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ORIGINAL RESEARCH

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Patient tolerance in office-based blue laser therapy for lesions of the vocal folds: Correlation with patients' characteristics, disease type and procedure-related factors

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Abstract

Objective: To report patient tolerance in office-based blue laser therapy for vocal fold lesions.

Methods: A retrospective review of the medical records of patients who underwent office-based blue laser therapy for lesions of the vocal folds between November 2021 and February 2023 was conducted. A total of 48 patients were included. Patient tolerance was assessed using the Iowa Satisfaction with Anesthesia Scale (IOWA). Patient tolerance was analyzed in relation to patients' demographic characteristics, disease type and severity, and procedure-related factors.

Results: The mean tolerance score of the study group was 1.51 ± 1.1. There was a significant difference in the mean tolerance score between smokers and non-smokers ($p = .038$). Patients with vocal fold cyst ($n = 3$) had the highest mean tolerance score followed by patients with vocal fold polyps ($n = 15$). There was a nonsignificant difference in the mean tolerance score between benign lesions of the vocal folds and leukoplakia. Patients with lesions extending to more than half the vocal fold had less tolerance than those with lesions limited to less than half the vocal fold (1.91 vs. 1.27, p value .041). There was a moderate and significant negative correlation between vocal fold movement VAS, swallowing VAS, and tolerance score. The mean total duration of the procedures was 10.38 ± 4.8 min. There was a mild negative correlation between the duration of the procedure and tolerance.

Conclusion: Office-based blue laser therapy for vocal fold lesions is a well-tolerated procedure. Patient should be instructed how to breathe quietly and avoid swallows to improve tolerance to surgery.

Level of Evidence: 4.

KEYWORDS

blue laser, office-based, surgery, tolerance, vocal fold lesions

1 | INTRODUCTION

The last two decades witnessed a reform in laryngology practice toward office-based surgery. This reform is mostly attributed to advances in technology, namely the introduction of the flexible endoscope with a working channel and fiber-based lasers. The shift from the operating room to the office has improved time efficiency and helped contain cost, which is a rising concern in health care across the globe. More importantly, it has spared the patient the risk of general anesthesia and the morbidity of direct laryngoscopy such as dental and/or mucosal injury. Office-based laryngeal surgery has also enabled surgeons to operate on the larynx in its neutral position and monitor voice quality. Patient's engagement during surgery is paramount and can improve the surgical outcome.

Office-based laryngeal surgery includes a spectrum of procedures among which is laser surgery. Numerous studies indicate that in-office laser surgery for benign and premalignant lesions of the vocal folds is a safe and effective alternative to surgery performed in the operating room in selected cases. In 2006, Zeitels et al. reported the successful use of the potassium titanyl phosphate (KTP) laser in the treatment of vocal fold dysplasia and recurrent respiratory papilloma with a completion rate exceeding 94%.[1] In 2007, Koufman et al. reported their experience in a cohort of 443 cases treated with different types of lasers and noted good surgical outcome.[2] A systematic review and meta-analysis on office-based laser therapy for Reinke's edema showed improvement in subjective and objective voice measures following treatment.[3] Despite the increasing use of lasers in-office, there are inherent limitations that need to be considered, most important of which is patient tolerance. The literature on this topic is limited to the old generation of photoangiolytic lasers, namely the pulse dye laser (PDL) and the KTP laser. Blue laser is a new generation of photoangiolytic lasers with a different wavelength (445 nm) and distinctive hybrid properties in terms of cutting and coagulation. Its tolerance during office-based laryngeal surgery has not been previously described. The purpose of this investigation is to report patient tolerance in office-based blue laser therapy for vocal fold lesions. This study is limited to the treatment of one anatomic site, namely the membranous portion of the vocal fold to limit variation in tolerance secondary to topographic differences in sensory receptors across various laryngeal subsites.[4] Patient tolerance was analyzed in relation to patients' demographic characteristics, disease type and severity, and procedure-related factors.

2 | METHODOLOGY

After having obtained the approval of the Institutional Review Board (IRB ID: BIO-2022-0280), a retrospective review of the medical records and video-recordings of patients who underwent office-based blue laser therapy for lesions of the membranous vocal folds at a tertiary referral center between November 2021 and February 2023 (a period of 13 months) was conducted. All cases reviewed were performed by the same surgeon (first author) to limit surgeon-related variation in surgical dexterity. Lesions of the posterior larynx or other laryngeal subsites were excluded. A total of 48 patients were included in this review. Each patient underwent one single procedure in an awake setting. Local anesthesia to the oropharynx and hypopharynx was applied using 2–3 puffs of Xylocaine spray while anesthesia to the larynx was achieved by dripping 3 cc of 2% lidocaine HCL on the vocal folds via the working channel of the flexible nasopharyngoscope (11001 UD1 Karl Storz). All patients were asked to sustain phonation of the vowel /e/ during the dripping of the anesthetic solution to ensure a successful laryngeal gargle. Patient tolerance was assessed using the Iowa Satisfaction with Anesthesia Scale (IOWA), which is a self-administered questionnaire composed of 11 items to measure the patient's satisfaction. The statements alternate between negative and positive with a total of six negative statements and five positive statements. The patient is provided with a set of response choices from "disagree very much," scored as −3, to "agree very much," scored as +3, to determine his level of agreement with the scale's statements. The score of positive statements remains the same while that of the negative statements is reversed. The sum of the scores is then divided by 11 to determine the mean tolerance score for each patient that can range from −3 (totally unsatisfied patient) to +3 (totally satisfied patient).[5]

Demographic data included age, gender, smoking, and reflux disease based on the patient's history. Disease-related variables included type of pathology (Reinke's edema, polyps, cysts, leukoplakia, and papilloma), bulk of the lesion using the Yonekawa classification (which the authors extended its use to include polyps),[6] and extent of vocal fold involvement (less or greater than half the vocal fold). Procedure-related variables included duration of the surgery, number of joules delivered, vocal fold movement, and swallowing during surgery. The vocal fold movement and swallowing were gaged using the visual analog scale (VAS) from 1 to 10, with 10 being excessive movement and constant swallowing respectively.[7] Two of the authors independently reviewed the video-recordings to determine disease-related variables such as type of lesion, extent of vocal fold involvement and bulk, as well as the vocal fold movement and swallowing during the procedure. The inter-rater variability was computed to assess the reliability of the reported findings.

2.1 | Statistical method

Categorical and continuous variables were described using frequencies and means (±standard deviation), respectively. ANOVA and Independent *t*-test were used to analyze continuous variables. Spearman's correlation coefficient was used to determine the correlation between continuous variables. Interrater reliability was computed using Cohen's kappa coefficient. All analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 24 software package. A two-tailed p value <.05 was considered statistically significant.

3 | RESULTS

3.1 | Demographic data

A total of 48 patients who underwent 48 in-office blue laser surgery were included in this study. The mean age of the study group was 54 ± 13 years with a male to female ratio of 1.18. Seventy percent of the patients were smokers and 1 out of 3 had a history of reflux disease. The mean tolerance score of the study group was 1.51 ± 1.1. See Table 1.

3.2 | Tolerance score in relation to demographic characteristics

There was a significant difference in the mean tolerance score between smokers and non-smokers ($p = .038$). Patients above the age of 65 years had higher tolerance score than those below the age of 65 years (1.71 ± 1.34 vs. 1.45 ± 1.04, respectively); however, the difference between the two subgroups was not statistically significant. Gender and history of reflux disease had no significant effect on patient tolerance. See Table 2.

TABLE 1 Demographic characteristics of the study population.

Demographic data	Cases ($n = 48$)
Gender (male:female ratio)	26:22
Age in years (mean ± SD)	54 ± 13
Smoking (*N* (%))	34 (70.8)
Reflux (*N* (%))	16 (33.3)
Tolerance score (mean ± SD)	1.51 ± 1.1

Abbreviation: SD, standard deviation.

TABLE 2 Tolerance score in relation to patient-specific variables.

Demographic data (present:absent)	Present	Absent	*p* value
Age < 65 years (38:10)	1.45 ± 1.04	1.71 ± 1.34	.520
Male (26:22)	1.63 ± 1.22	1.36 ± 0.94	.388
Smoking (34:14)	1.31 ± 1.14	1.97 ± 0.86	.038*
Reflux (16:32)	1.46 ± 1.21	1.53 ± 1.06	.831

*Statistically significant $p < .05$.

3.3 | Tolerance score in relation to disease-specific variables

Patients with vocal fold cyst ($n = 3$) had the highest mean tolerance score followed by patients with vocal fold polyps ($n = 15$) (1.99 ± 1.43 and 1.84 ± 0.95, respectively). Those with Reinke's edema ($n = 19$) and leukoplakia ($n = 10$) had lower mean tolerance scores (1.32 ± 0.97 and 1.28 ± 1.46, respectively). There was a non-significant difference in the mean tolerance score between benign lesions of the vocal folds (Reinke's edema, polyps, cysts) and leukoplakia (1.58 ± 1.01 and 1.24 ± 1.39, respectively, *p* value .364).

There was a significant difference in the tolerance score between lesions occupying less than half the vocal folds ($n = 18$) versus those larger than half the vocal folds ($n = 30$) (1.91 vs. 1.27, *p* value .041). Patients with lesions extending to more than half the vocal fold had less tolerance than those with lesions limited to less than half the vocal fold. There was no significant difference in the mean tolerance scores of patients with type 1 ($n = 10$), type 2 ($n = 9$), and type 3 lesions ($n = 20$), indicating that the bulk of the lesion did not affect the tolerance of the patient. See Table 3.

3.4 | Tolerance score in relation to procedure-related variables

The mean VAS for vocal fold movement and swallows of the study group was 4.44 ± 2.75 and 3.83 ± 2.89 respectively. The mean total duration of the procedures was 10.38 ± 4.8 min with a range of 1.87–20.47 min. The number of joules was recorded for 29 out of the 48 patients (9 patients with Reinke's edema seven of whom had type 3 lesions; 13 patients with polyps five of whom have type 3 lesions; 2 patients with cysts; and 5 patients with leukoplakia). The mean total amount of energy given was 115.86 ± 82.5 J with a range of 13– 367 J.

There was a moderate and significant negative correlation between vocal fold movement VAS, swallowing VAS, and tolerance score. The higher the number of swallows, and the more frequent the vocal fold mobility, the less the tolerance. There was also a mild

TABLE 3 Tolerance score in relation disease-specific variables.

	More than ½ ($n = 30$)	Less than ½ ($n = 18$)			*p* value
Size	1.27 ± 1.19	1.91 ± 0.96			.041*
	Type 1 ($n = 10$)	Type 2 ($n = 9$)	Type 3 ($n = 20$)		
Bulk of lesion	1.87 ± 1.1	1.46 ± 1.07	1.46 ± 0.91		.534
	Reinke's edema ($n = 19$)	Polyps ($n = 15$)	Cysts ($n = 3$)	Leukoplakia ($n = 10$)	
Type of lesion	1.32 ± 0.97	1.84 ± 0.95	1.99 ± 1.43	1.28 ± 1.46	.516

*Statistically significant $p < .05$.

TABLE 4 Correlation between tolerance score and procedure-related factors.

	Spearman's correlation	*p* value
VAS VF movement	−.427	.002*
VAS swallowing	−.372	.008*
Number of joules	−.085	.660
Duration of procedure	−.237	.102

Abbreviations: VAS, visual analogue scale; VF, vocal fold.
*Statistically significant $p < .05$.

negative correlation between the duration of the procedure and tolerance. See Table 4.

4 | DISCUSSION

Office-based laser surgery is gaining ground as an effective treatment modality for benign and premalignant lesions of the larynx. However, this shift in treatment from the operating room to the clinic has its limitations such as restricted angle of visibility, inability to retract tissues, and difficulty in determining the endpoint of surgery.[8] Another major limitation that is of paramount importance is patient tolerance. Although proper administration of anesthesia to the upper airway is crucial, patient tolerance is also contingent on disease and procedure-related factors. The results of this investigation showed that tolerance score decreased with aging and increased significantly with history of smoking. Patients with vocal fold cysts and polyps had higher tolerance scores that those with vocal fold Reinke's edema or leukoplakia. Moreover, there was a negative correlation between the tolerance score, vocal fold movement and swallowing. The tolerance score decreased with the increase in the duration of surgery. This made sense given the expected attenuation of anesthesia toward the end of surgery.

The results of this investigation are in alignment with the results of previous studies on tolerance of office-based laser surgery using other types of lasers. See Table S1. In 2006, Rees et al. investigated discomfort level in 89 patients who underwent in-office PDL for various pathology of the upper aerodigestive system. On a scale of 1–10, with 1 being maximum discomfort, the average discomfort score during the procedure was 7.4. Most of the discomfort was in the throat. The average discomfort score decreased after surgery and more than 2/3 of their study group did not have to use painkillers. Among those who had previous treatment under general anesthesia, 87% preferred in-office surgery. The authors did not report the correlation between the discomfort score, patients' disease characteristics and/or procedure-related factors.[9] In 2009, Halum et al. reported their experience with the use of the CO_2 and the KTP lasers in-office for the treatment of 10 patients with benign laryngeal lesions. Patient's discomfort was rated immediately after surgery and postoperatively on follow up. Office-based laser surgery was well tolerated and the mean scores for burning, and pain were 2.3 and 2.0, respectively.[10] In 2012, Young et al. conducted a prospective study looking at patient tolerance for in office laryngeal procedures, 19% of which were KTP laser treatment. The average patient discomfort score on a scale of 1-00 was 37. More than 90% of the patients would undergo the procedure again and would recommend it to other patients. The average duration of the procedure was 13 ± 8 min and the overall completion rate was 92%. The authors discussed procedure-related factors such as the presence of copious secretions, limited angle of visualization and restriction in reaching the pathology, but no correlations of these factors with the discomfort VAS score were made.[11] In 2018, Hamdan et al. investigated patient tolerance in a cohort of 154 subjects who underwent 178 procedures including 63 thulium laser cases. All the laser cases were performed using the transnasal approach except for three cases which were operated via the transoral approach. Tolerability among other measures such as procedure discomfort, anxiety and overall experience were gaged on a scale of 1–5 with 5 being the least comfortable. Using the transnasal approach, the tolerability score was 1.68 ± 1.05 in the overall study group. There was no significant difference in the tolerability scores between males and females, nor between those above or below the age of 65 years.[12] Zheng et al. investigated disease-related factors and patient tolerance in a cohort of 56 patients who underwent in-office KTP laser therapy. Using the Derkay score to gage disease severity and its anatomic distribution, the authors found that patients with lesions of the posterior glottis had poor tolerance in comparison to those without posterior glottic lesions. There was also a negative correlation between the total number of anatomical laryngeal subsites involvement and tolerance score. The tolerance score differed significantly between those with vocal fold polyps and cysts, and those with Reinke's edema, dysplasia and recurrent respiratory papillomatosis. Patients with vocal fold cysts and polyps had better tolerance than those with other types of pathology. With respect to procedure-related factors, there was a significant negative correlation between the number of swallows, vocal fold movement, aberrant laser strikes and tolerance. The authors did not consider the duration of surgery or the number of joules delivered during the procedure. Regarding patients' characteristics, only smoking and reflux correlated with tolerance score.[7]

The results of our investigation and those reported by others stress the need for proper patient selection for office-based laser therapy. The surgeon should be more diligent in treating young patients with history of smoking. The decrease in tolerance score with age noted in our study, although statistically nonsignificant, is substantiated by the decrease in laryngeal sensation and attenuation of the adductor reflex that occurs with aging. Ma et al. investigated laryngeal sensory function using a tactile aesthesiometer in a cohort of 37 healthy adults and showed that for every 10 years of age increment, there was a 19% decrease in the odds of having a laryngeal adductor reflex. In their study, the tactile stimuli were delivered to the false vocal folds, aryepiglottic folds, and lateral pyriform sinus.[13] The negative correlation between smoking and tolerance reported in our study and in the study by Zheng et al. is also substantiated by the exaggerated cough and excess of mucus noted in smokers. Experimental studies have shown that chronic smoking causes an increase in cough sensitivity secondary to enhanced synaptic transmission from the upper airway cough receptors to the nucleus tractus solitarius.[14]

The results of our investigation also indicate that patients with vocal fold cysts and polyps had better tolerance than those with Reinke's edema and leukoplakia. This difference in tolerance score can be ascribed to the fact that cysts and polyps are discrete and well-delineated lesions in comparison to Reinke's edema which involves the entire membranous portion of the vocal fold. This alludes to the fact that the more extensive and spread the lesion is, the worse the tolerance level. This study also showed a negative correlation between tolerance score, vocal fold movement and swallowing VAS scores. These findings are reasonable knowing that a calm surgical bed facilitates unsedated office laryngeal surgery and improves tolerance. To that end, patient education and counseling prior to surgery is important. Patients scheduled for office-based laryngeal surgery should be instructed to breathe slowly and avoid swallowing as much as possible to help provide a still surgical field. There was also a mild negative correlation between the duration of the procedure and tolerance. This emphasizes the need for high dexterity and surgical skills to achieve the desired surgical outcome in a limited period. Despite the advances in the delivery of local anesthesia to the upper airway, using the "laryngeal gargle," percutaneous injections, or a nebulizer, surgery is limited by the short window of time that rarely exceeds 12–15 min.[15]

This study is the first to report patient tolerance to blue laser in-office laryngeal surgery, nevertheless, it has its limitations; one is its retrospective nature, two is the limited number of patients, particularly when stratified by type of pathology, and third is the inherent bias in the selection of patients for office-based surgery versus surgery in the operating room. A larger prospective study is needed to elucidate the clinical significance of the correlation of patient tolerance with demographic characteristics and disease type and severity.

5 | CONCLUSION

Office-based blue laser therapy for vocal fold lesions is a well-tolerated procedure. Age and history of smoking should be accounted for in patient selection. Treatment of discrete lesions of the vocal folds such as cysts and polyps are more tolerated than more spread lesions such as Reinke's edema. Patient should be instructed how to breathe quietly and avoid swallows to improve tolerance to surgery.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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