Diode Laser Microsurgery for Treatment of Early-Stage Glottic Cancers: Oncological Outcomes and Our Experiences

Suat Bilici, Ali Rıza Gökduman, Özgür Yiğit

Abstract

Objective: The aim of our study was to demonstrate oncological outcomes and to point out our experiences in treating early-stage glottic cancers using diode laser microsurgery.

Methods: This retrospective study was conducted from August 2009 to January 2016 at the Istanbul Education and Research Hospital and included 43 patients affected by T1 and T2 glottic squamous-cell carcinoma (SCC) (n=42) and verrucous carcinoma (n=1) and treated endoscopically using diode laser (30 W, 980 nm). According to the Union for International Cancer Control/American Joint Cancer Committee's (UICC/AJCC) 2002 laryngeal cancer classification, our carcinomas were classified as T1a in 33 (76.7%), T1b in 7 (16.3%), and T2 in 3 (7%) patients.

Results: The case study included 42 males (97.6%) and 1 female (2.4%), aged 41–83 years, with a mean age of 61.4 years. Patient included in data analysis had a mean follow-up period of 31 months (range, 5–83). The 43 laser cordectomies performed were type II in 8 cases, type III in 10 cases, type IV in 7 cases, type Va in 7 cases, type Vb in 2 cases, type Vc in 7 cases, and type Vd in 2 cases. Local recurrence occurred in 5 patients (11.6%). The interval between the laser surgery and development of recurrence ranged from 13 to 81 months (median=28). Synechia and granuloma formation occurred on the anterior commissure in 7 patients (18.9). Overall survival, disease-free survival, ultimate local control, and laryngeal preservation rates at 2 years were 97.7%, 95.2%, 87.5%, and 92.6%, respectively.

Conclusion: Diode laser microsurgery is a reliable surgical technique that offers good oncological outcome and functional results in the treatment of early-stage glottic cancer.

Keywords: Glottic carcinoma, diode laser, transoral microlaser surgery

Introduction

The term early-stage glottic cancer refers to carcinoma in situ (Tis) and T1 and T2 carcinomas of the larynx without cervical lymph node metastasis (1). Early-stage glottic cancer is one of the most curable malignancies in the head and neck region (2). Many studies have pointed out the effectiveness of various treatment modalities such as radiotherapy (RT), open partial laryngectomy (OPL), or endoscopic laryngeal microsurgery (3-7). The selection of treatment modalities depends upon multiple factors including tumor features, clinical assessment by the operator, patient preferences, cost, the term and availability of treatment, and the risk of complications (8). Even so, determination of the optimal treatment option is a complicated matter. Laser treatment is now recognized as a good alternative to open surgery and RT, and it provides organ preservation as well as good functional and oncological outcomes.

In 1972, Strong and Jako previously described the application of a carbon dioxide (CO_2) laser for the treatment of laryngeal carcinomas (9). Other laser applications, such as the Nd: Yag diode laser, have been used in recent years for the treatment of early-stage glottic carcinoma. The diode laser has numerous advantages, such as excellent hemostatic properties, small size, portability, simplicity of use, rapid installation, anticipated longevity, and all-purpose usage, as well as cost-effectiveness (10, 11). To the best of our knowledge, few reports in the literature have described the use of transoral diode laser microsurgery for the treatment of glottic cancer.

In this paper, we present our relevant experience in microsurgical treatment of early-stage glottic carcinoma using a diode laser.

Methods

This was a retrospective clinical study. Between August 2009 and January 2016, 43 consecutive patients with early-stage glottic cancer were treated using micro-endoscopic diode laser surgery in the Department of Otorhinolaryngology, İstanbul Training and Research Hospital. Of these, 42 patients had biopsy-proven squamous-cell carcinoma (SCC) of the vocal cords and one had verrucous

Department of Otorhinolaryngology, İstanbul Training and Research Hospital, İstanbul, Türkiye

Address for Correspondence:
Suat Bilici
E-mail: suatbilici@yahoo.com

carcinoma. Informed consent was obtained from all the participants. None of the patients had undergone previous RT or surgical treatment. According to laryngeal cancer classification, the carcinomas were classified as T1a in 33 (76.7%), T1b in 7 (16.3%), and T2 in 3 (7%) patients. None of the patients had neck metastases.

Pre-operative diagnostic assessment included flexible and rigid endoscopy at 30° and, occasionally, computed tomography (CT) in selected patients to exclude the presence of cartilage invasion of the anterior commissure, invasion of the paraglottic space of the lesion, and invasion completely to the floor of the ventricle.

The micro-endoscopic diode laser procedures were performed under general anesthesia using surgical microscopy with a 400 mm focus and direct laryngoscopy according to the Kleinsasser technique using the contact diode laser (30 W, 980 nm) ("Biolitec Ceralas," CeramOptec, Bonn, Germany). The mode of operation was a continuous wave, with variable power (~10 W), delivered to a flexible optical fiber (≥300 μm) (Figure 1). The patients were ventilated using a reinforced endotracheal tube suitable for laser surgery. Surgical margins were sent frozen, intraoperatively, for pathology. An extended resection was performed later when a positive result was reported by pathologist. All patients were then examined using rigid endoscopy at 30° and/or a flexible fiber optic laryngoscope. Repeated microlaryngoscopy and excisional biopsies were performed when relapses were suspected in re-examinations.

Statistical analysis

Statistical analysis was conducted using the SPSS 22.0 (IBM Corp. Armony, NY, US) for Windows software package. The descriptive analysis included the use of mean, standard deviation, frequency, and ratio. The distribution of the data was tested using the χ^2 test. Overall and disease-free survival rates were determined using the Kaplan–Meier method. A p value of less than 0.05 was considered statistically significant.

Results

The population comprised 42 males (97.6%) and 1 female (2.4%), ranging in age from 41 to 83 years (mean, 61.4). The follow-up period ranged from 5 to 83 months, with a mean follow-up period of 31 months. The cordectomy types of the 43 laser cordectomies performed were type II (subligamental) in 8 patients, type III (transmuscular) in 10 patients, type IV (total) in 7 patients, type Va (extended to the anterior commissure and contralateral cord) in 7 patients, type Vb (extended to the arytenoid) in 2 patients, type Vc (extended to the supraglottic area) in 7 patients, and type Vd (extended to the subglottis) in 2 patients (Table 1). None of the patients required tracheotomy in their surgeries. Five (11.6%) patients experienced local recurrence within periods varying from 13 to 81 months (mean=28). Three (7%), 1 (2.3%), and 1 (2.3%) recurrences referred to the T1a, T1b, and T2 TNM stages, respectively. One case was a tumor involving both the anterior commissure and vocal cord, 2 cases were carcinomas involving the anterior commissure, and 2 cases were carcinomas involving the arytenoid (Table 2). Of the 5 patients with local recurrences, 2 patients underwent total laryngectomy and 2 were managed with larynx-sparing treatment: a supracricoid laryngectomy in one patient and RT in the other. One patient refused treatment and left the follow-up. Two patients died: one from heart disease and the other from colorectal malignancy, with no deaths related to laryngeal malignancy.

Figure 1. Diode laser (30 W, 980 nm) (Biolitec Ceralas, Bonn, Germany)
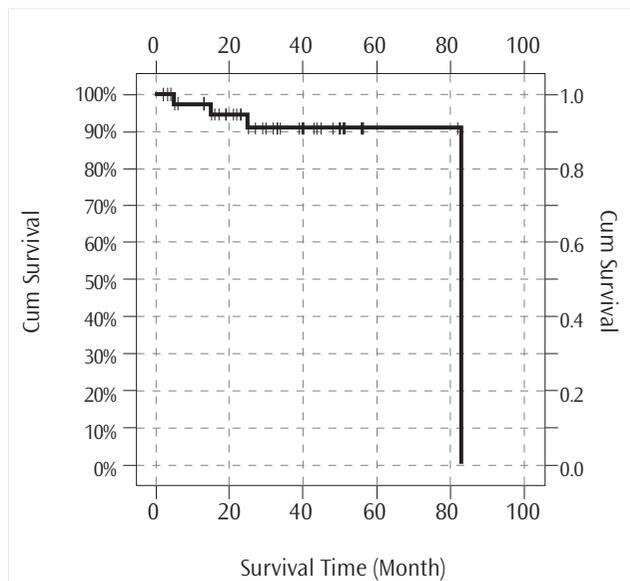

Figure 2. Overall survival rate in 43 patients treated using diode laser surgery

Postoperatively, synechia and granuloma occurred on the anterior commissure in 6 patients (18.9%). These synechia and granulomas occurred in patients with T1b (5 patients), T1a (1 patient), and T2 (1 patient) lesions. A total of 17 patients suffered from fetid halitosis (Table 3).

In total, 4 patients (9.3%) developed mild or moderate dysplasia on the opposite vocal cord after a mean of 15 months. None of the patients developed a metastatic disease.

The overall 2-year survival rate was 94.6%, and the 2-year disease-free survival rate was 90.5% (Figure 2, 3). The 2-year ultimate local control with laser alone was 87.5%. Of the 5 patients with local recurrences, 2 (40%) were managed with further organ-sparing treatment. After salvage therapy, laryngeal preservation was achieved in 92.6% of the surviving patients.

Discussion

The CO_2 laser has been the primary form of laser used since the beginning of the laser surgery. Nevertheless, it has some limitations

Table 1. Distribution of the type of endoscopic cordectomy, in 43 patients

Type of cordectomy	T1a	T1b	T2	Total
Type 2 (Subligamental cordectomy)	8	-	-	8 (18.6%)
Type 3 (Transmuscular cordectomy)	10	-	-	10 (23.3%)
Type 4 (total cordectomy)	6	1	-	7 (16.3%)
Type 5 A (extended to the anterior commissure	6	1	-	7 (16.3%)
Type 5 B (extended to the arytenoid)	2	-	-	2 (4.6%)
Type 5 C (extended to the supraglottic area	-	5	2	7 (16.3%)
Type 5 D (extended to the subglottis)	1	-	1	2 (4.6%)
Total	33 (76.7%)	7 (16.3%)	3 (7%)	43 (100%)

Table 2. Results of recurrence in 43 patients

Results	n	%
Recurrence(localization)	5	11.6
Anterior commissure	2	4.65
Arytenoid	2	4.65
Anterior commissure+vocal cord	1	2.30
Recurrence (TNM stage)		
T1a	3	7
T1b	1	2.3
T2	1	2.3

TNM: tumor neck metastasis; n: 43 patients

Table 3. Results of current status and complications of the patients

Results	n	%
Current status		
- Alive, disease free	40	93
- Died of other causes	2	4.65
- Without follow	1	2.30
Complications		
- Synechia and granuloma	7	16.2
T1a lesion	1	2.30
T1b lesion	5	11.6
T2 lesion	1	2.30
- Smelling halithosis	17	39.5

n: 43 patients

Figure 3. Disease-specific survival rate in 43 patients treated using micro-endoscopic diode laser surgery

diode laser appears to be more sensitive, more cost effective, and less invasive and has a high coagulation capability.

The early symptoms, easy diagnosis, and rare cervical lymph node involvement make the treatment of early-stage glottic cancer successful in most patients, and several treatments are currently available for these cancers (15). Of these, open partial surgery has several disadvantages, including postoperative complications such as pain, edema, subcutaneous emphysema, wound infection, and tracheotomy that necessitate a long length of stay in hospital and cause the deterioration of sound quality. Similarly, the long duration of the treatment and side effects such as mucosal damage and xerostomia are inhibitive for RT (10). For these reasons, an optimal treatment has still not been identified.

The ideal treatment modality for this cancer would be the one that offers high cure rates and good voice quality, does not require hospitalization, has no side effects, and does not necessitate a tracheotomy. Therefore, laser surgery is considered the first therapeutic choice, especially for the treatment of Tis and T1 glottic cancers. Regardless, the RT option must always be suggested to the patient. In our series, the RT option was offered to all the patients, and they preferred laser surgery.

Conditions for the use of microsurgery laser techniques include good exposure of the glottic region and anterior commissure-without deep involvement of the anterior commissure, ventricle, and the supraglottic or subglottic region or impairment of vocal cord mobility-and posterior extension of the lesion as far as the vocal process (10).

The oncological and functional outcomes, laryngeal preservation rate, low morbidity, and good postoperative voice quality after laser endoscopic microsurgery are regarded as ideal by many authors. CO_2 and diode laser treatment for early-stage glottic carcinoma has provided similar success in terms of local oncological control, which varies from 87% to 96% (10, 15-18). This rate in our

such as high cost, increased bleeding that occurs during surgery, and difficulty in treating profound and curved areas (12, 13). Other lasers frequently used in otorhinolaryngological surgeries are the diode and Nd: Yag lasers. The diode laser spreads wavelengths that are absorbed primarily by hemoglobin and melanin. The penetration depth depends on the concentration of these chromophores and can reach depths of 300–1000 µm, which makes it optimal for photocoagulation (10, 13, 14). Compared with other lasers, the
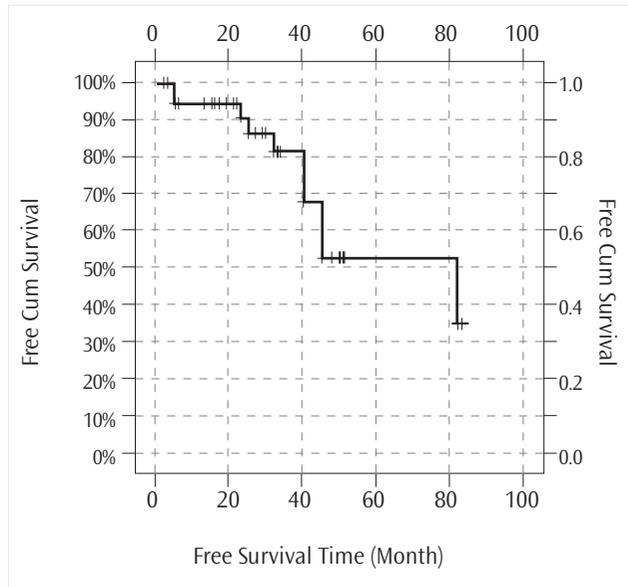
series was 87.5% after 2 years. Motta et al. (17) described an overall survival rate of 85% and an adjusted survival rate of 97% in 432 T1a patients treated using transoral CO_2 microsurgery. In our study, the overall 2-year survival rate was 94.6% and the 2-year disease-free survival rate was 90.5%. The laryngeal preservation, when comparing the CO_2 laser with the diode laser, had rates of 98% and 97.4%, respectively (18, 19). In our series, the laryngeal preservation rate was 92.6%, and the results are close to those reported in previous studies.

In previous reports, the majority of the authors agree on a significant reduction in the duration of hospitalization after laser endoscopic surgery (2, 20, 21). In our study, similar results were obtained, regardless of the extent of the resection.

The application of tracheotomy is unusual after laser microsurgery for treatment of laryngeal cancer (16, 22, 23). Moreau and Pierre reported that laser treatment was a successful treatment for early-stage laryngeal carcinoma in 160 patients, and tracheotomy was not required for any patient in the postoperative period (22). Similarly, none of the patients required intraoperative or postoperative tracheostomy in our series.

The major complications that occurred with the use of the diode laser were related to the more extensive procedures and those with anterior commissure involvement (24). No major intraoperative or postoperative complications occurred in our series. An endotracheal tube fire is the most frightening complication and can be disastrous or even deadly (25). This was avoided by ventilating the patients using a reinforced endotracheal tube suitable for laser surgery in addition to wrapping with cold gauze.

Foul smelling halitosis has been reported in the literature as a rare side effect of relatively more extended laser surgery (23). However, in our results, we found that halitosis is the most frequent complication (approximately 40%) in the postoperative period, especially in the first days, and can be reduced by symptomatic treatment in a short time, based on our experience.

The anterior commissure region is the most troublesome area for laser surgery because it is not well exposed. Therefore, reaching the border of the tumor is difficult, and it cannot be completely removed with the tumor. A wide resection of the anterior commissure may lead to synechia and granuloma formation on the region during the postoperative period. These adverse effects were seen more frequently in T1b stage lesion than in T1a and T2 stage lesions in the present study. The rate of granuloma formation and synechia in our study agreed with that reported in other studies in the recent literature (18.9%) (10, 23).

This study has several limitations. One is the limited number of cases. Another is that the follow-up period was approximately 2.5 years. A 5-year follow-up will lead to more reliable oncological results.

Conclusion

The present series confirmed diode laser microsurgery as a reliable and inexpensive procedure, which led to a short hospitalization time and very low surgical morbidity. Preliminary oncological outcomes suggested that it should be considered as an optional alternative modality for the treatment of early-stage glottic cancers. However, further investigations are needed to evaluate the long-term oncological results of the diode laser treatment of early-stage glottic cancer.

References

1. Hsin LJ, Fang TJ, Chang KP, Fang KH, Tsang NM, Chen YL et al. Transoral endoscopic CO2 laser microsurgery in early laryngeal cancers. Chang Gung Med J 2009; 32: 517-25.

2. Ansarin M, Cattaneo A, Santoro L, Massaro MA, Zorzi SF, Grosso E, et al. Laser surgery of early glottic cancer in elderly. Acta Otorhinolaryngol Ital 2010; 30: 169.

3. Chen MF, Chang JT, Tsang NM, Liao CT, Chen WC. Radiotherapy of early-stage glottic cancer: analysis of factors affecting prognosis. Ann Otol Rhinol Laryngol 2003; 112: 904-11. [CrossRef]

4. Gallo A, de Vincentiis M, Manciocco V, Simonelli M, Fiorella ML, Shah JP. CO2 laser cordectomy for early stage glottic carcinoma: a long-term follow-up of 156 cases. Laryngoscope 2002; 112: 370-4. [CrossRef]

5. Iro H, Waldfahrer F, Altendorf-Hofmann A, Weidenbecher M, Sauer R, Steiner W. Transoral laser surgery of supraglottic cancer: follow-up of 141 patients. Arch Otolaryngol Head Neck Surg 1998; 124: 1245-50. [CrossRef]

6. Peretti G, Nicolai P, Redaelli De, Zinis LO, Berlucchi M, Bazzana T et al. Endoscopic CO2 laser excision for tis, T1, and T2 glottic carcinomas: cure rate and prognostic factors. Otolaryngol Head Neck Surg 2000; 123: 124-31. [CrossRef]

7. Milovanovic J, Jotic A, Djukic V, Pavlovic B, Trivic A, Trivic SK et al. Oncological and Functional Outcome after Surgical Treatment of Early Glottic Carcinoma without Anterior Commissure Involvement. BioMed Res Int 2014; doi: 10/1155/2014/464781.

8. Milovanovic J, Djukic V, Milovanovic A, Jotic A, Banko B, Jesic S et al. Clinical outcome of early glottic carcinoma in Serbia. Auris Nasus Larynx 2013; 40: 394-9. [CrossRef]

9. Strong MS, Jako GJ. Laser surgery in the larynx. Ann Otol Rhinol Laryngol 1972; 81: 791- 8. [CrossRef]

10. Ferri E, Armato E. Diode laser microsurgery for treatment of Tis and T1 glottic carcinomas. Am J Otolaryngol 2008; 29: 101-5. [CrossRef]

11. Bajaj Y, Pegg D, Gunasekaran S, Knight LC. Diode laser for paediatric airway procedures: a useful tool. Int J Clin Pract 2010; 64: 51-4. [CrossRef]

12. Fanjul M, García-Casillas MA, Parente A, Canizo A, Lain A, Matute JA, et al. Utilización del láser diodo en la vía aérea pediátrica. Cir Pediatr 2008; 21: 79-83

13. Vilaseca I, Bernal-Sprekelsen M, Luis Blanch J. Transoral laser microsurgery for T3 laryngeal tumors: Prognostic factors. Head Neck 2010; 32: 929-38.

14. Sullins KE. Diode laser and endoscopic laser surgery. Vet Clin North Am Small Anim Pract 2002; 32: 639-48. [CrossRef]

15. Peretti G, Nicolai P, Piazza C, Redaelli de Zinis LO, Valentini S et al. Oncological results of endoscopic resections of Tis and T1 glottic carcinomas by carbon dioxide laser. Ann Otol Rhinol Laryngol 2001; 110: 820-6. [CrossRef]

16. Shapshay SM, Hybels RL, Bohigian RK. Laser excision of early vocal cord carcinoma: Indications, limitations and precautions. Ann Otol Rhinol Laryngol 1990; 99:46-50.

17. Motta G, Esposito E, Motta S, Tartaro G, Testa D. CO2 laser surgery in the treatment of glottic cancer. Head and Neck 2005; 27: 566-73. [CrossRef]

18. Bocciolini L, Presutti L, Laudadio P. Oncological outcome after CO2 laser cordectomy for early-stage glottic carcinoma. Acta Otorhinolaryngol Ital 2005; 25: 86-93.

19. Edizer DT, Cansız H. Transoral Laser Microsurgery for Glottic Cancers - Complications and Importance of the Anterior Commissure Involvement. Istanbul Med J 2013; 14: 12-5. [CrossRef]

20. Moustapha S, Dassonville O, Bozec A, Gilles P. Laser endoscopic microsurgery of laryngeal cancer. Int Arch Otorhinolaryngol 2014; 18: 36-8.

21. Brasnu D. Chirurgie conservatrice des cancers du larynx: de la chirurgie partielle par voie cervicale à la chirurgie minimale invasive. E-mémoires de l'Académie Nat de Chir 2010; 9: 77-81.

22. Moreau PR, Pierre R. Treatment of laryngeal carcinomas by laser endoscopic microsurgery. Laryngoscope 2000; 110: 1000-6. [CrossRef]

23. Bumber Z, Prgomet D, Janjanin S. Endoscopic CO2 laser surgery for supraglottic cancer—ten years of experience. Coll Antropol 2009; 33: 87-91.

24. Tunçel U, Cömert E. Preliminary results of diode laser surgery for early glottic cancer. Otolaryngol Head Neck Surg 2013; 149: 445-50. [CrossRef]

25. Dhar P, Malik A. Anesthesia for laser surgery in ENT and the various ventilatory techniques. Trends Anaesth Crit Care 2011; 1: 60-6. [CrossRef]