

ONCOLOGIC OUTCOMES OF TRANSORAL LASER SURGERY OF SUPRAGLOTTIC CARCINOMA COMPARED WITH A TRANSCERVICAL APPROACH

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Abstract: *Background.* To evaluate the oncologic effectiveness of transoral laser surgery of supraglottic cancer, we compared a group of patients treated with laser surgery, with a stage-matched group treated with a transcervical approach.

Methods. Twenty-six patients who underwent laser surgery were retrospectively compared with 26 patients who underwent a transcervical approach. In both groups, the patients were classified as follows: 8% stage I, 23% stage II, 46% stage III, and 23% stage IV.

Results. The 5-year disease-specific survival rates were 80% for the laser group and 72% for the transcervical group ($p = .5$). The ultimate 5-year laryngeal preservation rate was 86% in the laser group and 80% in the transcervical group ($p = .6$). In both arms, all patients classified as T1 and T2 who survived 5 years after the surgical treatment of tumors retained the larynx.

Conclusions. The oncologic results of transoral laser surgery of supraglottic cancer are equivalent to those of the classic transcervical approach. ©2008 Wiley Periodicals, Inc. *Head Neck* 30: 750–755, 2008

Keywords: supraglottic carcinoma; transoral laser surgery; supraglottic laryngectomy; outcome; survival

The organ preservation treatment for supraglottic carcinoma may include surgery, radiotherapy,

or chemotherapy (neoadjuvant or concomitant), as single-modality therapy or combined treatment.^{1–3} With this expanding armamentarium, laryngeal preservation has become a legitimate therapeutic goal, and issues such as quality of life are receiving overdue attention. However, strikingly, the single cancer type that showed a decrease in survival during the past 2 decades in the United States was laryngeal cancer. Five-year relative survival for patients with laryngeal cancer diminished from 68.1% (1980–1982) to 64.7% (1992–1999).⁴ The most notable decline in the 5-year relative survival occurred among early-stage supraglottic cancers and supraglottic cancers classified as T3N0M0. Although no definitive statements can be made through analysis of the existing data, the declining survival rate coincided with the increase in nonsurgical management with radiation alone and chemoradiation in the early 1990s. In his work, Hoffman et al also hypothesized that the decline in survival may be linked to trends to perform less aggressive primary site surgery—thereby avoiding laryngectomy—or, perhaps, the performance of less comprehensive neck surgery.

If organ preservation surgery is part of the treatment protocol of supraglottic carcinomas,

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then a transoral approach or external transcervical routes are available to gain access to the primary tumor. It was Alonso⁵ who in 1947 described the horizontal supraglottic partial laryngectomy as a surgical treatment of supraglottic carcinoma. The objective of conservation laryngeal surgery was designed not only to be oncologically sound but also to be voice saving and cause less morbidity.^{2,6}

Endoscopic treatment for supraglottic cancer with CO₂ laser was introduced by Strong and Jako⁷ in 1972. The technique of transoral laser resection of these tumors seems to contradict classic rules of oncologic surgery,¹ because advanced tumors have to be divided and removed in 2 or more pieces. Nevertheless, it is possible to do this relatively safely due to the hemostatic effect of the CO₂ laser, and the use of an operating microscope, which allows the detection of the border between tumor and healthy tissue.

Regarding the treatment of the neck, most of the authors agree that elective neck dissection should be performed even in stages I and II, due to the high probability of occult neck metastases.^{2,9-11}

The avoidance of temporary tracheotomies, a lower incidence of pharyngocutaneous fistulas, and a faster return to swallowing are the main functional advantages of endoscopic laser surgery compared with conventional supraglottic laryngectomy.^{2,8,12,13}

The oncologic results of transoral laser surgery seem to be comparable to those of classic supraglottic laryngectomy if clean surgical margins can be reached.^{8,14-16} However, no previous study has compared in 2 groups of patients with the same characteristics the oncologic results of the endoscopic approach with those of open supraglottic laryngectomy.

We designed our study to evaluate the oncologic effectiveness of transoral laser surgery of supraglottic cancer, comparing a group of patients treated with this method, with another similar group treated with a classic transcervical approach.

PATIENTS AND METHODS

Patients. The clinical records of 26 previously untreated patients with squamous cell carcinoma of the supraglottis, who were treated with laser surgery at the Hospital Universitario Central de Asturias from March 1999 to June 2002, were reviewed. To establish a control group, we selected

Table 1. Clinico-pathological characteristics of the studied patients.

Parameter	LS group	TA group
Age, median	59 y	59 y
Sex		
Male	25	25
Female	1	1
T classification		
T1	3 (11%)	3 (11%)
T2	8 (31%)	8 (31%)
T3	15 (58%)	15 (58%)
N classification		
N0	16 (62%)	16 (62%)
N1	4 (15%)	4 (15%)
N2	5 (19%)	6 (23%)
N3	1 (4%)	0
TNM stage		
I	2 (8%)	2 (8%)
II	6 (23%)	6 (23%)
III	12 (46%)	12 (46%)
IV	6 (23%)	6 (23%)

Abbreviations: LS, transoral laser surgery; TA, conventional transcervical approach.

26 patients treated with conventional supraglottic partial laryngectomy at the same center between February 1988 and March 2002. To obtain 2 groups statistically comparable, we used as election criteria the disease stage (according to the TNM system of the Union Internationale Contre le Cancer, 6th Edition), age, and sex. None of our patients had distant metastases at the time of diagnosis. All patients had a history of heavy smoking (mean, 45 pack-years smoked) and alcohol consumption (mean, 70 g of alcohol per day). The clinicopathologic data from the patients of both groups are shown in Table 1. Follow-up was available on all patients.

Supraglottic laryngectomy was indicated in patients with supraglottic tumors and acceptable pulmonary conditions, irrespective of age and stage, who showed no involvement of the vocal cords or the laryngeal framework. When indicated, supraglottic resection was extended to accommodate resection of the arytenoid, the valleculae, the base of the tongue, and the medial wall of the pyriform sinus ("extended" supraglottic laryngectomy). Until 1999, all the supraglottic laryngectomies were performed at our institution through a transcervical approach. We used a modification of the Alonso's technique as described by Herranz et al.¹⁷ From 1999, transoral laser surgery was indicated in T1, T2, and selected T3 (tumors with limited pre-epiglottic space invasion)

supraglottic tumors, if the tumor was completely exposable during the preceding diagnostic microlaryngoscopy. Patients who did not fulfill these criteria reached transcervical supraglottic laryngectomy or total laryngectomy. Transoral laser resection of supraglottic tumors was performed according to the recommendations of Davis.¹⁸

All the patients underwent a bilateral neck dissection (functional and/or radical, based on clinical and surgical findings). Neck dissections were performed in the same procedure as primary tumor removal in transcervical approaches, and just in 1 patient treated with the transoral approach. In the remaining patients treated with CO₂ laser (25 patients), neck dissections were performed about 15 days after the removal of the primary tumor. Neck dissections were staged to minimize the risk of airway swelling and therefore to reduce the tracheotomy rate.

Additional postoperative radiotherapy was administered to 6 patients (23%) in the laser surgery arm and to 9 patients (35%) in the transcervical approach arm. After 1995, postoperative radiotherapy was administered to the patients with histologically N2 or N3 neck lesions, or with close surgical margins, mainly at the base of the tongue. Before 1995, postoperative radiotherapy was also administered to histologically N1 neck lesions (3 patients in the transcervical approach group underwent postoperative radiotherapy for N1 neck metastases). This fact explains the observed differences in the number of patients that received radiotherapy in each of the treatment arms. If needed, radiotherapy courses were scheduled within 6 weeks postoperatively and delivered weekly over a period of 6 to 10 weeks to reach a total dose of 45 to 60 Gy.

Statistical Analysis. Statistical analysis was performed using chi-square, with Yates' correction where appropriate, and Fisher's exact tests. Survival curves were calculated using the Kaplan-Meier product limit estimate. Deaths from causes other than the index tumor or its metastases were not considered treatment failures, and these patients were censored in all analyses involving the length of survival. Differences between survival times were analyzed by the log-rank method.

p values of <.05 were considered to be statistically significant. All data were analyzed with the help of the SPSS 11.5 statistical software package.

Table 2. Oncologic results.

Parameter	LS group	TA group
5-year disease-specific survival	80%	72%
5-year local control	70%	70%
Recurrences		
Local	8	8
Regional	1	3
Distant	1	3
Cured with salvage treatment		
Laser	1	1
TL	2	3
RT	1	0
Ultimate 5-year laryngeal preservation rate	86%	80%

Abbreviations: LS, transoral laser surgery; TA, conventional transcervical approach; TL, total laryngectomy; RT, radiotherapy.

RESULTS

Ninety-six percent of the patients with histopathologic diagnosis of supraglottic squamous cell carcinoma were male. Mean age was 59 years in both arms (range, 37–81 years in the laser surgery group and 43–78 years in the transcervical approach group).

The incidence of surgical complications and functional results of both surgical procedures in our cohort of patients were described elsewhere.¹²

The minimum follow-up for the patients alive at last visit in our department was 48 months for the laser surgery group and 36 months for the patients in the transcervical approach group. The mean follow-up was 49 months for the laser surgery arm and 53 months for the transcervical approach arm.

In the laser surgery group, during the follow-up period, 8 patients developed local recurrence, 1 patient regional recurrence, and 1 patient distant metastases. Four of the 8 patients with local recurrences underwent successful salvage, 2 of them retaining their larynx (1 had a second endoscopic laser procedure and the other underwent radical radiotherapy) (Table 2). In this group, there were 11 deaths (42%), of which 5 (45%) were caused by disease. In the transcervical approach group, 8 patients developed local recurrence, 3 regional recurrence, and 3 distant metastases. Again, 4 of the 8 local recurrences were successfully salvaged, but only 1 of them retained the larynx (he underwent salvage transoral laser surgery and postoperative radiotherapy) (Table 2). There were 13 deaths (50%), of which 6 (46%) were caused by disease. Therefore, there were no differences in the local control rate between the 2 procedures (*p* = 1).

Table 3. Distribution of local recurrences by T classification.

T classification	LS group	TA group
1	0% (0/8)	0% (0/8)
2	14% (1/8)	33% (2/8)
3	86% (7/8)	67% (6/8)

Abbreviations: LS, transoral laser surgery; TA, conventional transcervical approach.

The 5-year disease-specific survival rates were 80% for the laser surgery group and 72% for the transcervical approach group ($p = .498$). If we consider only local control, the 5-year recurrence-free survival rates were 65% for the laser surgery group and 69% for the transcervical approach group ($p = .96$). The ultimate 5-year laryngeal preservation rate was 86% in the laser surgery group and 80% in the transcervical approach group ($p = .599$). In both groups, all patients who survived 5 years after the surgical treatment of tumors classified as T1 and T2 retained his larynx.

The 5-year local recurrence-free survival rates in patients classified as T1 and T2 were 83% for the laser surgery group and 80% for the transcervical approach group ($p = .6$). However, in the patients classified as T3, the 5-year local recurrence-free survival rates dropped to 51% for the laser surgery group and to 46% for the transcervical approach group ($p = .84$). Therefore, T classification was a predictor of local recurrence ($p = .015$) (Table 3). However, the only clinicopathologic parameters associated with disease-specific survival were N classification and disease stage ($p = .007$ and $p = .021$ respectively).

DISCUSSION

The traditional treatment paradigm for squamous cell carcinoma of the larynx has been surgery, usually total laryngectomy, followed by radiotherapy. This strategy has historically achieved cure rates approximating 60% to 70%.⁴

In supraglottic cancer, the goal of treatment is to achieve cancer cure and function preservation. Supraglottic laryngectomy represents a conservative procedure in which the upper portion of the larynx is removed without sacrificing the normal functions of the organ (speech production, deglutition, and respiration) and without the need for a permanent tracheostoma. For appropriately staged supraglottic cancers, the outcome of transcervical supraglottic laryngectomy is comparable to the results achieved with total laryngectomy, and, in addition, the functions of respiration, de-

glutition, and phonation are retained.^{2,6,11,19,20} To achieve appropriate oncologic and functional results, the indications for this type of surgery must be carefully respected and the operation should be performed accurately. The management of the neck remains of paramount importance, since survival of patients with supraglottic cancer depends more on neck disease than on the primary tumor,^{10,11,17,19} as stated in our results. Most authors advocate bilateral elective neck dissection^{2,9,19,20}; however, in selected cases (T1-T2 N0 lateral supraglottic carcinomas), ipsilateral functional neck dissection could be performed without compromising survival.¹⁰

If a resection with no residual tumor is technically possible, supraglottic laryngectomy can be done endoscopically, because its oncologic results are considered by many authors comparable to those of the open supraglottic laryngectomy.^{8,14-16} However, the most notable decline in the 5-year relative survival for patients with laryngeal cancer in the United States during the past 2 decades occurred among early-stage supraglottic cancers and supraglottic cancers classified as T3N0M0.⁴ Patterns of initial management across this same period indicated an increase in the use of chemoradiation with a decrease in the use of surgery. Despite the decrease in the use of surgery, an increase in the use of less aggressive primary site surgery—thereby avoiding laryngectomy—and the spread of endoscopic procedures, led the authors to hypothesize that part of the decline in survival may be linked to trends to perform less aggressive partial laryngeal surgery. To date, this statement cannot be rejected since no previous study has compared, in 2 groups of patients with the same characteristics, the oncologic results of the endoscopic approach with those of open supraglottic laryngectomy.

The functional results of laser surgery compared with those of open supraglottic laryngectomy in the group of patients analyzed in this study have been published elsewhere.¹² Briefly, the avoidance of temporary tracheotomies, a lower incidence of pharyngocutaneous fistulas, and a faster return to swallowing are the main functional advantages of endoscopic laser surgery compared with conventional supraglottic laryngectomy, while the long-term swallowing results hardly differ between both treatment arms when similar patients are compared.

In the present study, the 5-year disease-specific survival rates, the incidence of local recurrences, and the ultimate 5-year laryngeal

preservation rates confirm the validity of the laser surgery approach compared with conventional open procedures in T1, T2, and selected T3 supraglottic tumors. In addition, although not significant, and probably not influencing the results, the percentage of patients that received postoperative radiotherapy was higher in the transcervical group. Therefore, our data show that the oncologic results of transoral laser resection of supraglottic cancer are equivalent to those of the classic transcervical approach. However, it should be taken into account that in the T3 tumors we indicated the transoral approach only in those cases with limited pre-epiglottic space invasion (invasion of the pre-epiglottic space that did not make contact with the thyroid cartilage). For this reason, to avoid a selection bias, the T3 tumors operated by the transcervical approach were also selected among those with limited pre-epiglottic space invasion.

The largest series evaluating laser surgery for supraglottic carcinomas^{1,14,15} document a considerable success in T1-T2 lesions (60% to 80% 5-year local recurrence-free survival) and a relatively high incidence of failures in T3-T4 cancers (40% to 74% 5-year local recurrence-free survival). This compares well with our results: in both treatment arms all patients who survived 5 years after the surgical treatment of tumors classified as T1 and T2 retained the larynx, and also 60% of patients classified as T3.

The higher incidence of local recurrences in T3 tumors leads to some authors not recommending²¹ laser surgery in these cases, while others advise restraint.¹⁴ We believe that careful selection of the patients is the keystone in the achievement of satisfactory oncologic and functional outcomes. It must be borne in mind that supraglottic laryngectomy is no longer possible if the cancer has invaded the floor of Morgagni's ventricle and the paraglottic space. Other contraindications are fixation of the arytenoids cartilage or vocal cord, and extensive extralaryngeal tumor extension into the tongue base or hypopharynx. These cases may no longer be amenable even to an extended supraglottic laryngectomy, and a total laryngectomy is often required. An alternative partial laryngectomy with acceptable morbidity and an excellent oncologic outcome for selected tumors that have infiltrated the pre-epiglottic space, the ventricle, or the paraglottic space, is the supracricoid partial laryngectomy-cricohyoidopexy (SCPL-CHP).²²⁻²⁴ Invasion of cricoid cartilage is the most significant limitation for this procedure. The local recurrence rates after SCPL-CHP are very low, ranging from 0% to

7%.^{23,25} It should be noted, however, that in this series most of the T3 tumors had only "minimal infiltration" of the pre-epiglottic space. Published data for T3 supraglottic carcinomas show that laser microsurgery can be considered an effective alternative for these selected T3 tumors.¹⁴⁻¹⁶ Although the local tumor recurrence rates are higher with laser microsurgery, the survival rates and organ preservation rates are comparable when we consider that secondary laryngectomies are necessary after SCPL-CHP due to intractable aspiration.²⁶

As mentioned, today the goal of treatment is to achieve cure and to preserve larynx function. Organ preservation strategies should include both endoscopic and open surgical approaches, as well as radiation and chemotherapy. The challenge is to choose the correct modalities for each patient. Endoscopic procedures should be limited to tumors completely exposable during preceding diagnostic microlaryngoscopy. If resection without residual tumor cannot be achieved by means of laser surgery, either transcervical procedures or chemoradiotherapy protocols must be carried out in order to preserve larynx function.

With careful selection of the patients, supraglottic laryngectomy (either endoscopic or transcervical) with bilateral neck dissection is a suitable treatment option for supraglottic squamous cell carcinoma, with oncologic and larynx preservation results similar to those obtained with chemoradiation protocols.²⁷ Postoperative recovery of the laryngeal function is the rule, and long-term sequelae are infrequent, with 71% of the patients avoiding adjuvant treatment, saving radiation to treat recurrent or second primary malignancies in the future.

In conclusion, transoral laser resection of supraglottic cancer should, together with classic transcervical supraglottic partial resection, be considered an established therapeutic modality. Technical skills and surgical experience should determine the election of the surgical method in each individual case.

REFERENCES

1. Eckel HE. Endoscopic laser resection of supraglottic carcinoma. *Otolaryngol Head Neck Surg* 1997;117:681-687.
2. Myers EN, Alvi A. Management of carcinoma of the supraglottic larynx: evolution, current concepts, and future trends. *Laryngoscope* 1996;106:559-567.
3. Moore BA, Holsinger FC, Diaz EM Jr, Weber RS. Organ-preservation laryngeal surgery in the era of chemoradiation. *Curr Probl Cancer* 2005;29:169-179.
4. Hoffman HT, Porter K, Karnell LH, et al. Laryngeal cancer in the United States: changes in demographics, patterns of care, and survival. *Laryngoscope* 2006;116:1-13.

5. Alonso JM. Conservative surgery of cancer of the larynx. *Trans Am Acad Ophthalmol Otolaryngol* 1947;51:633-642.
6. Jaworowska E. Horizontal laryngectomy in treatment of laryngeal cancer-oncologic and function results. *Ann Acad Med Stetin* 1998;44:175-195.
7. Strong MS, Jako GJ. Laser surgery in the larynx: early clinical experience with continuous CO₂ laser. *Ann Otol Rhinol Laryngol* 1972;81:791-798.
8. Rudert HH, Werner JA, Höft S. Transoral carbon dioxide laser resection of supraglottic carcinoma. *Ann Otol Rhinol Laryngol* 1999;108:819-827.
9. Weber PC, Johnson JT, Myers EN. The impact of bilateral neck dissection on pattern of recurrence and survival in supraglottic carcinoma. *Arch Otolaryngol Head Neck Surg* 1994;120:703-706.
10. Rodrigo JP, Cabanillas R, Franco V, Suarez C. Efficacy of routine bilateral neck dissection in the management of the N0 neck in T1-T2 unilateral supraglottic cancer. *Head Neck*. 2006;28:534-539.
11. Suárez C, Rodrigo JP, Herranz J, Díaz C, Fernández JA. Complications of supraglottic laryngectomy for carcinomas of the supraglottis and the base of the tongue. *Clin Otolaryngol* 1996;21:87-90.
12. Cabanillas R, Rodrigo JP, Llorente JL, Suarez V, Ortega P, Suarez C. Functional outcomes of transoral laser surgery of supraglottic carcinoma compared with a transcervical approach. *Head Neck* 2004;26:653-659.
13. Peretti G, Piazza C, Cattaneo A, De Benedetto L, Martin E, Nicolai P. Comparison of functional outcomes after endoscopic versus open-neck supraglottic laryngectomies. *Ann Otol Rhinol Laryngol* 2006;115:827-832.
14. 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;124:1245-1250.
15. Motta G, Esposito E, Testa D, Iovine R, Motta S. CO₂ laser treatment of supraglottic cancer. *Head Neck* 2004; 26:442-446.
16. Ambrosch P, Kron M, Steiner W. Carbon dioxide laser microsurgery for early supraglottic carcinoma. *Ann Otol Rhinol Laryngol* 1998;107:680-688.
17. Herranz J, Gavilán J, Martínez-Vidal J, Gavilán C. Horizontal supraglottic laryngectomy: modifications to Alonso's technique. *Op Tech Otolaryngol Head Neck Surg* 1993;4:252-257.
18. Davis RK. Laser supraglottic laryngectomy. *Curr Opin Otolaryngol Head Neck Surg* 1998;6:139-143.
19. Herranz J, Martínez Vidal J, Martínez Moran A. Supraglottic laryngectomy. Still on-going. *Acta Otorrinolaringol Esp* 2006;57:235-241.
20. Scola B, Fernandez-Vega M, Martinez T, Fernandez-Vega S, Ramirez C. Management of cancer of the supraglottis. *Otolaryngol Head Neck Surg* 2001;124:195-198.
21. Davis RK, Kriskovich MD, Galloway EB III, Buntin CS, Jepsen MC. Endoscopic supraglottic laryngectomy with postoperative irradiation. *Ann Otol Rhinol Laryngol* 2004;113:132-138.
22. Gallo A, Mancio V, Simonelli M, Pagliuca G, D'Arcangelo E, de Vincentiis M. Supracricoid partial laryngectomy in the treatment of laryngeal cancer: univariate and multivariate analysis of prognostic factors. *Arch Otolaryngol Head Neck Surg* 2005;131:620-625.
23. Laccourreye O, Brasnu D, Merite-Drancy A, et al. Cricohyoidopexy in selected infrahyoid epiglottic carcinomas presenting with pathological preepiglottic space invasion. *Arch Otolaryngol Head Neck Surg* 1993;119:881-886.
24. Ferlito A, Silver CE, Howard DJ, Laccourreye O, Rinaldo A, Owen R. The role of partial laryngeal resection in current management of laryngeal cancer: a collective review. *Acta Otolaryngol* 2000;120:456-465.
25. Schwaab G, Kolb F, Julieron M, et al. Subtotal laryngectomy with cricohyoidopexy as first treatment procedure for supraglottic carcinoma: Institut Gustave-Roussy experience (146 cases, 1974-1997). *Eur Arch Otorhinolaryngol* 2001;258:246-249.
26. Ambrosch P. The role of laser microsurgery in the treatment of laryngeal cancer. *Curr Opin Otolaryngol Head Neck Surg* 2007;15:82-88.
27. Forastiere AA, Goepfert H, Maor M, et al. Concurrent chemotherapy and radiotherapy for organ preservation in advanced laryngeal cancer. *N Engl J Med* 2003;349: 2091-2098.