The Application of the Potassium-Titanyl-Phosphate (KTP) Laser in the Management of Subglottic Hemangioma

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Background: Subglottic hemangioma is the most common neoplasm of the infant airway. Most lesions involute spontaneously; however, some may grow to cause life-threatening respiratory tract distress. The standards of treatment have been tracheotomy, corticosteroids, and laser vaporization. However, use of the carbon dioxide laser has been associated with increased risk of damage to adjacent mucosa and an increased risk for the development of subglottic stenosis postoperatively.

Objective: To review our experience with the use of the potassium-titanyl-phosphate laser in the treatment of subglottic hemangioma.

Patients and Methods: A retrospective review of 6 patients with subglottic hemangioma treated with the potassium-titanyl-phosphate laser was carried out at a tertiary care children's hospital. Patients' medical charts were evaluated for factors such as age, sex, degree of airway obstruction, location of hemangioma, number of laser procedures performed, and postoperative results, including short- and long-term complications.

Results: All 6 patients had significant relief of airway obstruction after use of the potassium-titanyl-phosphate laser. Five of the patients had localized disease, and one had circumferential subglottic involvement. The average number of procedures was 1.7. There were no intraoperative complications. One patient had prolonged intubation following surgery, and only one developed grade 1 subglottic stenosis requiring dilation. Long-term results have been promising in that all patients are asymptomatic and follow-up laryngoscopy and bronchoscopy have shown complete resolution of the hemangioma.

Conclusion: The potassium-titanyl-phosphate laser can be used to provide significant clinical relief of airway obstruction due to grade 1 and 2 subglottic hemangioma, with minimal complications.


SUBGLOTTIC hemangioma is considered one of the most common neoplasms of the infant airway. As opposed to a vascular malformation, which is a collection of abnormal vessels forming a lesion that is present at birth and grows with the child, a hemangioma is a vascular tumor that enlarges by rapid proliferation of epithelial cells and is usually not present at birth.1 These lesions can undergo cellular growth, vascularization, ulceration, hyperkeratosis, and, rarely, malignant change.2

Infantile subglottic hemangioma usually presents with stridor during the first 6 months of life and can cause life-threatening respiratory tract distress. It has been estimated that approximately 1.5% of all congenital laryngeal anomalies are hemangiomas. However, this may be an underestimation. The mean age at diagnosis is between 3 and 4 months. Girls are affected twice as often as boys. There is no hereditary predisposition, and the condition is rare in the African American population.3

Brodsky et al4 observed that a cutaneous hemangioma was present in 50% of patients with subglottic hemangioma. The natural history of this disorder consists of a phase of rapid growth during the first 8 months of life followed by a slow involutational phase that generally begins by the age of 12 months. However, in 10% to 20% of children, the subglottic hemangioma may seriously compromise the airway before involution has taken place.5 Because of the potential for significant airway obstruction, these histologically benign lesions require intervention.

Report6 of the first successful treatment by New and Clark (1919) has prompted numerous others to advocate various different treatment modalities, including tracheotomy, radiation therapy,
PATIENTS AND METHODS

This was a retrospective medical record review of children treated with the KTP laser for symptomatic subglottic hemangioma. Between September 1990 and February 1998, 6 patients were diagnosed as having mild disease and were treated for subglottic hemangioma using the KTP laser at the Children’s Hospital of Michigan, Detroit. This procedure was chosen because it was believed that the mild form of the disease would be more amenable to the KTP laser.

Hospital, clinic, and surgical records were reviewed for age at onset of symptoms, age at diagnosis, sex, site of lesion, site of associated lesions, initial treatment modality, number of laser treatments, end point of treatment, need for tracheotomy, postoperative complications, duration of intubation after surgery, period of follow-up, long-term response to therapy, and complications, if any.

The procedures were performed under the guidance of the senior surgeon (D.M.). The technique involved the use of rigid bronchoscopy with the KTP laser adaptation and application. General anesthesia was used with spontaneous ventilation. The KTP laser flexible fiber is passed down the side channel of the rigid ventilating bronchoscope, thus maintaining a closed anesthesia technique. The laser was used with continuous vaporization at a setting of 5 W in a single or repeated pulse mode at 0.5 second. The hemangiomas were partially or completely vaporized. The end point of each treatment was at least 60% to 70% patency of the airway. Of the 6 patients, 5 were extubated postoperatively. All patients received preoperative dexamethasone (Decadron), 0.5 mg/kg.

cryotherapy, electrocautery, interferon alfa-2a, sclerosing agents, corticosteroids, embolization, open surgical excision, and laser ablation. The fact that so many treatments are still used suggests that an ideal method of management has not been found.

Recent advances in technology have made lasers a common management option. There are numerous reports describing the use of various types of lasers. The carbon dioxide laser has been widely used. It is characterized by a wavelength of 10,000 nm (invisible) and requires an aiming beam during operation. This laser is absorbed by tissues with a high water content, has poor tissue penetration, and is less effective for coagulation. Therefore, it is less effective in the treatment of vascular lesions. Sie et al, in 1994, reported a 10-year experience with use of the carbon dioxide laser for subglottic hemangioma and noted that serial procedures were required and that approximately 20% of the patients developed posttreatment subglottic stenosis.

The Nd:YAG laser is considered a “coagulating laser.” It has a wavelength of 1064 nm (invisible) and requires an aiming beam for use. It has a deep coagulating effect. However, there is significant danger of transmural injury and possibly increased risk of subglottic stenosis if used for subglottic hemangiomas. 

The potassium-titanyl-phosphate (KTP) laser has a wavelength in the visible light range (532 nm). It does not require an aiming beam and can be delivered via fiberoptic fibers. It is also preferentially absorbed by hemoglobin and, therefore, is effective in the treatment of vascular lesions such as subglottic hemangiomas.

Since 1990, we have treated subglottic hemangioma using endoscopic vaporization of the lesion with the KTP laser. Because of the preferential absorption by hemoglobin and the ability to direct the laser via fiberoptics, we believed this would be more effective in vaporizing the hemangioma while being less destructive to the surrounding tissue.

RESULTS

Table 1 summarizes the pretreatment patient data. Of the 6 patients, 4 were girls. Age at onset of symptoms ranged from 1 to 8 months. The age at diagnosis ranged from 1 to 10 months (mean, 4½ months). There was a median duration of 5 weeks before diagnosis. Symptoms consisted of biphasic stridor, hoarseness, and/or raspy cry. One patient presented with poor feeding. Five patients also had associated respiratory tract compromise. Fifty percent had associated cutaneous hemangiomas at the time of diagnosis. These were noted only in female patients.

The lesion involved the left subglottis in 4 of the 6 patients. One patient had circumferential subglottic hemangioma, and the other had posterior subglottic involvement. The degree of stenosis ranged from 30% to 70%. In one patient, there was no information available on the degree of stenosis.

Table 2 lists the number of procedures performed and the results. Four patients required 2 laser procedures for 90% to 95% removal of the hemangioma. Two patients required only one treatment. The end point of each treatment was to gain at least 50% to 90% reduction of the hemangioma so that the airway would have approximately 60% to 70% patency. The patients who required 2 procedures (patients 1, 3, 5, and 6) had the second procedure performed 1 month after the first to complete the excision of the lesion. Patients 1, 5, and 6 had approximately 50% to 70% reduction of the hemangioma on the first attempt, which gave a reasonably patent airway. Meanwhile, patient 3 had 90% reduction on the first attempt. Patients 2 and 4 required only one procedure, with 80% reduction in patient 2 and 100% removal in patient 4.

There were no intraoperative complications. However, one patient (patient 4) had prolonged intubation after the procedure. She was extubated on postoperative day 9. The length of follow-up ranged from 1 to 9 years (average, 3.2 years). The long-term results have been promising in that all patients are asymptomatic and follow-up direct laryngoscopy and rigid bronchoscopy have shown complete resolution of the hemangioma. Long-term complications include granuloma formation in patients 2, requiring laser excision, and grade 1 subglottic stenosis in patient 4, requiring tracheal dilation. In addition, patients 2, 3, and 5 had 10% to 15% subglottic stenosis secondary to scarring, which was asymptom-
atic and did not require intervention. No patient required a tracheotomy.

**COMMENT**

Infantile subglottic hemangioma is the most common head and neck neoplasm of infancy. It is a self-limiting but potentially fatal disease. The most common presenting symptom is stridor, which is usually progressive, and most cases present within the first 6 months of life. Some patients may present with recurrent or persistent croup, cough, noisy breathing, cyanosis, failure to thrive, hoarseness, dysphagia, progressive dyspnea, hemoptyis, vomiting, or the presence of a cutaneous lesion. Symptoms are directly related to the size and location of the lesion and to the age of the patient. The diagnosis of infantile subglottic hemangioma is made by history and physical examination results, along with a high index of suspicion.2-5,9 The use of fiberoptic laryngoscopy may provide some information about the presence of a lesion but does not allow for a complete assessment of the entire subglottic airway. Radiographic evaluation may demonstrate symmetric or asymmetric subglottic narrowing.10 A definitive diagnosis is made by direct laryngoscopy and bronchoscopy, and thorough airway evaluation must be undertaken to rule out coexisting pathologic features. There are many accepted treatment options in the literature. When selecting the appropriate treatment, one must consider the size of the lesion, lesion thickness, patient age, urgent nature of the patient’s presenting condition, and available treatment modalities within the surgeon’s institution. In this review, the KTP laser appears to be a useful mode of therapy in managing patients with subglottic hemangiomas. All patients in our study avoided a tracheotomy tube. In addition, all but one patient had limited one-sided involvement; this patient had a circumferential lesion. None had previous surgical treatment before use of the KTP laser.

Since the original description of laryngeal hemangiomas in 1864, many methods of treatment have been recommended. Many of the lesions will spontaneously involute, and their biological behavior has made observation a viable option for some. However, with untreated lesions, the mortality may be as high as 50%.9 The unpredictable nature of this lesion and its significant risk of airway obstruction generally lead to either medical or surgical intervention.

There have been several forms of management suggested. These include use of sclerosing agents; intralobular corticosteroids; with or without endotracheal intubation; tracheotomy; interferon alfa-2a; cryosurgery; open surgical excision; external beam irradiation or endoscopic placement of a radioactive gold grain; and laser endoscopic surgery. All modalities have had some success, but generally the accepted treatment has been the use of laser excision, expectant management with use of corticosteroids, and open surgical excision.11-15

Radiation treatment has been used for many years. However, the theoretical concerns of radiation therapy-induced malignant neoplasms have placed this treatment out of favor.16 Interferon alfa-2a is promising for the management of massive cervicofacial hemangiomas, but its effects are delayed and therefore would not be appropriate for life-threatening or symptomatic hemangiomas causing airway obstruction. Tracheotomy is associated with significant morbidity and mortality, and so-

**Table 1. Pretreatment Patient Data**

<table>
<thead>
<tr>
<th>Patient No./ Sex</th>
<th>Age, wk</th>
<th>At Onset of Symptoms</th>
<th>At Diagnosis</th>
<th>Location of the SGH</th>
<th>Stenosis, %</th>
<th>Other Airway Lesions</th>
<th>Cutaneous Hemangioma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F</td>
<td>4</td>
<td>4</td>
<td>Circumferential</td>
<td>60-70</td>
<td>None</td>
<td>NS, lip, and tongue</td>
<td>Yes</td>
</tr>
<tr>
<td>2/M</td>
<td>5.5</td>
<td>10</td>
<td>L lateral subglottis</td>
<td>60</td>
<td>None</td>
<td>Lip, SP, and TP</td>
<td>No</td>
</tr>
<tr>
<td>3/F</td>
<td>6</td>
<td>12</td>
<td>L lateral subglottis</td>
<td>Unknown</td>
<td>40</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>4/F</td>
<td>8</td>
<td>8</td>
<td>Posterior larynx with subglottic extension</td>
<td>40</td>
<td>None</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>5/M</td>
<td>28</td>
<td>32</td>
<td>L lateral subglottis</td>
<td>40</td>
<td>None</td>
<td>None</td>
<td>No</td>
</tr>
<tr>
<td>6/F</td>
<td>32</td>
<td>40</td>
<td>L lateral subglottis</td>
<td>30-40</td>
<td>None</td>
<td>None</td>
<td>No</td>
</tr>
</tbody>
</table>

*SGH indicates subglottic hemangioma; NS, nasal septum; L, left; SP, soft palate; and TP, tonsillar pillar.

**Table 2. The Number of Treatments and Results of KTP Laser Excision of Subglottic Hemangiomas**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>No. of Laser Treatments</th>
<th>Duration Between Treatments, mo</th>
<th>Length of Follow-up, y</th>
<th>Complications</th>
<th>Long-term Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>None</td>
<td>Resolved hemangioma</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>NA</td>
<td>3</td>
<td>Granuloma formation and 10%-15% SGS</td>
<td>Resolved hemangioma and mild scarring</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>10%-15% SGS</td>
<td>Resolved hemangioma and mild scarring</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>NA</td>
<td>4</td>
<td>Prolonged intubation and grade 1 SGS</td>
<td>Resolved hemangioma</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>10%-15% SGS</td>
<td>Resolved hemangioma and mild scarring</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>None</td>
<td>Resolved hemangioma</td>
</tr>
</tbody>
</table>

*KTP indicates potassium-titanyl-phosphate; SGS, subglottic stenosis; and NA, not available.*
lutions have been developed to avoid tracheotomy in infants. One-stage open surgical procedures can relieve the obstruction while avoiding a tracheotomy and complications of prolonged tracheotomy (speech and language delay).17

Open surgical procedures are recommended for large hemangiomas at the beginning of the rapid growth phase, for bilateral subglottic hemangiomas, when there is extralaryngeal extension, and/or for airway obstruction of 50% or more.17 The decision to use an open surgical procedure is not an easy one, but it is a viable option when large lesions have not responded to other modalities and in cases that would otherwise necessitate tracheotomy.

The use of the carbon dioxide laser has been of therapeutic value. Some suggest that it is useful in avoiding tracheotomy, but this conclusion is confounded by the concomitant use of corticosteroids. There often is the need for several treatments when there is more than 50% airway obstruction. There also is risk of severe subglottic stenosis due to absorption of laser energy by uninvolved mucosa.7,17

The use of the KTP laser in our patient group has presented us with a satisfactory management option in our experience, to date. All of our patients were completely asymptomatic after treatment. On average, our patients required 1.7 procedures. There was only one significant long-term complication associated with the KTP laser—patient 4 developed grade 1 subglottic stenosis requiring dilation. No tracheotomy tube was necessary, and there were no intraoperative complications. In our experience, the preferential absorption of the KTP laser by the hemoglobin molecule and the ability to direct it by fiberoptics have made it more effective and less destructive to the surrounding tissue, with limited sequelae of subglottic scarring.

Our experience does not advocate against other forms of treatment “tailored” to particular problems, ie, circumferential lesions or extensive lesions beyond the airway or associated with other causes of airway obstruction. More extensive lesions may require an open procedure.

The main concern of infantile subglottic hemangioma appears to be the potential for airway obstruction during the proliferative phase. No specific treatment is without the potential for morbidity, mortality, or both. In our opinion, the least invasive treatment instituted to maintain the patient as symptom free as possible, to keep the patient safe from potential airway obstruction without introducing significant risk of treatment sequelae for this benign lesion, and to deliver the patient to the threshold of lesion involution is a reasonable goal.

In our experience, the results with the use of the KTP laser have been encouraging in patients with mild cases of subglottic hemangioma (grade 1 and 2 stenosis). It can be favorably compared with other “standards” of treatment. The facility with which the KTP laser can be seriatim used to provide significant relief of airway obstruction, due to infantile subglottic hemangiomas, in the absence of significant associated complications warrants continued investigation with this modality. As no perfect treatment exists, our philosophy regarding management is not rigid and we optimistically await advancement in the treatment of this debilitating and potentially life-threatening congenital airway lesion.

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REFERENCES