

Inadverted Perforation of Trachea: An Enigma or A Challenge

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ABSTRACT

Introduction: traumatic injuries to the respiratory tract are rare, only a small portion of the trachea is unprotected above the manubrium sternalis, exposing the neck. The incidence is low and mortality is very high, higher than 82%. **Objective:** report of a case and analysis of the literature. **Case reports:** 46-year-old male who was admitted to the emergency room with four gunshot wounds to the thorax and extremities, vital signs: T/A: 139/36 mm Hg. HR: 107 bpm. RF: 20rpm. Temp 36.9°C. Sat 97%. Glasgow 6 points, neck with increased volume at the expense of subcutaneous emphysema, predominantly on the right, which extends to both hemithorax. **Discussion:** the clinical presentation of this pathology is non-specific. They present with generalized subcutaneous soft tissue emphysema, explosive and overwhelming, pneumomediastinum and/or pneumothorax. Other added signs may be respiratory failure, hemoptysis, or shock. The specific diagnosis is bronchoscopic but the most sensitive study is computed tomography, it is necessary to have the adequate inputs or resources, as well as the expertise of multidisciplinary personnel. Endoscopic treatment is the primary approach with a success rate of 50%; however, if it fails or is not feasible, early surgical treatment is mandatory. **Conclusions:** tracheal perforations are so complex that they require multidisciplinary management, with a third level medical care infrastructure. Surgery is the mainstay in resolving treatment in emergency or elective cases, its delay is a catastrophic outcome for the patient.

Keywords: Trauma. Respiratory tract. Tracheal perforation. subcutaneous emphysema. Pneumothorax.

INTRODUCTION

In the annals of history, tracheal surgery dates back to ancient Egypt in 3100 BC, where tracheostomy is described in hieroglyphs from the Abydos region. In addition, in the Ebers Papyrus 1550 BC, a tracheal tracheotomy has been detailed. [1] Traumatic airway injuries are rare; only a small portion of the trachea is unprotected above the manubrium sternalis, exposing the neck, and that is relatively little. [2] The causes of tracheal perforations are as diverse as they can be congenital or acquired, and sometimes as rare as tracheocele or as "common" as direct trauma. [2, 3] The incidence of laryngotracheal trauma in the United States of North America is 1:125,000, with 82% mortality from airway injuries. Traffic accidents are the main cause in 26% to 37%, followed by direct neck trauma. [3, 4] However, a tracheal perforation is a very rare but very challenging complication; [5] the real incidence in Mexico is unknown, due to the few documented case series reported, however, it is a fatal complication when it occurs and a diagnosis is not established in a timely manner. [6]

OBJECTIVE

Report of a case and analysis of the literature.

CASE REPORTS

A 46-year-old male who was admitted to the emergency department with four gunshot wounds to the thorax and extremities, with the following vital signs T/A: 139/36 mm Hg. HR: 107 bpm. RF: 20rpm. Temp 36.9°C. Sat 97%. Glasgow 6 points, neck with increased volume at the expense of subcutaneous emphysema, predominantly on the right, which extends to both hemithorax. Anterior chest with multiple wounds from a firearm projectile; it is noteworthy that three of

them present traumatopnea. Two bilateral endopleural tubes were placed, reporting blood flow from the right tube of 540 ml, upon placement (hemopneumothorax) and no reported flow from the left tube (pneumothorax). Chest X-ray control showed significant subcutaneous emphysema, firearm projectiles in soft tissues, and expansion of both hemithorax after placement of probes. (Figure 1 and 2)

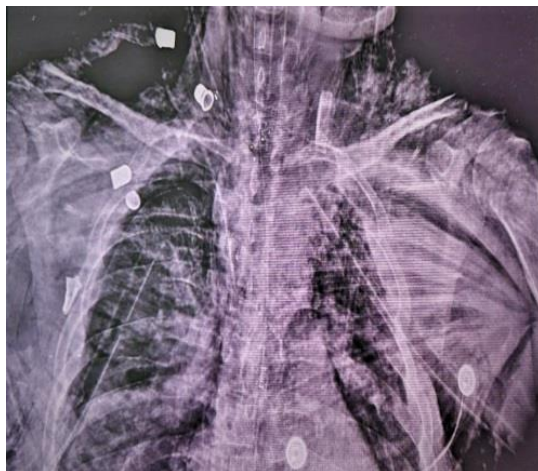


Figure 1

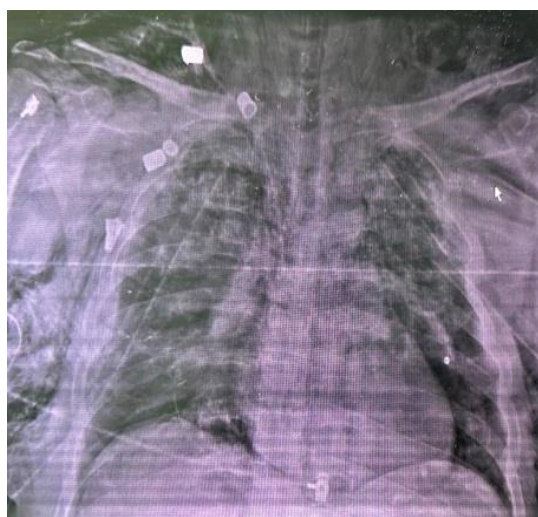


Figure 2

Anteroposterior x-ray of the chest with subcutaneous emphysema in the neck, thorax, multiple radio-opaque images of firearm projectiles, as well as shapeters in the midline. Bilateral endopleural probes with complete pulmonary expansion.

Six hours after admission, the patient presents with hemodynamic instability, altered alertness and in shock, with decompensated metabolic and respiratory acidosis, decreased urinary output, increased nitrogen levels, and hyperkalemia, for which management is initiated. with emergency orotracheal intubation and admission to intensive care. Blood gases PH 7.07, PCO2 62, PO2 87, LAC 1.9 HCO3 18 BE 12.1, Laboratories with; Leukocytosis 20.9 Neutrophilia 84.9 Hemoglobin 15.8 Hematocrit 47.9 Platelets 151,000, Sodium 138, Potassium 6.5, Calcium 0.77, BUN 41 Urea 88, glucose 14, creatinine 2 mg/dl; anuria with 0.1 ml/kg/hr. With mechanical ventilation, intubated with a 7.5 Fr orotracheal cannula, in controlled mode limited by volume

to 490 ml, respiratory rate 12, PEEP 7, Trigger 3.0, FiO₂ 100%, performing peak pressure of 30 cm H₂O, plateau pressure 24, transair pressure 6, driving pressure 17 cm H₂O, minute volume 7.8 L/min, and static compliance 28, dynamic compliance 21, mechanical power 16.5, visualizing flow-time curve with intrinsic PEEP; clinically with subcutaneous emphysema on the face, neck and thorax. (Figure 3)



Figure 3

A computed tomography of the neck and chest was performed, showing massive infiltration of soft tissues in the chest and neck, with a Hounsfield unit (HU, is the number assigned to each pixel), at a maximum negative (-188 HU), similar to air (emphysema), [7] for the same reason a disruption of continuity is detected in a helical image slice at the level of the junction of the first with the second tracheal cartilage of 1.2 cm x 0.9 cm on its anterior face. (Figure 4 and 5)



Figure 4

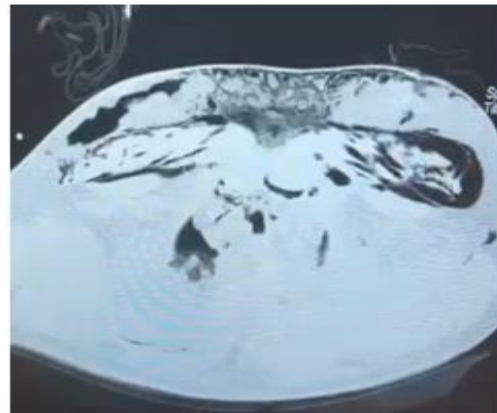


Figure 5

Simple ct of the neck and chest showing a lesion in the trachea on the right side, as well as scutaneous emphysema in the anterior and lateral chest, with pneumo mediastinum and bilateral pneumothorax.

An assessment is requested by the Surgery service, who decides his immediate admission to the operating room, on his transfer he presents a sudden drop in blood pressure and very low

saturation up to 35%, falling into cardiorespiratory arrest. Advanced cardiopulmonary resuscitation was started, without obtaining return of spontaneous circulation, with the imminent death of the patient.

DISCUSSION

The clinical presentation of this pathology (tracheal perforation) is non-specific. Pathognomonic findings are overwhelming, explosive, generalized subcutaneous soft tissue emphysema, pneumomediastinum, and/or pneumothorax. Other added signs may be respiratory failure, hemoptysis, or shock. Its presentation will depend on the clinical scenario and the time it takes to become evident, which can be immediate or even late. The atypical or strange nature of the clinical picture then makes it an enigma in the diagnosis, uncertain or unreliable, and consequently in its treatment; [8, 9] Therefore, unfortunately, its delay will directly pulverize the prognosis or the patient's life itself. The opportune diagnosis of a tracheal perforation is crucial and decisive, [10] suspicion must be confirmed with computed tomography and specifically with the bronchoscopy study. [9, 11] and even with computed tomography it is not possible to detect tracheal perforations of 2 mm in diameter, which can only be specifically detected in the intraoperative period, [12] or postmortem, as reported in a patient with progressive percutaneous emphysema. who passed away in a short time. Postmortem computed tomography showed bilateral pneumothorax, giving sensitivity but almost no specificity. When only the forensic autopsy revealed that the tracheostomy tube had not reached the trachea and was mistakenly inserted into the right chest cavity via the peritracheal route. [13] The specific diagnosis is with bronchoscopy but the most sensitive study is computed tomography. On the other hand, the critically ill patient usually requires invasive devices to facilitate monitoring and optimize treatment. And although chest radiography is sometimes sufficient, computed tomography and nuclear magnetic resonance are the ideal imaging modalities for its evaluation, especially in cases of acute tracheal injury. [14]

There are risk factors for tracheobronchial injuries that are divided into:

- Mechanical: multiple intubation attempts, and/or due to instrumentation with the use of a stylet during intubation, incorrect endotracheal tube, double lumen tube, poor extubation, post-surgical treatment, etc. [9, 11, 12, 13, 15, 16]
- Anatomical: age > 65 years, congenital tracheal diverticulum, tracheal bronchus, being a woman, tracheal inflammation or infectious process, inhaled steroids, tracheal distortion with airway or mediastinal neoplasms, Mournier-Kuhn syndrome. [15, 16, 17]
- Although traumatic tracheobronchial injuries are extremely rare, and existing reports have little evidence, coupled with the lack of a useful or practical classification that allows individual cases to be compared with each other; Therefore, other researchers expose the classification of the three digits, considering its practical use of being able to group individual cases and develop recommendations for diagnosis and therapy. [18] On the other hand, injuries can be classified as partial and/or complete, partial when the dorsal membranous bridge remains intact or <50% of the circumference, while complete separation, with injury of >50% of the circumference where there may be retraction of the trachea into the thorax. [4, 19] Another morphological classification system created by Cardillo et al. details the degrees of tracheal injury and is used to standardize treatment: [20, 21]

- Grade I: Superficial laceration without mediastinal emphysema or esophageal injury, conservative treatment, follow-up with bronchoscopy.
- Grade II: lesion that extends through the muscle wall with pneumomediastinum or subcutaneous emphysema. Management depends on the CT findings and the result of the patient's clinical evaluation.
- Grade IIIA: complete laceration with esophageal or mediastinal herniation.
- Grade IIIB: it is any laceration with esophageal injury and mediastinitis, which requires multidisciplinary evaluation, minimally invasive surgery with the use of stents, metallic or silicone, and covering them with adhesives (fibrin or cyanoacrylate), especially in lesions <5 mm and can be removed in 4-6 weeks.

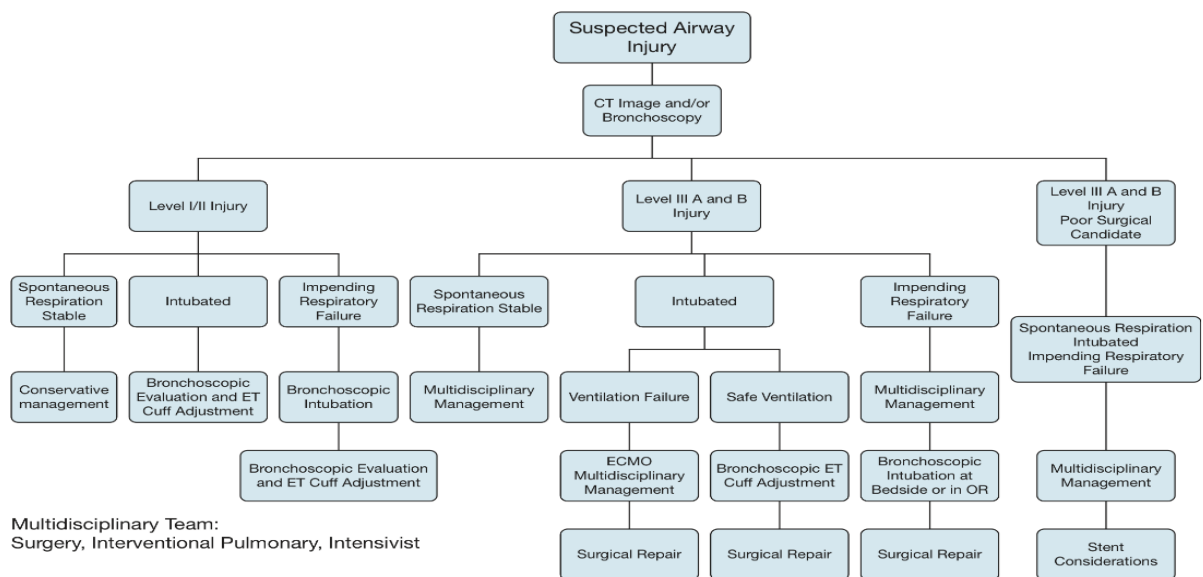


Figure 6.

Algorithmic approach to contemporary treatment of tracheobronchial injuries. Ecmo = extracorporeal membrane oxygenation; or = operating room. Image taken from the following: Grewal H.S., Dangayach N.S., Ahmad U., et al. Treatment of Tracheobronchial Injuries: A Contemporary Review. *Chest*. 2019; 155(3):595-604.

The red flags of tracheal lesions are: persistence of hypoxemia after endotracheal intubation without evident pneumothorax, continuing and extension of pneumothorax despite endopleural tube placement, persisting underwater bubbling of the endopleural seal (inadvertent insertion into lung parenchyma) and spreading pneumomediastinum and deep subcutaneous emphysema in the neck as evidenced by chest x-ray. [15]

As regards the treatment of tracheal perforations, it is therefore imperative to have a certain diagnosis that allows establishing the most appropriate management option. For this reason, the expertise of multidisciplinary personnel (emergency physician, surgical physician, critical medicine physician, radiology physician, nursing, inhalation therapy, etc.) and having the appropriate supplies or resources for diagnosis at the outset is essential. (Emergency bronchoscopy, emergency endoscopy, computed tomography or nuclear magnetic resonance) as well as for medical and/or surgical treatment, as well as patient follow-up. [22] On the other

hand, it has been reported that if the trauma is so great, or depending on its location and extent, the orotracheal tube may be insufficient or interfere with the surgical field; This is where membrane oxygenation for extracorporeal circulation (Extracorporeal Circulation Membrane Oxygenation, ECMO) is indicated, which is defined as a form of life support that allows oxygenation of blood directly into the venous system, bypassing pulmonary gas exchange. [23, 24] Covering and plugging with a cuffed tracheostomy tube has been described as treatment of tracheal perforation, but the patient died. [25] The therapeutic concept will depend on the underlying cause, location, and size of the perforation, but decision-making is also influenced by the severity of the course of sepsis and the extent of respiratory dysfunction in the patient. Endoscopic management with tracheobronchial stent placement is the most common treatment and offers some results. Reconstructive surgical procedures are reserved predominantly for patients with refractory fistula or septic multi-organ failure, on the eve of death. [26] Endoscopic treatment is the primary approach with a success rate of 50%; however, if it fails or is not feasible, early surgical treatment is mandatory. Direct closure with absorbable sutures or reconstruction with alloplastic or allogeneic material should be preferred. For larger defects or high proximal esophagotracheal fistulas, local transposition of muscle flaps or free muscle flaps plays an important role. [27] Surgical techniques are variable, where it has been reported that the team of surgeons (thoracic and plastic) exposed the tracheal and esophageal perforations with a J-type incision in the neck, extending to the sternal notch, and the esophageal stent was removed. The 2 muscles, the sternohyoid and the sternothyroid, were dissected and rotated downward after detachment upward; managing to cover the trachea and esophagus. [28] Penetrating tracheal injuries can usually be repaired primarily with nonabsorbable sutures, muscle flaps, pericardial patch, and laryngeal or costal cartilage plasties. [29] The surgical approaches will vary according to the anatomical site of the tracheal lesion, which can be from a right thoracotomy, a median sternotomy, or direct in the neck at the discretion of the surgical team's expertise. [8, 9, 18, 28] On the other hand, the use of metal stents in the trachea for stenosis and/or perforations that cause multiple complications such as fractures, overgrowth, and granulomas, as well as exorbitant labor upon removal, have been documented; For this reason, efforts have been made to incorporate silicone stents and/or mixed stents, or to implant a biodegradable polydioxanone stent. Not yet conclusive. [30]

CONCLUSIONS

- Tracheal perforation is an entity with a high risk of mortality and morbidity, its accurate diagnosis is critical for conservative or surgical treatment, which must be installed immediately; on this lies its prognosis and the life of the patient.
- The clinical manifestations of tracheal perforation are not specific, which makes possible a diagnostic suspicion that is convergent in performing an emergency computed tomography and, if possible, in an endoscopy of the tracheobronchial and esophageal tree, in the shortest possible time to confirm and/or rule out the diagnosis.
- Tracheal perforations are so complex that they require multidisciplinary management, high-level technical-surgical skills, and a third-level healthcare infrastructure. The lack of some of these elements is fatal, directly affecting the survival of the patient.
- Surgery continues to be the mainstay in the resolving treatment of tracheal perforations in emergency cases or elective, its delay in most cases evokes a catastrophic outcome for the patient.

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