Recurrent respiratory papillomatosis (RRP) is a chronic disease with an annual incidence of 4.3 per 100,000 children in the United States [1]. The current standard of care for management of children with RRP is surgical therapy with a goal of complete removal of papillomatous lesions while preserving normal structures and preventing airway scarring. Laser treatment of papillomatosis has been described, most commonly using the carbon dioxide laser. The primary criticism of laser treatment is the potential for tissue injury related to thermal damage, as well as potential for viral transmission through the laser plume [2]. For these reasons, the endoscopic microdebrider has come into favor for treating pediatric patients, with the majority of ASPO members reporting it as their preferred technique [3]. In patients with severe disease, adjunctive treatment may be added.

According to data collected by the National Registry for Recurrent Respiratory Papillomatosis, children with RRP require an average of 4.4 surgical procedures annually [4]. Laryngeal sequelae can be an unfortunate consequence of recurrent surgical intervention, with a 12% rate of glottic stenosis and a 34% rate of anterior commissure synechiae in children undergoing two or more surgical procedures for RRP [5]. Lateral airway stenosis in combination with aggressive RRP can lead to tracheomalacia, which significantly increases the risk of developing distal tracheal or pulmonary disease [6]. Tracheotomy results in a squamo-columnar junction at the tracheotomy site, and papillomatosis has a predilection for such histological sites. This results in rapid colonization of papilloma at the tracheotomy and an increased chance for distal spread [7]. For this reason, tracheostomy is
considered by most authors to be a last resort in the management of RRP. We describe our management of three tracheostomy dependent patients with complex glottic stenosis.

2. Case series

2.1. Case 1

A 16-year old male came to us after being managed since childhood at an outside institution. Tracheostomy was performed at age 5, and the child had been managed by endoscopic debridement approximately every three months at that institution. He had also undergone a trial of interferon therapy. At the time of his presentation to Cohen Children’s Medical Center, he had complete glottic stenosis and a high burden of subglottic, tracheal and bronchial disease (Fig. 1).

After presenting to our institution, he underwent frequent aggressive debridement using the laryngeal microdebrider (Medtronic, Elizabeth, NJ) approximately every 4–6 weeks. The glottic stenosis was sharply divided using a sickle knife, and the glottis was repeatedly dilated using a 10 mm airway balloon (Acclarent, Menlo Park, CA). Following dilation, the glottic, subglottic and tracheal disease was aggressively debrided. He also had a significant burden of disease in the right upper lobe bronchus.

After about eight months of treatment, his burden of disease was dramatically improved, and his glottis remained widely patent between procedures (Fig. 2). He has now tolerated capping of his tracheotomy tube for approximately 1 year, but has not yet been decannulated due to a recent diagnosis of squamous cell carcinoma of the right upper lobe of his lung.

2.2. Case 2

A tracheostomy-dependent 17 year old female with a history of complete glottic stenosis and severe RRP was referred to the division of pediatric otolaryngology at Cohen Children’s Medical Center for further management. She had previously been managed by intermittent carbon dioxide laser treatment, but had not received any adjuvant therapies. At the time of presentation to us, she had complete glottic stenosis with subglottic papillomatosis and tracheal disease (Fig. 3). She underwent frequent debridement of papillomatosis every 4–6 weeks using the laryngeal microdebrider. Prior to debridement, her glottic stenosis was sharply divided using a sickle knife followed by dilation with a 10 mm airway balloon. Despite frequent intervention, her glottis continued to restenose completely between visits.

Following three attempts at endoscopic division of the complete glottic stenosis and balloon dilation, she underwent...
endoscopic division with right cordotomy and endoscopic laryngeal stent placement. The stent was removed 1 week postoperatively, and her glottis had completely restenosed 8 weeks following the procedure. Ultimately, she underwent double-stage laryngotracheoplasty with posterior costal cartilage grafting and left vocal fold suture lateralization (Fig. 4). Persistent problems with partial restenosis resulted in several additional dilation procedures including the use of mitomycin-c during one procedure. Ultimately, her glottis remained patent and she was decannulated approximately ten months following laryngotracheoplasty (Fig. 4). She was capped continuously for six months prior to decannulation and has remained asymptomatic without evidence of stridor at her last follow up eight months following decannulation. She continues to have mild posterior subglottic papilloma and is still receiving routine debridement of laryngeal RRP every three months.

2.3. Case 3

A 5-year old child who had recently undergone urgent tracheotomy for RRP and severe glottic stenosis was referred to the division of pediatric otolaryngology at Cohen Children’s Medical Center for further management. She had previously undergone frequent carbon dioxide laser assisted removal of her papillomatosis, without any adjuvant treatments. Upon initial presentation, she had a near-complete glottic stenosis with a significant burden of glottic, subglottic and tracheal disease (Fig. 5). She underwent frequent laryngeal microdebrider assisted debridement of papillomatosis with balloon dilation of the glottic stenosis. Approximately sixteen months into treatment, she had a widely patent glottic airway which remained patent between procedures (Fig. 6). She was subsequently decannulated and remains asymptomatic greater than 1 year following decannula-

![Fig. 4](#) Post-operative images for case #2. (A) Larynx at time of LTP with posterior cartilage graft. (B) Larynx s/p cordotomy. (C) Larynx immediately prior to decannulation.

![Fig. 5](#) Pre-operative images for case #3. (A) Larynx – near-complete stenosis. (B) Trachea – significant papillomatosis.

![Fig. 6](#) Post-operative images for case #3. (A) Larynx – significantly improved airway. (B) Trachea – improved burden of disease.
tion with no evidence of RRP. She continues to undergo routine bronchoscopy every six months to evaluate for RRP.

3. Results

Three children with complex glottic stenosis secondary to severe recurrent respiratory papillomatosis were treated at our institution since 2011. Two of the patients had complete glottic stenosis and the third had near complete stenosis. Two patients were managed using balloon dilation alone, and the third also underwent laryngotracheal reconstruction with posterior costal cartilage grafting. Two patients have been successfully decannulated and the other patient has been tolerating continuous tracheostomy cuffing for 1 year. All three patients underwent balloon dilation with aggressive debridement of papillomatosis every 4–6 weeks. In two patients, the glottic airway was patent, and the third continued to have complete restenosis between procedures and required laryngotracheoplasty with multiple post-operative dilation procedures to establish an adequate glottic airway.

4. Discussion

Airway scarring and stenosis can be an unfortunate consequence of surgical management of aggressive RRP. Either iatrogenic airway stenosis or a high burden of disease, or a combination of the two can lead to tracheostomy tube placement in these patients. A variety of open procedures have been described for managing airway stenosis associated with RRP. Perkins et al. published a series of five patients with iatrogenic airway stenosis, all of whom were successfully decannulated following open surgical procedures, including laryngotracheoplasty and laryngofissure [6]. Another study showed an 83% decannulation rate in tracheotomized RRP patients following open airway reconstruction, and concluded that major airway reconstruction may be safe in this cohort of patients [8]. Although endoscopic techniques were used as an adjunct in both series, there is a paucity of literature regarding endoscopic management as a primary surgical treatment resulting in decannulation in RRP patients with complex glottic stenosis. There is no published literature on the long-term sequelae of open surgery on development of lower airway disease, but open surgery could permit spread of disease to the surgical site. For this reason, we feel that when feasible, endoscopic approaches are a superior option to achieving decannulation. There is also no consensus regarding the timing of open and/or endoscopic repair, and the majority of the patients described by Boston et al. had active disease at the time of open repair [8].

In our series of three patients with complex glottic stenosis, we were able to successfully manage two patients using endoscopic techniques alone. The third patient required an open laryngotracheoplasty in addition to multiple endoscopic procedures. All three patients have an adequate glottic airway. Based on our experience, we feel that aggressive endoscopic management of glottic stenosis can be surprisingly effective in patients with this very challenging pathology, and should be considered as a primary method of treatment in these patients. All three patients in our series had active disease during the time that we addressed the glottic stenosis, which was aggressively and frequently treated. We feel that the presence of active disease should not delay treatment, and that timely decannulation should be a priority.

When treating patients with aggressive papillomatosis, steps should be taken to prevent long-term complications such as glottic stenosis. Delayed complications of laser surgery, including anterior glottic webbing, arytenoid fixation, and vocal fold fibrosis [9–11] have been well-described, and the frequency of such complications is increased in patients with a higher burden of disease requiring more frequent intervention [11]. These complications of laser surgery are thought to be due to thermal damage, and the laryngeal microdebrider has come into favor because it is thought to be safer and easier to use, mitigating concerns regarding thermal damage [12,13]. El-bitar described a 25% soft-tissue complication rate with the use of carbon dioxide laser, which dropped to zero following adaptation of the laryngeal microdebrider [14]. Although there are few reported complications associated with the microdebrider in the literature, we feel that regardless of the surgical tool that is used, it is important to practice caution in patients with bilateral anterior commissure involvement, because violation of the epithelium bilaterally can result in significant scarring [15]. Our preferred method for management of laryngeal papillomatosis is the microdebrider, and we feel that frequent surveillance and vigilance to prevent bilateral vocal fold injury are of utmost importance in preventing long-term soft tissue complications such as glottic stenosis.

The role of adjuvant therapies in treating recurrent respiratory papillomatosis and in preventing long-term complications remains unclear. A literature review reveals only one randomized controlled trial evaluating the efficacy of cidofovir [16] which fails to demonstrate improvement over placebo, and a Cochrane review found insufficient evidence to support the efficacy of cidofovir [17]. Other adjuvant agents which have been described include indole-3-carbinol, acyclovir, retinoic acid and avastin, but definitive data to support their use is lacking. Although all three of our patients underwent frequent debridement of their disease, it is important to note that all three patients were enrolled in a double blind placebo-controlled trial evaluating celecoxib for management of RRP. This is a double-blinded placebo controlled crossover study, so the timing of the intervention is unknown. Therefore, although all three patients had improvement of their disease burden while undergoing treatment which along with their improved glottic stenosis allowed for decannulation, celecoxib may be a confounding factor in their improvement. None of the patients were undergoing any other adjuvant therapy during the treatment period.

5. Conclusions

Endoscopic techniques can be surprisingly effective in the management of glottic stenosis secondary to RRP. Given the quality of life issues and concerns for distal spread associated with tracheostomy placement in patients with RRP, the use of endoscopic techniques, including balloon dilation, directed toward decannulation, should be considered early in the course of treatment for patients with complex glottic stenosis. Although we feel that endoscopic dilation can be surprisingly effective as a primary method of treatment for complex glottic stenosis, open surgical reconstruction should be considered for salvage in patients who fail endoscopic management.

References


