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HEAD AND NECK

# Indications and results of extended total laryngectomy with en-bloc resection of overlying cervical skin

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## Abstract

**Purpose** Extended total laryngectomy with en-bloc resection of overlying cervical skin (ETL) is indicated in cases with infiltration of the pre-laryngeal soft tissues. The present study analyses the surgical indications and the results of ETL in our hospital.

**Methods** Retrospective review of 38 patients treated with an ETL during the period 1988–2016.

**Results** The indications for ETL were the initial treatment of tumors with extralaryngeal extension ($n=16$), salvage treatment after failure of partial surgery or radiotherapy ($n=17$), and total laryngectomy in patients with infection or fibrosis of the skin over the larynx ($n=5$). The surgical defect was reconstructed with local flaps in 3 cases, with pectoralis major flaps in 34 cases, and with an internal mammary artery perforator flap in one case. The rate of pharyngocutaneous fistula in the postoperative period was 16%. 5-year cancer-specific survival for patients treated with an ETL was 67.1%. The patients with positive margins and those operated as a salvage treatment after failure of previous treatments showed worse survival.

**Conclusions** ETL offers acceptable oncological results for patients with tumors with extralaryngeal extension. Myocutaneous or myofascial pectoralis major flaps allow for adequate reconstruction of the surgical defect with a low rate of complications.

**Keywords** Extended total laryngectomy · Total laryngectomy · Extralaryngeal extension · Salvage surgery

## Introduction

The introduction of partial surgery techniques in selected cases and the generalization of radiotherapy and chemo-radiotherapy have reduced the use of total laryngectomy as initial treatment of patients with locally advanced carcinomas of the larynx over the last few decades [1]. However, total laryngectomy remains the surgical technique of choice in the management of patients with locally advanced tumors with cartilaginous involvement or extralaryngeal extension [2, 3], as well as in a large proportion of cases of recurrence [4].

Occasionally, patients with an extralaryngeal extension present with infiltration of the pre-laryngeal soft tissues or even become externalized. In these situations, it is indicated to perform a total extended laryngectomy with en-bloc resection of prelaryngeal soft tissues and the cervical skin (ETL), a procedure known as laringectomie carré In the French literature [5], and as squared laryngectomy [6] in other countries of Europe because it is characterized by the removal of a square skin area overlaying the larynx and strap muscles.

In our centre, the main indication for ETL is the clinical or radiological suspicion of extralaryngeal extension of the tumor with infiltration of the prelaryngeal soft tissues and fixation of the tumor at the level of the dermis. Occasionally, this technique is indicated in tumor recurrences after previous radiotherapy candidates for a total laryngectomy where the anterior cervical skin shows signs of infection or marked fibrosis, questioning its viability and healing capacity.

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The aim of the present study is to analyse the surgical indications and the postoperative and oncological results achieved with ETLs in our centre.

## Material and methods

The present study was carried out retrospectively using a database that prospectively collects information about epidemiological data, characteristics of the tumor, treatment and follow-up of patients with malignant head and neck tumors treated at our tertiary referral University Hospital [7]. All patients were evaluated by an oncological board that proposed treatment according to the institutional protocols and characteristics of the patients.

All the patients treated with an ETL during the period 1988–2016 were included in the present study. Thirty-eight procedures of this type were carried out in our centre during this period. There was a predominance of men ($n=37$, 97.4%), with an average age at the time of surgery of 60.8 years (range 40.4–80.8 years). All patients had a diagnosis of squamous cell carcinoma, and all of them had a radiological imaging study (CT or MRI) prior to the laryngectomy. The average period of follow-up of the patients included in the study was 6.6 years (range 0.33–22.1 years).

### Surgical technique

The area of skin to be resected in continuity with the laryngeal block was delimited from the imaging studies and physical examination. The skin incision was then made, deepening it to include the subcutaneous tissue and the anterior cervical fascia sheets reaching the infrahyoid musculature. From this moment, the surgical procedure was continued similar to that of a conventional total laryngectomy. Subtotal or total thyroidectomy was associated depending on the location and extension of the tumor. Neck dissections were also performed when indicated without additional incisions.

Once the pharynx was sutured, the cervical defect was reconstructed. In non-irradiated patients with limited cutaneous resection, reconstruction was carried out by creating local flaps with horizontal incisions extended laterally in the upper and lower limits of the defect. The two lateral cutaneous-fascial flaps were then mobilized towards the midline. However, most cases required regional flaps. In our centre, when tissue supply was required, a pectoralis major flap was used either as a myocutaneous flap (Fig. 1) or as a myofascial flap with a free skin graft sutured on the external face of the flap (Fig. 2). The selection of the design of the flap depended on the morphology of the patient and the thickness of the chest wall.

### Analysis of data

We analysed the indication of surgery, either as the initial treatment of a tumor, as a salvage surgery, or as treatment of chondronecrosis, collecting the history of the previous radiotherapy. In relation to the surgery, we evaluated the technique of reconstruction of the cervical defect, the status of the surgical margins, as well as the appearance of postoperative complications at a local level. A positive margin was defined as the presence of tumor at the surgical margin by the reporting pathologist. We quantified the duration of hospital stay as a measure of postoperative morbidity.

For patients operated as treatment of the tumor, we analysed the specific survival considered from the date of completion of the ETL.

We used Fisher's exact test in the comparisons between qualitative variables, and the Kruskal–Wallis nonparametric test to compare the duration of hospital stay according postoperative complications. The estimates of the specific survival were carried out with the Kaplan–Meier actuarial method, using the log-rank test in the comparison of the survival curves.

The study was approved by the Institutional Review Committee of our centre and was carried out in accordance with the principles indicated in the Declaration of Helsinki.

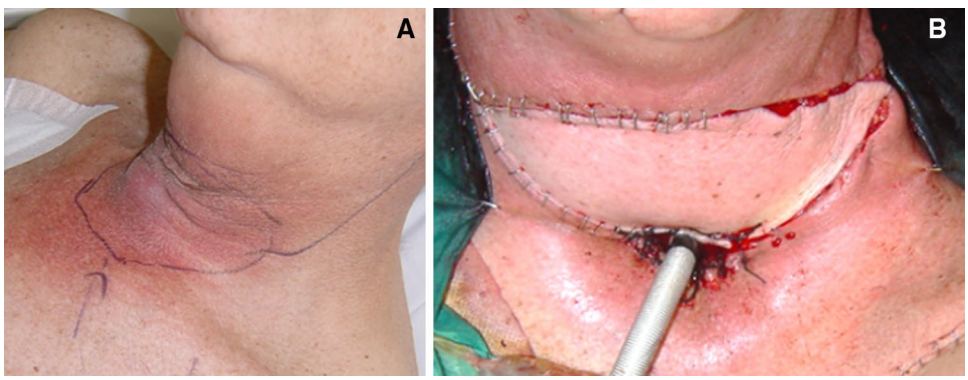


**Fig. 1** Anterior cervical skin area to be resected (**a**) and final reconstruction with a pectoralis major myocutaneous flap (**b**) in a patient treated with an extended total laryngectomy with en bloc resection of the overlying cervical skin

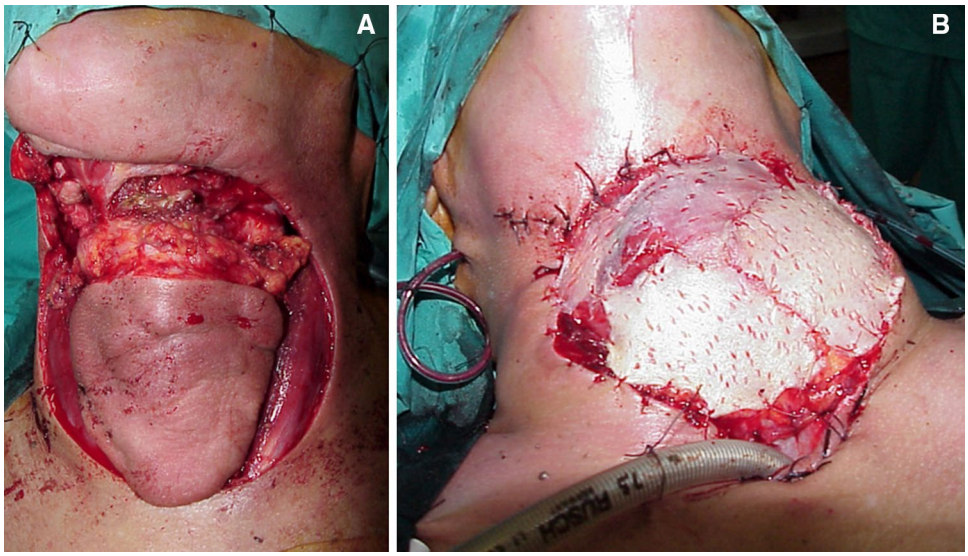


**Fig. 2** Incision of the cervical skin and subcutaneous tissues (**a**) and final reconstruction with a myofascial flap of pectoralis major and a free skin graft (**b**) in a patient treated with an extended total laryngectomy with en bloc resection of the overlying cervical skin

## Results

ETL was the initial treatment of tumors with extralaryngeal extension (cT4) for 16 patients (42.1%) in which the clinical and radiological exploration showed an infiltration of soft tissues of the anterior cervical region. In 10 cases it was the treatment of an index tumor of the larynx, and in 6 it was the treatment of a second laryngeal neoplasm in patients previously treated with radiotherapy. The indication for surgery was a salvage treatment for 17 patients (44.7%). Previous treatments were partial supraglottic or supracricoid surgery in 4 cases, and radiotherapy or chemo-radiotherapy in 13 cases. Additionally, an ETL was performed in 5 patients (13.2%) with marked fibrosis in the anterior cervical skin after the previous radiotherapy, in two patients with a local recurrence without extralaryngeal extension, and in three patients with condronecrosis. Twenty-seven patients (71.1%) had been treated with radiotherapy in the neck prior to the ETL. After surgery, nine of the non-irradiated patients received adjuvant treatment with radiotherapy or chemo-radiotherapy. In two patients adjuvant treatment was rejected due to comorbidity and poor general condition. Table 1 of the supplementary material shows the age, sex, sequence of the surgery (primary versus savage), local extension in the pathological study (pT/rpT), the status of the resection margins, the outcome in the last control and follow-up time for all the patients included in the present study. Unilateral or bilateral neck dissections were carried out in 23 patients simultaneously to the laryngectomy. Neck dissections were not performed in patients with the neck already treated surgically and in cases of chondronecrosis.

In three patients without previous radiotherapy, it was possible to reconstruct the defect with cervical cutaneous local flaps. The vast majority of patients ($n=34$, 98.5%) were reconstructed with pectoralis major flaps, either as a myocutaneous flap ($n=10$) or as a myofascial flap with a free skin graft ($n=24$). On one additional occasion, the surgical defect was reconstructed with a cutaneous flap of internal mammary perforators (IMAP).

During the postoperative period, 6 patients (15.8%) had a pharyngocutaneous fistula, and 4 patients (10.5%) an infection or dehiscence of the cervical wound but without fistulisation. The totality of cases of fistula appeared in patients reconstructed with a pectoral flap. There were no significant differences in the appearance of fistulas depending on the history of previous radiotherapy ($P=0.650$), although the frequency of fistulisation for patients previously treated with radiotherapy was higher (18.5% versus 9.1%). All pharyngocutaneous fistulas were resolved with topical wound cures, with the exception of one case in which a second pectoralis major flap was required.

The median duration of hospital stay for the global of patients was 15 days (range 8–77 days). There were significant differences in the duration of hospital stay according to the appearance of postoperative complications ($P=0.0001$). The average period of hospital stay for patients without complications at the cervical level was 14.7 days, for patients with an infection or dehiscence of the wound it was 29.1 days, and for patients with a pharyngocutaneous fistula it was 35.5 days.

For patients in whom the indication for surgery was the extralaryngeal extension of the tumor ($n=33$), the pathological study showed anterior infiltration of the prelaryngeal soft tissue in 90.9% of cases. Three patients had lymph node metastases in the neck dissections performed.

Excluding the three patients in whom the indication for surgery was the treatment of a chondronecrosis, the 5-year specific survival for the group of patients with oncological

treatment was 67.1% (CI 95% 51.1–83.1%). The cause of death for the 11 patients who died as a consequence of the tumor was a local recurrence in nine patients, and a regional recurrence with distant metastasis in two patients. The pathological study showed positive resection margins in 6 of the 35 patients with tumor (17.1%). There were significant differences in the specific survival depending on the status resection margins. The specific survival at 5 years for patients with free margins was 81.9% (CI 95% 67.4–96.4%), while all patients with positive margins died as a consequence of the tumor in a period of less than 2 years ($P < 0.0001$). Figure 3a shows the specific survival curves according to the status of the resection margins. There were significant differences in the specific survival depending on the indication of the surgery ($P = 0.014$). Specific survival at 5 years for patients in whom total laryngectomy was performed as the initial treatment of an index or a second tumor ($n = 17$) was 87.4% (CI 95% 71.0–100%), and for those patients treated with a salvage surgery ($n = 18$) it was 48.1% (CI 95% 24.4–72.5%). Figure 3b shows the specific survival curves according to the sequence of the surgery (primary surgery versus salvage surgery).

## Discussion

The anterior extralaryngeal extension of T4 laryngeal carcinomas with involvement of the prelaryngeal soft tissues is an unusual situation and requires specific surgical management, including the prelaryngeal soft tissues and anterior cervical skin in the resection, along with the laryngectomy.

It is known that the perichondrium and the laryngeal cartilages act as a natural barrier that limits the extension of the tumor outside the larynx. At the oncological level, the larynx appears as a closed box. The resection of this closed box leads to a high local control rate of the disease even in advanced tumors, as compared to other tumor locations.

The anterior extralaryngeal extension of the tumor can occur at the expense of penetration and infiltration through the thyroid and cricoid cartilages, or through the thyrohyoid or cricothyroid membranes, without infiltration of the cartilages [8]. In a study carried out by Beitler et al. [9] that analysed 45 cases of total laryngectomy with pathologically confirmed extralaryngeal extension of the tumor, 40% of the cases did not show the penetration of the thyroid cartilage in the pathological study. Similarly, in a study by Chen et al. [10] that analysed specimens of total laryngectomy with extralaryngeal extension, penetration through the thyroid cartilage appeared only in 44% of the cases. In patients with a history of previous partial open surgery of the larynx, tumor recurrences are more likely to infiltrate the prelaryngeal tissues because of the opening or absence of thyroid cartilage that creates a preferential infiltration pathway.

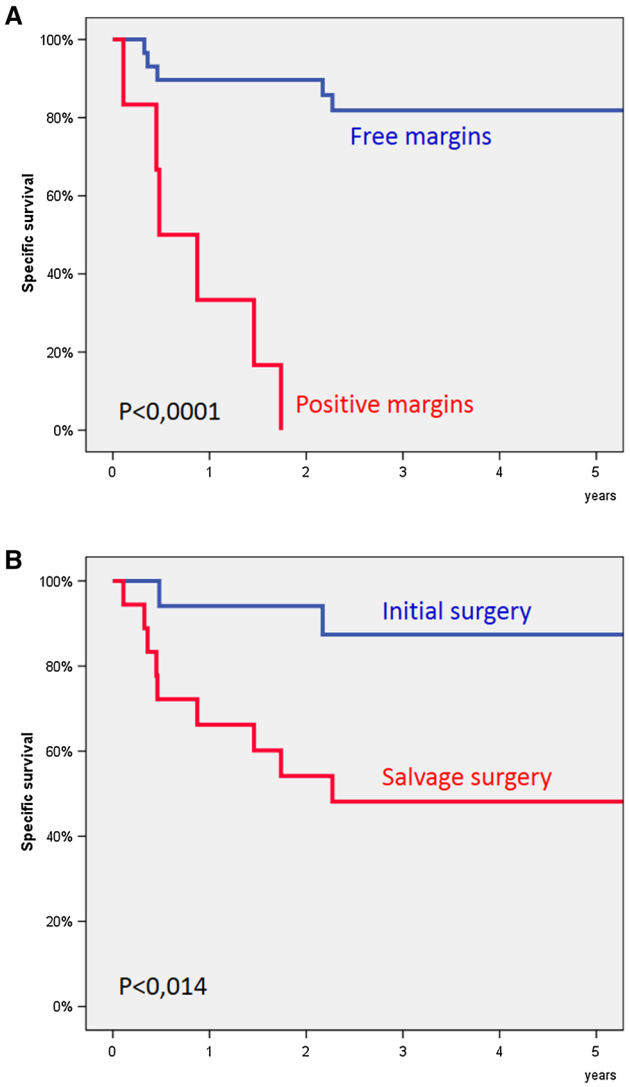


**Fig. 3** Specific survival for patients treated with an extended total laryngectomy with en bloc resection of the overlying cervical skin according to the status of the resection margins (**a**) or according to the sequence of the surgery (initial versus salvage surgery) (**b**)

In cases with a significant extralaryngeal extension, the protection of the closed box has been broken. The surgical limits of conventional total laryngectomy become insufficient to safely contain the tumor spread. In these situations, it is necessary to define new anatomical limits where resections with wide margins of healthy tissue compensate for the loss of the protective role of usual anatomical barriers such as cartilage and perichondrium.

There are few studies that have specifically analysed the results of patients treated with an ETL with en bloc resection of the overlying cervical skin. Croce et al. [6] were the first authors to analyse a limited series of 4 cases: one case as the initial treatment of a tumor with extralaryngeal extension, and 3 cases as salvage surgery after a local recurrence in

patients treated with partial surgeries. They achieved control of the disease in three of the patients. Subsequently, Gallo et al. [11] analysed the results obtained with ETL as salvage surgery in a cohort of 15 patients with local recurrence with extralaryngeal extension after previous treatment with radiotherapy (2 cases) or partial surgery (13 cases). According to their results, the 5-year specific survival was 60%. Finally, Mosleh et al. [12] presented the results of 14 patients with carcinomas with extralaryngeal extension. Three cases showed externalization of the tumor and four of them had received previous treatment with radiotherapy or partial surgery. The authors reported a percentage of pharyngocutaneous fistula of 28.6% and dehiscence or infection of the wound of 14.3%. They achieved control of the disease in 64.3% of the patients, and a 5-year overall survival of 50%.

In our centre, the indications for ETL include the evidence of anterior extralaryngeal extension that surpasses the plane of the strap muscles in imaging studies, or the clinical impression of tumor infiltration of the subcutaneous cellular tissue prior to surgery or intraoperatively. Occasionally, this technique was used in patients without extralaryngeal extension of the tumor, but with doubts about the viability of the healing process of the anterior cervical tissues. In these situations, we believe it is convenient to remove those tissues with questionable viability and replace them with flaps that favour the healing process.

Our study presents the largest published series of patients treated with an ETL, including patients with an extralaryngeal extension of the tumor treated as the initial treatment and patients treated as salvage surgery after previous treatment with radiotherapy or partial surgery. According to our results, the 5-year specific survival in oncological patients was 67.1%. The variables that were significantly related to specific survival were the sequence of the surgery and the status of the resection margins. The patients in whom the ETL was performed as a salvage surgery had worse prognosis. The importance of resection margins in the control of the disease should be noted. All patients with positive margins died as a consequence of the tumor in a period of less than 2 years.

Among the methods of reconstruction of the defect after an ETL, the pectoralis major flap was the most commonly used by all authors [6, 11, 12]. Local skin flaps, deltopectoral flaps [13], supraclavicular flaps [14], or internal mammary perforator flaps [15] have also been used. An alternative to local or regional flaps would be the use of free flaps.

Direct closure with local flaps is only feasible in cases with very limited cervical skin resections in non-irradiated patients. Most cases require distant tissue to reconstruct the cutaneous defect. In our centre, the reconstructive method of choice was the pectoralis major flap. The advantage of the pectoralis major flap is that it provides quickly and reliably a sufficient amount of tissue easily adaptable to the defect. In addition, the high vascularization of the muscular component facilitates the healing process at the local level, an attribute especially useful in patients previously treated with radiotherapy [16]. A disadvantage of the pectoralis major myocutaneous flap is that it can be too bulky depending on the constitution of the patient. In these situations, we prefer to make a myofascial flap and graft with free skin the exposed surface of the flap.

The frequency of pharyngocutaneous fistulas in patients treated with an ETL was 16%. This frequency is similar to the percentage of fistulas observed in a cohort 272 patients treated with total laryngectomy in our centre during the period 2000–2017, which was 14% [17]. The frequency of fistulas in those patients with a prior treatment with radiotherapy was double than in the non-irradiated patients (18.5% versus 9.1%), although given the limited sample size, the differences did not reach statistical significance.

The main limitation of the present study is that it was not possible to analyse variables with the potential capacity to affect the results due to its retrospective nature, such as prior tracheotomy or extension of prelaryngeal infiltration. Also, it was not possible to study the correlation between imaging studies prior to surgery with pathological results.

## Conclusion

ETL with en bloc resection of the overlying cervical skin is a surgical technique that offers acceptable oncological results in patients with an anterior extralaryngeal extension of the tumor, with a 5-year specific survival of 67.1%. The myocutaneous or myofascial pectoralis major flap allows adequate reconstruction of the surgical defect with a low frequency of complications.

### Compliance with ethical standards

**Conflict of interest** The authors declare no conflict of interest.

**Research involving human participants** All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional, regional and national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed consent** For this type of study, formal consent is not required.

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