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Laser Microsurgery as An Alternative to Total and Partial Laryngectomies in Glottic and Supraglottic Lesions: An Experimental Study

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Abstract:

Background: Malignant tumors of the head and neck represent 6,6% of all tumors registered by the American Cancer Society, with laryngeal cancer accounting for almost 21% of the head and neck region. The development of surgical techniques that preserve function, as well as improving or maintaining survival, has been a priority in laryngeal, as in other types of cancer, for the last 50 years. After the introduction of the CO2 laser for the treatment of benign and very early malignant laryngeal lesions by Strong and Jako . Endoscopic Transoral Laser Microsurgery permits complete tumour resection, yet is associated with higher rates of laryngeal preservation, less morbidity (particularly swallowing defects) lower frequency of pharyngocutaneous fistula and shorter hospitalization than open surgery, it is possible to minimize the loss of healthy tissue and to lower the overall morbidity. Hence the use of transoral laser surgery has been internationally accepted as a valid treatment option for early laryngeal cancer; however, its use in advanced laryngeal diseases remains controversial

Aim: This study as held to investigate the possibility for proper resection of selected cases of laryngeal cancer using trans-oral Laser Microsurgery as an alternative to total and partial laryngectomy

Methodology: 40 patients diagnosed as Laryngeal Cancer and indicated for partial or total laryngectomy were enrolled in this study. after removal of the specimen it will be fixed on a special holder and the tumor will be removed by laser with safety margin. The two specimens (the resected larynx and laser excised tumor) will be subjected to detailed histopathological examination to detect the presence of tumor in the remaining part of the larynx after laser excision of tumor and in the safety margin around the laser excised tumor. The safety margin around the laser excised tumor will be measured.

Results: Positive margin was found at surgical upper(A) margin (22.5%), surgical lower (D) margin (12.5%). However, at surgical lateral (B– C) margin no positive cases were reported, and higher positive margin was found among laser upper (A`) margin (32.5%),laser lateral (B` – C`) margin (17.5%) and finally laser lower(D`) margin (47.5%) of all studied patients. Regarding tumor type: the cases with both sites' lesions had higher positive margin, followed by supraglottic (40%) lesions in A than glottic lesions (0%). However, in D` margin glottic lesions (31%) had higher positive margin than supraglottic lesions (0%)

Conclusion: Transoral laser microsurgery is a suitable alternative to total or partial laryngectomy with statistically significant agreement for margins between both techniques

Keywords: Laryngeal cancer, Transoral laser microsurgery, supraglottic, laryngectomy

1. Introduction

The development of surgical techniques that preserve function, reduce side effects and safeguard quality of life, as well as improving or maintaining survival, has been a priority in laryngeal, as in other types of cancer, for the last 50 years. In fact, the first alternative to total laryngectomy was reported in 1939 by Alonso, who introduced horizontal supraglottic laryngectomy, which permitted organ preservation in supraglottic laryngeal cancer [1-3].

After the introduction of the CO₂ laser for the treatment of benign and very early malignant laryngeal lesions by Strong and Jako [4]. Steiner et al expanded the indications of transoral laser surgery to all tumor categories of the upper aerodigestive tract in the early 80s [5-7].

Endoscopic Transoral Laser Microsurgery permits complete tumour resection, yet is associated with higher rates of laryngeal preservation, less morbidity (particularly swallowing defects), shorter feeding tube emplacement times, fewer tracheotomies, lower frequency of pharyngocutaneous fistula and shorter hospitalization than open surgery, it is possible to minimize the loss of healthy tissue and to lower the overall morbidity [8]. This method can be seamlessly integrated into any therapeutic regimen while maintaining all salvage treatment options [9-10].

Until recently, open surgical conservative approaches and radiotherapy have competed as the standard treatment of early and moderately advanced pharyngeal and laryngeal cancer. The advent of microsurgical endoscopic procedures using the CO₂ laser represents an important advance in terms of less invasive, more precise, and more functional surgery, resulting in lower morbidity and a better quality of life for the patient [11].

Hence the use of transoral laser surgery has been internationally accepted as a valid treatment option for early laryngeal cancer; however, its use in advanced laryngeal diseases remains controversial

MATERIALS AND METHODS

This study consists of 40 patients with cancer larynx underwent surgical treatment (Total or partial laryngectomy) at ORL department of Faculty of medicine, Cairo university.

The study was approved by the scientific committee of Otorhinolaryngology Head and Neck surgery department, scientific committee of Medical Biochemistry department and the scientific committee of Faculty of medicine, Cairo University.

Written informed consent was obtained from each of the participants after approving the study protocol by the Ethics Committee of Faculty of Medicine, Cairo University.

The patients were enrolled according to the following Inclusion criteria: Patients proved pathologically to have SCC of the larynx, Patients treated surgically, by either total or partial laryngectomy and Patient with T (2-3), N0, M0 Cancer Larynx. On the other hand, Patients with laryngeal malignancy other than SCC and Patients diagnosed as T4 laryngeal cancer subjected to radio-chemotherapy were excluded from the study. Full ORL examination including either external or Endoscopic laryngeal assessment were done for every patient of the study.

Before the surgical procedure, a Written consent was taken after full explanation of the operation and other alternatives with a Routine preoperative laboratory investigations and blood

grouping & matching and preparation of blood transfusion. And a Preoperative anesthesia consultation.

The surgery is tailored according to TNM staging as the Techniques used were: Total laryngectomy and supracricoid partial laryngectomy (SCPL) .Following the surgical steps as stated by Anderson and Sataloff (Anderson and Sataloff , 2005),the patient was positioned with a sandbag under the shoulders and a head ring, and the operating table head-up.

A marker pen was used to indicate the line of incision, a utility incision. Using a 15 blade, the skin, subcutaneous fat, and platysma were incised. After the surgical tumor removal,The pharyngeal defect was closed using 3/0 vicryl sutures in 2 layers, a nasogastric tube was inserted and Patients were transferred to the ward post operatively, started nasogastric tube feeding for 14 days.

Post-surgical Laser excision of the tumor

After removal of the specimen, it will be fixed on a special holder by four pins superiorly, inferiorly and laterally ,the specimen will be incised vertically by surgical blade in the midway between the arytenoids til the vocal cords in case of supraglottic laryngectomy and til the cricoid cartilage in case of total laryngectomy .**Figure(1)**

The CO2 laser device is carefully calibrated to ensure precise cutting and minimal thermal damage. The laser device handpiece was used to remove the tumor from the specimen based on the gross picture seen by the naked eye without affecting the integrity of the specimen with simulating the clinical scenario of using such technique in tumors removal. **Figure(2)**.The safety margin around the laser excised tumor will be examined in comparison to the surgical margins for tumor infiltration.

The specimens is fixed in buffered formalin then routinely processed until embedded in paraffin wax. Serial sections as thin as 9 microns are obtained using Macrocut Tome sectioning system and stained with H&E and then analyzed under microscope in the pathology lab with referring to surgical upper margin (A), surgical lower margin (D)and surgical lateral margin(B– C) Moreover,laser upper margin (A`) laser lateral margin (B` – C`)and finally laser lower margin (D`)



Figure (1) is showing the tumor specimen after being incised vertically in the midway between the arytenoids



Figure (2) is showing the laser device handpiece during removing the tumor from the specimen based on the gross picture seen by the naked eye without affecting the integrity of the specimen

STATISTICAL ANALYSIS

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Chi-square test was used when comparing between non-parametric categorical data while Kappa test (k) was done for measurement of agreement between surgical margins and laser margins

RESULTS

(40%) of cases had glottic tumors and, supraglottic in (25%) and both (glottic and supraglottic) in (35%) of cases. (70%) of cases were bilateral and (55%) of studied patients had fixed vocal cord. As regard the tumor staging, it was T2 in (27.5%) and T3 in (72.5%) of all studied patients

Positive margin was found at (A) margin (22.5%), (D) margin (12.5%). However, at (B– C) margin no positive cases were reported, and higher positive margin was found among TLM (A`) margin (32.5%), (B` – C`) margin (17.5%) and finally (D`) margin (47.5%) of all studied patients. Regarding tumor type: the cases with both sites' lesions had higher positive margin, followed by supraglottic (40%) lesions in A than glottic lesions (0%). However, in D` margin glottic lesions (31%) had higher positive margin than supraglottic lesions (0%)

Also, high Statistically significant ($p\text{-value} < 0.001$) good agreement ($k = 0.75$) between (A) and (A`) in diagnosis of tumor safety margin in all studied patients as well as Statistically significant ( $P = 0.01$ ) fair agreement ( $k = 0.27$ ) between (D) and (D`) in diagnosis of tumor safety margin in all studied patients were found

DISCUSSION

In the past, open partial laryngectomy (OPL) could remove tumour tissue drastically, dramatically lowering the postoperative recurrence risk; however, due to the loss of normal laryngeal function induced by considerable resection, patients' quality of life and voice suffered significantly after surgery.

TLM has gradually become one of the main ways to treat early glottic carcinoma because of its many advantages, such as less trauma, overall postoperative condition, less hospitalization cost, less intraoperative and postoperative complications and so on. However, it has been difficult to have a consensus on the invasion of the anterior union and some patients with stage T2 and T3.

In the current study we found that, positive margin was found at (A) margin (22.5%), (D) margin (12.5%). However, at (B– C) margin no positive cases were reported, and higher positive margin was found among TLM (A`) margin (32.5%), (B` – C`) margin (17.5%) and finally (D`) margin

(47.5%) of all studied patients. In harmony with **(Hoffmann et al., 2016)** study, who aimed to identifying outcome predictors of transoral laser cordectomy for early glottic cancer the as “positive or suspicious margins” group included 83 patients (41.3%) Similarly, a study of 507 patients by **(Fiz et al., 2017)** who assessed the impact of close and positive margins in transoral laser microsurgery for Tis-T2 glottic cancer, they yielded a positive margin rate of 45.4%, Furthermore, a study of 595 patients by **(Peretti et al., 2010)** who study transoral CO2 laser treatment for Tis–T3 glottic cancer: they documented a rate of 43.7%. Moreover, two hundred and three patients in **(To et al., 2015)** study underwent primary transoral laser microsurgery. Of these, 166 had glottic and 37 had supraglottic squamous cell carcinoma, **To et al** found that the histological margins were reported as positive in 54 patients (27%). In **(Hanna et al., 2019)** study who enrolled A total of 1959 patients with TIS-T3 laryngeal squamous cell carcinoma as A National Database Study, they found that the national positive margin rate was 22.3%. In other study by **(Mariani et al., 2023)**, who analyzed the impact of margin status on local control and survival, and the management of close/positive margins after transoral CO₂ laser microsurgery for early glottic carcinoma. they found negative margins in 286 cases (81.5%) and close margins in 23 cases (6.5%), whereas positive margins were present in 42 cases (12%).

Furthermore **(Jumaily et al., 2019)** study examined overall survival (OS) rates of patients with positive tumor margin status compared to negative tumor margin status after TLM in clinical T1-2 glottic SCC. Of 747 patients meeting inclusion criteria, 598 (80.1%) had negative margins However, higher rate was reported by **(Hendriksma et al., 2018)** who aimed to evaluate the surgical margin status in patients with early glottic cancer (Tis-T2) treated with transoral CO(2) laser microsurgery, on local control, as they mentioned that positive margins were seen in 68 patients (81.0%) and margin status after TLM did not significantly influence LC ($p = 0.489$), Moreover, in the literature there is disagreement about margin-tumor distance: **Hoffmann and Sigston** considered 0.5 mm as safe distance(**Sigston et al., 2006**), **(Hoffmann et al., 2016)** **(Dispenza et al., 2010)** Other authors as **(Dispenza et al., 2010)** **(Ansarin et al., 2009)** **(Fiz et al., 2017)** suggested 1 mm as range and others reported 2 mm(**Hartl et al., 2007**) **(Charbonnier et al., 2016)**.

Regarding tumor type in the present study, we found the cases with both sites' lesions had higher positive margin, followed by supraglottic (40%) lesions in A than glottic lesions (0%). However, in D` margin glottic lesions (31%) had higher positive margin than supraglottic lesions (0%)

In opposite side **(Hanna et al., 2019)** population, supraglottic tumors had a substantially higher Positive margin than glottic tumors (31% vs 20%); however, tumor subsite was not a significant predictor of margin status after controlling for confounders in the multivariable model. Interestingly, **(Pedregal-Mallo et al., 2018)** reported a Positive margin of 17% for supraglottic cancers as compared with 2% for glottic. In addition, the study by **(Wilkie et al., 2015)** yielded a Positive margin of 23.5% after initial surgery and 11.8% after definitive surgery for supraglottic tumors. However, these rates correspond to only 4 and 2 patients, respectively, out of 17. Other

studies in the literature similarly report low numbers of supraglottic cases undergoing TLM, making meaningful comparisons between subsites difficult (**To et al., 2015**) as they enrolled 170 cases 153 glottic and 17 supraglottic. Our findings regarding stages of tumor are in line with many studies as (**Hanna et al., 2019**) study that T3 tumors had an exceptionally high positive margin rate (56.3% vs 38.1% for T2 and 17.3% for T1). On multivariable analysis, T3 tumors were 5 times as likely to yield positive margins as T1 tumors. Few TLM studies include adequate numbers of T3 patients.

CONCLUSIONS

Under the conditions of the current study the following conclusions might be evident: Transoral laser microsurgery is a suitable alternative to total or partial laryngectomy with statistically significant agreement for margins between both techniques

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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