Near Total Laryngectomy: A Versatile Approach for Voice Restoration in Advanced T3 and T4 Laryngeal Cancer: Functional Results and Survival

SHERIF I. MAAMOUN, M.D.; GAMAL AMIRA, M.D. and ALLA YOUNIS, M.D.
The Department of Surgical Oncology, National Cancer Institute, Cairo University.

ABSTRACT

Purpose: Creation of a tunneled mucosal shunt between the trachea and pharynx that is controlled by remaining intrinsic laryngeal musculature with its nerve supply is an acceptable voice restoration procedure for advanced T3 and T4 laryngeal cancer. Such a tunnel will allow unilateral direction of air from lung to pharynx during phonation and will prevent aspiration since deglutition is a vagal mediated response which will induce contraction of tubed laryngeal musculature preventing aspiration. We previously reported our preliminary experience with the technique and we adopted the voice restoration approach based on the concept of the near total laryngectomy thereafter.

Methods: Forty five patients with histologically proven squamous cell carcinoma of the larynx were included in this study (between January 1998 and February 2001). They were 42 males and 3 females with a mean age of 52.6 years. Criteria for selection were a normal vocal process and arytenoid cartilage on the opposite side of the lesion as evidenced by endoscopy and CT scan with no major subglottic extension. In two patients supraglottic laryngectomy was carried out and in four other patients, complete tumor extirpation necessitated total laryngectomy. Accordingly, near total laryngectomy was carried out in the remaining 39 patients. Following a near total laryngectomy, where all laryngeal mucosa and cartilages are resected sparing the contralateral arytenoid cartilage with the overlying mucosa and surrounding musculature, the shunt was created by tubing the remaining mucosa with augmentation by pyriform sinus mucosa if necessary. The resulting tube was fashioned over 14 FG catheter for diameter control only and the remaining muscles were sutured over the tube. A permanent tracheostomy was established. Voice training was started postoperatively following resumption of oral feeding.

Results: Only one patient died in the immediate postoperative period due to massive myocardial infarction. One patient developed reactionary hemorrhage that was explored and controlled. Minor salivary fistula developed in nine patients (23.1%) and all were managed conservatively, none required intervention. Two patients (7.6%) had a retracted tracheostomy that required refashioning. Thirteen patients (33.3%) suffered transient aspiration that resolved spontaneously, none required intervention. Six patients developed recurrent disease (15.8%). The overall two year disease free survival was 76%. None of the cases developed laryngeal mucosal recurrences. Intelligible speech was achieved in 31 patients (81.6%). In the seven patients with shunt failure, insertion of a one way valve was successful in five patients in restoring a good quality voice.

Conclusion: Near total laryngectomy is an oncologically safe procedure with acceptable complications that are well tolerated. It represents an ideal solution for patients with advanced T3 and T4 laryngeal cancer. Voice quality is very good and it does not require further management as is the case with prosthetic voice shunt valves.

Key Words: Laryngeal cancer - Near total laryngectomy.

INTRODUCTION

Laryngeal cancer continues to be a favorably prognostic disease with two year survival figures of 60-70% in advanced disease stages (T3 and T4) following total laryngectomy [1]. Quality of life, namely voice restoration, becomes the major issue in these patients [2]. Tracheoesophageal puncture with the insertion of a one way valve (TE puncture) had been widely practiced as an acceptable voice restoration procedure following total laryngectomy. Although the technique is easy and speech results are satisfactory, several problems had been reported. Valve maintenance and cleaning, cost of the valve, valve loss and blockage were among the major concerns [3]. This results in discontinued use of the valve by most patients and the reported incidence of valve rejection is in the range of 60-80% particularly after the second year
Several voice restoration procedures had been attempted ever since the first laryngectomy was performed more than a century ago [6]. The success of a voice restoration procedure must be tested against the following three criteria: oncologic safety, avoidance of aspiration and production of intelligible speech. Introduction of the near total laryngectomy (NTL) by Pearson et al. [7] provided a natural one way valve and several reports had been published attesting to the safety of the procedure. We previously reported our preliminary experience with the technique [8] and we have adopted the voice restoration approach for all patients with advanced laryngeal cancer that presented to our department. The following is a report of our final results with NTL as regards oncologic safety, complications of the procedure and voice production.

**PATIENTS AND METHODS**

Forty five patients with laryngeal cancer were included in the study period, between January 1998 and February 2001. There were 42 males and three females. Criteria for patient selection included those with biopsy proven squamous cell carcinoma of the larynx with either T3 or T4 stage and a single uninvolved aryttenoid cartilage as evidenced by direct laryngoscopy and CT scan of the neck. This included patients with T3 and T4 supraglottic, glottic and transglottic lesions. Patient's ability to climb stairs (two floors) was used as a rough index for tolerance to the procedure, since transient aspiration in the postoperative period is a common sequel after the procedure. Pulmonary functional tests were performed only in marginal cases (history of previous chest disease, chronic obstructive pulmonary disease, age over seventy years). The final choice of the surgical procedure was decided intraoperatively because despite the extensive preoperative assessment, in certain occasions, operative findings will dictate either a lesser (supraglottic or vertical hemilaryngectomy) procedure or a total laryngectomy and TE puncture. In two patients supraglottic laryngectomy was carried out and in four other patients complete tumor ablation necessitated a total laryngectomy with insertion of a valve. Those patients were not included in our results but they were mentioned here to demonstrate the flexibility of the procedure and reinforce the need for patient's consent prior to the procedure. Accordingly, NTL was carried out in thirty nine patients. The mean age was 52.6 years (range: 40-77). The technique has been described in detail elsewhere and was previously reported by our group [7,8]. The essential steps of the procedure are demonstrated in Figs. (1-6). All patients were subjected to a voice restoration approach where the larynx was entered through the uninvolved ventricle. In general, after completion of neck dissection according to the nodal stage of the disease, the larynx on the side of the tumor was mobilized as in total laryngectomy with devascularization of the larynx and division of the thyroid gland. The recurrent laryngeal nerve with its node bearing tissue was divided on the tumor side and included with the specimen together with the pre laryngeal muscles. Attention was then directed to the apparent uninvolved hemilarynx where the sternothyroid muscle was detached from its attachment to the thyroid cartilage and was reflected downwards bearing the ala of the thyroid cartilage and was exposed downwards bearing the ala of the thyroid cartilage and exposing the part of the thyroid gland that was going to be preserved which was also reflected laterally exposing the cricothyroid muscle. Care should be experienced here to avoid injury to the recurrent laryngeal nerve which is essential for the voice shunt function. At this stage, the presence of edema of the paralaryngeal spaces or enlarged recurrent laryngeal lymph nodes were a contraindication of the procedure. A wedge of the ala of the thyroid cartilage was next excised with care to avoid violating the paraglottic space. This step exposed the ventricle on the contralateral side of the larynx which represented the point of entrance into the endolarynx. Although this step is somewhat tedious and requires meticulous dissection and hemostasis, yet it provides the surgeon with the ability to conform the procedure to be supraglottic, vertical hemilaryngectomy or NTL according to the tumor extent. Hook retractors were placed inside the larynx and the window was gradually enlarged until a clear view of the tumor and the other endolaryngeal structures was obtained. Once the eligibility of the procedure was ascertained, tumor extirpation proceeded under direct vision by extending the resection first superiorly through the vallecula on the healthy side and then extending the dissection horizontally removing the epiglottis and preepiglottic space and then downwards on the tumor side with the extent of mucosal excision being dictated by the tumor.
extent. With the larynx attached only inferiorly, attention was directed toward creation of the tracheostome which was placed through a separate skin incision between the third and fourth tracheal rings and anaesthetic ventilation was switched over newly formed stoma. Now with the pharynx opened, a finger was introduced in the region of the hypopharynx to place the tissues of the cricoid and the interarytenoid regions under stretch. A scissor cut was next

Fig. (1): The larynx is completely mobilized.

Fig. (2): Opening of the larynx by division of a wedge of the thyroid cartilage.

Fig. (3): The larynx has been divided into tumor bearing part and voice part.

Fig. (4): Final part of the procedure with incision of the interarytenoid mucosa.

Fig. (5): The specimen has been removed with piece meal excision of the cricoid cartilage in preparation of shunt creation.

Fig. (6): Creation of the voice shunt by tubing of mucosa.
carried out downwards from the site of the previous ventricular opening removing as much mucosa as necessary across the true cord and slanting through the upper tracheal rings in a way that encompassed that tumor with clear subglottic margins and meanwhile permitted tubing of the tracheal dome. The specimen by then was left hanging by the stretched interarytenoid region and mucosa over the cricoid cartilage which was incised exposing the interarytenoid muscle. A separate mucosal margin was incised and sent for frozen section examination while the specimen was finally removed. Subperichondrial resection of the cricoid cartilage was next carried out. The extent of this excision was just to permit tubing of the remaining trachea. The finally remaining mucosa overlying the arytenoid cartilage was then rolled over to create the voice shunt. Shunt diameter was controlled by the use of a number 12 or 14 FG catheter which was removed at the end of the procedure as it was just being used as a template to control the shunt diameter avoiding too big or too small conduit. Extra mucosa could be imported by the use of an ipsilateral pyriform sinus rotational flap. Tubing was done using 3/0 absorbable sutures avoiding the mucosa so that no sutures or knots were placed inside the shunt. Finally the remaining interarytenoid muscle was rolled over the shunt which was further covered by the remnants of the strap muscles. In order to demonstrate the dynamic function of the shunt, intra-operative testing with a nerve stimulator was carried out. The pharynx was then closed in the usual fashion and a nasogastric feeding tube was introduced. Postoperatively, patients were maintained on tube feeding until healing of the pharynx took place. Speech training sessions were started after resumption of oral feeding. Full speech development was achieved after an average of 2-5 sessions each consisting of 10 to 15 minutes. Videofluoroscopy was carried out after establishment of reasonable voice to test the shunt by looking for the vibrating segment during voice production and to exclude the presence of minor aspiration that would not be detected clinically. Our indications for postoperative radiation therapy included those with T4 lesion or positive cervical lymph nodes. All patients were followed up by flexible endoscopy every three months during the first year and biannually thereafter. Special tests were symptom directed. The average follow up period was 24 months (range 12-36) with the least follow-up of 12 months. Survival figures were calculated using the log rank statistical test.

RESULTS

A voice restoration approach was used in 45 patients with laryngeal cancer in the study period from June 1996 to February 2001. In six patients a different procedure had to be carried out due to operative findings: supraglottic laryngectomy in two patients and total laryngectomy in four patients. They were not included in the final analysis. Accordingly, thirty eight males and one female with laryngeal cancer were available for evaluation. Tumor characteristics and lymph node status are shown in Table (1).

Table (1): Tumor site and lymph node status.

<table>
<thead>
<tr>
<th>Tumor site:</th>
<th>Number of patients</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Supra-glottic</td>
<td>15</td>
<td>38.5</td>
</tr>
<tr>
<td>Glottic</td>
<td>7</td>
<td>17.9</td>
</tr>
<tr>
<td>Transglottic</td>
<td>17</td>
<td>43.6</td>
</tr>
<tr>
<td>Tumor stage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>28</td>
<td>71.8</td>
</tr>
<tr>
<td>T4</td>
<td>11</td>
<td>28.2</td>
</tr>
<tr>
<td>Lymph node status (pathological):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>12</td>
<td>30.8</td>
</tr>
<tr>
<td>Bilateral</td>
<td>3</td>
<td>7.6</td>
</tr>
</tbody>
</table>

The average operation time was 2.5 hours with an estimated blood loss in the range of 200 ml; none of the patients required blood transfusion. Eighteen patients received postoperative radiation therapy either due to T stage (11 patients) or the presence of positive cervical nodes (7 patients). One patient died in the immediate postoperative period which was not directly related to the procedure. This was a 77-year-old hypertensive male who developed a massive myocardial infarction on postoperative day six. He died two days later. Complications were detected in 15 patients (38.5%) as shown in Table (2).

Table (2): Post-operative complications.

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. (%)</th>
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</thead>
<tbody>
<tr>
<td>Pharyngeal fistula</td>
<td>9 (23.1%)</td>
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<tr>
<td>Retracted tracheostomy</td>
<td>3 (7.6%)</td>
</tr>
<tr>
<td>Reactionary hemorrhage</td>
<td>1 (2.6%)</td>
</tr>
<tr>
<td>Wound infection</td>
<td>2 (5.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>15 (38.5%)</td>
</tr>
</tbody>
</table>
One patient suffered reactionary hemorrhage few hours after surgery. The neck was immediately explored and a bleeding lingual artery was detected and ligated; further course was uneventful. Nine patients (23.1%) developed salivary fistula which was minor (less than 100ml) and closed spontaneously under conservative measures without surgical intervention and without prolongation of hospital stay. Two patients (7.6%) had a retracted tracheostoma following suture removal. Both patients underwent refashioning of the stoma. Erythema and wound infection were detected in two patients and all healed well with frequent dressings and antibiotics.

Aspiration: Thirteen patients (33.3%) developed transient aspiration through the shunt which was mild, intermittent and manifested by occasional dropping into the trachea. Those patients were kept under close monitoring and were instructed to consume semisolid food and to apply firm pressure over the lower neck during swallowing. They all closed spontaneously over varying periods of time from 2-12 months, none required intervention. Frequent chest X-rays were obtained until the aspiration stopped completely.

Speech: Articulated intelligible speech was obtainable in thirty one patients out of the thirty eight patients (81.6%). The average time for proper speech development was 7-8 days. The high success rate observed here was largely attributable to patient’s motivation as most of them could not read or write and fear of withdrawal from society was the major driving force. In the seven patients where voice could not be achieved, the insertion of a Blom Singer valve in the mucosal shunt was attempted with success in five patients. In the last two patients, valve insertion was not possible due to complete shunt occlusion.

Survival: The overall recurrence rate was 15.8% (six patients out of thirty eight). Two patients died within the first year due to disease progression while one patient developed massive cervical recurrence 7 months following completion of therapy. He underwent total pharyngectomy and gastric pull-up but he died in the immediate post-operative period from severe chest infection. The second patient developed CT evidenced bilateral pulmonary deposits 9 months after surgery. One patient developed soft tissue recurrence in the neck which was inoperable on exploration. Three patients suffered cervical nodal recurrence. The overall two year disease free survival for the group was 76%.

DISCUSSION

Voice rehabilitation is a prime concern in the management of patients with advanced laryngeal cancer. Although esophageal speech will produce the most natural voice following laryngectomy, it is achievable in only 40% of patients [9]. The dual functions of the larynx include providing a controlled jet of air (pitch) that will pass into the pharynx and eventually through the mouth while on the other hand, during deglutition, the larynx provides an essential protective mechanism to prevent aspiration. This mechanism, brought up by the intrinsic laryngeal muscles, is a vagal mediated reflex which will provide tight closure of the vocal folds [6]. Early attempts at voice restoration following total laryngectomy were based on the principle of directing pulmonary air into the pharynx by inserting a metallic tube extending from a pharyngeal fistula with its other end connected to the tracheostomy tube. Several modifications of the technique were later introduced with the intent of creating an internal tracheo-esophageal fistula. All these techniques suffered the same principle complications; although good intelligible speech was produced, yet aspiration and stenosis were so common and ultimately led to intervention and sacrifice of the fistula [6]. The delicate balance of laryngeal function during phonation and deglutition explained the failure encountered by the early procedures as they were primarily addressing only one function namely directing the pulmonary air into the pharynx while ignoring the protective mechanism incurred by the larynx to prevent aspiration [5]. Pearson et al. [10], described a technique to use the remaining laryngeal mucosa in creating a neoglottis which will preserve voice but not nasal breathing. The technique has been known as Near Total Laryngectomy. In a broad definition, it is a biologic voice created independent of a prosthesis and yet driven by pulmonary air. It makes use of the remaining laryngeal mucosa overlying an uninvolved arytenoid cartilage together with remnants of the true and false cord and intact
The recurrent laryngeal nerve to fashion the shunt. Such a shunt will act as a neoglottis driving air into the pharynx for phonation, while during deglutition it closes by contraction of the vagally innervated remaining intrinsic musculature at the shunt wall. During phonation, the patient will occlude the stoma with his finger thus directing pulmonary air through the newly created shunt into the pharynx, while during deglutition, the shunt will close by virtue of the remaining intrinsic muscles to prevent aspiration.

The NTL fulfills the three essential criteria of a voice preserving procedure. It is oncologically safe. Preservation of a mucosal strip in the NTL does not endanger the radical tumor resection since it has long been known that total laryngectomy is carried out principally to avoid aspiration and not due to oncologic reasons [6,11]. The reported survival figures in the different series are in the range of 60-70% which matches those following total laryngectomy [12-14]. We did not encounter any incident of shunt recurrence in our series with least follow up of 12 months. The exact incidence of shunt recurrence in the different series is somewhat controversial. It varies from 2% to 8% but careful analysis of these reports showed that some of the recurrences described were in fact due to a second primary with a time lag greater than six years following surgery and in other reports the figure includes incidences where NTL was used as a salvage procedure following radiation failure for early stage cancers [10,15,16]. In the report by Pearson et al. [17], radiation failure should be considered a relative contraindication to NTL since, in addition to the poor survival results, radiation could impair the function of the intrinsic laryngeal muscles during the shunt creation. On the other hand, postoperative radiation had no effect on shunt function and patients will maintain their speech during treatment course [14]. Of the eighteen patients who received radiation therapy in our group, there were no functional complications. The second major issue tested in our report was the incidence of aspiration. The NTL is a dynamic rather than a static shunt and it utilizes a minimal strip of mucosa attached to the vocal process of one arytenoid cartilage. Such mucosa is crucial in the initiation of the reflex closure of the shunt during deglutition [18,19]. There had been several arguments to the dynamic nature of the shunt as some authors attributed its protective nature to its adequate size (length and width) [20,21]. In our report, the function of the shunt could be demonstrated intra-operatively by the use of a nerve stimulator. This step is also crucial in predicting patient’s response to post-operative aspiration since aspiration in a static shunt will never heal and a revision surgery or shunt excision becomes important to save the patient’s life. Furthermore, the dynamic nature of the shunt could also be demonstrated postoperatively by endoscopy showing a tight mucosal hood rather than a flaccid mucosal fold and during swallowing it moves upwards against the base of tongue [22]. Thirteen patients in our group developed transient aspiration, however, none required further intervention. The generally accepted figure for major aspiration is in the range of 9-15% and although several procedures have been described to preserve the shunt, results had been poor [23]. On the other hand, insertion of a voice valve through the shunt was a reasonable solution in our group (five patients).

Eighty five percent of our patients achieved a good satisfactory speech by the third postoperative week. Voice production following NTL could be demonstrated as early as the second postoperative day. However, active speech therapy should be started on the second week for complete healing to take place [24]. Quality of voice is acceptable in over 80% of patients. Failure to speak following NTL is attributed to shunt stenosis and transient loss of voice could be experienced during radiation therapy due to mucosal edema. It is usually reversible and will return following completion of therapy [25,26].

The overall complications of the NTL are similar to those reported after total laryngectomy and are well tolerated [27].

In conclusion, adopting a voice restoration approach, through an uninvolved ventricle or vallecula is a versatile approach that will help the surgeon choose the best voice restoration procedure for the patient [20,29]. The NTL is a dynamic shunt that functions in a manner similar to that of the natural larynx. It is oncologically safe and is suitable for most patients with advanced laryngeal cancer. Complications are minimal and well tolerated.
REFERENCES


