

CO₂ Laser Surgery for Early Laryngeal and Hypopharyngeal Cancer

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Abstract

Recent years have seen paradigm shift in the treatment of early laryngeal tumors towards microscopic CO₂ laser resection because of excellent oncologic and functional results. The coupling of the carbon dioxide (CO₂) laser to the operating microscope has greatly simplified, even revolutionized, microlaryngoscopic surgery. Focus is now not just on oncological outcome but also on preservation of vocal function. This results in a continuous conflict between the need to remove tissue for oncological stability and the need to preserve tissue for optimal vocal function.

Keywords: Laryngeal cancer, Hypopharyngeal cancer, CO₂ laser.

INTRODUCTION

The use of the CO₂ laser in the endoscopic management of patients with early laryngeal cancer represents an obvious extension of the clinical application of conventional cold instruments for endoscopic resection,¹⁻³ with advantages of precision, hemostasis and decreased postoperative oedema. Transoral microlaryngoscopic CO₂ laser resection of laryngeal cancer has distinct advantages over treatment with either radiation therapy or open partial laryngectomy.⁴⁻¹⁰ Resection with the CO₂ laser is almost always complete in one sitting as against nearly six weeks of treatment with radiation therapy. The resection is generally performed as a daycare procedure. Most importantly for the patient, a tracheostomy is not required. Finally, should treatment with the laser be found to be inadequate, use of other options, namely radiotherapy and open surgery, are still available.

PATIENTS AND METHODS

Four hundred and forty-eight patients with previously untreated early laryngeal and hypopharyngeal cancers were evaluated and treated by transoral endoscopic laser resection from January 2000 to May 2010 at the Department of surgical oncology, Prince Aly Khan Hospital, Mumbai,

India. The patients ranged in age from 18 to 86 years (median age, 57 years) and there were 417 males and 31 females with M:F ratio of 13:1. All patients were assessed with rigid laryngoscopes and computed CT imaging was only done when anterior commissure, subglottic, or paraglottic space invasion was suspected (e.g. bulky lesions or impairment of vocal fold mobility). TNM staging system was used for staging in this study. There were 322 cases of glottic, 72 cases of supraglottic and 54 cases of hypopharyngeal carcinoma (Table 1). Median post-treatment follow-up was 46 months.

In glottic series, there were 188 cases of T1a, 45 cases of T1b, and 89 cases of T2 stage (Table 2). None of the cases had palpable neck nodes at presentation. In supraglottic and hypopharyngeal series 28 cases were of T1, 88 cases of T2 and 10 cases of T3 stage (Table 2). The vocal cords were freely mobile in all cases, including the ones with T3 lesions, 86 cases had N0, 9 cases had N1, 24 cases had N2

Table 1. Site-wise distribution

Site	Number	Percentage
Glottic	322	71.87%
Supraglottic	72	16.07%
Hypopharynx	54	12.05%

Table 2. T-stage wise distribution of laryngeal cancers

Stage Site	T1	T2	T3
Glottic	T1a-188 (58.38%) T1b-45 (13.97%)	89(27.63%)	–
Supraglottis and hypopharynx	28(22.22%)	88(69.84%)	10(7.93%)

Table 3. N status at presentation

Site	N0	N1	N2	N3
Glottic	322(100%)	–	–	–
Supraglottis and hypopharynx	86(68.25%)	9(7.14%)	24(19.04%)	7(5.5%)

and 7 cases had N3 neck status at presentation (Table 3). All the cases with positive neck nodes were subjected to neck dissection and 24 out of 40 cases had delayed neck dissection 3 to 4 days after CO₂ laser resection of their primary tumors.

All patients were allowed to eat on the day after surgery. Naso-enteral feeding tubes or tracheostomy was not used in any patients. Postoperative radiotherapy or reoperation with an enlargement of previous margins was indicated when surgical margins were found to have squamous cell carcinoma on findings from the permanent paraffin section. If a patient did not wish to undergo a repeat surgery or this was not possible for any reason, treatment with postoperative radiotherapy was chosen.

Postoperatively patients were followed until death or at the longest until June 2010. All the patients who completed minimum one year of follow-up were included in the study. Local control, disease free survival and organ preservation were the main outcomes.

SAFETY MEASURES

When using the CO₂ laser certain safety measures are advised in order to prevent injury to the patient and to the operating room personnel. The endotracheal tube should be of non-inflammable material; hence the commonly used polyvinyl endotracheal tubes are absolutely prohibited during microlaryngeal laser surgery. A red rubber tube is used, preferably wrapped in reflective aluminum foil to prevent damage, as a hole created in the tube can cause combustion of the anesthesia gases and fire. Soaked

cottonoids are placed in the larynx to prevent thermal damage to the tissues. Theatre personnel are advised to wear goggles to protect the eyes from accidentally reflected laser beam.

PROCEDURE

The resection is performed transorally using a suspension laryngoscope and an operating microscope which is coupled with the CO₂ laser. An orotracheal tube is used for general anesthesia. Tracheotomy is avoided. Proper exposure of the lesion is vital to ensure an adequate excision with oncologically safe margins.

The laser beam is now focused accurately to a spot-size and manipulated with the help of a micromanipulator to permit precise excision in a relatively bloodless field. For a small lesion that can be visualized in its entirety, monobloc (Figs 3 and 4) resection is performed by cutting through normal tissue at the margins of the tumor. A larger lesion is excised in multiple segments as determined by the field of exposure. This method of cutting through tumor tissue, though unconventional in open surgery is the recommended technique. The resection is completed segment by segment, as the tumor is excised in wedges till the supple normal tissue is left behind.

The CO₂ laser is an excellent cutting tool with limited capability for coagulation. Minor ooze is controlled either with a defocused laser beam or with a cottonoid soaked in 1:100,000 adrenaline solution. For control of larger bleeders as encountered when resecting lesions of the supraglottis, pyriform, or oropharynx, an electrocautery connected to an insulated suction tip is used. For glottic lesions, hemostasis is generally much simpler.

Lesions on the anterior commissure, anterior third of the vocal cord, infrahyoid epiglottis, vallecula and base of the tongue, are very often difficult to visualize. Techniques are described to improve the exposure and facilitate resection. For example, resecting the false cord to expose the growth on the anterior third of the true cord and the anterior commissure; or resecting the suprahyoid epiglottis to expose the growth on the infrahyoid region.

INDICATIONS

The most widely accepted indication for transoral CO₂ laser resection of laryngeal/hypopharyngeal cancer is an early cancer with freely mobile vocal cords, no gross invasion of the paraglottic or the preepiglottic spaces and good exposure on suspension laryngoscopy.

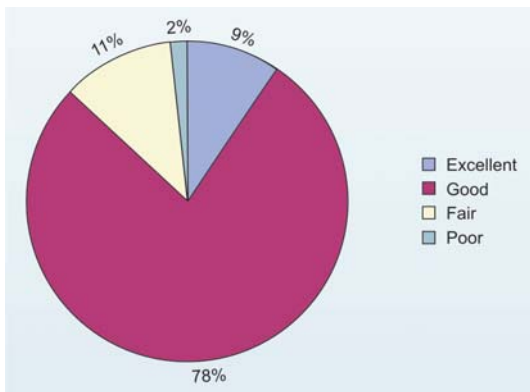


Fig. 1: Schematic representation of postoperative voice quality in supraglottic and hypopharyngeal cancer group: excellent–9.2%, good–80.48, fair–8.7%, poor–1.45%

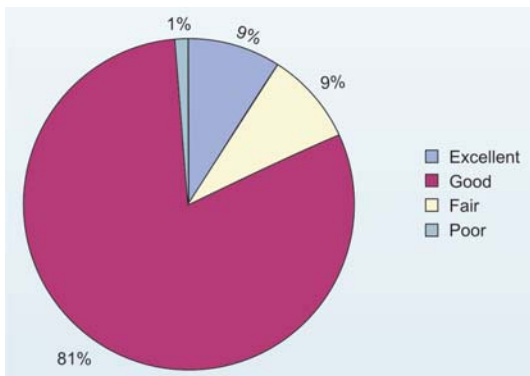


Fig. 2: Schematic representation of postoperative voice quality in glottic cancer group: excellent–9.4%, good–77.35%, fair–11.32%, poor–1.8%

Presence of metastatic lymph node does not preclude endoscopic resection of the primary. In fact, in many cases it strengthens the case for endoscopic resection of the primary prior to neck dissection.

The following are the main indications for transoral resection:

- Dysplasia/Ca *in situ* (TIS) of the vocal cord.
- T1/T2 mid cord lesion.
- Select cases of T1/T2 lesions of the anterior commissure with only superficial invasion and very good exposure on laryngoscopy.
- T1/T2 lesions of the supraglottis, marginal zone, hypopharynx.

There is potential for expanding the indications of transoral laser resection to include lesions that are more advanced than the ones mentioned above for e.g. superficially invasive T3 lesions of the supraglottis/hypopharynx. It depends on the surgeon's experience, expertise and treatment philosophy.

Lesions with gross invasion of the paraglottis and some impairment of cord mobility (T2b) can be resected transorally but the author does not recommend it because alternatives that are oncologically safer and more effective are available viz the open partial laryngectomy procedures.

LIMITATIONS

Inadequate exposure of the tumor on transoral micro-laryngoscopy can make endoscopic resection impossible or unsafe. Certain conditions can make direct laryngoscopy extremely difficult or impossible. These include trismus due to any cause, such as submucous fibrosis, previous oral surgery or radiation therapy; inability to extend the neck due to severe cervical spondylosis or due to fibrosis as a result of previous surgery or radiotherapy; anatomical peculiarities of the dental arch, anteriorly placed larynx or a tongue. In all these conditions, even lesions that are seemingly easily resectable as viewed on indirect laryngoscopy, may have to be offered alternative methods of treatment.

RESULTS

Positive or close margins on paraffin sectioning were reported in 9 cases of glottic cancers and 23 cases of supraglottic and hypopharyngeal cancers (Table 4). In glottic series, re-laser was possible in 5 cases and 4 cases were treated with adjuvant radiotherapy. While in supraglottic and hypopharyngeal series all 23 cases were treated with adjuvant radiotherapy (Table 4).

Postoperative adjuvant radiotherapy was given in 57 cases of supraglottis and hypopharynx series as 23 cases had because of positive or close margins and 34 cases had positive neck nodes.

Voice quality was excellent in 9.4%, good in 77.35%, fair in 11.32% and poor in 1.8% in supraglottic and hypopharyngeal cancers (Fig. 1). Voice quality was excellent in 9.2%, good in 80%, fair in 8.7%, and poor in 1.45% of glottic series (Fig. 2).

In the glottic series, 61/322 (19%) had recurrences; 60 recurred locally and 1 developed cervical lymph node metastasis (Table 5). Of the 60 local recurrences 45(73%) underwent organ preserving salvage treatment. This included another transoral laser resection in 22 cases, open partial laryngectomy in 11 cases and radiotherapy in 12 cases. The remaining 15/60 cases had to undergo total laryngectomy. Thus, the larynx preservation was possible in 307/322 (95%) cases.

Table 4. Positive cut margins and adjuvant treatment given

Site	Number(%)	Adjuvant treatment	
		Re-laser	Radiotherapy
Glottic	9(2.7%)	5	4
Supraglottis and hypopharynx	23(18.25%)	0	23

Table 5. Patterns of recurrences

Recurrence	Number	Local	Regional	Locoregional
Glottic	61(18.94%)	60(18.63%)	1(0.3%)	0
Supraglottis and hypopharynx	24(19.04%)	20(15.87%)	3(2.38%)	1(0.79%)



Fig. 3: Microlaryngoscopic picture of T1 right mid cord lesion



Fig. 4: En bloc CO₂ laser resection of right mid cord lesion

In the supraglottic and hypopharyngeal series, there were 24 recurrences. Of which 20 were local recurrences, 3 cases had regional and 1 case had both locoregional recurrence (Table 5). Of 20 local recurrences, 5 were salvaged by Near total laryngectomy with partial pharyngectomy, 2 by total laryngectomy, 2 by supracricoid partial laryngectomy with CHP, while transoral laser was possible in only one case. 3 cases which developed only neck disease were salvaged with neck dissection followed by radiotherapy. 1 case that

developed locoregional disease was salvaged by re-laser and neck dissection followed by radiotherapy and 11 cases could not be salvaged because of the advanced stage of the disease. Thus larynx preservation of this entire series was 119/126(94.44%).

Distant metastases was seen in 4/126 (3.17%) cases of the supraglottic and hypopharyngeal series while 7/322 (2.17%) of the glottic series. Second primary tumors were seen in 2/126 (1.58% cases) of supraglottic and hypopharyngeal series and 5/322 (1.55%) cases of glottic carcinoma.

The over all survival for the glottic series was 96% and for the supraglottic/hypopharynx series was 88%.

DISCUSSION

Glottic Ca in Situ

Patients present with persistent hoarseness. Laryngoscopy reveals leukoplakia, erythroplakia. It may be localized or diffuse. It may involve both vocal cords separately sparing the anterior commissure or the two vocal cords may be involved incontinuity across the anterior commissure.

Two experienced pathologists may report the same lesion differently – one calling it “Severe dysplasia”, the other calling it “Carcinoma in situ”. To the clinician both represent entities of a biological continuum. Both demand the same treatment, viz., mucosal excision, sparing the deeper tissues. The patient must quit smoking. Dysplastic/carcinoma *in situ* lesions often have a tendency to recur after excision or cord stripping and may call for multiple excisions over a period of years. Even so, radiotherapy is best avoided and reserved only for infiltrative cancer.

As mentioned above, the endeavor should be to excise the lesion completely and prevent damage to the lamina propria so that the voice quality remains good. Zeitels has described a phonomicrosurgical technique for this.¹¹⁻¹³ It involves injecting 1:100,000 adrenaline in saline submucosally with a 26 guage needle which will lift the mucosa and the lesion off the lamina propria. If the patch is localized, conventional micro scissors and forceps are used for excision. For diffuse lesions, the cord is stripped with

the CO₂ laser using a microspot at low wattage. In case there is a microinvasive component, when saline is injected, the mucosa at the site of invasion will remain tethered to the lamina propria and will not be lifted off. In such a situation, only a limited portion of the lamina propria is resected along with the entire leukoplakia to minimize damage to the quality of voice.

If the lesion involves both vocal cords and the anterior commissure, the procedure may have to be staged to prevent formation of a web. However, bilateral cord lesions with uninvolved anterior commissure are tackled at the same session.

T1/T2 Glottic Cancer

Small midcord lesions are resected en bloc. Larger lesions are resected in segments, cutting through the tumor until normal supple tissue is reached. This way, as much normal tissue as possible is preserved, to ensure good quality of voice.

For lesions in the anterior one-third of the cord and the anterior commissure, if the exposure is inadequate, it is best to first resect the portion of the supraglottis, viz the false cord and the base of the epiglottis. This gives a good exposure of the glottis. The lesion can then be resected either en bloc or in segments depending on the size of the tumor. While resecting a lesion on the anterior commissure, if it is found that there is erosion of the thyroid cartilage, the procedure is either converted to an open partial laryngectomy or a laser assisted window partial laryngectomy is performed. Lesions of the anterior commissure will necessitate resection of the anterior most portions of both vocal cords. Left to itself, it will form an anterior web. To prevent this, it is necessary to interpose a silicone keel between the two cords until the healing on both sides is complete. The placement of keel is carried out endoscopically using the Leichtenberger needle.

Lesions involving the true cord, posteriorly, may necessitate resection of the vocal process of the arytenoid, retaining the main body of the arytenoid cartilage. With progress in microlaryngeal laser surgery, the need for open vertical partial laryngectomy has been reduced significantly.

Supraglottic Cancer with Mobile Vocal Cords T1/T2/ Early T3

A distending laryngopharyngoscope is used. Only the cases with freely mobile vocal cords are selected for endoscopic

laser resection. Size and surface extent should not be the limiting factors. Even early invasion of the pre-epiglottic space is amenable to endoscopic resection. Tumors at the free border of the epiglottis or localised lesions on the edge of the aryepiglottic fold are easy to resect. A tumor on the infrahyoid epiglottis needs to be exposed adequately before resection. This is achieved by first resecting the suprahoid portion of the epiglottis, transecting from one pharyngo-epiglottic fold to the other. Thereafter, the infrahyoid epiglottis, with the tumor, is resected along with the pre-epiglottic space.

If a supraglottic tumor has involved the mucosa overlying a mobile arytenoid, it is not necessary to resect the cartilage. Under the magnification of the operating microscope, the overlying mucosal tumor along with sufficient submucosal margin is very easily peeled off with the help of the laser, preserving the arytenoid cartilage and the soft tissues covering it. This is oncologically safe, prevents the problem of postoperative aspiration, and is therefore a major advantage over the open procedure.

Presence of metastatic neck node can be dealt with by an appropriate neck dissection either at the same sitting or 4-5 days later. Postoperative radiation therapy is only given if the resection margins are compromised or if the neck nodal disease so demands. As in the case of glottic cancer, the need for open partial laryngectomy for supraglottic cancer with freely mobile vocal cords has also significantly reduced due to progress in microlaryngoscopic laser surgery.

Hypopharyngeal Cancers

T1/T2 squamous cancers of the pyriform and the posterior pharyngeal wall were generally treated with radiation therapy, largely due to the difficulty of surgical access to these regions. Using the distending laryngopharyngoscope, these lesions can now be excised transorally with the CO₂ laser coupled to the operating microscope. In the postcricoid region, such an excision is only advisable for a small lesion confined to one wall; a circumferential excision will lead to complete stenosis of the pharynx. Like the supraglottis, the oropharynx and the hypopharynx are highly vascular regions and proper instrumentation is mandatory. Very large tumors may not fit into one field and will therefore need readjustment of the scope from time to time. These lesions may at first seem formidable because of their size; however, if the case selection is proper (mobile vocal cords; no cartilage erosion; no parapharyngeal soft tissue invasion;

and no ankyloglossia), it becomes progressively easier as one resects the tumor, segment by segment. In the hypopharynx, it is recommended that one proceed from the proximal portion of the tumor to the distal (Cranio-caudal direction).

As mentioned in the earlier section, the arytenoid cartilage must be preserved whenever feasible in order to avoid problems of postoperative aspiration. If a pyriform cancer extends on to the mucosa overlying a mobile, functioning arytenoid, the tumor can be resected along with the submucosal soft tissue, preserving the arytenoids.

In case the neck nodes are enlarged, neck dissection is deferred for about 4-5 days, particularly if the lateral pharyngeal wall is resected.

Hospitalization: Almost all cases of glottis cancer were treated on an ambulatory care basis unless, there were associated medical problems demanding admission to the hospital. Most patients with supraglottic and hypopharyngeal cancer were hospitalized overnight unless the lesion was very small. Hospitalization was longer for those undergoing concurrent neck dissections. None required tracheostomy for endoscopic resection.

Swallowing: Two patients, (post radiotherapy recurrence of pyriform cancer) developed persistent aspiration following endoscopic resection, including the resection of the arytenoids. Both these cases had to have a prolonged feeding gastrostomy. In one patient of pyriform cancer, nasogastric tube feeding had to be continued for a few weeks during which he also received postoperative radiation therapy because the resection margins were unsatisfactory.

Patients of glottic cancer resumed oral feeds on the same day as surgery, those of supraglottis and hypopharyngeal cancers generally resumed oral feeds on the first post-operative day with minimal dysphagia and almost all barring the 3 cases mentioned above were on regular diet within a week following surgery, salvage procedures included repeat endoscopic laser resection, partial or total laryngectomy and radiation therapy.

CONCLUSION

From the point of view of oncological safety as also quality of life, transoral CO₂ laser resection of early laryngeal and hypopharyngeal cancer is a very useful treatment method that every H and N surgeon must endeavor to develop expertise in. Presence of metastatic cervical nodes does not preclude endoscopic resection of the primary. The major advantage over the open surgical procedure is the smooth postoperative recovery and avoidance of tracheostomy.

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