

Value and utility of 532 nanometre pulsed potassium-titanyl-phosphate laser in endoscopic laryngeal surgery

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Abstract

Objectives: Recently, the 532 nm pulsed potassium-titanyl-phosphate laser has emerged as an effective angiolytic laser for treating mucosal lesions of the larynx in the operating theatre and clinic. We sought to assess the current impact of potassium-titanyl-phosphate laser on our laryngeal surgery practice.

Study design: Retrospective review of 710 patients undergoing endoscopic laryngeal surgery over a one-year period.

Methods: Medical records of the endoscopic laryngeal procedures were reviewed; 386/710 had been performed in the clinic and 324/710 in the operating theatre under general anaesthesia. Indications for the procedures were classified by pathology.

Results: Pulsed potassium-titanyl-phosphate laser was used in 209/386 clinic procedures. The indications for these procedures were: dysplasia (114/209 procedures), papillomatosis (89/209), varices or ectasia (three of 209), and 'other' (three of 209). Pulsed potassium-titanyl-phosphate laser was used in 178/324 operating theatre endoscopic laryngeal procedures. The indications for these procedures were: cancer (54/178 procedures), dysplasia (52/178), papillomatosis (38/178), varices or ectasia (13/178), polyps (six of 178), nodules (six of 178), stenosis (five of 178), granulation (three of 178), and amyloid (one of 178).

Conclusions: Due to its versatility, the 532 nm pulsed potassium-titanyl-phosphate laser is our most commonly utilised instrument for performing endoscopic laryngeal surgery.

Key words: Larynx; Vocal Cords; Laser Surgery

Introduction

Photoangiolytic (also known as microvascular ablation) using lasers is a valuable strategy for treating many vocal fold lesions. This treatment approach is based on the concept of selective photothermolysis,^{1–3} wherein laser energy is confined to the microcirculation that supports growth of benign and malignant laryngeal disease. Photoangiolytic lasers target haemoglobin, and one of the peaks of greatest haemoglobin absorbance correlates closely to the wavelength of the 532 nm potassium-titanyl-phosphate (KTP) laser. The selectivity of photoangiolytic lasers leads to improved vocal outcomes by allowing maximum preservation of the layered microstructure of the vocal fold, including the superficial lamina propria.^{4,5}

Photoangiolytic has been shown to be effective in treating a number of lesions, including papillomatosis,^{6–11} dysplasia,^{4,12–14} microvascular angiomata^{5,15} and early glottic cancer.¹⁶ In recent years, the 532 nm pulsed KTP laser has emerged as an effective angiolytic laser for treating mucosal lesions of the

larynx, both in the operating theatre and the clinic (Figure 1). Its value and utility have been progressively established in the literature for a variety of lesions.^{17,18} However, there has been limited adoption of this technology to date. Therefore, we sought to assess the current impact of KTP laser on our laryngeal surgery practice.

Materials and methods

A retrospective chart review of 710 consecutive endoscopic laryngeal surgical procedures performed over a one-year period (1 July 2007 to 30 June 2008) was undertaken. We analysed the medical records of patients who had undergone endoscopic laryngeal procedures in the operating theatre (under general anaesthesia) and in the clinic (under local anaesthesia), in order to determine which procedures used 532 nm pulsed KTP laser (Aura XP; Laserscope, San Jose, California, USA). The number of cases using KTP laser was then reported as a fraction of the total number of endoscopic laryngeal cases during the one-year period. Those cases in which

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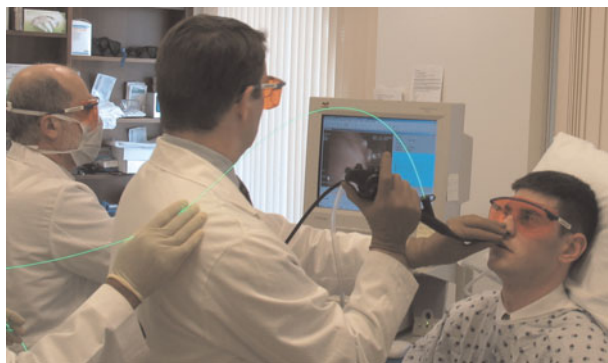


FIG. 1

Clinic treatment of a patient with glottic papillomatosis, using pulsed KTP laser. The laser fibre (green due to a pulse of 532 nm laser energy) is passed through the side-port working channel of a flexible laryngoscope.

the laser was used as the primary method of treatment, and cases in which it contributed to management of a vascular component of a lesion, were further classified according to laryngeal pathology.

This study was approved by the institutional review board of Massachusetts General Hospital.

Results

Of the 710 endoscopic laryngeal procedures reviewed, 386 (54 per cent) were performed in the clinic and 324 (46 per cent) in the operating theatre under general anaesthesia.

Fifty-four per cent of the 386 clinic procedures (209/386) were performed with pulsed KTP laser, and the remaining 46 per cent (177/386) using endolaryngeal injection. The majority of clinic procedures were done to treat dysplasia. Table I lists the laryngeal pathology treated in these 209 KTP laser cases.

Fifty-five per cent of the 324 operating theatre procedures (178/324) were performed with pulsed KTP laser. Glottic cancer was the most common diagnosis in these cases. The indications for these 178 procedures are listed in Table II.

Overall, 55 per cent (387/710) of all endoscopic laryngeal procedures undertaken in the one-year study period utilised KTP laser.

Discussion

Due to its versatility, 532 nm pulsed KTP laser is our most commonly utilised instrument for performing

TABLE I

LARYNGEAL LESIONS TREATED WITH 532 NM KTP LASER: CLINIC PROCEDURES*

Lesion	Cases (<i>n</i>)
Dysplasia	114
Papillomatosis	89
Varices or ectasia	3
Granuloma	1
Supraglottic cyst	1
Foreign body	1

*Local anaesthesia; *n* = 209

TABLE II

LARYNGEAL LESIONS TREATED WITH 532 NM KTP LASER: OPERATING THEATRE PROCEDURES*

Lesion	Cases (<i>n</i>)
Cancer	54
Dysplasia	52
Papillomatosis	38
Varices or ectasia	13
Polyp	6
Nodule	6
Stenosis	5
Granulation	3
Amyloid	1

*General anaesthesia; *n* = 178

endoscopic laryngeal surgery (being used in 55 per cent of all endoscopic laryngeal procedures undertaken in the one-year study period). The solid-state nature of the laser makes it a reliable surgical tool, and no maintenance of the laser was required during the one-year study period. The laser's fibre-optic delivery system makes it suitable for treatment of laryngeal disease in both the operating theatre and the clinic, depending upon the clinical indication. With these technical advantages, the 532 nm KTP laser has created a paradigm shift in our management of most laryngeal pathology involving the epithelium, and especially the delicate, pliable phonatory mucosa.

Angiolytic laser treatment of pre-malignant (dysplastic) epithelium^{4,13,14} was introduced in 1999, after being used previously for papillomatosis.⁷⁻⁹ Initially used exclusively to increase precision in microflap dissection of dysplasia,¹³ the KTP laser is now also used to involute disease without resection, by ablating the intralesional and sublesional microcirculation of the dysplastic lesion. Using the KTP laser, either alone or as a complement to microflap dissection, phonosurgical management of even diffuse glottic dysplasia can be accomplished with maximum preservation of the underlying superficial lamina propria. Disease at the anterior commissure can also be treated with minimal risk of cicatrization or web formation. Twenty-nine per cent (52/178) of operating theatre procedures utilising KTP laser were undertaken to treat dysplasia, the second most common indication for KTP laser use in this group of patients. In the clinic, dysplasia was the most common condition treated with KTP laser (114/209, 55 per cent of all clinic cases).

Since it is not unusual for patients with dysplasia to have recurrent disease even after effective initial treatment, surveillance is warranted. Clinic-based pulsed KTP laser treatment of recurrent disease eliminates the 'watchful waiting' approach often adopted by clinicians who choose to avoid multiple general anaesthetics and microlaryngeal procedures on delicate phonatory mucosa. In our treatment model, the initial procedure is performed under general anaesthesia, and recurrent dysplasia is usually ablated in the clinic under topical anaesthesia.⁴ This treatment strategy is well tolerated and effective at managing chronic and recurrent

dysplastic vocal fold changes, and enables optimal voice preservation.⁴ For these reasons, dysplasia accounted for the majority of clinic KTP laser procedures.

Our extensive, successful clinical experience in treating dysplasia with pulsed KTP photoangiolytic prompted us to assess its value for treating selected cases of, microinvasive vocal fold cancer.¹⁶ Our photoangiolytic treatment of microinvasive cancer was based on the principles of aberrant neovascularity described by Jako and Kleinsasser,¹⁹ and the tumour angiogenesis process described by Folkman.^{20,21} Glottic cancer was the most frequent diagnosis in our patients receiving KTP laser treatment in the operating theatre (accounting for 30 per cent of all endoscopic laryngeal procedures utilising KTP laser). Dysplasia and papillomatosis were less common in the operating theatre group, because patients with these conditions are often managed in the clinic after initial treatment, whereas cancer is not treated in the clinic. As previously reported in a prior investigation,¹⁶ KTP laser photoangiolytic was found to be highly successful in treating early glottic cancer.

- **The selectivity of photoangiolytic lasers enables improved vocal outcomes by allowing maximum preservation of the layered microstructure of the vocal fold, including the superficial lamina propria**
- **The fibre-optic delivery system makes the KTP laser suitable for treatment of laryngeal disease in the operating theatre or clinic, depending upon the clinical indication**
- **The KTP laser is a valuable tool in the management of most benign and malignant laryngeal disease**

Papillomatosis was another common indication for KTP laser use in our surgical practice, both in the operating theatre (38/178, 21 per cent) and in the clinic (89/209, 43 per cent). This was undoubtedly due to the unpredictable and irregular presentation and recurrence pattern of this condition. Our strategy was to treat patients initially in the operating theatre, where the extent of the papillomatosis and any surgically-induced soft-tissue changes could be adequately assessed. The KTP laser has proven its utility in ablating disease with maximum preservation of the underlying superficial lamina propria,¹⁴ and we used this laser in almost every patient treated for papilloma (Figure 2). Subsequent treatments were performed in the clinic, depending on patient tolerance and preference, extent of disease, and location of the papilloma. In the clinic, KTP laser treatment for papilloma is primarily used on the superior and medial glottic surfaces as well as in the supraglottis and subglottis.⁴ Similarly to patients with dysplasia and cancer, patients with papillomatosis require extended follow up to detect recurrent disease. Even though clinic-based pulsed KTP laser ablation is sometimes less effective than

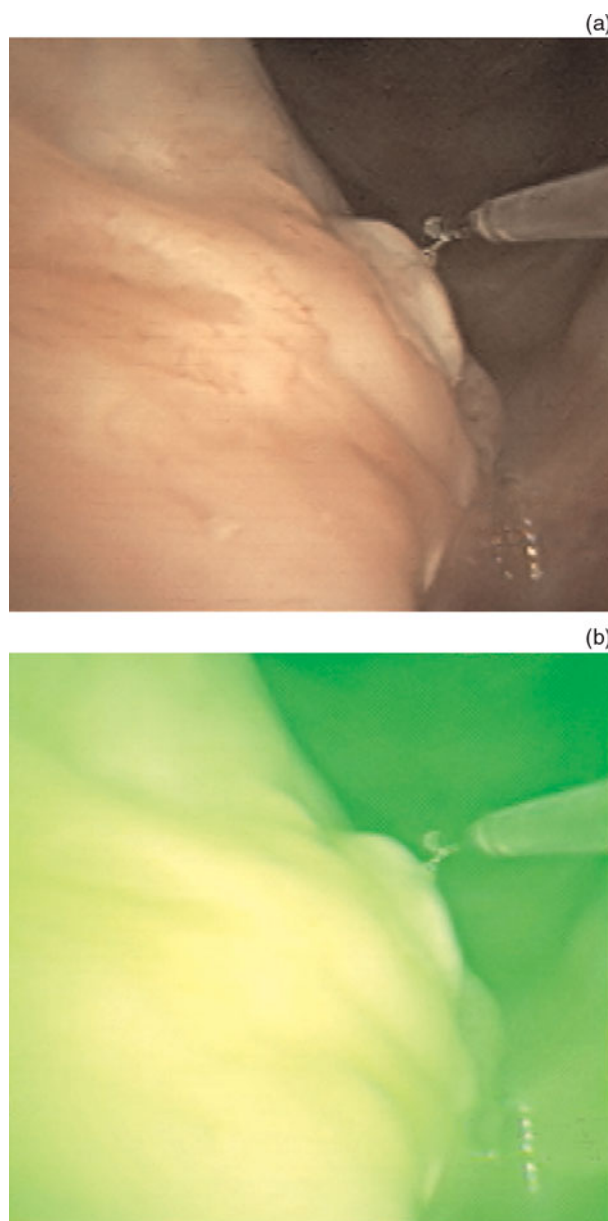


FIG. 2

Laryngoscopic images obtained during clinic treatment of papilloma. (a) The laser fibre directed at a focus of papilloma. (b) During the 15 millisecond pulse of 532 nm laser energy, the image is briefly obscured by a green flash.

similar photoangiolytic treatment in the operating theatre, due to the time constraints associated with topical anaesthesia, post-treatment dysphonia is often reduced as well. Although this treatment strategy results in more frequent procedures (and therefore a greater total number of cases) due to limitations of the therapeutic window imposed by topical anaesthesia, patients are able to avoid the risks of multiple general anaesthetics.

The versatility of KTP laser is shown by its use in treating varices and ectasia (in our study, 13 patients were treated for such lesions in the operating theatre, and three in the clinic). Due to the selectivity of the 532 nm wavelength KTP laser for haemoglobin, and its ability to minimise tissue trauma with an extended

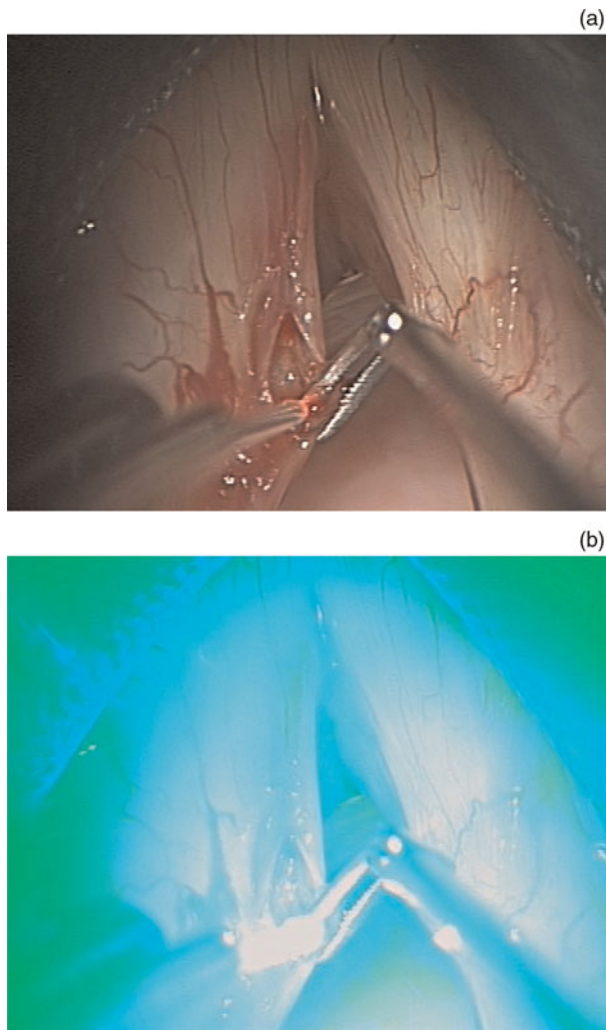


FIG. 3

Intra-operative images obtained during microlaryngoscopy with pulsed KTP laser photoangiolytic treatment of a vascular lesion. (a) The laser fibre directed at a vascular lesion on the undersurface of a microflap. (A larger vascular malformation, which was treated subsequently, is also seen on the superior surface of the vocal fold.) (b) During the 15 millisecond pulse of 532 nm laser energy, the image is briefly obscured by a green flash.

pulse width,²² pulsed KTP laser photoangiolytic provides a relatively safe and effective microlaryngoscopic treatment for varices and ectasia of the vocal folds.⁵ The settings of the pulsed KTP laser can be calibrated for use on the undersurface of epithelial microflaps (Figure 3), in order to treat the vascular component of haemorrhagic polyps and fibrovascular lesions. The variable pulse width and selectivity of the laser confines its energy to the vascular lesion, limiting the destructive effect on the (extremely thin) flap and the adjacent superficial lamina propria. Use of the pulsed KTP laser enhances the precision of phonosurgical management of these lesions by preventing extravasation of blood into the superficial lamina propria, which can lead to a delayed recovery and potential suboptimal vocal result.

Widespread adoption of this valuable technology is primarily limited by its cost, with most KTP laser

units costing \$70 000 or more. However, the utility of the KTP, as presented in this study, has been proven for a wide variety of common laryngeal pathology. The concepts of selective photoangiolytic extend to any lesion that is primarily vascular or that relies on microcirculation for its growth. The potential value of this technology therefore probably extends beyond the larynx to other mucosal surfaces, such as the upper and lower aerodigestive tract, nasal and sinus cavities, middle ear, and urogenital tract. It is our hope that the current study will supply much-needed objective data, in order to assist surgeons by advising clear indications for KTP laser use, while also providing them with key information to support institutional investment.

Conclusion

The KTP laser is a valuable tool in the management of most benign and malignant laryngeal diseases; we used it in 55 per cent of all endoscopic laryngeal cases managed over a one-year period.

Once incorporated into surgical practice, the KTP laser has the potential to become a widely used surgical tool, with applications for use in treating mucosal disease within the endolarynx and throughout the aerodigestive tract.

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