Partial Laryngectomy to Treat Early Glottic Cancer After Failure of Radiation Therapy

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Objective: To evaluate the role of partial laryngectomy to treat glottic cancer after failure of radiation therapy.

Design: A 12-year retrospective outcome analysis.

Setting: University referral center.

Patients: A total of 19 patients who underwent partial laryngectomy to treat glottic cancer after failure of radiation therapy.

Results: The follow-up period in this group ranged from 31 to 144 months. After surgery, a laryngocutaneous fistula was observed in 4 cases, and flap necrosis occurred in 2, but these complications were successfully managed. Maximum phonation time after surgery ranged from 3 to 28 seconds (median phonation time, 10.2 seconds). Of these 19 patients, 3 developed local recurrence. These cases were successfully treated with total laryngectomy. A surgical margin of less than 1 mm was found to be a significant risk factor for local recurrence after partial laryngectomy.

Conclusions: These results indicate that partial laryngectomy is a useful option for the treatment of irradiation failure in the treatment of stage I and stage II vocal cord carcinomas. However, careful follow-up is mandatory for patients with a small surgical margin.


The Treatment of T1 and T2 squamous cell carcinoma of the glottis is controversial because early vocal cord cancers can be effectively treated with either surgery or radiotherapy. In Japan, voice quality after radiation is clearly superior to that after any type of surgical resection, so irradiation remains the most common treatment option. The rate of recurrence following irradiation ranges from 6% to 41%. Surgery is often reserved as a salvage option for patients with early glottic cancer in whom the cancer recurs after radiation. While total laryngectomy is usually used to treat recurrent tumors, in selected cases conservation surgery with preservation of a portion of the larynx is feasible. This study reviews the functional results, complications, larynx conservation rates, and survival rates of patients who underwent conservation surgery for squamous cell carcinoma of the larynx as a salvage procedure for recurrent tumors resistant to radiotherapy.

There was no postoperative mortality among the 19 patients of this study. All patients received a tracheostomy during the operative procedure. The time from operation to the closure of the tracheostoma and the thyrostome ranged from 14 to 80 days. All patients were able to swallow without aspiration within 9 to 29 days after the operation (median, 17 days). Aspiration pneumonia did not occur in any patient. A laryngocutaneous fistula was observed in 4 cases and partial flap necrosis occurred in 2 cases, but all of these complications were successfully managed without surgical closure. Of these 19 patients, 3 (16%) developed local recurrence (2 rT1 and 1 rT2 at the time of postirradiation recurrences). These patients ultimately underwent successful total laryngectomy. In these 3 patients only, the surgical margin was less than 1 mm (Table 2). Such small surgical margins were a significant risk factor for local recurrence (P<.01). Analysis of other factors did not reveal significant differences between local failure and local control groups; these factors included T classification, disease-free interval, dose of radiation at the initial treatment, involvement of the vocal process, involvement of the vocal muscle, and invasion of the contralateral vocal cord (Table 2). Cartilage...
MATERIALS AND METHODS

Between January 1989 and December 1998, 91 patients with previously untreated T1 and T2 invasive squamous cell carcinoma of the glottis were treated with radiotherapy with curative intent at the Department of Otolaryngology, the University of Tokyo Hospital, Tokyo, Japan. Local recurrence developed in 32 (35%) of 91 patients (Table 1). The local recurrence rates within T classifications were 12 (30%) of 40 in T1, and 20 (39%) of 51 in T2. All 32 patients subsequently underwent salvage surgery, including 19 patients who had a partial laryngectomy.

This article will document the clinical course of the 19 patients who underwent partial laryngectomy. Clinical data were obtained from patient medical records. Pathology reports were reviewed for the assessment of the results of the histologic examination of the larynx. The follow-up period ranged from 31 to 144 months. All patients were men, with an average age of 62 years (age range, 49-72 years). The total dose of radiotherapy ranged from 6000 to 7000 rad (60 to 70 Gy) (median dose, 6300 rad [63 Gy]). The disease-free interval after radiotherapy ranged from 1 to 67 months (median interval, 21 months). Nine patients had T1 tumors and 10 patients had T2 at the initial treatment according to the International Union Against Cancer criteria.13 In 2 cases, the recurrent tumor extended beyond its original site. At the time of postirradiation recurrences, 13 cases were staged as recurrent (r) T1, 5 as rT2, and 1 as rT3. Computed tomographic scans were done for every patient before partial laryngectomy. Cartilage invasion was not detected in any patient. Squamous cell carcinoma was diagnosed in all cases both at the initial treatment and at the diagnosis of recurrence.

A total of 19 patients who had a partial laryngectomy met the criteria set by Biller et al14 for partial laryngectomy. Our criteria included the following: (1) the thyroid cartilage should not be invaded; (2) the arytenoid, except for the vocal process, should be free of tumor; (3) the supraglottic extension should extend no further than the lateral extension of the sinus of Morgagni; and (4) the recurrence should correlate with the primary tumor previously treated with radiotherapy. We performed a frontolateral laryngectomy in 4 patients, an extended frontolateral laryngectomy in 13 patients, and a hemilaryngectomy in 2 patients. Frontolateral laryngectomy consisted of removal of the frontototal part of the ala of the thyroid cartilage with the anterior commissure and the ipsilateral vocal cord, including the paraglottic lesions. Additional excision of part of the opposite vocal cord was performed according to the extent of the tumor. In the extended frontolateral laryngectomy, part or all of the arytenoids was removed in addition to that described for the frontolateral laryngectomy. Fourteen patients had a 1-stage surgery and 5 underwent a 2-stage operation.15 Following the partial laryngectomy, the larynx was reconstructed using a cervical skin flap13 in 4 patients and a combination of cervical skin flap and sternohyoid muscular flap16 in 15 patients. The maximum phonation time (MPT)12,17 after the partial laryngectomy was measured in 13 patients at least 6 months after surgery. Patients were asked to phonate a sustained vowel sound (“a”) at a comfortable pitch and intensity level for as long as they could.

The Kaplan-Meier method18 was used to calculate larynx conservation rates. Several prognostic factors for local control were examined using the Fisher exact test.

### Table 1. Local Recurrence After Radiotherapy and Results of Salvage Surgery

<table>
<thead>
<tr>
<th>Cancer Stage</th>
<th>Local Recurrence After Radiotherapy</th>
<th>Carbon Dioxide Laser</th>
<th>Partial Laryngectomy</th>
<th>Total Laryngectomy</th>
<th>Surgically Salvaged and Voice Conserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a (n = 25)</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>T1b (n = 15)</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>T2 (n = 51)</td>
<td>20</td>
<td>1</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total (N = 91)</td>
<td>32</td>
<td>2</td>
<td>18</td>
<td>11</td>
<td>18</td>
</tr>
</tbody>
</table>

Cervical lymph node metastasis occurred in 3 patients. One was diagnosed as having recurrence after radiotherapy and underwent a modified radical neck dissection simultaneously at the time of salvage surgery, and the others were diagnosed during the follow-up period after the salvage surgery and were successfully treated with radical neck dissection. No patients died during the observation periods.

The overall 5-year larynx conservation rates of T1 and T2 squamous cell carcinoma of the glottis were as follows: T1a, 90%; T1b, 93%; and T2, 72% (Figure 1). Of 32 patients with irradiation failure for carcinoma of the glottis, laryngeal function was preserved in 18 (56%): 2 by carbon dioxide laser microsurgery and 16 by partial laryngectomy.

The MPT was measured in 13 patients. In all cases, the MPT was measured at least 6 months after the operation and ranged from 3 to 28 seconds (median MPT, 10.2 seconds). The MPT did not correlate either with T classification or surgical procedures (Figure 2).

**COMMENT**

Treatment of irradiation-resistant T1 and T2 glottic carcinoma with conservation surgery was first described in 1951.19 Since then, many reports about the efficacy of vertical partial laryngectomy against recurrent disease after radiotherapy have been published.1-11 These studies con-
firm that a good cure rate and conservation of function can result from vertical partial laryngectomies that are performed to treat recurrent glottic carcinoma. Biller et al.\textsuperscript{14} proposed several contraindications for partial laryngectomy after radiotherapy: (1) vocal cord immobility; (2) extension of the tumor to the contralateral vocal cord or subglottic lesion; and (3) extension of the tumor beyond its original site. In our study, 7 patients exhibited at least 1 of these contraindications. However, local recurrence after salvage surgery was observed in only 1 patient whose recurrent tumor after radiotherapy extended to the subglottic lesion. Encouraged by the results of the present study and reports by Lavey and Calcatera,\textsuperscript{3} we suggest expanding the criteria for salvage partial laryngectomy as follows: A patient with persistent or locally recurrent glottic cancer should be considered for a partial laryngectomy unless the tumor invades (1) the arytenoid cartilage except vocal processes, (2) beyond the anterior half of the contralateral vocal cord, (3) subglottically more than 10 mm in the anterior half or 5 mm in the posterior half of the larynx, or (4) into the thyroid or cricoid cartilage.

Prior to the performance of a partial laryngectomy, we routinely performed thin-sliced computed tomographic scans of the neck to determine whether the tumor extended into subglottic, paraglottic, preepiglottic, or supraglottic spaces. In addition, we performed preoperative microlaryngoscopic examination under general anesthesia to study the precise extension of tumor. All anatomic sites containing tumor either before or after radiotherapy were included in the partial laryngectomy specimen. With these efforts, we believe that a partial laryngectomy can be performed for the salvage surgery of a T3 tumor causing vocal cord fixation, as long as the tumor is confined to the paraglottic region and meets the 4 proposed criteria.

In this study, the frequency of local recurrence after the salvage operation did not significantly correlate with the involvement of the vocal process and vocal muscles. On the other hand, patients with a small surgical margin had a significantly higher recurrence rate than those with surgical margins of 1 mm or more, which agrees with findings reported by Shah et al.\textsuperscript{20} These results suggest that an intraoperative examination to determine the surgical margin is essential to the decision-making process.\textsuperscript{20} Fortunately, all 3 patients with local recurrence after partial laryngectomy underwent successful total laryngectomy. Thus, careful follow-up after conservation surgery for radiation failure is essential to detect local recurrence and enable successful salvage by total laryngectomy.\textsuperscript{21}

Although a number of authors have reported an increased incidence of infectious and healing complications in patients who underwent frontolateral laryngectomy for salvage of radiation failures,\textsuperscript{22-25} our incidence of fistula formation was similar to those of partial laryngectomy performed at the initial treatment.\textsuperscript{9,10} In most cases, we reconstructed the larynx using a combination of regional skin flap\textsuperscript{15} and the sternohyoid muscles\textsuperscript{16} to...
cover the thyroid cartilage and to avoid occurrence of dead space in the wound. This method of reconstruction may be favorable for reconstruction after partial laryngectomy in patients who have undergone radiotherapy. In addition, we performed a 2-stage operation to avoid fistula formation by resecting a large area of the larynx. This method seemed to decrease complications. The indications, effectiveness, and complications of salvage partial laryngectomy after radiation failure are very similar to those of partial laryngectomy performed at the initial treatment.8,10,11 Thus, primary radiotherapy may be prescribed for early glottic cancers without concern that it precludes the future use of larynx-conserving surgery.

The MPT after frontolateral laryngectomy ranged from 3 to 28 seconds, with an average of 10.2 seconds. Of course, these values were slightly lower than those obtained preoperatively (14 seconds), but similar to those obtained after partial laryngectomy (9.4-11 seconds).3,12,17 Although the number of patients in this study was limited, we did not find a correlation between MPT and T classification or surgical procedures. Interestingly, some patients with T2 tumors kept good phonatory function, despite having a large area of the larynx resected. This conservation of phonation may result from the bulk of the skin flap for augmentation.

In summary, laryngeal function was preserved in 18 (56%) of 32 patients who received salvage laser microsurgery or partial laryngectomy to treat glottic carcinoma after irradiation failure. We believe that precise evaluation of each case, including preoperative computed tomography studies, microlaryngoscopic examination, intraoperative examination to determine surgical margin, and close follow-up to detect the recurrence in the early stages, is essential to successfully treat glottic carcinoma after irradiation failure and also to preserve laryngeal function.

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