HEAD AND NECK

Supracricoid laryngectomies: oncological and functional results for 152 patients

Laringectomie sopracricoidee: risultati oncologici e funzionali su 152 pazienti

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SUMMARY

The purpose of this study was to evaluate the oncological and functional outcomes in patients who underwent supracricoid laryngectomies with a crico-hyoidopexy (SCL-CHP) or a crico-hyoido-epiglottopexy (SCL-CHEP) for the treatment of primary and reccurent laryngeal cancer. A retrospective study was conducted on 152 consecutive patients seen from January 1996 to December 2006. Overall survival (OS) and disease-free survival (DFS) were analysed using the Kaplan-Meier method, and were compared according to the type of surgery and clinical stage of the tumour. The mean period before decannulation, nasogastric tube (NGT) removal and recovery of a normal diet and speech were evaluated, and statistical analyses were performed regarding the association with the type of surgery and arytenoidectomy. The median follow-up period was 49.9 months (range: 10–110 months). The 3- and 5-year OS were 87.5 and 83.5%, respectively, and 3- and 5-year DFS were 78.3 and 73.7%, respectively. For patients with early stages tumours, the 5-year OS and DFS were 92.3 and 84.6% respectively, whereas for patients with locally advanced stage tumours, the OS and DFS were 74.3 and 62.2%, respectively. Significant differences in OS and DFS for patients who had early or locally advanced cancers were found ($p = 0.0004$ and $p = 0.0032$, respectively). The rate of overall local control was 92.1%, while the mean period until decannulation or NGT removal was 25.1 and 16.6 days, respectively. The mean period until NGT removal was significantly different according to the type of surgery ($p = 0.0001$) and whether arytenoidectomy was performed ($p = 0.0001$). The reliable oncological and functional results of SCL for early and locally advanced laryngeal cancers are confirmed by our series of patients.

KEY WORDS: Supracricoid laryngectomies • Functional outcome • Laryngeal cancer • Organ-preserving surgery

RIASSUNTO

Lo scopo di questo lavoro è stato valutare i risultati oncologici e funzionali in pazienti sottoposti a laringectomia parziale sopracricoidea con crico-ioido-pessia (CIP) e crico-ioido-epiglotto-pessia (CIEP) per lesioni primitive e recidive di cancro laringeo. È stato condotto uno studio retrospettivo su 152 pazienti consecutivi dal mese di gennaio 1996 a dicembre 2006. La sopravvivenza globale e la sopravvivenza libera da malattia sono state analizzate con il metodo di Kaplan-Meier e sono state confrontate secondo il tipo di intervento chirurgico e lo stadio clinico. Abbiamo valutato, inoltre, la media del tempo di decannulazione e rimozione del sondino nasogastrico, così come la ripresa della fonazione, deglutizione e respirazione. L'analisi statistica è stata eseguita in base al tipo di intervento chirurgico e alla procedura di aritenoidectomia. La mediana del follow-up è stata di 49,9 mesi (intervallo 10-110 mesi). La sopravvivenza globale e libera da malattia a 3 e 5 anni è stata del 87,5%, 83,5% e del 78,3%, 73,7% rispettivamente. I pazienti con stadio precoce hanno riportato una sopravvivenza globale e libera da malattia a 5 anni di 92,3% e 84,6%, mentre per quelli con stadio avanzato i valori sono stati di 74,3% e 62,2%. Una differenza statisticamente significativa è stata riscontrata confrontando la sopravvivenza globale e libera da malattia a 5 anni per gli stadi precoci rispetto a quelli avanzati ($p = 0,0004$ and $p = 0,0032$ rispettivamente). Il controllo locale è stato del 92,1%. La media del tempo di decannulazione è stata di 25,1 giorni; quella di rimozione del sondino nasogastrico di 16,6 giorni. Quest'ultima è risultata statisticamente significativa nel confronto sia in base all'intervento chirurgico ($p=0,0001$) che alla eventuale aritenoidectomia ($p = 0,0001$). L'attendibilità dei risultati oncologici e funzionali è stata confermata dalla nostra casistica, sia per i pazienti con stadio precoce che avanzato.

PAROLE CHIAVE: *Laringectomie sopracricoidee • Outcome funzionale • Cancro della laringe • Protocollo chirurgico di conservazione d'organo*

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Introduction

Supracricoid laryngectomy (SCL) is an organ-preserving surgery that is indicated for selected patients with T1b to T4a laryngeal cancer; SLC was first described by Mayer and Rieder in 1959 and was modified by Piquet et al. in 1974. SCLs involve the removal of the thyroid cartilage, both true and false cords, ventricles, paraglottic and pre-epiglottic spaces and the epiglottis [1 2]. The latter may or may not be resected depending on the extent of the tumour. According to the type of reconstruction, SCLs are classified as SCL-crico-hyoidopexy (SCL-CHP) or SCL-crico-

hyoido-epiglottopexy (SCL-CHEP) [3 4]. It is necessary to preserve the cricoid cartilage, hyoid bone and at least one functional cricoarytenoid unit to preserve the airways and functioning of the laryngeal sphincter to avoid permanent tracheostomy. SCLs with CHP and CHEP provide reliable oncological and functional results for selected patients with glottic and supraglottic carcinomas, as well as for patients who need salvage surgery for recurrence [5-8]. The purpose of this study was to evaluate the oncological and functional outcomes of a cohort of 152 patients at 3 and 5 years after treatment with SCL as organ-preserving surgery.

Materials and methods

A retrospective study was conducted on 152 consecutive patients who underwent SCL from January 1996 to December 2006 at the Otolaryngology Head and Neck Surgery Unit of "Azienda Ospedaliera di Rilievo Nazionale dei Colli – Ospedale Monaldi", Naples (Italy). The patients included 138 men (90.8%) and 14 (9.2%) women with a median age of 45 years (range: 24–78 years) as shown in Table I. Of the 152 patients, 29 had glottic cancer and 123 had supraglottic cancer; 16 patients were clinically categorised as N1.

SCL was the primary treatment for 144 patients (94.8%), whereas 8 (5.2%) underwent surgery for local relapse after a previous treatment: 4 (2.6 %) had been previously treated with a CO_2 transoral laser resection and 4 (2.6%) had received previous radiotherapy.

All patients had been diagnosed with squamous cell carcinoma of the larynx that was histologically confirmed by biopsy. Clinical staging of the tumour according to 2010 UICC classification system [9] was performed by instrumental analysis and functional imaging, including optical fibre videolaryngoscopy, direct microlaryngoscopy under general anaesthetic with biopsy, bronchoscopy, oesophagoscopy, blood gas analysis, spirometry, neck ultrasonography, contrast-enhanced CT and/or MRI scanning of the neck, high-resolution chest CT and, as of 2005, total body CT with positron-emission tomography (^{18}F-FDG PET/CT) for patients with locally advanced disease [10].

Table I. Characteristics of patients who underwent SCL according to age, gender and Karnofsky performance status.

Characteristic	N	%
Patients	152	
Age (years)		-
<55	32	21%
55-72	104	68.4%
>72	16	10.6%
Median (years)	45	-
Range (years)	24–78	-
Gender		
Male	138	90.8%
Female	14	9.2%
Karnofsky performance status		
100	37	24.3%
90	69	45.3%
80	46	30.4%

The type of SCL chosen was based on the localisation and extension of the tumour.

The indications for CHEP were: (1) glottic tumours classified as T1b as limited to the vocal cords, with both vocal cords having normal mobility; (2) glottic tumours classified as T2, with tumour extension to the ventricle, false vocal cord, petiole of the epiglottis, and/or an impaired true vocal cord; (3) selected glottic tumours classified as T3 due to paraglottic spread without fixation of the arytenoid cartilage; or (4) selected tumours classified as T4a due to limited anterior invasion through the thyroid cartilage. The indications for CHP were: (1) supraglottic tumours classified as T2 due to invasion of the vocal cords and anterior commissure, with or without impaired mobility of the true vocal cords; (2) selected supraglottic-glottic tumours classified as T3 due to fixation of the true vocal cords and/or invasion of the pre-epiglottic space, but without fixation of arytenoid cartilage; and (3) selected tumours classified as T4a due to limited anterior invasion through the thyroid cartilage.

The local contraindications for SCL were: (1) invasion of the posterior commissure; (2) massive invasion of the posterior paraglottic space, with potential diffusion to the submucosa of the pyriform sinus or involvement of the retrocricoid area or trachea; (3) cancer involving both arytenoids; (4) true arytenoid fixation; (5) invasion of the cricoid cartilage, front or posterolateral subglottic invasion of > 5 mm; (6) extralaryngeal spread of tumour; and (7) cN of ≥ 2. For our team, the general contraindications for SCL were uncontrolled diabetes mellitus, severe chronic obstructive pulmonary disease (FEV1 of <30%), severe heart failure, age over 75 years (except in very specific exceptions), psychiatric syndromes, personal motivations and a Karnofsky index less than 80% [11].

The resection of one arytenoid was indicated in the surgical register by the symbol "+A", followed by the side from which the arytenoid was removed. In all cases, laryngeal reconstruction was performed if the intraoperative examination of resection margins using frozen sections was reported as negative; later, the margins were checked again using definitive pathology.

Surgical treatment

Thirty-one (20.4%) patients underwent SCL-CHEP +A, 27 (17.7%) underwent SCL-CHEP, 64 (42.1%) underwent SCL-CHP +A, and 30 (19.8 %) underwent SCL-CHP. Neck dissection (ND) was performed in 138/152 (90.8%) of patients: ND was bilateral in 92 (60.5%) cases

and unilateral in 46 (30.3%) cases. Elective ND was performed in 122 cN0 patients (80.3%) and curative ND was performed in 16 cN+ (10.5%) patients. Fourteen patients affected by cT1bN0 glottic cancer (9.2%) did not undergo ND (10 were between 70–75 years old and 4 had previously been treated by carotid endarterectomy).
Unilateral selective ND (SND II-IV) was performed in 46 patients staged cT2N0; bilateral SND was performed in 76 patients (50%), 14 of whom were staged cT1bN0 and 63 of whom were staged cT3N0. Modified radical ND (MRND) Type III ipsilateral to the lesion and contralateral SND were performed in 14 patients (9.2%) with clinical evidence of neck metastasis. Finally, ipsilateral MRND Type III and contralateral SND extended to level VI and thyroidectomy was performed in 2 patients affected with cT4aN1 cancer.
The diseases were reclassified according to the 2010 UICC classification system [9] as follows: pathological examination of the specimen showed that 27 patients had glottic cancer: 23 pT1b and 4 pT4a. Among the 125 patients who were affected by supraglottic cancer, 55 were pT2 and 70 pT3. A total of 106 patients (76.8%) were pN0, whereas 32 patients (23.2%) had at least one positive lymph node (reported as pN+): 6 of these patients were pN1, 10 patients were N2a, 13 patients were N2b and 3 patients were N2c (Table II). Early (local or systemic) and later complications were assessed in all patients.

Postoperative treatment

Adjuvant radiotherapy was recommended for patients with histopathologically positive N stage tumours, positive surgical margins, or extracapsular tumour spread. In our series, 32 (21%) pN+ patients were treated with adjuvant radiotherapy according to the guidelines of the National Comprehensive Cancer Network (NCCN) [12]. The dose range was 44 to 60 Gy (2.0–1.6 Gy per fraction) since pathological examination did not reveal extracapsular spread or tumour-positive margins.

Table II. Pathological staging in the cohort (UICC 2010).

pTNM	Glottic		Supraglottic		Total
	N	%	N	%	N
pT1b	23	15.1	0	0	23
pT2	0	0	55	36.2	55
pT3	0	0	70	46.1	70
pT4a	4	2.6	0	0	4
					152
pN0	9	6.5	97	70.3	106
pN1	2	1.5	4	3	6
pN2	0	0	26	18.7	26
pN2a	0	0	10	7.2	10
pN2b	0	0	13	9.4	13
pN2c	0	0	3	2.2	3
					138

The same rehabilitation protocol was applied to all patients, except for those who developed severe early complications. Our protocol entailed the following: A) from the second postoperative day, placement of a non-cuffed fenestrated tracheostomy tube for phonation exercises; B) from the sixth postoperative day onward, intermittent occlusion of the tracheostomy tube during the day and breathing exercises; and C) starting from the eighth postoperative day, rehabilitative exercises for swallowing.

Oncological outcomes

The primary oncological endpoints included overall survival (OS) and disease-free survival (DFS) calculated from the date of surgery. The endpoint for OS was the date of death, regardless of cause, whereas the endpoint for DFS was date of recurrence. In both cases, censored data were calculated based on the date of last follow-up. Three- and five-year data were reported. We calculated the above-cited endpoints according to T stage (early T1b-T2 vs. locally advanced T3-T4a) for both surgical procedures (CHP vs. CHEP). Survival curves were calculated using the Kaplan-Meier method.

Functional outcomes

For evaluation of the short-term postoperative recovery, the primary endpoints included the mean time until decannulation and nasogastric tube (NGT) removal, calculated from the date of surgery. The NGT was removed under the supervision of a speech therapist after the patient was able to swallow liquids without aspiration; the tracheostomy tube was removed if the patient tolerated the procedure well without dyspnoea. We evaluated the above-cited endpoints according to the surgical procedure (CHP vs. CHEP) and removal of one cricoarytenoid unit (SCL vs. SCL +A).
For evaluation of long-term postoperative recovery, we utilized the Performance Status Scale for Head and Neck Cancer Patients edited by List [13] one year after the surgical procedure. This scale includes three major outcomes, each one corresponding to a subscale: normalcy of diet, intelligibility of speech and eating in public.
The normalcy of diet subscale assessed the degree to which a patient is able to eat a normal diet; it involves a ranking of 10 food categories that are arranged from easy-to-eat at the low end to hard-to-eat at the high end. The rating is based on the highest-ranking food that the patient is able to eat.
The intelligibility of speech subscale is a 5-item scale with descriptors ranging from "never understandable" to "always understandable." The rating is based on the degree to which the interviewer is able to understand the patient's speech.
The latter subscale assesses the degree to which the patient eats in the presence of others. It consists of five levels ranging from "always eats alone" at the low end to "no restriction of place, food, or companion" at the high end.

Statistical analysis

For comparison of survival curves, we used the Log-rank and Wilcoxon tests. For comparison of mean values, we used a univariate ANOVA. For all tests, the α level was fixed at 0.05. Statistical analyses were performed using JMP®, Version 10.0.0. SAS Institute Inc., Cary, NC, 1989-2007.

Results

The median follow-up period was 49.9 months (range: 10–110 months); 17 patients were lost to follow-up.

Oncological results

Thirteen patients died of laryngeal carcinoma, 9 due to locoregional recurrence and 4 for distant metastasis, while 12 patients died from causes other than laryngeal carcinoma.

For the entire cohort of patients, the OS was 87.5% after 3 years and 83.5% after 5 years, whereas the DFS after 3 and 5 years was 78.3% and 73.7%, respectively, as shown in Figure 1.

The SCL-CHP subgroup had a 5-year OS of 76.6% and a 5-year DFS of 67.1%, whereas the SCL-CHEP subgroup had a 5-year OS of 83.7% and a 5-year DFS of 81% (Fig. 2-A and Fig. 3-A).

For patients with early stage tumours, 5-year OS was 92.3% and 5-year DFS was 84.6%. For patients with locally advanced tumours, 5-year OS was 74.3%, whereas the 5-year DFS was 62.2% (Fig. 2-B and Fig. 3-B).

The difference between the OS for patients with early or locally advanced tumours was significant (Log-rank (df = 1) = 10.323, p = 0.0013; Wilcoxon (df = 1) = 12.534, p = 0.0004), whereas the difference between OS for the SCL-CHP and SCL-CHEP subgroups was not significant (Log-rank (df = 1) = 1.2003, p = 0.2733; Wilcoxon (df = 1) = 1.3436, p = 0.2464).

The difference between DFS of patients with early or locally advanced tumours was significant (Log-rank (df = 1) = 9.425, p = 0.0021; Wilcoxon (df = 1) = 8.679, p = 0.0032), whereas the difference between DFS of the SCL-CHP and SCL-CHEP subgroups was not significant (Log-rank (df = 1) = 2.919, p = 0.0875; Wilcoxon (df = 1) = 2.790, p = 0.0948). Oncologic results are reported in Table III.

In the subgroup of patients who had been previously treated, 5-year OS and DFS was 100% (4/4) and 75% (3/4) respectively, for patients treated with CO_2 transoral laser surgery, while 5-year OS and DFS was 50% (2/4) and 50% (2/4) respectively for patients treated with radiation therapy.

Local control and recurrence

The overall recurrence rate was 26.3% (40/152), while the locoregional recurrence rate was 13.2% (20/152). There were 12 local recurrences, for which the following salvage treatments were given: total laryngectomy (TL) alone in 3 cases, TL and adjuvant radiotherapy in 6 cases, TL and neck dissection limited to the sixth level in 2 cases and TL and adjuvant chemoradiotherapy in one case. Three patients died after salvage surgery, whereas at the last follow-up, 9 patients were alive and disease-free. The overall local control rate was 92.1%.

Recurrence in the neck was observed in 8 patients, 3 of whom who were previously classified as cN0 and 5 as cN1. Five patients were treated with MRND and adjuvant chemotherapy, whereas 3 patients underwent chemotherapy alone. Two patients died from regional recurrence and 6 patients were alive and disease free at the last follow-up; overall, after neck salvage therapy, the regional control rate was 94.7%.

Sixteen patients developed distant metastases, including 13 cases of lung metastases, 2 cases of bone metastases and one case of liver metastases. Four patients died, whereas 12 were still alive at the last follow-up; the rate

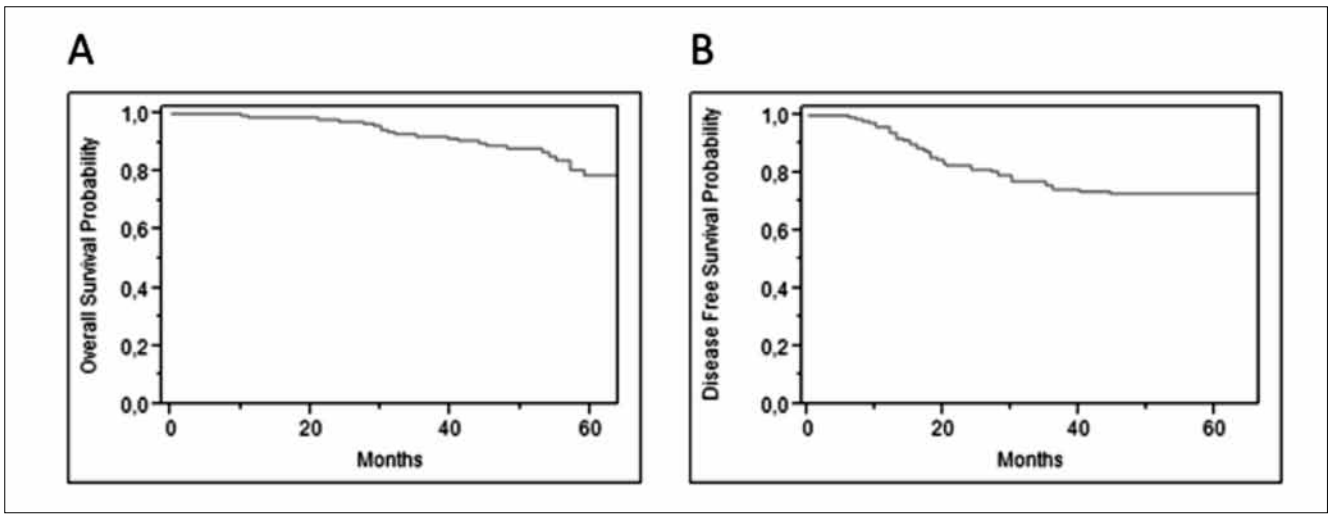

Fig. 1. Probability of overall survival (A) and disease-free survival (B) for the entire cohort.

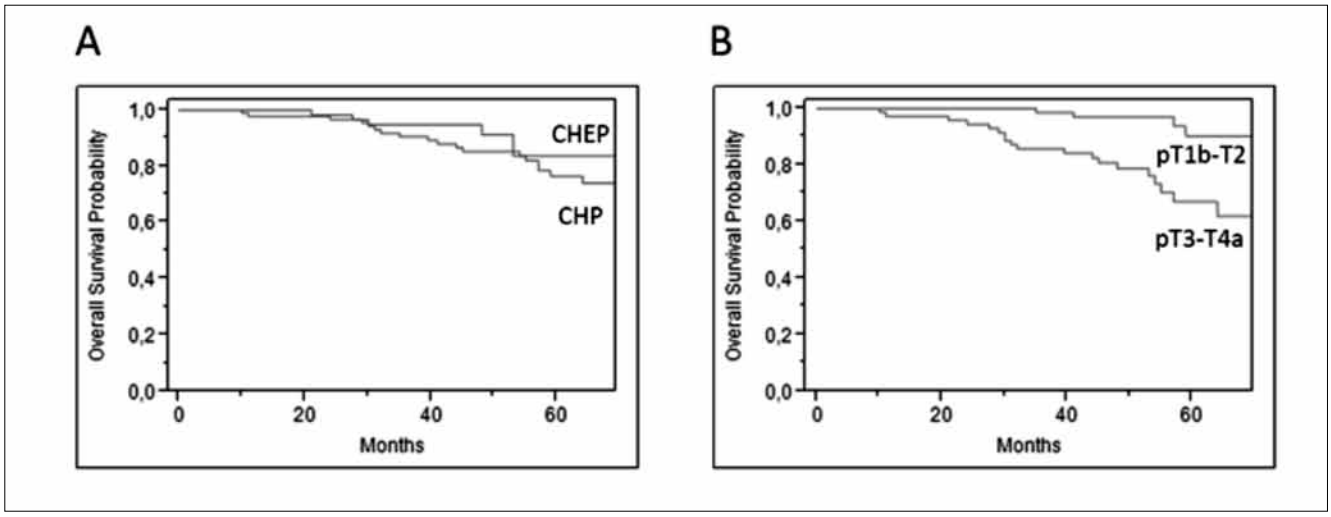

Fig. 2. Probability of overall survival according to the type of surgery (A) and pathological stage (B). CHEP: crico-hyoido-epiglottopexy; CHP: crico-hyoidopexy. Pathological staging was conducted according to the 2010 UICC classification system.

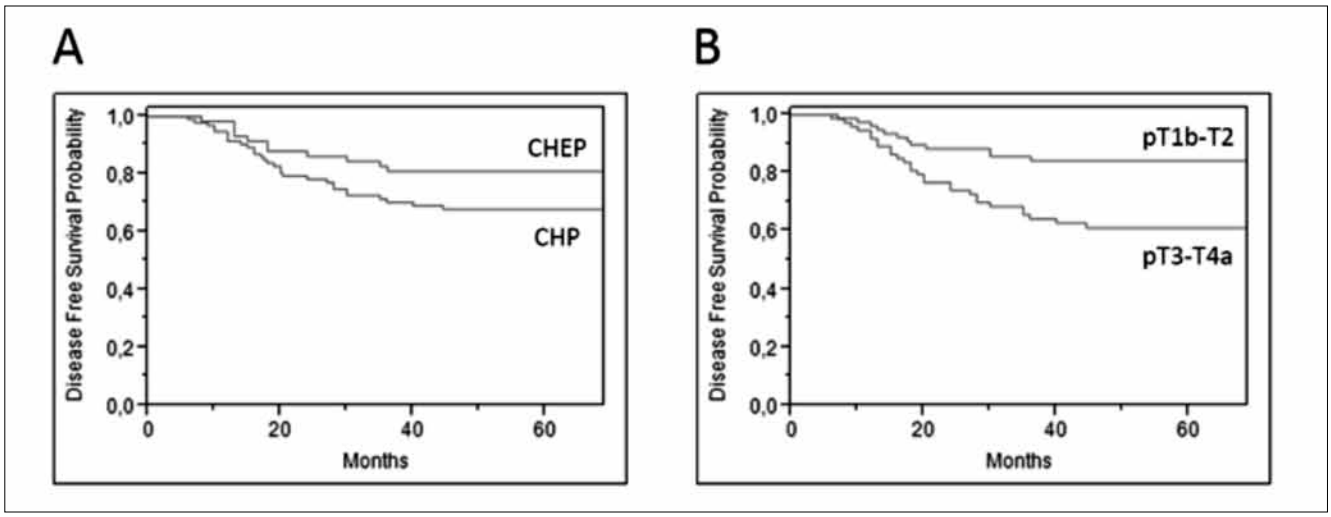

Fig. 3. Probability of disease-free survival according to the type of surgery (A) and pathological stage (B). CHEP: crico-hyoido-epiglottopexy; CHP: crico-hyoidopexy. Pathological staging was conducted according to the 2010 UICC classification system.

of distant metastases was 10.5% (16/152). Finally, the frequency of second primary tumours was 2.6%, with 4 cases of second primary cancers of the colon.

Functional results

1. Comparison of short-term postoperative recovery

Respiratory function of all patients was restored by natural means, with decannulation after an average of 25.1 days (median: 25, range: 22–30). One patient who had been treated with SCL-CHP +A was not able to swallow without aspiration and it was necessary to use percutaneous gastrostomy until the subsequent functional recovery of swallowing occurred 3 months later. The mean time until NGT removal was 16.6 days (median: 16, range: 12–63). The mean time until NGT removal was 13.6 days after SCL-CHEP and 18.4 days after SCL-CHP: these values were significantly different (p = 0.0001). In contrast, the mean time until decannulation was 25.2 days after SCL-CHEP and 25 days after SCL-CHP, with no significant difference (p = 0.502).

Table III. Analysis of oncological results according to type of surgery and clinical stage.

	Global	Early	Locally advanced	p value	CHP	CHEP	p value
5-year OS	83.5%	92.3%	74.3%	0.0004	76.6%	83.7%	0.2464
5-year DFS	73.7%	84.6%	62.2%	0.0032	67.1%	81%	0.0948

OS, overall survival; DFS, disease-free survival; CHP, cricohyoidopexy; CHEP, cricohyoidoepiglottopexy

The mean time until NGT removal was 12.9 days when both of the arytenoids were spared and 18.8 days when one cricoarytenoid unit (+A) was removed. The difference between these subgroups was significant (p = 0.0001). In contrast, the mean time until decannulation was 25.2 days when both of the arytenoids were spared and 25 days when one cricoarytenoid unit (+A) was removed; these values were not significantly different (p = 0.493).

Considering only SCL-CHEP patients according to whether an arytenoidectomy performed, the difference between the mean times until NGT removal was significant (p = 0.0001), whereas the difference between the mean times until decannulation was not significant (p = 0.443).

Considering only SCL-CHP patients according to whether an arytenoidectomy performed, the mean times until NGT removal were significantly different (p = 0.0001), whereas the difference between the mean times until decannulation was not significantly different (p = 0.703).

The short-term functional results are reported in Table IV.

2. Comparison of long-term postoperative recovery

The mean score for intelligibility of speech was 94.6. The difference between the SCL-CHEP (mean 96.5) and SCL-CHP (93.3) groups was not significant (p = 0.126). Likewise, there was no significant difference (p = 0.143) between the group that received one arytenoidectomy (+A) (mean 93.4) and the group that in which both arytenoids were spared (mean 96.5).

The average score for eating in public was 92.7 for the entire cohort. The difference between the SCL-CHEP (mean 93.1) and SCL-CHP (92.5) groups was not significant (p = 0.818). Likewise, there was no significant difference (p = 0.884) between the group that received one arytenoidectomy (+A) (mean 92.9) and the group that in which both arytenoids were spared (mean 92.5).

The mean score for the normalcy of the diet was 95.7. There was no significant difference (p = 0.717) between the SCL-CHEP (mean 96.0) and SCL-CHP (95.5) groups. Likewise, there was no significant difference (p = 0.631) between the group that received one arytenoidectomy (+A) (mean 95.5) and the group in which both arytenoids were spared (mean 96.1).

Complications

Early complications occurred in 7 (4.5%) of patients, whereas late sequelae were observed in 6 (4%) cases (Table V). All complications were treated successfully with medical or surgical treatment. It was necessary to reduce the mucosal flap using CO_2 laser surgery in 3 patients (2 CHP and 1 CHEP) because of narrowing of the airway space at the level of the neoglottis.

In terms of the type of surgery provided, we observed 4 complications in the CHEP patients (2 early and 2 late) and 9 in CHP patients (5 early and 4 late). No patient died of complications.

Discussion

The management of laryngeal cancer is focused on improving survival while preserving function; total laryngectomy is undoubtedly an effective oncological surgery, but substantially impairs the quality of life, mainly due to the permanent tracheostoma and loss of voice [14].

Various types of surgical and non-surgical approaches to avoid total laryngectomy have been used. Currently, radiation therapy alone, concurrent chemoradiotherapy, transoral laser surgery and supracricoid laryngectomy are generally utilised of treatment for early and selected locally-advanced laryngeal cancers that have the advantage of preserving laryngeal function, although the optimal primary treatment is still debated [15-20].

Nevertheless, attention to functional preservation and conservative approaches that are gradually replacing total laryngectomy as primary treatment are most likely some of the reasons for the failure in improving survival rates of patients with laryngeal cancer in the last 30 years [21-23].

Since the reports by Mayer and Rieder and Piquet et al. describing SCL with CHEP or CHP for the treatment of selected glottic and supraglottic carcinomas, numerous reports have demonstrated the reliable oncological and acceptable functional results of this procedure [12].

When the indications and contraindications are carefully assessed and surgery is performed with precise attention to the technical details of the procedure, goods result can be achieved using SCL [24].

In the case of any of the oncological contraindications for SCL that were described in the Materials and Methods section, organ preservation can be achieved only by

Table IV. Analysis of the functional results according to the type of surgery and arytenoidectomy.

	Global	CHP	CHEP	p value	SCL	SCL + A	p value
Decannulation, days	25.1	25	25.2	0.502	25.2	25	0.493
NGT removal, days	16.6	18.4	13.6	0.0001	12.9	18.8	0.0001
	Global	**CHEP**	**CHEP + A**	**p value**	**CHP**	**CHP + A**	**p value**
Decannulation, days	25.1	25.4	25	0.443	25	25.1	0.703
NGT removal, days	16.6	11.5	15.4	0.0001	14.1	20.4	0.0001

CHP, cricohyoidopexy; CHEP, cricohyoidoepiglottopexy; SCL, supracricoid laryngectomy; A, arytenoidectomy.

Table V. Early and late postoperative complications.

Complication	N	%
Early		
Acute cervical bleeding	2	1.3
Aspiration pneumonia	3	2
Wound infection	2	1.3
Late		
Frequent aspiration	2	1.3
Laryngeal soft tissue stenosis	4	2.6
Laryngeal fibrosis	0	0

chemoradiotherapy, even if total laryngectomy is often the most appropriate option [25-31].

The literature includes reports of 3-year survival rates of 71.4–95.7% and 5-year survival rates of 79–88% for patient with laryngeal cancer [26-29]. In our series, the 3- and 5-year OS rates were 87.5% and 83.5%, respectively, with 3- and 5-year DFS rates of 78.3% and 73.7%, respectively. Our series of laryngeal cancer patients is one of largest described to date, and the results are in agreement with those of previous papers.

Our data demonstrated a significant correlation ($p = 0.0013$ and $p = 0.0004$ for OS; $p = 0.0021$ and $p = 0.0032$ for DFS) between pathological stage (pT) and overall/disease-free survival rates; as expected, survival was inversely correlated with pT score.

In contrast, there was no correlation ($p = 0.2733$ and $p = 0.2464$ for OS; $p = 0.0875$ and $p = 0.0948$ for DFS) between the type of surgery performed and survival rates, indicating that both CHEP and CHP are effective techniques for management of laryngeal cancers.

Recurrence and metastasis of laryngeal cancer have also been discussed in the literature. Pinar et al. [8] reported a 92.5% local control rate (LC) in SCL patients; in the series reported by Topaloglu [24], the local control rate was 97.8 % following CHP. Dufour et al. [25] reported a 5-year local control rate of 91.4%; similarly, Chevalier [31] reported a rate of 92% in patients treated with CHEP. Of our 152 patients, 7.9% developed local recurrence, 5.3% developed regional metastasis, 10.5% developed distant metastasis and 2.6% developed a second primary tumour, for a local control rate of 92.1%.

In the subgroup of patients for whom previous treatment had failed to control the same type of laryngeal cancer, SCL performed as a salvage procedure provided a good oncological outcome (patients previously treated with CO2 trans-oral laser had OS and DFS of 100% and 75% respectively, whereas patients treated with radiation therapy had OS and DFS of 50% and 50% respectively). These results are consistent with those of recent reports and demonstrate that SCL is a reliable salvage procedure; in addition, the outcome of SLCs compare favourably with the mainstay of salvage and oncological laryngeal surgery in general, namely total laryngectomy [7 20 22].

Although the neoglottic mechanism for swallowing and generating voice after SCL resembles that of the normal larynx, laryngeal function is not normal and there is evidence that these patients have chronic problems with swallowing and aspiration and have a perceptibly abnormal voice with a breathy, strained and rough quality [33-36].

The mean time until decannulation and NGT removal, which indicate proper functioning of the neoglottis, are are commonly used to evaluate short-term functional outcome of SCLs.

The time of decannulation is the most important event for functional success in terms of respiration, and its delay may be associated with laryngeal stenosis, granulations and impaired laryngeal elevation, resulting in dysphagia. The times reported in the literature vary from 7 to 38 days [37-39]. Our rate of decannulation was 100% with a mean time until decannulation of 25.1 days.

The time of NGT removal is used to evaluate functional success in terms of swallowing. The rate of NGT removal reported in the literature varies from 92% to 100% and the mean time until NGT removal after SCLs that has been reported is between 15 and 70 days [37-39]. In our study, the rate of NGT removal was 99.3% and the mean time until NGT removal was 16.6 days. Therefore, the results obtained in the current series are in agreement with previous reports.

The SCL techniques for the removal (CHP) or preservation (CHEP) of the suprahyoid epiglottis differ; therefore, the consequences of these surgeries on the dynamics of swallowing and aspiration are different, which was also the case for patients with locally advanced tumours who received unilateral arytenoid resection. Our series is one of the largest in which functional outcome was related to the type of surgery and arytenoidectomy.

Pinar et al. [8] recently reported that the mean time until decannulation and NGT removal was significantly longer in CHP patients than in CHEP patients; Yuce et al. [40] reported a significant difference for both functional endpoints between patients treated with CHP or with CHP +A. In the paper by Park et al. [41], there was significant difference between both mean values for patients who were treated with CHEP or CHEP +A, but not for the subgroups treated with CHP or CHP +A, most likely owing to the small number of such patients. According to Bron et al. [5], the type of SCL and arytenoidectomy did not have a significant effect on swallowing. Our results showed a significant difference in the time until NGT removal according to the type of surgery ($p = 0.0001$) and whether unilateral arytenoidectomy was performed ($p = 0.0001$), whereas there was no significant difference in the time until decannulation of these groups ($p = 0.502$ and $p = 0.493$, respectively).

In the present series, complications related to aspiration (5/152) occurred more frequently in CHP patients (4/5)

than in CHEP patients (1/5), whereas laryngeal stenosis (4/152) occurred with similar rates in these two subgroups, and was related to arytenoid oedema, posterior prolapse of the epiglottis or a mucosal flap of the neolarynx. None of the patients required a revision of the pexy or conversion to total laryngectomy.

The present results confirm that the preserved suprahyoid portion of the epiglottis may help protect the airway during swallowing; the resection of one arytenoid in addition to the SCL has a negative effect on this function. The compensatory overactivity of the remaining arytenoid and a mass effect due to hypertrophy of the mucosa covering the arytenoidectomy site lead to complete glottic closure [41]. In any case, it is clear that SCL patients require extensive rehabilitation after surgery to achieve good functional outcomes [36].

The long-term functional outcomes involve recovery of 3 main functions of the larynx: speech, breathing and swallowing. Some authors [42] have stressed that speech in SCL patients is obviously worse than that of normal subjects. Nevertheless, most authors have reported acceptable functional results for SCL [8 33].

Luna-Ortiz et al. [43] evaluated patients who underwent SCLs, mostly with preservation of both arytenoids, using the Performance Status Scale for Head and Neck Cancer Patients, whereas Bron et al. [7] used the same scale for patients treated with SCL, mostly associated with a unilateral arytenoidectomy. In spite of the differences in these series, the results obtained were similar.

Our results demonstrated no significant differences in the scores for the 3 sections of the Performance Status Scale for Head and Neck Cancer Patients according to the type of surgery and arytenoidectomy (intelligibility of speech: $p = 0.126$ and $p = 0.143$; eating in public: $p = 0.818$ and $p = 0.884$; normalcy of diet: $p = 0.717$ and $p = 0.631$, respectively) in agreement with the results of previous reports.

Currently, the oncological results of treating early laryngeal carcinomas with laryngeal transoral laser surgery (TLS) and radiotherapy are comparable to those of SCL, reaching 80% to 95% control of local disease [15 16]; the former options are valid, less invasive and provide good functional results and fewer problems in functional recovery. Furthermore, TLS appears to be a cost-effective alternative to surgical procedures and radiotherapy [44].

However, local control by TLS may be inadequate when the cancer has invaded the anterior commissure [45 46]; in this case and/or in the case of difficulties in exposition, SCL may be indicated.

The impossibility of addressing laryngeal areas that are out of direct sight, hidden, or placed "around the corner" during TLS, along with the reduced local control for patients affected by anterior commissural cancer who are undergoing TLS [45 46], may be remedied by using transoral robotic surgery (TORS) [47]. Given its intrinsic features, such as angled 3D visualisation of the surgical field, instrumentation with multiple degrees of rotation and increased surgical accuracy and precision, it should be considered complementary and not as an alternative to TLS. Whenever the indications for TLS or TORS are not fulfilled, SCL is desirable.

Currently, the non-surgical options for locally advanced cancer are radiotherapy alone or chemoradiotherapy, according to the protocols of Department of Veteran Affairs Laryngeal Cancer Study Group (VA) and the RTOG91-11 trials [18 19]; these organ-sparing treatments have a higher rate of acute and late toxicities [48] and appear to be associated with lower rates of survival and organ-preservation than SCL [28].

Therefore, in our opinion, when patients with contraindications are carefully excluded, SCL should be the preferred option for treatment of locally advanced laryngeal squamous cell carcinomas, considering its results in terms of disease control and functional preservation [49].

Conclusions

Reliable oncological results in terms of the overall and disease-free survival rates and local control for patients undergoing SCL have been reported in the literature and were confirmed in our analysis of patients with early and locally advanced laryngeal cancer. SCL-CHEP and SCL-CHP provided similar short-term functional results considering the time to NGT removal and closure of the tracheostomy. The long-term functional results, as assessed by recovery of normal diet and speech were also comparable. We strongly believe that the fundamental requirements to obtain good oncological and functional results are proper patient selection, adherence to surgical indications and early, intensive rehabilitation after surgery.

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