Office-Based Potassium Titanyl Phosphate Laser–Assisted Endoscopic Vocal Polypectomy

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**Importance:** Vocal polyps are common exophytic laryngeal lesions that usually necessitate microscopic laryngeal surgery under general anesthesia. Office-based indirect laryngoscopic procedures provide an alternative management option and can be performed comfortably under flexible endoscopic guidance. Combining angiolytic potassium titanyl phosphate (KTP) laser treatment and flexible endoscopic polypectomy should alleviate the risks of surgery under general anesthesia and expedite lesion regression.

**Objectives:** To combine angiolytic KTP laser treatment and endoscopic polyp removal and to evaluate the clinical applicability, treatment outcomes, and adverse effects of office-based KTP laser–assisted vocal polypectomy.

**Design:** Case series of KTP laser treatment (n=16) and KTP laser–assisted polypectomy (n=20). Patients underwent pretreatment and 2- and 6-week posttreatment evaluation with videolaryngostroboscopy (VLS), maximal phonation time, and a 10-item voice handicap index. Perceptual (GRB [grade, roughness, breathiness] scale) and acoustic analyses were performed before and 6 weeks after treatment.

**Setting:** Tertiary teaching hospital.

**Participants:** Thirty-six outpatients with unilateral hemorrhagic vocal polyps.

**Interventions:** Under local anesthesia, the KTP laser fiber was passed through the working channel of the flexible laryngoscope to photocoagulate the microvasculature of the polyp in all patients. Removal of coagulated vocal polyp using a flexible, endoscopic, blunt-ended grasping forceps immediately after KTP laser application was performed in the polypectomy group.

**Main Outcomes and Measures:** Results of VLS, maximal phonation time, 10-item voice handicap index, and perceptual and acoustic analyses.

**Results:** Six weeks after KTP laser treatment with and without polypectomy, 19 and 12 patients, respectively, experienced complete recovery and much improvement of mucosal wave. Maximal phonation time and the voice handicap index improved significantly 2 weeks after KTP laser with polypectomy (P<.01), whereas significant improvements were noted 6 weeks postoperatively in both treatment groups (P<.05). Acoustic and perceptual analyses also revealed significant improvements in both study groups (P<.05). During follow-up, we did not notice significant adverse effects.

**Conclusions and Relevance:** Potassium titanyl phosphate laser–assisted vocal polypectomy is a safe, practical, and effective alternative option to treat hemorrhagic vocal polyps in the outpatient department, offering comparable but earlier therapeutic effects than KTP laser alone.
most significant advantage of KTP and pulsed-dye lasers is the proximity between the 532-nm and 585-nm wavelengths, respectively, of each laser and the absorbance peak of oxyhemoglobin, which results in selective angiolysis and photocoagulation of the vascular lesions with minimal thermal injury to the lamina propria of the vocal fold.

Although KTP and pulsed-dye lasers can ablate the vascular components of vocal lesions effectively, more than 1 laser procedure might be required, and a relatively long wait might be needed before the lesion regresses completely. On the other hand, indirect laryngomicrosurgery is difficult to master because of the transoral manipulation of the long curved instruments and the difficulty of controlling oozing from the wound. Therefore, in this study, we aimed to combine the 2 office-based procedures, angiolytic KTP laser treatment followed by flexible endoscopic removal of the coagulated vocal polyp. We further evaluated the clinical applicability, treatment outcomes, and potential adverse effects of this modified procedure.

**METHODS**

**SUBJECTS**

From January 1 through December 31, 2011, 36 outpatients with unilateral hemorrhagic vocal polyps were recruited. Clinical diagnoses of vocal polyps were based on results of examinations using a videolaryngostroboscope (VLS) (model 9400; KayPentax). All patients received vocal hygiene education at the first clinical visit, including advice on sufficient hydration, avoidance of acidogenic food, smoking cessation, and adequate voice rest. To ensure complete removal of the vocal polyp during a single procedure, we included only small polyps with a long-axis diameter less than 30% of the vocal fold length visualized on image-processing software (Image J, version 1.44; National Institutes of Health). We excluded nonhemorrhagic and/or wide-based polyps. Among the recruited patients, 20 underwent KTP laser–assisted polypectomy, whereas the other 16 were treated with the KTP laser without endoscopic removal of the polyps. The institutional review board of the Far Eastern Memorial Hospital approved the study protocol.

**KTP LASER-ASSISTED VOCAL POLYPECTOMY**

The procedure began with local anesthesia of the nasal cavity using a cotton pledget soaked with 1:1000 epinephrine and lidocaine hydrochloride solution, 2%, followed by spraying of the lidocaine solution over the pharynx, tonsils, and vallecula. With an experienced resident physician operating the transnasal flexible laryngoscope (VNL-1570STK; Pentax), which was connected to a high-definition video processor (EPK-I; Pentax), the patient was instructed to phonate a sustained /ee/ sound when 5 mL of lidocaine hydrochloride, 2%, was dripped into the laryngeal introitus. After achieving adequate local anesthesia, the 0.6-mm KTP laser fiber was passed through the working channel of the flexible laryngoscope to photocoagulate the microvasculature of the targeted vocal polyp. Laser settings were 6 to 8 W per pulse, with a pulse width of 15 to 25 milliseconds and a 2-Hz repetition rate (IDAS/532 surgical laser system; Alma). The end point of KTP laser treatment was the involution or photocoagulation of the microcirculation, which could be visualized as blanching or darkening of the lesion, respectively (Figure 1 A). In the 20 patients undergoing KTP laser–assisted polypectomy, flexible blunt-ended grasping forceps were applied through the operating channel of the endoscope to remove the avascular vocal polyp imme-

![Figure 1](http://example.com/f1.png)
Immediately after KTP laser treatment (KA1806S; Pentax) (Figure 1B and C). In cooperative patients, the mean (SD) time for completion of the procedure was about 15 (4) minutes. A 3-day voice rest period was prescribed postoperatively.

OUTCOME EVALUATION

Clinical evaluation and outcome measurements, including VLS, maximal phonation time (MPT), and a 10-item voice handicap index (VHI-10) were performed before and 2 and 6 weeks after the procedure. Videolaryngostroboscopy was performed by instructing the patient to phonate a sustained /ee/ sound with habitual pitch and intensity using a 70° rigid endoscope and a 3-chip CCD camera (Tricam SL NTSC model 20222120; Karl Storz) or a digital laryngoscope (VNL-1590 STi; Pentax) with the corresponding video processor (EPKi; Pentax). Each session of the VLS examination was digitally recorded onto a portable hard disk using a computerized video processor (NHX-B10, Grass Valley Inc). The results were assessed according to the consensus of 2 otolaryngologists (C.-T.W. and P.-W.C.), categorized as (1) complete recovery (normal mucosal wave propagation with symmetric phase and amplitude), (2) much improvement (normal mucosal wave propagation with minimal asymmetric phase or amplitude), (3) some improvement (presence of phase asymmetry or decreased amplitude, but the mucosal wave was improved compared with baseline), and (4) no change or worse.

Acoustic analyses were performed before and 6 weeks after treatment using a 3-second sample of a sustained vowel (/a/). We applied a multidimensional voice program (model 4500: Kay Elemetrics Corp) to analyze various acoustic measurements, including jitter (percentage), shimmer (percentage), noise to harmonic ratio (NHR), fundamental frequency (F0) in female patients, and variation of fundamental frequency (vF0) in female patients. Perceptual rating of voice quality was evaluated before and 6 weeks after treatment using a 4-point GRB (grade, roughness, breathiness) scale. To assess measurement consistency, 10% of the voice recordings were randomly selected for blinded reevaluation.

STATISTICAL ANALYSIS

The data were analyzed using commercially available software (SAS, version 9.1 [SAS Institute, Inc] and SPSS software, version 18.0 [SPSS Inc]). We used a paired t test to compare the acoustic measurements before and after the procedures and unpaired t test to compare the outcome between the 2 treatment groups. Consistencies of perceptual ratings of voice quality were evaluated using the Pearson correlation coefficient. P < .05 was considered to be statistically significant. Unless otherwise indicated, data are expressed as mean (SD) values.

RESULTS

We enrolled 10 men and 26 women with unilateral vocal polyps; their ages ranged from 26 to 66 years, with a mean age of 45 years. Left vocal folds were involved in 21 patients; polyps in the other 15 originated from right vocal folds. The mean size of the vocal polyp was 17% of the vocal fold length (SD, 5%; range, 12%-26%). Results of all pathological examinations of the resected polyps were benign. All patients tolerated the procedure well under local anesthesia in an office setting.

In 20 patients undergoing KTP laser–assisted polypectomy, VLS evaluation performed 2 weeks after the procedure demonstrated complete recovery in 11 (55%) and much improvement of mucosal wave in 6 (30%). After 6 weeks, results of the VLS examination in the polypectomy group showed complete recovery in 14 patients (70%) and much improvement of vocal fold vibration in 5 (25%). Figure 2 shows serial images before and 2 weeks after KTP laser–assisted vocal polypectomy. We noted persistent phase asymmetry and reduced amplitude of mucosal wave in 1 patient at 6 weeks after the procedure. Videolaryngostroboscopic examination showed residual polypoid content in the Reinke’s space. Because this patient was satisfied with the treatment outcome, she refused subsequent laryngomicrosurgery under general anesthesia.

In the 16 patients receiving KTP laser treatment only, VLS results 2 weeks after the procedure demonstrated complete recovery in 5 (31%) and much improvement...
of vocal fold vibration in 4 (25%). Subsequent VLS results at 6 weeks showed complete recovery in 6 patients (38%), much improvement in 6 (38%), some improvement in 2 (12%), and no improvement in 2 (12%). In the 2 patients with no improvement after KTP laser treatment, one underwent KTP laser–assisted polypectomy, whereas the other underwent laryngomicrosurgery under general anesthesia. Both patients recovered completely afterward.

Objective outcome measures of the patients undergoing KTP laser–assisted polypectomy demonstrated a significant increase of mean MPT from 10.7 (4.0) seconds before treatment to 14.0 (4.3) seconds 2 weeks after treatment (P = .002, paired t test). Mean MPT measured at the 6-week follow-up also revealed significant improvement from the baseline value to 14.9 (4.3) seconds (P = .001, paired t test). For the patients undergoing only KTP laser treatment, mean MPT measured 2 weeks after the treatment did not show significant improvement (10.9 [4.0] seconds) compared with 10.2 (5.1) seconds before treatment (P = .71, paired t test). Six weeks after treatment, mean MPT had improved significantly to 13.9 (5.2) seconds (P = .003, paired t test, compared with the pretreatment value) (Figure 3A). Comparison of the MPT measurements between the 2 study groups revealed a significant difference at 2 weeks after the treatment (P = .03, unpaired t test), whereas no statistical differences existed before and 6 weeks after treatment (P > .05, unpaired t test).

Subjective assessments of the KTP laser–assisted polypectomy group indicated a significant reduction in mean VHI-10 scores from 20.8 (6.9) points before treatment to 13.7 (8.1) points 2 weeks after treatment (P = .005, paired t test). At the 6-week follow-up, mean VHI-10 measurements remained significantly lower than those collected at baseline (9.4 [5.3] points; P < .001, paired t test). In patients treated with the KTP laser alone, although mean VHI-10 scores had improved from 21.7 (9.0) before to 16.7 (9.2) points 2 weeks after treatment, the difference was not statistically significant (P = .11, paired t test). In contrast, 6 weeks after the treatment, mean VHI-10 scores had decreased significantly to 11.1 (11.0) points (P = .02, paired t test, compared with the pretreatment score) (Figure 3B). None of the comparisons of VHI-10 measurements showed statistically significant differences between the 2 groups before and 2 and 6 weeks after treatment (P > .05, unpaired t test).

The Table compares pretreatment acoustic and perceptual variables with those measured 6 weeks after treatment in both groups. Perceptual analyses revealed significant improvements of GRB scale scores 6 weeks after KTP laser–assisted vocal polypectomy (P < .001, paired t test). Consistencies in perceptual ratings indicated substantial and significant agreement (P = .001; Pearson correlation coefficients, 0.79). Acoustic analyses conducted 6 weeks after treatment revealed significant improvements in jitter and shimmer (P = .02 and P < .001, respectively, paired t test). Although measurements of NHR, and F0/vF0 in female patients, also showed improvements, the changes did not reach statistical significances (P > .05, Table). For the patients receiving only KTP laser treatment, acoustic measurements at 6 weeks also demonstrated significant improvements in GRB scale scores, shimmer, and vF0 in female patients (P < .05), whereas the improvements of jitter, NHR, and F0 in female patients did not reach statistical significance (P > .05).

We encountered 1 case of vessel rupture with subsequent vocal hematoma during the KTP laser procedure. We postponed the surgery for 1 month until complete resolution of the hematoma. After reducing the laser energy, the second operation was completed uneventfully. Treatment outcome at the 6-week follow-up indicated complete recovery of the mucosal wave in this patient. Other adverse effects after KTP laser treatment in both groups included dysphonia, increased sputum, itchy throat, and cough, which usually resolved within 1 week. We did not note any significant sequelae, such as vocal fold fibrosis, scarring, atrophy, or recurrence of vocal lesions, during follow-up.

**DISCUSSION**

Office-based surgical procedures are part of an emerging trend in modern laryngology, including various di-
agnostic and therapeutic management options, such as vocal fold augmentation, intraluminal corticosteroid injection, biopsy of laryngeal lesions, and laser procedures. The major advantages of office-based procedures include minimal invasiveness, reduced costs, avoidance of general anesthesia, and the possibility of monitoring real-time vocal function during the operation. Compared with direct laryngoscopic microsurgery, procedures using a flexible fiberscope under local anesthesia avoid potential injury to the teeth, cervical spine, and tongue after laryngeal suspension.

The concept of ablation of microvascular lesions of vocal folds using a KTP laser was introduced a decade ago. Earlier studies applied short-duration (3-7 seconds) continuous laser energy for treatment of various laryngeal/pharyngeal disorders, including varices and ectasia, venous malformation, and intubation granuloma. Later research showed that delivering pulsed KTP laser energy can achieve photoangiolytic effects more precisely than short-duration continuous laser energy. Rupture of vessel walls can be prevented by increasing pulse width and fiber-to-tissue distance and decreasing laser energy. Several studies have applied a pulsed KTP laser for the treatment of various laryngeal disorders, such as recurrent laryngeal papillomatosis, leukemia and dysplasia, and Reinke’s edema.

A previous study reported successful in-office ablation of hemorrhagic vocal polyps using the pulsed-dye laser. The sizes of vocal lesions regressed significantly in 78% of the study population after 1 to 2 courses of laser treatments; 14% of the patients required surgical polypectomy. Likewise, office-based KTP laser treatment also requires more effort in patients with a severely deviated nasal septum or hypertrophic inferior turbinate. In addition, achieving adequate local anesthesia can be time-consuming in patients with sensitive larynges. When firing the KTP laser in conscious patients, the surgeon must maintain an adequate distance between the fiber tip and vocal fold (1-3 mm). Accidental contact of the fiber tip with the vocal fold can cause harmful thermal injury to the underlying Reinke’s space. Finally, care should be taken to avoid accidental firing of the KTP laser while the fiber tip is in the operating channel; otherwise, an ignition may occur.

### Table. Measurements of Acoustic and Perceptual Analyses at 6 Weeks After KTP Laser Treatment With and Without Vocal Polypectomy

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Treatment Group, Mean (SD)</th>
<th>KTP Laser With Polypectomy</th>
<th>KTP Laser Only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 20)</td>
<td>Baseline 6 wk</td>
<td>Baseline 6 wk</td>
</tr>
<tr>
<td>GRB scale score</td>
<td>3.65 (1.87)</td>
<td>0.55 (0.83)</td>
<td>4.58 (1.31)</td>
</tr>
<tr>
<td>Jitter, %</td>
<td>1.67 (1.09)</td>
<td>0.99 (0.59)</td>
<td>2.13 (1.08)</td>
</tr>
<tr>
<td>Shimmer, %</td>
<td>3.06 (0.82)</td>
<td>2.07 (0.62)</td>
<td>4.02 (1.58)</td>
</tr>
<tr>
<td>NHR</td>
<td>0.14 (0.08)</td>
<td>0.11 (0.03)</td>
<td>0.13 (0.03)</td>
</tr>
<tr>
<td>F0, Hz</td>
<td>211 (17.9)</td>
<td>217 (34.1)</td>
<td>208 (21.7)</td>
</tr>
<tr>
<td>vF0, %</td>
<td>2.99 (5.44)</td>
<td>1.22 (0.45)</td>
<td>2.13 (0.63)</td>
</tr>
</tbody>
</table>

Abbreviations: F0, fundamental frequency in female patients; GRB, grade, roughness, breathiness; KTP, potassium titanyl phosphate; NHR, noise to harmonic ratio; vF0, variation of fundamental frequency in female patients.

*P < .01, paired t test, compared with baseline.

*P < .05, paired t test, compared with baseline.

^c^ Nonsignificant statistical difference (*P > .05), paired t test, compared with baseline.

sesses several advantages. First, varices and ectasia of vocal folds, if present, could be managed simultaneously using KTP laser photocoagulation (Figure 2). In addition, the application of KTP laser before vocal polypectomy facilitates the complete removal of the polyp by an endoscopic instrument and significantly reduces oozing from the wound during operation (Figure 1C). Finally, transnasal endoscopic procedures are less likely to be interrupted by the gag reflex and are easier to perform by most otolaryngologists than transoral procedures under local anesthesia.

Compared with KTP laser treatment alone, additional polypectomy achieves earlier therapeutic effects (Figure 3). In this series, most patients receiving KTP laser–assisted vocal polypectomy reported significant improvements of phonatory functions shortly after 3 days of voice rest, compared with several weeks of an involution period in patients receiving KTP laser treatment alone. Based on these preliminary experiences, we propose that KTP laser–assisted vocal polypectomy is most suitable for patients with high occupational voice demands who seek to recover adequate phonatory ability within a limited period of voice conservation and who are unwilling or unable to undergo laryngomicrosurgery under general anesthesia. For patients without substantial vocal demands and for those who can accept a longer voice conservation period, KTP laser alone should be considered primarily in treating small hemorrhagic vocal polyps.

Similar to other procedures using a transnasal fiberscope, passing the endoscope transnasally might require more effort in patients with a severely deviated nasal septum or hypertrophic inferior turbinate. In addition, achieving adequate local anesthesia can be time-consuming in patients with sensitive larynges. When firing the KTP laser in conscious patients, the surgeon must maintain an adequate distance between the fiber tip and vocal fold (1-3 mm). Accidental contact of the fiber tip with the vocal fold can cause harmful thermal injury to the underlying Reinke’s space. Finally, care should be taken to avoid accidental firing of the KTP laser while the fiber tip is in the operating channel; otherwise, an ignition may occur.
Our intention for this modified procedure is not to replace standard bimanual phonosurgery under the microscope but to serve as an alternate management option. The literature had mentioned that office-based procedures are less accurate than microsurgery under general anesthesia and might lead to subsequent procedures because of (1) inability to dissect the Reinke’s space and (2) reduced visual precision associated with the movement of vocal folds. Therefore, for larger wide-based vascular polyps with prominent involvement of the Reinke’s space, clinicians could consider applying a KTP laser in a standard microflap technique by way of photoagulation, followed by careful dissection and complete removal of the coagulated polypoid content (James A. Burns, MD, written communication, September 13, 2012). For patients with an extremely high demand for tocoagulation, followed by careful dissection and complete removal of the coagulated polypoid content (James A. Burns, MD, written communication, September 13, 2012).

In this study, although outcome measurements demonstrated significant improvements as long as 6 weeks after surgery (Figure 3 and Table), subsequent modification of inadequate phonation habits should always be highlighted to patients to prevent lesion recurrence. Moreover, despite most vocal polyps requiring surgical intervention, some lesions might regress spontaneously. Therefore, further controlled studies that include a parallel group of conservative management may delineate the role of the KTP laser with optional vocal polypectomy. Because normal tension of vocal folds is maintained under local anesthesia, overtrimming of the vocal fold epithelium is rarely encountered (Figures 1 and 2). However, patients should always be informed about the potential risk of vocal fold injury during the additional endoscopic polypectomy.

In conclusion, our study results indicate that KTP laser-assisted vocal polypectomy is a safe, practical, and effective alternative treatment for small hemorrhagic vocal polyps, with limited adverse effects. This procedure offers comparable effectiveness with earlier recovery of phonatory function than KTP laser treatment alone. Potassium titanyl phosphate laser-assisted vocal polypectomy is most suitable for patients of high vocal demands who may not tolerate long-term voice conservation.

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Author Contributions: All the authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Wang, Lai, and Cheng. Acquisition of data: Wang, Huang, and Lo. Analysis and interpretation of data: Wang, Huang, Liao, and Cheng. Drafting of the manuscript: Wang and Lo. Critical revision of the manuscript for important intellectual content: Wang, Huang, Lai, and Cheng. Statistical analysis: Wang and Liao. Obtained funding: Wang. Administrative, technical, and material support: Wang, Huang, Liao, and Cheng. Study supervision: Lo, Lai, and Cheng.

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**Announcement**

Clinical Problem Solving: Pathology Temporarily Closed to New Submissions

Due to a recent dramatic increase in the number of submissions for the monthly Pathology Quiz section, *JAMA Otolaryngology—Head & Neck Surgery* has temporarily stopped accepting new submissions for this feature. Submissions will resume in July 2013.