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Complications of treatment of recurrent laryngeal papillomatosis with the carbon dioxide laser in children

EZZAT M. SALEH, M.D. (Assuit, Egypt)

Abstract

A retrospective study of the complications of treatment with the carbon dioxide (CO_2) laser of 17 patients diagnosed to be suffering from recurrent laryngeal papillomatosis is presented. No immediate complications occurred except one case of laryngospasm and failure to intubate during anaesthesia leading to hypoxic encephalopathy. Three patients were completely free from disease and complications. Another patient was free from laryngeal lesions but developed a papilloma in the right tonsillar pillar. Five other patients showed one or more multiple sites of involvement in addition to the larynx. Laryngeal scarring developed in ten patients. Six patients (35.29 per cent) developed scarring as anterior glottic webs while in two scarring (11.7 per cent) occurred as posterior glottic webs. One developed scarring in the supraglottic region. The remaining one had scarring in both the glottic and supraglottic regions. One patient developed tracheal scarring necessitating laryngo-tracheal separation. Two patients were psychologically disturbed during treatment requiring psychiatric consultation and therapy.

Introduction

Recurrent laryngeal papillomatosis is a serious and potentially life threatening disease in spite of being a benign condition. Its unpredictable course and its propensity to recur repeatedly following surgical removal are clear. It may have a profound psychological, social and economic impact on both the patients and families (Pransky and Seid, 1990).

A wide variety of methods have been used for the treatment of laryngeal papillomatosis (Robbins and Woodsons, 1984). In spite of failure of CO_2 laser to solve the problem of recurrence, it is the current treatment of choice for recurrent laryngeal papillomatosis (Elo and Mate, 1988).

Some authors (Strong *et al.*, 1976) described CO_2 laser as the optimal method for the removal of all visible lesions whilst allowing for preservation of important structures such as laryngeal cartilages, vocalis and uninvolved mucosa. Due to the precision of laser surgery and lack of bleeding during CO_2 laser dissection others (Irwin *et al.*, 1986) hoped that it might be an ideal instrument for ablation of recurrent laryngeal papillomatosis.

Little attention in the literature has been paid to complications of treatment of laryngeal papillomatosis with CO_2 laser (Wetmore *et al.*, 1985; Crockett *et al.*, 1987).

This study was done to find out complications of treatment of recurrent laryngeal papillomatosis using the CO_2 laser to determine the incidence and severity of such complications.

Materials and methods

Medical records of 20 patients, proved histopathologically to have recurrent laryngeal papillomatosis, were obtained and their data were retrieved. Three adult patients with a life long history of popillomatosis were excluded as they were adult and were treated not only with the laser but also with other surgical modalities (cryosurgery, microlaryngoscopic removal and diathermy cauterization).

Seventeen patients who underwent multiple endoscopic removal with the CO_2 laser were included in the study. General anaesthesia was administered either via orotracheal intubation or through tracheostomies in tracheostomized patients. Safety precautions were strictly used for the patients and the operating rooms attendants. Papillomas were lasered using the microscope and the laser attachment with CO_2 laser ranging from 8 to 12 W and 0.5 to 1.0 s exposure time. All patients were usually followed up two weeks to four months. Twelve patients were treated with interferon as adjuvant to CO_2 lasering. Another patient was treated with cytoxan and prednisone as an adjuvant to CO_2 lasering. Only three patients were treated without any adjuvant therapy to CO_2 laser.

Immediate and delayed complications were looked for. Emphasis was applied to laryngeal scarring, its sites, degree and its treatment. Patients with multiple sites of involvements were analysed as regard site of involvement and elapsed duration between treatments and appearance of other lesions.

Results

The patients included in this study were ten girls and seven boys. The disease began below or at age of two years in 12 patients. The onset was at two and a half years in two other patients. Another two commenced it at the age of four years. Only one the onset was at the age of seven.

From Department of Ear, Nose and Throat, Assuit Medical School.
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No intra- or immediate post-operative complications in the form of bleeding, burns, fires, injuries to the patients or operating rooms attendants were recorded. No respiratory or air way compromise intra- or immediate post-operatively was recorded with the exception of laryngospasm due to failure of intubation during anaesthesia in a one year old baby. This necessitated tracheostomy. This baby developed cardiac arrythmia and later on hypoxic encephalopathy.

Ten patients developed laryngeal scarring as a delayed complication of treatment of recurrent laryngeal papillomatosis with CO_2 laser. Six had anterior glottic webs (35.29 per cent), while two had posterior glottic webs (11.7 per cent). Supraglottic scarring occurred in only one patient. Another one had both glottic and supraglottic scarring. Four of them were mild scarring which sucessfully treated again with CO_2 laser. Another one was treated with repeated multiple dilatation and subsequent decanulation of her tracheostomy. The remaining five patients were treated with keel placement; the tracheostomy of one patient was successfully decannulated. The laryngeal papillomatosis had resolved completely in these five patients at time of keel placement. The anterior commissure was found to be involved in all patients who developed scarring later on in spite of care and attention to avoid such scars. However, in three other patients the anterior commissure was involved without the further complication of scarring.

One patient developed tracheal scarring as he had tracheobronchial papillomatosis. He was treated with laryngotracheal separation (an unusual procedure in such a disease) as the papilloma was found to be filling the mid cervical trachea and thick scarring was noted down to the fourth tracheal ring.

Two patients presented with papillomatosis in one or more sites at the time of presentation and first treatment. Another four developed this after a long period of treatment (nine to 10 years).

During the course of treatment two patients (11.7 per cent) were psychologically disturbed. This occurred in the form of intense fear of medical procedures, instruments specially needles, tapes and bandages.

The data is summarized in Table I.

TABLE I

Patient number	Age at onset	Tracheostomy	Other sites of Adjuvant	involvement	Treatment of Glottic webs	Involvement of glottic webs	Ant. commissure
1	2 years	No	Interferon	No	No	No	Positive
2	2½ years	No	Interferon	Rt tonsillar pillar	Anterior	CO_2 lasering	Positive
3	7 years	No	No	Inferior pole of tonsil	No	No	No
4	1½ years	No	No	No	No	No	
5	1 year	No	No	No	No	No	No
6	2 years	No	Interferon	No	Anterior	CO_2 lasering	Positive
7	4 years	No	Interferon	No	Anterior	Keel placement	Positive
8	2 years	No	Interferon	Soft palate	Anterior	Keel placement	Positive
9	2 years	Yes, then decannulated	Interferon	No	Supraglottic	Laser and dilatation	No
11	2½ years	Yes	Interferon	No	Posterior glottic with in terarytenoid scarring; anterior commissure	Keel replacement	Positive
12	4 years	Yes	Interferon	Tonsillar pillar with soft palate	Anterior glottic web, distorted	Keel placement	Positive
13	9 months	Yes	Interferon	Bronchial, tonsillar pillar	No	No	Positive
14	2 years	Yes	Cytoxan	Bronchial	Tracheal scarring	Laryngotracheal separation	Positive
15	15 months	Yes	Interferon	No	Anterior glottic web	Keel placement	Positive
16	1 year	Yes	Interferon	No	No	No	Positive
17	4 years	Yes, then decannulated	Interferon	No	Anterior glottic web	Kal placement	Positive

Discussion

In the past several years, the CO_2 laser has become the most universally accepted treatment for recurrent laryngeal papillomatosis. The laser is favoured because of its haemostatic properties as papilloma tend to be friable and vascular (Strong, 1987). Its surgical superiority is also due to its minimal production of oedema in tissues post-operatively (Crockett and Reynolds, 1990). This is preferable in laryngeal papillomatosis in order to avoid airway compromise in children with a smaller larynx. This study demonstrates the both of these advantages and also the safety of the CO_2 laser as there were no intra- or immediate post-operative complications such as bleeding, oedema, air way compromise, unintentional tissue damage, burns air way fires.

Because of its precision dissection, the laser allows for vaporization of the lesions without to damage or harm to the underlying supporting structures (Strong *et al.*, 1976; Strong, 1987). However delayed formation of laryngeal

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webs was reported by Crockett *et al.* (1987) in approximately 36 per cent of their patients. The most common sites affected were the anterior commissure, followed by the posterior commissure and interarytenoid region. Wetmore *et al.* (1985) reported 10 patients out of 40 (25 per cent) with anterior glottic webbing, and two patients with posterior glottic webbing. The tendency of delayed formation of laryngeal scarring and webbing after treatment of laryngeal papillomatosis with CO_2 laser was also demonstrated in the study. Six children out of 17 (35.29 per cent) developed anterior glottic webs. Two others developed posterior glottic webs (11.7 per cent). One developed supraglottic webs. Another patient developed both supra- and glottic scarring. Patients with laryngeal scarring necessitate further surgery and endoscopies. This treatment ranged from division with the laser, laryngeal dilatation, keel placement and in one patient laryngotracheal separation. This high incidence of delayed scarring may be attributed to wide use of the CO_2 laser by those with limited experience. In an earlier study (Strong *et al.*, 1976), scarring complicated treatment with CO_2 laser in only seven patients out of 110 (6.3 per cent) in the form of anterior glottic webs. Posterior glottic webs developed in only two patients in their study. This low incidence may be due to limited, cautious, careful use of the laser by only experienced endoscopists. In comparison to the pre laser era, the incidence of scarring due to a variety of methods of treatment of laryngeal papillomatosis was slightly lower than that due to use of CO_2 laser (Table II).

Several experimental studies have attempted to define the histological effects as healing of laryngeal laser surgery *versus* conventional methods. Comparison was made between healing of the true vocal fold wounds in dogs following CO_2 laser ablation of the superior surface of the true vocal fold epithelium versus stripping with conventional microcup forceps (Dunkin *et al.*, 1986). Delayed formation of granulation tissue and re-epithelization was noted in the vocal folds treated with laser *versus* that treated with microcup forceps. A giant cell reaction was noted in the submucosa in the vocal folds treated with laser probably secondary to the charred debris of CO_2 laser ablation. Despite the precise control affected by laser, many of the lasered vocal folds revealed vocalis muscle oedema and destruction. They also found that after healing occurred dense fibrosis was found in the vocal muscle injured during CO_2 laser ablation of the overlying squamous epithelium. Although small numbers of animals were used, this experimental study showed that healing of the delicate vocal folds following laser surgery may not be uncomplicated or as complete as previously hoped and wished. Leonard *et al.* (1988) found more subepithelial nervous tissue damage in lasered than in stripped vocal folds, but increased deposition of fibrous tissue in the subepithelium with healing following both procedures.

In all patients who developed anterior glottic webbing, the anterior commissure was involved. However, in three more patients the anterior commissures were involved without further delayed scarring. So careful attention to the anterior commissure area must be paid during laser ablation. Staged papilloma removal for the disease in the anterior commissure is more appropriate to prevent apposition of raw mucosal surface. Also injudicious use of the laser may injure the deeper tissue layers; careful use of the CO_2 laser by experienced endoscopists is mandatory.

Multiple site involvement was observed in this study to occur in six patients out of 17 (35.29 per cent). These sites were shown in Table I. Two of them presented at the time of first endoscopy. Four others developed it after nine to 10 years of treatment with the laser. It is not clear whether it was due to the CO_2 laser or due to the aggressiveness of the disease as most of the patients (12 out of 17) commenced the disease below the age of two years. In 1989, Cole *et al.* attributed aggressiveness as a function of age of onset with a younger onset denoting more severe disease. The other possibility is seeding of the HPV DNA during CO_2 laser and implantation of it in the sites of further trauma during surgery and anaesthesia. Recently, Kashima *et al.* (1991) identified HPV DNA in the CO_2 laser plume from recurrent laryngeal papillomatosis. They concluded that this identification of HPV DNA in the laser plume raised concern regarding potential risks from exposure to the plume, particularly to the endoscopists and operating team. These HPV DNA may still be infectious (Ito, 1960; Ito and Evans, 1961) and seeding of such intact HPV DNA leads to involvement of sites other than the larynx specially sites of trauma such as the palate and tonsils. In another study, Abramson *et al.* (1990) demonstrated that HPV DNA cannot be detected in the smoke of plume from vaporization of laryngeal papillomatosis unless direct suction is made with papilloma tissue during surgery. Unfortunately, this contact with papilloma tissue either with suction tips, endotracheal tubes or even endoscopies is inevitable.

Two patients developed psychological disturbance during treatment. This is not related to the CO_2 laser. Majoros *et al.* (1964) mentioned that one patient in their study committed suicide after having had treatment for 24 years. So psychological support and reassurance must be a mandatory and part of the management of such a relentless disease.

The aim of surgical treatment of recurrent laryngeal papillomatosis is to remove as much of the papilloma mass as possible in order to provide a satisfactory airway and good voice and to do this as atraumatically as possible to prevent the risk of seeding with papilloma further down

TABLE II
COMPARISON OF LARYNGEAL SCARRING FOLLOWING THERAPY IN PRELASER AND LASER STUDIES

Pre-laser studies			Studies using laser		
Study	Method of removal	Scarring	Study	Anterior glottic webs	Postglottic
Cohen *et al.* (1980)	Microforceps	9/90 (10%)	This study	6/17 (35.29%)	2/17 (11.7%)
			Crocket *et al.* (1987)	15/66 (36%)	
Bröjrk and Weber, (1956)	Diathermy	8/28 (28.5%)	Westmore *et al.* (1984)	10/40 (25%)	2/40 (5%)
Majorus *et al.* (1964)	Electrocoagulation	12/58 (20.7%)	Strong *et al.* (1976)	7/110 (6.3%)	3/110 (2.7%)
Singleton and Adkins (1972)	Cryosurgery	1/21 (4.8%)	Ossof *et al.* (1991)	3/14 (21.4%)	

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the respiratory tract and creating scarring in the larynx (Irwin *et al.*, 1986). Long before the same comment was reported by Majoros *et al.* (1964) and they added that the surgeon's worth is measured not by the number of times he has to remove papillomatosis nor the number of years it takes to control papillomatosis but by the child's reaching adulthood with a relatively normal larynx. This study demonstrates that the CO_2 laser neither achieves the aims of surgical treatment nor significantly alters the rate of recurrence, particularly with florid lesions which tend to spontaneous unpredictable regression and remission complicating the evaluation of treatment.

Extensive investigations for laryngeal papillomatosis have to continue to find out a better method of treatment in this common disease in children with minimal complications. Photodynamic therapy which has been used successfully in only two patients by Abramson *et al.*, 1988 with a follow-up of only 13 months still needs further research and study. Recently Abramson *et al.*, 1992 used photodynamic therpay successfully in 33 patients with laryngeal papillomatosis. They attempted to optimize the effect of this form of therapy and minimize complications. Fried (1991) in a review article of the current uses of the laser in otolaryngology enumerated the complications of the CO_2 laser and recommended the use of the free electron laser. In addition, immuno- incompetence of patients with recurrent laryngeal papillomatosis was found by Perrich *et al.* (1990). They evaluated the immunological status of four patients with this disorder. Further investigations for the immuno-incompetence in such patients is needed. Reppucci *et al.* (1991) found that retinoic acid is not only able to modulate the differentiation pathway determined by the stem cells but also at viral DNA level. They suggested that retinoic acid possesses the regulatory ability to slow the replication of viral DNA in human laryngeal papilloma cells in the active phase, thereby inducing a latent phase in human laryngeal papillomatosis.

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Address for correspondence:
Ezzat M. Saleh, M.D.,
Department of Ear, Nose and Throat,
Assuit Medical School,
Assuit University, Assuit,
Egypt, 71516.

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