

Fully covered self-expanding metallic stent placement or three-tube method for esophagomediastinal fistula

A STROBE-compliant article

Yonghua Bi, MD, PhD^a, Hongmei Chen, MD^b, Xinwei Han, MD, PhD^{a,*} , Jianzhuang Ren, MD, PhD^{a,*}

Abstract

To determine the safety, feasibility and clinical outcomes of interventional methods for the management of esophagomediastinal fistula, and to investigate the effect of stent placement on fistula healing and the swallowing. Sixty consecutive patients with esophagomediastinal fistula were treated using interventional method and were retrospectively assessed. Patients received 3-tube but without covered stent placement were placed in group A, the remaining patients received covered stent placement with/without 3-tube method were placed in group B. Tubes and stents would be removed once fistula heals. Interventional procedures were technically successful all patients (100%). Esophageal stents and abscess drainage tubes were successfully removed from 14 patients. Three patients underwent stent removal during the perioperative period, resulting in a clinical success rate of 88.5% of 26 patients in group B. A total of 13 complications were found in all patients, including 5 major complications. Patients in group B showed a higher healing rate of abscess cavity and better dysphagia score than group A. During follow up, 17 patients in group A and 11 patients in group B were still alive. Interventional treatment is safe, feasible and efficacious for esophagomediastinal fistula; covered stent placement can promote fistula healing and improve swallowing.

Abbreviation: SCT = spiral computed tomography.

Keywords: esophageal cancer, esophageal covered stent, esophagomediastinal fistula, three-tube method

1. Introduction

Common causes of esophagomediastinal fistula include anastomotic leaks after esophagectomy, and iatrogenic or spontaneous esophageal perforations.^[1] Management of an esophagomediastinal fistula remains challenging and is often associated with high morbidity and mortality.^[2] Surgical repair of the fistula or resection procedure has been the traditional method. Despite advances in surgical treatment during the past several decades, overall mortality still ranges from 20% to 50%.^[3–6] Successful management of an esophagomediastinal fistula requires prompt elimination of contamination in the mediastinum. Various treatment protocols have been used for this purpose, including the application of biodegradable fibrin glue, transluminal drainage and insertion of self-expandable metallic esophageal stent.^[1,4,7–10] Despite these modalities, the optimal protocol still needs to be determined.^[4,11,12] This retrospective study was designed to determine the safety, feasibility and clinical outcomes of interventional methods in patients with esophagomediastinal fistula, and to investigate the effect of stent placement on fistula healing and the swallowing.

2. Materials and Methods

2.1. Patient selection

This study was approved by the Ethics Committee and Medical Records Management Section of Zhengzhou University. Informed consent was obtained from each patient in accordance with the guidelines and regulations for clinical study. All patients with esophagomediastinal fistula due to esophageal cancer who were seen in our institution between April 2013 and March 2018 were included in the study. The diagnosis of an esophagomediastinal fistula was made based on chest spiral computed tomography (SCT, Fig. 1A and B) and esophagography (Fig. 1C and D). This study excluded patients who were not suitable for stent placement, such as those with high esophageal fistula, potential airway compression, or a fistula that involved the tracheal bronchus. Due to treatment willingness, economic burden, or worry about stent complications (such as migration, restenosis), patients who received 3-tube (jejunal feeding tube, gastrointestinal decompression tube, and mediastinal drainage tube) but without covered stent placement were placed in group A; the remaining patients who received

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

^a Department of Interventional Radiology, the First Affiliated Hospital of Zhengzhou University, Zhengzhou, China, ^b Department of Ultrasound, Zhengzhou Central Hospital Affiliated to Zhengzhou University, Zhengzhou, China.

*Correspondence: Xinwei Han, Professor of Department of Interventional Radiology, The First Affiliated Hospital of Zhengzhou University, No.1, East Jian She Road, Zhengzhou 450052, China (e-mail: dreamweaver08@126.com).

Copyright © 2022 the Author(s). Published by Wolters Kluwer Health, Inc.

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Bi Y, Chen H, Han X, Ren J. Fully covered self-expanding metallic stent placement or three-tube method for esophagomediastinal fistula: A STROBE-compliant article. *Medicine* 2022;101:39(e30894).

Received: 11 February 2022 / Received in final form: 30 August 2022 / Accepted: 1 September 2022

<http://dx.doi.org/10.1097/MD.0000000000030894>

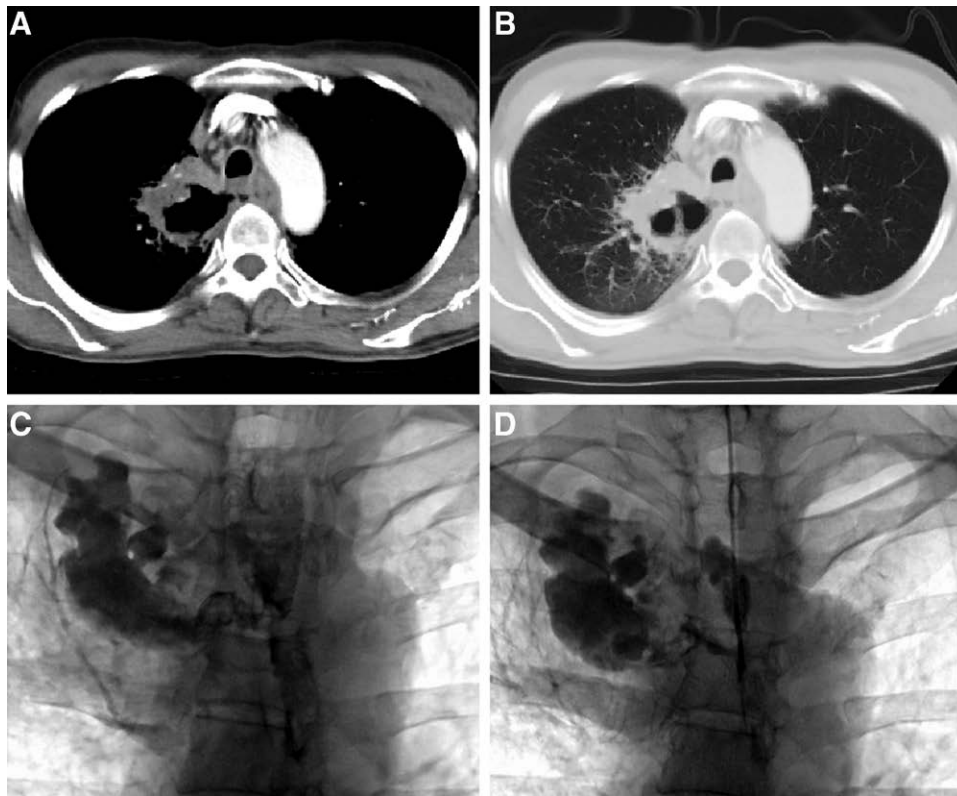


Figure 1. A 66-year-old man with spontaneous esophagomediastinal fistula due to esophageal squamous cell carcinoma after chemotherapy. (A–B) A mediastinal abscess was shown by chest SCT scan in the mediastinal and lung windows before interventional procedure. (C–D) Esophagography showing an esophagomediastinal fistula in the middle esophagus and irregular abscess cavity. SCT = spiral computed tomography.

covered stent placement with or without a 3-tube method were placed in group B.

2.2. Three-tube placement

All of the interventional procedures were performed under the guidance of fluoroscopy. The pharyngeal cavity and esophagus were anesthetized with an oral lidocaine spray. The tip of a 5-F cobra catheter was introduced into the distal end of mediastinal abscess cavity. The cobra catheter was then exchanged with a 5-F pigtail catheter (Cook Medical, Inc., Bloomington, IN) as a mediastinal drainage tube for continuous negative pressure suction. All patients were not allowed to eat or drink water before the procedure. A jejunal feeding tube was introduced into the jejunum for enteral nutrition and a tube was inserted into the gastric cavity for gastrointestinal decompression (Fig. 2A and B). Patients were permitted oral feeding after successful sealing of the fistula or complete blockage of the fistula by the covered stent was confirmed by esophagography. Antibiotic treatment was used before and after procedure.

2.3. Esophageal covered stent placement

All patients in group B received placement of esophageal self-expandable covered metallic stent (Nanjing Micro-Tech Medical Company, Nanjing, China) under fluoroscopic guidance. The stent diameter ranged from 16 to 22 mm and stent length ranges from 60 to 160 mm. A 5F cobra catheter was inserted transorally into the gastric cavity and then exchanged with a stiff guide wire. A covered stent system was introduced via the stiff guide wire and released to block the fistula (Fig. 2C). Repeated esophagography was performed immediately to confirm closure of fistula (Fig. 2D). Chest SCT and esophagography were performed

to show the change of the abscess cavity and the position of the abscess drainage tube during follow-up (Fig. 3A and B). The abscess drainage tube was adjusted for effective drainage if necessary. The drainage tube and covered stent were removed if complete disappearance of the abscess cavity was confirmed by chest SCT (Fig. 3C and D).

2.4. Definitions

Technical success was defined as a successful stent or 3-tube placement with no severe procedure-related adverse events perioperatively. Major complications were defined as perioperative death, esophageal rupture, massive bleeding, or severe stent migration or restenosis that required stent removal.

2.5. Statistical analysis

Continuous variables are expressed as mean \pm standard error. The clinical outcomes and technical success rate were compared using the Fisher's exact test. The survival rate was analyzed using the Kaplan–Meier curves.

3. Results

3.1. General information

This study involved a total of 60 patients with esophagomediastinal fistula, including 43 men and 17 women. There were 34 patients in group A and 26 patients in group B. The median age was 60.8 ± 1.9 and 61.8 ± 2.0 in group A and group B, respectively. In 48 patients esophagomediastinal fistula formed due to resection of esophageal cancer, and in 12 patients it was due to spontaneous rupture of esophageal cancer. Seventeen patients showed normal temperature in group A, and the

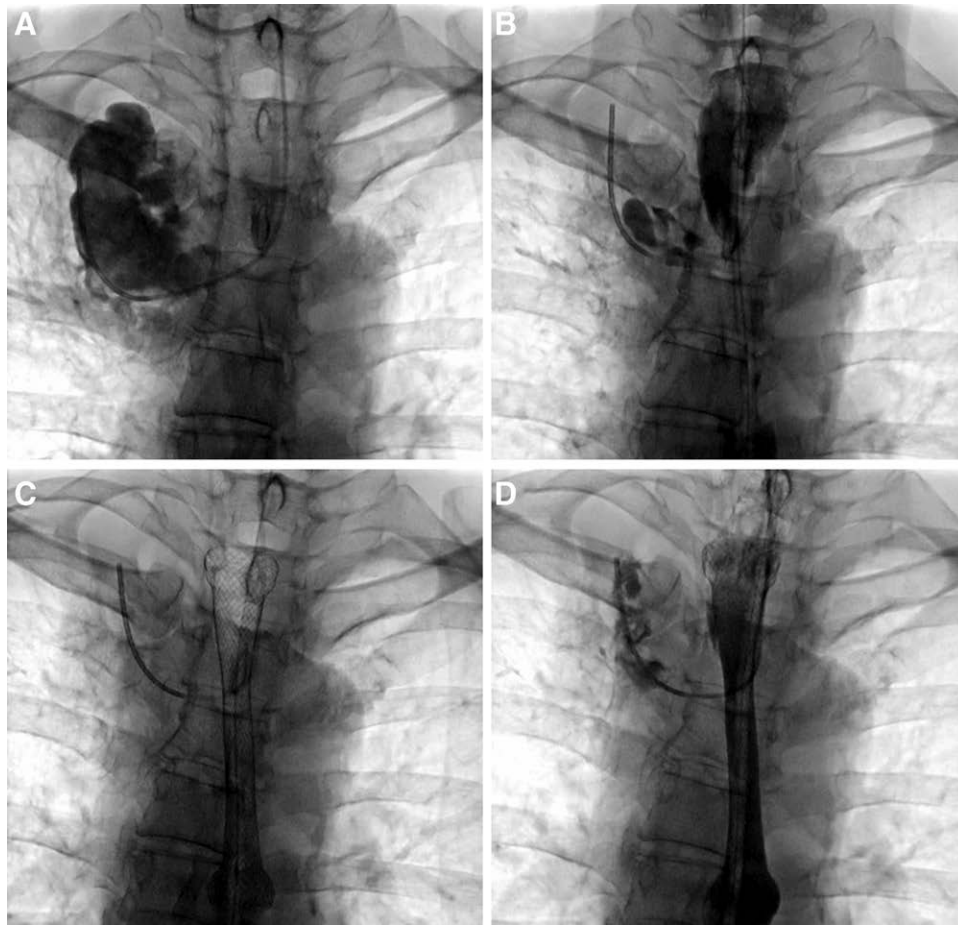


Figure 2. Interventional methods for the treatment of esophagomediastinal fistula. (A) A 5F catheter was introduced through into the distal end of mediastinal abscess cavity. (B) Esophagography was performed by drainage tube and showed a decreased abscess cavity 1-week post-procedure. (C) An esophageal covered stent was placed for this patient. (D) Esophagography showed that the contrast agent flows through the stent with no fistula after esophageal covered stent and drainage tube placement.

remaining patients showed fever, with a mean temperature of $38.6^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$. The maximal leukocytes were $11.2 \times 10^9/\text{L}$ and $9.9 \times 10^9/\text{L}$ ($P = .43$), and maximal neutrophil were 81.0% and 78.9% ($P = .58$) for group A and B, respectively. The mean duration of disease before referral to hospital was 11.5 ± 3.6 months in group A and 14.9 ± 4.3 months in group B. The mean duration from esophageal surgery to fistula formation was 7.0 ± 2.6 months in group A and 8.9 ± 3.7 months in group B. There were no significant differences in duration of disease, duration of fistula symptoms, maximal body temperature, maximal leukocytes count and maximal neutrophil percent between group A and group B (Table 1).

3.2. Interventional procedure outcomes

The median durations from fistula to interventional treatment were 7 days and 10 days for group A and B, respectively. All patients underwent successful 3-tube and covered stent placement, for a technical success rate of 100%. A total of 36 esophageal covered stents (25 common stents and 11 segmental stents) were placed, including 7 stents (4 common stents and 3 segmental stents) that were used as replacements. The median diameter of esophageal stents was 18 mm (range: 16–22 mm), and the median length was 120 mm (range: 60–160 mm). Three patients underwent stent removal during the perioperative period due to repeated stent migration ($n = 2$) or fistula closure failure ($n = 1$). The remaining patients showed satisfactory expansion of stents and successful fistula closure, for a clinical success rate of 88.5%

(23/26) in group B. There were no significant differences in time of hospitalization, average days of hospitalization or cumulative days of hospitalization between group A and group B.

3.3. Complications

A total of 13 complications occurred in all patients, including 5 major complications (1 death, 3 severe stent migration and 1 severe stent restenosis). One perioperative death was found in group A. This patient died of massive hemorrhage due to spontaneous rupture of fistula 3 days post-procedure. Obstruction or migration of the abscess drainage tube was found in 2 patients in group A. Stent migration was found in 8 patients in group B, with a migration rate of 39.1% (8/26). Two patients showed stent restenosis, with a restenosis rate of 13.0% (2/26). Stents were adjusted or replaced from 0 to 4 times. The abscess drainage tube was adjusted or replaced a median of 2 times (range 0–9 times).

3.4. Follow-up

Two patients in group B were lost to follow-up. The remaining 58 patients were successfully followed up, with a mean duration of 11.0 ± 2.0 months and 12.5 ± 2.3 months for group A and group B, respectively. Chest SCT showed that the abscess cavity healed in 18 of 34 patients in group A, and 20 of 24 patients in group B. The healing rate of fistula was significantly lower in group A than that in group B ($P = .02$). For patients with healing

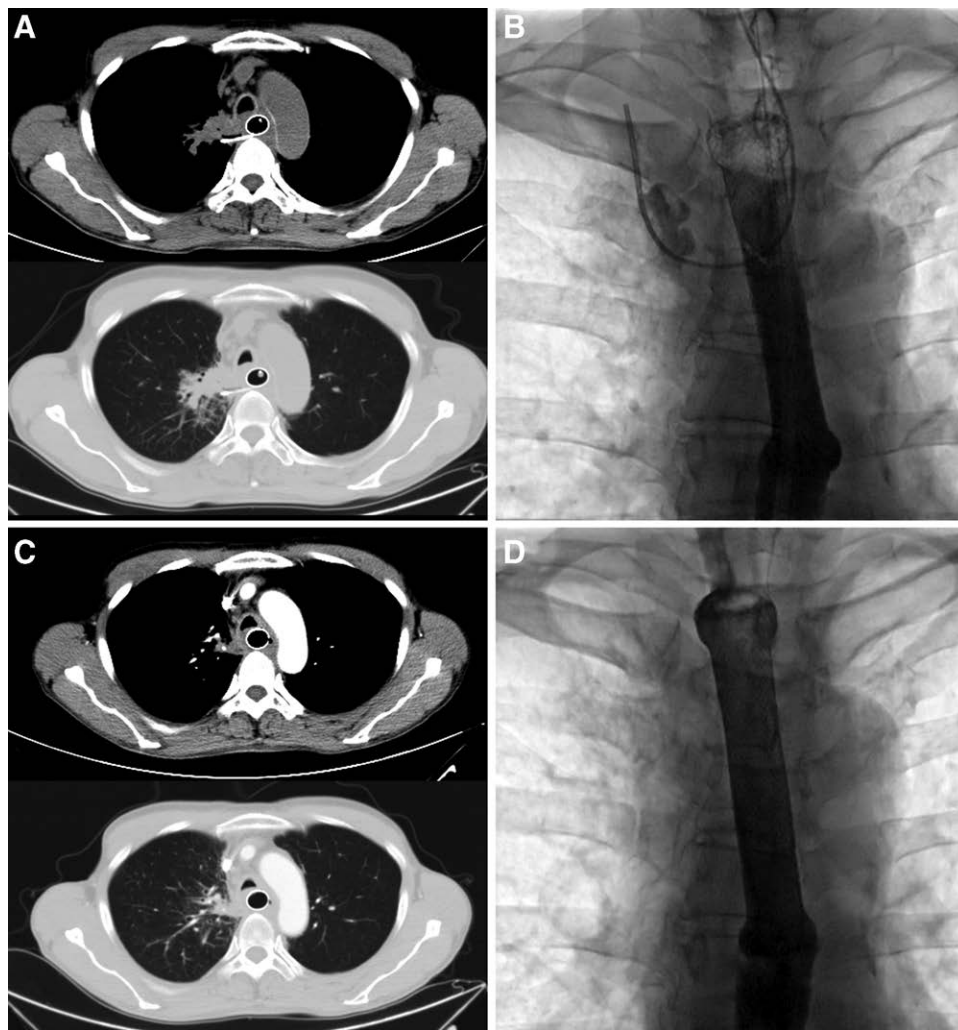


Figure 3. Follow-up by chest SCT scan and esophagography. (A–B) Three weeks after stent placement, chest SCT showed mediastinal abscess decreased obviously and stent and drainage tube in good position; esophagography showed that the contrast agent flows through the stent with no fistula and mediastinal abscess decreased. (C–D) Ten weeks after stent placement, chest SCT scan showed disappearance of mediastinal abscess, and the drainage tube was removed successfully. SCT = spiral computed tomography.

Table 1

Patient characteristics.

	Group A	Group B	P
n	34	26	
Gender, Male	25 (73.5%)	18 (69.2%)	.12
Age (yrs)	60.8 ± 1.9	61.8 ± 2.0	.74
Cause of fistula			
Resection of esophageal cancer	29	19	.33
Spontaneous rupture of esophageal cancer	5	7	.33
Duration of disease (mo)	11.5 ± 3.6	14.9 ± 4.3	.53
Duration from surgery to fistula formation (mo)	7.0 ± 2.6	8.9 ± 3.7	.67
Duration of fistula symptoms (months)	0.1 (0, 1.0)	0.2 (0, 2.0)	.35
Duration of fistula to interventional treatment (d)	7.0 (5.0, 14.0)	10.0 (5.5, 19.3)	.42
Maximal body temperature (°C)	38.6 ± 0.1	38.7 ± 0.1	.54
Maximal leukocytes (×10 ⁹ /L)	11.2 ± 1.2	9.9 ± 0.9	.43
Maximal neutrophil (%)	81.0 ± 2.4	78.9 ± 2.8	.58

of the abscess cavity, the duration from the interventional procedure to healing showed no significant difference between group A and group B. During follow up, abscess drainage tubes were

removed from 18 patients, and esophageal stents were successfully removed from 11 patients. The mean retention duration was 3.2 ± 0.7 months for stents and 4.1 ± 0.5 months for abscess drainage tubes, respectively. Patients in group B showed a better dysphagia score than group A on the day of discharge and during follow-up ($P = .01$). By the endpoint of follow up, 17 patients in group A and 11 patients in group B were still alive (Table 2). Twenty-eight patients died from multiple organ failure, lung infection, or metastasis due to tumor progression or recurrence. One patient died from a cardiac accident and the another died of spontaneous bleeding due to esophageal fistula. None of the deaths were related to procedure. The median survival was 13.2 months and 19.2 months in group A and B, respectively ($P = .44$). The 1-, 3-, 5-year survival rates were 52.9%, 37.1%, and 37.1% for group A, 63.6%, 21.8%, 0.0% for group B, respectively (Fig. 4).

4. Discussion

We retrospectively reviewed a series of 60 consecutive patients treated with interventional methods for esophagomediastinal fistula. Our data demonstrate that interventional treatment is safe, feasible and efficacious for esophagomediastinal fistula. Covered stent placement can promote healing of the abscess cavity and improve the swallowing. Stent migration occurred in

Table 2
Outcomes of interventional procedure.

	Group A	Group B	P
Hospital stay			
Time of hospitalization	2.5 ± 0.3	2.9 ± 0.4	.37
Average d of hospitalization	23.5 ± 5.4	30.5 ± 7.7	.45
Cumulative d of hospitalization	50.0 ± 7.2	63.9 ± 9.7	.24
Healing of abscess cavity			
Healing/Non healing	18/16	20/4	.02
Duration from procedure to healing (mo)	5.9 ± 0.8	5.2 ± 1.5	.66
Follow-up			
Loss to follow-up	0	2	.17
Duration of follow-up (mo)	11.0 ± 2.0	12.5 ± 2.3	.62
Death/alive	17/17	13/11	.79
Dysphagia score			
Before the procedure	3.8 ± 0.1	3.6 ± 0.1	.09
Day of discharge	3.6 ± 0.2	1.6 ± 0.4	<.01
During follow up	2.3 ± 0.4	1.1 ± 0.3	.01

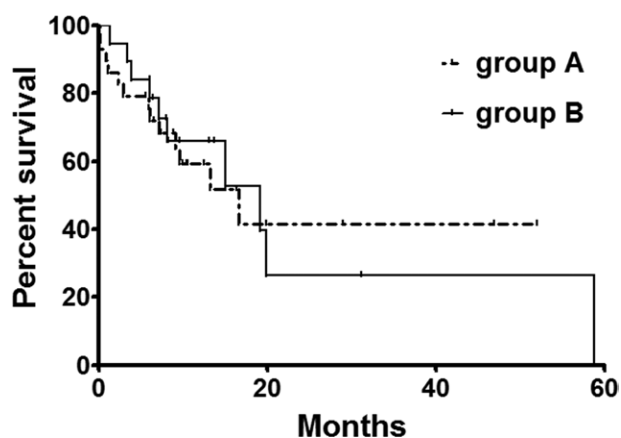


Figure 4. Survival rate follow-up. The 1-, 3-, 5-year survival rates were 52.9%, 37.1%, and 37.1% for group A, 63.6%, 21.8%, 0.0% for group B, respectively.

39.1% of 26 patients in group B, which is similar to previous reports.^[13,14] Only 1 perioperative death was observed, which was lower than reported previously.^[6,13,15,16]

Esophageal stents are initially inserted as a palliative treatment for esophageal diseases. Currently, esophageal stents have been used to treat benign esophageal diseases.^[13,15,17–19] Plastic stents are often used for the treatment of benign esophageal leaks or strictures owing to the ability to remove them more easily and with less damage to the esophageal wall.^[15] Metallic stents are mainly used for the treatment of malignant strictures^[20–22] or esophageal perforation or fistula.^[23–26] An uncontrollable mediastinal abscess is the leading cause of death in patients with malignant esophagomediastinal fistula. The key to treatment to successfully block the fistula by covered stent placement and adequate drainage of the abscess cavity. The timely management of our patients resulted in satisfactory clinical outcomes on the healing of fistula as well as the improvement of feeding, suggesting that the interventional method is effective and feasible.

There were certain complications in this study. One perioperative death was found in group A. A total of 13 complications were found in all patients, including 5 major complications. Obstruction or migration of the abscess drainage tube was found in 2 patients in group A. Stent migration was found in 8 patients in group B, with a migration rate of 39.1% (8/26).

Our study had some limitations. This was a retrospective study although a large series of patients were included. The

esophageal stents should be adjusted due to complication and abscess drainage tubes needed to be replaced repeatedly during follow-up. Our data indicated that covered stent placement can promote the healing of the abscess cavity and improve the swallowing condition; however, stent placement does not improve survival time. A prospective multi-center study is necessary to further demonstrate the advantages of stent placement. In conclusion, interventional treatment is safe, feasible and efficacious for esophagomediastinal fistula; covered stent placement can promote the healing of the abscess cavity and improve swallowing.

Author contributions

Conceptualization: Yonghua Bi, Xinwei Han.

Data curation: Hongmei Chen.

Investigation: Yonghua Bi, Hongmei Chen, Jianzhuang Ren.

Methodology: Yonghua Bi, Xinwei Han, Jianzhuang Ren.

Project administration: Jianzhuang Ren.

Resources: Hongmei Chen.

Supervision: Xinwei Han, Jianzhuang Ren.

Visualization: Jianzhuang Ren.

Writing – original draft: Yonghua Bi, Hongmei Chen.

Writing – review & editing: Xinwei Han, Jianzhuang Ren.

References

- [1] Leers JM, Vivaldi C, Schafer H, et al. Endoscopic therapy for esophageal perforation or anastomotic leak with a self-expandable metallic stent. *Surg Endosc.* 2009;23:2258–62.
- [2] Urschel JD. Esophagogastrostomy anastomotic leaks complicating esophagectomy: a review. *Am J Surg.* 1995;169:634–40.
- [3] Junemann-Ramirez M, Awan MY, Khan ZM, et al. Anastomotic leakage post-esophagogastrectomy for esophageal carcinoma: retrospective analysis of predictive factors, management and influence on longterm survival in a high volume centre. *Eur J Cardiothorac Surg.* 2005;27:3–7.
- [4] Zheng YZ, Dai SQ, Shan HB, et al. Managing esophageal fistulae by endoscopic transluminal drainage in esophageal cancer patients with superior mediastinal sepsis after esophagectomy. *Chin J Cancer.* 2013;32:469–73.
- [5] Blewett CJ, Miller JD, Young JE, et al. Anastomotic leaks after esophagectomy for esophageal cancer: a comparison of thoracic and cervical anastomoses. *Ann Thorac Cardiovasc Surg.* 2001;7:75–8.
- [6] Hofstetter W, Swisher SG, Correa AM, et al. Treatment outcomes of resected esophageal cancer. *Ann Surg.* 2002;236:376–84.
- [7] Bi Y, Li J, Yi M, et al. Interventional protocol for treatment of complications after esophagojejunostomy for esophagogastric carcinoma. *Gastroenterology Res Prac.* 2019;2019:1465301.
- [8] Toussaint E, Eisendrath P, Kwan V, et al. Endoscopic treatment of post-operative enterocutaneous fistulas after bariatric surgery with the use of a fistula plug: report of five cases. *Endoscopy.* 2009;41:560–3.
- [9] Lippert E, Klebl FH, Schweller F, et al. Fibrin glue in the endoscopic treatment of fistulae and anastomotic leakages of the gastrointestinal tract. *Int J Colorectal Dis.* 2011;26:303–11.
- [10] Bi Y, Li J, Yu Z, et al. Modified type of double-covered self-expandable segmental metallic stents for palliation of esophageal fistula. *J Laparoendosc Adv Surg Tech A.* 2019;29:875–9.
- [11] Pennathur A, Luketich JD. Resection for esophageal cancer: strategies for optimal management. *Ann Thorac Surg.* 2008;85:5751–6.
- [12] Lang H, Piso P, Stukenborg C, et al. Management and results of proximal anastomotic leaks in a series of 1114 total gastrectomies for gastric carcinoma. *Eur J Surg Oncol.* 2000;26:168–71.
- [13] Freeman RK, Van Woerkom JM, Ascoti AJ. Esophageal stent placement for the treatment of iatrogenic intrathoracic esophageal perforation. *Ann Thorac Surg.* 2007;83:2003–7; discussion 2007.
- [14] Schubert D, Scheidbach H, Kuhn R, et al. Endoscopic treatment of thoracic esophageal anastomotic leaks by using silicone-covered, self-expanding polyester stents. *Gastrointest Endosc.* 2005;61:891–6.
- [15] Hunerbein M, Stroszczyński C, Moesta KT, et al. Treatment of thoracic anastomotic leaks after esophagectomy with self-expanding plastic stents. *Ann Surg.* 2004;240:801–7.

- [16] Freeman RK, Ascoti AJ, Wozniak TC. Postoperative esophageal leak management with the Polyflex esophageal stent. *J Thorac Cardiovasc Surg.* 2007;133:333–8.
- [17] Fischer A, Thomusch O, Benz S, et al. Nonoperative treatment of 15 benign esophageal perforations with self-expandable covered metal stents. *Ann Thorac Surg.* 2006;81:467–72.
- [18] Peters JH, Craanen ME, van der Peet DL, et al. Self-expanding metal stents for the treatment of intrathoracic esophageal anastomotic leaks following esophagectomy. *Am J Gastroenterol.* 2006;101:1393–5.
- [19] Bi Y, Ren J, Li J, et al. A novel fully covered self-expandable segmental metallic stents for the treatment of refractory esophageal stenosis. *J Thorac Dis.* 2019;11:1363–9.
- [20] Kauer WK, Stein HJ, Dittler HJ, et al. Stent implantation as a treatment option in patients with thoracic anastomotic leaks after esophagectomy. *Surg Endosc.* 2008;22:50–3.
- [21] Bi Y, Li J, Yi M, et al. Self-expanding segmental radioactive metal stents for palliation of malignant esophageal strictures. *Acta Radiol.* 2020;61:921–6.
- [22] Bi Y, Yi M, Yu Z, et al. Covered metallic stent for the treatment of malignant esophageal fistula combined with stricture. *BMC Gastroenterol.* 2020;20:248.
- [23] Bi Y, Zhu X, Yu Z, et al. Interventional radiology protocol for treatment of esophagogastric anastomotic leakage. *Radiol Med.* 2019;124:1253–61.
- [24] Siersema PD. Treatment of esophageal perforations and anastomotic leaks: the endoscopist is stepping into the arena. *Gastrointest Endosc.* 2005;61:897–900.
- [25] White RE, Mungatana C, Topazian M. Expandable stents for iatrogenic perforation of esophageal malignancies. *J Gastrointest Surg.* 2003;7:715–9; discussion 719.
- [26] Bi Y, Wu Z, Yi M, et al. Three-tube method and covered metallic stent for the treatment of anastomotic leakage after esophagectomy. *BMC Gastroenterol.* 2020;20:330.