

# Efficacy of Treating Children With Anterior Commissure and True Vocal Fold Respiratory Papilloma With the 585-nm Pulsed-Dye Laser

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**Objective:** To report preliminary results regarding the safety and efficacy of the 585-nm pulsed-dye laser (PDL) for the treatment of juvenile-onset recurrent respiratory papillomatosis (JORRP) in the pediatric population.

**Design:** Prospective longitudinal cohort study.

**Setting:** Two pediatric otolaryngology referral centers.

**Patients:** Twenty-three pediatric patients ranging in age from 6 months to 17 years.

**Interventions:** The 585-nm PDL was used for at least 1 treatment on each of these patients to treat JORRP of the true vocal folds or anterior commissure.

**Main Outcome Measures:** Complications from the use of the 585-nm PDL in the treatment of JORRP.

**Results:** There was no evidence of anterior commissure webbing or true vocal fold scarring in this group of 23 patients followed up for 3 months to 1 year.

**Conclusions:** The 585-nm PDL seems to be a safe instrument for treatment of JORRP. There is the potential that improved voice outcomes may be apparent when compared with traditional therapies because the vocal fold epithelium seems to be unharmed when treated with this method. Furthermore, the lack of epithelial damage incurred by the 585-nm PDL should enable more aggressive surgical excision of anterior commissure disease. Further prospective longitudinal studies examining voice outcomes are needed.

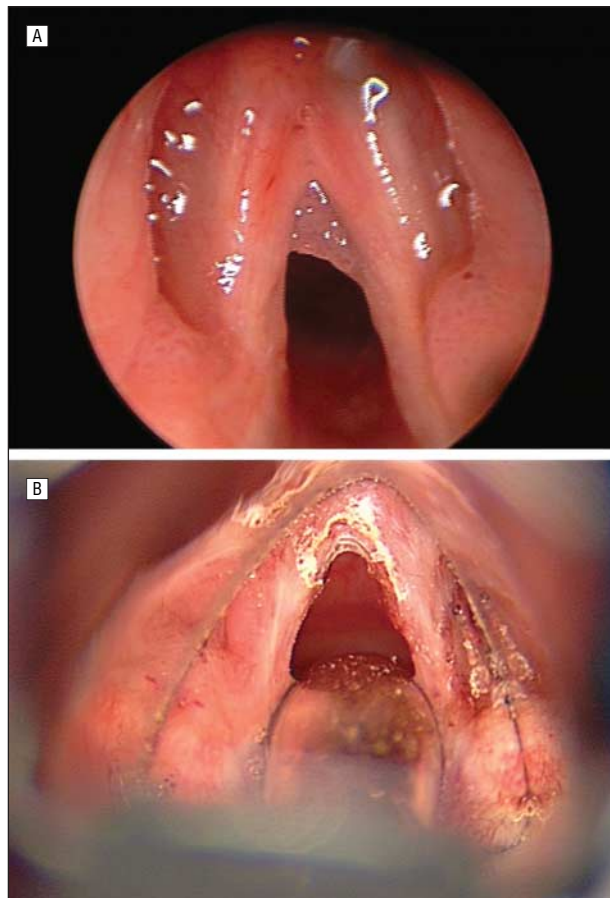
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**R**ECURRENT RESPIRATORY PAPILLOMATOSIS (RRP) is the most common benign neoplasm of the larynx and the second most common cause of hoarseness in children.<sup>1</sup> The incidence in the United States is 4.3 cases per 100 000 children, and there are approximately 2300 new cases per year.<sup>2</sup> It is a disease of viral origin that is caused by human papillomavirus types 6 and 11. The most commonly involved laryngeal sites are at junctions of squamous and respiratory epithelium<sup>3</sup>; these include the laryngeal surface of the epiglottis, the upper and lower margins of the ventricle, and the undersurface of the true vocal folds (TVFs).<sup>4</sup> The predilection of RRP for these sites can lead to airway compromise if it is not treated early. In addition to airway concerns, cases in which RRP involves the TVFs and anterior commissure generates a high rate of morbidity in terms of voice quality and can interfere with both communication and education.

Recurrent respiratory papillomatosis can occur in both the pediatric and adult patient populations. The pediatric form, juvenile-onset RRP (JORRP), is the more aggressive subtype. Children who are diagnosed when they are younger than 3 years are 3.6 times more likely than those diagnosed when they are older than 3 years to require more than 4 surgical procedures annually. This younger age group is also approximately 2 times more likely to have papilloma in 2 or more laryngeal sites.<sup>5</sup>

Historically, the primary treatment for JORRP has been surgical ablation. Children requiring more than 6 surgeries per year are often considered for adjuvant therapy. Interferon alfa,<sup>2</sup> indole-3-carbinol,<sup>6</sup> photodynamic therapy,<sup>7</sup> and ribavirin<sup>8</sup> have all been used in such children with varying degrees of success. Cidofovir, an antiviral agent initially approved to treat cytomegalovirus retinitis in the patient population with human immunodeficiency virus, has recently gained

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**Figure 1.** Anterior commissure juvenile recurrent respiratory papillomatosis before (A) and after (B) pulsed-dye laser treatment.

popularity as an adjuvant therapy alternative.<sup>9-11</sup> However, at least 1 recent article<sup>12</sup> has highlighted the potential risks of such therapy that must be weighed against the benefits of administration.

Surgery remains the mainstay of therapy for most children with JORRP. The involvement of RRP in the anterior commissure is particularly problematic owing to its impact on voice quality and the difficulties associated with complete eradication of disease from this location. Aggressive treatment must be avoided to prevent subsequent scarring and potential anterior glottic web formation. Anterior commissure disease often requires procedures to be staged, which results in more frequent trips to the operating room.

The surgical technique chosen is particularly important. The carbon dioxide laser was the predominant instrument used in the 1980s and 1990s. When coupled to an operating microscope, the carbon dioxide laser is able to precisely vaporize papilloma with minimal bleeding.<sup>13</sup> Unfortunately, the carbon dioxide laser also has the potential to cause thermal damage to adjacent normal laryngeal structures. The microdebrider has become an increasingly popular alternative treatment technique because it can remove bulky disease without producing unwanted heating. The main disadvantages of the microdebrider relate to the excision of sessile disease, difficulty working in areas where scarring and fibrosis are present, and accessing areas such as the ventricle.

A more recent addition to the RRP surgical treatment armamentarium is the 585-nm pulsed-dye laser (PDL). The 585-nm PDL has proven effective in treating RRP in the adult population.<sup>13-16</sup> The PDL has the added advantages of preserving the epithelial covering of the TVFs, providing the ability to treat the anterior commissure without fear of causing scarring,<sup>13,14</sup> and a flexible delivery system that permits access to areas that are difficult to reach, such as the ventricles.

## METHODS

This study included all children with JORRP who were seen at 2 tertiary care pediatric otolaryngology departments from January 1, 2004, to December 31, 2005, and who were treated for RRP involving the TVFs or the anterior commissure. The study population consisted of 23 children aged 6 months to 18 years. A total of 37 procedures were performed using the PDL. Prior surgical or adjuvant therapy was documented when adequate records were available. When possible, each patient preoperatively underwent a flexible fiberoptic laryngoscopic examination and video laryngostroboscopy (all patients underwent flexible fiberoptic laryngoscopy preoperatively; of these, 10 [37%] of 27 also underwent videostroboscopy). After the children underwent suspension with a Lindholm laryngoscope to allow microscopic visualization of the larynx, a formal laryngoscopy and bronchoscopy were performed. The diagnosis of RRP was pathologically confirmed by an intraoperative biopsy. Bulky papilloma was usually first treated with the microdebrider.

The flexible PDL fiber catheter was placed through a malleable, hollow guiding probe. The PDL was used for anterior commissure, TVF, and tracheal sessile papilloma (**Figure 1**). The number of laser pulses was recorded for each case. The patients were followed up according to the normal protocol established at each institution.

## RESULTS

Anterior commissure webbing or scarring of the TVFs was evaluated either in the physician's office with flexible laryngoscopy or at the time of the follow-up operative procedure. The following details were recorded: age and sex of patient, other surgical modalities used concomitantly, and number of pulses of PDL per session (**Table**).

## COMMENT

The 585-nm PDL was designed so that any tissue injury it causes is confined to the perivascular region with thrombus formation within the vessels, endothelial cell necrosis, and red blood cell extravasation and does not affect the surrounding structures.<sup>17-19</sup> The theoretical advantage of this form of laser rests in its ability to disrupt blood flow to the papilloma while producing a minimal amount of epithelial scarring.<sup>17,20,21</sup> The PDL has been used previously in the treatment of cutaneous vascular malformations, hemangiomas, and hypertrophic scars in addition to adult glottic papillomatosis.<sup>13-16,22</sup>

The initial pilot study,<sup>15</sup> in which the PDL was used to treat adults with RRP, compared the carbon dioxide laser with the PDL in 3 patients. The PDL was not used

**Table. Cohort of Patients Treated With 585-nm PDL**

Patient No./ Sex/Age, y*	Procedures, No. †	Adjuvant Treatment‡	Total Pulses Fired, No. §
1/M/9	3	C	158
2/M/9	6	C, M	7
3/F/16	7	C, M	153
4/F/12	4	C	84
5/M/9	2	C, M	92
6/M/5	5	C, M	102
7/M/2	4	C, M	95
8/M/4	4	None	40
9/F/15	1	M	48
10/M/17	1	None	132
11/M/14	4	None	106
12/F/15	5	None	161
13/M/4	2	M	45
14/F/0.5	5	None	27
15/M/6	1	C	48
16/M/5	1	C, M	40
17/F/5	1	M	38
18/M/6	1	None	9
19/M/4	4	None	140
20/M/4	2	None	82
21/F/6	8	C, M	160
22/F/8	6	M	140
23/M/9	3	C	None

Abbreviations: C, cidofovir; M, microdebrider; PDL, pulsed-dye laser.

\*Age of child at time of first operative treatment for juvenile-onset recurrent respiratory papillomatosis.

†Number of procedures where PDL was used with or without other modalities.

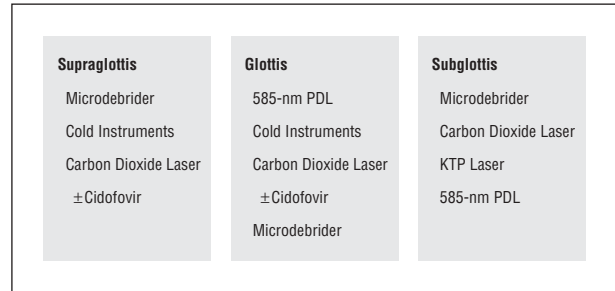
‡Coadjuvant treatments.

§Energy and pulses of PDL used at first operative procedure (to serve as examples for typical use of PDL).

on the TVFs in this case study; however, on those laryngeal sites where it was used, the epithelial surface was preserved, and there was complete regression of the papilloma. In a subsequent larger pilot study<sup>14</sup> involving 41 adult cases (20 of whom had anterior commissure involvement), there were no complications reported, and most patients reported a subjective improvement in voice following treatment. Only 1 group to date has used a similar laser (a 577-nm flash pump dye laser) in the treatment of RRP in a pediatric population of 9 patients ranging in age from 2 to 20 years. The outcome measures were ease of operation, safety, and decrease in size of the treated papilloma 2 weeks following surgery. There were no complications reported, and 5 of the patients had greater than 90% regression of the treated lesions.<sup>23</sup>

The specific aims of this case series were to report preliminary results regarding the safety and efficacy of the application of the 585-nm PDL for the treatment of JORRP in the pediatric population. This study was longitudinal in design, and surgical modalities in addition to the PDL were used on sites other than the TVFs and anterior commissure. Given the absence of uniform treatment, preoperative and postoperative RRP staging scores were not evaluated, and formal voice outcomes either in the form of validated voice instruments or videostroboscopy were not consistently available. These outcome parameters will be an essential part of a future longitudinal study.

The PDL seems to be particularly applicable to the anterior commissure, membranous TVFs, and the ven-



**Figure 2.** Proposed algorithm for treatment of juvenile-onset recurrent respiratory papillomatosis. The instruments are listed in the order that we recommend they be implemented. KTP indicates potassium-titanyl-phosphate; PDL, pulsed-dye laser.

tricles. All patients in this series had significant anterior commissure disease, an area that has been difficult to treat with traditional methods. Because the epithelium of the TVFs is not damaged by PDL therapy, opposing surfaces can be treated simultaneously. The results for this series of patients show the PDL to be a useful treatment instrument, and the patients showed no evidence of scarring or web formation on subsequent examinations. The ability to more aggressively treat the anterior commissure region as well as the membranous TVFs translates into potential improved voice outcomes. In addition, some children had longer intervals between treatments when they were treated with the PDL vs standard therapies; however, the small number of children involved precludes formal conclusions from being drawn. In addition to treating the anterior commissure, the flexible PDL fiber permitted access to and treatment of hard-to-treat areas such as the ventricles, infraglottic area, and trachea. The PDL was also effective on areas already scarred from prior surgical intervention without causing more damage to the laryngeal epithelium.

The site and amount of disease dictate the options that are most viable to improve the airway without producing long-term untoward adverse effects such as glottal webbing or marked stiffening of the vocal folds. We propose a treatment algorithm showing sites where the PDL should be considered for use (**Figure 2**). Children with JORRP often present a more difficult challenge than their adult counterparts because they frequently have bulky disease. As a result, a combination of therapies is often required for treatment. The emphasis here is on control because the recidivistic nature of JORRP makes “cure” difficult to achieve. If control of disease is the ultimate goal, treatment options that limit damage to laryngeal tissue should receive primary consideration.

In conclusion, this study involved a small number of patients and therefore does not lend itself to definitive recommendations. Consistent with previous studies of adult patients with RRP, the PDL has been demonstrated to be a safe instrument and to be equally effective as an alternative surgical modality in the treatment of JORRP. The therapeutic characteristics of this modality strongly suggest potential long-term improvement in voice quality. This will be confirmed as more children with JORRP are treated with the PDL from the onset of their disease. Progressive investigation of both the pliability of the TVFs as well as the possible glottal ap-

erture closure defects will be possible, and functional outcomes can be better explored. Our current recommendation is that the PDL seems to be safe for the treatment of JORRP, particularly when there is significant anterior commissure and TVF disease.

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**Author Contributions:** Drs Cunningham and Pransky 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:* Hartnick and Pransky. *Acquisition of data:* Boseley, Franco, and Pransky. *Analysis and interpretation of data:* Boseley, Franco, and Cunningham. *Drafting of the manuscript:* Hartnick and Boseley. *Critical revision of the manuscript for important intellectual content:* Hartnick, Boseley, Franco, Cunningham, and Pransky. *Administrative, technical, and material support:* Franco and Pransky. *Study supervision:* Hartnick, Cunningham, and Pransky.

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