

Indications and outcome of CO₂ lasers in Larynx in a Tertiary care center.

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Abstract:

Background: Lasers are relatively newer and popular addition to the domain of laryngology. The lasers have offered a time and cost effective option to cold surgical techniques and have been used in the treatment of various laryngeal pathologies. However, it may be associated with complications which can be minimized by proper understanding of the mechanism of lasers. **Aim:** To study the indications, advantages, complications and outcomes of CO₂ laser in laryngeal pathologies. **Materials and methods:** 40 patients, admitted in the department of ENT surgery of our institution, who were treated with CO₂ laser were included in the study and were analyzed for the indications, advantages, complications and outcome of CO₂ laser surgery prospectively. **Results:** Out of the 40 patients, 27 were males and 16 were females in a ratio of 2:1. The mean age was 29.85 years and age range was 6 to 70 years, the age group 16-30 years constituted the majority (37.5%). Post corrosive laryngeal stenosis was the major indication (35%). Tracheostomy was required in 40% patients. Complications were noted in 27.5% patients, the most common were immediate oedema and late granulation formation. 80% patients could be discharged next day of the surgery and 75% of tracheostomised patients were decannulated within a month of surgery. **Conclusion:** CO₂ laser is an effective option in management of laryngeal pathologies. While it offers various advantages over conventional surgeries, it can be associated with complications. However the outcome is favourable and encourages us to continue and recommend lasers for laryngeal surgeries.

Keywords: CO₂ laser, Laryngology, Laser.

Introduction:

The word 'laser', is an *acronym* for light amplification by stimulated emission of radiation. It is used to treat pathologies such as stenosis, recurrent respiratory papillomatosis, leukoplakia, nodules, polypoid degeneration, granulomas and malignant laryngeal diseases.^[1] Surgeon can choose wavelengths from CO₂, Nd: YAG, Argon, KTP lasers but CO₂ laser is renowned for its precision, particularly when coupled with microscope for delicate atraumatic surgery and remains the mainstay of lasers in laryngeal surgeries.^[2]

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Laser is thought to be new “Aladdin’s Lamp” which can “perform miracle surgery”.^[3] Ruby laser was invented by Theodore Maiman in 1960. Patel

invented the first CO₂ laser in 1964. In early 1970s CO₂ laser with microscope and micro manipulator was introduced by Strong, Jako and Briedemeier.^[1]

CO₂ laser has a wavelength of 10.6 micron which helps to penetrate into soft tissue with little heat dissipating to adjacent tissues^[1]. The laser light is then transformed within tissue to thermal energy, raising the tissue temperature to 100 degree Celsius and vaporizing the tissue water content. A rapid thermal drop of laser energy in tissue surrounding the incision results in shallow and predictable tissue penetration with minimal oedema.^[2] The haemostatic capability of CO₂ laser is limited to blood vessels not larger than capillaries (15mm). The CO₂ laser beam can be focused to create a precise cut and defocused to produce coagulation of small blood vessels (1mm).^[2]

CO₂ Lasers are associated with better prognosis but complications following CO₂ laser usage can be very serious.^[4] These complications can be reduced to minimum with proper understanding of mechanism and application of lasers.

The purpose of this paper is to study the indications, advantages, complications and outcome of carbon dioxide laser surgeries in laryngeal pathologies.

Materials and Methods:

The present study involved the review of 40 patients, who were treated with CO₂ laser (Image 1) in the department of ENT Surgery, VS hospital Ahmedabad, during a period of two years, from July 2011 to June 2013, prospectively. Patients were explained about the laser surgery and informed consent was obtained from the patients and patient's relatives prior to the surgery. All the procedures were performed as per standard guidelines and ethical standards. Analysis was done for the epidemiological data, indications, advantages and complications of CO₂ laser surgery. Post operatively, patients were followed up at one week, one month and six months to study the long term outcomes.

Image 1: CO₂ Laser



Results:

A total of 40 patients were included in this study of which 27 (67.5%) were males and 13(32.5%) were females in the ratio of 2:1 (Image 2).

The patients included were of age ranging from 6 years to 70 years at the time of surgery. The median age was 25 years and the mean age was 29.85 years. Adolescents and young adults in the age group 16- 30 years constituted the majority (37.5%), followed by adults aged 31-45years (22.5%). (Image 3)

Image 2: Gender distribution

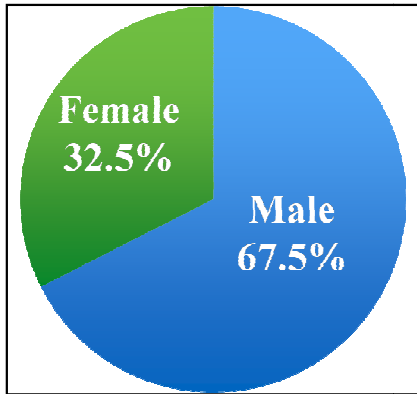
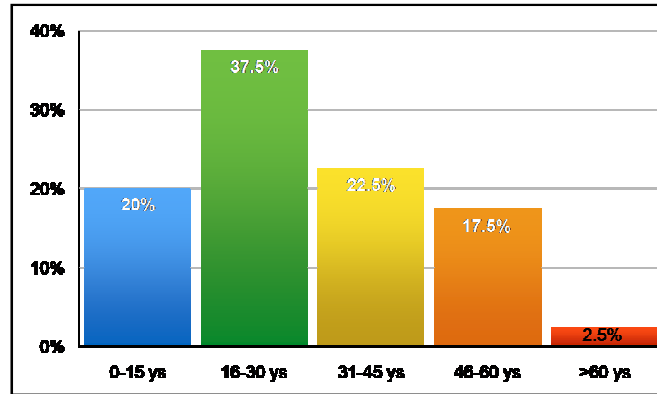


Image 3: Age distribution of patients



Laryngeal stenosis after ingestion of corrosive substance was the commonest indication of CO₂ laser surgery followed by post traumatic laryngeal stenosis. Many patients were having compromised air passage as we were dealing with laryngeal pathologies. Thus there were number of patients (40 %) who already had tracheostomy either at our institution or outside for various reasons. Post corrosive laryngeal stenosis was the commonest indication for tracheostomy (Table 1).

Table 1: Indications of CO₂ Laser and Tracheostomy

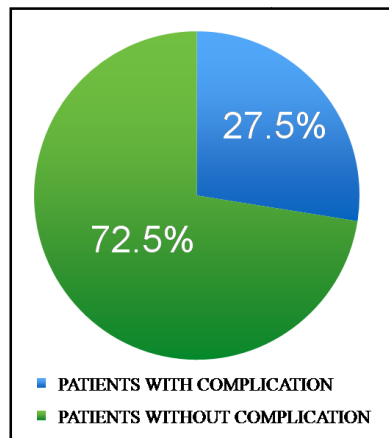
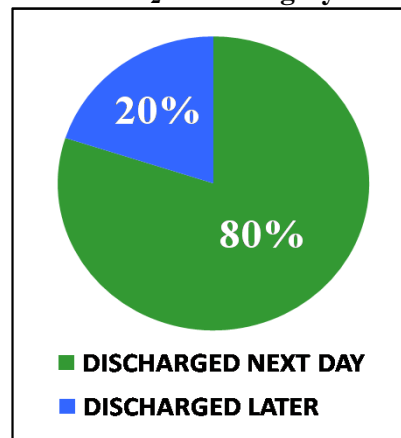
Sr. No.	Indications	No. of Patients	Tracheostomised
1	Post corrosive laryngeal stenosis	14 (35%)	11 (27.5%)
2	Post traumatic laryngeal stenosis	7 (17.5%)	2 (5%)
3	Bilateral abductor palsy	6 (15%)	1 (2.5%)
4	Carcinoma larynx	4 (10%)	1 (2.5%)
5	Laryngeal papilloma	4 (10%)	1 (2.5%)
6	Vocal cord polyp	4 (10%)	-
7	Saccular subglottic cyst	1 (2.5%)	-
	Total	40 (100%)	16 (40%)

All cases operated with laser were targeted with high accuracy and minimal bleeding intra-operatively. However, as all surgical procedures are bound to be associated with some kind of complications, laser is no exception. In our study, complications were seen in 11 (27.5%) patients, most common complications being immediate oedema and late granulation formation (Image 4). Some patients had more than one complication (Table 2).

Most of the patients (80%) were discharged on the next day of the surgery. 20% of the patients, required hospital stay of more than one day as they developed some complications (Image 5). In our study, all patients were followed up after one week, one month and six months. By taking vigorous follow up exercise, we had reported six patients with late granulation formation and one patient with recurrence of disease. All these patients with complications were managed appropriately.

Table 2: Complications of CO₂ laser

Complications	Immediate oedema	Bleeding	Subcutaneous emphysema	Late granulations	Recurrence
Post corrosive laryngeal stenosis	4 (10%)	-	-	5 (12.5%)	-
Post traumatic stenosis	-	-	2 (5%)	1 (2.5%)	-
Bilateral abductor palsy	1 (2.5)	-	-	-	-
Carcinoma larynx	1 (2.5%)	1 (2.5%)	-	-	-
Laryngeal papilloma	-	-	-	-	1 (2.5%)
Total	6 (15%)	1 (2.5%)	2 (5%)	6 (15%)	1 (2.5%)

Image 4 Incidence of complications**Image 5 Hospital stay after CO₂ laser surgery**

We had also given closure trial to tracheostomised patients in follow up, mostly after one month. Out of 16 tracheostomised patients, we had successfully removed tracheostomy tube in 12 (75%) patients.

Discussion:

The use of CO₂ lasers in surgery has offered an efficient alternative to cold surgical techniques.

Besides being convenient and exact, CO₂ lasers offer surgeons an opportunity for unobstructed vision of the operation field with minimal tissue manipulation and a longer working distance. Decreased risk of postoperative bleeding, increased sterility, minimal surrounding tissue damage, better intra-operative haemostasis, better post operative voice quality and reduced post operative pain are among the potential benefits of laser surgery.^[1] Laser also afford briefer hospital stays and shorter wound recovery periods, particularly for patients with laryngeal cancer. More healthy, functionally important structures can be preserved facilitating early recovery of physiological function and better oncological results.^[5] Because of these technical and functional advantages, CO₂ laser has gradually replaced partial external surgeries for the treatment of laryngeal carcinoma.

The indications of CO₂ lasers in laryngology include laryngeal stenosis, recurrent respiratory papillomatosis, leukoplakia, vocal cord keratosis, nodules, polyps, polypoid degeneration (Reinke's oedema), granulomas, arytenoidectomy in bilateral vocal cord palsy, debulking obstructing carcinoma of upper airway, carcinoma in situ, and malignant laryngeal

disease¹. Laryngeal stenosis was the commonest indication of CO₂ laser surgery in our study, ingestion of corrosive substance being the commonest etiology of stenosis followed by trauma. Maximum number of patients belonging to the age group of 16 to 30 years may be related to increased incidence of suicidal attempts, road traffic accidents and trauma in adolescents and young adults. Increased road traffic accidents in males, being the breadwinners of the family, also explain the male preponderance as evident in our study.

Although CO₂ laser surgery results in a reduced complication rate; yet complications do occur and can range from intra-operative endotracheal tube fire accidents to early and late postoperative sequelae.^[4] Complications can be divided into minor and major complications. Minor complications are defined as those that resolve spontaneously or with conventional outpatient treatment without any consequence, while major are those that require intensive medical treatment, blood transfusion, or revision surgery.^[4] The common complications include local infection, post operative haemorrhage, emphysema, post-operative mucosal oedema, aspiration- pneumonia, voice impairment, synechiae formation, stenosis, glottic incompetence and granuloma formation.^[4]

Postoperative haemorrhage was the most serious complication and is seen in 3-14 % patients as per study done by Prgomet et al.^[4] Precise resection of the tumour and careful haemostasis are of paramount importance.

The other dreaded complication of CO₂ laser is airway fire.^[6] It is important to exercise laser safety precautions in the operating room during these cases which include wet eye pads and towels to cover the patient's face; ensuring that the patient is not jetted while the laser is on, in case jet ventilation is used and keeping sterile saline or water handy at the operating table. In the event of an airway fire, water needs to be poured into the airway immediately and the anaesthetist is immediately notified to turn off the oxygen and anaesthetic gases. The endotracheal tube is then withdrawn and the patient is bag masked. Once the patient's oxygen saturation is stable, a bronchoscopy is performed to assess the extent of mucosal damage and airway can be reestablished by endotracheal intubation. The patient should remain intubated for at least 48 hours while being treated with intravenous antibiotics. Trial extubation can be attempted 48 hours later followed by a repeat bronchoscopy.^[6]

The complication rate as per various studies ranged between 3 to 19%^[4] with mortality rate of 0 to 3%.^[7] In the present study the incidence of complication is 27.5% with immediate oedema and late granulation formation being the commonest (15%). Though the complication rate is relatively higher in our study as compared to previous studies but serious sequelae are low with no mortality. Out of 40 only 1 patient (2.5%) has shown intra-operative bleed which is in accordance with the bloodless nature of CO₂ laser surgery with the limitation that CO₂ laser cannot coagulate large diameter blood vessels. To prevent oedema and granulations, short course of oral steroids was given to the patients postoperatively. Even though, some patients, mostly of post corrosive stenosis, required granulation removal and dilatation on regular intervals. We have also recorded 2 cases of mild subcutaneous emphysema which resolved in few days with conservative management. One case of

recurrence is due to the nature of juvenile laryngeal papilloma while no case of infection or excessive pain is reported.

We have discharged 80% of the patients next day of the surgery. Rest of the patients have required hospital stay of more than one day as they have developed some complications postoperatively which have been managed accordingly. Regular follow up has been done at one week, one month and six months and all patients have shown earlier and faster functional improvement as compared to conventional cold surgeries. All cases of bilateral vocal cord palsy have shown good voice quality postoperatively.

CO₂ laser surgery in small non obstructing lesions of larynx does not require tracheostomy. In our study tracheostomy is required in 40% patients. However, 75% of them have been successfully decannulated after one month of surgery.

Conclusion:

From the present study it can be concluded that CO₂ laser surgery, despite being a newcomer, has successfully incorporated itself as a treatment modality in benign and malignant laryngeal conditions. It carries the advantage of microscopic precision, bloodless operative field and complete sterility. Complications can be further reduced by a proper understanding of the mechanism of the laser and having a clear concept of their management if they occur. The relatively low postoperative morbidity, faster recovery, lesser duration of hospital stay and good functional results support the favourable outcome provided by CO₂ laser surgery and add strength to its efficacy in laryngeal surgeries.

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