

# Functional Outcome of Supracricoid Partial Laryngectomy With Cricohyoidopexy

## Radiation Failure vs Previously Untreated Cases

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**Objective:** To evaluate the postoperative course and functional outcomes achieved in patients treated with supracricoid partial laryngectomy (SPL) with cricohyoidopexy.

**Design:** Retrospective analysis.

**Setting:** National Cancer Institute "Regina Elena."

**Patients:** Eighty-two consecutive patients who underwent SPL with cricohyoidopexy between September 1, 1988, and June 30, 2005, were evaluated. The patient cohort was divided into 2 groups: one affected by untreated laryngeal cancer and the other with laryngeal recurrence after radiotherapy.

**Main Outcome Measures:** The postoperative com-

plications and functional outcomes of both patient groups were evaluated and statistically compared.

**Results:** No statistical differences were found between the functional results of the 2 groups of patients analyzed.

**Conclusion:** Although a slightly delayed recovery of physiological functions of the larynx could be termed a disadvantage of SCL with cricohyoidopexy after radiotherapy, this operation is a reliable and useful procedure for selected patients with recurrent cancer who would otherwise have been operated on and received a total laryngectomy.

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SINCE ITS DESCRIPTION BY Majer and Rieder in 1959, supracricoid partial laryngectomy (SPL) with cricohyoidopexy has demonstrated that it can provide a good surgical alternative to the conventional partial and total laryngectomy in the treatment of specific glottic and supraglottic cancers.<sup>1-4</sup> Factors against SPL with cricohyoidopexy include invasions of cricoid and arytenoid cartilage, massive invasion of the preepiglottic space, invasion of the base of the tongue, invasion of the thyroid cartilage with extralaryngeal extension, extensive subglottis carcinomas, generally poor condition, and poor bronchopulmonary function of the patient. The failure of radiotherapy is not a contraindication for this technique. On the contrary, presented with long-term functional and oncologic results achieved with SPL, several authors have proposed this surgical procedure as an alternative to radical surgery in the case of laryngeal recurrence after radiotherapy.<sup>5-8</sup> The role of SPL as a salvage surgery after radiation failure still remains un-

clear and has been met with resistance. Even if, and when, a good oncologic result is achieved, major postoperative complications and major difficulties in a functional recovery have been reported.<sup>5-8</sup> At present, several reports<sup>7,8</sup> have documented the postoperative morbidity and functional outcomes of supracricoid partial laryngectomy in the treatment of laryngeal recurrence after irradiation. In the present study, we retrospectively evaluated and compared the postoperative course and functional outcomes achieved in 2 groups of patients treated with SPL with cricohyoidopexy.

## METHODS

From September 1, 1988, through June 30, 2005, 82 consecutive patients with squamous cell carcinoma of the larynx underwent SPL with cricohyoidopexy. Eighty-one patients were male and 1 was female. Their ages ranged from 28 to 75 years, with a mean age of 58.5 years. Sixty-five patients underwent primary surgery, and 17 underwent salvage surgery to treat a recurrence of laryngeal cancer after radio-

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**Table 1. TNM Classification of 65 Untreated Patients\***

No. of Patients	T Stage	N Stage
2	T1a	N0
38	T2	N0
6	T2	N1
1	T2	N2a
3	T2	N2b
1	T2	N2c
7	T3	N0
1	T3	N2b
4	T4	N0
1	T4	N2b
1	T4	N2c

\*A total of 2 patients had T1a disease, 49 had T2 disease, 8 had T3 disease, and 6 had T4 disease.

therapy. The patients' conditions were staged according to the 2002 American Joint Committee on Cancer staging system,<sup>9</sup> as listed in **Table 1** and **Table 2**. Preoperative operations included computed tomography of the larynx and lung, ultrasonography of the neck and liver, pulmonary and cardiac function tests, and direct laryngoscopy with biopsy with the patient under general anesthesia.

The 17 patients who underwent radiotherapy with cobalt 60 were staged before radiotherapy as having T1 and T2 disease in 12 and 5 cases, respectively (Table 2). Among the patients with T1 disease, the field of treatment was a 5-cm<sup>2</sup> area, extending from the superior border of the thyroid cartilage to the lower border of the cricoid cartilage, with a total dose of 66 Gy (2 Gy/d). Among the patients with T2 disease, the field of treatment was a 10- by 8-cm area, which included neck lymphatic areas II through IV, with a dose of 46 Gy and a boost of 24 Gy on the larynx, giving a total dose of 70 Gy (2 Gy/d). The subsequent disease-free interval, with complete macroscopic remission, ranged from 8 to 193 months (mean, 48.5 months), and all the failures could be considered recurrences. At the time of recurrence, none of the patients had distant metastatic disease, and a regional node was involved in only 1 case. In all cases a temporary tracheotomy was performed between the third and the fourth tracheal rings, and a nasogastric feeding tube was inserted during the operation.

A neck dissection was performed in 56 (68%) of the 82 patients; 11 (65%) of 17 had been previously radiotreated and 45 (69%) of 65 had not. Homolateral selective neck dissection (levels II-V) was performed in 15 cases, bilateral selective neck dissection (levels II-V) was performed in 40, and 1 patient had a radical neck dissection on one side and a selective neck dissection (levels II-V) on the other.

A cephalosporin antibiotic was administered to all patients preoperatively and also postoperatively for 5 to 7 days. Routine checks of the pulmonary, cardiac, hematic, and renal function were performed during the postoperative course. We performed postoperative radiotherapy for 9 patients (11%) because of positive margins (1 case), thyroid cartilage invasion (1 case), and the existence of more than 3 positive neck nodes (7 cases).

Postoperative management of the tracheostomy and nasogastric feeding tube was as follows. The tracheal cannula was removed when respiratory function returned through natural airways. The swallowing rehabilitation was started in the 14 days after surgery, and the nasogastric feeding tube was removed when patients became able to swallow their own saliva. An evaluation of the swallowing function, performed 3 months after surgery, was done using the Pearson and Leipzig scale (0, none; 1, occasional cough, no clinical problem; 2, con-

stant cough worsening with meals or swallowing; 3, pulmonary complications).<sup>10,11</sup> When severe impairment of deglutition with pneumonia was still present 1 month after surgery, we performed percutaneous endoscopic gastrostomy.

Speech therapy was started by the end of the second postoperative week. Voice quality and overall speech intelligibility were assessed at least 3 months after surgery according to a 4-grade scale (0, nonhoarse; 1, slightly hoarse; 2, moderately hoarse; and 3, severely hoarse) and by measuring maximum phonation time, defined as the best of 3 attempts in seconds to sustain the vowel *a* at a comfortable intensity.<sup>12</sup>

Functional outcomes were evaluated in terms of postoperative morbidity, time of decannulation, swallowing recovery, and phonatory function. The postoperative morbidity was evaluated in terms of early, late, and medical complications. Mortality caused by a postoperative complication or having occurred during the first postoperative month in patients without complications was concluded as being linked to surgery.

Postoperative complications and functional recovery were considered in total and were related to the 2 groups of patients. The differences in complication rate and functional recovery among the 2 groups were compared using the  $\chi^2$  test and the Fisher exact test.<sup>13</sup> The significance level was set at  $P < .05$ .

## RESULTS

### POSTOPERATIVE MORBIDITY

Three patients (4%) who had not previously undergone radiotherapy died postoperatively because of heart failure and unknown causes. These deaths occurred on the 4th, 15th, and 30th postoperative days.

Early postoperative complications occurred in 24 patients (29%): 9 (35%) who had previously received radiotherapy and 15 (53%) who had not previously been treated, with a statistically significant difference between the 2 groups (53% vs 23%;  $P = .04$ ; **Table 3**). In 1 patient, who had cirrhosis, pneumothorax and acute thrombophlebitis of the internal jugular vein occurred postoperatively on days 1 and 8. Pneumothorax spontaneously resolved after a few days; the acute thrombophlebitis required surgical ablation of the internal jugular vein because of recurrent bleeding. Other early complications (Table 3) were resolved with adequate medical therapy and/or compressive dressing. Ankylosis of the cricoarytenoid joints, chondronecrosis, and cervical fistula were not encountered in our series.

Late postoperative complications occurred in 22 patients (27%): 4 (24%) received irradiation and 18 (28%) did not, and no statistically significant differences were found between the 2 groups (24% vs 28%;  $P = .97$ ; Table 3). An asymptomatic postoperative laryngocele discovered 1 year after surgery was successfully managed with surgical removal. Laryngeal fibrosis stenosis, which occurred in 1 patient who had not previously received radiotherapy, was resolved with surgical resection of the laryngeal scar tissue with an external approach and fashioning of a new cricohyoidopexy. Mucosal laryngeal stenosis, which occurred in 10 patients (4 who had received radiotherapy and 6 who had not) during the first postoperative year, was treated with endoscopic laser resection. Nonetheless, the respiratory space was inadequate in 2 cases (2%).

**Table 2. TNM Classification of 17 Untreated Patients\***

No. of Patients	Preradiotherapy T Stage	Radiotherapy Dose at T Stage, Gy	Radiotherapy Dose at N Stage (Levels II-IV), Gy	Disease-Free Interval, mo	Recurrence T Stage
1	T1a	66	0	14	rT1b
1	T1a	66	0	145	rT1a
1	T1a	66	0	8	rT2
1	T1a	66	0	150	rT2
1	T1a	66	0	9	rT1a
1	T1a	66	0	22	rT1a
1	T1b	66	0	193	rT1b
1	T1b	66	0	10	rT1b
1	T1b	66	0	16	rT1a
1	T1b	66	0	56	rT2N1
1	T1b	66	0	26	rT2
1	T1b	66	0	57	rT3
1	T2	70	46	8	rT2
1	T2	70	46	41	rT2
1	T2	70	46	11	rT2
1	T2	70	46	21	rT2
1	T2	70	46	24	rT2

\*A total of 6 patients had T1a disease, 6 had T1b disease, and 5 had T2 disease.

Medical complications occurred in 6 patients (7%), 2 (12%) who had received radiotherapy and 4 (6%) who had not. Again, the results were without a statistically significant difference between the 2 groups (12% vs 6%;  $P = .97$ ; Table 3).

### DECANNULATION

The tracheostomy tube was removed in 75 (91%) of 82 patients between 6 and 180 days (mean, 19.3 days) after surgery. Considering the groups of patients, those who had and had not received radiotherapy, decannulation was possible in 16 (94%) of 17 and 59 (91%) of 65 patients, respectively, after a time ranging from 6 to 65 days (mean, 21.7 days) and 6 to 180 days (mean, 18.4 days) and without a statistically significant difference between the groups (94% vs 91%;  $P = .97$ ).

Concerning the 7 patients who could not be decannulated, 2 patients died in the immediate postoperative period; in 3 patients a total laryngectomy was required because of permanent postoperative aspiration, and in 2 cases the respiratory space remained insufficient because of mucosal laryngeal stenosis despite endoscopic laser treatment.

### SWALLOWING

The mean time before removal of the nasogastric feeding tube was 15 days (range, 6-30 days). A definitive restoration of satisfactory swallowing (grade 0-1) was achieved within 3 months after surgery in 72 patients (88%): 58 (89%) of 65 had not previously undergone radiotherapy and 14 (82%) of 17 had undergone radiotherapy, with no statistically significant difference between the 2 groups (89% vs 82%;  $P = .97$ ). Of the 82 patients, 66 patients had temporarily impaired swallowing (43 with grade 2 and 23 with grade 1), 7 patients developed pneumonia from aspira-

tion that required suspension of oral intake of food and antibiotic therapy, and 6 patients required a temporary postoperative percutaneous endoscopic gastrostomy because of grade 3 postoperative aspiration still being present 1 month after surgery. Complete recovery of the swallowing function within a year occurred in 3 cases, and a total laryngectomy was required in 3 patients (previously untreated) because of remaining aspiration.

### PHONATION

Voice quality was evaluated in 75 of 82 cases in which decannulation was possible and was assessed to be grade 0, 1, 2, and 3 in 3%, 40%, 31%, and 27% of the patients, respectively. The maximum phonation time ranged from 2 to 18 seconds (mean, 7.9 seconds). In 59 previously untreated patients, the maximum phonation time ranged from 2 to 18 seconds (mean, 7.7 seconds) compared with a range of 3 to 16 seconds (mean, 8.2 seconds) in 16 patients previously radiotreated. These results were without a statistically significant difference between the groups (7.7 vs 8.2 seconds;  $P = .90$ ).

### COMMENT

The management of laryngeal recurrence after failed radiotherapy remains a controversial topic. In the case of laryngeal neoplastic recurrence, the surgical procedure aims to remove the neoplasm with a wide edge of healthy tissue. Viani et al<sup>14</sup> reported that many patients with laryngeal recurrence after failed radiotherapy had an advanced tumor by the time of the diagnosis, with almost half being transglottic T3 or T4 tumors. Therefore, total laryngectomy remains the most frequently performed salvage procedure for radiotherapy failure.<sup>14</sup> Total laryngectomy allows good oncologic results but determines

**Table 3. Postoperative Complications**

Postoperative Complications	Patients, No. (%)	
	Radiotherapy and SCPL (n = 17)	SCPL (n = 65)
Early surgical complications		
Wound infection	3	4
Partial cervical flap necrosis		3
Subcutaneous emphysema	2	2
Cervical bleeding		4
Lymphorrhea		1
Arytenoid edema	3	1
Thrombophlebitis of the internal jugular vein	1	
<b>Total (P = .04)</b>	<b>9 (53)</b>	<b>15 (23)</b>
Late surgical complications		
Laryngeal stenosis	4	7
Pneumonia from aspiration		7
Laryngocele		1
Permanent postoperative aspiration		3
<b>Total (P = .97)</b>	<b>4 (23.5)</b>	<b>18 (27.6)</b>
Medical complications		
Digestive tract hemorrhage	1	2
Cardiac infarction	1	1
Pneumothorax	0	1
<b>Total (P = .97)</b>	<b>2 (11.7)</b>	<b>4 (6.1)</b>

Abbreviation: SPL, supracricoid partial laryngectomy.

the loss of laryngeal voice and requires a definitive tracheostomy. In recent decades, partial laryngectomies had been used as a salvaging procedure to treat selected patients in whom radiotherapy failed.<sup>5-8,15,16</sup> A partial laryngectomy is an attractive method of managing recurrent laryngeal cancer because it preserves speech, avoids permanent tracheostomy, and allows normal oral alimentation. However, the successful management of laryngeal recurrence after failed radiotherapy requires the use of a strict oncologic selection criteria and is therefore used only for selected patients.

The SPL has more extensive indications compared with the other conservative surgical technique.<sup>6</sup> The breadth of the indications is justified by the fact that the lower limit of the resection corresponds to the higher border of the cricoid cartilage, whereas the higher limit is the glossoepiglottic vallecula. One arytenoid can be removed at the posterior space, and the paraglottic space can be completely removed laterally so that its involvement does not impede progress. More specifically, the SPL is indicated in cases of T1 or T2 supraglottic lesions that involve the ventricle, infrahyoid epiglottis, and false vocal cord, with or without extension to the glottis; T1b or T2 glottic lesions that involve the ventricle, false vocal cord, petiole of the epiglottis, and mucosa of arytenoid cartilage; and selected T3 transglottic carcinoma with true vocal cord fixation and/or limited preepiglottic space invasion, without invasion of the arytenoid cartilage. According to Laccourreye et al<sup>2</sup> and Brasnu,<sup>4</sup> this can also apply to selected cases of T4 supraglottic and transglottic carcinomas that invade the thyroid cartilage.

Such a wide spectrum of indications makes the SPL a useful surgical procedure in the case of radiotherapy fail-

ure. Additionally, this procedure avoids the partial resection of the thyroid cartilage, which is inevitable in other external conservative procedures, thereby eliminating the risk of perichondritis originating from the otherwise resultant cartilage residual stump. Even if adequate tumor control can show the value of SPL as a salvage surgery after radiation failure, the use of this surgical technique meets a certain resistance. This is due to the significant difference in postoperative morbidity and functional recovery among patients who did and did not undergo irradiation. In our series, results of analysis of the postoperative morbidity and functional recovery (comparing the patients who did and did not undergo radiotherapy) did not show a higher rate of radiotherapy-induced complications. The proportion of early surgical complications in patients who received radiotherapy was significantly higher than that in patients who did not receive radiotherapy (53% vs 23%;  $P = .04$ ; Table 3). In addition, most of the early postoperative complications observed in our series (wound infection, partial cervical flap necrosis, cervical bleeding, lymphorrhea, and acute thrombophlebitis of the internal jugular vein) occurred only in patients who had some type of neck dissection, which acted as a major risk factor in certain incidents.

Late postoperative complications occurred globally in 27% of the patients, without a significant difference among the groups (24% vs 28%;  $P = .97$ ; Table 3). Laryngeal stenosis, noted in 11 patients, 4 who received radiotherapy and 7 who did not, was the main late complication in our series. The stenosis was related to hypertrophic scar tissue in only 1 case, whereas in the remaining 10 cases stenosis was due to edema in the residual arytenoid mucosa. With the surgical approach, the stenosis was resolved within a year in 9 cases (1 external resection and 8 endoscopic laser treatments), whereas in the remaining 2 cases the respiratory space remained insufficient despite endoscopic laser treatment.

Medical complications in 6 (7%) of 82 cases caused the death of 2 patients in the first postoperative month. No statistically significant differences were noted between patients who had and had not received previous radiotherapy (12% vs 6%;  $P = .97$ ; Table 3).

In regard to respiration, decannulation 1 year after surgery was obtained in 91% of all patients. In comparing the 2 groups, no significant differences were found in the rate of decannulation (94% vs 91%;  $P = .97$ ). We reported a moderate delay in the mean time until decannulation (19.3 days) compared with literature data relative to major studies.<sup>17</sup> The delay in the decannulation time may be connected to a rehabilitation procedure that we used in the first years of our experience, this procedure being the tendency to remove the tracheal cannula only once complete recovery of swallowing was achieved. Whenever possible, we now perform an early removal of the tracheal cannula to permit a greater physiological range of the pharyngeal-laryngeal axis during swallowing.

Swallowing impairment is the main functional problem of the SPL with cricohyoidopexy, since the glottic sphincter has been totally removed. Also, the contemporary dissection of the superior laryngeal nerve, which is necessary for sensitive innervation of the supraglottic larynx, could cause weakness of sensitive power and a reduction



in the defense reflex. In our series, some impairment of swallowing was present in all cases at the start of rehabilitation for varying times. A temporary grade 1 or 2 aspiration was noted postoperatively in 80% of patients. A definitive restoration of satisfactory swallowing (grades 0-1) was achieved within 3 months after surgery in 72 patients (88%): 58 (89%) who did not previously receive radiotherapy and 14 (82%) who did and with no statistically significant difference between the groups (89% vs 82%;  $P=.97$ ). Pneumonia from aspiration occurred in 8% of the patients, with a rate of incidence similar to that previously documented.<sup>17</sup> To guarantee sufficient nutritional supply owing to the marked difficulty of feeding through the normal digestive tract, it was necessary to construct a percutaneous endoscopic gastrostomy in 6 cases, 1 month after surgery. Functional recovery in 3 cases was made possible by rehabilitation therapy, and in the remaining 3, with the agreement of the patients, it was decided to perform a total laryngectomy (almost 1 year after the original surgery).

Regarding speech, voice quality was valued in 75 cases in which decannulation was possible. The maximum duration with which the vowel *a* was sustained was significantly shorter in patients in our series than in healthy adult laryngeal speakers (a mean of 7.9 seconds compared with 16 seconds), but no appreciable differences were observed in SPL speakers treated before as opposed to after radiation failure (7.7 vs 8.2 seconds;  $P=.90$ ). This reduced maximum phonation time reflects a lesser resistance to the air passage of the neoglottis. It never reaches a complete closure, thereby resulting in air loss during phonation. This altered phonic dynamic also explains the variable degree of hoarseness inevitably present in most of the cases evaluated in our series (97%). Satisfactory voice intelligibility was achieved in all cases.

In conclusion, SPL with cricohyoidopexy is a good, useful treatment either for T2 to T3 primary laryngeal cancer or in strictly selected cases of recurrence after radiation therapy. When a tumor recurs, it is more likely to extend beyond its original site, making total laryngectomy necessary in most cases. However, we have reported that in selected cases, SPL with cricohyoidopexy can be used with good functional results and an acceptable level of postoperative complications. The delay in recovery of the swallowing and respiratory function did not affect the final result. On the basis of the oncologic and functional results, the performance of SPL as a salvage surgery for radiation failure should be viewed as a selective application of a treatment modality that maximizes preservation of function while at the same time achieves a local control and survival rate that would be obtained with salvage total laryngectomy. Finally, we observe that in our series and in the literature, the functional outcomes for swallowing and speech are still lacking objective parameters of evaluation. We believe that every effort has to be made to make uniform the format for outcome presentation, particularly in regard to swal-

lowing and voice, to properly analyze and compare the literature data.

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