

Pharyngeal mucosal closure in total laryngectomy: comparison between vertical and T-shaped closure

Cierre de la mucosa faríngea en la laringectomía total: comparación entre cierre vertical y cierre en T

Adolfo Montemayor-Alatorre, Ruth P. Serna-Vazquez, Karla M. Santos-Santillana, Josefina A. Morales-del Ángel, José R. Córtes-Ponce, and José L. Treviño-González*

Otolaryngology and Head and Neck Surgery Division, School of Medicine and University Hospital "Dr. Jose E. González", Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico

Abstract

Objective: The objective of this study was to compare the outcomes vertical and T-shaped pharyngoplasty closure techniques after total laryngectomy (TL) and to evaluate the factors associated with the development of pharyngocutaneous fistula. **Method:** We performed a retrospective study that included patients with a histopathological diagnosis of laryngeal cancer that underwent TL between 2009 and 2021. **Results:** Fifty-seven patients were included in the study. A total of 14 patients underwent a vertical closure of the neopharynx (24.6%), while 43 patients underwent a T-shaped closure (74.4%). Pharyngocutaneous fistula was the most common complication, observed in 40.4% of cases ($n = 23$). No difference in the rate of complications was observed between groups, with the exception of tracheal dehiscence which was reduced in patients with T-shaped closure ($n = 2$, 4.7% vs. $n = 5$, 35.7%, $p = 0.002$). Diabetes mellitus was more frequently observed in patients with the development of pharyngocutaneous fistula ($n = 7$, 30.4% vs. $n = 3$, 8.8%, $p = 0.03$). **Conclusions:** Although complications were lower in the T-shaped closure group, we could not establish the superiority of either technique.

Keywords: Laryngectomy. Laryngeal cancer. Wound closure techniques. Fistula. Treatment outcome.

Resumen

Objetivo: Evaluar los desenlaces de la técnica vertical en comparación con la técnica en T para el cierre de faringoplastia posterior a una laringectomía total, y evaluar los factores asociados con el desarrollo de fistula faringocutánea. **Método:** Estudio retrospectivo de pacientes con diagnóstico de cáncer de laringe a quienes se realizó laringectomía total como tratamiento, de 2009 a 2021. **Resultados:** Se incluyeron 57 pacientes. A 14 (24.6%) se les realizó una faringoplastia con cierre en T y a 43 (74.4%) un cierre vertical. La fistula faringocutánea fue la complicación más frecuente, presente en el 40.4% de los casos ($n = 23$). No se observaron diferencias en el desarrollo de complicaciones entre grupos, con excepción de la dehiscencia traqueal, la cual fue menos frecuente en el grupo de cierre en T ($n = 2$, 4.7% vs. $n = 5$, 35.7%; $p = 0.002$). La diabetes mellitus se asoció con el desarrollo de fistula faringocutánea ($n = 7$, 30.4% vs. $n = 3$, 8.8%; $p = 0.03$). **Conclusiones:** Aunque se observó una tendencia a una disminución de las complicaciones en el grupo de cierre en T, no se encontró superioridad de una técnica sobre otra.

Palabras clave: Laringectomía. Cáncer de laringe. Técnicas de cierre quirúrgico. Fistula. Desenlace de tratamiento.

*Correspondence:

José L. Treviño-González
E-mail: jose.trevinog@uanl.mx

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Introduction

Total laryngectomy (TL) is the standard treatment for advanced laryngeal cancer and as salvage surgery after chemotherapy or radiotherapy failure¹. During TL, the closure of the mucosa of the anterior wall of the pharynx is a critical step. The most common pharyngeal closure lines are vertical and T-shaped, using continuous sutures. The selection of the technique is based on the shape and size of the defect, the elasticity of the remaining tissue, and, in great part, to the preferences of the surgeon². Few studies have evaluated the effectivity of different pharyngoplasty techniques and the reported results are controversial³.

The type of closure technique has been associated with short- and long- term complications⁴. Pharyngocutaneous fistulas (PCF) are the most common complication, with an incidence between 3 and 65%. The development of PCF is due in part to the dehiscence of the pharyngeal sutures and other related risk factors⁵. Dysphagia is also frequently observed in laryngectomized patients. The previous studies have associated the development of dysphagia with vertical pharyngeal closure⁶. However, evidence evaluating the patients' outcomes associated with the type of pharyngeal closure after TL is heterogeneous.

Determining the most effective technique could potentially decrease morbidity, mortality, hospitalization time, and the delay of adjuvant treatment. The objective of this study was to compare the outcomes of both vertical and T-shaped pharyngoplasty closure techniques after TL.

Methods

We performed a retrospective study that included patients with a histopathological diagnosis of laryngeal cancer that underwent TL between 2009 and 2021 at the Otolaryngology and Head and Neck Surgery department at Hospital Universitario "Dr. José E. González". The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. This study was performed according to the principles stipulated in the Declaration of Helsinki. This project was approved by the Research and Ethics committee of our institution (reference number OT20-00010). The following data were obtained: demographic data, relevant

medical history, alcohol and tobacco use, clinical presentation, stage and localization of the tumor, primary closure technique, complications, start of oral feeding, duration of hospitalization, adjuvant treatment, and follow-up.

Subjects

We obtained a sample of subjects over 18 years of age, with histopathological diagnosis of stage 3 or stage 4 pharyngeal carcinoma that underwent TL or salvage laryngectomy with vertical or T-shaped pharyngoplasty. The patients with a diagnosis of extrinsic larynx carcinoma, pharyngeal reconstruction with flap augmentation, a follow-up shorter than a month, presence of distant metastases, or a history of surgery for head and neck cancer were excluded.

Study protocol

The patients were assigned to two different groups based on the surgical closure technique. All surgeries were performed by 2 surgeons (AMA and BGA). In Group 1, the technique consisted of a vertical closure of the mucosa with continuous Connel-Mayo sutures, a second layer of submucosa closure with the same sutures, and a third muscular layer closed with horizontal mattress sutures. All surgeries in group 1 were performed by AMA. In Group 2 —performed by BGA— the technique consisted in a T-shaped mucosa closure with continuous Connel-Mayo sutures, a second layer of submucosa closure with the same sutures, and a third muscular layer closed with horizontal mattress sutures. In both groups, care was taken to close the mucosa without punctures and maintaining inverted edges. In all patients, before closure, a nasogastric tube (NG) was inserted to ensure postoperative feeding and nothing by mouth was indicated.

Statistical analysis

All analyses were performed using SPSS Statistics version 24.0 (SPSS, Inc., Armonk, NY). We obtained the frequencies and percentages for all qualitative variables. We obtained measures of central tendency and the dispersion for quantitative variables. A Pearson's chi-squared test was performed or Fisher Exact test, for 2 × 2 tables. The groups were compared according to pharyngoplasty technique. A value of $p < 0.05$ was considered statistically significant.

Results

Demographic characteristics

Subject characteristics are described in table 1. Fifty-seven patients were included with a mean age of 57 ± 9.3 years. A total of 14 patients underwent a vertical closure of the neopharynx (24.6%), while 43 patients underwent a T-shaped closure (74.4%). Males were the most affected sex ($n = 52$, 91.2%). A total of 43 (75.4%) and 48 (84.2%) had a history of alcohol consumption and tobacco use, respectively. Biomass exposure was most frequently observed in patients in the vertical closure group compared with T-shaped closure ($n = 5$, 37.5% vs. $n = 2$, 4.7%, $p = 0.002$). Dysphonia was the most common symptom, observed in 54 patients (94.7%). Glottic carcinoma was the most frequently observed ($n = 31$, 54.4%), followed by transglottic ($n = 25$, 43.8%), and supraglottic ($n = 1$, 1.6%) carcinoma. A T4 stage was reported in most patients ($n = 40$, 70.2%). No patients had distance metastasis. The histopathologic report showed squamous cell carcinoma in 94.7% of the cases. Nodal metastasis was observed in 31.6% of the cases ($n = 18$) and extracapsular invasion in 3.5% ($n = 2$). Salvage laryngectomy was performed in 7 patients (12.3%).

Patients' outcomes associated with closure type

Patients' outcomes are shown in table 2. All patients underwent the insertion of a NG for nutrition. A total of 10 patients (17.5%) required the use of a gastrostomy tube for adequate feeding. Intrahospitalary stay was reduced in patients with T-shaped closure compared with vertical closure, with no statistical significance (12.9 ± 7.9 vs. 17.1 ± 8 , $p \geq 0.05$). PFC was the most common complication, observed in 40.4% of cases ($n = 23$). No difference in the rate of complications was observed between groups, with the exception of tracheal dehiscence. Tracheal dehiscence was significantly lower in patients with T-shaped closure ($n = 2$, 4.7% vs. $n = 5$, 35.7%, $p = 0.002$).

Factors associated with the development of PCF

A total of 23 patients developed PCF (40.4%). No differences between alcohol consumption, tobacco,

Table 1. Demographic characteristics of the studied population

Patients' characteristics	Vertical closure	T-shaped closure	p
	(n = 14)	(n = 43)	
Age (mean, SD)	59.5 $\pm$ 9.2	59.4 $\pm$ 9.5	> 0.05
Female, n (%)	1 (7.1)	4 (9.3)	> 0.05
Alcohol consumption, n (%)	12 (85.7)	31 (72.1)	> 0.05
Alcohol consumption, grams per week	244.7 $\pm$ 382.3	368.1 $\pm$ 489.6	> 0.05
Tobacco use, n (%)	12 (85.7)	36 (83.7)	> 0.05
Tobacco use, pack year	36.1 $\pm$ 26.9	32.7 $\pm$ 36.6	> 0.05
Drug use, n (%)	1 (7.1)	5 (11.6)	> 0.05
Biomass exposure, n (%)	5 (35.7)	2 (4.7)	0.002*
Diabetes mellitus, n (%)	4 (28.6)	6 (14)	> 0.05
Hypertension, n (%)	6 (42.9)	12 (27.9)	> 0.05
Symptomatology			
Dysphonia, n (%)	14 (100)	40 (93)	> 0.05
Dyspnea, n (%)	4 (28.6)	21 (48.8)	> 0.05
Dysphagia, n (%)	2 (14.3)	14 (32.6)	> 0.05
Weight loss, n (%)	2 (14.3)	14 (32.6)	> 0.05
Need for urgent tracheostomy, n (%)	8 (57.1)	24 (55.8)	> 0.05
T stage			
T3, (%)	3 (21.4)	14 (32.6)	> 0.05
T4, (%)	11 (78.6)	29 (67.4)	> 0.05
N stage			
N0, (%)	10 (71.4)	20 (46.5)	> 0.05
N1, (%)	0 (0)	13 (30.2)	0.01*
N2, (%)	3 (21.4)	7 (16.3)	> 0.05
N3, (%)	1 (7.1)	3 (7.0)	> 0.05
Histological tumor characteristics			
Squamous cell carcinoma, n (%)	13 (92.9)	41 (95.3)	> 0.05
Nodal metastasis, n (%)	1 (7.1)	17 (39.5)	0.02*
Nodal extracapsular extension, n (%)	1 (7.1)	1 (2.3)	> 0.05
Adjuvant radiotherapy, n (%)	7 (50)	14 (32.6)	> 0.05
Adjuvant chemotherapy, n (%)	2 (14.3)	15 (34.9)	> 0.05
Salvage laryngectomy, n (%)	4 (28.6)	3 (7)	> 0.05

* $p < 0.05$.

SD: standard deviation.

and drug use were observed between groups. Diabetes mellitus was more frequently observed in patients with the development of PCF ($n = 7$, 30.4% vs. $n = 3$, 8.8%, $p = 0.03$). Salvage laryngectomy was performed in 21.7% ($n = 5$) patients with PCF compared with 5.9% ($n = 2$) in patients without PCF ($p \geq 0.05$). Intrahospitalary stay was significantly higher in patients

Table 2. Patients' outcomes associated with closure type

Outcomes	Vertical closure	T- shaped closure	p
	n = 14	n = 43	
Need for gastrostomy, n (%)	2 (14.3)	8 (18.6)	> 0.05
Initiation of oral diet (days), mean (SD)	37.6 ± 60.6	20.0 ± 19.6	0.04*
Intrahospitalary stay (days), mean (SD)	17.1 ± 8	12.9 ± 7.9	> 0.05
Complications			
PCF, n (%)	7 (50)	16 (37.2)	> 0.05
Day of diagnosis of PCF, mean (SD)	7.6 ± 17.5	3.13 ± 5.7	> 0.05
Tracheal stenosis, n (%)	4 (28.6)	6 (14)	> 0.05
Esophageal stenosis, n (%)	1 (7.1)	1 (2.3)	> 0.05
Dysphagia, n (%)	4 (28.6)	10 (23.3)	> 0.05
Wound infection, n (%)	3 (21.4)	7 (16.3)	> 0.05
Tracheal dehiscence, n (%)	5 (35.7)	2 (4.7)	0.002*

*p<0.05.

SD: standard deviation; PCF: pharyngocutaneous fistulas.

with PCF (17.1 ± 11.8 vs. 12.1 ± 3.1, p = 0.01). A higher rate of tracheal dehiscence was observed in patients with PCF (n = 6, 26.1% vs. n = 1, 2.9%, p = 0.03) (Table 3).

Discussion

Surgical closure technique for pharyngoplasty is a determinant factor in the development of post-operative complications. A myriad of closing techniques exists, and yet there is very little literature comparing results between them. This may be due to the fact that the closing technique is not routinely specified in post-operative notes, which would impede analyses of this variable in review articles addressing PCF⁷.

We performed a retrospective analysis to compare two techniques of pharyngeal closure: vertical and T-shaped with continuous sutures. We found that both techniques presented similar outcomes. We observed a reduced incidence of PCF and other complications including tracheal stenosis, dysphagia, wound infection, and esophageal stenosis in patients in the T-shaped closure group. However, no statistical significance was found. Tracheal dehiscence was significantly reduced in the T-shaped closure group when compared with vertical closure. In the present study, we found an incidence of PCF similar to previous reported literature. The development of PCF was associated with a history of diabetes mellitus and with a increased postoperative intrahospitalary stay.

Table 3. Factors associated with pharyngocutaneous fistula formation

Evaluated variables	PCF	Non-PCF	p
	n = 23	n = 34	
Age (mean, SD)	61.1 ± 8.3	58.3 ± 9.9	> 0.05
Female, n (%)	1 (4.3)	4 (11.8)	> 0.05
Alcohol consumption, n (%)	18 (78.3)	25 (73.5)	> 0.05
Tobacco use, n (%)	19 (82.6)	29 (85.3)	> 0.05
Drug use, n (%)	2 (8.7)	4 (11.8)	> 0.05
Biomass exposure, n (%)	2 (8.7)	5 (14.7)	> 0.05
Diabetes mellitus, n (%)	7 (30.4)	3 (8.8)	0.03*
Hypertension, n (%)	10 (43.5)	8 (23.5)	> 0.05
Need for urgent tracheostomy, n (%)	14 (60.9)	18 (52.9)	> 0.05
Histological tumor characteristics			
Nodal metastasis, n (%)	6 (26.1)	12 (35.3)	> 0.05
Nodal extracapsular extension, n (%)	1 (4.3)	1 (2.9)	> 0.05
Salvage laryngectomy, n (%)	5 (21.7)	2 (5.9)	> 0.05
Intrahospitalary stay (days), mean (SD)	17.1 ± 11.8	12.1 ± 3.1	0.01
Wound infection, n (%)	7 (30.4)	3 (8.8)	> 0.05
Tracheal dehiscence, n (%)	6 (26.1)	1 (2.9)	0.03*

*p < 0.05.

SD: standard deviation; PCF: pharyngocutaneous fistulas.

Authors, such as Boltes Cecatto et al., Deniz et al., and Avci et al., evaluated the technique by focusing in the comparison of interrupted versus continuous sutures. They found that continuous sutures significantly reduce the incidence of PCF⁷⁻⁹. Avci et al. concluded that, aside from the type of suture used, the closing technique is also a critical factor in the development of PCF⁷. Davis et al. observed a higher rate of PCF formation, dysphagia, and strictures in patients in the vertical closure¹⁰. Walton et al. found that when salvage laryngectomies were excluded from their analysis, T-type closure had a lower fistula rate compared with vertical group, with no difference of postoperative strictures between groups¹¹. However, literature remains controversial. The type of closure has been associated with the postoperative development of dysphagia and pseudo-diverticulum. Van der Kamp et al. found a greater incidence of pseudo-diverticulum in patients with vertical closure compared with T-shaped closure¹². In addition, prolonged surgery time has been associated with the development of PCF; this agrees with a systematic review published by Boltes

Cecatto et al.⁸. Patients that underwent vertical closure had, in average, shorter surgeries and a smaller incidence of PCF.

In our study, most of the salvage laryngectomies developed PCF. In the meta-analysis published by Boltes Cecatto et al., 54% of the analyzed studies showed that pre-operative RT had a significant correlation with the development of PCF^{8,13}. Liang et al. reported a greater incidence of PCF in patients that underwent RT (21.2%) compared with patients that did not undergo RT (11.6%)¹⁴.

We observed a 40% overall incidence of PCF with no difference between the closure technique used. The overall incidence of PCF after TL is heterogeneous, being from 11.2% to 34.8% depending on the assessed literature^{14,15}. Several risk factors for the development of PCF have been studied, being a history of previous radiotherapy one of the most important¹³. Other associated risk factors include advanced age, history of smoking, preoperative albumin and hemoglobin, T stage, tumor site, and among others¹³. We hypothesize that the tumor size in our population played a major role for high incidence of PCF in patients without a history of radiotherapy. Despite considered T4a in TNM staging and candidates for surgical management, we commonly observed local advanced disease with high tumor burdens which influence at the time of reconstruction and pharyngeal closure.

The main strength of this paper is that each closure technique was performed by a single surgeon, with an identical surgical protocol between the patients of each group. The main limitations are the retrospective aspect of our study, and the relatively small sample size.

Conclusion

The pharyngeal vertical and T-shaped closure techniques using uninterrupted Connel-Mayo sutures show similar efficacy. Although complications were lower in the T-shaped closure group, we could not establish the superiority of either technique. Further studies with larger sample sizes are needed to develop a better understanding of the importance of the closure technique for pharyngoplasty and to find the technique associated with better surgical outcomes.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of humans and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality of data. The authors declare that they have followed their center's protocols on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

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