



Laryngeal Perforation by Projectile by Firearm

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ABSTRACT

Introduction: Neck trauma represents from 5 to 10% of aggressions and with a mortality rate of up to 7%. Laryngeal trauma is fatal, with mortality of up to 80%. **Objective:** Presentation of a case and review of the literature. **Method:** A 21-year-old male is in the emergency department with a gunshot wound to the neck. Surgical exploration of the neck was performed, with injury to the larynx at the level of the thyroid cartilage on the anterior and superior aspect with destruction in 30%, 2 x 3 cm multifragmented involving the upper notch and 2% the thyroid membrane. **Discussion:** In the diagnosis of laryngeal trauma, acute injuries and chronic injuries should be sought, since the functions of the larynx as an anatomical structure and with the function of being the critical intersection for breathing, swallowing and expression, where neuropathies that affect the movement of the vocal cords can significantly affect quality of life. **Conclusion:** it is essential to have an infrastructure for effective or correct diagnosis and treatment. The trauma surgeon must make decisions regarding the approach, procedure and follow-up, which with his experience and knowledge may be an option to resolve as assertively as possible for the benefit of the patient. Tracheostomy is not currently a strict or forceful indication.

Keywords: Neck trauma. Laryngeal trauma. Projectile wound. Tracheotomy. Thyroid cartilage. Larynx. Thyroid.

INTRODUCTION

Neck trauma accounts for 5 to 10% of assaults and with a mortality rate of up to 7%. In Mexico there is a high rate of violence in men, as in the rest of the world with a mortality rate from homicides as alarming as the sixth cause of death in 2023; moreover, those who become survivors of the aggression consequently have temporary or mostly permanent and disabling sequelae, not to mention the cost in health, human and economic resources. [1] Trauma to the larynx is fatal, mortality of up to 80% has been reported, but it is essential to know its functions for the protection and functionality of the human being. The larynx is responsible for breathing, sound production, and protecting the trachea from aspiration of food through the cough reflex. Bioengineered repair surgery is essential to continue these functions. [2] Lethal upper airway obstruction is uncommon and often results from an ingested foreign body or granuloma, however, the etiology of laryngeal granuloma is multifactorial, with several underlying causes, such as chronic irritation resulting from endotracheal intubation, vocal cord injury or trauma, gastroesophageal reflux disease, laryngopharyngeal reflux, chronic cough, laryngeal trauma, or may be associated with infectious agents, autoimmune conditions, or iatrogenic factors. [3]

Cervical injuries caused by hangings have a high mortality rate. Survivors may present for medical care with subtle symptoms that mask life-threatening injuries to vital structures in the neck. [4] Initial treatment of open laryngeal trauma should be performed immediately, but in cases where no injury is apparent at the beginning or in later stages, several factors can cause changes in the structure and function of the larynx, which with infection can lose tissue and become further complicated. [5] Another form of laryngeal trauma is corrosive substances, such as the mechanism of action of emamectin benzoate, an insecticide, which, when ingested in certain cases, showed more serious complications, such as respiratory failure and aspiration pneumonia. [6] Another etiology of laryngeal trauma is fracture of the thyroid cartilage, resulting from a sudden and rapid increase in airway pressure during a sneeze with obstructed nostrils, which may be one of the rare causes of spontaneous pneumomediastinum. [7] There are cases in which biphasic stridor and dyspnea can occur several weeks after an intubation event with chondronecrosis of the cricoid, due to trauma to the laryngeal cage. [8] Finally, we must not leave aside the most frequent laryngeal trauma in the larynx, which is due to the obstruction of foreign bodies that can be very varied or even unusual, since the sudden obstruction would cause immediate death, or failing that only the ingestion of the foreign body, or cause a reactor laryngeal spasm. [9] Blunt trauma is associated with several causes of death, including mechanical asphyxia (such as strangulation, ligature strangulation, hanging, suffocation, choking, plastic bag asphyxiation, gagging, and blood inhalation) and other causes (such as atypical drowning, carbon monoxide poisoning, head trauma due to a traffic accident, burns, electrocution, and cerebral edema). [10] The incidence of laryngeal lesions after intubation in patients with acute respiratory distress syndrome, when the only significant risk factor for symptomatic laryngeal lesions was the number of reintubations and the secondary objective was to analyze the progression of these laryngeal lesions. [11] Some patients with laryngeal injury after endotracheal intubation often present with mature fibrosis that compromises cricoarytenoid joint mobility and glottic function long after the initial injury, a higher rate of decannulation, and fewer surgical procedures compared with delayed intervention. This makes laryngeal lesions two, acute and chronic. [12] The complexity of the anatomical region of the neck can cause traumatic effects on all structures, including aerodigestive, musculofascial, vascular, endocrine or nervous structures. For this reason, accurately diagnosing complex whiplash is challenging and can be extremely difficult. Therefore, we cannot forget that the diagnostic errors that occur in certain situations can be accompanied by a rapid and unfavorable evolution towards death. [13] To date, it is impossible to have real statistics in Mexico on laryngeal trauma, due to their diagnostic complexity or because of their very nature of immediate death.

OBJECTIVE

Presentation of a case and an analysis with a review of national and international medical literature.

METHOD

A 21-year-old man who is in the Emergency Department of the General Hospital "Dr. Rubén Leñero", with a gunshot wound to the neck today with 3 hours of evolution, evaluated by the Surgery service. The patient reports denying allergies, surgical and chronic-degenerative diseases. He mentions pain at the neck level at the entry site, in the central neck and at the exit site of the firearm projectile, in addition, he presents minimal dysphonia. On physical examination he is conscious, calm cooperating with Glasgow of 15 points. Weight: 120 Kg.

Height: 1.64 m. With vital signs with heart rate of 118x', respiratory rate of 26x', temperature of 37.1°C, blood pressure of 105/67 mm Hg. Without characteristic facies, with a short neck and entry hole of the projectile on the left side in zone III below the mandible, with an exit hole on the right side in zone I, with probable oblique linear path in zone II with penetration of the platysma muscle and little active bleeding in the exit orifice. No hard data of emphysema, pulsatile hematoma or active bleeding. Cardiopulmonary without apparent involvement, no pleuropulmonary syndrome is associated, abdomen without alterations, rest without data to comment.

Laboratories on admission with hemoglobin of 15.25 g/dl. Hematocrit 44.89%. Platelets: 370.50 x 103mm³. Leukocytes: 18.9 x 103mm³. Neutrophils: 93.86%. Lymphocytes: 4.59%. Monocytes: 1.39%. Prothrombin time of 11.8". 30.5" thromboplastin time. Glucose: 173.4 mg/dl. Urea: 24.4mg/dl. Creatinine: 0.7 mg/dl. Sodium: 137 mEd/l. Potassium: 4.61 mEd/l. Chlorine: 102 mEd/l. Initial blood gases with pH: 7.37. PCO₂: 44 mm Hg. PO₂: 72 mm Hg. Lac: 1.6 mmol/L. HCO₃: 25.4 mmol/L. BE ecf: 0.1 mmol/L SatO₂: 89%.

A portable chest x-ray was reviewed, rotated with deficient technique without finding radiological data of emphysema in soft tissues or pneumomediastinum or anatomical structural alteration of what is visible in the neck, in the mediastinum and without data of pneumothorax. See Figure 1.



Figure 1

Subsequently, and thanks to its relative hemodynamic stability and without hard frank data of neck trauma, a simple CT scan of the neck and chest was performed. In the sagittal section with the pulmonary window, no lesion can be visualized, however, in the coronal sections, the neck does allow evidence of multiple isolated densities with the air-like pixels, outside the corresponding anatomical sites. See Figures 2, 3 and 4.



Figure 2

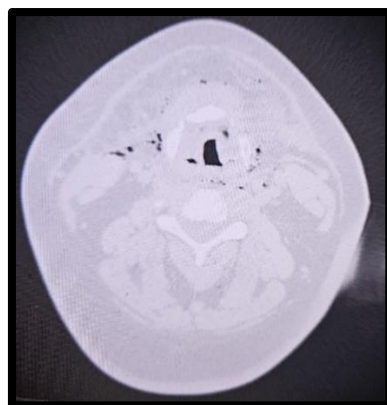


Figure 3



Figure 4

With the evident results of paraclinical studies and the etiology of the trauma with the anterior trajectory of the projectile in the neck areas, with perforation of the platysma muscle, emergency surgical exploration of the neck was performed. With an anterior approach and due to the suspicion of the trajectory of the projectile, all the areas involved were explored, finding lesion in the larynx at the level of the thyroid cartilage on the anterior and upper side with destruction in 30%, 2 x 3 cm multifragmented that involves the upper notch and in 2% the thyroid membrane. See figures 5 and 6.



Figure 5



Figure 6

A reconstruction is performed by joining the segments with suture with polyglycolic acid of 00, with separate single stitches (in the absence of another permanent suture), a successful reconstruction is achieved. Likewise, hemorrhage of the right external jugular vein is controlled, it is ligated with silk of 00 with transfixive point. Pretiridoid muscles and right sternocleidomastoid muscle with U-points are repaired with polyglycolic acid of 00 correctly. Haemostasis is verified and culminates with a usual closure. Tracheostomy was initiated, however, due to the patient's own challenging anatomy and the lack of extended length tracheostomy tubes, the procedure was suspended. Post-surgical surveillance is carried out in the intensive care unit, successfully. A new contrasted computed tomography study of the neck and chest was performed 72 hours after surgical reconstruction, where no lesion was visible and no air leak was evidenced. See figures 7 and 8.

**Figure 7****Figure 8**

The patient was extubated and sedation was withdrawn after 7 days and was discharged from the hospital at home 3 days later, (after the esophagogram) without any complication for a control in the Surgery and Otorhinolaryngology consultation.

DISCUSSION

Regarding the diagnosis of laryngeal trauma, acute injuries and chronic injuries should be sought, since the functions that the larynx fulfills as an anatomical structure and function are the critical intersection for breathing, swallowing and expression, where neuropathies that affect the movement of the vocal cords can significantly alter the quality of life. [14] Laryngeal electromyography is used to evaluate laryngeal biomechanics and subsequently for the treatment of spasmodic dysphonia. [15] It has been documented that postmortem computed tomography is routinely used in many forensic institutions to guide the subsequent autopsy and is especially useful for diagnosing fractures of the hyoid-larynx complex and specifically in the thyroid cartilage. [16, 17] Computed tomography is a revealing study of the longitudinal rupture of the thyroid cartilage, emphysema of the neck and presence of air in the anterior superior mediastinum, considering the most practical and essential in the diagnosis, due to its characteristics of being non-invasive, it is fast and effective. [18] In addition, it evidences the presence of air in the projection outside the pharynx and in the soft tissues of the lateral, anterior, and posterior surfaces of the neck, showing specific transverse damage to the entire thyroid cartilage. [19] In conclusion, computed tomography is a high-value study because it has a very high range of specificity and diagnostic sensitivity, and is useful as a guide in initial surgical management and for immediate follow-up. [20, 21]

On the other hand, flexible bronchoscopy is mainly used to diagnose foreign bodies in the airways. Due to advances in pediatric anesthesia, many teams have considered the removal of foreign bodies by flexible bronchoscopy or preoperative traumatic lesions in the laryngeal cage, with the increased pressure of recording the clinical picture and not making the error of a post-surgical or post-repair examination, due to the increase in intrinsic pressure typical of the study. [22] The best way to achieve a safe airway, when appropriate, is by intubating the awake patient through a flexible bronchoscope and placing an endotracheal tube distal to the site of injury. [23, 24] When flexible or rigid endoscopes are available and reveal laryngeal abnormalities in 34.9% to 97.0% of all patients, primarily edema and erythema. Significant lesions were reported in up to 80% of patients. Three studies repeated endoscopy two to three weeks later and showed persistent obstruction, being moderate to severe in 9.8%–11.8% of

trauma patients, being very specific as a diagnostic method. [25] It is necessary to know the routine and correct indication of each specific study, such as flexible laryngoscopy, indirect mirror laryngoscopy, laryngeal stroboscopic, direct laryngoscopy, and laryngoscopy by suspension in the office. [26] Imaging techniques such as computed tomography, magnetic resonance imaging, and positron emission tomography help differentiate these changes from tumor recurrence, cartilage necrosis, and even undocumented postoperative or post-radiation trauma. [27]

With regard to treatment for laryngeal trauma, aggressive management is carried out against shock, local debridement, tracheal-cricoid anastomosis or tracheal-tracheal, reduction and fixation of laryngeal cartilage, repair with local transposition flaps and reconstruction of the airways, tracheal-cricoid anastomosis or tracheal-tracheal operations were undergone, or by reduction and fixation of broken cartilage. placed with iodoform gauze finger intraluminal stents for (8.2 ± 1.6) days. None of them underwent a protective tracheostomy. [28]

The main objective of the trauma surgeon is to consider the important aspects of surgical treatment are to ensure full breathing, acceptable forms of feeding and the use of reliable wound closure techniques aimed at preventing digestive tract failure with the aim of maintaining the structure and aerostasis of the laryngotracheal region. [18] The choice of myoplasty method for multiple unilateral wounds of the laryngopharynx remains relevant. No description of the recommended myoplasty technique for these lesions has yet been found in the available national and international literature sources. [18, 29] Throughout history, many innovations have contributed to the development of modern surgery, improving patient outcomes and expanding the range of treatment options available to patients in trauma neck surgery, the surgical microscope, the Hopkins rigid endoscope, laryngeal nerve monitoring, cochlear implants, and laser surgery; the difference is having these innovations in routine surgical practice. [30] In addition, both the surgeon and the surgical team need to be prepared, as cricothyrotomy is currently recommended as the preferred method due to its ease, speed, and safety in life-threatening airway emergencies, where standard tracheal intubation and mask ventilation fail because of challenging anatomy or the very nature of the cause of laryngeal or tracheal trauma. [31, 32]

Some authors determine that the unique and highly functional anatomy of the upper airways poses challenges for drug delivery, where wound healing therapies target fibrotic and inflammatory processes, due to laryngeal/tracheal trauma, where the latest advances in laryngotracheal applications is that of drug delivery in particle form and in bulk, where its potential, challenges and usefulness are analyzed. [33] However, laryngotracheal scars are a fibroproliferative disease caused by aberrant wound scarring after a damaging effect on the tissues of the larynx and trachea. And this is caused by the most pathogenically important healing, repair, and scarring factors in post-intubation laryngotracheal stenosis, including transforming growth factor $\beta 1$, vascular growth factor A, type I collagen, type III, and matrix metalloproteinases. [34]

The success of the treatment of laryngotracheal lesions depends on rapid decision-making by the trauma surgeon, the correct evaluation of the patient, the securing of the airway (and without the need for tracheostomy) with the maintenance of hemodynamic stability. Early surgical intervention should be aimed at optimally treating laryngotracheal lesions to prevent

disastrous long-term consequences or death of the patient. [35] In neck surgeries, such as the surgery called the Dong method, it significantly improves postoperative pronunciation and recovery time, whereas tracheostomy may not be necessary during bilateral anastomosis in reconstructive nerve trauma deletion. [36] There is conflicting evidence for tracheostomy versus intubation in laryngeal injury, and it should be assessed that surgical intervention likely requires stabilization, monitoring, and management of other concomitant injuries, delayed treatment may severely affect the voice and airway later in life. [37]

On the other hand, a study of a total of 33 fractures between 1995 and 2004 is reported, with a higher prevalence in men (85%) and young adults (mean age 34 years). Blunt force was the most common cause (97%), 61% were treated conservatively, 24% required tracheostomy and 21% needed emergency surgery, with a reported mortality rate of 0%. [38] Laryngeal fractures are life-threatening injuries that are often associated with long-term morbidity. Their injuries included a tear of the thyroid membrane, avulsion of the epiglottis and complete pharyngeal repair, with an early tracheostomy, together with a careful surgical repair and up to 7 months after the initial injury they are reoperated (chronic injuries), with results of achieving excellent breathing and voice, with a safe and competent swallowing. [39]

In recent years, there has been a noticeable increase in the number of patients affected by diseases of the larynx, including cancer, trauma, and other ailments that lead to voice loss. However, the newly developed artificial throat can not only be used as a sound emitter, but also as an intelligent sound sensor, integrating sound perception technology with the help of algorithms. [40] As for the sound sensor, capacitive, piezoelectric, electromagnetic, and piezoresistive materials have been widely exploited in the field. Some sound sensors are self-powered and can be combined with other physiological signs. [41]

CONCLUSIONS

The diagnosis of laryngeal trauma is complex when it is very subtle asymptomatic as in this case, but it can be fatal if the correct diagnosis and resolute surgical treatment are not carried out immediately. It is essential to have an infrastructure for effective or correct diagnosis and treatment. The trauma surgeon must make decisions, in terms of a correct approach, at the specific time, carry out the urgent and/or scheduled procedure, as well as its follow-up, which with his experience and knowledge may be an option to resolve as assertively as possible in order to benefit the patient. Tracheostomy is not currently a strict or blunt indication, as it will depend on each case according to the type or amount of damage of the laryngeal trauma.

Conflict of interest

The authors declare that they have no conflict of interest.

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