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**Angaben zur Veröffentlichung / Publication details:**

Karatzanis, Alexander D., George Psychogios, Johannes Zenk, Frank Waldfahrer, Joachim Hornung, George A. Velegrakis, and Heinrich Iro. 2009. "Evaluation of available surgical management options for early supraglottic cancer." *Head & Neck* 32 (8): 1048–55. https://doi.org/10.1002/hed.21289.



# EVALUATION OF AVAILABLE SURGICAL MANAGEMENT OPTIONS FOR EARLY SUPRAGLOTTIC CANCER

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**Abstract:** *Background.* This study was undertaken to evaluate the oncologic results of endoscopic and open surgical techniques in early supraglottic cancer.

*Methods.* We performed a retrospective evaluation of 101 patients surgically treated for stage I or II supraglottic carcinomas. Laser surgery, horizontal laryngectomy, and total laryngectomy were compared for disease-specific survival and local control rates. Surgical techniques were additionally compared for incidence of major complications, related tracheotomies, and swallowing function retention.

*Results.* No statistically significant differences were noted among the different types of procedures regarding disease-specific survival and local control. A lower incidence of major complications, permanent gastrostomies, and significantly lower incidence of tracheotomies were noted for laser surgery compared with open techniques.

*Conclusion.* Larynx-preserving surgical modalities offer comparable oncologic results with total laryngectomy in early supraglottic cancer. In addition, laser surgery has a lower incidence of complications and better functional results compared with open partial or total laryngectomy.  *Head Neck* **32:** 1048–1055, 2010

**Keywords:** supraglottic cancer; local control; prognosis; surgery; survival

Laryngeal cancer is the second most common type of head and neck cancer worldwide.[1] The supraglottis represents the primary tumor site in 30% to 40% of laryngeal carcinoma cases, while in certain geographic regions it tends to be the most frequently implicated subsite of the larynx.[2] Due to the rich local lymphatic drainage system and the relatively late appearance of symptoms, diagnosis is often made at a more advanced stage; hence, prognosis has traditionally been poorer for supraglottic carcinomas, compared to glottic lesions.[1,3] Nevertheless, the goal of treatment for early supraglottic carcinomas currently is to achieve function preservation in addition to cancer cure.[4,5]

The modern armamentarium of organ preservation treatment for supraglottic cancer includes transoral $CO_2$ laser microsurgery (TLM), open partial laryngectomy, and radiotherapy with or without concomitant chemotherapy, in single- or

combined-modality schemes.[5,6] For accurately staged cases, the outcome of organ-preservation treatment modalities should be comparable with results achieved by total laryngectomy.[5] Moreover, important functions of the larynx, including respiration, safe deglutition, and phonation, can be retained with organ-preservation treatment, with significant positive impact on the patient's quality of life.[7,8]

Interestingly, the advent of organ-preservation treatment modalities was followed by a recently noted decrease in survival from laryngeal cancer.[9] The most notable decline in disease-specific survival occurred, in fact, among early-stage and T3N0M0 supraglottic tumors. Reasons for this striking observation are not clear, but it has been hypothesized that the decline in survival could be linked, among other things, to the increasing tendency by treating physicians to avoid total laryngectomy and perform more conservative primary site surgery.[9] The aim of the present study was to evaluate the oncologic results of endoscopic and open larynx-preservation surgical techniques for TNM stage I and II supraglottic cancer and compare them to results of the more traditional approach of total laryngectomy (TL).

## MATERIALS AND METHODS

A retrospective study was conducted at an academic tertiary referral center (Department of Otorhinolaryngology, Head and Neck Surgery, University of Erlangen–Nuremberg Medical School, Erlangen, Germany). Relevant approval from the institutional review board of the hospital was obtained. The files of all patients who underwent primary surgical treatment for pT1 or pT2/pN0 or cN0/M0 supraglottic carcinomas between 1970 and 2004 were studied. It is noted that all patients who underwent a neck dissection were pN0 while the rest were cN0. All pathology reports were reviewed and staging was conducted according to the 2002 American Joint Committee on Cancer (AJCC) and Union Internationale Contre le Cancer (UICC) classification.[10] Patients with insufficient data, systemic disease at the time of diagnosis, histology other than squamous cell carcinoma, patients with second primary tumors at the time of diagnosis, and those who received postoperative radiotherapy and/or chemotherapy were excluded from the study. Moreover, only cases that had been observed for at least 60 months were evaluated. Consequently, a total of 101 cases were finally assessed.

Disease-specific survival (DSS) and local control (LC) were calculated according to T classification. Moreover, evaluation of neck management with respect to survival was performed in all cases. All primary tumor pathology reports were assessed for status of surgical margins. Surgical margins were considered as positive when characterized by the presence of invasive carcinoma at the edge of resection on permanent section pathology. The 5-year DSS rate was defined as the percentage of patients alive for more than 5 years divided by the total number of patients who died of the tumor of interest. This rate included only deaths specifically due to this specific tumor and excluded all other deaths in the patient group. The LC reflected the analysis of tumor recurrence in the primary site, and was calculated from the date of surgery to the date of local recurrence diagnosis or date of last follow-up. Local recurrence was defined as invasive carcinoma developing after completion of initial treatment at the anatomic site of the primary tumor.

All surgical techniques employed in this series were compared according to T classification, for DSS, and LC rates. The decision to perform each type of surgery is difficult to be retrospectively assessed. However, such decision was generally based on the experience of the surgeon, anatomic location, extent of the lesion, and available treatment modalities at the time of diagnosis. Surgical techniques were additionally compared for incidence of major complications and related tracheotomies. Data regarding retention of swallowing function among the different surgical techniques was also gathered. Short- or long-term swallowing inability was determined by evaluating the incidence of temporal and permanent percutaneous gastrostomies (PEG), respectively. Major complications were defined as those which necessitated prolonged hospitalization, blood transfusion, additional surgery, or admission to the intensive care unit. Data regarding management of local failures and overall salvage of the larynx were also gathered and assessed.

Statistical analysis was performed using the Kaplan–Meier method with 95% intervals, and the chi-square test. Software SPSS Version 17 (SPSS, Chicago, IL) for Microsoft Windows was used for the analysis. A $p$ value of less than .05 was considered significant.

**Table 1.** The different types of procedures used in this series, according to T classification.

| Surgical technique | No. of cases |
|---|---|
| T1 classification | 29 |
| TLM | 19 (65.5%) |
| HL | 10 (34.5%) |
| T2 classification | 72 |
| TLM | 30 (41.6%) |
| HL | 19 (26.4%) |
| TL | 23 (32%) |
| Total no. of cases | 101 |

*Abbreviations: TLM, transoral $CO_2$ laser microsurgery; HL, horizontal laryngectomy; TL, total laryngectomy.*

## RESULTS

Among the 101 patients that were finally included in the study, 90 were men (90%) and 11 were women (10%). Mean age in the whole study group was 60 years, ranging between 36 and 83 years. No significant differences were noted regarding age and sex distribution among groups of patients undergoing different surgical procedures. Mean follow-up period was 67 months. Overall, 29 T1 and 72 T2 cases were included in the study. The different types of procedures employed, according to T classification, are presented in Table 1. TLM, representing the only transoral approach in this series, was the most common procedure for both T classifications. Transcervical techniques for T1 cases included horizontal laryngectomy (HL) and for T2 cases HL and TL.

Five-year DSS was 81.9% overall in this series. For T1 cases, DSS was 79.4% and for T2 cases 82.9%. LC was 90.8% overall in this series. For T1 cases, LC was 87.0% and for T2 cases 92.3%. Results of Kaplan–Meier analysis of DSS and LC for T1 cases, according to surgical technique, are shown in Figure 1. No statistically significant differences were noted between the different types of procedures ($p = .631$ and $p = .924$, respectively). Results of Kaplan–Meier analysis of DSS and LC for T2 cases, according to surgical technique, are shown in Figure 2. Again, no statistically significant differences were noted among the different types of procedures ($p = .924$ and $p = .143$, respectively).

Among 11 patients with local failure overall, 7 had undergone TLM and 4 HL. TLM recurrences were managed with repeated laser surgery (3 patients), HL (1 patient), and salvage laryngectomy (3 patients). Four of these 7 patients died from disease. Overall, retention of the larynx was possible in 94% of TLM cases. On the other hand, all HL recurrences were managed with salvage laryngectomy except 1 patient that died due to unrelated reasons before any treatment was employed. Two of the 4 patients with recurring HL cases died from tumor. Overall, retention of the larynx was possible in almost 90% of HL cases.

According to pathology reports, positive surgical margins (R1) were found in 3 cases in this series, 1 following TLM, and 2 following HL. All of these were T2 classification cases. The overall incidence of positive margins was, therefore, 3% in this series. One of the patients with R1 died within 1 year after surgery for reasons not related to the tumor of interest. In the remaining 2 cases, a recurrence was noted, and none survived for 5 years. However, the number of these cases was not sufficient for statistical evaluation.

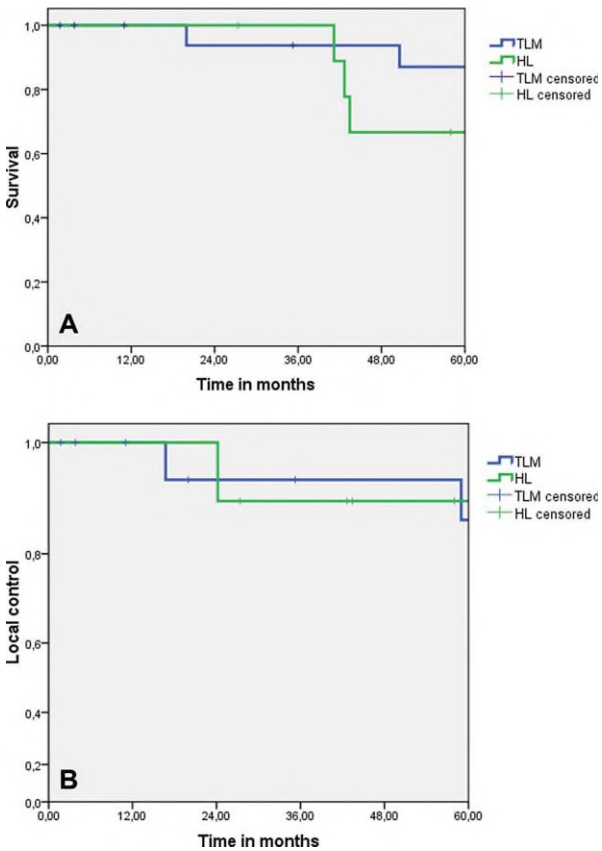


**FIGURE 1**. Kaplan–Meier analysis of disease-specific survival ($p = .631$) (**A**) and local control ($p = .924$) (**B**) of T1 cases according to surgical technique. TLM, transoral $CO_2$ laser microsurgery; HL, horizontal laryngectomy; TL, total laryngectomy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

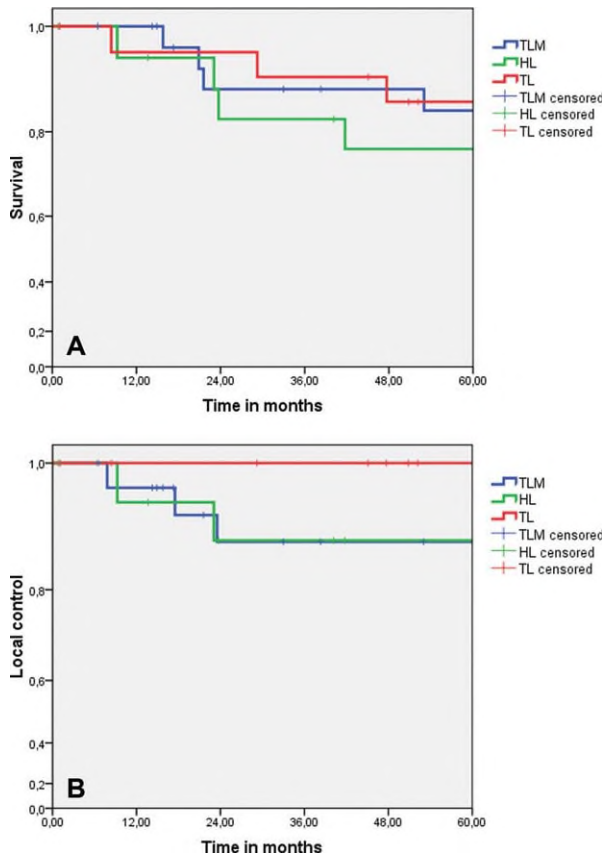


**FIGURE 2**. Kaplan–Meier analysis of disease-specific survival ($p = .924$) (**A**) and local control ($p = .143$) (**B**) of T2 cases according to surgical technique. TLM, transoral $CO_2$ laser microsurgery; HL, horizontal laryngectomy; TL, total laryngectomy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Overall, 61 patients underwent some form of neck dissection in this series. Conversely, in 40 cases the neck was not primarily treated. Among the patients with nontreated necks, 33 had been managed before the year 1991 while the remaining 7 that were more recent had refused to receive neck treatment. It is noted here that in our institution, N0 neck was not routinely addressed during primary treatment of early supraglottic tumors before the year 1991. In all cases in which the neck was primarily managed, either a bilateral or ipsilateral to the side of tumor functional neck dissection was performed, depending on the exact location of the primary lesion and the T classification. In TLM cases specifically, surgery of the neck was performed either simultaneously with the primary site procedure or, in some cases, within 10 days, when permanent histology results from the primary tumor had been made available. As expected, DSS was superior in cases where the neck was primarily treated, although statistical significance was not reached (90.9% vs 70%, $p = .23$, for T1 category, and 83.8% vs 81.1%, $p = .47$, for T2 category).

Major complications in this series included postoperative bleeding, aspiration, fistula or granulation tissue formation, and dyspnea. Specific types and incidence of complications, according to surgical procedure, are presented in Table 2. Incidence was 8.1% for TLM, 24.1% for HL, and 17.4% for TL. A lower incidence was therefore noted for TLM compared with open techniques, although statistical significance was not reached (TLM vs HL $p = .09$ and TLM vs TL $p = .2$). Incidence and type of tracheotomy, according to surgical technique, are presented in Table 3. A significantly lower incidence of related tracheotomies was found regarding TLM compared to transcervical techniques (TLM vs HL and TLM vs TL, $p < .001$). Overall, PEG was performed in 36 (35.6%) cases. These included 20 of 29 (68.9%) HL cases and 16 of 49 (32.6%) TLM cases. However, a permanent PEG, suggesting long-term swallowing inability, was only necessary in 6 cases overall, 3 (6.1%) after TLM, and 3 (10.3%) after HL (Table 3).

## DISCUSSION

Although organ preservation was initially used as a term to describe combined chemotherapy

**Table 2.** Type and incidence of complications according to surgical technique.

| Surgical technique | Total no. of cases | Total no. (incidence) of complications | No. of cases by type of complication | | | | |
|---|---|---|---|---|---|---|---|
| | | | Bleeding | Granulation formation | Aspiration | Fistula | Dyspnea |
| TLM | 49 | 5 (10.2%) | 1 | 2 | 0 | 0 | 2 |
| HL | 29 | 7 (24.1%) | 1 | 0 | 3 | 1 | 2 |
| TL | 23 | 4 (17.4%) | 1 | 0 | 0 | 2 | 1 |

*Abbreviations: TLM, transoral $CO_2$ laser microsurgery; HL, horizontal laryngectomy; TL, total laryngectomy.*

**Table 3.** Type and incidence of tracheotomies as well as gastrostomies according to surgical technique.

| Surgical technique | Total no. of cases | No. (incidence) of transient tracheotomies | No. (incidence) of permanent tracheotomies | Total no. (incidence) of tracheotomies | No. (incidence) of permanent PEG |
|---|---|---|---|---|---|
| TLM | 49 | 4 (8.1%) | 3 (6.1%) | 7 (14.2%) | 3 (6.1%) |
| HL | 29 | 17 (58.6%) | 4 (13.7%) | 21 (72.3%) | 3 (10.3%) |
| TL | 23 | 0 | 23 (100%) | 23 (100%) | 0 |

*Abbreviations: PEG, percutaneous gastrostomy; TLM, transoral $CO_2$ laser microsurgery; HL, horizontal laryngectomy; TL, total laryngectomy.*

and radiation protocols, today it also includes a wide array of surgical techniques for laryngeal cancer.[3] New technology and instrumentation have opened the way for endoscopic minimally invasive strategies, while a renewed interest has also been witnessed regarding open preservation surgeries.[3,8] On the other hand, a decrease in survival of patients with laryngeal cancer has been noted in recent decades and this decrease has been more evident with early and T3N0M0 supraglottic lesions.[9] Although no conclusions have yet been reached regarding the causes of this alarming observation, it has been hypothesized that the decrease could be related to the recently increased tendency by treating physicians for employment of nonsurgical management, or even a recent tendency by surgeons to perform less comprehensive neck surgery, and less radical, function-reserving, primary site surgery for supraglottic lesions.[5,9] In order to challenge the last of the 3 pre-mentioned hypotheses, ie, employment of less radical surgery for early supraglottic cancer, we evaluated the oncologic results of laser surgery and HL for TNM stage I and II supraglottic lesions and compared them with results of a more aggressive surgical technique, namely TL. No statistically significant differences were noted regarding either DSS or LC among the pre-mentioned surgical approaches. These results suggest that larynx-preserving surgical modalities offer similar oncologic results with more aggressive surgery and, therefore, do not seem to be responsible for the recently noted decrease in survival from early supraglottic cancer. A prospective, multi-institutional trial would be necessary, nevertheless, in order to further challenge this hypothesis.

In recent years, glottis-preserving TLM has become a reliable surgical treatment option for supraglottic cancer.[5,6,11–14] TLM was introduced in laryngeal cancer surgery by Strong and Jacko[15] in 1972. Vaughan[16] was the first to describe supraglottic cancer excision with laser in 1978. Today, TLM represents a minimally invasive surgical approach which allows tumors to be removed with limited sacrifice of healthy tissue and with retention of organ function.[3,6,8] Functional results of TLM are generally considered superior to those of open surgery and in many cases comparable with radiotherapy.[3,5,8] Other advantages of TLM include low morbidity and mortality, avoidance of tracheotomy, shorter periods of hospitalization, and low costs.[3,5,11–14] In addition, TLM has repeatedly demonstrated cure rates for supraglottic cancer comparable with those of open surgery or primary radiotherapy.[5,6,7,11–14,17] This therapeutic effectiveness has been confirmed by the present study.

Most cases in the present series were treated by TLM. A standard piecemeal technique for laser excision, as described by Steiner and Ambrosch,[18] is routinely utilized in our institution. This technique allows narrow margin control with maximum preservation of function. The laser is typically used as a cutting instrument rather than one to vaporize the tumor. Frozen section control is necessary as an indicator for further resection, although frozen sections do not always correlate with permanent pathology.[19] The significance, nevertheless, of achieving tumor-free surgical margins cannot be overstressed. In a previous study from our department, it was shown that TLM for supraglottic cancer offers satisfying oncologic results as long as free surgical margins can be obtained.[12] Unfortunately, although TLM affords increased precision and hemostasis, it may pose serious difficulties in order for pathologists to reliably assess the status of tumor resection margins.[20] On the other hand, TLM may offer easy access to the tumor site for repeated resection whenever dictated by pathology.[3] In the present study, tumor-free margins were reached in all but 3 cases. Incidence of positive surgical margins was therefore 3%. Oncologic results were not affected by the status of surgical margins in this study due to this very low rate.

Such a low incidence is, at least in part, related to the fact that all patients who received postoperative radiotherapy, as would typically be the case for those with positive surgical margins, were not evaluated in this study due to the previously mentioned selection criteria.

Safe use of a $CO_2$ laser mandates increased awareness and training on behalf of the surgeon and operating room personnel.[3,21] Airway fire is perhaps the most feared complication, and strict caution against it cannot be overemphasized. Other potential complications include granulomas, bleeding, dyspnea requiring emergency tracheotomy, and aspiration pneumonia.[3] A low incidence of major complications was found for TLM cases in this series. Isolated types of complications, such as postoperative dyspnea or granulation formation, were in fact too rare to be separately commented upon. Moreover, overall incidence was lower for TLM compared with transcervical techniques, although statistical significance was not reached (Table 2). However, TLM showed a significantly lower incidence of tracheotomies compared with open procedures (Table 3). Regarding permanent tracheotomies in particular, which are expected to have the most serious impact on the patient's quality of life, an acceptable incidence of 6.1% was noted for TLM. Moreover, long-term swallowing difficulties as evidenced by the presence of a permanent PEG were noted in only 6.1% of TLM cases compared to 10.3% of HL cases (Table 3). Finally, it should be noted that 94% of TLM cases managed to retain their larynx during the course of the disease, a rate higher than but comparable to that of HL cases (90%).

HL was originally developed by Alonso Regules[22] in 1939. This technique, with its later modifications, has been able to produce high cure rates with improved preservation of function in selected supraglottic lesions.[3,5,6] Today, HL is considered a well-accepted mode of treatment for early and moderately advanced supraglottic lesions and may even be considered the standard of comparison for evaluation of newer function-preserving surgical techniques.[6] In the present series, nevertheless, HL showed a higher incidence of complications and a significantly higher incidence of tracheotomies compared with TLM. Regarding the latter, nevertheless, it is noted that in our institute a tracheotomy is almost routinely performed intraoperatively during HL for prophylactic reasons and is later closed as soon as the patient's condition allows it. This is perhaps the main reason for the large difference that was noted regarding the incidence of tracheotomies between HL and TLM in this series. However, HL also showed a significantly higher incidence of permanent tracheotomies (13.7% vs 6.1%) compared with laser surgery. Oncologic results, on the other hand, were comparable between the 2 techniques, as previously mentioned. Other available larynx-preserving surgical techniques for supraglottic cancer, such as the supracricoid partial laryngectomy with cricohyoidopexy, were not assessed in the present study.[3,6]

The traditional management approach for supraglottic cancer has been TL followed by radiotherapy.[6] Billroth is credited for performing the first TL for cancer in 1873.[23] This procedure, which is traditionally the standard against which all other forms of treatment must be measured,[24] was only employed for management of T2 cases in our series. Therefore, it produced comparable oncologic results with larynx-preserving techniques at an additional cost of a permanent tracheotomy and total loss of laryngeal function in every case. Since this is a retrospective study, reasons for the selection of this procedure in cases where it was employed are not known. It is hypothesized, however, that treating physicians might have overestimated the anatomic extent of some lesions, particularly with regard to the glottis, and thought it impossible to achieve control with less radical surgery. On the other hand, it should be kept in mind that larynx-preserving techniques, especially TLM, were not as popular in the past as they are today. It is also noted that in recent years where laser surgery has become a treatment standard, TL has no longer been employed for early supraglottic lesions in our center. It may be suggested, therefore, that with current treatment standards, most of the cases in the TL group would have undergone less radical surgery. In any case, the presence of such a group in this series provides a comparison standard for function-preserving approaches. This comparison is not, as already mentioned, in favor of TL since it failed to produce superior oncologic results. Therefore, it may be concluded that total laryngectomy should only be reserved for more locally advanced supraglottic lesions where organ-preserving techniques are not applicable. In every case, a thorough diagnostic workup is essential in order to decide which surgical procedure can lead to maximum tumor

control and functional outcome. This decision must always be reassessed according to the intraoperative findings.

It is now widely accepted that the clinically N0 neck should always be included in the primary treatment plan of supraglottic lesions.[25–27] Such a tactic is based on the knowledge that supraglottic cancer, even during early local stage, is characterized by a significant incidence of occult metastases in the neck.[28,29] Moreover, it has been previously shown that the survival of patients with supraglottic cancer is largely determined by this high rate of cervical node metastases, and failure in the neck is generally the most likely cause of treatment failure.[25,28] Today, we routinely perform functional neck dissection for TNM stage I and II supraglottic lesions in our institution. The procedure is performed ipsilateral to the lesion in laterally localized tumors and bilaterally in the rest of the cases, as previously proposed.[25] However, this has not been the case in former years when the pre-mentioned prognostic significance was not realized, therefore explaining the high rate of particularly T1 classification cases treated before 1991 which did not receive any primary treatment of the neck. It is noted, however, that similar cases in which the neck could have been managed with postoperative radiotherapy were not assessed here due to the selection criteria of this study. The lower DSS rate that was, nevertheless, noted for the group of cases with untreated necks confirms once again the prognostic significance of neck management in early supraglottic cancer. In fact, nonprimary treatment of the neck seems to be the main reason explaining why DSS for T1 cases overall was lower compared with T2, since the majority of untreated necks belonged to T1 classification cases. It may, therefore, be suggested, in accordance with previous reports, that no matter which surgical technique is selected for the management of early supraglottic cancer, the neck must also be primarily addressed.[25–28]

In conclusion, larynx-preserving surgical modalities have been found to offer comparable oncologic results with the more traditional approach of TL in T1 and T2 supraglottic cancer. Moreover, laser surgery has been shown to have the lowest incidence of complications and best functional results among available surgical options and should, therefore, be placed in the first line of treatment for early supraglottic cancer. In any case, management of the neck must be included in the primary treatment plan of early supraglottic lesions.

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