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The techniques of nonmuscular closure of hypopharyngeal defect following total laryngectomy: the assessment of complication and pharyngoesophageal segment

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Abstract

The usual method of reconstructing a hypopharyngeal defect during total laryngectomy includes pharyngeal muscle layer closure, which may result in high pharyngoesophageal pressure. We hypothesize that nonclosure of the pharyngeal muscle can reduce the pressure of the pharyngoesophageal segment which can reduce the chances of the formation of pharyngocutaneous fistulae. A technique of nonmuscular closure of a hypopharyngeal defect is presented. The differences in the rate of fistula formation and swallowing function between patients with usual and nonmuscular closure were also studied. Sixty consecutive laryngectomees were enrolled in this study. Thirty patients received usual closure after total laryngectomy, whereas the other 30 patients underwent non closure of their pharyngeal muscles. One patient (3.3 per cent) in the nonmuscular closure group and three patients (10 per cent) in the usual closure group developed a pharyngocutaneous fistula. The pharyngoesophageal pressures of the nonmuscular closure group were significantly lower than those of the usual closure group. We conclude that the technique of nonclosure of the pharyngeal constrictor muscle after total laryngectomy is relatively more simple and is not associated with a higher rate of fistula formation. Furthermore, nonclosure of the pharyngeal constrictor muscle is preferable to muscular closure because it reduces the spasm of the pharyngoesophageal segment which limits voice rehabilitation.

Key words: Laryngeal neoplasms; Surgery, operative; Pharyngeal muscles; Fistula

Introduction

Pharyngocutaneous fistula formation is a major complication after total laryngectomy. The predisposing factors implicated in the fistula formation include a low post-operative haemoglobin level, pre-operative tracheostomy, and simultaneous radical neck dissection in combination with pre-operative radiotherapy (Lavelle and Maw, 1972). In addition, McConnel (1988) used manofluorography to reveal higher pharyngeal pressure in patients with a total laryngectomy than in normal controls. He also suggested that the higher pharyngoesophageal pressure in the laryngectomees might explain the high incidence of post-laryngectomy fistulae when compared with procedures elsewhere in the digestive tract (McConnel and Logemann, 1990).

The relationship between voice rehabilitation after total laryngectomy, anatomy and the pharyngoesophageal pressure has been also documented. Failure of oesophageal or tracheoesophageal voice acquisition is commonly attributed to the spasm of the pharyngoesophageal segment (Baugh *et al.*, 1990). Several procedures to reduce the pressure in the pharyngoesophageal segment have been proposed, including pharyngeal constrictor myotomy (Singer and Blom, 1981; Henley and Souliere, 1986; Horowitz and Sasaki, 1993) and pharyngeal plexus neurectomy (Singer *et al.*, 1986).

During total laryngectomy, the usual method of reconstructing the hypopharyngeal defect is a three-layer closure; mucosa, submucosal soft tissue and pharyngeal constrictor muscles are each closed in a separate layer for reinforcement of and stronger hypopharyngeal sutures; however, the method may result in high pharyngoesophageal pressure. Olson and Callaway (1990) and Clevens *et al.* (1993) have successfully demonstrated the two-layer nonmuscular closure technique which leaves the pharyngeal muscle opened to eliminate the possibility of pharyngoesophageal spasms. This technique is not only associated with a lower fistula formation rate but also avoids the need for secondary procedures

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such as pharyngeal constrictor myotomy and/or pharyngeal plexus neurectomy to achieve fluent oesophageal or tracheoesophageal voice.

Dysphagia is sometimes encountered with total laryngectomy. By using manofluorography, McConnel *et al.* (1986) has shown an increased pharyngeal resistance in patients with total laryngectomy which results in the need for higher propulsive forces to allow for effective swallowing. Schobinger (1958) proposed that the spasm of the cricopharyngeal muscle is one of the causes of dysphagia after total laryngectomy.

To eliminate problems caused by the usual methods of reconstructing a hypopharyngeal defect, we demonstrate a technique of nonmuscular closure of a hypopharyngeal defect following total laryngectomy. This study is also designed to assess the incidence of fistula formation and the physical characteristics of the pharyngoesophageal segment after total laryngectomy between the patients receiving different surgical methods of hypopharyngeal closure.

Materials and methods

From March 1986 to August 1994, 60 consecutive patients with advanced laryngeal carcinoma receiving total laryngectomy, were enrolled into this study. Initially, 30 patients (group A) received the usual hypopharyngeal closure during total laryngectomy and the following 30 patients (group B) underwent the technique of nonclosure of the pharyngeal muscle. The general data and outcomes of wound healing of the 60 patients were reviewed. Six randomized laryngectomees without post-operative complications or radiation therapy from each group were evaluated by the air insufflation test and videofluoroscopy of the pharyngoesophagus.

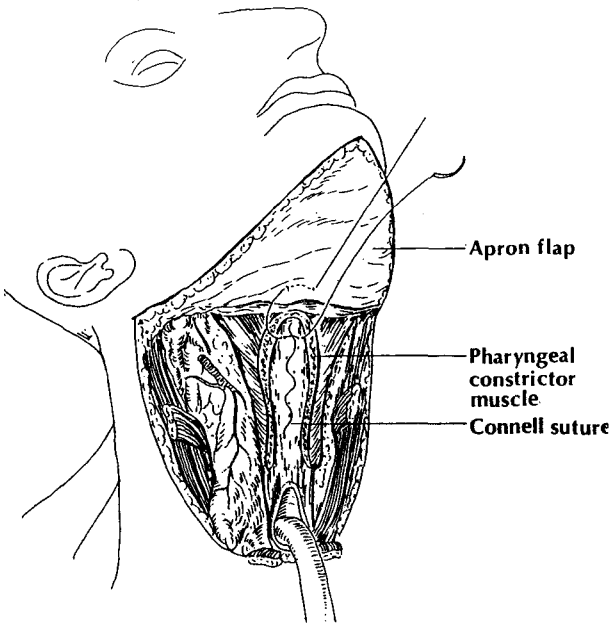

FIG. 1
Diagram of surgical techniques.

Surgical techniques for nonclosure of pharyngeal muscle

After standard wide field total laryngectomy, the mucosal layer of the hypopharyngeal defect was closed with a continuous 2-0 chromic Connell suture. The middle part of the suprahyoid muscle and end constrictor muscles on the caudal end of the wound were approximated with a 2-0 chromic suture. The submucosal layer was closed with an interrupted 3-0 chromic suture which approximated the ventral surface of the skin apron flap and submucosal soft tissue layer of the pharyngeal wound (Figure 1). Care was taken not to include the elements of the pharyngeal constrictor muscle in these sutures. Two drainage tubes were put on both sides of the sutures and the skin wound was closed. We did not use a dilator or stent to prevent overclosure of the pharyngoesophageal segment.

Air insufflation test

A modified air insufflation test described by Baugh *et al.* (1987) was applied to obtain pressure measurements of the pharyngoesophageal segment. A 14 French rubber catheter connected to a mercury manometer was passed transnasally into the pharyngoesophagus below the level of the inferior border of the pharyngoesophageal segment. Each modified air insufflation test was performed by the same physician, with a compressible balloon to blow air at a flow increment of 2 mmHg per squeeze. Pharyngoesophageal pressure of the segment was measured at the moment when sound was produced. Three independent measurements were taken to obtain a mean pressure.

Videofluoroscopy of pharyngoesophageal segment

By using a Panasonic AG-7300 videocassette recorder, the videofluoroscopic findings were recorded on 3/4 inch videotape at thirty frames per second. Each 15 ml liquid barium bolus which reached a particular point in the pharyngoesophagus was identified and the following measurements were made by the same senior radiologist:

(1) Pharyngoesophageal transit time (PETT): The time interval between when the bolus head passes the ramus of mandible and the inferior border of the pharyngoesophageal segment.
(2) Pharyngoesophageal opening time (PEOT): The time it takes for the pharyngoesophageal segment to fully open during swallowing.
(3) Antero-posterior diameter (AP): The antero-posterior length of the pharyngoesophageal segment when it is fully open during swallowing.

Statistical analysis methods

The general data of 60 patients were analysed by using the nonparametric Fishers' exact test. The air insufflation test data and videofluoroscopic findings were analysed by using the Wilcoxon-Mann-Whitney Test.

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TABLE I
GENERAL DATA OF 60 LARYNGECTOMEES

Characteristics	Group A (n = 30)	Group B (n = 30)
Sex: M/F	9/1	7/3
Mean age	58.7	64.7
Tumour stage		
II	1	1
III	14	8
IV	15	19
Adjuvant therapy		
pre-OP R/T	6	10
post-OP R/T	14	11
Concomitant ND	7	18
Pre-OP tracheotomy	2	2
Fistulae complication	3*	1*

*$p>0.5$.
ND: neck dissection.
R/T: radiotherapy.

Results

The results are outlined in Table I and Table II. Among the 30 patients in group A who received the usual closure methods for the hypopharyngeal defect, three (10 per cent) suffered from post-operative pharyngocutaneous fistulae. One case occurred in a patient who had pre-operative radiotherapy and another occurred in a patient who had tracheotomy prior to laryngectomy. Both of them required a myocutaneous flap to repair their fistulae. The third patient developed a fistula on the ninth day of the post-operative period and which was healed by a simple primary closure. On the other hand, among the other 30 patients of group B whose pharyngeal constrictor muscles were left open, only one patient (3.3 per cent) suffered from a pharyngocutaneous fistula. After pressure dressing and antibiotic treatment, the fistula was primarily closed and healed satisfactorily. However, the statistical analysis of the fistula rate of these two groups reveals $p>0.5$ which means no significant difference existed.

In the air insufflation study, the mean pharyngoesophageal pressure of six patients from group A demonstrated 34 mmHg which is significantly higher than the mean pressure of 26 mmHg ($p<0.01$) from group B. In the videofluoroscopic study, the mean PETT, PEOT and AP diameter of the patients from group A were 239 ms, 783 ms and 10.3 mm compared with 244 ms, 677 ms and 10.3 mm from group B, respectively. All differences in the videofluoroscopic study between the two groups showed no statistically significant difference ($p>0.5$).

TABLE II
CHARACTERISTICS OF PHARYNGOESOPHAGEAL SEGMENT IN 12 LARYNGECTOMEES WITHOUT RADIATION OR COMPLICATION

Characteristics	Group A (n = 6)	Group B (n = 6)
Sex: M/F	6/0	5/1
Mean age	62.6	61.8
Air insufflation test		
mean pressure (mmHg)	34*	26*
Videofluoroscopy		
mean PETT (ms)	239‡	244‡
mean PEOT (ms)	783‡	677‡
mean AP (mm)	7.1‡	10.3‡

*$p<0.01$.
‡$p>0.5$.
PETT: pharyngoesophageal transit time.
PEOT: pharyngoesophageal opening time.
AP: antero-posterior diameter.

Discussion

The development of a pharyngocutaneous fistula is a major complication of total laryngectomy. It delays wound recovery, the beginning of oral intake, and voice rehabilitation and postpones the start of post-operative radiotherapy which may adversely affect local regional tumour control. It may result in exposure of the carotid artery to salivary pooling which may cause a devastating arterial rupture. Horowitz and Sasaki (1993) proposed that cricopharyngeal myotomy performed at the time of total laryngectomy could greatly diminish the peak pressure generated during swallowing, which reduces the possibility of developing a pharyngocutaneous fistula. We consider that nonclosure of the pharyngeal muscle following laryngectomy can greatly decrease the pressure in the pharyngoesophagus and further prevent fistula formation. Furthermore, our closure technique which directly approximates the ventral surface of the skin apron flap and submucosal soft tissue layer of the pharyngeal wound does not only cover the first layer of the wound but also eliminates the formation of haematoma in the dead space between the two layers. In our series, only one case (3.3 per cent) of 30 patients with nonmuscular closure developed a post-operative pharyngocutaneous fistula. Although statistical differences of fistula formation rate between the two groups is not significant due to the limited sample size, it highlights that this surgical technique is relatively simple and is not associated with a higher fistula formation rate than the usual method of pharyngeal muscle closure. Our results are compatible with the series of Olson and Callaway (1990) and Clevens *et al.* (1993).

Pharyngoesophageal spasm is manifested clinically by a sudden increase in pressure with an abrupt termination of sound production of oesophageal or tracheoesophageal voice. Singer *et al.* (1981) suggested that increased pharyngoesophageal tone following total laryngectomy was an important factor in the failure to achieve satisfactory oesophageal or tracheoesophageal voice. In order to avoid pharyngoesophageal spasm, a few surgical techniques have been developed which include pharyngeal constrictor myotomy (Singer and Blom, 1981; Henley and Souliere, 1986; Horowitz and Sasaki, 1993) and pharyngeal plexus neurectomy (Singer *et al.*, 1986) to improve the acquisition of alaryngeal voice. However, myotomy may also be associated with many surgical and functional complications such as breathiness of tracheoesophageal voice production (Mahieu *et al.*, 1987), haematoma, wound infection, and pharyngeal leakage (Scott *et al.*, 1993). The technique of nonclosure of the pharyngeal muscle shares a common merit with pharyngeal constrictor myotomy for it not only

avoids pharyngoesophageal spasm but also obviates the need for further myotomy and/or neurectomy and their attendant complications.

With the relative safety of nonmuscular closure having been demonstrated, these results have to be considered within the context of restoration of a fluent alaryngeal voice. Baugh *et al.* (1987) demonstrated that success of tracheoesophageal voice could be predicted prior to tracheoesophageal puncture based upon intrapharyngoesophageal pressure measurements by the air insufflation test. On patients without tracheoesophageal puncture, a modified air insufflation test was applied to assess the pressure of the pharyngoesophageal segment for the purpose of predicting the fluency of tracheoesophageal voice. Our objective measurements of pharyngoesophageal pressures confirm the hypothesis that nonclosure of the pharyngeal muscles limits the ability of the pharyngeal constrictor muscle to contract in response to oesophageal distention, which may allow a significant number of laryngectomees to achieve fluent tracheoesophageal voice production without additional interventions.

Schobinger (1958) proposed the spasm of the cricopharyngeal muscle as a cause of dysphagia after total laryngectomy. Alteration of the postlaryngectomy pharyngeal structure may be expected to have an impact on swallowing function. We propose that the sphincter activity of the pharyngoesophageal segment may be assessed by videofluoroscopy based upon the degree of narrowing of the barium column of the pharyngoesophageal segment and the speed of the bolus movement and pharyngoesophageal opening during deglutition. A wider and faster peristalsis of the pharyngoesophageal segment will demonstrate less activity of the pharyngoesophageal sphincter. Our videofluoroscopic recordings revealed a wider mean AP diameter and a shorter PEOT of the pharyngoesophageal segment in patients from the nonmuscular closure group. These results may be regarded as a lower sphincter activity of the pharyngoesophageal segment in the nonmuscular closure group than in the usual closure group, although there is no significant statistical difference shown.

We conclude that nonclosure of the pharyngeal muscle following total laryngectomy is a relatively simple surgical technique and is not associated with a higher fistula rate than the usual closure methods. The pharyngoesophageal pressure which was measured by the modified air insufflation test demonstrated significantly lower data, which may predict the fluency of the tracheoesophageal voice. Our techniques of nonmuscular closure of hypopharyngeal defect following total laryngectomy can avoid the need for secondary procedures such as pharyngeal constrictor myotomy and/or pharyngeal plexus neurectomy and their attendant complications.

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