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Laser-Based Rejuvenation of the Upper Airway: A Novel Non-Surgical Approach to Habitual Snoring

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Abstract

Introduction: This study aimed to evaluate the efficacy of Erbium-Doped Yttrium Aluminium Garnet (Er: YAG, 2940 nm), combined with a long-pulse Nd: YAG laser, in mitigating habitual snoring.

Methods: Thirty patients participated in the single-arm prospective study, receiving approximately 20,000 pulses of the Er: YAG laser directed at the target sites using a patterned beam from the PSO3X handpiece in Long Pulse (LP) mode, followed by long-pulse Nd: YAG irradiation of the submental and lateral neck region. Treatments were administered on days 0, 15, and 45. The treatment response was evaluated through subjective methods, including the Snore Outcomes Survey (SOS) and the Spouse/Bed Partner Survey (SBPS). Anatomical enhancement was assessed using the Mallampati classification before each session and nine months subsequent to the final session.

Results: The mean Mallampati class decreased from 3.50 ± 0.68 to 2.43 ± 0.73. Statistically significant alterations were observed in the SOS and SBPS scores, which increased from 47.10 ± 11.34 to 66.22 ± 11.18 and from 44.38 ± 16.22 to 63.11 ± 14.64, respectively. Older age showed a borderline correlation with the Mallampati class, whereas weight and BMI did not; patients with lower baseline SOS scores tended to improve more.

Conclusion: In this single-arm pilot study, the combined Er: YAG and Nd: YAG protocol was well tolerated and was associated with improvements in habitual snoring; controlled trials are required to confirm its efficacy in the early management of snoring.

Keywords: Snoring, Erbium-doped yttrium aluminium garnet, Obstructive sleep apnea

Introduction

"Sleep disordered breathing" (SDB) encompasses a range of conditions, ranging from simple snoring to obstructive sleep apnoea (OSA).[1,2] Snoring is highly prevalent in the general population and results from turbulent airflow and vibration of pharyngeal tissues.[3] In the United States, snoring has been linked to increased marital discord and even divorce.[3] Additionally, if uncomplicated snoring is not addressed at its nascency, the patient's symptoms may worsen, potentially resulting in the onset of OSA, a condition marked by episodes of hypopnea or complete apnoea, usually caused by the collapse of soft tissue in the upper airway.

OSA can be diagnosed by a history of breathing difficulties during sleep and the occurrence of five or more episodes of hypopnea or apnoea per hour during a sleep study.[1,2] It has been linked to various serious or chronic medical conditions, such as hypertension and angina pectoris,[2] and, as sleep-disordered breathing progresses, to cardiovascular disease and excessive daytime sleepiness. The last of these is widely regarded as a contributor to impaired daytime functioning.

While numerous surgical procedures, including uvulopalatopharyngoplasty, can offer considerable alleviation of symptoms associated with sleep-disordered breathing, these interventions often involve considerable pain and discomfort during the postoperative phase. Non-surgical interventions, such as continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP) machines, often induce discomfort for both the patient and their partner.[4,5] Recently, erbium-doped yttrium aluminium garnet (Er: YAG) lasers (2940 nm) have been shown to be effective in alleviating the symptoms of SDB by promoting collagen remodelling in the submucosal tissues without downtime. This neocollagenesis effectively preserves airway patency in the upper airway (UA).[6] Although certain studies have demonstrated the efficacy of this treatment method in Western populations, it has not been investigated in patients from Asia, who are more susceptible to snoring due to a greater accumulation of visceral fat that further narrows the upper airway.[6-8] To date, the combination of oropharyngeal Er: YAG and submental Nd: YAG laser therapy has not been evaluated for habitual snoring in an Indian and more broadly an Asian population, in whom narrower upper airways and greater visceral adiposity may influence response. We therefore aimed to assess the subjective and anatomical effects of this combined protocol.

Methodology

The study included thirty patients who sought treatment

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for habitual snoring. Baseline assessment included a comprehensive medical history, lifestyle evaluation (smoking, alcohol, sleep posture), and physical examination. Inclusion criteria were habitual snoring for at least 6 months and willingness to participate in follow-up assessments. Exclusion criteria included pregnancy, craniofacial malformations, recent nasal or pharyngeal surgery, a history of sleep-related neurological disorders, and use of other snoring therapies within the past 3 months.

The study was approved by the Institutional Ethics Committee (approval number I.E.S.C/189/2024, dated 11/2024), and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants, including consent for the use and publication of clinical images.

The patency of each patient's oropharyngeal airway was assessed at baseline and again nine months post-final session using the Mallampati classification, which has the following classes: Class I—complete visualisation of the soft palate, uvula, and tonsils; Class II—visualisation of the soft palate along with the superior aspect of the tonsils and uvula; Class III—visibility limited to the base of the tonsils and soft palate; Class IV—only the hard palate is visible. A Snore Outcomes Survey (SOS), which measured a subjective change in the patient's airway, and a spouse/bed partner survey (SBPS) were also filled out by the patient and their partner, respectively. The SOS and SBPS are widely recognised and validated tools that are employed in the subjective assessments of patients suffering from sleep-disordered breathing (SDB).[9,10]

The SOS questionnaire contains 8 questions that assess different aspects of a patient's snoring. Questions 1, 2, and 8 evaluate the patient's perceived intensity and severity of their snoring. Questions 3 and 4 address the relationship between snoring and excessive daytime sleepiness. Questions 5 and 7 examine the patient's perception of how snoring affects their partner's sleep quality. Lastly, question 6 asks the patient to compare their current snoring to how it was one year ago.

The bed partners of the patients were given the SBPS questionnaire to evaluate how the patients' condition affects their quality of life. The first question asks the bed partner to rate the current severity of the patient's snoring, then to rate their perception of the severity of the snoring 4 weeks prior. Finally, the bed partner is asked to rate the extent to which they are bothered by snoring. Both questionnaires were quantified based on a Likert scale, with a score of 0 denoting very severe snoring and a score of 100 implying that the patient does not suffer from snoring.[9,10]

Laser Procedure

Each patient was positioned supine, and approximately 20,000 pulses of the Er: YAG laser were administered to the base of the tongue, buccal mucosa, pharyngeal arches, soft palate, uvula, tonsils, and posterior pharyngeal wall utilising a collimated and patterned beam from the PSO3X handpiece in Long Pulse (LP) mode (pulse duration of 600 μs) at 2.2 J/cm^2 with a 7-mm spot size (SP SPECTRO, Fotona, Slovenia).[8] In addition, a long-pulse Nd: YAG laser in piano mode (pulse duration of 0.3 - 60 seconds) was used on the submental and lateral neck regions at 250 J/cm^2 to promote lipolysis and reduce external airway compression. Subcutaneous temperature was maintained at 42°C using continuous infrared thermography (SP SPECTRO, Fotona, Slovenia). The procedure was performed on days 0, 15, and 45. Each session lasted approximately 30–40 minutes and was performed by the same dermatologist.

Evaluation

The patient's oropharyngeal opening was assessed utilising the Mallampati classification prior to each session (days 0, 15 and 45) and subsequently re-evaluated nine months after the final session. The primary outcome was to assess the improvement in the oropharyngeal airway using the Mallampati classification. This assessment was performed by a clinician blinded to the participants' previous scores. The secondary outcome evaluated enhancements in the Snore Outcomes Survey (SOS) and the Spouse/Bed Partner Survey (SBPS).[9,10]

Statistics

Statistical analysis was performed using SPSS version 21. Descriptive statistics, including means and standard deviations, were calculated for continuous variables, frequencies, and percentages for categorical variables to summarise the demographic and clinical characteristics of the study cohort and baseline snoring severity. Pearson correlation coefficients were computed to assess the linear relationships between continuous variables, specifically between demographic factors and baseline snoring severity scores, as well as between changes in Mallampati scores and subjective snoring outcomes. Paired t-tests were utilised to evaluate the statistical significance of changes in the Snore Outcomes Survey (SOS) and Spouse/Bed Partner Survey (SBPS) scores from baseline to post-treatment sessions. Independent samples t-tests and one-way ANOVA were employed to compare continuous outcome variables between different patient subgroups, such as those categorised by baseline Mallampati score and BMI. Chi-square tests were employed for categorical comparisons among responder groups. To identify independent predictors of continuous improvement in snoring severity, multivariate linear regression models were constructed, with change in the SOS score as the dependent variable and baseline demographic and clinical factors as independent variables. For clinically meaningful interpretation of treatment response, patients were categorised into 'High Responders (≥ 20-point improvement, n = 14)', 'Moderate Responders (10–19 points, n = 12)', and 'Non-Responders (< 10 points, n = 4)'. A p-value of less than 0.05 was considered statistically significant for all analyses.

No a priori sample-size calculation was performed, as this was an exploratory pilot study; a post-hoc sensitivity analysis indicated that, with 30 paired observations and $\alpha = 0.05$ (two-sided), the study had approximately 80% power to detect a within-subject effect size of Cohen's d

≈ 0.53. The normality of the paired difference scores was assessed using the Shapiro–Wilk test (SOS: W = 0.945, $P = 0.12$; SBPS: W = 0.944, $P = 0.17$; Mallampati change: W = 0.50, $P < 0.001$). The SOS and SBPS change scores were normally distributed and were analysed with paired t-tests, whereas the Mallampati change departed from normality and was analysed with the Wilcoxon signed-rank test. The three pre-specified pre–post comparisons (SOS, SBPS, and Mallampati) were treated as confirmatory primary and secondary endpoints, and all three remained statistically significant after Bonferroni correction for these comparisons; the demographic correlations, subgroup comparisons, and the multivariate regression were regarded as exploratory and hypothesis-generating; no formal correction for multiple comparisons was applied to these exploratory analyses, which are interpreted with caution.

Results

Demographics

Thirty patients were recruited for the study. 83.3% of the patients were male (n = 25), while the rest were female (n = 5, 16.7%). The average age of the participants was 45.8 years (± 10.7 years), with a mean BMI of 26.87 ± 3.34 kg/m². The majority of patients were married (73.3%, n = 22). The participants demonstrated multiple comorbidities, including hypertension (26.7%, n = 8), deviated nasal septum (20%, n = 6), diabetes (20%, n = 6), recurrent rhinitis (16.7%, n = 5), and hypothyroidism (6.7%, n = 2). Thirty percent of the patients (n = 9) were smokers, and 53.3% (n = 16) consumed alcohol. Fifty percent (n = 15) of the participants were identified as side sleepers, while 26.7% (n = 8) preferred a prone position and 23.3% (n = 7) chose a supine position. Ten patients (33.3%) reported experiencing sleep deprivation (Table 1).

Baseline Snoring Severity

The mean Mallampati score was 3.50 (± 0.68), and the average Snore Outcomes Survey (SOS) score was 47.1 (± 11.34) at baseline, suggesting that, on average, the patients exhibited an anatomically constricted airway and a moderate self-assessment of snoring severity. The mean score of the Spouse/Bed Partner Survey (SBPS) was 44.38 (SD ± 16.2), reflecting a similar level of snoring severity as perceived by their partners.

Age showed the strongest positive association with the Mallampati score ($r = 0.35$, $P = 0.057$), suggesting that older individuals tended to have more restricted oropharyngeal views, although the correlation narrowly missed statistical significance. Similarly, weight ($r = 0.20$, $P = 0.29$), BMI ($r = 0.12$, $P = 0.53$), and height ($r = 0.19$, $P = 0.31$) demonstrated modest positive correlations, though none reached significance.

Baseline SOS scores did not correlate significantly with BMI (r = -0.17, $P = 0.36$) or with age (r = -0.03, $P = 0.87$); older age was instead associated with a smaller improvement in snoring (r = -0.34, $P = 0.07$). No significant correlations were identified between baseline SOS scores and other demographic variables, including gender, alcohol consumption, smoking status, presence of rhinitis, deviated septum, comorbidities, duration of symptoms, sleep deprivation, or marital status. Similarly, no statistically significant correlations were identified between baseline SBPS scores and any demographic variables.

Table 1. Baseline characteristics of the study population (N = 30).

Characteristic	Value
Age, years	45.8 ± 10.7 (range 23-67)
Male/ Female gender	25 (83.3%) / 5 (16.7%)
Body-mass index, kg/m²	26.9 ± 3.3 (range 21.3-38.2)
Married	22 (73.3%)
Duration of symptoms, years	2.9 ± 2.3 (median 2.0)
Current smoker	9 (30.0%)
Alcohol consumption	16 (53.3%)
Sleep deprivation	10 (33.3%)
Previous BiPAP use	2 (6.7%)
Recurrent rhinitis	5 (16.7%)
Deviated nasal septum	6 (20.0%)
Hypertension	8 (26.7%)
Diabetes mellitus	6 (20.0%)
Hypothyroidism	2 (6.7%)
Sleep position (lateral/prone/supine)	15 / 8 / 7 (50.0 / 26.7 / 23.3%)

Values are mean ± SD or n (%).

Improvement in Mallampati Class

Marked improvements were noted in the mean Mallampati class, decreasing from 3.50 ± 0.68 to 2.43 ± 0.73 (Δ = -1.07 ± 0.37; 95% CI -1.20 to -0.93; Wilcoxon signed-rank test, $P < 0.001$), signifying a substantial enhancement in anatomical patency (Figure 1; Table 2). At baseline, there were 18 patients classified as Mallampati class IV, 14 of whom improved to class III (Figure 2), and 3 improved to class II (Figure 3). Additionally, 9 patients initially classified as Mallampati class III improved to class II, and 3 patients classified as Mallampati class II improved to class I (Figure 4). However, one patient classified as Mallampati class IV did not respond to the treatment and remained in the same classification. These changes remained persistent once evaluated again after 9 months.

Improvement in Self-Reported Snoring (SOS) and Partner-Reported Snoring (SBPS)

All 30 patients finished the SOS questionnaire; however, only 26 spouses or bed partners completed the SBPS. The SBPS received fewer responses because four of these patients slept alone in a separate room. The mean baseline SOS score (47.10 ± 11.34) demonstrated a significant improvement to 66.22 ± 11.18 following the treatment (Δ = 19.11 ± 10.19, paired t(29) = -10.27, $P < 0.0001$, Cohen's d = 1.88; 95% CI 15.31–22.91). Additionally, the SBPS exhibited a notable enhancement from 44.38 ± 16.22 to 63.11 ± 14.64 (Δ = 18.73 ± 8.85, paired t(25) = -10.79, $P < 0.0001$, Cohen's d = 2.12) (Figure 1). Across the three assessments, all outcomes improved progressively, with a statistically significant change at each successive sitting

Table 2. Primary and secondary outcomes from baseline to final assessment.

Outcome	n	Baseline (mean ± SD)	Final (mean ± SD)	Mean change (95% CI)	Statistical test	Effect size
Mallampati class (primary)	30	3.50 ± 0.68	2.43 ± 0.73	-1.07 (-1.20 to -0.93)	Wilcoxon, $P < 0.001$	dz 2.92
SOS (secondary)	30	47.10 ± 11.34	66.22 ± 11.18	19.11 (15.31 to 22.91)	Paired t(29) = 10.27, $P < 0.001$	dz 1.88
SBPS (secondary)	26	44.38 ± 16.22	63.11 ± 14.64	18.73 (15.15 to 22.30)	Paired t(25) = 10.79, $P < 0.001$	dz 2.12

Change scores: Mallampati expressed as final minus baseline (a reduction denotes improvement); SOS and SBPS as final minus baseline (an increase denotes improvement). Mallampati change scores departed from normality (Shapiro-Wilk W = 0.50, $P < 0.001$) and were analysed with the Wilcoxon signed-rank test; SOS and SBPS change scores were normally distributed. All participants improved on the SOS and SBPS; one patient showed no change in Mallampati class. Final values are those recorded at the day-45 assessment. SBPS n = 26 (four participants slept alone). dz, Cohen's d for paired data.

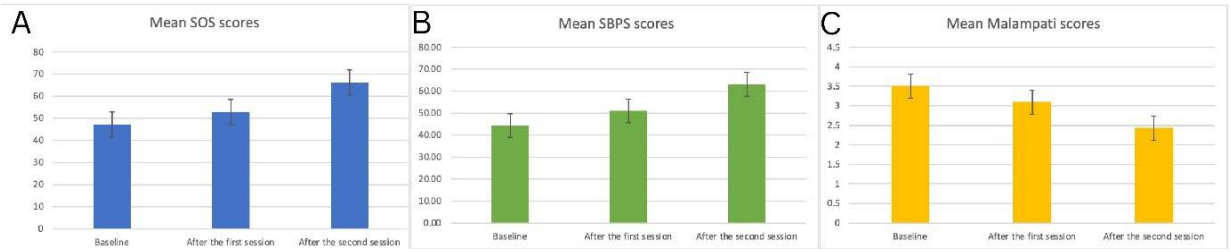

Figure 1. Bar graphs depicting the change in SOS, SBPS and Mallampati scores over time, (A) Mean SOS scores increased from 47.10 at baseline to 52.74 after the first session and eventually to 66.22 after the second session, (B) Mean SBPS values increased from 44.38 at baseline to 51.05 after the first session and eventually to 63.11 after the second session, (C) Mean Mallampati class reduced from 3.5 at baseline to 3.1 after the first session, and it eventually decreased to 2.43 after the second session

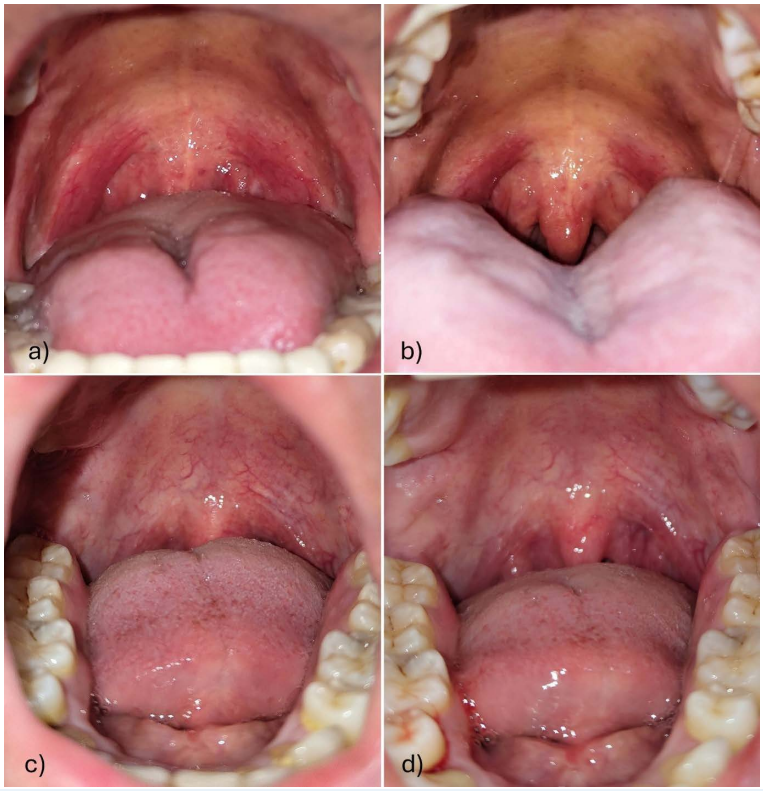

Figure 2. Improvement in the Mallampati class of two patients from class IV (a) and (c) to class III (b) and (d), respectively

(Friedman test, $P < 0.001$ for SOS, SBPS and Mallampati; Kendall's W = 0.96, 0.90 and 0.77, respectively), and every pairwise step remained significant after Holm correction (Table 3). For the continuous outcomes, this was confirmed by repeated-measures ANOVA (SOS $F(2,58) = 87.1$; SBPS $F(2,50) = 93.9$; Greenhouse-Geisser-corrected $P < 0.001$). Every patient improved on the SOS, and 26 of 30 patients (86.7%) achieved an improvement of 10 points or more (high responders 46.7%, moderate responders 40.0%, non-responders 13.3%).

Mallampati improvement and SOS change were not significantly correlated (r = -0.12, $P = 0.54$). Age and weight showed weak, mostly non-significant negative associations with improvement (age with SOS change r = -0.34, $P = 0.07$; weight with SBPS change r = -0.39, $P = 0.05$). Lower baseline SOS scores were associated with greater improvement (r = -0.47, $P = 0.01$), a relationship that may partly reflect regression to the mean. One-way ANOVA indicated no significant differences in SOS improvement between Mallampati classes I–IV ($F = 1.95$, $P = 0.162$).

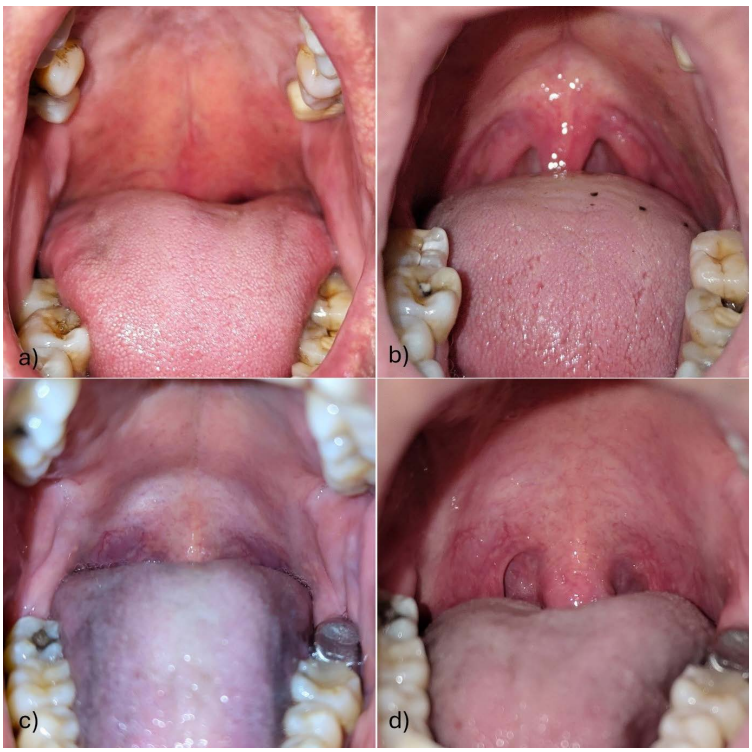

Figure 3. Improvement in the Mallampati class of two patients from class IV (a) and (c) to class II (b) and (d), respectively

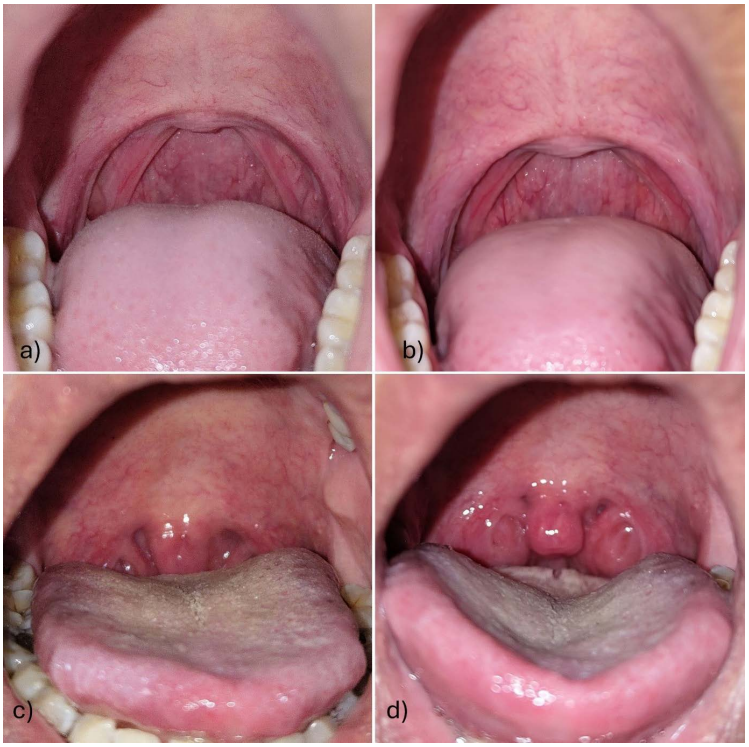

Figure 4. Improvement in the Mallampati class of two patients from class II (a) and (c) to class I (b) and (d), respectively

Table 3. Change in each outcome across the treatment course

Outcome	Baseline	After session 1 (day 15)	After session 2 (day 45)	Omnibus test	Pairwise (Holm-adjusted)
SOS	47.10	52.74	66.22	Friedman $p<0.001$ (Kendall W 0.96); RM-ANOVA $F(2,58)=87.1$, GG $p<0.001$	All three steps $p<0.001$
SBPS	44.38	51.05	63.11	Friedman $p<0.001$ (Kendall W 0.90); RM-ANOVA $F(2,50)=93.9$, GG $p<0.001$	All three steps $p<0.001$
Mallampati	3.50	3.10	2.43	Friedman $p<0.001$ (Kendall W 0.77)	All three steps $p\leq0.001$

GG, Greenhouse-Geisser corrected (applied because Mauchly's test indicated non-sphericity). Kendall's W is the effect size for the Friedman test. Pairwise comparisons used the Wilcoxon signed-rank test with Holm correction.

Predictors of Treatment Response

High responders tended to be younger and had a slightly lower BMI. A multivariate regression analysis using age, BMI, and baseline Mallampati score as predictors of SOS improvement demonstrated no statistically significant independent predictors ($R^2 = 0.16$, $P = 0.20$). Trends demonstrated diminished responsiveness correlated with advancing age and elevated Mallampati class at baseline. Subgroup analyses indicated that non-smokers, side-sleepers, and patients devoid of comorbidities or rhinitis exhibited the highest average responder scores. Conversely, patients with nasal septal deviation, comorbidities, or those who slept supine exhibited relatively diminished responsiveness. Despite lacking statistical significance, these trends may inform future patient selection and counselling.

Adverse Events

The sole adverse effect reported was a mild irritation at the posterior pharynx, as indicated by 23 patients (76.7%), which subsided after several hours.

Discussion

Our single-arm study suggests that the combined long-pulsed Er: YAG (2940 nm) and Nd: YAG laser protocol may be associated with improvement in habitual snoring as evidenced by a marked reduction in the Mallampati score from 3.50 to 2.43. These improvements may be attributable, at least in part, to the distinctive capacity of the Er: YAG laser to stimulate collagen tightening and the formation of new collagen, thereby reshaping and fortifying oropharyngeal tissues as demonstrated by prior studies with comprehensive histological evidence.[11-13] The efficacy was likely augmented by the reduction of submental and lateral neck adipose tissue, thereby diminishing external pressure through the application of the long-pulsed Nd: YAG laser.

The subjective improvements reported by our patients through the SOS and SBPS align closely with international findings. For example, Picavet et al. demonstrated an increase in the mean SOS score from 33.7 to 56.2 and an increase in the SBPS from 35 to 61.5 in the experimental group.[10] These changes were not observed in patients enrolled under the control arm of the study, suggesting that these alterations were unlikely to be caused by a placebo effect. Similarly, Neruntarat et al. reported a pooled patient satisfaction rate of 80% and noted a widening of the upper airway dimension.[8]

The clinical implications of our findings are significant. Improved airway patency would be expected to translate into better sleep quality; earlier Er: YAG series have reported sustained subjective benefit for both patients and their bed partners.[14,15] Additionally, reducing snoring can greatly enhance social and family relationships, resolving marital tensions and improving overall household harmony.[4,8] Further, Er: YAG therapy has been shown to be relatively long-lasting, as demonstrated by Kassab et al, with 65.2% of their patients being pleased with the long-term amelioration of their snoring. Nonetheless, 34.8% of the patients indicated a recurrence of symptoms following the 2-year follow-up.[14] This lasting efficacy is critical because many patients, especially in Asia, prefer non-invasive options due to cultural or personal apprehensions about surgery. The significance of our work is also underscored by the fact that it is among the first to be conducted in India and more broadly throughout Asia, where the prevalence of snoring is significantly higher, partially due to anatomical factors such as narrower upper airways and greater visceral fat deposition.[1]

From an economic and practical standpoint, Er: YAG therapy offers considerable benefits, especially in resource-constrained settings common in many Asian countries. Its minimally invasive nature, coupled with minimal side effects, quick recovery, and lower overall costs, makes it highly accessible and appealing for widespread adoption. High patient acceptance further improves its attractiveness as a feasible clinical solution in populous and developing nations like India.

However, not all patients in our study responded equally well to non-invasive therapy. Approximately 13.3% showed limited improvement, indicating the need for careful patient selection. Our study identified non-smokers, side sleepers, younger people and those with lower BMI and no comorbidities to respond better with laser therapy. Fini Storchi et al. similarly observed variability in response between individuals in their prospective Er: YAG series.[6] Thus, personalised patient counselling and targeted selection could greatly enhance treatment success.

Limitations and Future Research Directions

This study, while demonstrating promising subjective and anatomical improvements in snoring with Er: YAG laser treatment, has several limitations. Firstly, the study employed a single-arm, pre-post design without a control group, which limited our ability to definitively attribute the observed improvements solely to the laser treatment. In the absence of a control or sham arm, a placebo or expectation-related contribution to the subjective outcomes cannot be excluded. Secondly, the secondary outcome measures, SOS and SBPS, are subjective and may be influenced by patient and partner biases. Future studies would benefit from incorporating objective measures of snoring, such as polysomnography or acoustic analysis. Thirdly, the sample size of 30 patients is relatively modest, which may limit the statistical power to detect subtle but potentially important predictors of treatment response and interaction effects. Larger, multicentre studies are needed to confirm these findings and explore subgroup effects with greater precision. In addition, the Mallampati classification is a clinician-dependent, semi-quantitative measure that was not designed to track treatment-induced change and was used here as a pragmatic anatomical surrogate. The participants were also self-referred for treatment, which may introduce selection and expectation bias and limit generalisability. Finally, because the protocol combined oropharyngeal Er: YAG and submental Nd: YAG

treatment, the relative contributions of the two modalities cannot be disentangled, and the observed effects should be attributed to the combined protocol rather than to Er: YAG alone. Randomised, sham-controlled trials incorporating objective snoring measures, larger sample sizes, longer follow-up, and mechanistic investigations would further clarify the efficacy of this combined laser protocol and optimise patient selection and treatment protocols.

Conclusion

Our findings suggest that this combined Er: YAG/Nd: YAG protocol could be a safe and patient-friendly tool in the armamentarium against snoring. It has potential benefits in the preliminary stages of snoring management, especially in patients unwilling to undergo invasive procedures or chronic BiPAP therapy. Investigating genetic and lifestyle factors that influence responsiveness, refining laser parameters for specific populations, and employing objective assessments such as polysomnography will help refine and integrate this therapy into clinical guidelines.

Authors' Contribution

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Methodology: Rohit Kothari, Rohan Manoj, Aayush Gupta.
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Visualization: Rohit Kothari, Rohan Manoj, Aayush Gupta.
Writing–Original Draft: Rohit Kothari, Rohan Manoj, Aayush Gupta.
Writing – Review & Editing: Rohit Kothari, Rohan Manoj, Asharbh Raman, Shubham Deokar, Vishavjit Singh, Aayush Gupta.

Competing Interests

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pune.) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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