented with symptoms of loud snoring and daytime somnolence. All patients had undergone polysomnography prior to treatment. Following Er:YAG laser treatment, several patients noticed improvement and reduced snoring. The patients' bed/bedroom partner(s) and family members also reported improvement and reduced snoring from these individuals. These results were supported by the snoring questionnaire, which also reflected a difference between snoring before and after laser treatment.
Patients' pre-treatment snoring scores (parts 1 and 2) ranged from 19 to 29 (mean, 24.4), their post-treatment scores ranged from 11 to 21 (mean, 15.9), and their improvement scores ranged from 3 to 16 (mean, 8.5). The improvement score was calculated by subtracting the post-treatment score from

the pre-treatment score. Differences in the pre- and post-treatment scores (parts 1 and 2) are listed in table 3 according to age group.
The post-treatment scores (parts 1 and 2) were significantly different from the pretreatment scores in all groups ($p < 0.001$). Post-treatment scores were examined according to age group. Post-treatment scores in Group I (25- to 34-year-olds) were not significantly different from those in Group II (35- to 49-year-olds) ($p = 0.954$). Post-treatment scores in Group III (50- to 70-year-olds), however, were significantly different from those in Groups I ($p = 0.001$) and II ($p = 0.002$).

Table 3. Descriptive statistics of improvement score (pre-application score – post-application score) according to age groups

Age group (years)	Improvement score			
	minimum	maximum	mean	standard deviation
I (25–34)	3	7	5.2	1.3
II (35–49)	5	12	7.9	2.2
III (50–70)	9	16	12.6	2.2

Statistically significant differences were observed between Groups I and II ($p = 0.009$) as well as between Group III and Groups I and II ($p < 0.001$).

During laser treatment, the patients' pain was assessed as mild, as determined by part 3 of the questionnaire. None of the patients required an anesthetic; however, 2 patients complained of mild temporary altered palatal sensation and 7 patients complained of a brief, transient dry throat/foreign body sensation in the throat. We observed no other adverse effects from laser treatment. None of the patients had any major complications.
All patients in this study suffered from habitual snoring prior to laser treatment. Following initial Er:YAG laser treatment, 25.2% of patients no longer snored. We noticed that improvement scores (pre- and post-score gap) of <5 did not positively correlate with satisfaction scores. Results from part 4 of the questionnaire indicated that after the third treatment, 65% of the patients were satisfied, more alert and focused, and breathed easier.

Discussion: Snoring is a social nuisance and may be a precursor to more serious conditions such as upper airway resistance syndrome and obstructive sleep apnea. Previous studies indicate that palatal flutter is the most important mechanism for snoring generation. Excessive daytime sleepiness in combination with simple snoring is a serious symptom that has been associated with increased occupational and traffic accidents as well as an increased rate of mortality. There are several treatment options for snoring and obstructive sleep apnea [6–8]. Treatment of simple snoring should be individualized and include conservative measures such as weight loss, position therapy, exercise, alcohol and sedative avoidance, and smoking cessation [9] . The next category of treatment is oral or dental devices used to advance the lower jaw, thus opening the upper airway to reduce or eliminate snoring [10, 11]. For more severe cases, physicians usually prescribe a continuous positive airway pressure (CPAP) device, which provides a constant flow of air into the mouth and nose so that the patient can breathe more easily during sleep. Other nonsurgical snoring therapies include oral tablets or nasal sprays containing different pharmaceuticals (e.g., decongestants). The first-line treatment for

sleep apnea is the CPAP device [12, 13]. When conservative treatments fail, surgical interventions are utilized (e.g., reduction, stiffening, and stabilization of the soft palate). Severe cases of snoring and apnea are typically treated with one of many surgical methods, mostly involving the uvula and soft palate, and sometimes also the pharynx (e.g., pillar procedure, injection snoreplasty, radiofrequency, and bipolar radiofrequency combined with injection). Some individuals choose not to treat their snoring condition because of numerous limitations, including high risks, costs, side effects, and low success rates of classical nonsurgical and surgical procedures [7, 13–17].

This study used a nonablative Er:YAG laser to tighten the uvula, soft palate, and surrounding tissues. The Er:YAG treatment provided a satisfactory outcome, similar to that achieved with other more aggressive treatments. The Er:YAG laser produces a wavelength of 2,940 nm. Its excellent energy absorption by water makes it an ideal laser for intraoral use and superficial skin resurfacing. As a result of the limited depth of penetration through the skin, there is less adjacent tissue damage, resulting in decreased erythema, edema, and pain. The Er:YAG laser can also cut hard tissue, including both bone and enamel, which makes it an obvious choice for oral and maxillofacial surgical procedures in which combination surgery is performed on both hard and soft tissue (i.e., crown elongation, tooth exposure, and implant uncovering procedures) [5] . The resulting shrinkage of collagen and neocollagenesis alters the throat configuration and consequently reduces snoring and other problems associated with sleep-disordered breathing. The average rate of improvement after three Er:YAG treatments was 65%. It is important to note that the results of our study using Er:YAG treatment may depend on the patient's type of snoring. For these reasons, examination prior to treatment and good anamnesis were essential for a patient to be included in this study. In addition to this concern, we also considered our exclusion criteria. The response rate to treatment could be improved by developing appropriate criteria to exclude nonresponding patients. It is also possible that variations in response to the treatment are a consequence of variations in the patients' collagen remodeling capacity [18]. The significantly better outcomes observed in elderly patients in our study might have been due to this remodeling capacity.

Er:YAG is a minimally invasive method that requires no special preparation, anesthetics, or post-treatment therapy. Besides surgery and other lasers, it is also minimally invasive and involves nonablative heating of the treated areas. The procedure was considered tolerable by the majority of patients. Furthermore, it is quick and easy to perform. Other studies have suggested that up to 80% of patients gain a sufficient benefit from Er:YAG laser treatment [19, 20] .

Although this study has limitations, the results on the ability of Er:YAG laser treatment to reduce patient snoring are quite encouraging. This study provides evidence that Er:YAG laser treatment causes little pain with a low risk of adverse side effects. It may reduce symptoms of snoring, at least in the short term. However, subjective data alone are not adequate, and objective testing will be needed to accurately document the efficacy of Er:YAG laser treatment on snoring. Additionally, most of the studies published on Er:YAG laser treatment were based on observational studies with a short observational time period following treatment. Long-term follow-up is essential to document the success of the Er:YAG laser procedure to treat snoring.

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Outpatient erbium:YAG (2940 nm) laser treatment for snoring:a prospective study on 40 patients

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Received: 26 July 2017 /Accepted: 3 January 2018 /Published online: 15 January 2018

Abstract: Snoring is a sleep phenomenon due to the partial upper airway obstruction during sleep which causes vibration of the tissues of the rhino-oro-hypopharynx and less frequently the larynx. This study evaluated the use and effectiveness of the erbium:YAG 2940-nm laser as an adjunctive in providing treatment for patients suffering from chronic snoring-related sleep disorders. A prospective study of 40 consecutive patients with snoring and sleep disorders was performed, assessing data before and after three Er:YAG laser treatment sessions. During laser treatment, the pain was almost absent. There were no side effects, except a very mild sore throat in 1 out of 40 patients. The patient's evaluation of satisfaction of the results obtained after the treatments showed that 85% of cases were very satisfied, 5 patients (12.5%) reported being fairly satisfied with the treatment and only 1 subject (2.5%) was not satisfied. Mallampati, Friedman Tongue Position, and degree of O (oropharynx) at nose oropharynx hypopharynx and larynx classification were significantly decreased after the laser sessions. The decrease of Epworth Sleepiness Scale and Visual Analogue Scale for loudness of snoring, waking up during sleep because of snoring, dry mouth on waking, and choking was all statistically significant. The incidence of dreaming during the night also raised significantly; 30/40 (75%) of cases perceived less tightness in their throat and better breathing after treatment. These results were stable at 20 months follow-up (14–24 q) in 72% of cases. Nonsurgical and non-invasive Er:YAG laser treatment demonstrated to be a valid procedure in reducing the loudness of snoring.

Introduction: Snoring is a phenomenon that is usually considered innocuous as it can only harm the bed partner of the snorer. Snoring can lead to crisis between couples and, according to the Nypost (Nypost, 9 January 2007 Dr. Rock Positano) in the USA, it is considered the first medical cause of divorce. Additionally, snoring may be very harmful for the patient because it can hide or precede an obstructive sleep apnea syndrome (OSAS) which is associated with hypertension, metabolic syndrome, diabetes, arrhythmias, coronary artery disease, heart failure, pulmonary hypertension, stroke, and neurocognitive and mood disorders [1, 2] as well as a major risk of car accidents through excessive sleepiness with mortality rates double those of other causes.

Snoring may hamper the quality of rest even if OSAS is not present, precipitating awakening because of its loudness. It occurs when a partial obstruction of the upper airways (rhino-oro-hypopharynx and in a minority of cases of the larynx) is present. The negative pressure provoked by the thoracoabdominal effort to breathe causes a vibration which determines the loudness of snoring. A nasal obstruction can accentuate the negative pressure enhancing snoring itself [3]. The key structure in snoring is the soft palate; it may vibrate through negative pressure that develops at this site and its structural length defines the severity of snoring or the appearance of apneas. Additionally, hypertrophic tonsils or an enlarged base of the tongue (for example in people who underwent tonsillectomy) can predispose snoring as well as, in a minority of cases, a "floppy" epiglottis [4]. The major source of vibration causing snoring has been observed in the soft palate and pharyngeal lateral

walls while the epiglottis and tongue base usually vibrate slightly [5]. If the obstruction becomes complete, snoring begins to be accompanied by apneas, with a variable degree of severity (OSAS).
To date, simple snoring has been treated with behavioral changes, pillar implant procedure, injection snoreplasty, various other surgical procedures, or with MAD (mandibular advancement device). Pillar implants are designed to work by stiffening the soft palate through the positioning of three tiny woven implants. Submucosal thickening is achieved by creating fibrotic capsules around the implants. Its aim is to decrease snoring and vibration of the soft palate. Postoperative pain usually lasts up to 3 days. This irreversible procedure is an efficient, reliable method in the long term but it could cause complaints such as dysphagia, foreign body sensation, and mouth dryness [6]. Injection snoreplasty uses the principle of palatal stiffening by creating scar tissue in the central part of the soft palate after injecting various sclerosing agents. The sclerosant agents cause palatal ulceration and sloughing, resulting in scar tissue, which is the aim of the procedure; this procedure may cause several days of postoperative pain [7]. Radiofrequency may also be used to cause stiffening of the soft palate by obtaining scar tissue [8] and has postoperative healing similar to injection snoreplasty, with swelling and at least 1 week of pain. There are many types of surgical treatments for snoring; among which, the best known are uvulopalatopharyngoplasty (UPPP), laser-assisted uvulopalatoplasty (LAUP) with an ablative laser, and radiofrequency tissue volume reduction (RFTVR). UPPP is performed under general anesthesia and patients are hospitalized at least for the first night after surgery. UPPP may have some significant complications ranging from respiratory complications, re-intubation, and pneumonia to cardiovascular complications, hemorrhage, and even death. LAUP and RFTVR are considered less invasive as they are performed under local anesthesia, but they have prolonged postoperative pain and many potential side effects, such as problems with smell and taste, pharyngeal dryness, globus sensation, vocal change, and pharyngonasal reflux [9]. All these surgical treatments are invasive, may have complications, and have low success rates and a quite significant number of relapses [10]. Nowadays, patients tend less to accept invasive surgical procedures and often decline to wear an oral appliance or discontinue such therapy in many cases (up to 55% of cases) [11]. Moreover, in the experience of the authors, there are some patients who refuse to wear a continuous positive airway pressure (c-PAP) device, even in cases of severe OSAS and when they are well informed about its risks [12]. Recently, a novel and preliminary outpatient Er:YAG laser treatment has been shown to be effective in reducing snoring and achieved a 65% satisfaction rate as well as improving the quality of sleep and breathing [13]. Based on these considerations, in our work, we wanted to see if we could raise the percentage of satisfaction of patients using a different approach based on the selection of the patient with a previous ear, nose, and throat (ENT) visit with Muller test and treating also the base of the tongue. In this study also, further parameters of sleep-related disorders were analyzed pre- and post-treatment.

Material and methods: The cohort for the present study consisted of 40 patients (29 male and 11 female, average age 53 years), who presented for snoring that caused relationship problems with bed partners, to the private practice of one of the authors (IFS). Treatment was provided using the erbium yttrium aluminum garnet laser (Er:YAG 2940 nm; LightWalker, Fotona, Slovenia). Five patients (12.5%) of these 40 presented for snoring and OSAS and they refused any other kind of treatment, including c-PAP, oral appliance (MAD), or surgery; preference was given for a non-invasive multi-step attempt from non-invasive to more invasive procedures to improve their apneas. The exclusion criteria were pediatric patients, pregnancy, and central (neuropathic) apneas.

All the following data were assessed before and after the treatment, in order to quantify the efficacy of the procedure or the better outcome of certain features for the patient.
During the pre-treatment, all patients underwent an ear, nose, and throat (ENT) examination visit with a modified Muller maneuver (FNMM) [14] with video-fibroscopy. The naso-pharyngoscope (Xion, Germany), connected to a high-resolution video system (Karl Storz Endovision TRICAM, Tuttlingen, Germany), was introduced through the nose to assess the anatomy of the upper airway. The FNMM was performed in the supine position without any pillow and the Muller test with NOHL (nose oropharynx hypopharynx and larynx) classification [15] was established, in order to evaluate the major site of obstruction and exclude cases with nonsuitable situations, i.e., floppy epiglottis causing laryngeal obstruction that cannot be reached with this outpatient laser treatment. The presence of laryngo-pharyngeal reflux (LPR) was evaluated with video-fibroscopy (Karl Storz, Germany), using Reflux Symptom Index (RSI) and Reflux Finding Score (RFS) [16]. Before treatment, the patients were divided into four classes according to Mallampati classification (class 1— full visibility of tonsils, uvula, and soft palate; class 2—visibility of hard and soft palate, upper portion of tonsils, and uvula; class 3—soft and hard palate and base of the uvula are visible; class 4—only hard palate visible) [17] and into 4 classes according to the FTP (Friedman Tongue Position) (Fig. 1) [17]. A body mass index (BMI) from 25 to 29.9 was considered overweight and a BMI of 30 or higher indicated obesity. Daytime sleepiness was evaluated using the Epworth Sleepiness Scale (ESS) [18] ranging from 0—lower daytime sleepiness—to 24—excessive daytime sleepiness. Patients who reported (together with their bed partner) an ESS over 9 were invited to perform a polysomnography to assess the presence of apneas. The same exam was also recommended in case of other suspect symptoms such as choking or the effective presence of apneas that were noted by the bed partner of the snorer. The polysomnography was analyzed by the same referent and using the same polygraph (CareFusion Noxturnal). The exception was for five patients who presented for snoring and OSAS and were examined in another medical practice.

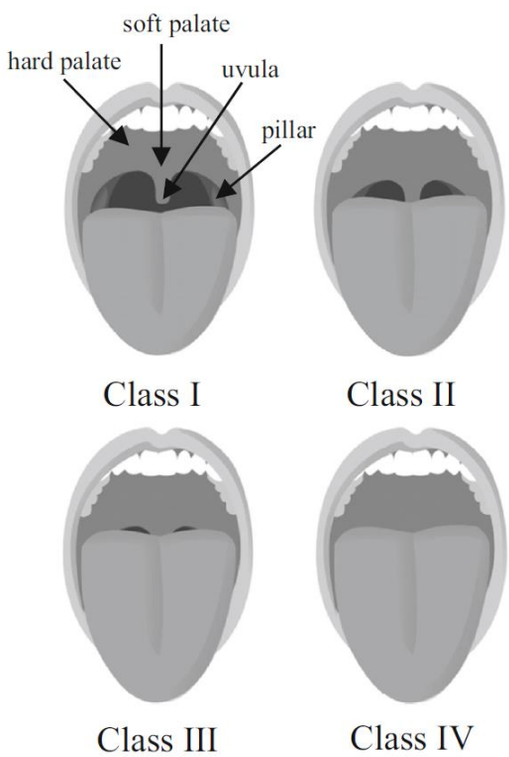

Fig. 1 FTP and Mallampati classification (Jmarchn, 2017, modified) [35]

The following parameters were scored by each patient and his/her bed partner before and after the treatment in order to quantify the efficacy of the procedure using a VAS (Visual Analogue Scale) from 1 to 10 pre- and post-laser treatment: the rating of snoring intensity (0—no snoring—up to 10— extreme snoring causing the bed partner to leave the bedroom) [8], difficulty to wake up at mornings, waking up during sleep because of snoring, dry mouth in the morning, subjective absence of dreaming during the night.
The treatment was performed on an outpatient basis.

Informed consent was obtained prior to initiating treatment and all the patients with OSAS were first informed to perform other kind of evidence-based treatments such as wearing c- PAP in moderate or severe OSAS, wearing MAD, or surgery, but they all refused to perform any other kind of treatment considered invasive or uncomfortable. Five cases already knew they were OSAS patients and wanted to try a mini-invasive treatment as they refused surgery, c-PAP, or MAD and were informed that in case of failure with OSAS, they could eventually perform multi-step treatments with an increasing degree of invasiveness and always controlling the results, step by step with polysomnography. The patients were all treated with the Er:YAG laser in a non-contact mode with irradiation of at least 7–8 pass of all regions with an overlap covering the entire mucosal surface, using a PS04 handpiece and collimated beam. The parameters were LP mode, 10 Hz, and fluence in the range of 1.6 J/cm2. The number of delivered treatment pulses per region and per patient depended on the severity of Muller test score, on the anatomy of the person, on the presence or absence of apneas, and on the severity of the symptoms and varied from a minimum of 11,086 to a maximum of 25,689 shots. Three sessions were performed at 0–15 and 45 days. The areas that were exposed to laser energy were soft palate and uvula and tonsillary regions, including the anterior and posterior pillars and the base of the tongue behind the circumvallate papillae as far as the anatomy of the patient and his compliance allowed (Fig. 2). Gag reflexes were overcome using relaxing breathing techniques, acupuncture point stimulations, or a topical lidocaine spray. The mechanism of action of the erbium:YAG laser is a photo-thermal effect, which causes shrinkage of the collagen fibers in the treated oral mucosa and initiates, through heat shock protein (HSP) action, a neo-collagenesis [19–22].

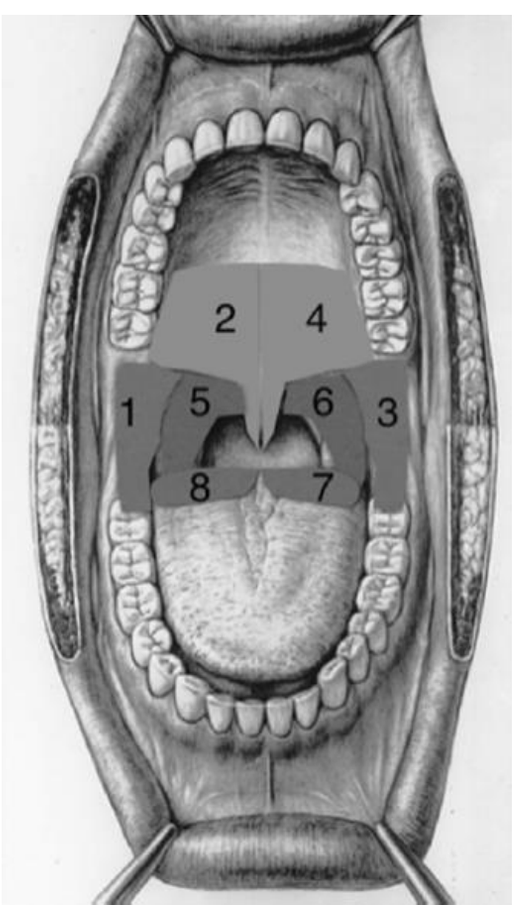

Fig. 2 Treated regions (Winter, 2017, modified) [36]

During the treatment, the pain response was measured on a Visual Analogue Scale (VAS) (from 0 = no pain to 5 = very severe pain). At the end of the treatment, the patient valued his/her immediate perception of a "wider throat" from a range from 0 to 5 and patients were asked about adverse effects.

Statistical analysis: Continuous variables are summarized as median (1st–3rd quartiles) and categorical variables as frequencies and percentages. Comparison of quantitative variables between pre- and post-treatment was made by Wilcoxon matched-pairs signed-ranks test, and comparisons of frequencies were made by McNemar test.
Values of $p < 0.05$ were considered statistically significant. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results: All patients completed all three sessions of the therapy. In 17 of 40 patients (42.5%), OSAS was first diagnosed performing a polysomnography for an altered ESS (Epworth Sleepiness Scale) or other suspect symptoms (choking, apneas noted by the partner). There were 22 OSAS patients; 4 patients had an initial OSAS (Apnea-Hypopnea Index (AHI) 5–15), 10 were moderate (AHI 15–30), and 8 severe OSAS (AHI > 30); 13 of these reported frequent choking during sleep.
Using the Mallampati classification, 20 of them (50%) were classified as class 4, 10 patients as class 3 (25%), 9 patients as class 2 (22.5%), and only 1 patient as class 1 (2.5%). Twenty subjects (50%) had a BMI lower than 25, 11 subjects (27.5%) were overweight, and 9 subjects (22.5%) were obese. Demographic and clinical characteristics of the enrolled patients were reported in Table 1.
All patients evaluated the pain during the therapy. After the first session, the median pain was 1 point (0–2), after the second it was 1 (0–1.7), and after the last one it was 1 (0–1) on the 0–5 pain scale. Gag reflexes were overcome using relaxing breathing techniques and acupuncture stimulations for the majority of patients. Only 4/40 patients (10%) received a topical lidocaine spray at the

Table 1 Demographic and clinical characteristics of the 40 patients enrolled at baseline

Median age (years)	51 (43–63.25)
BMI	24.9 (22.9–29.3)
Drug allergy	8 (20%)
Smoke	
Non smokers	31 (77.5%)
Current smokers	7 (17.5%)
Ex-smokers	2 (5%)
Comorbidities	15 (37.5%)
Quality of breath	
Not good	21 (52.5%)
Acceptable	9 (22.5%)
Good	10 (25%)
Assumption of concomitant drugs	17 (47.2%)
Septum	
Aligned	8 (20%)
Minor	5 (12.5%)
Moderate	11 (27.5%)
Severe	16 (40%)
Tonsils	
Intravelic	9 (22.5%)
Extravelic < 50%	12 (30%)
Extravelic > 50%	4 (10%)
Tonsillectomy	15 (37.5%)
Soft palate	
Regular	7 (17.5%)
Slackened grade 1	18 (45%)
Slackened grade 2	13 (32.5%)
Slackened grade 3	2 (5%)
Uvula	
Regular	9 (22.5%)
Slightly hypertrophic	16 (40%)
Severely hypertrophic	15 (37.5%)
Reinke's chronic vocal fold edema	4 (10%)
Laryngo-pharyngeal reflux	22 (55%)
Obstructive sleep apnea syndrome	22 (55%)

first session. In the successive laser sessions, gag reflexes lowered in all patients and there was no further need to use topical lidocaine. There were no other adverse effects of this laser therapy noted at any of the three sessions except a mild sore throat for a few hours in 1 of 40 (2.5%) treated subjects—these required no analgesic treatment and ceased spontaneously.
Patients were asked regarding their own satisfaction after the three laser sessions. Of the 40 treated patients, 34 (85%) were satisfied after the laser treatment, 5 patients (12.5%) reported being fairly satisfied with the treatment, and only 1 subject (2.5%) was not satisfied. All assessments were reevaluated 1 month after treatment with a final visit.
The Mallampati classification was significantly decreased after the laser treatment ($p = 0.001$), as well as the FTP and "O" (oropharynx) grade of obstruction at the NOHL classification
($p = 0.001$ for both) (Fig. 3).
Of 20 patients classified as class 4 from the Mallampati classification, 12 (60%) were classified as class 3 or 2 after the laser treatment, while 8 (40%) patients did not show any change; of the 23 subjects classified as class 4 from the FTP scale, almost 61% were classified as class 3 or 2 after the treatment.

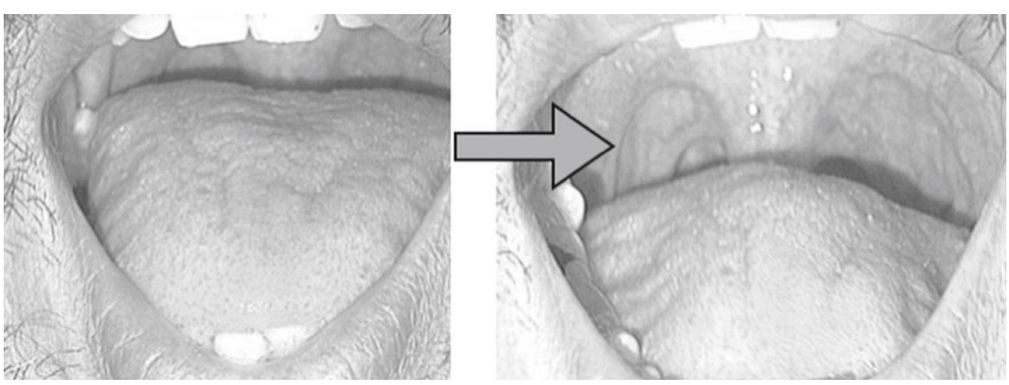

Fig. 3 Improvement of FTP from grade 3 (a) to grade 2 (b)

After the laser treatment, 30/40 (75%) patients reported to have an immediate sensation of breathing improvement and wider throat.
Apart from each patient's general assessment of snoring reduction, for more detailed result evaluation, the patients were provided with questionnaires assessing various aspects of patient's snoring experience before and after the treatment (Table 2).
Snoring severity significantly improved after the procedure. The median snoring VAS score according to the bed partners was reduced from a median value of 10 to 3 ($p < 0.0001$) which allowed to four couples that slept in separate beds to sleep together again while the daytime sleepiness, assessed with the ESS score, was reduced from 4 to a median value of 2 ($p < 0.0001$).
The quality of the sleep showed a significant increase from an initial median value of 5 to a median value of 10 ($p < 0.0001$), and also, the intensity of the dreaming perceived by the patients significantly increased ($p < 0.0001$). In particular, 15 patients who never reported dreams before the treatment began to dream again from the day after the first session.
Mouth dryness at wake-up time significantly decreased after the laser treatment ($p < 0.0001$), as well as the difficulty in waking in the morning ($p<0.001$) and the waking up during sleep because of snoring ($p < 0.0001$).
Notably, all but one (12 out of 13 patients) of the patients reporting choking before the treatment reported that this symptom had ceased ($p = 0.001$).

The subgroup analysis according to BMI categories and obstructive sleep apnea syndrome (OSAS) did not show any significant difference in reporting satisfaction of the treatment effect and improvement in breathing and in the variables assessing various aspects of patient's snoring situation.

The change in patient general assessment of snoring reduction, pre- and post-laser treatment, was significant in patients with and without OSAS and in normo-weight and overweight patients.

A subgroup analysis was performed to compare the improvement in snoring reduction in patients with or without tonsillectomy (excluding four patients with extravelic tonsil > 50%).

The change of patient's general assessment of snoring reduction, pre- and post-laser treatment, was significant in patients with and without tonsillectomy and only the improvement in dreaming and the reduction of the difficulty to wake up at mornings were non-significant in patients with tonsillectomy (p = 0.06 and p = 0.13, respectively).

Table 2 Comparison of patient's general assessment of snoring reduction variables pre- and post-laser treatment

	Pre-treatment $N = 40$	Post-treatment $N = 40$	p value
Friedman Tongue Position			0.001
Class 4	23/39 (59.0)	9/39 (23.1)	
Class 3	11/39 (28.2)	19/39 (48.7)	
Class 2	4/39 (10.3)	8/39 (20.5)	
Class 1	1/39 (2.5)	3/39 (7.7)	
Mallampati			0.001
Class 4	20/38 (52.6)	8/38 (21.1)	
Class 3	8/38 (21.1)	17/38 (44.7)	
Class 2	9/38 (23.7)	7/38 (18.4)	
Class 1	1/38 (2.6)	6/38 (15.8)	
Muller test (oropharyngeal)			0.001
Class 4	23/38 (60.5)	9/38 (23.7)	
Class 3	14/38 (36.8)	23/38 (60.5)	
Class 2	1/38 (2.6)	5/38 (13.2)	
Class 1	0/38 (0.0)	1/38 (2.6)	
Epworth Sleepiness Scale	4 (2–10)	2 (0–5)	< 0.0001
Epworth Sleepiness Scale			0.005
≤ 9	28/39 (71.8)	36/39 (92.3)	
> 9	11/39 (28.2)	3/39 (7.7)	
VAS snoring	10 (8–10)	3 (1–5)	< 0.0001
Restful sleep	5 (0–10)	10 (8–10)	< 0.0001
Difficulty to wake up	0 (0–7.5)	0 (0–0)	< 0.001
Dreaming at night	2 (0–10)	8 (6–10)	< 0.0001
Waking up during sleep	0.5 (0–5)	0 (0–0)	< 0.0001
Dry mouth	6 (0–10)	0 (0–0)	< 0.0001
Choking	12/37 (32.4)	1/37 (2.7)	< 0.001
AHI	16.4 (6.4–27.7) $N = 11$	15.1 (6.4–19) $N = 11$	0.08

Table 3 Differences in various treatments for snoring

	ER:YAG laser	Pillar implants	C-PAP	LAUP	UPPP	RFTVR ablation	Sclerotherapy	Oral appliance
Pain or discomfort	Low /none	Low	Low/medium	High	High	Low/medium	Low/medium	Low/medium
Potential side effect/most reported complication	None	Partial extrusion (< 1%)	Nocturnal awakenings (46%), nasal congestion and dryness (44%)	Transient VPi (27%)	Transient VPi (22%)	Mucosal ulceration and breakdown	Mucosal ulceration and breakdown	TMJ problems
Sedation	None	Local	None	Local/general	General	Local	Local	None
Recovery time	None	24 h or less	N/A	7 days	Up to 2 weeks	24 h or less	24 h or less	None
Snoring	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
OSAS	N/A	N/A	Yes	Yes	Yes	No	No	Yes
Physician time	Medium	Low	Low	High	High	Medium	Medium	Medium

VPi velopharyngeal inadequacy, *LAUP* laser-assisted uvulo-plasty, *UPPP* uvulopalatopharyngoplasty, *RFTVR* radiofrequency tissue volume reduction, *TMJ* temporo-mandibular joint

Notably, in the four subjects with extravelic tonsil > 50%, the treatment did not seem to be effective.
A recent paper of a series treated for snoring with an Er:YAG laser showed that the greatest improvement and satisfaction were experienced by patients aged ≥ 50 years [13].
Of the 22 OSAS patients, only 11 patients accepted to test their sleep through a polysomnography after the laser treatment. In those patients who accepted to undergo the polysomnography after the treatment, the measures of AHI before and after the treatment did not show any significant difference ($p = 0.08$). The patients that did not show an AHI improvement at polysomnography nevertheless noticed anyway a subjective improvement and were advised to proceed to further treatments to treat OSAS.
The 40 enrolled patients, after a mean of 20 months of follow-up (14–24), were asked by telephone interview to assess the sustainability of the improvement in snoring reduction. Thirty-two patients agreed to answer to the interview. All the interviews were performed by the same author (IFS) in order not to influence differently the patient. Twenty-three patients (71.9%) affirmed that their improvement was stable, five (15.6%) reported a partial loss of the effect, and only four (12.5%) patients reported loss of effect after 5 to 24 months (median 18.5 months). These latter patients were proposed to perform a new laser treatment if they wished. No patient had reported any subjective side effect at a mean of 20 months of follow-up, even if they did not want to repeat the polysomnography exam.

Discussion: Snoring can be treated in various ways. Lifestyle counseling is very important in patients with sleep disorders and patients should be advised to go to bed having had an early and light supper with no alcohol. Sleeping tablets should be avoided as well as the supine position. Older-generation antihistamine tablets should be replaced in those patients who need them, with new-generation drugs that do not cause sleepiness. Patients should be taught to sleep with the chest slightly up and on one side. A multi-step approach to sleep disorders raising from non-invasive to invasive procedures could be adopted and this could be applied also to snoring and not only to OSAS [23].
With the increase in the quality of life, many patients tend now to refuse a more invasive approach. Also, with greater awareness through the Internet, many know that UPPP and other related surgical procedures may be invasive, painful, and not only fail to improve patient symptoms, but may, in fact, result in a worsening in the patient's condition [24, 25].
Table 3 summarizes the differences in various treatments for snoring.
In this series, all kinds of existing procedures (surgery, MAD, c-PAP in OSAS cases) were illustrated to patients prior to the start of laser treatment and all the patients enrolled in this series refused any kind of invasive or uncomfortable treatment.
The outpatient Er:YAG laser treatments were assessed as non-invasive, non-painful, and had no side effects, even at follow-up, in keeping with other studies [13, 26–28].
Many authors reported that 65–85% of patients responded positively to the Er:YAG laser treatment [13, 26–28]. In this study, the treatment was effective in reducing the loudness of snoring and raising the quality of sleep in many other sleeping disorder symptoms and the results were statistically significant.
In snoring patients, the most frequent site of collapse is the oropharynx (uvula, soft palate, and lateral pharyngeal walls) and the base of the tongue which can be easily reached with the Er:YAG laser (especially the velum). The fact that the collapse can be present at the same time at different section

levels (also the epiglottis which cannot be reached with this type of procedure) may explain the lack of results in certain patients. The identification of the site and of the dynamic pattern of obstruction is mandatory in planning the therapeutic decision-making [29] and patients with a relevant BL^ collapse (larynx) at the NOHL classification should be excluded from treatment. Another criterion of exclusion for future patients could be the tonsil size obstructing over 50% of the oropharynx, as in these patients, the treatment did not seem to be effective.

A recent study demonstrated that the oropharyngeal airway significantly increased after the treatment as a result of the photothermic effects of the Er:YAG lasers [30]. The shrinkage was also noticed in the histological examination of the soft palate of 20 rats that were exposed to the energy of an Er:YAG laser using the same snoring handpiece (PS04) in a noncontact mode that was used in the present study. A noticeable contraction of the soft palate occurred immediately after laser application and this was also evident histologically in the soft palate after sacrificing the animal [31]. This explains the immediate sensation of a wider throat after the laser treatments that 75% of patients reported in this series and improvement in breathing, as affirmed by the patients. In fact, a lowering of FTP, Mallampati, and the degree of collapse at BO^ was observable after the treatment and was statistically significant. Other authors report this improvement of Mallampati after Er:YAG laser treatment for snoring [27].

Some recent articles [26, 30] reported the possibility of Er:YAG laser to be effective also in OSAS patients. In the present study, we observed that it raised the subjective quality of sleep in patients who refused any other kind of treatment, but it did not reduce AHI, so it might not be indicated in OSAS cases. There is the need for further investigation as the number of patients who accepted to perform a polysomnography after treatment is too little. Also, polysomnography was performed after 1 month, but it would have been better to perform it after the neo-collagenogenesis is well established, i.e., after 2–3 months.

One of the limitations of the present study is the lack of an objective measurement of the snoring's loudness before and after laser treatment. Other authors used the VAS of loudness of snoring to evaluate results after treatments [8]. The results were valued with a patient and his bed partner through interview and it was always performed by the same examiner.

Another limitation of the study is a lack of a control group, as only patients treated with Er:YAG laser were included. A further limitation is that all the patients refused a DISE (drug-induced sleep endoscopy) [32–34] prior to treatment. However, from the results obtained, it can be hypothesized that the nose oropharynx hypopharynx larynx (NOHL) while lying without cushion that was performed with an awake patient was sufficiently reliable.

Conclusions: Er:YAG laser can represent a good alternative to more aggressive standard treatment options for the treatment of snoring, as, comparing to more aggressive surgical and also nonsurgical methods, we report better results for simple snoring with no side effects or risks for the patients. Er:YAG laser treatment is easy to perform and has an extremely high success rate in producing a positive change in sleep patterns. It requires no device to be worn during sleep, involves no chemical treatment and no anesthesia, and does not require a sterile operational field [27].

Nonsurgical and minimally invasive treatment with Er:YAG laser was demonstrated to be effective in a statistically significant way, to reduce the loudness of snoring and many other sleep disorder symptoms by widening the upper airway. This laser treatment showed no major side effects through long-term follow-up and the results were sustainable at 20 months.

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CASE REPORT: A novel Erbium: YAG fractional laser treatment for reduction of snoring using „Romeo®“ handpiece: a pilot study

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Disclosures: All participants signed informed consent form. No financial or any other kind of compensation has been offered to the participants in this trial group. This lecture has been made possible with the help of Asclepion Laser Technologies – the manufacturer of the Romeo Laser.

Aim: To evaluate safety and effectiveness of the new laser handpiece for snoring reduction in order to establish a protocol for this kind of treatment and follow up.

Introduction: Snoring is the mildest one of entities in a group of disorders known as sleep disordered breathing. Usually, this is the first warning that severe airways obstruction while sleeping can occur. It is caused by combination of factors like excessively relaxed throat muscles, large uvula, large tonsils and/or adenoids, nasal congestion, structural problems of the nose – deviated septum or nasal polyps, cysts and tumors. Some non -“anatomical” factors can also contribute to snoring like excessive weight, alcohol consumption, allergies, smoking and sleep position, thyroid dysfunction and sedatives. Approximately half of all individuals over 60 snore regularly. Snoring people may be diagnosed with socially unacceptable snoring (SUS), which refers to snoring that is loud enough to prevent the sleeper's bed partner or roommate from sleeping. There are a large number of treatment modalities in order to reduce snoring as well as OSA depending of the cause. Most of them are related with patient discomfort and low compliance. That means that we are obligated to seek for treatment option which will be comfortable for patient (no pain, no swallowing problems, no general or local anesthesia, no absentism), safe and effective in the same time. We do believe that a fractional Erbium:YAG treatment with new “Romeo” 4 mm handpiece specially designed to treat the soft palate can be method of choice in patients with significant „webbing“ of the soft palate in order to boost collagen production and tissue tightening which reduces the vibration of the uvula, anterior tonsillar pillars and soft palate structures during sleep.

Patients and methods: This pilot study was conducted in Bagatin Clinic, Zagreb, Croatia from July 2016 to February 2017.
Ten patients – 9 men and 1 woman (age range 25-55; mean 38, 1 y.o.) with severe snoring were enrolled into study. Inclusion criteria were: socially unacceptable snoring due to fluttering of uvula, tonsillar pillars, and soft palate. Exclusion criteria were: Mallampati score >2, tonsils size according to Freedman > 2, severe nasal obstruction, craniofacial malformations and tumors.
Snoring severity was measured by patients using Snore Lab v.3.7.3 app (Riveva Softworks Ltd.) starting 48 hours after laser treatment. The patients were self-measuring themselves every other night for the period of 4 weeks and once weekly during weekdays for the period of 4-6 months after the treatment. The results were sent electronically to the Clinic.
All patients were treated by fractional YAG laser with newly designed handpiece in ambulatory facility without local anesthesia in sitting position. Handpiece was positioned on six points in anterior pillars,

uvula and soft palate using fractional mode E10, 300 nm, with fluence from 50 J/cm^2 to 70 J/cm^2 on Asclepion Erbium YAG MCL31 Dermablate Laser.

Results: No adverse effects were encountered. In all patients reduction of snoring was significant. Mean reduction of snoring in terms of time and amplitude was between 40% and 60% in 4-6 months interval, while more than 50% of the subjects and their bedpartners stated “excellent improvement”. At the time this abstract is written, 9 months post treatment results are still pending.

Conclusion: A novel Erbium: YAG fractional laser treatment using „Romeo®“ handpiece is safe and effective in treatment of simple snoring caused by fluttering of uvula, tonsillar pillars and soft palate. It is quick, easy to perform, has no downtime for the patients, can be done without local or topical anesthesia in ambulatory facility by any MD licensed physician with sufficient anatomical background. Our results are promising for proper selected patients in order to achieve better quality of sleep and quality of life in general.

CASE REPORT: NightLase® Procedure – Laser Snoring and Sleep Apnea Reduction Treatment

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ABSTRACT: Conventional treatments for snoring and sleep apnea have included everything from oral appliances to uvuloplastic operations, radiofrequency tissue ablation, CPAP (Continuous Positive Airway Pressure) masks and alternative medicine. Minimally invasive dentistry, with the use of a laser, now gives us the option for performing non-ablative Er:YAG tightening of the uvula, soft palate and surrounding tissues with a fractional laser handpiece. This treatment, called NightLase®, is provided by Fotona.
This case report describes the treatment of patients with sleep apnea using an Er:YAG laser, with a long-term follow-up from 28-36 months. These clinical cases are part of an uncontrolled study to evaluate the usefulness of the laser in snoring and sleep apnea treatment. Representative case examples following Mallampati classification are included and the benefits of NightLase® therapy over conventional methods will be explained.

I. INTRODUCTION: It has been estimated that roughly 30% to 50% of the US population snore and almost 1/3 suffer from sleep apnea. However, only 5% have been diagnosed and treated [1-2].
Snoring and sleep apnea result from obstructed airways. This can be an outcome of many different factors such as anatomic deviations, tumors, polyps, allergy, large adenoids and tonsils, large uvula or a long soft palate [3-6].
Heavy snoring is sometimes called “heroic” snoring and may affect bed partners, causing severe marital conflicts.
Snoring is not sleep apnea and sleep apnea is not snoring. Still, many patients with loud snoring often have obstructive sleep apnea (OSA).
An overnight sleep study known as polysomnography (PSG) should be conducted on severe snorers to conclude if they have OSA. During the sleep test, the number and length of possible apneic periods is recorded, and oxygen levels, heart rhythm (EKG), body position and teeth grinding are examined. Treatment can be discussed after the sleep study results are evaluated.
In obstructive sleep apnea syndrome (OSAS), several breathing pauses may cause a significant decrease in the blood oxygen level and cardiac arrhythmia. OSAS is life threatening [7] with long-term effects resulting in lung and heart problems.
This may also interact with the brain’s restorative REM sleep periods and cause concentration, memory and mood problems. Daytime sleepiness, morning headaches, sexual dysfunction, hallucinations and short-term memory loss are other problems related to OSA [7-9].

- Non-surgical treatment options for patients suffering from OSA include oral appliances, palatal implants, weight loss, alternative medicine and continuous positive airway pressure (CPAP) masks [10].
- Surgical methods include laser-assisted uvulo-palatoplasty (LAUP) or uvulopalatopharyngoplasty (UPPP)[11], radiofrequency tissue ablation (RFTVR) and palatal implants [12-14].

a) Laser Treatment Option: NightLase®: There are many benefits of the NightLase® treatment, such as no need for anesthesia, no pain and only three short 20-minute sessions with immediate results.
This case presentation describes the treatment of patients with sleep apnea using an Er:YAG laser, with a long-term follow-up period of 28-36 months. These clinical cases are part of an uncontrolled study to evaluate the usefulness of the laser in snoring and sleep apnea treatment.

II. MATERIALS AND METHODS: Patients with different OSA levels were included in this case report, all from a general dental practice. Ten (10) patients were randomly selected and five (5) typical cases are presented here in pictures – pre-op, post-op and recall. All treatments were performed from late 2011 to the first quarter of 2012. All patients agreed with the treatment protocol using the Er:YAG laser and allowed for the clinical photographs taken pre- and post-op to be used in presentations. Three (3) patients were using a CPAP mask before treatment. No anesthesia was used. Mallampati classification (Fig. 2) was used before and after the treatments.
All treatments were performed with a Fotona LightWalker AT laser (Fotona, Slovenia – also other Fotona models can be used). Before each treatment, the effects of the Er:YAG laser treatment were explained to the patient (Fig. 1a). A fractional laser beam (Fig. 1b) was used with a HP PS04 handpiece at minimally invasive settings according to the manufacturer's protocol:

- the laser beam is fired at soft intraoral tissue with a repetition rate of 10 Hz in LP mode
- the laser beam is manually delivered across the target, either vertically or horizontally (depending on the region)
- several passes are performed across each region (with well-defined overlap)
- the treated tissue is thermally processed and consequently shrinks
- sessions are scheduled in proper time intervals
- total delivered pulses vary per patient from between 10,000-15,000.

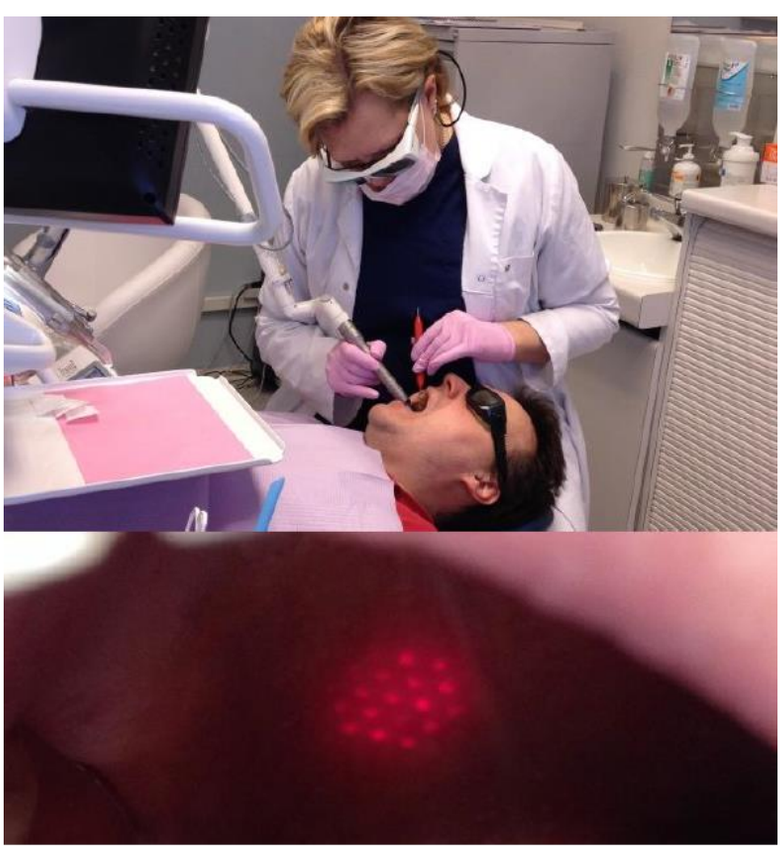
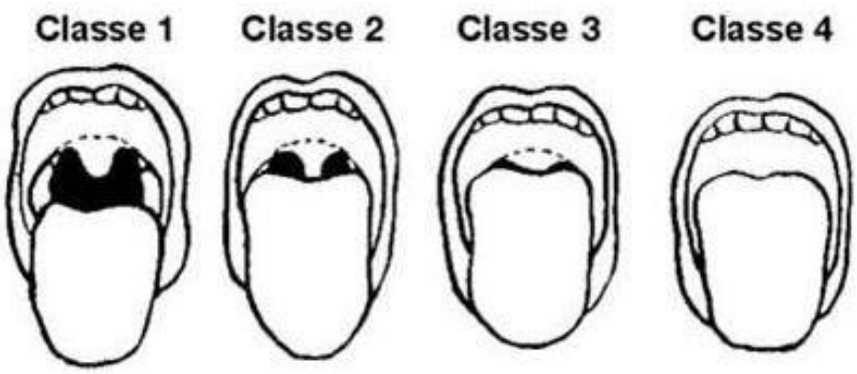


Fig. 1 a, b: Procedure showing NightLase® treatment



Class 1: Full visibility of tonsils, uvula and soft palate
Class 2: Visibility of hard and soft palate, upper portion of tonsils and uvula
Class 3: Soft and hard palate and base of the uvula are visible
Class 4: Only hard palate visible

Fig. 2: Mallampati classification

a) Clinical Case No. 1

The patient was a 46-year-old female patient. Medical anamnesis revealed severe OSA with related headaches and daytime drowsiness. Intraoral examination showed Mallampati class IV. The result post-op showed class I (Fig. 3).

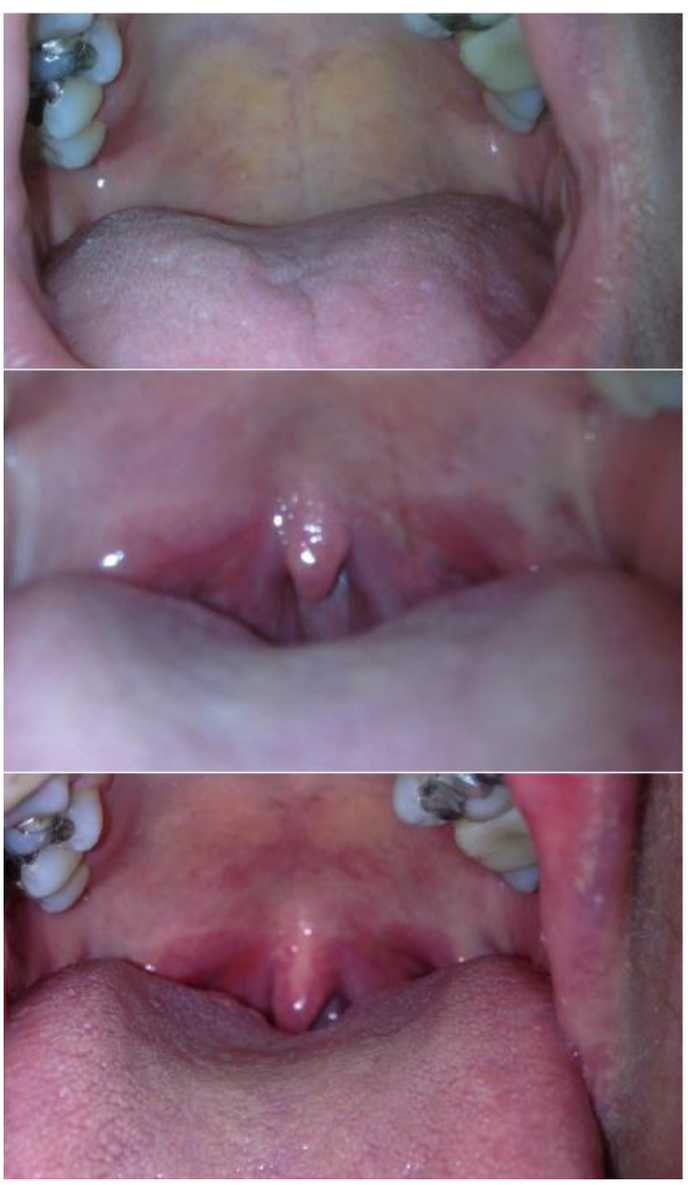


Fig. 3: Patient no. 1 a) pre-op class IV, b) post-op Tx3, class I, c) RC 36 months post-op, class II

b) Clinical Case No. 2

The patient was a 42-year-old female. Medical anamnesis included severe OSA and use of a CPAP mask. The biggest issue for the patient was heavy snoring causing relationship problems. Intraoral examination showed Mallampati class IV. The result post-op was class I (Fig. 4).

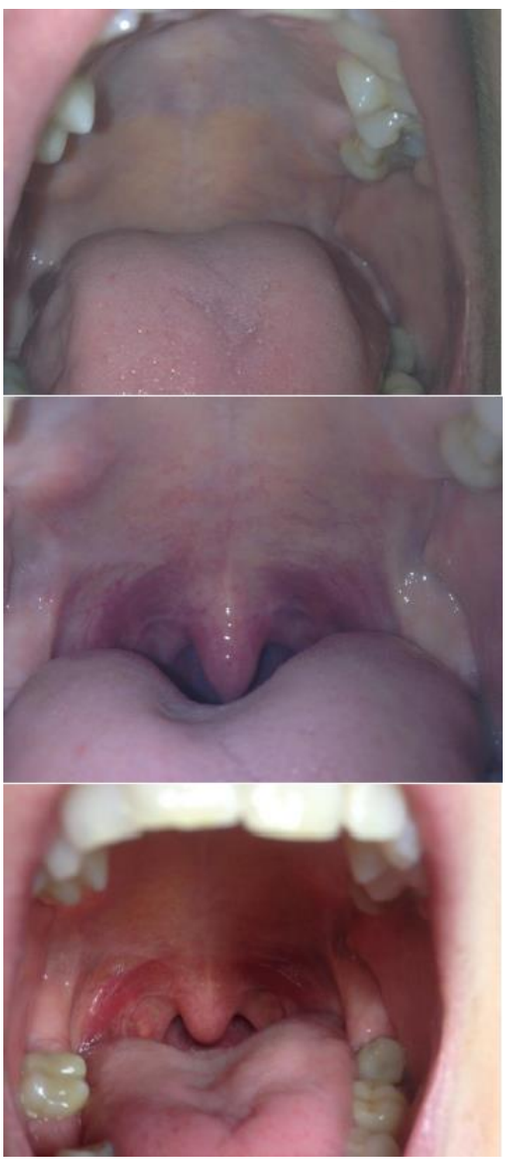


Fig. 4: Patient no. 3 a) pre-op, class IV, b) post-op Tx3, class I, c) RC 36 months post-op, class I

c) Clinical Case No. 3

The patient was a 30-year-old male and former ice-hockey player; lately not able to exercise at all – out of breath immediately; severe OSA. He had been using a CPAP mask now for two years with discomfort. Mallampati class IV was reduced post-op to class I (Fig. 5).

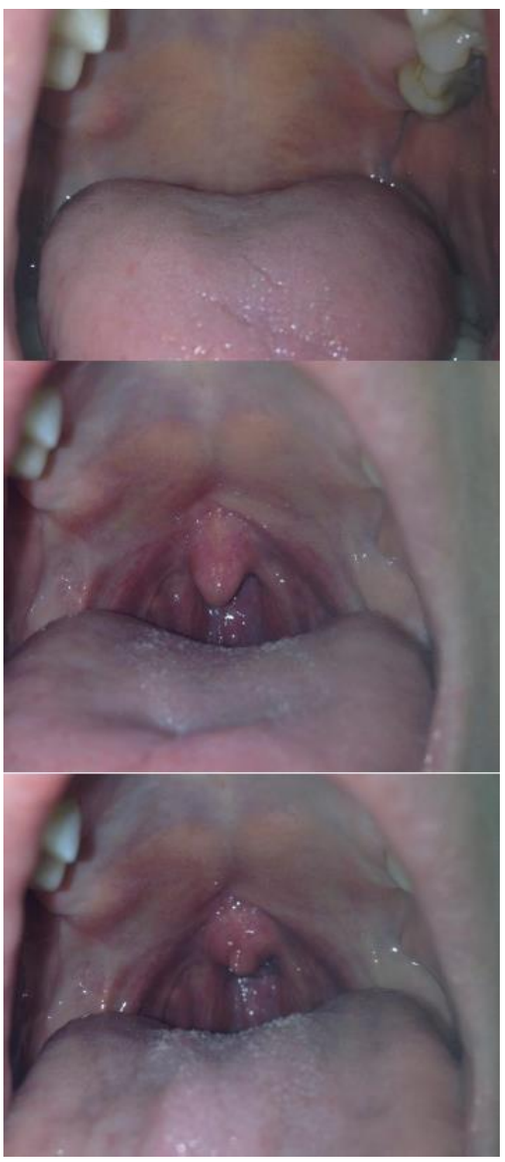


Fig. 5: Patient no. 3 a) pre-op, class IV, b) post-op Tx3, class I, c) RC 36 months post-op, class I

d) Clinical Case No. 4

The patient was a 45-year-old male with snoring and breathing problems causing relationship stress. Mallampati class IV was reduced post-op to class I (Fig. 6).

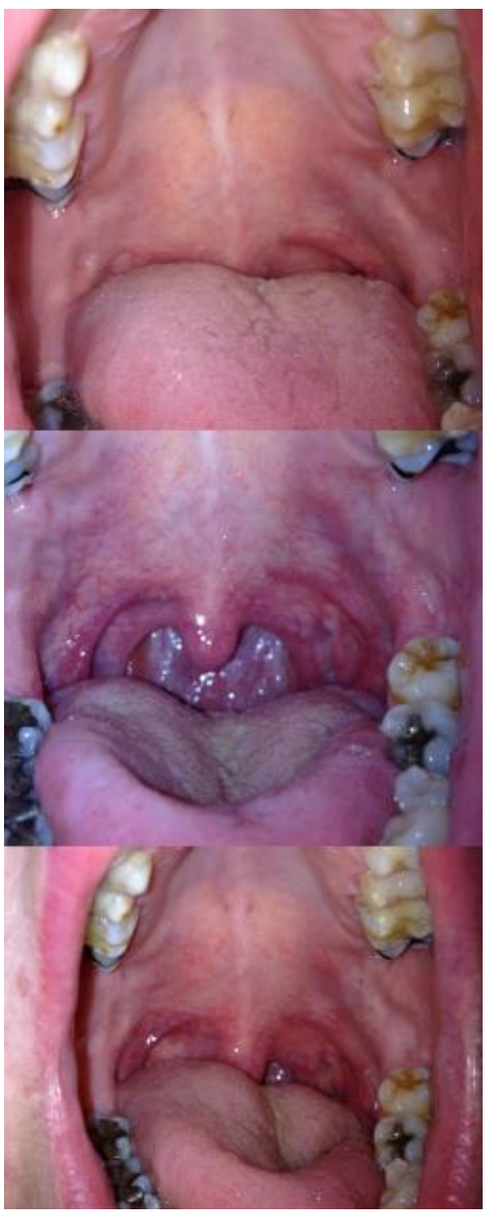


Fig. 6: Patient no. 4 a) pre-op, class IV, b) post-op Tx3, class I, c) RC 28 months post-op, class II

e) Clinical Case No.5

The patient was a 56-year-old male with moderate OSA; relationship problems, sleeping problems, sore throat and morning headaches. Mallampati class IV was reduced post-op to class I (Fig. 7).

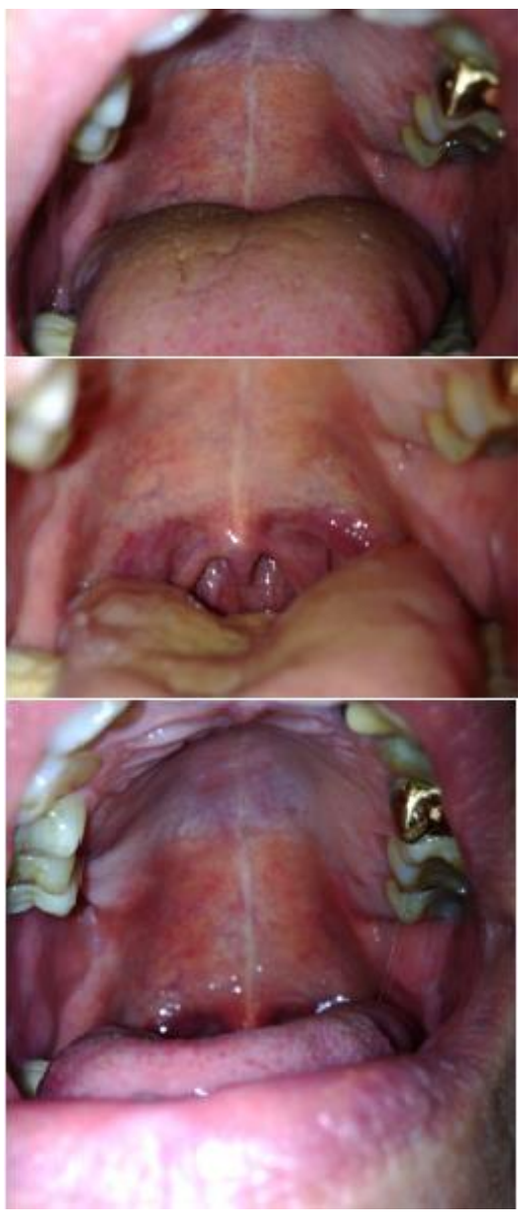


Fig. 7: Patient no. 5 a) pre-op, class IV, b) post-op Tx3, class I, c) RC 36 months post-op, class II

No anesthesia was used during these treatments. All patients using the CPAP mask could discontinue use of the mask after the 1st treatment.

III. RESULTS: After the third treatment, patients reported improvement better than 85%. Average improvement after one treatment session was 51% and after the second session, 61% (see figure 8).

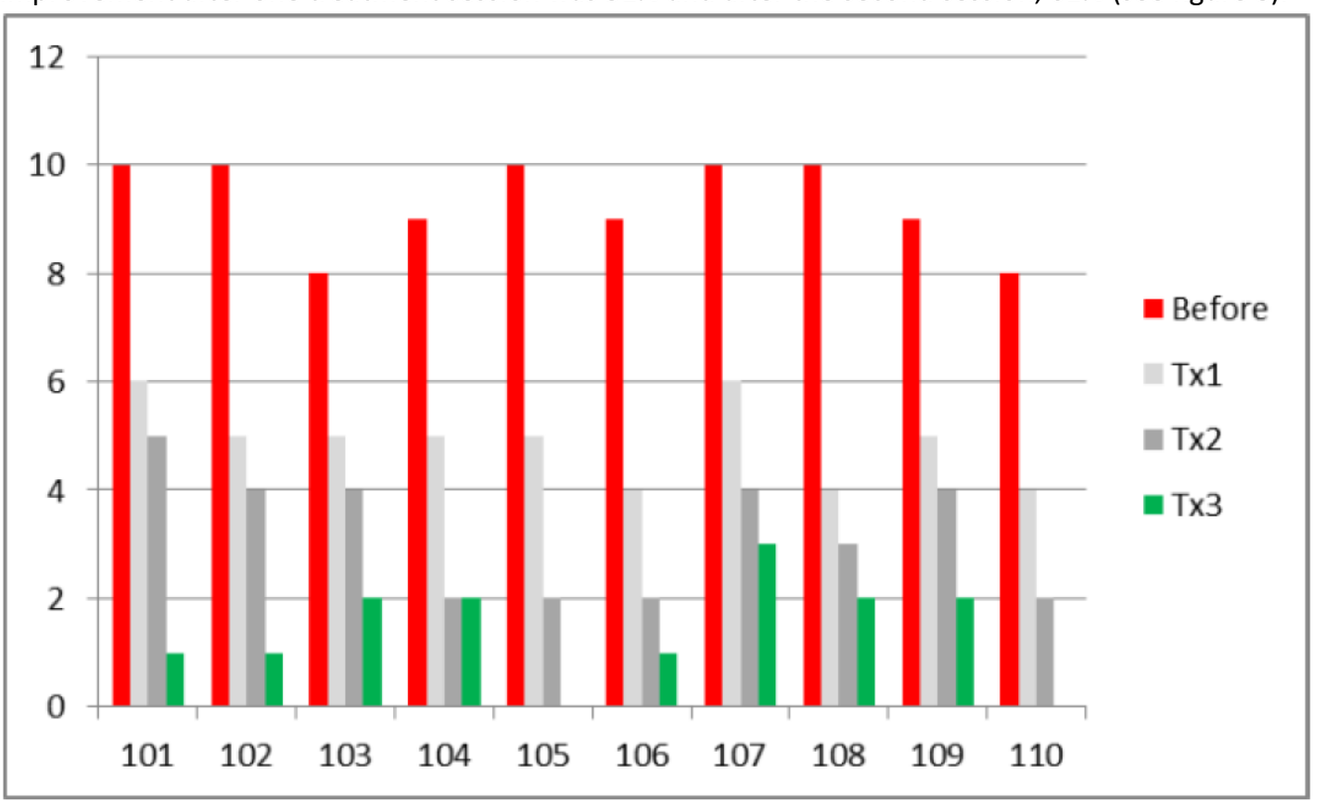


Fig. 8: Total score for snoring reduction: post-op 3 treatments

IV. DISCUSSION: Both snoring and sleep apnea are cause for several health issues and are potentially life-threatening [8]. Still, most patients are unwilling to treat these due to multiple side effects, unsuccessful non-surgical and surgical treatments and uncomfortable procedures [15].
Among other treatments, a minimally invasive laser treatment is now available. In this method, laser light is used for non-ablative thermal heating of the tissue, which subsequently causes shrinking of the collagen fibers. This phenomenon opens up the airways and reduces snoring and sleep apnea.
In these treatments the success rate was over 85% (figure 8). Even after 28-36 months the results were still good. NightLase is an easy treatment to perform, with no pain during or after the treatment. Therefore it can also be repeated with minimum discomfort to the patient. The procedure is safe with no need for anesthesia or medication. Consequently, it produces a good night's sleep and better life quality for the patient and their partner sharing the same bed. However, patient selection with proper examination and exclusion criteria is important to identify the therapy needed.

V. CONCLUSIONS: NightLase® is a safe and very successful treatment for reducing snoring and sleep apnea. It is a minimally invasive treatment with no need for special arrangements, either pre- or post-therapy. Since no anesthesia is needed, the treatment is well accepted by patients. Long-lasting effects –from one year up to 36 months – allow for high overall satisfaction among patients. NightLase is supported by Evidence Based Dentistry.

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