

# Endoscopic management of recurrent tracheoesophageal fistula with trichloroacetic acid in pediatric patients

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## ABSTRACT

**Introduction.** Surgical repair of recurrent tracheoesophageal fistula has a high risk of complications. Therefore, various endoscopic techniques have been used to avoid complications.

**Objective.** To understand the usefulness of trichloroacetic acid endoscopic application for the treatment of recurrent tracheoesophageal fistula.

**Materials and methods.** An observational, descriptive, retrospective, case-series-based study was carried out in a tertiary pediatric hospital. Records of patients with recurrent tracheoesophageal fistula from 2015 to 2021 were reviewed. All patients within this period underwent brushing and trichloroacetic acid application.

**Results.** Mean time of recurrent tracheoesophageal fistula occurrence was 4.8 months (range: 1-19.2). Two patients had a small fistula (less than 4 mm), three patients had a medium fistula (4 mm), and two patients had a large fistula (more than 4 mm). Mean sessions for fistula closure were 2.2 (range: 1-4). Mean time between procedures was 22 days (range: 14-30). Mean follow-up since fistula closure confirmation was 33 months (range: 9-72), during which no recurrences were noted.

**Conclusion.** Endoscopic management of recurrent transesophageal fistula with trichloroacetic acid is a safe and effective procedure. Brushing and trichloroacetic acid combined improve success rates. Fistulas over 4 mm in diameter require more procedures. However, a larger patient cohort and a longer follow-up period are needed to confirm this.

**KEY WORDS:** Esophageal atresia; Tracheoesophageal fistula; Endoscopic treatment.

## MANEJO ENDOSCÓPICO DE LA FÍSTULA TRAQUEOSOFÁGICA RECURRENTE CON LA APLICACIÓN DE ÁCIDO TRI-CLOROACÉTICO, EN EL PACIENTE PEDIÁTRICO

### RESUMEN

**Introducción.** La reparación quirúrgica de la fístula traqueoesofágica recurrente tiene alto riesgo de complicaciones por lo que se han utilizado diversas técnicas endoscópicas para evitarlas.

**Objetivo.** Conocer la utilidad de la aplicación endoscópica de ácido tricloroacético para el tratamiento de la fístula traqueoesofágica recurrente.

**Material y método.** Estudio observacional, descriptivo y retrospectivo, tipo de serie de casos en un hospital pediátrico de tercer nivel. Se revisaron los expedientes de pacientes con fístula traqueoesofágica recurrente de 2015 a 2021. En todos los pacientes durante este periodo se realizó cepillado y aplicación de ácido tricloroacético.

**Resultado.** El tiempo medio de aparición de la fístula traqueoesofágica recurrente fue de 4,8 meses (rango 1-19,2). Dos con fístula pequeña (menor a 4 mm), tres con fístula mediana (4 mm) y dos con fístula grande (mayor a 4 mm). El número medio de sesiones para cerrar la fístula fue 2,2 veces (rango 1-4). El intervalo medio entre procedimientos fue 22 días (rango 14-30). El tiempo medio de seguimiento desde la confirmación de cierre de la fístula fue de 33 meses (rango 9-72), periodo de tiempo donde no se observó recurrencia del cuadro.

**Conclusión.** El manejo endoscópico de la fístula traqueoesofágica recurrente con la aplicación de ácido tricloroacético es un procedimiento seguro y efectivo. La técnica de cepillado y aplicación de ácido tricloroacético mejora la efectividad de éxito. La fístula mayor de 4 mm de diámetro requiere mayor número de procedimientos; sin embargo, se requiere mayor número de pacientes y mayor tiempo de seguimiento para poder aseverar esta opinión.

**PALABRAS CLAVE:** Atresia de esófago; Fístula traqueoesofágica; Tratamiento endoscópico.

## INTRODUCTION

Esophageal atresia with tracheoesophageal fistula is one of the most frequent congenital esophageal malformations, with an incidence of 1/2,500-1/4,500<sup>(1,2)</sup>. Recurrent tracheoesophageal fistula occurs as a complication following initial surgical repair in 3-15% of cases<sup>(3)</sup>. A second

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open repair or thoracotomy review is technically demanding and has a high risk of complications, including bleeding, infection, pneumothorax, atelectasis, bronchopleural fistula, esophageal fistula, recurrent tracheoesophageal fistula, musculoskeletal deformities, etc. Reported incidence of a second recurrent tracheoesophageal fistula following a second repair ranges from 10% to 22%, approximately<sup>(4,5)</sup>. Typical symptoms include coughing – especially while eating –, recurrent cyanosis, and respiratory infections. It can be confirmed by means of esophagogram, bronchoscopy, esophagoscopy, and tomography<sup>(6-9)</sup>. However, other pathologies such as deglutition disorders, malacia, fistulas, laryngeal cleft, and gastroesophageal reflux should be ruled out. Gdanietz and Krause successfully described the first endoscopic treatment of recurrent tracheoesophageal fistula using plastic adhesives in 1975<sup>(10)</sup>. In the last decade, various endoscopic techniques have been regarded as safe, but still with low success rates. Trichloroacetic acid application was described by Sung in 2008<sup>(11)</sup>, Lelonge in 2015<sup>(6)</sup>, and Lara in 2019<sup>(12)</sup>. Even though it showed good results with 50% topical trichloroacetic acid for recurrent tracheoesophageal fistula closure, use and postoperative follow-up have not been standardized yet. Up until now, no endoscopic procedure has been accepted as the gold standard treatment owing to the variability of results and the few cases reported. The objective of this work was to understand the usefulness of trichloroacetic acid endoscopic application for the treatment of recurrent tracheoesophageal fistula.

## MATERIALS AND METHODS

An observational, descriptive, retrospective, case-series-based study was carried out in a public tertiary pediatric hospital. Records of patients diagnosed with recurrent tracheoesophageal fistula from 2015 to 2021 were reviewed. All patients within this period underwent brushing and trichloroacetic acid application. Patients with esophageal atresia and recurrent tracheoesophageal fistula following surgical repair were included. Fistulas originating from a secondary cause were excluded. Age, sex, diagnosis, clinical manifestations, time of fistula occurrence, fistula size, fistula location, number of sessions, time between procedures, post-endoscopic complications, and follow-up were analyzed.

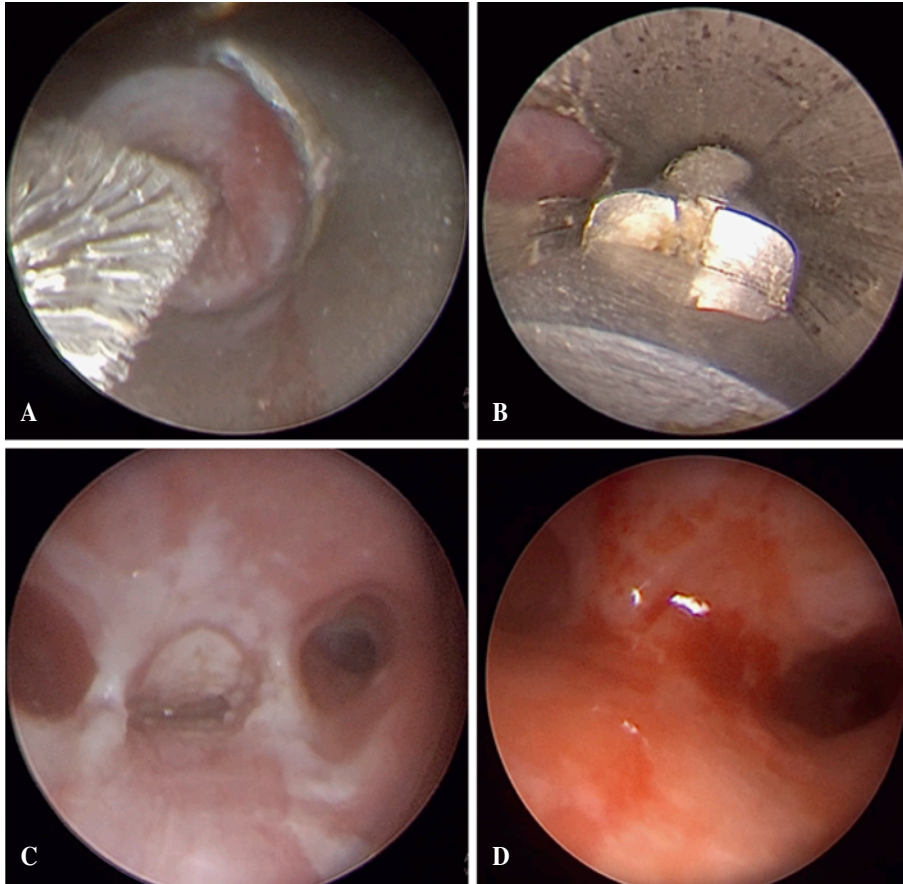
### Technique

Under general anesthesia, a direct laryngotracheobronchoscopy is carried out to review and identify the fistula. Immediately after, a rigid bronchoscope is inserted – its size varying according to patient weight and age –, and the defect's diameter is measured through an 8Fr (2.64 mm) ureteral catheter or a 4 mm Hopkins scope (0°). The distal end of the bronchoscope is then leaned towards the

posterior wall of the trachea, at the level of the fistula – this allows the bronchoscope to be safely held in the fistula orifice during the application of the chemical compound. Following bronchoscope stabilization, brushing of the fistula tract is carried out using a bronchial brush to cause a mucosal lesion along its circumference. A small cotton swab is then impregnated with 50% trichloroacetic acid solution, held by an endoscopic forceps, and the compound is topically applied on the defect opening or along the fistula tract – this should be repeated twice or thrice within 20-30 seconds before the procedure ends, always under endoscopic control to corroborate it has been adequately performed. The procedure is conducted on an outpatient basis, and follow-up is carried out through bronchoscopy – in case of persistent fistula, the procedure is repeated – until the fistula has been completely closed. Clinical control is the final step of the process (Fig. 1).

## RESULTS

Recurrent tracheoesophageal fistula closure with trichloroacetic acid was achieved in all cases, which means none of the patients required open surgery. Seven cases were identified – four male patients and three female patients. None of the patients was excluded. Initial surgical repair of esophageal atresia was carried out using the open approach in six cases, and the thoracoscopic approach in one case. In six patients, it was performed following tracheoesophageal fistula closure + primary esophagoplasty. In one patient, primary tracheoesophageal fistula + gastrostomy was conducted, but with deferred esophagoplasty owing to the presence of a large breach between both ends. Three patients had esophageal stenosis following primary atresia repair. Since they had vomit and reduced food tolerance, an esophagogram was carried out. It revealed the presence of stenosis at the anastomotic site, so balloon dilatation was performed. These patients subsequently had recurrent tracheoesophageal fistula. Coughing while eating and repeated respiratory infections were the clinical manifestations that led us to suspect recurrent tracheoesophageal fistula in all patients. Mean time of recurrent tracheoesophageal fistula occurrence following primary fistula closure – confirmed through bronchoscopy – was 4.8 months (range: 1-19.2 months). During bronchoscopy, passage was made through the fistula tract. An 8Fr (2.64 mm) ureteral catheter was used in two patients, a 4 mm Hopkins scope was employed in three patients, and a large fistulous orifice (more than 4 mm) was observed in two patients. In five patients, the fistula was located in the lower third of the trachea (3-4 tracheal rings away from the carina), and in two patients, it was located in the carina. In all cases, it was located at the exact same place as the primary tracheoesophageal fistula. Mean sessions of this procedure until fistula closure were 2.2 (range:



**Figure 1.** Trichloroacetic acid application in a large (more than 4 mm) recurrent tracheoesophageal fistula located in the carina. A) Fistula brushing. B) Topical application using a cotton swab impregnated with 50% trichloroacetic acid solution, held by an endoscopic forceps in the defect opening or along the fistula tract. C) Endoscopic control immediately after the procedure. D) Control bronchoscopy following four sessions where total fistula closure is observed.

1-4). Mean time between procedures was 22 days (range: 14-30 days). Fistula closure was confirmed through bronchoscopy. All patients were asymptomatic, and none of them had post-endoscopic complications. All procedures were carried out on an outpatient basis. Mean follow-up since fistula closure confirmation was 33 months (range: 9-72 months), during which no recurrences were noted (Table I).

## DISCUSSION

In the last decade, various endoscopic techniques for recurrent tracheoesophageal fistula repair have been published, with an overall success rate of 74%<sup>(13)</sup>. These techniques include fistula tract obstruction, fistula de-epithelialization, or a combination of both. For instance, histoacryl alone has a success rate of 62%<sup>(10,14-17)</sup>, fibrin glue alone has

**Table I. Patient's data.**

Patient	Esophageal stenosis	Clinical signs	Occurrence time	Location	Size	Sessions	Follow-up
1	No	Cough, respiratory infection	4.8 months	Carina	> 4 mm (large)	4	72 months
2	No	Cough, respiratory infection	1 month	Trachea	< 4 mm (small)	1	16 months
3	Dilatation	Cough, respiratory infection	19.2 months	Trachea	4 mm (medium)	2	66 months
4	No	Cough, respiratory infection	5.1 months	Trachea	> 4 mm (large)	3	18 months
5	No	Cough, respiratory infection	1.4 months	Trachea	< 4 mm (small)	2	12 months
6	Dilatation	Cough, respiratory infection	2.1 months	Carina	4 mm (medium)	2	9 months
7	Dilatation	Cough, respiratory infection	1.2 months	Trachea	4 mm (medium)	2	31 months
<b>Mean</b>			<b>4,8 months</b>			<b>2,2</b>	<b>33 months</b>



**Figure 2.** Recurrent tracheoesophageal fistula size. A) Small (< 4 mm in diameter). B) Medium (4 mm in diameter). C) Large (> 4 mm in diameter).

a success rate of 67%<sup>(14,18-22)</sup>, diathermy alone has a success rate of 50%, and laser (KTP and Nd:YAG) has a success rate of 80%<sup>(23-25)</sup>. However, the endoscopic techniques combined have higher success rates<sup>(13)</sup>. Case publications by Sung in 2008<sup>(11)</sup>, Lelonge in 2015<sup>(6)</sup>, and Lara in 2019<sup>(12)</sup> have reported better results with the endoscopic application of 50% topical trichloroacetic acid. Trichloroacetic acid is a strong acid used in chemical skin exfoliation. A small amount of it at a 50% concentration is not toxic, it is neutralized by tracheobronchial secretions, and it does not damage the distal airway. It also causes de-epithelialization, which technically generates soft tissue edema and subsequent fibrosis, leading to obliteration<sup>(6)</sup>. All cases in our study were successfully repaired, with no recurrences being noted in the follow-up period. Following initial surgical repair in patients with type C Gross esophageal atresia, the tracheal and the esophageal suture stay in close contact<sup>(3,6,7,26)</sup>. The most important formation mechanism of recurrent tracheoesophageal fistula involves the presence of a small dehiscence in the esophageal suture, which causes an anastomotic leak – this did not occur in our patients. However, it often goes unnoticed as it remains blocked by the mediastinal tissues, causing an inflammatory reaction that will eventually compromise the tracheal suture, and giving rise to recurrent fistula<sup>(27-29)</sup>. Another risk factor is esophageal stenosis, which requires balloon dilatation. Even though dilatation is a safe and effective treatment for esophageal stenosis, a vigorous dilatation strategy may tear the anastomotic mucosa apart and cause fistula recurrence<sup>(27,30)</sup>. In our study, three out of the seven patients had esophageal stenosis following initial anastomosis. Series balloon dilatations (more than 4 dilatations) were carried out in these patients, who subsequently developed fistula. In our department, diagnosis and recurrent tracheoesophageal fistula closure are achieved based on bronchoscopy and clinical manifestations, contrarily to other authors who routinely resort to esophagogram and tomography. Mean

occurrence time was 4.8 months following initial surgery, but it varied widely, consistent with global literature. The most frequent location was the lower third of the trachea, which is also where tracheoesophageal fistula most frequently originates in type C Gross esophageal atresia. In our study, fistulas were classified as small (less than 4 mm), medium (4 mm), and large (more than 4 mm). These measures were obtained in relation to the diameter of the materials used at diagnosis during initial bronchoscopy (Fig. 2). Mean trichloroacetic acid sessions were 2.2, which falls within the mean reported by Lelonge<sup>(6)</sup> and Sung<sup>(11)</sup>. Fistulas over 4 mm in diameter required more procedures (3-4 sessions) than fistulas under 4 mm in diameter (1-2 sessions), but significant clinical improvement was noted in all cases since the first session. We believe the optimal mean time between procedures should be one month, which is enough for healing and fibrosis formation at the chemically cauterized site, consistent with Sung's findings. Our results report greater effectiveness than Sung and Lara's<sup>(6,12)</sup>. It should also be mentioned that none of our patients had complications, and all procedures were managed on an outpatient basis, contrarily to what the aforementioned authors had previously described. During follow-up, all patients remained asymptomatic, with no fistula recurrence. Mean follow-up was 33 months. However, given the small sample size, a longer follow-up period and a larger patient cohort are required.

## CONCLUSION

Endoscopic management of recurrent transesophageal fistula with trichloroacetic acid is a safe and effective procedure. Brushing and trichloroacetic acid combined improve success rates. Fistulas over 4 mm in diameter require more procedures. However, a larger patient cohort and a longer follow-up period are needed to confirm this.



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