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Clinical Outcome and Survival Analysis of Rigid Carbon Dioxide Transoral Laser Microsurgery in Glottic Squamous Cell Carcinoma of the Larynx

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ABSTRACT

Objective: The aim of this study was to evaluate treatment outcomes, the recurrence and larynx preservation rates, and the survival status of patients treated with transoral laser microsurgery with a rigid carbon dioxide system for glottic squamous cell carcinoma of the larynx.

Methods: Patients with squamous cell carcinoma of the glottic larynx who underwent transoral laser microsurgery using rigid carbon dioxide laser between 2008 and 2019 at a tertiary referral center were reviewed. Non-rigid laser cases and laryngeal cancers other than those affecting the glottic region were excluded. Demographic variables, tumor stage, type of cordectomy, larynx preservation rate, complications, and recurrence data were recorded. Two-, 3, and 5-year overall, disease-free, and disease-specific survival rates were calculated. Patients with recurrent tumors were reviewed in detail.

Results: Two hundred six transoral laser microsurgery operations and 185 patients were treated during the study period. After exclusions, 90 transoral laser microsurgery operations and 86 patients were included. The median follow-up was 57.2 months. Tumor recurrence occurred in 16 (18.6%), including local (n=14), locoregional (n=1), and regional (n=1) recurrence. The larynx preservation rate was 94.2%. The 5-year overall, disease-free, and disease-specific survival rates in Tis-T3 tumors were 93.7%, 75.5%, and 98.8%, respectively. The 5-year overall survival rates by T stage were 92.3% in Tis, 95.3% in T1, 100% in T2, and 80% in T3 tumors. Anterior commissure involvement had no significant effect on survival. En-bloc resection was achieved in 76 (88.4%).

Conclusion: Excellent oncological outcomes with minimal complication rates, high survival, local control, and larynx preservation rates were achieved with transoral laser microsurgery in the treatment of glottic laryngeal cancers.

Keywords: Carbon dioxide laser, glottis, larynx cancer, laser surgery, squamous cell carcinoma of the larynx

Introduction

Larynx cancer is one of the most common cancers in the upper aerodigestive tract. Glottic squamous cell carcinoma (SCC) has previously been treated well, with open partial laryngectomy, total laryngectomy, radiotherapy (RT), or chemoradiation (CRT) protocols.[1,2] In the last 50 years, with the emergence of new technologies, there is a trend toward minimally invasive and larynx-preserving treatment modalities. Intensity-modulated radiotherapy (IMRT) and transoral surgical approaches have become the first choices in the treatment of glottic larynx cancer.[2]

In 1972, a carbon dioxide (CO_2) laser was first used endoscopically for larynx surgery by Strong and Jako.[3] Transoral laser microsurgery (TLM) was later popularized by Steiner.[4] Today, TLM has become the first-line treatment in early larynx cancers due to the advantages of not requiring a cervical incision or tracheostomy, faster recovery, shorter hospital stay, low postoperative morbidity, early recovery of normal swallowing and speech functions, and availability of re-excision with TLM as a salvage procedure.[1,2] Transoral laser microsurgery is recommended in selected post-radiation salvage cases. Transoral laser microsurgery gives similar outcomes in postoperative voice quality and voice-related quality of life in comparison to IMRT.[5,6]

This study aimed to review our 12 years of experience with TLM in glottic laryngeal SCC treatment in our institution. Clinical outcomes, recurrence rates, and survival status of

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patients who were treated with rigid CO_2 laser for Tis, T1, T2, and selected T3 glottic laryngeal SCC were analyzed.

Methods

After Kocaeli University Institutional Review Board approval (decision number: KU-GOKAEK 2020/5.04, project number: 2020/88) was granted, a retrospective analysis of patients who underwent TLM using a rigid CO_2 laser (Limmer Laser GmbH, Berlin, Germany) between 2008 and 2019 was performed. Primary glottic laryngeal cancers which may partially extend to supraglottis, subglottis, or paraglottic region (Tis-T3) were included. Primary supraglottic, subglottic, and hypopharyngeal cancers or cancers with extensive destruction of the larynx in which the primary tumor origin was not clear were excluded. Patients with a diagnosis of SCC, confirmed by histopathology, its variants, and in situ carcinoma were included. Exclusion criteria also included patients with benign lesions or other histologic tumor types; patients who underwent TLM with other than rigid CO_2 laser; patients scheduled for TLM but with perioperative identification of cartilage invasion or extra-laryngeal involvement; and cases lost to follow-up.

After the patient selection was established, data regarding age, gender, smoking status, alcohol consumption, past medical and surgical history, operation notes, length of hospital stay, pathology reports, tumor–node–metastasis (TNM) stage, postoperative complications, postoperative nasogastric feeding tube requirement, adjuvant treatment status, tumor recurrence status, recurrence date, salvage treatment, and last follow-up dates were tabulated. If the patient died during follow-up, the date of death and cause of death information was collected. Patients who did not attend follow-up were recalled for examination and evaluation of recurrence. Patients who were unable to attend control visits or had inadequate data were also excluded from the study. Operation notes and preoperative imaging were evaluated to determine the TNM stage and the presence of anterior commissure involvement.[7] After meticulous evaluation of the operation notes and the recorded operation videos, the procedures were classified according to the endoscopic cordectomy classification of the European Laryngological Society.[8,9] Overall survival (OS), disease-free survival (DFS), disease-specific survival (DSS) rates, and larynx preservation rates (LPRs) were calculated. A small number of patients who received primary RT but underwent salvage TLM were included in the clinical outcomes of this study but not included in the survival statistics.

Main Points

- The 5-year overall, disease-free, and disease-specific survival rates in glottic Tis-T3 laryngeal tumors after transoral laser microsurgery (TLM) using rigid carbon dioxide (CO_2) laser were 93.7%, 75.5%, and 98.8%, respectively.
- The larynx preservation rate after rigid CO_2 laser cordectomy was 94.2%.
- Anterior commissure involvement had no significant effect on survival or recurrence.
- En-bloc resection was achieved in 88.4% of cases.
- Minimal complications and high local control rates were achieved with TLM.

All the patients had biopsy-proven results for larynx cancer before the TLM operation. All TLM operations were performed by the senior author. Histopathological evaluations were performed by the same pathology team.

Surgical Technique

All procedures were performed under general anesthesia in the operating theatre. Orotracheal intubation was performed via 5.5 or 6.0, dual-cuffed, laser-safe intubation tubes. Suspension laryngoscopy was performed. Under direct viewing using an operation microscope (Zeiss, Oberkochen, Germany), the tumor and its extension to adjacent structures, cartilage invasion, subglottic extension, and extra laryngeal extension through the cricothyroid membrane were evaluated. Elevators were used to palpate the mass to assess deep invasion and operability with negative surgical margins. Zero degree or angled (45°-70°) endoscopes were used for further subglottic examination if required. A laser micromanipulator (Sharplan Acuspot, Lumenis, Yokneam, Israel) was attached to the microscope, and the CO_2 laser device was connected to the micromanipulator. The eyes and faces of patients were covered with wet gauze. Wet pads were laid over the tube to prevent damage to the subglottis or trachea.

The CO_2 laser was used in *continuous* or *super pulse* mode at 3-10 W. About 2-3 mm safe surgical margins were implemented on medial surfaces of the vocal cords, while 5-7 mm safe surgical margins were set on lateral surfaces and in the subglottic region. Depth of invasion was assessed intraoperatively by palpation and under direct microscopic examination. In some cases, partial tumoral incisions were made to further investigate the deep extension of the tumor. The surgeon continuously monitored the safe surgical margins under high magnification. If the deep tumoral margin was close to the thyroid cartilage, the inner perichondrium was included in the dissection. For better pathological evaluation, the inner perichondrium was peeled off with an elevator in appropriate cases. Counter-pressure on the cricoid cartilage was performed as required for optimal visualization of the anterior commissure. At the anterior commissure, 2-3 mm normal mucosa was included in the dissection. Resection included the Broyle's ligament and the surrounding inner perichondrium of the thyroid cartilage, retaining the cartilage intact, in cases with anterior commissure involvement. Extra laryngeal spread through the cricothyroid membrane or thyroid cartilage was continuously monitored. Identification of extra laryngeal spread perioperatively led to abortion of the surgery or switching to open surgery according to the patients' preoperative decision. Most of the tumors were resected en-bloc although a proportion underwent piecemeal tumor excision. Surgical margin biopsies were taken mostly from the surgical field and rarely from the excised specimen. In cases suspicious for positive margins, the surgical margin biopsies were sent for frozen section diagnosis. Re-excision of the positive surgical field was performed in the same setting. However, in most cases, the absence of macroscopic tumor tissue was sufficient, and surgical margin biopsies were sent for paraffin section analysis. The operation was concluded after hemostasis was ensured.

Clinical Follow-Up

In the early postoperative period, patients were advised voice rest for 1 week. The patients received nebulized normal saline 4 times a day. During postoperative day 1, patients were followed for aspiration, breathing difficulties, or bleeding. An oral diet was initiated 4 hours after surgery.

In the long-term, patients were initially invited for follow-up every 1-2 months, then every 3-6 months in the following 2 years, and finally every 6-12 months in the third to fifth postoperative years. Annual follow-up was requested after the fifth postoperative year. Routine flexible fiberoptic laryngoscopy and neck examinations were performed at every visit. Direct laryngoscopy under general anesthesia and biopsy from the suspicious lesions or granulation tissues, if present for more than 3 months, were performed.

Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences, version 20.0 (IBM Corp., Armonk, NY, USA). The data are presented as mean and SD if normally distributed or as median and range if non-parametrically distributed. The chi-square test was used for the analysis of nominal variables. Survival analysis was calculated using the Kaplan–Meier method. Survival estimates are given with the standard errors. Log rank (Mantel–Cox) test was used for comparison of survival rates. *P*-value was set to .05.

Results

Between 2008 and 2019, 185 patients underwent a total of 206 TLM operations. Ninety-nine patients did not meet the study criteria and were excluded. Thus, a total of 86 patients and 90 TLM operations were included in the study. Three of the patients (3.5%) were female and 83 (96.5%) were male. The mean age of the patients was 62 ± 9 years, ranging from 44 to 83 years. Sixty-six patients had data concerning smoking history. Six (9.1%) patients had never smoked, while the remaining 60 patients smoked on average 42.5 ± 24.7 pack-years. Five (5.8%) patients had a history of alcohol abuse.

Postoperative pathology reports indicated that 66 (76.7%) patients had invasive SCC and 20 (23.3%) had carcinoma in situ. Among the invasive SCCs, 7 were verrucous carcinomas, 1 was papillary SCC, and 1 was spindle cell carcinoma. The degree of differentiation was assessed in 26 (30.2%) patients, in which 16 (62%) were well-differentiated, 6 (23%) were moderately differentiated, and 4 (15%) were poorly differentiated.

With respect to tumor stage, there were 20 (23.3%) Tis, 37 (43%) T1a, 12 (14%) T1b, 11 (12.8%) T2, and 6 (7%) T3 tumors. One of the T3 tumors was spindle cell carcinoma and 1 was verrucous carcinoma. Degrees of differentiation of the remaining 4 T3 carcinomas were as follows: well-differentiated (n=2), moderately differentiated (n=1), and poorly differentiated (n=1). In nodal staging, all patients were clinically N0. Four of the patients had received primary RT, and the recurrent tumor was salvaged with TLM. None of the patients had distant metastasis at the time of diagnosis.

According to the European Laryngeal Society's endoscopic cordectomy classification, we performed 12 (14%) type I, 16 (19%) type II, 6 (7%) type III, 10 (12%) type IV, 29 (34%) type Va, 11 (13%) type Vb, 13 (15%) type Vc, 11 (13%) type Vd, and 3 (3%) type VI cordectomies (Table 1). Forty-two (49%) patients had anterior commissure involvement. Partial arytenoid excision was performed in 11 (12.8%) patients. Tumor was excised en-bloc in 76 (88.4%) cases and piecemeal fashion in 10 (11.6%) patients.

Table 1. T Stages and Cordectomy Types

		T Stage					
		Tis	T1a	T1b	T2	T3	Total
Cordectomy type	I	9	3	0	0	0	12
	II	2	14	0	0	0	16
	III	3	3	0	0	0	6
	IV	0	10	0	0	0	10
	Va	5	3	10	0	0	18
	Vb	0	3	0	0	0	3
	Vc	0	0	0	3	0	3
	Va + Vb + Vc	0	0	0	1	2	3
	Vb + Vd	0	0	0	1	0	1
	Va + Vd	0	0	0	3	0	3
	Vc + Vd	0	0	0	1	0	1
	Va + Vc + Vd	0	0	0	1	2	3
	Vb + Vc	0	0	0	1	0	1
	Va + Vb + Vc + Vd	0	0	0	0	1	1
	Va + Vb + Vd	0	1	0	0	0	1
	Vb + Vc + Vd	0	0	0	0	1	1
	VI	1	0	2	0	0	3
Total		20	37	12	11	6	86

Only primary transoral laser microsurgeries were included in this table, and salvage cordectomies were excluded.
Tis: carcinoma in situ.

The median length of hospital stay was 2 (1-7) days. The median follow-up was 57.2 (1.6-146.2) months. In the early postoperative period, none of the patients required tracheostomy or nasogastric tube feeding. Two patients suffered mild-degree liquid aspiration and 1 had difficulty in swallowing. These symptoms regressed during follow-up in all 3 patients. There were no cases of laryngeal bleeding or stenosis. Due to positive surgical margins and the absence of residual soft tissues to excise in the surgical field, 1 patient received adjuvant RT. None of the other patients required adjuvant treatment after TLM.

In the postoperative period, granulation tissue was present in 15 (17.4%) patients. Eight of them (53.3%) had anterior commissure involvement. One type II, 3 type III, and 11 type IV or extended cordectomies were performed in these patients.

A second look was performed in 8 patients, and local recurrence was identified in 2 patients in the long term.

A total of 10 (11.6%) patients had anterior synechia or web formation. Nine out of 10 patients had anterior commissure involvement. Secondary surgery to excise web formation was required in only 1 patient. No additional surgery was performed on the remaining patients.

Survival Analysis

The 5-year OS, DFS, and DSS rates were 93.7 ± 3.1%, 75.5 ± 5.5%, and 98.8 ± 1.2%, respectively (Figure 1A, 1B, and 1C). Four RT failure patients who underwent salvage TLM were excluded from the survival analysis. Two of them did not show any recurrence during the 5-year follow-up. One of the patients underwent a total laryngectomy for local recurrence. Total laryngectomy and bilateral neck dissections were recommended to the other patient for locoregional recurrence, but he refused the treatment. All 4 patients are still alive.

The 5-year OS and DFS rates of the patients with anterior commissure involvement were 97.3 ± 2.7% and 72.2 ± 8.2%; those rates for patients without involvement were 90.6 ± 5.3% and 78.5 ± 7.4% respectively. However, anterior commissure involvement did not have any significant effect on survival rates (for OS $P = .827$, for DFS $P = .219$).

According to T stage, the 5-year OS rates were 92.3 ± 7.4% in Tis, 95.3 ± 3.3% in T1, 100% in T2, and 80 ± 17.9% in T3. The 2-, 3-, and 5-year OS, DFS, and DSS rates with respect to T stages are given in Table 2.

After excluding the patient who refused total laryngectomy, the larynx was preserved in 81 (94.2%) patients. Together with the salvage TLMs, local control was achieved with TLM alone in 74 (86%) patients. Four patients died during the 5-year follow-up. The cause of death was laryngeal cancer in 1 patient, lung cancer in 2 patients, and cardiac failure in the remaining patient.

Analysis of Recurrence

Following TLM, 16 (18.6%) patients had recurrent disease. Fourteen of them had local, 1 had locoregional, and 1 had regional recurrence (Table 3). The median (range)

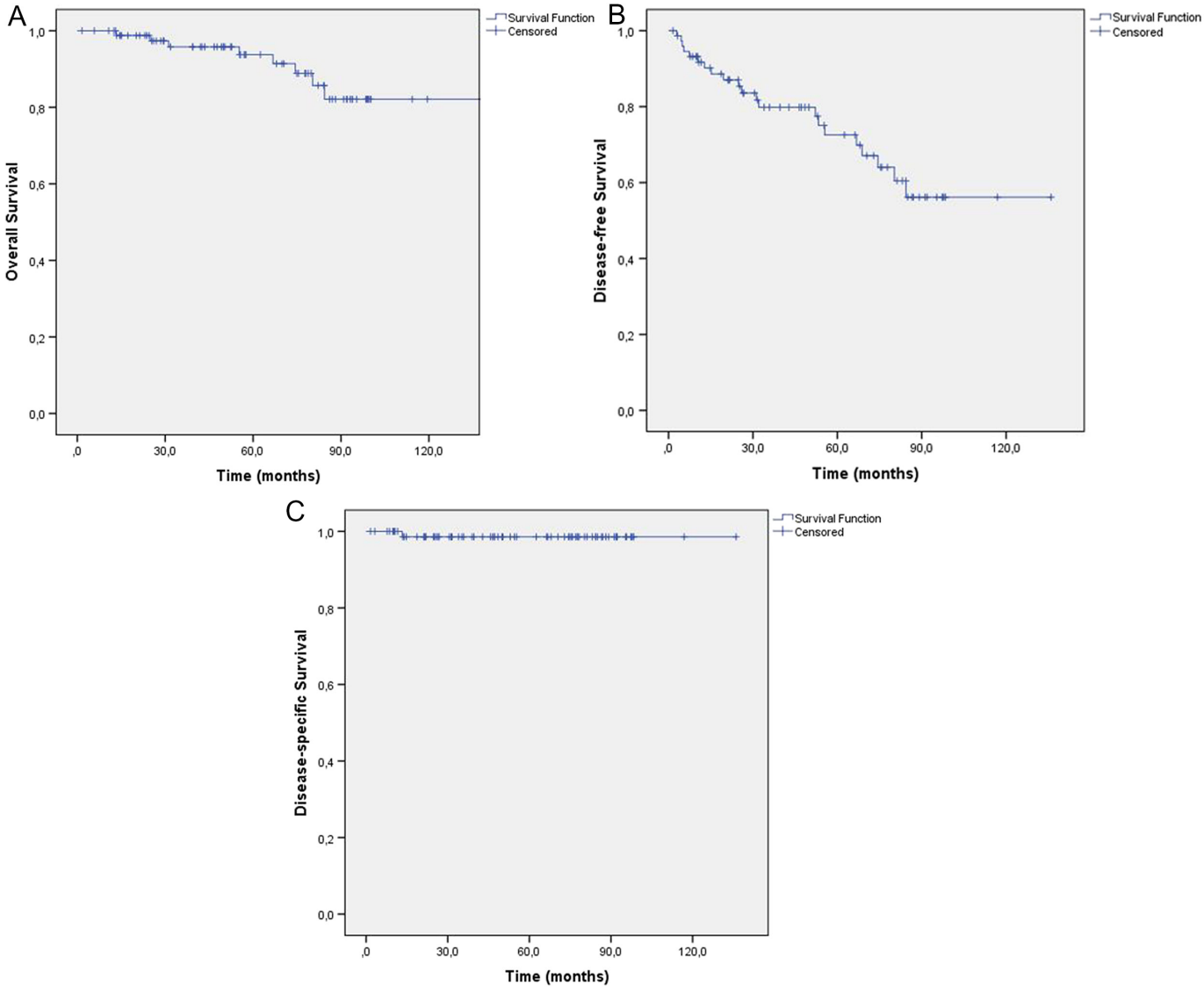

Figure 1. Kaplan–Meier survival graphs: (A) overall survival; (B) disease-free survival; and (C) disease-specific survival.

Table 2. Two-, 3-, and 5-Year Survival Rates According to the T Stage

	Overall Survival			Disease-Free Survival			Disease-Specific Survival		
T Stage	**2-Year**	**3-Year**	**5-Year**	**2-Year**	**3-Year**	**5-Year**	**2-Year**	**3-Year**	**5-Year**
Tis	100%	100%	92.3 ± 7.4%	100%	85.7 ± 9.4%	71.4 ± 12%	100%	100%	100%
n	16	15	13	15	14	14	15	14	13
T1	100%	95.3 ± 3.3%	95.3 ± 3.3%	91.1 ± 4.2%	86.1 ± 5.3%	79.6 ± 6.6%	100%	100%	100%
n	47	40	33	45	40	34	47	39	28
T2	100%	100%	100%	90.9 ± 8.7%	90.9 ± 8.7%	90.9 ± 8.7%	100%	100%	100%
n	8	7	6	8	6	5	9	8	6
T3	80 ± 17.9%	80 ± 17.9%	80 ± 17.9%	40 ± 21.9%	40 ± 21.9%	40 ± 21.9%	80 ± 17.9%	80 ± 17.9%	80 ± 17.9%
n	4	3	2	4	4	3	4	4	2
All	98.8 ± 1.2%	95.8 ± 2.4%	93.7 ± 3.1%	89.7 ± 3.4%	83.4 ± 4.4%	75.5 ± 5.5%	98.8 ± 1.2%	98.8 ± 1.2%	98.8 ± 1.2%
n	76	64	50	73	63	54	75	63	48

Survival estimates were given with the standard errors.
n, number of patients; Tis, carcinoma in situ.

interval between TLM and time of recurrence was 14 (2.9-68.8) months. Two of the patients with recurrence had previously received RT and underwent TLM for salvage therapy. Excluding these 2 people, the recurrence rate for primary TLM was 16.3%. Anterior commissure involvement had no significant effect on overall recurrence [$P=.224$, odds ratio (OR): 1.98, 95% CI: 0.65-6.04] or recurrence rate in T1 tumors ($P=.397$, OR: 1.88, 95% CI: 0.44-8.07). After recurrence, salvage TLM

Table 3. List of Patients with Recurrence

T Stage	Pathology	History of Radiation to Larynx	Recurrence	Salvage Treatment	Time* (months)
Tis	In situ SCC	No	Local	TLM (type IV)	26
Tis	In situ SCC	No	Local	Total laryngectomy + BND	32.1
Tis	In situ SCC	No	Local	Radiotherapy	55.5
T1a	Moderately differentiated SCC	Yes	Local	Total laryngectomy	5.1
T1a	SCC	No	Local	Laryngofissure cordectomy	7.4
T1a	Well-differentiated SCC	Yes	Locoregional	None	8.9
T1a	Poorly differentiated SCC	No	Local	Cordectomy with cold instruments	10.4
T1a	SCC	No	Local	Radiotherapy	19.5
T1a	SCC	No	Local	TLM (type III)	52.2
T1a	SCC	No	Local	TLM (type III)	68.8
T1b	SCC	No	Local	TLM (typeVa–Vc)	15.2
T1b	Verrucous SCC	No	Local	TL + BND + adjuvant treatment	53.3
T2	Well-differentiated SCC	No	Local	Radiotherapy	2.9
T3	Well-differentiated SCC	No	Local	Chemoradiation therapy	4.5
T3	Spindle cell variant	No	Local	TL + adjuvant treatment	4.9
T3	Poorly differentiated SCC	No	Regional	Neck dissection + adjuvant radiotherapy	12.8

Type of cordectomy was given in parenthesis next to TLM.
*The time interval between the date of primary TLM and the recurrence.
BND, bilateral neck dissections; SCC, squamous cell carcinoma; Tis, in situ carcinoma; TL, total laryngectomy; TLM, transoral laser microsurgery.

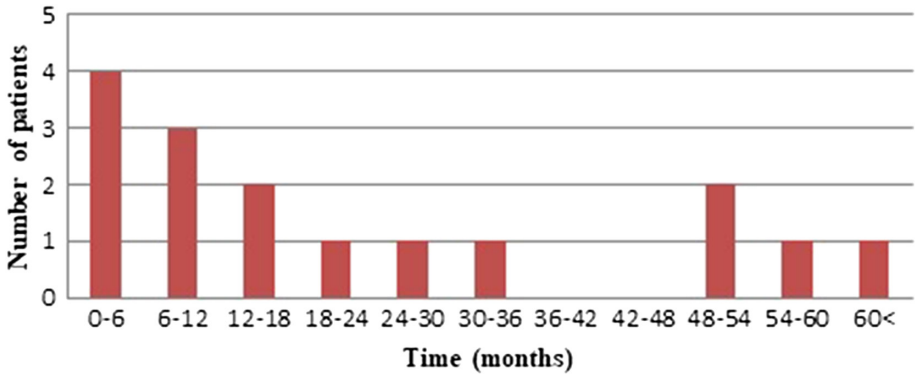

Figure 2. The time of recurrence following transoral laser microsurgery.

was performed in 4 patients, total laryngectomy in 4 patients, laryngofissure cordectomy in 1 patient, and cordectomy with cold steel instruments in 1 patient. Three patients received RT. One patient was given CRT. One patient with regional recurrent disease underwent neck dissection and received RT to the neck. Total laryngectomy was recommended in 1 patient, but he refused the treatment.

Following TLM, 7 out of 16 (43.8%) recurrences were within the postoperative first year (Figure 2). Disease recurrence was identified in 1 patient after 5 years.

Discussion

Transoral laser microsurgery using CO_2 laser is currently widely used in laryngeal surgery. By using an endoscope or a microscope, benign, malign, or premalignant laryngeal lesions are excised without necessitating an external incision while preserving laryngeal vital functions.[5] Surgeons prefer TLM since it allows precise tissue cuts and shortens the operative time.[1,2,10] The advantages for the patients include that TLM gives minimal damage to normal swallowing and speech functions and provides quick recovery. Besides, post-radiation toxicities such as xerostomia, difficulty in swallowing and mastication, and secondary malignancy formation are not present after TLM.[11,12] In our patients, the length of hospital stay and the time interval from TLM to normal swallowing function were very short. Normal swallowing was achieved on the same day in most cases and during the immediately following days after extensive surgery. None of the patients required a nasogastric tube or gastrostomy tube.

Preservation of laryngeal framework and strap muscle function with TLM protects swallowing and respiration functions; thus, none of our patients required tracheostomy. Indirectly, the absence of a tracheostomy shortens hospital stay, decreases treatment cost, and decreases postoperative dysphagia rates.[13] Also, the lack of a need for tracheostomy and subsequent dependence and impairment of life quality will help cancer patients to choose TLM as a first-line treatment option.

Under the microscope, TLM provides better macroscopic tumor tissue/healthy tissue discrimination. Angled endoscopes and fiberoptic systems help to access the anterior commissure, subglottic region, and ventricles. This allows large tissue excision in a relatively limited area with negative surgical margins.[6] Epiglottic petiole and ventricular bands may be excised to increase the visualization of the tumor. During the times when TLM first emerged, piecemeal tumor excision was recommended to identify deep tumoral margins and expand the operative view.[14] Together with the increase in experience and a better understanding of the 3-dimensional tumor orientation, large tumoral masses can be excised en-bloc. Our approach in 88.4% of the patients was en-bloc tumor resection. Splitting the tumor may be performed for large tumors and in cases with anatomical restrains. Still, en-bloc resection can be accomplished with meticulous dissection in most cases.

Oncologically favorable outcomes are accomplished with TLM. In a large study including 404 patients with T1a tumors, Canis et al[2] achieved a 14.4% recurrence rate, 5-year local control rate of 86.8%, and an LPR of 97.3% with TLM alone. In the same study, the 5-year OS, DFS, and DSS rates of T1a tumors were 87.8%, 76.1%, and 98.0%, respectively. In the report of Weiss et al.[15] a 5-year local control rate of 90.2%, an LPR of 92.2%, and a 5-year DFS rate of 72.4% were accomplished with TLM in T1b tumors. In one study, Canis et al[1] categorized glottic SCC into pT2a and pT2b according to the reduced mobility of the vocal cords. They reported 21% and 35% recurrence rates together with 76.4% and 57.3% 5-year DFS rates in pT2a and pT2b tumors, respectively. In pT3 tumors, 32% recurrence rate and 57.8% DFS rate were achieved.[1] In Tis-T2 early glottic cancers, Hendriksma et al[14] reported a 19% recurrence rate, 78.6% 5-year local control rate, and 100% LPR. Similar high survival and LPR and limited recurrence rates were accomplished in our study. In our series, patients with T2 tumors had higher survival rates compared to T1 and Tis. However, we believe this was a result of the limited number of patients with T2 tumors. Most of our study patients had T1 tumors. The lowest survival rates were achieved in T3 tumor cases, as per the literature.[1,12]

In a recent meta-analysis, CO_2 TLM was found to have superior LPR, OS, and DSS rates in T1 glottic laryngeal cancers compared to primary RT.[16] Similarly, high LPR was achieved with TLM in T2-T3 glottic carcinoma.[1,2,10,16] Possible reasons for higher LPR in TLM include the availability of the histopathological examination of the specimen and the surgical margins, better characterization of the tumoral margins in ongoing TLM session, better and wide view of the surgical field during follow-up, a higher chance of early identification of tumor recurrence and early re-excision, and availability of alternative larynx-preserving treatment options (such as new TLM, open

partial laryngeal surgery, or RT) for recurrent tumors. In post-RT patients, the recurrent tumor is mostly submucosal and multicentric; and additional tissue edema makes it difficult to identify tumor recurrence. Also, for recurrent tumors after RT, total laryngectomy is mostly the only viable option. Our study provided a parallel high LPR with TLM. Still, similar local control rates with the 2 treatment modalities were achieved in T1-T2 glottic tumors.[16,17]

Generally, TLM was preferred in T1a mid-cordal tumoral lesions. However, T2-T3 tumors can also be excised by experienced surgeons with oncologically successful results. We believe TLM is a better alternative to open, partial surgery in selected advanced cases. Although it is harder to perform TLM in large tumors, our study showed promising results with TLM and the probability of laryngeal preservation in advanced cases (LPR in T3: 83% and T2: 100%).

There is a controversy in the literature about the anterior commissure involvement being a risk factor for recurrence.[5,12,18] In a study of 463 patients, Rödel et al[19] reported decreased local control rates in T1a and T1b tumors with anterior commissure involvement, but there was no such relationship in T2 tumors. Additionally, survival rates of patients with anterior commissure involvement did not differ from the rest of the patients. Hoffmann et al[20] reported decreased local control rates, LPRs, and DFS rates in Tis-T2 glottic cancers with anterior commissure involvement. In our study, no significant relationship between anterior commissure involvement and recurrence rates or survival rates was present. It has been reported that the vertical extension of the tumor toward the supraglottis or subglottis, rather than the horizontal extension in anterior commissure involvement, is riskier in terms of microscopic tumor invasion.[21] Successful application of TLM is completely dependent on clear vision and access to the tumor and the glottic region. Although the use of an endoscope and flexible systems will help visualization, patients with a large tongue, small mandible, and additional diseases, such as trismus, may not be ideal for TLM. In our clinical experience, in cases in which a clear anterior commissure exposure was achieved with direct laryngoscopy, the anterior commissure was resected, including the inner perichondrium of the thyroid cartilage, and oncologically safe results were obtained.

The first 2 years are very important in follow-up after TLM. In the literature, the average time between TLM and first recurrence has been reported to be between 15.3 and 34.4 months.[2,19,20] In our study, 43.8% of the recurrences occurred within the first year. Therefore, patients should be followed closely in the early postoperative period, and biopsy should be taken without delay from suspicious granulation tissues that do not respond to medical treatment.[22]

Transoral laser microsurgery also has some advantages for recurrent tumors. In particular, leaving the field open and maximum preservation of the laryngeal framework make it easier to detect any recurrence and determine its spread. Recurrence after RT can often be submucosal and widespread, and evaluation might be difficult. In case of a recurrence after TLM, the patient still has the option of re-excision with TLM, open surgery, and CRT. This means that all possible treatment options are still available and the larynx has a higher chance of being preserved again. In our study, in some of the cases with tumor recurrence, it was possible to preserve the larynx with transoral or open surgery or non-surgical larynx-sparing treatments. We believe that LPRs would be higher if the patients were more consistent in attending their follow-up appointments and/or ceased smoking.

Elective neck dissection is not necessary for early-stage glottic cancers. Neck dissection is performed only in the presence of clinical/radiological lymph node positivity in the preoperative period. When TLM is chosen, neck dissection can be performed simultaneously or 3 weeks after TLM. In our series, regional recurrence was encountered in only 1 case without local recurrence, and therapeutic neck dissection was performed.

Instead of rigid CO_2 laser, transoral endoscopic or microscopic procedures can be performed with flexible lasers, such as blue or diode lasers, monopolar cautery, or cold steel instruments. We have experience in all these techniques, but the aim of this study was to include only rigid CO_2 laser cases, all performed by the senior author, and investigate only those patients with SCC of the glottic larynx. Other tumor types and transoral surgical approaches were excluded.

Our study has several limitations due to its retrospective nature. Functional results such as quality of life, voice quality, and swallowing function of the patients could not be evaluated. Changes in patient registration and electronic medical record systems and deficiencies in data entry prevented access to more detailed data. The majority of the excluded patients were excluded due to inadequate follow-up information. Poor socioeconomic status of the patients, moving away to other cities, and coming from distant places were the main causes of data loss. With higher case numbers or combined evaluation of more than 1 referral center data, stronger comparisons can be made, and a more robust identification of factors affecting survival rates may be possible. The results of our study confirm the success of TLM in both anterior commissure involvement and advanced-stage tumors. In our study, we did not evaluate pathological prognostic factors such as perineural or lymphovascular invasion due to the absence of data. The primary aim of this study was to determine survival rates using a specific technique.

Conclusion

High survival, local control, and LPRs and satisfactory oncological outcomes were achieved with TLM in Tis, T1, T2, and selected T3 tumors. Recurrence rates after TLM were low. Half of the tumor recurrence was detected in the postoperative first year. Therefore, early postoperative follow-up of cancer patients is crucial. In appropriate cases, re-resection with TLM was advocated to achieve local control. Transoral laser microsurgery had a very low complication rate. Reasonable outcomes were achieved in cases with anterior commissure involvement. Instead of piecemeal resection, en-bloc resections can be performed in many patients, and this will facilitate the pathological examination of the specimen. Due to successful oncological outcomes, low complication rates, and fast recovery rates, TLM is safe and practical in the treatment of glottic laryngeal cancer.

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Informed Consent: A waiver for the informed consent requirement was granted by the Ethics Committee of Kocaeli University since the study was retrospective.

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