Original Article

Management of Post-Intubation Tracheal Membrane Ruptures

Aykut Eliçora MD[1], Aslı G. Akgül MD[1], Salih Topçu MD PhD[1], Serkan Özbay MD[1], Tülay Hoşten MD[2], Hüseyin F. Sezer MD[1], Sultan Şevik Eliçora MD•[3]

Abstract

Background: Iatrogenic tracheal rupture is a rare complication after intubation. Overinflation of the tracheal cuff was speculated to be a frequent cause of tracheal rupture. The surgical approach is a widespread treatment for tracheal ruptures. The aim of this study is to evaluate the results of conservative and surgical therapy approaches in tracheal rupture cases inflicted by tracheal intubation.

Methods: Data on 12 patients who experienced tracheal ruptures secondary to intubation were reviewed. The average age of the patients was 58 years (range of 38 to 81 years). Six patients were men and 6 patients were women. Four of the patients were performed thoracotomy for primary surgery and underwent surgical therapy. 8 patients were treated conservatively. The results of both approaches were evaluated.

Results: Patients, who underwent both conservative and surgical therapy, were completely recovered. There was no rupture originated complication or death.

Conclusions: Both conservative and surgical therapies are appropriate for treatment of membranous tracheal rupture.

Keywords: Conservative approaches, intubation, tracheal rupture

Cite this article as: Eliçora A, Akgül AG, Topçu S, Özbay S, Hoşten T, Sezer HF, Eliçora SS. Management of post-intubation tracheal membrane ruptures. *Arch Iran Med*. 2016; **19(7):** 491 – 495.

Introduction

Although traumatic and iatrogenic tracheal injuries are very rare, such injuries are life-threatening. Intubation is the most common cause of iatrogenic injury.[1] The proportion of tracheal rupture secondary to double-lumen tube intubation ranges from 0.05% – 0.19%. This proportion is lower upon single-lumen tube intubation.[2,3] Although the rate of posterior wall injury is associated with the employed technique, 0.2% – 0.9% of tracheostomies are associated with such injuries.[4,5] The most common symptoms of tracheal rupture secondary to intubation are subcutaneous emphysema and respiratory distress, developing immediately after intubation.[6] The first-line diagnostic method is bronchoscopy. No precise consensus on the use of a conservative or surgical approach to treat tracheal rupture secondary to intubation has yet emerged. We seek to share the conservative and surgical methods to treat 12 tracheal ruptures developing secondary to intubation.

Materials and Methods

Data on 12 patients who experienced tracheal ruptures secondary to intubation were retrospectively reviewed. Patients were treated and followed-up in our clinic, between 2005 and 2014. The average age of the patients was 58 years (range of 38 to 81 years). The female/male ratio was one (M/F = 6/6). Four patients were intubated with double-lumen tubes and eight with single-lumen tubes. Ten patients were intubated due to elective surgery and two because of medical emergencies (myocardial infarction and cerebrovascular disease). Intubation was not recorded as difficult in any cases. Tracheal lacerations were confirmed via fiberoptic bronchoscopy in all cases. Age, sex, symptoms, treatments, outcomes, as well as radiological and endoscopic findings were noted in details (Table 1).

In four patients, double-lumen tube intubation was considered as the principal factor causing rupture. One of the patients had narrowed tracheal lumen due to retrosternal goiters; another patient had reduced support of the posterior trachea owing to treat oesophageal cancer. Two patients had no predisposing factors. In two patients, emergency intubations, associated with a cerebrovascular disease and myocardial infarction, were performed. Use of a stylet was among the predisposing factors. In six cases intubated with single-lumen tubes under preoperative elective conditions.

Results

Nine patients developed subcutaneous emphysema after intubation. This was the principal indicator arousing a suspicion of tracheal laceration. Intraoperative mediastinal emphysema developing in three cases also made us suspect tracheal lacerations. In three cases that developed peroperative mediastinal emphysema, the tracheal laceration could be observed from the outside during operation. Pneumothorax was radiologically detected on the right side in two cases, and a tracheal laceration was observed upon chest CT of one case with subcutaneous emphysema (Figure 1a, 1b). Fiberoptic bronchoscopy was used to diagnose tracheal lacerations in all cases; longitudinal lacerations were evident in membranous regions (Figure 2). In eight cases, tracheal lacerations were located in the upper two-thirds of the tube and in the lower one-third of four cases. The longest laceration was 6 cm and the shortest was

Authors' affiliations: [1]Department of Thoracic Surgery, Faculty of Medicine, Kocaeli University, Kocaeli, Türkiye, [2]Department of Anesthesiology and Reanimation, Faculty of Medicine, Kocaeli University, Kocaeli, Türkiye, [3]Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Bülent Ecevit University, Zonguldak, Türkiye.
•**Corresponding author and reprints:** Aykut Eliçora MD, Department of Thoracic Surgery, Faculty of Medicine, Kocaeli University, Kocaeli, Turkey. Tel:+90-262-3037575, E-mail: aykutelicora@yahoo.com.tr.
Accepted for publication: 18 May 2016

Table 1. Age, sex, symptoms, radiological and endoscopic findings, treatments, and outcomes

Age	Gender	Endotrachealtube type	Laceration lenght	Reasonforintubation	Symptoms/radiographic findings	Treatment	Results
45	Female	Single Lumen	3 cm	Lumbar disc herniation, discectomy (elective)	Subcutaneous emphysema	Conservative Spontaneous breathing Oxygen support Antibiotics	Successful
40	Male	Double Lümen	3 cm	Esophagus Cancer, Right thoracotomy Esophagectomy (elective)	Subcutaneous emphysema, Dyspnea.	Conservative İntubation, Mechanical ventilation, Antibiotics	Successful
38	Female	Double Lümen	5 cm	Right lung, Hydatid Cyst, Right thoracotomy, cystectomy capitonnage (elective)	Perop. Mediastinalemphysema	Surgicalsuture Oxygensupport Antibiotics	Successful
70	Male	Double Lümen	6 cm	Retrosternalgoitre, Collarincision+Right thoracotomy (elective)	Perop. Subcutaneous emphysema	Surgicalsuture Oxygensupport Antibiotics	Successful
72	Male	Double Lümen	4.5 cm	Lung Cancer Right thoracotomy Pneumonectomy (elective)	Perop. Mediastinal emphysema	Surgicalsuture Oxygensupport Antibiotic	Successful
60	Female	SingleLumen	2 cm	Lumber disk hernisi (elective)	Subcutaneous emphysema	Conservative Spontaneousbreathing Oxygensupport Antibiotics	Successful
55	Female	SingleLumen	3 cm	Renal cancer, Nephrectomy (elective)	Subcutaneous emphysema Right pneumothorax	Conservative Spontaneous breathing Antibiotics Chest tube	Successful
42	Female	SingleLumen	2.5 cm	Thyroidectomy (elective)	Subcutaneous emphysema	Conservative Spontaneous breathing Antibiotics	Successful
73	Female	SingleLumen	3 cm	Cerebrovascular disease (emergency)	Subcutaneous emphysema	Conservative Tracheostomy Mechanical ventilation Antibiotics	Successful
65	Male	SingleLumen	3.5 cm	Prostate Cancer	Subcutaneous emphysema	Conservative Spontaneous breathing Antibiotics	Successful
81	Male	SingleLumen	3 cm	Myocardial infarction (emergency)	Subcutaneous emphysemaRight pneumothorax	Conservative Spontaneous breathing Antibiotics Chest tube	Successful
53	Male	SingleLumen	6 cm	Esophagus Cancer , Right thoracotomy Esophagectomy.	Perop. Mediastinal emphysema	Surgical suture Antibiotics	Successful

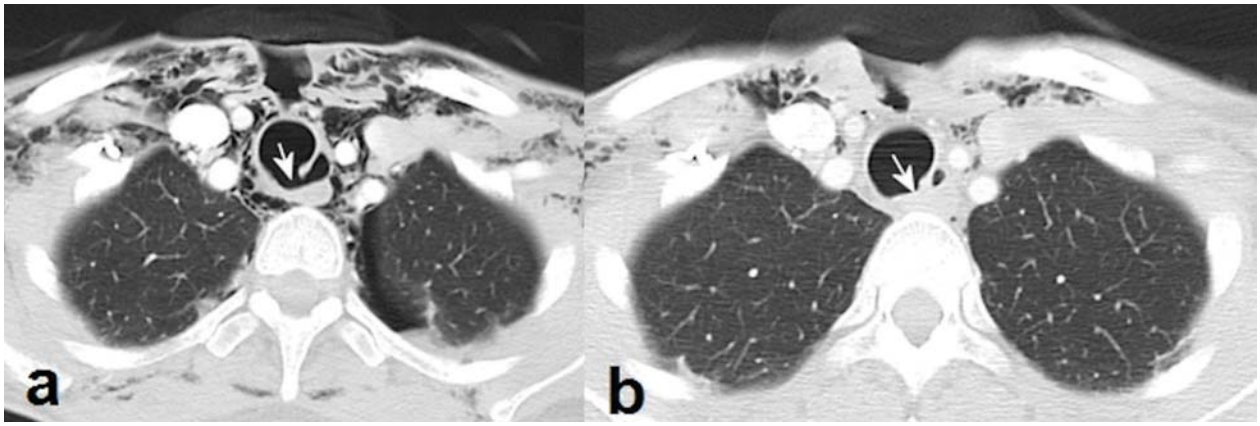

Figure 1. Thorax computed tomography images ; **a)** tracheal laceration (White arrow) and subcutaneous emphysema; **b)** After five days, healed tracheal laceration (White arrow).

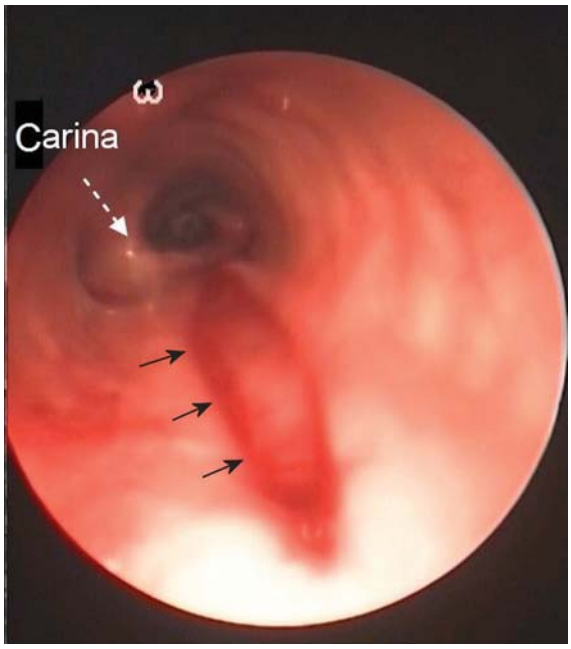

Figure 2. Fiberoptic bronchoscopy image shows tracheal laceration (Black arrow).

2 cm (average length: 3.7 cm). The laceration length in patients who underwent surgical therapy and conservative therapy was 4.5 – 6 cm and 2 – 3.5 cm, respectively.

Four patients who underwent thoracotomy were treated by surgical sutured. As tracheal lacerations developed during thoracic surgery (right posterolateral thoracotomy) in three patients, the choice of surgical treatment became a priority. An additional, intraoperative, posterolateral thoracotomy incision was made to treat a laceration with 6 cm long in a patient with a retrosternal goiter in whom tracheal rupture was accompanied by a laceration extending up to the level of the carina. To repair the posterior wall, the mediastinal pleura was opened and surgically sutured (two cases) using single vicryl stitches and in one case, continuously sutured using polydioxanone (PDS). The region between the trachea and esophagus was supported with an intercostal muscle flap in one case. These patients were evaluated via rigid bronchoscopy at the end of their operations, before anaesthesia was terminated. Conservative approaches were preferred in eight cases. Two cases were endotracheally intubated in a region distal to the laceration, with the assistance of fiberoptic bronchoscopy, due to requirements for mechanical ventilation. Intubated patients were extubated after 48 hours. As the patient with a history of cerebrovascular disease required long-term mechanical ventilation, a tracheostomy was performed distal to the laceration.

Conservative approaches, featuring spontaneous breathing, were applied in six patients. All of these patients received oxygen support and ampicillin sulbactam treatment (4 g/day). The epithelisation of the lacerations were observed via fiberoptic bronchoscopy on postoperative days 3 and 7, after the subcutaneous emphysema had resolved. All patients responded to treatment and none died.

Discussion

Iatrogenic tracheal rupture after intubation is extremely rare. The incidence upon single-lumen endotracheal tube placement is between 1/20,000 and 1/75,000.[7,8] In recent years, new devices and methods have been developed to make intubation easier. Tracheal rupture is a complication that every doctor may encounter. Also, there is no consensus on the treatment of this complication.

As the diameter of double- lumen tubes is greater than that of

single-lumen tubes, intubation with the former tubes often causes rupture of the tracheal tube.[8,9] Typically, the lesions present as longitudinal lacerations on the posterior tracheal wall.[8] Four of our patients were intubated with double-lumen tubes consistent with literature indications, and their lacerations exhibited longitudinal extensions. As the female trachea is narrower, shorter, and weaker than that of males, tracheal rupture occurs more often in females.[1,8,10,11] In our experience, the female-to-male ratio was unity. The exact cause of tracheal rupture secondary to intubation remained uncertain.

As the left posterior wall of the trachea is anatomically supported by the oesophagus, tracheal lacerations often develop on the right side.[10] In one of our patients intubated with a single-lumen tube, and in another intubated with a double-lumen tube, tracheal lacerations developed during oesophageal surgery.

Over-inflation of the cuff of the endotracheal tube is another most common cause of tracheal rupture.[6,12] The cuff should be deflated, when positioning the tube, to prevent trauma to the tracheal mucosa.[13] When the cuff is inflated, positioning of the head and body during operation is important. Diffusion of nitric oxide into the cuff during operation can increase cuff pressure, which should be as low as possible in patients undergoing oesophageal surgery. During oesophageal dissection, the membranous region of the trachea becomes more vulnerable.[14] In two of our cases, tracheal rupture occurred during oesophageal surgery; in this context, a thin membranous trachea is a major risk factor.

Even intubation is not difficult, tracheal lacerations can develop throughout the path taken by the intubation tube if the tube tip damages the mucosa. Similarly, stylets in intubation tubes may cause tracheal lacerations.[3,15] Stylets were used in two of our patients, who required emergency intubations.

If subcutaneous emphysema develops during or after surgery, a tracheal mucosal injury should be suspected.[6] It should not be forgotten that pneumomediastinum and pneumothorax might also be present.[16] Such conditions, make it difficult to locate the tracheal injury because of extensive subcutaneous emphysema of the head, neck, and chest. Computed tomography (CT) and bronchoscopy should be used in combination when a tracheal injury is suspected. A pneumomediastinum evident on computed tomography may suggest a tracheal laceration. However, the evident location of a tracheal laceration on CT, does not always coincide with that detected via bronchoscopy. The sensitivity of tracheal laceration detection by CT is 85%.[17] Therefore; bronchoscopic evaluation is a favoured first-line approach to diagnose tracheal laceration.

Traditionally, lacerations are treated surgically. Lacerations in the lower two-thirds of the trachea are classically repaired via right thoracotomy, whereas those in the upper one-third are treated via a cervical incision.[18,19] If patients in poor condition are treated via open thoracic surgery, the mortality rate is over 71%.[20] Lacerations can be repaired without additional incisions if the lacerations develop during open thoracic surgery.[2,10] Three of our patients developed tracheal lacerations during thoracic surgery; these were sutured immediately.

Several small series have suggested that a conservative approach is optimal. However, no full consensus has yet been attained. Non-surgical treatments of tracheal lacerations are becoming increasingly common. Recent studies have shown that conservative approaches can be used in patients with minimal symptoms, those who do not exhibit progression or oesophageal injury, those who spontaneously respire, and those who are extubated within 24 hours.[6,10] Some authors focus on the length of the tracheal laceration, and suggest the use of a conservative approach in patients who are clinically stable and who have lacerations less than 2 cm long.[21] However, some authors suggest that even a 4-cm-long laceration can be treated conservatively.[22] Many studies advocate use of a conservative approach independent of the length of laceration. The longest laceration length in our series was 3.5 cm; we treated the patient conservatively. In our series, we found that the distance from the laceration to the carina, and subcutaneous emphysema, affected the choice of a conservative approach regardless of the length of the laceration. In our clinical experience, a conservative approach is appropriate to treat a tracheal laceration in the upper two-thirds of the trachea. Any pneumothorax or pneumomediastinum causing respiratory distress should be first drained. If the patient requires mechanical ventilation, s/he should be intubated via fiberoptic bronchoscopy with the placement of the endotracheal tube cuff distal to the laceration. Although no consensus on ventilation mode is yet apparent, high-pressure ventilation should be avoided. Intubated patients should be extubated as soon as possible.

Placing stents in tracheal lacerations developing after intubation is an alternative to surgery, especially if surgery is high-risk.[23] If a patient requires a prolonged entubation, tracheostomy is a simple and less invasive procedure as an alternative to surgery.[24] In one of our cases who required prolonged intubation, a tracheostomy was created distally to the tracheal laceration.

The limit of this study is that the number of the patients is low due to the rareness of the case. There is a need for multicentered studies in which the number of patients is high.

In conclusion, treatment of tracheal lacerations prioritises airway management and prevention of the mediastinitis development and tracheal strictures. Many factors influence the choice between a conservative and surgical approach. Treatment planning can be difficult because the symptoms of extensive subcutaneous emphysema and respiratory distress are quite alarming. Surgical treatment is associated with high mortality in patients with poor condition. Surgical intervention should be preferred when air leakage, accompanied by mediastinitis cannot be controlled, and mechanical ventilation is impossible. However, surgery, especially thoracic surgery featuring right thoracotomy, affords the advantages of early diagnosis and repair of tracheal rupture secondary to intubation. In other cases (esp. in lacerations under 3.5 cm), bronchoscopic examinations should be performed conservatively, particularly if unnecessary surgical procedures should be avoided. This will reduce the mortality rate.

Conflict of interest: *None*

References

1. Hofmann HS, Rettig G, Radke J, Neef H, Silber RE. Iatrogenic ruptures of the tracheobronchial tree. *Eur J Cardiothoracic Surg*. 2002; 21(4): 649 – 652
2. Borasio P, Ardissone F, Chiampo G. Post–intubation tracheal rupture. A report on ten cases. *Eur J Cardiothorac Surg*. 1997; 12 (1): 98 – 100.
3. Massard G, Rouge C, Dabbagh A, Kessler R, Hentz JG, Roeslin N, et al. Tracheobronchial lacerations after intubation and tracheostomy. *Ann Thorac Surg*. 1996; 61 (5): 1483 – 1487.
4. Kost KM. Endoscopic percutaneous dilatational tracheotomy: A prospective evaluation of 500 consecutive cases. *Laryngoscope*. 2005; 115(10): 1 – 30.
5. Sviri S, van Heerden PV, Samie R. Percutaneous tracheostomy–longterm outlook, a review. *Crit Care Resusc*. 2004; 6 (4): 280 – 4.
6. Marty–Ane´ CH, Picard E, Jonquet O, Mary H. Membranous tracheal

rupture after endotracheal intubation. *Ann Thorac Surg*. 1995; 60 (5): 1367 – 1371.
7. Gomez-Caro Andres A, Moradiellos Diez FJ, Ausin Herrero P, Díaz-Hellín Gude V, Larrú Cabrero E, de Miguel Porch E, et al. Successful conservative management in iatrogenic tracheobronchial injury. *Ann Thorac Surg*. 2005; 79 (6): 1872 – 1878.
8. Lampl L. Tracheobronchial injuries. Conservative treatment. *Interact Cardiovasc Thorac Surg*. 2004; 3(2): 401 – 405.
9. Schneider T, Volz K, Dienemann H, Hoffmann H. Incidence and treatment modalities of tracheobronchial injuries in Germany. *Interact Cardiovasc Thorac Surg*. 2009; 8 (5): 571 – 576.
10. Conti M, Pougeoise M, Wurtz A, Porte H, Fourrier F, Ramon P, et al. Management of postintubation tracheobronchial ruptures. *Chest*. 2006; 130 (2): 412 – 418.
11. Cardillo G, Carbone L, Carleo F, Batzella S, Jacono RD, Lucantoni G et al. Tracheal lacerations after endotracheal intubation: a proposed morphological classification to guide non–surgical treatment. *Eur J Cardiothorac Surg*. 2010; 37 (3): 581 – 587.
12. Jo YY, Park WY, Choi E, Koo BN, Kil HK. Delayed detection of subcutaneous emphysema following routine endotracheal intubation –a case report. *Korean J Anesthesiol*. 2010; 59 (3): 220 – 223.
13. Walles T, Friedel G, Stöltzing H, Thon KP. Case studies of iatrogenic tracheal injury during intraoperative ventral positioning. Symptoms, diagnostics, and differential therapy. *Chirurg*. 2007; 78(4): 374 – 378.
14. Fouroulis C, Simeoforidou M, Michaloudis D, HatzitheoWlou K. Pericardial patch repair of an extensive longitudinal iatrogenic rupture of the intrathoracic membranous trachea. *Interactive Cardiovasc Thorac Surg*. 2003; 2(4): 595 – 597.
15. Liu H, Jahr JS, Sullivan E, Waters PF. Tracheobronchial rupture after double – lumen endotracheal intubation. *J Cardiothorac Vasc Anesth*. 2004; 18(2): 228 – 233.
16. Nishiumi N, Maitani F, Yamada S, Kaga K, Iwasaki M, Inokuchi S, et al. Chest radiography assessment of tracheobronchial disruption associated with blunt chest trauma. *J Trauma*. 2002; 53(2): 372 – 377.
17. Chen JD, Shanmuganathan K, Mirvis SE, Killeen KL, Dutton RP. Using CT to diagnose tracheal rupture. *AJR Am J Roentgenol*. 2001; 176(5): 1273 – 1280.
18. Gabor S, Renner H, Pinter H, Sankin O, Maier A, Tomaselli F, et al. Indications for surgery in tracheobronchial ruptures. *Eur J Cardiothorac Surg*. 2001; 20(2): 399 – 404.
19. Meyer M. Iatrogenic tracheobronchial lesions–a report on 13 cases. *Thorac Cardiovasc Surg*. 2001; 49(2): 115 – 119.
20. Carbognani P, Bobbio A, Cattelani L, Internullo E, Caporale D, Rusca M. Management of postintubation membranous tracheal rupture. *Ann Thorac Surg*. 2004; 77 (2): 406 – 409.
21. Jougon J, Ballester M, Choukroun E, Dubrez J, Reboul G, Velly JF. Conservative treatment for postintubation tracheobronchial rupture. *Ann Thorac Surg*. 2000; 69 (1): 216 – 220.
22. Singh S, Gurney S. Management of post–intubation tracheal membrane ruptures: A practical approach. *Indian J Crit Care Med*. 2013 Mar; 17(2): 99 – 103.
23. Yopp AC, Eckstein JG, Savel RH, Abrol S. Tracheal stenting of iatrogenic tracheal injury: A novel management. *Ann Thorac Surg*. 2007; 83(5): 1897 – 1899.
24. 24. Peña MT, Aujla PK, Choi SS, Zalzal GH. Acute airway distress from endotracheal intubation injury in the paediatric aerodigestive tract. *Otolaryngol Head Neck Surg*. 2004; 130(5): 575 – 578.