Author Query Form

Journal: *Annals of Translational Medicine*
Manuscript ID: ATM-16-684
doi: 10.21037/atm.2016.10.32
Title: A new technique to repair huge tracheo-gastric fistula following esophagectomy
Corresponding author: Alfonso Fiorelli

Dear Dr. Fiorelli,

The proof of your manuscript is attached on the following page(s). Please read through the document carefully to check for accuracy, reference citations, and figures and tables. Please also be aware a professional copyeditor may have edited your manuscript to comply with the ATM style requirements.

In addition to proofing the article, the following queries have arisen during the preparation of your paper. Please address the queries listed below by making the appropriate changes in the text.

If you have any other revisions that you would like to make, this will be the last opportunity to do so before the article is published. In particular, please ensure that the author's names and affiliations have been identified correctly, and the address of the corresponding author is correct.

If the changes cannot be easily described through email, please annotate this proof according to the annotation guidelines as detailed on the following page.

Query Reference	Query	Author's response
Q1	Please note that the link with the DOI number for the manuscript should be valid only after the whole issue is official published.	
Q2	Please note that alterations cannot be made after you have approved for publication, irrespective of whether it is Online First.	
Q3	Author SURNAMES (family names) have been highlighted in red - please check that these are correct.	
Q4	Please check affiliations, correspondence details.	
Q5	Please check acknowledgements section and confirm the disclosure.	
Q6	Any funding for this paper or research reported? If so, please provide information of the funding.	
Q7	Please provide the English Form for affiliation.	
Q8	Please provide a running title within limits to 60 characters.	

Once you have completed your revisions and/or addressed all the queries, or if you are satisfied with the proof in its existing form, please email: e-proof@amegroups.com.

To ensure the timely publication of your article, please respond within 48 hours.

Making corrections

Use Adobe Reader – available for free from http://get.adobe.com/reader/ – to open the attached document.

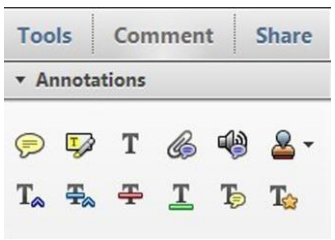

Figure 1 Adobe Acrobat X

Adobe Professional 7:
Tools → Commenting → show Commenting Toolbar

Adobe Reader 8:
Tools → Comments & Markup → show Comments and Markup Toolbar

Adobe Reader 10 and above:
Comment → choose either Sticky Note or Highlight Text

In-text edits	**Select the appropriate symbol and then click and drag over the text to be modified.** **Replace** : denotes where the text should be replaced with an alternative option **Strikethrough** : crosses out the text **Underline** : underlines the text **Add note to text** : links selected text with a pop-up note
Sticky notes	**To make a note:** choose the Sticky Note option and then click on a desired location **Changing the name:** double-click and choose Options → Sticky Note Properties → General → insert desired name **To move:** click anywhere (apart from the text field) and drag **To resize:** click on the right or left hand order and drag **To close:** click the box on the upper right corner; this does NOT delete your note **To delete:** click and press the Delete keyboard button or right click and select delete from the drop-down menu
Highlighting	**This allows you can highlight parts of the text.** **To highlight:** select Highlight and then click and drag over the text to be highlighted. When finished, click on Highlight again to turn off the option. **To change the colour:** double-click on the highlighted text and choose Options → Properties → Appearance → Color

Saving your changes:
Click on *File → Save* before closing the document.

For more detailed instructions on using Adobe Acrobat, please refer to
http://www.adobe.com/support/acrobat/gettingstarted/

Case Report

A new technique to repair huge tracheo-gastric fistula following esophagectomy

Francesco Paolo Caronia[1], Alfonso Fiorelli[2], Mario Santini[2], Roberto Alfano[3], Sergio Castorina[4]

[1]Thoracic Surgery Unit, Istituto Oncologico del Mediterraneo Hospital, Catania, Italy; [2]Thoracic Surgery Unit, Seconda Università degli Studi di Napoli, Naples, Italy; [3]General Surgery Unit, Seconda Università degli Studi di Napoli, Naples, Italy; [4]Azienda Ospedaliera Ospedali Riuniti Villa Sofia-Cervello, Palermo, Italy

Correspondence to: Alfonso Fiorelli, MD, PhD. Thoracic Surgery Unit, Second University of Naples Piazza Miraglia, 2 I-80138 Naples, Italy. Email: alfonso.fiorelli@unina2.it.

Abstract: We reported the management of a life-threatening condition as a large tracheo-gastric fistula involved the carina, the left and the right bronchus that complicated Ivor Lewis esophagogastrectomy for esophageal cancer. An urgent right thoracotomy was performed and the tracheal defect was covered with a reversed pedicled pericardial patch reinforced with an intercostal muscle flap. Cervical esophagostomy and a feeding jejunostomy completed the operation. Five months later, the continuity of gastrointestinal tract was restored using a transverse colon.

Keywords: Tracheo-gastric fistula; esophagectomy; esophageal cancer

Submitted Sept 05, 2016. Accepted for publication Sept 13, 2016.
doi: 10.21037/atm.2016.10.32
View this article at: http://dx.doi.org/10.21037/atm.2016.10.32

Introduction

Tracheo-gastric fistula after esophagectomy for cancer is a rare and life-threatening clinical condition (1,2). Surgery, when feasible, is the treatment of choice despite the large size of the fistula makes it challenging. Herein, we described a new technique as the use of pericardial and intercostal flaps for closing a huge tracheo-gastric fistula after esophagectomy for cancer.

Case presentation

A 55-year-old male was referred to our institution for managment of squamous cell carcinoma of the middle-third of the esophagus. No induction therapy was perfomed and all diagnostic exams excluded lymph node involvement and distant metastases.

The patient underwent a subtotal esophagectomy and the gastric conduit was anastomosed to the cervical esophagus ~~trough a mediastinal route~~ using a circular stapler. The patient was extubated in post-operative day-1 (POD-1) and discharged from the intensive care unit (ICU) ~~on~~ POD-3. A cervical emphysema occurred ~~on~~ POD-7. Esophago-gastroscopy and flexible bronchoscopy showed the necrosis of gastric tubule, distally to the cervical anastomosis, and a huge fistula that involved the carina, the main right and left bronchus (*Figure 1*). Following, the patient had an acute severe respiratory failure due to right hypertensive pneumothorax with left mediastinal shift and extensive subcutaneous emphysema. He was immediately intubated with an 8-mm side cuffed oral tube that was ~~selectively~~ placed ~~under endoscopic view~~ within left main bronchus to overcome the carinal defect and assure the ventilation. A right thoracotomy was immediately performed. The excision of gastric tubule and all necrotic tissues showed a carinal defect of 4 cm in size (*Figure 2A,B*). Pericardium was pediculized (*Figure 2C,D*) and used to reconstruct the pars membranacea of the trachea (*Figure 2E,F*). Then, endotracheal tube was proximally retired into the trachea to allow the ventilation of both lungs. Despite the lack of air leaks after instillation of saline solution, we noticed a paradoxical movement of the pericardial flaps ~~during the positive air-way pressure of mechanical ventilation~~. Thus, an intercostal muscle flap was used to reinforce the reconstruction of the posterior wall of the trachea (*Figure 2G,H*). An end-cervical esophagostomy, an esophageal diversion and a feeding jejunostomy completed the operation. Four drains were left in site, one within neck, two within the

Figure 1 Flexible bronchoscopy showed the tracheo-esophageal fistula. Available online: http://www.asvide.com/articles/XXX

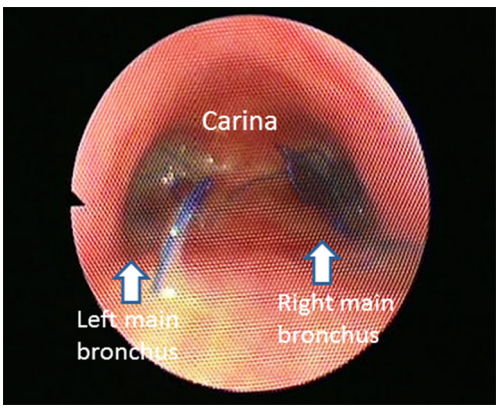

Figure 3 Complete closure of the fistula with stitches still inside the right and left bronchus.

mediastinum and one in abdomen. The patient was ventilated with low-tidal volumes and airway pressures to preserve tracheal closure. Repeated bronchoscopes were performed to exclude any defect of fistula closure and to clean air way from secretions. Antibiotics were given based on airway and blood cultures. Enteral feeding was administered since the 5th post-operative day and all drains were removed ~~on~~ 15 days after. Bronchoscopy performed on 27th POD showed the healing of tracheal defect and normal air-way patency. Patient was extubated on 28th POD and discharged 5 days later.

Three months' follow-up bronchoscopy showed a normal air-way patency in absence of fistula and/or stenosis. The stitches were well evident (*Figure 3*) but they were expectorated few weeks later. Five months later, a successfully esophageal replacement with a colon conduit was performed. Patient died 9 months later for abdominal recurrence.

Discussion

A fistula between the trachea and the gastric tube related to esophagectomy is a rare and life-threatening clinical condition (1,2). Despite conservative and endoscopic treatments have been proposed (4-7), surgery remains the treatment of choice when feasible (7-11). However, it could be particularly challenging, as in the present case, due to the large dimension of the fistula (about 4 cm) and its extension (involving carina, main left and right bronchus).

Impaired blood supply to the gastric tube was the most likely explanation for development of fistula, in the present case. The necrotic gastric tubule invaded the carina and the main left and right bronchus. The critical respiratory condition of the patient required an emergency surgery. Over the years, several strategies have been proposed to repair tracheo-bronchial fistula using alloplastic, prosthetic materials, and intra or extra-thoracic muscle flaps (7-15). However, all these procedures resulted to be unfeasible for closure our defect. The direct closure of the fistula ~~or performing an end-to-end tracheo-bronchial anastomosis~~ was at high risk of failure due to the extension of local infection. ~~Autologous or bovine pericardium, pleural flap or extra-thoracic muscle flaps had a too thin depth for closing a large defect as the present, with high risk of rupture due to positive airway pressure of mechanical ventilation.~~ Song *et al.* (16) reported a successful gastrotracheal fistula closure with a twisted pericardial flap after Ivor Lewis esophagogastrectomy for esophageal cancer. Gorenstein *et al.* (17) and Foroulis *et al.* (18) reported the use of a free pericardial patch for closing a tracheal laceration during a transhiatal esophagectomy. In this case, we also used a pericardial patch to repair the carinal defect but conversely to previous experiences (17,18), the pericardium flap was not twisted niether used as free to preserve its vascularization. Philippi *et al.* (19) described the use of intercostal muscle flaps for reconstruction of posterior wall of trachea in dogs. Its flap consisted of three intercostal muscles with their pedicle applied to the posterior wall of trachea with the pleural aspect facing the tracheal lumen. We fashioned only a single intercostal muscle flap that was fixed over the pericardial patch in order to reinforce the tracheal reconstruction and prevented any ~~damange~~ due to ~~positive airway pressure during mechanical ventilation.~~ In addition, the intercostal muscle flap assisted the neo-vascularization of the pericardial flap and thus facilitated the physiological healing of the lesion (20). Despite the prolonged mechanical ventilation (28 days), no ~~failure~~ of

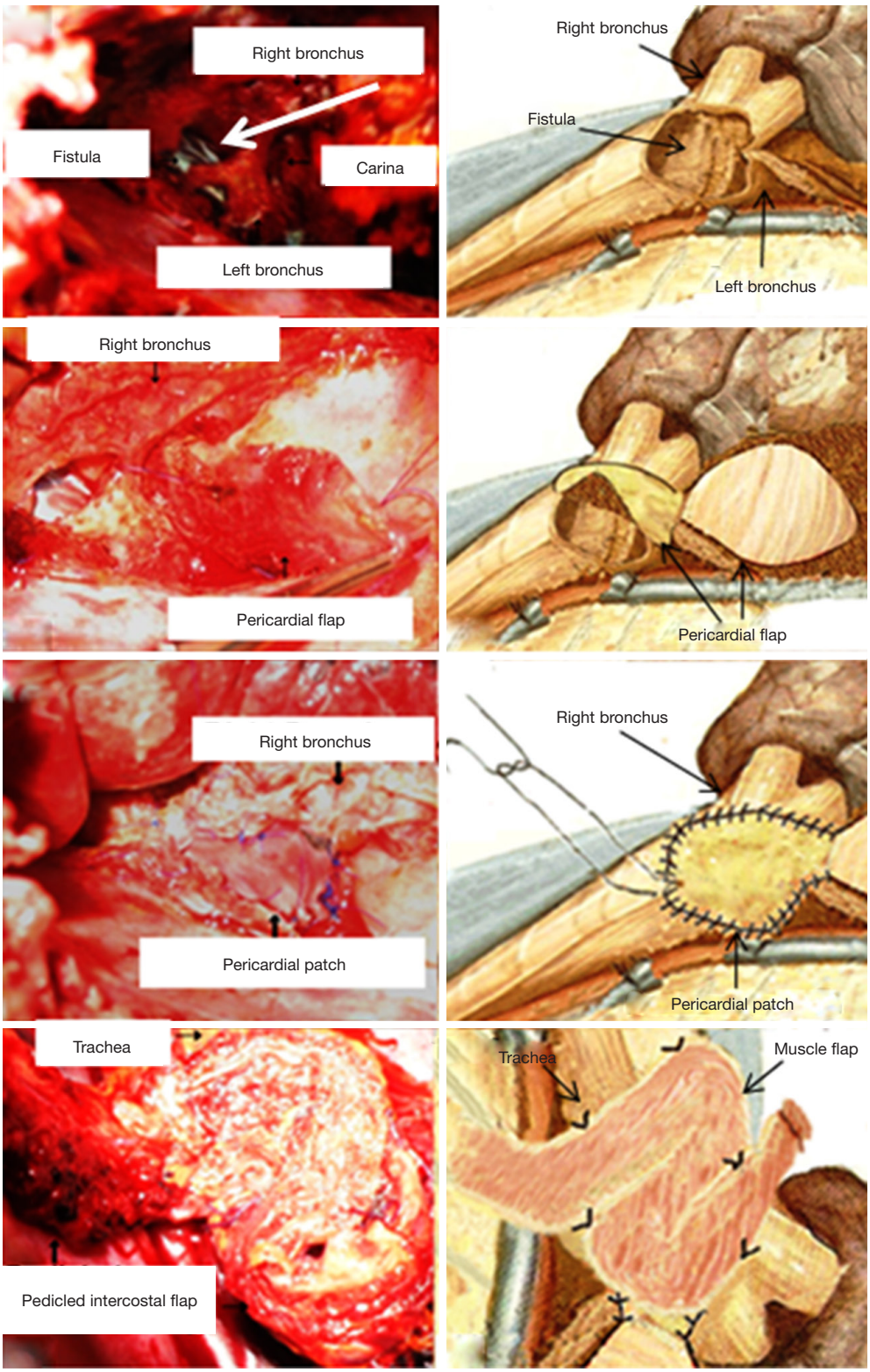

Figure 2 Tracheal defect with tracheal tube (white arrow) within the left main bronchus (A-B); mobilization of pericardial flap without torsion (C-D); fistula closure with pericardial flap (E-F); reinforcement of closure with intercostal muscle flap (G-H).

closure occurred.

In conclusion, our new technique as the use of pericardial patch reinforced with intercostal flap could be useful for surgeons in the management of a rare and challenging situation as tracheo-gastric fistula after esophagectomy for cancer.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

References

1. Buskens CJ, Hulscher JB, Fockens P, et al. Benign tracheo-neo-esophageal fistulas after subtotal esophagectomy. Ann Thorac Surg 2001;72:221-4.
2. Yasuda T, Sugimura K, Yamasaki M, et al. Ten cases of gastro-tracheobronchial fistula: a serious complication after esophagectomy and reconstruction using posterior mediastinal gastric tube. Dis Esophagus 2012;25:687-93.
3. Caronia FP, Fiorelli A, Santini M, et al. A new technique to repair huge tracheo-gastric fistula following esophagectomy. Asvide 2016;3:xxx.
4. Fiorelli A, Esposito G, Pedicelli I, et al. Large tracheobronchial fistula due to esophageal stent migration: Let it be! Asian Cardiovasc Thorac Ann 2015;23:1106-9.
5. Wang F, Yu H, Zhu MH, et al. Gastrotracheal fistula: treatment with a covered self-expanding Y-shaped metallic stent. World J Gastroenterol 2015;21:1032-5.
6. Santini M, Fiorello A, Cappabianca S, et al. Unusual case of Boerhaave syndrome, diagnosed late and successfully treated by Abbott's T-tube. J Thorac Cardiovasc Surg 2007;134:539-40.
7. Fiorelli A, Frongillo E, Santini M. Bronchopleural fistula closed with cellulose patch and fibrin glue. Asian Cardiovasc Thorac Ann 2015;23:880-3.
8. Marty-Ané CH, Prudhome M, Fabre JM, et al. Tracheoesophagogastric anastomosis fistula: a rare complication of esophagectomy. Ann Thorac Surg 1995;60:690-3.
9. Kalmár K, Molnár TF, Morgan A, et al. Non-malignant tracheo-gastric fistula following esophagectomy for cancer. Eur J Cardiothorac Surg 2000;18:363-5.
10. Li YD, Li MH, Han XW, et al. Gastrotracheal and gastrobronchial fistulas: management with covered expandable metallic stents. J Vasc Interv Radiol 2006;17:1649-56.
11. Kron IL, Johnson AM, Morgan RF. Gastrotracheal fistula: a late complication after transhiatal esophagectomy. Ann Thorac Surg 1989;47:767-8.
12. Poje CP, Keane W, Atkins JP Jr, et al. Tracheo-gastric fistula following gastric pull-up. Ear Nose Throat J 1991;70:848-50.
13. Caronia FP, Fiorelli A, Santini M, et al. A persistent tracheocutaneous fistula closed with two hinged skin flaps and rib cartilage interpositional grafting. Gen Thorac Cardiovasc Surg 2016;64:625-8.
14. Caronia FP, Fiorelli A, Zanchini F, et al. Reconstruction with a pectoralis major myocutaneous flap after left first rib and clavicular chest wall resection for a metastasis from laryngeal cancer. Gen Thorac Cardiovasc Surg 2016;64:294-7.
15. Caronia FP, Fiorelli A, Arrigo E, et al. Management of subtotal tracheal section with esophageal perforation: a catastrophic complication of tracheostomy. J Thorac Dis 2016;8:E337-9.
16. Song SW, Lee HS, Kim MS, et al. Repair of gastrotracheal fistula with a pedicled pericardial flap after Ivor Lewis esophagogastrectomy for esophageal cancer. J Thorac Cardiovasc Surg 2006;132:716-7.
17. Gorenstein LA, Abel JG, Patterson GA. Pericardial repair of a tracheal laceration during transhiatal esophagectomy. Ann Thorac Surg 1992;54:784-6.
18. Foroulis CN, Simeoforidou M, Michaloudis D, et al. Pericardial patch repair of an extensive longitudinal iatrogenic rupture of the intrathoracic membranous trachea. Interact Cardiovasc Thorac Surg 2003;2:595-7.
19. Philippi D, Valleix D, Descottes B, et al. Anatomic basis of tracheobronchial reconstruction by intercostal flap. Surg Radiol Anat 1992;14:11-5.
20. Rendina EA, Venuta F, Ricci P, et al. Protection and revascularization of bronchial anastomoses by the intercostal pedicle flap. J Thorac Cardiovasc Surg 1994;107:1251-4.

Cite this article as: Caronia FP, Fiorelli A, Santini M, Alfano R, Castorina S. A new technique to repair huge tracheo-gastric fistula following esophagectomy. Ann Transl Med 2016. doi: 10.21037/atm.2016.10.32