ORIGINAL ARTICLE

Transoral Laser Microsurgery for Advanced Laryngeal Cancer

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Objective: To report the oncologic and functional outcomes of transoral laser microsurgery (TLM) in the treatment of advanced laryngeal cancer.

Design: Prospective case series study.

Setting: Multi-institution (academic, tertiary referral centers).

Patients: A total of 117 patients with pathologically confirmed T2 to T4 lesions, stage III or stage IV, glottic or supraglottic carcinoma of the larynx were treated with TLM from 1997 to 2004. All patients had a minimum follow-up period of 2 years.

Interventions: Transoral laser microsurgery in 117 patients, neck dissection in 91 patients, and adjuvant radiotherapy in 45 patients.

Main Outcome Measures: End points analyzed included laryngeal preservation, overall survival, disease-free survival, local control, locoregional control, and distant metastases. Postoperative complications, tracheotomy rate, and feeding-tube dependence were also examined.

Results: The median follow-up period among surviving patients was 5 years. At 2 years, the percentage of patients with an intact larynx after treatment was 92%. The 2-year local control and locoregional control rates were 82% and 77%, respectively. The 2-year disease-free and overall survival rates were 68% and 75%, respectively. The 5-year Kaplan-Meier estimates were local control, 74%; locoregional, control, 68%; disease-free survival, 58%; overall survival, 55%; and distant metastases, 14%. Four patients (3%) experienced treatment-related deaths. Seven patients (6%) experienced a postoperative hemorrhage. Of those patients with organ preservation and no disease recurrence, 2 patients (3%) were tracheotomy dependent, and 4 patients (7%) were feeding-tube dependent.

Conclusions: In patients with advanced laryngeal cancer, TLM with or without radiotherapy is a valid treatment strategy for organ preservation. Furthermore, low morbidity and mortality and excellent oncologic and functional outcomes make TLM an attractive therapeutic option.

Arch Otolaryngol Head Neck Surg. 2007;133(12):1198-1204

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ADVANCED-STAGE SQUAMOUS cell carcinoma of the larynx is a complex disease that poses numerous challenges to patients and physicians alike. In recent years, comparable outcomes have been reported for approaches that employ conservation or organ preservation surgery, and for those that employ radiotherapy (RT) and chemotherapy.[1,2] Given the collective inability of these strategies to make a substantial impact on overall survival, an emphasis on functional results has evolved. Transoral laser microsurgery (TLM) is a relatively new type of conservation surgery for advanced laryngeal cancer. It uses the carbon dioxide laser via an endoscopic approach to the larynx. Pioneered in Boston, Massachusetts, by Strong and Jako,[3] endoscopic carbon dioxide laser–based surgery has been advocated for treatment of early-stage laryngeal cancer since the 1970s. Only more recently have some medical centers in Europe and North America expanded the use of TLM for advanced-stage disease.[4-8]

In TLM, the tumor is repeatedly divided and removed piece by piece, allowing the surgeon to microscopically map tumor depth and assess margins in multiple planes. This method confers several advantages: (1) the ability to thoroughly map the tumor-host interface assuring a smarter margin clearance and minimum loss of healthy tissue; (2) fewer surgical contraindications based on tumor size, extent, or location; (3) the avoidance of extensive reconstruction, therefore eliminating the morbidity of a donor site and resulting insensate laryngopharyngeal graft; (4) a general avoidance of tracheostomy; (5) early swallowing postoperatively because there are no suture lines to heal; and

(6) maintenance of all options in terms of salvage treatments should recurrence occur.

Surgeons at Mayo Clinic Arizona (Scottsdale), Mayo Clinic Jacksonville (Jacksonville, Florida), Washington University (St Louis, Missouri), and the University Hospital (Göttingen, Germany) have prospectively collected data of patients undergoing TLM for head and neck cancers of all sites at their institutions since 1997. This multicenter study represents an analysis of those patients treated for advanced-stage laryngeal cancer from 1997 to 2004.

METHODS

PATIENTS

Patients were considered for the present study if they underwent TLM with curative intent for previously untreated biopsy-proven stage III or stage IV (staged according to the American Joint Committee on Cancer criteria[9]) squamous cell carcinoma of the glottic or supraglottic larynx.[9] Patients with T1 primary tumors and overall early-stage disease were excluded from the analysis. All patients had a minimum follow-up period of 2 years. Eligibility criteria for TLM are broad. Contraindications include inadequate endoscopic access, extension of tumor to involve the great vessels of the neck, marked extension of the primary tumor and the nodal disease merged or encased around the great vessels, and tumor extension, such that complete resection would put the patient at risk for aspiration (ie, bilateral arytenoid invasion). It is unknown how many patients were evaluated but not considered to be candidates for TLM based on these contraindications. Unlike chemotherapy- and RT-based treatment regimens, select patients with large-volume T4 tumors (defined as a tumor penetrating through cartilage or extending more than 1 cm into the tongue base) are eligible for TLM. In addition, no rigid age-related, hematological, biochemical, or performance status criteria preclude patients from TLM surgery.

TREATMENT

Primary Surgery

The primary tumor was removed under general anesthesia and before any neck dissection was performed following the principles of TLM popularized by Steiner[4] and others.[5-8,10] In contrast to the more traditional en bloc oncologic prototype, TLM involves an incisional resection technique. Under microscopic guidance, the dissection proceeds piece by piece, dividing the tumor repeatedly, thus allowing the operator to accurately follow a precise anatomical map of the tumor-host interface and path of invasion. Advocates of this method point to a more logical tumor resection and greater preservation of normal tissues, structure, and function.

Neck Dissection and Adjuvant RT

Indications for neck dissection were determined by surgeon preference, the presence or absence of positive nodes, risk of occult metastasis, patient preference, and the use of planned adjuvant RT.

The decision to offer adjuvant RT to the primary site or neck varied by surgeon and was based on primary tumor characteristics, aggressive histopathological findings, choice of surgical treatment of the neck, nodal status, and the presence or absence of extracapsular extension.

Table 1. Functional Outcome Swallowing Scale[a]

Stage	Symptoms
0	Normal function and asymptomatic
1	Normal function with episodic or daily symptoms of dysphagia
2	Compensated abnormal function manifested by considerable dietary modifications or prolonged mealtime (without weight loss or aspiration)
3	Decompensated abnormal function with weight loss of <10% of body weight over 6 mo owing to dysphagia; or daily cough, gagging, or aspiration during meals
4	Severely decompensated abnormal function with weight loss of >10% of body weight over 6 mo owing to dysphagia; or severe aspiration with bronchopulmonary complications. Nonoral feeding for most nutrition
5	Nonoral feeding for all nutrition

[a] Data are from Salassa.[11]

Table 2. Communication Scale

Stage	Symptoms
0	Normal speech
1	Minor dysphonia
2	Grossly dysphonic
3	Near-total loss of speech
4	Speech requiring aid
5	No speech

Outcome Measures

End points analyzed were overall survival, disease-free survival, local control, locoregional control, distant metastases, laryngectomy-free survival, and laryngeal preservation. All end points and differences between groups were calculated using the Kaplan-Meier method and log rank test. All events were measured from the day of surgery to the date of their occurrence or the date of last follow-up. Deaths occurring within 30 days of surgery were considered to be treatment related. Disease-free survival was calculated using local or regional recurrence, distant metastases, and death as a result of primary disease as uncensored events. Laryngectomy-free survival was calculated using either death from any cause or laryngectomy as uncensored events. All analysis and medical chart review was carried out in accordance with appropriate institutional review board regulations and approval. Demographic and survival data was evaluated using Microsoft Excel (Microsoft Corp, Redmond, Washington) and SPSS statistical software (version 13.0; SPSS Inc, Chicago, Illinois).

Follow-up

To assess organ functions, permanent tracheotomy and feeding-tube dependency were recorded. In addition, speech and swallow functions were further evaluated after treatment in select patients using 2 clinical tagging systems, the Functional Outcome Swallowing Scale (FOSS) (**Table 1**) and Communication Scale (CS) (**Table 2**).[11,12] Both scoring systems are clinically relevant and easy to use by both medical and allied medical staff. Furthermore, an intact organ was considered to be functioning if the patient had stage 2 or better swallow function and stage 2 or better communication function after treatment. According to these criteria, a patient would eat safely without aspiration, weight loss, or a feeding tube and have the ability to communicate adequately via laryngeal speech in all social environments.

Table 3. Characteristics of Patients According to Treatment[a]

Characteristic	All Patients (N=117)	TLM Alone With or Without Neck Dissection (n=72)	TLM With or Without Neck Dissection, With Adjuvant RT[b] (n=45)
Age, mean (range), y	60 (26-81)	59 (26-81)	60 (43-78)
Sex			
Male	98 (84)	61 (85)	37 (82)
Female	19 (16)	11 (15)	8 (18)
Site of tumor			
Supraglottis	75 (64)	43 (60)	32 (71)
Glottis	42 (36)	29 (40)	13 (29)
AJCC stage[c]			
III	58 (50)	45 (63)	13 (29)
IV	59 (50)	27 (38)	32 (71)
TNM stage			
pT stage			
T2	11 (9)	5 (7)	6 (13)
T3	73 (62)	48 (67)	25 (56)
T4	33 (28)	19 (26)	14 (31)
pN stage			
N0	62 (53)	48 (67)	14 (31)
N1	19 (16)	11 (15)	8 (18)
N2a	10 (9)	3 (4)	7 (16)
N2b	16 (14)	9 (13)	7 (16)
N2c	8 (7)	1 (1)	7 (16)
N3	2 (2)	0	2 (4)

Abbreviations: RT, radiotherapy; TLM, transoral laser microsurgery.
[a] Data are presented as number (percentage) except where indicated.
[b] To neck and/or primary site (because of rounding, not all percentages total 100%).
[c] Staged according to the American Joint Committee on Cancer (AJCC) Staging Manual.[9]

Table 4. Distribution of Neck Dissection by N Stage

N Stage	Neck Dissection			
	None	Ipsilateral	Bilateral	Total
N0	23	22	17	**62**
N1	0	10	9	**19**
N2a	2	4	4	**10**
N2b	0	6	10	**16**
N2c	0	1	7	**8**
N3	0	0	2	**2**
Total	**25**	**43**	**49**	**117**

RESULTS

PATIENTS

From January 1997 to August 2006, 140 patients with stage III or stage IV carcinoma of the larynx were treated with TLM at Mayo Clinic Arizona, Mayo Clinic Jacksonville, the University of Göttingen, or Washington University. Twenty-three patients had follow-up of less than 2 years and were excluded from the analysis. This left 117 patients, who are the subjects of this study. Their characteristics are shown in **Table 3**. The mean (median) duration of follow-up among surviving patients was 59 months (5 years) (range, 24-113 months). The contribution to the study by individual institutions was Mayo Clinic Arizona and Mayo Clinic Jacksonville, 30 patients; Göttingen University, 65 patients; and Washington University, 22 patients.

Table 5. Distribution of Adjuvant RT by Tumor and T Stage

Tumor	No RT	Primary Site	Neck(s)	Primary Site and Neck(s)	Total
Glottic					
pT2	1	0	0	0	**1**
pT3	19	0	8	0	**27**
pT4	9	3	1	1	**14**
Supraglottic					
pT2	4	0	6	0	**10**
pT3	29	5	9	3	**46**
pT4	10	2	6	1	**19**
Total	**72**	**10**	**30**	**5**	**117**

Abbreviation: RT, radiotherapy.

SURGERY

Neck Dissection, RT, and Chemotherapy

Neck dissections were performed in 92 patients (79%). The distribution of neck dissections by nodal stage is shown in **Table 4**.

Forty-five patients (34%) received adjuvant RT to the neck or primary site or both (**Table 5**). A total of 15 patients (13%) received adjuvant RT to the primary site.

Four patients (3%) received adjuvant chemotherapy. One patient had a T4N2b supraglottic carcinoma that was retrospectively staged M1 after a liver lesion thought to be benign was found to be metastatic disease. The remaining 3 patients had glottic tumors staged T2N1M0, T3N1M0, and T4N0M0.

Complications

Mortality. A total of 4 patients (3%) experienced treatment-related deaths. Three of these patients died of unknown causes within 30 days of surgery and were considered to have experienced treatment-related deaths. Five weeks after TLM, a fourth patient experienced a fatal anoxic brain injury following aspiration of a blood clot during a second-look procedure and biopsy.

Bleeding. Six patients (5%) experienced bleeding from the primary site that required intervention. The bleeding occurred 15 days or sooner after TLM. An additional patient experienced postoperative bleeding from a tongue laceration that required suturing to repair. The precise cause of the injury was not established.

Primary Site. Four patients (3%) formed redundant arytenoid mucosa and underwent further laser surgery to reduce this. Two of the 4 required a temporary trache-

Table 6. Tracheotomy and Feeding-Tube Dependence[a]

Tumor, TNM[b]	Adjuvant RT	Tracheotomy Dependent	Feeding-Tube Dependent	Reason for Dependency
Glottic				
T4N0	Neck	Yes	No	Laryngeal edema
Supraglottic				
T3N0	None	Yes	No	Laryngeal stenosis
T3N0	None	No	Yes	Aspiration
T3N0	None	No	Yes	Aspiration
T3N2c	Primary and neck[c]	No	Yes	Aspiration
T2N1	None	No	Yes	Aspiration
T4N0	Primary	No	Yes	Aspiration

Abbreviation: RT, radiotherapy.
[a] In 68 patients, alive at last follow-up, with organ preservation and no disease recurrence.
[b] Staged according to the American Joint Committee on Cancer Staging Manual.[9]
[c] "Primary" indicates that RT was to the primary site.

otomy, and the other 2 patients developed permanent supraglottic stenosis. One of these developed perichondritis (without adjuvant RT) that ultimately healed with conservative treatment.

Neck Dissection and Other Medical Complications. Of the 117 patients, 1 experienced a hematoma; 1, a chyle leak; and 1, a vagal nerve injury. One patient developed unilateral blindness following retinal ischemia perioperatively, and another experienced a serious lower gastrointestinal hemorrhage.

Radiation Therapy. Two patients developed chondroradionecrosis; 1 developed an open neck wound and experienced a fatal carotid blowout more than 30 days after surgery. This patient had no complications at the primary site. The other patient underwent temporary tracheostomy for laryngeal edema during the RT.

Duration of Hospital Stay. Fiscal models of health care vary considerably between Europe and North America. In the North American subgroup of 52 patients, the mean (median) duration of hospital stay was 5.7 (5) days (range, 1-16 days). In Germany, historically patients have been kept in hospital longer than in the United States, and health care institutions are financially penalized if patients are discharged sooner than would occur following equivalent open surgical procedures. The hospitalization data from Göttingen therefore were not included in this part of the analysis.

Laryngeal Preservation. Ninety patients were alive at the minimum follow-up period of 2 years. The actual 2-year laryngeal preservation rate was 92% (83 of 90). The Kaplan-Meier estimate of laryngeal preservation at 5 years was 86% (95% confidence interval [CI], 79%-94%). For the end point of laryngectomy-free survival, where either laryngectomy or death from any cause constituted treatment failure, the 2-year and 5-year estimates were 70% (95% CI, 62%-78%) and 51% (95% CI, 41%-61%), respectively.

Functional Outcomes. Sixty-eight patients were alive with no evidence of disease recurrence and a preserved larynx at their last follow-up. Two of 68 patients (3%) were tracheotomy dependent, and 5 of 68 patients (7%) were feeding-tube dependent after treatment (**Table 6**). Of these 68 patients, we were able to assess 30 (44%) using the FOSS staging system. The overall median posttreatment FOSS stage was stage 1 (normal function with episodic or daily symptoms of dysphagia). Of the 68 patients, 28 were assessed after treatment using the CS. The overall median posttreatment CS score was stage 2 (grossly dysphonic). For the end point of functional laryngeal preservation, 22 of 28 patients (79%) achieved a FOSS and CS stage of 2 or better.

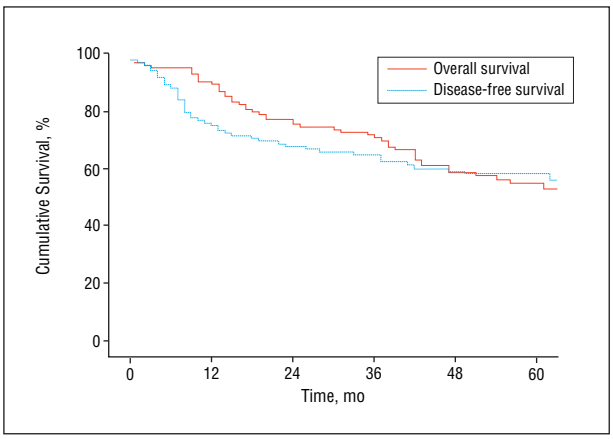

Figure 1. Rates of overall and disease-free survival. At 2 years and 5 years, the rates of overall survival were 75% and 55%, respectively (95% confidence interval [CI], 67%-83%). The 2-year and 5-year estimates of disease-free survival were 68% and 58% (95% CI, 47%-68%), respectively.

Survival Outcomes. The median follow-up period among surviving patients was 5 years. The 2-year and 5-year estimates of overall survival were 75% (95% CI, 67%-83%) and 55% (95% CI, 45%-65%), respectively. The 2-year and 5-year estimates of disease-free survival were 68% (95% CI, 60%-77%) and 58% (57% CI, 47%-68%), respectively (**Figure 1**). Overall and disease-free survival did not differ substantially between patients treated with TLM alone and patients treated with TLM and adjuvant RT.

Patterns of Failure. By the 2-year follow-up point, there had been 19 local treatment failures. The 2-year local con-

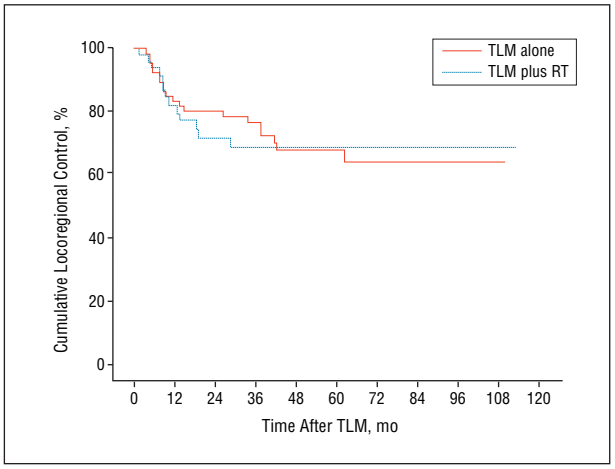

Figure 2. Rates of locoregional control by adjuvant radiotherapy (RT). At 2 years, the rates of locoregional control were as follows: 77% (95% confidence interval [CI], 69%-85%) for all patients, 80% (95% CI, 71%-90%) for patients receiving transoral laser microsurgery (TLM) alone, and 72% (95% CI, 58%-86%) for patients receiving TLM and adjuvant RT (*P*=.89 for the comparison between TLM alone and TLM plus adjuvant RT).

trol rate was 82% (95% CI, 74%-89%). The 5-year local control estimate was 74% (95% CI, 65%-83%). At 2 years, the rate of locoregional control was 77% (95% CI, 69%-85%). There was no statistical difference with respect to local control or locoregional control between patients who received TLM alone or those who received TLM and adjuvant RT (**Figure 2**). Local control in those patients who did not receive adjuvant RT (n=72) at 2 years was 83% (95% CI, 74%-92%) and at 5 years was 75% (95% CI, 63%-87%) (**Table 7**).

Distant Metastases. At 2 years, 7 patients (6%) had developed distant metastases. At 5 years, the Kaplan-Meier estimate of distant metastases–free survival was 86% (95% CI, 79%-94%). Patients who received TLM and adjuvant RT experienced significantly greater rates of distant metastases (*P*=.01) compared with patients treated with TLM alone.

COMMENT

By moving away from a traditional view of the en bloc resection, TLM has greatly expanded endoscopic capabilities within the upper aerodigestive tract. It has some unique advantages as a conservation laryngeal technique. Surgeons are no longer biased to select a tumor to fit an operation but can have confidence in clearing large tumors providing exposure is adequate and functional consequences are tolerable. It is important to note that TLM for advanced lesions is quite equipment and experience intensive. The use of endoscopic laser surgery continues to evolve. In 1992, Eckel and Thumfart[10] described a series of 100 patients treated by endoscopic laser surgery for laryngeal cancer. The authors concluded that surgery could only be performed in select T1 and T2 tumors.[10] In 2006, Huang et al[13] described a similar series of 217 patients. The series contained only 3 T3 carcinomas and no T4 carcinomas.[13] In contrast, some authors[4-6,12] have expanded the use of TLM to include both advanced-stage laryngeal and other head and neck cancers. In the past decade, there has been a shift toward nonsurgical management of advanced laryngeal cancer.[2,14,15] The reasons for this are multiple and complex and may include changing patient expectations, medical economics, and the proliferation of randomized and nonrandomized data concerning the use of chemotherapy- and RT-based treatment regimens. However, changes to overall survival have been refractory to nonsurgical treatments and may actually be decreasing.[15]

The Radiotherapy Oncology Group (RTOG) 91-11 Trial[16] concluded that, given comparable survival outcomes between nonsurgical and surgical methods (ie, laryngectomy), the logical preference must be for a nonsurgical organ-preserving approach. The results of the RTOG 91-11 Trial demonstrated concurrent chemo-RT (CRT) to be the superior nonsurgical modality and therefore the treatment of choice for advanced laryngeal cancer. This view largely ignored the established role of current open partial laryngectomy techniques and a growing expertise with organ-preserving TLM in Europe and North America. In responding to this contention, the RTOG 91-11 Trial[17] investigators pointed to a lack of outcome data supporting the effectiveness of TLM in intermediate and advanced vocal cord lesions. The data presented herein can specifically compare the outcomes of TLM with or without adjuvant RT to the RTOG 91-11 Trial data.

OUTCOMES DATA

Transoral laser microsurgery is an effective treatment for advanced laryngeal cancer. The present study demonstrates 2-year and 5-year overall survival rates of 75% and 55%, respectively. This compares with 74% and 54% rates for CRT and 75% and 56% rates for RT alone in RTOG 91-11.[17] Disease-free survival is similarly encouraging with 2-year and 5-year figures of 68% and 58%, respectively, for TLM compared with 61% and 31% for CRT and 44% and 27% for RT alone. At 2 years, the local control rate for TLM at the primary site was 82%, and the locoregional control rate was 77%. Concurrent chemoradiotherapy achieved a 2-year local control rate of 80% and a locoregional control rate of 78%. Radiotherapy alone is capable of only 58% local control and 56% locoregional control at 2 years. The data in the present study are most encouraging considering the higher percentage of T4 tumors (28%) compared with those found in the CRT (10%) and RT alone (9%) arms of the RTOG 91-11 Trial.[17] Five-year data are now available from the RTOG 91-11 Trial. Notably, the laryngectomy-free survival rate fell to 46%, and the disease-free survival rate is reported to be 39% with CRT. Treatment-related toxicity in this arm was substantial, and there was a 34% mortality rate from cancer in this group.[16] In addition, only 45 of 117 patients (34%) received TLM with adjuvant RT. The RT was delivered both within and outside our institutions by various protocols with and without attenuation of dose to the larynx. The addition of RT in the present study did not notably influence overall disease-specific survival or local control but was associated with a slightly increased incidence of distant metastases. We believe this trend represents selection bias given that RT

Table 7. Treatment to Primary and Neck

Site of First Recurrence	Adjuvant RT, No.					Neck Dissection, No.			
	None	Primary Site Indications	Neck Indications	Primary Site and Neck Indications	Total	None	Unilateral	Bilateral	Total
None	49	4	17	4	**74**	14	29	31	**74**
Local	15	5	4	0	**24**	7	8	9	**24**
Regional	5	0	2	0	**7**	0	0	1	**1**
Locoregional	0	0	2	0	**2**	3	2	2	**7**
Distant metastases	2	1	5	1	**9**	1	0	1	**2**
Second primary	1	0	0	0	**1**	0	4	5	**9**
Total	**72**	**10**	**30**	**5**	**117**	**25**	**43**	**49**	**117**

Abbreviation: RT, radiotherapy.

is more likely to be employed in treatment of patients with advanced nodal disease and/or more worrisome histopathologic and other risk factors that may be associated with a poorer overall prognosis.

ORGAN PRESERVATION AND FUNCTION

Transoral laser microsurgery is organ and function preserving. At 2 years, 83 of 90 patients (92%) had a preserved larynx. The 5-year laryngeal preservation rate was 86%. In the RTOG 91-11 Trial at 2-years, 94 of 107 patients (88%) survived with an intact larynx following CRT compared with 61 of 87 patients (70%) receiving RT alone.[17] We defined a functioning larynx as one with a communication scale score of stage 2 and a FOSS score of stage 2 or better. Although we accepted that data are not available for all patients, 22 of 28 patients (79%) for whom they were available met our criteria as having a functional intact larynx at last follow-up. At the time of analysis, 68 patients were alive at last follow-up with organ preservation and no evidence of disease recurrence. Two of 68 patients (3%) were tracheotomy dependent, and 5 of 68 patients (7%) were feeding-tube dependent after treatment. In the RTOG 91-11 Trial at 1 year, 23% of the patients assigned to CRT were limited to soft foods or liquids only, and 3% could not swallow at all. The number of patients who were feeding-tube dependent or tracheotomy dependent was not reported.[17]

COMPLICATIONS

Transoral laser microsurgery is safe. One patient died as a direct consequence of a planned staged second-look procedure that followed the primary tumor excision. This was the only death related to the primary TLM procedure. Three other deaths were classified as treatment related because they occurred within 30 days of surgery. The causes of each were unknown but most likely were associated with medical comorbidities rather than TLM per se. Even if we include them as treatment-related deaths, a 3% mortality rate in the present study compares favorably with 3% to 5% rates of treatment-related fatalities after RT alone or with CRT.[17] Multimodality RT and chemotherapy can be difficult treatments for patients to endure, and strict inclusion criteria, including age, performance status, and renal and metabolic functions, often apply. Severe toxic effects are observed in 40% to 80% of patients.[17-19] No such exclusion criteria exist for TLM. Only a small number of patients developed strictures, tongue lacerations, or perichondritis following TLM. Chemotherapy and RT protocols can produce pharyngoesophageal strictures in as many as 21% of patients.[20] Furthermore, the rate of chondroradionecrosis is reported to be 5% or higher following primary RT.[21]

GENERAL CONSIDERATIONS

The issue of cost is beyond the scope of the current study and will be explored in a subsequent article. The length of stay and duration of treatment as related to overall costs may be considerable, however. The mean duration of a surgical stay in hospital of just over 5 1/2 days and the general avoidance of tracheostomy will be important considerations in future cost analyses, particularly given that only one-third of patients in the present study group received postoperative RT.

Finally, the view expressed by the RTOG 91-11 Trial investigators that "radiotherapy with concurrent cisplatin should be considered standard care for patients desiring laryngeal preservation,"[17(p2098)] and "that laryngectomy should be performed only as salvage surgery,"[17(p2098)] is challenged by the present study, as is the premise that surgery for advanced laryngeal cancer equals total laryngectomy. We present herein alternative oncologic and functional results from multiple institutions, with most patients receiving single-modality therapy. Furthermore, the rates of laryngeal preservation, morbidity, and mortality are acceptable. Advanced laryngeal cancer is a complex disease process posing many challenges to patients, families, multidisciplinary cancer care teams, and society at large. Management strategies for patients should be individualized, and discussion should take into account all available surgical and nonsurgical treatment options.

In conclusion, in patients with advanced-stage laryngeal cancer, TLM with or without RT is a valid and attractive treatment strategy with acceptable rates of organ preservation and low morbidity. At present, no specific standard of care for advanced-stage laryngeal cancer exists.

Submitted for Publication: April 26, 2007; final revision received August 17, 2007; accepted August 23, 2007.
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Author Contributions: Drs Hinni, Salassa, Grant, Pearson, Hayden, Martin, Christiansen, Haughey, Nussenbaum, and Steiner had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Hinni, Salassa, Grant, Pearson, and Haughey. *Acquisition of data:* Hinni, Salassa, Grant, Pearson, Hayden, Martin, Christiansen, Haughey, Nussenbaum, and Steiner. *Analysis and interpretation of data:* Hinni, Salassa, Grant, Pearson, and Haughey. *Drafting of the manuscript:* Hinni, Salassa, and Grant. *Critical revision of the manuscript for important intellectual content:* Hinni, Salassa, Grant, Pearson, Hayden, Martin, Christiansen, Haughey, Nussenbaum, and Steiner. *Statistical analysis:* Grant and Hinni. *Administrative, technical, and material support:* Hinni, Salassa, Hayden, Martin, Christiansen, Haughey, Nussenbaum, and Steiner. *Study supervision:* Hinni, Salassa, Pearson, and Steiner.
Financial Disclosure: None reported.
Previous Presentation: This article was presented at The American Head & Neck Society 2007 Annual Meeting; April 28, 2007; San Diego, California.

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