



# Surgical or conservative management of post intubation tracheal injury: when and how?

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**Abstract:** Iatrogenic tracheal or tracheobronchial injuries occur after intubation, percutaneous tracheostomy or rigid bronchoscopy. The incidence is relatively rare; however, this complication can potentially be life-threatening. We report 13 patients with an iatrogenic tracheal laceration treated between 2011 and 2019 and a literature review to assess the different treatment options. On the base of our experience and the review of the literature surgical treatment remains the gold standard; conservative management is safe in clinically stable patients without complications like pneumomediastinum, mediastinitis or oesophageal laceration.

**Keywords:** Tracheal injury; post-intubation laceration; trachea; iatrogenic tracheal injury; tracheobronchial laceration; tracheostomy

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## Introduction

Tracheobronchial lacerations are a heterogeneous group of injuries occurring after blunt thoracic trauma or, more rarely, after iatrogenic procedures. These two types of injury are different in terms of mechanism of trauma, anatomic site of damage, severity of subsequent respiratory complications. We will address only iatrogenic tracheobronchial lacerations.

This complication is related to intubation, percutaneous tracheostomy or rigid bronchoscopy; the tear is usually longitudinal, and it is located on the posterior wall of the trachea; it can be associated to an oesophagus lesion.

Despite the incidence is relatively low (0.05–0.5%), this lesion is potentially life-threatening; prompt diagnosis is crucial to reduce morbidity and mortality. High-risk settings are emergency intubation, late and inappropriate removal of the stylet during intubation, use of high-pressure cuffs, use of a double lumen tube, endotracheal tube repositioning and percutaneous tracheostomy. Also, there are patient-

specific risk factors: female gender, high body mass index (BMI), prolonged use of steroids and a short neck with a difficult intubation (1).

Iatrogenic tracheobronchial injury is considered a life-threatening condition; optimal management is still controversial. Historically, surgical repair is considered the gold standard; however, in selected cases a conservative approach could be considered as well as endoscopic treatment. The decision-making process can be easy in some cases and very difficult in others.

## Methods

Thirteen tracheal post-intubation injuries were diagnosed (*Table 1*). In 7 patients (53.8%) the tracheal laceration occurred during elective single lumen intubation, in 5 (38.5%) during emergency intubation and in 1 (7.7%) during double lumen intubation; the latter one was immediately repaired during the same surgical procedure. Intubation was reported to be difficult in one case; a stylet

**Table 1** From January 2011 to May 2019, 13 cases of tracheal post-intubation injury are diagnosed in thoracic surgery department of Rome. Their clinical features are exposed in the table

No.	Age (years)	Smoker (Y/N)	Diabetes (Y/N)	Treatment	Approach	Hospital stay	Complications	Mechanism of intubation	Stylet (Y/N)	Length (mm)	Position	Height	PNX (Y/N)	Pneumomediastinum (Y/N)	Subcutaneous emphysema (Y/N)
1	83	N	N	Surgery	Right thoracotomy	8	N	Elective surgery	N	45	Post	Distal	N	Y	Y
2	67	N	N	Surgery	Right thoracotomy	6	N	Elective surgery	N	25	Post	Distal	N	Y	Y
3	43	Y	N	Surgery	Right thoracotomy	12	N	Emergency	Y	10	Post	Distal	Y	Y	Y
4	52	Ex	N	Surgery	Right thoracotomy	7	N	Elective surgery	N	40	Post	Median	N	Y	Y
5	56	N	N	Surgery	Right thoracotomy	7	N	Elective surgery	N	60	Post	Distal	N	Y	Y
6	77	N	Y	Surgery	Right thoracotomy	7	Cerebral ischemia	Elective surgery	N	30	Post	Median	N	Y	Y
7	57	Y	N	Surgery	Right thoracotomy	10	N	Elective surgery	N	30	Post	Distal	Y	Y	Y
8	65	N	N	Surgery	Right thoracotomy	5	N	Elective surgery	N	25	Post	Distal	N	Y	Y
9	46	Y	N	Surgery	Cervicotomy	28	Pneumonia	Emergency	N	40	Post	Proximal	N	Y	N
10	56	Y	N	Surgery	Right thoracotomy	6	N	Elective thoracic surgery	N	25	Post	Distal	Y	Y	N
11	73	Y	Y	Surgery	Right thoracotomy	4	N	Emergency	Y	25	Post	Distal	N	Y	Y
12	47	Ex	N	Conservative	-	13	N	Emergency	Y	10	Ant	Proximal	N	N	Y
13	87	N	Y	Conservative	Fibrin glue endoscopic application	18	N	Emergency	Y	20	Post	Median	N	Y	Y

PNX, pneumothorax; Y, yes; N, no.



**Figure 1** Endoscopic diagnosis of posterior tracheal laceration after intubation (4). The surgical approach is performed by right lateral thoracotomy and a direct repair with interrupted PDS 4.0 stitches is made. PDS, polydioxanone.

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was used in 4 cases.

Clinical signs and symptoms were: subcutaneous emphysema in 84.6% of the cases, pneumomediastinum in 92.3% and pneumothorax in 23.1%. Preoperative assessment included computed tomography (CT) in all but one patient and fiberoptic bronchoscopy.

The tracheal laceration was on the posterior wall, at the junction between the cartilaginous and membranous portion on the right side, in 12 patients (92.3%) and on the anterior wall in 1 (7.7%); the mean length was  $29.61 \pm 13.91$  mm (range, 10–60 mm); they were all longitudinal and transmural. The site of lesion was proximal (cervical trachea) in 2 patients (15.4%), upper thoracic in 3 (23.1%) and pre-carinal in 8 (61.5%).

## Results

Eleven patients were treated surgically and 2 conservatively. The indication for either treatment was based on clinical and endoscopic findings. In accordance with Ross *et al.* (2) and Massard *et al.* (3), the indications for conservative treatment are non-progressive mediastinal and/or subcutaneous emphysema, less than 5 cm in length at endoscopic evaluation, no major communication with the mediastinal space, absence of oesophageal injury, stable vital signs and an absolute contraindication to surgery for concomitant disorders. In all the other cases surgery should be considered mandatory.

Intraoperative ventilation was performed with an extra-long single-lumen endotracheal tube placed under

bronchoscopic guidance and advanced to selectively intubate the left main bronchus. The surgical approach was a lateral right thoracotomy in 10 patients and a cervical incision in 1 (laryngotracheal laceration). Direct repair with interrupted (polydioxanone) PDS 3-0 or 4-0 stitches was performed (*Figure 1*); in four patients the suture was covered with mediastinal tissue. In one patient with a tracheoesophageal fistula, oesophageal direct repair was performed, and the tracheal suture was covered with an intercostal muscle flap. Ten patients were extubated within 24 hours after surgery and one after 48 hours. One patient died in 3th postoperative day for massive cerebral ischemia. One patient with postoperative pneumonia required antibiotic therapy for 7 days. No other major complications occurred.

In two patients we considered a conservative approach; one had a cervical iatrogenic post-intubation laceration of the anterior wall of trachea. He was intubated after blunt trauma and mechanically ventilated. The diagnosis of tracheal injury was made after 24 hours, after the onset of subcutaneous emphysema. Endoscopic assessment confirmed the presence of a 10-mm tracheal laceration. Due to hemodynamic instability, a multidisciplinary team considered conservative treatment. The single lumen tube was advanced distally to the lesion, avoiding cuff hyperinflation. Treatment included broad-spectrum antibiotics and clinical and endoscopic observation. The patient was extubated without complications after 8 days.

The second patient undergoing conservative treatment was an 82-year-old emphysematous woman intubated with a stilet tube for respiratory failure in an emergency setting. Subcutaneous emphysema in the neck was immediately visible after intubation and it was highly suspicious for tracheal laceration. Fiberoptic bronchoscopy confirmed the presence of a 20-mm lesion of the posterior tracheal wall. Due to the clinical status of the patient [advanced chronic obstructive pulmonary disease (COPD), acidosis, pneumonia in the right lower lobe], the laceration was covered with fibrin-glu. Tracheostomy was performed and an extra-long cannula was placed with the cuff distal to the laceration; broad-spectrum antibiotics were started was administered. After three weeks the patient still required ventilatory support. The lesion was healed and she was sent for rehabilitation (5).

## Discussion

Iatrogenic tracheal lacerations show peculiar characteristics;

they are more often located on the posterior wall of the trachea since the membranous wall is more fragile and there is certainly a “locus minoris resistentiae” at the junction with the cartilaginous portion; they are frequently found on the right side because the proximity to the oesophagus on the left side stabilize the tracheal wall. The mechanism of intubation explains why the lesion is almost always directed longitudinally. Occasionally, tracheal tears can extend into the main bronchi.

Optimal management is still controversial in some specific settings (6,7). Surgical repair is certainly the gold standard. Many authors proposed a number of criteria to facilitate and categorise the choice between surgical and conservative management producing flow chart algorithms. Nonetheless, there is still some debate since only series with limited numbers have been reported (8).

In 1998, Massard and colleagues (3) proposed their indications for conservative management based on anatomical and clinical criteria. In clinically stable patients, without any difficulty to be mechanically ventilated if intubated or no respiratory distress if already extubated, without oesophageal injuries, absence of mediastinal fluid collections or other signs of mediastinitis, nonprogressive mediastinal or subcutaneous emphysema, less than 5 cm in length and no major communication with the mediastinal space, they proposed conservative management with clinical and endoscopic monitoring, broad spectrum antibiotics, physiotherapy and oxygen therapy if required.

More recently, Cardillo *et al.* (9) reported a personal classification in four classes based on anatomical features. He recommended for the first time to refer these patients to high experience centers. Unfortunately, this classification was not helpful in clinical decision-making since they did not consider the clinical status of the patient.

In 2007 Schneider *et al.* (10) reported a series of 29 patients with tracheobronchial post-intubation injury. They described 3 criteria for choosing nonoperative management: uncomplicated mechanical ventilation without any loss of tidal volume, a laceration sufficiently covered by the oesophagus and mild subcutaneous emphysema that does not increase during mechanical ventilation. In their series, only 11 patients were treated conservatively; all of them had a delayed diagnosis at more than 24 hours after the laceration. They considered the delay of diagnosis itself to qualify the patient for conservative management, after confirming a stable clinical status. Leoncini and colleagues (11) in 2016 published

one of the larger series; they stated that the indication for surgery was not represented by the extension of the lesion but by the evidence of respiratory failure; conservative management should be considered only for those with stable respiratory parameters. Some authors proposed an endoscopic technique for tracheal repair in patients at high risk for surgery and severe comorbidities without mediastinitis or oesophageal injury. Fiorelli *et al.* (12) proposed the endoscopic application of fibrin glue over the tracheal laceration and Welter *et al.* (13) in 2010 reported a new technique for endoscopic intraluminal repair with a single running suture under visual control in three patients. This technique shows three major limitations: the patient has to tolerate jet ventilation for more than one hour; if the laceration involves the main bronchi the lumen is too small to insert and rotate the needle; if the tracheal tear is on the right side on the edge of the membranous part, it is impossible to insert the needle tangentially into the tracheal rings.

In all the other patients, surgical management is mandatory. If mechanical assistance is required, major air leaks related to a tracheal laceration may compromise ventilation that can be improved only by closing the tear. The second goal of surgical repair is to prevent mediastinitis. A third reason to consider surgical repair is the potential long-term airway stenosis in case of conservative approach (14).

In our experience, the indications for conservative or surgical treatment were based on clinical and endoscopic findings. We advocate surgery for patients with respiratory failure requiring mechanical ventilation, pneumothorax and progressive subcutaneous emphysema, a length >2 cm, presence of oesophageal injury or major communication with the mediastinal space, mediastinal fluid and mediastinitis. On the other hand, in patients with stable vital signs, breathing spontaneously or with no difficulties in mechanical ventilation, minimal non-progressive emphysema and no signs of mediastinal communication or infection, we consider a conservative approach, as in those with unacceptable high operative risk.

In conclusion, non-operative conservative management is a safe option in a selected group of patients although surgery remains the gold standard in the vast majority of them.

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## Footnote

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

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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