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Case Report

# Massive Tracheal Rupture in Blunt Chest Trauma: Reconstruction with Autologous Pericardium

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## Abstract

Tracheal blunt trauma is a rare entity in the pediatric population due to its specific anatomy and biomechanical characteristics. The resulting injury can compromise the airway and quickly become lethal. Early bronchoscopy is essential to diagnose and classify the damage and severity of the lesion to the airway, as well as for postoperative follow-up. In addition to an early diagnosis, it is essential to manage a successful therapeutic intervention, often by surgery.

Tracheal reconstruction is a challenging procedure for thoracic surgeons. When direct closure is not possible, a circumferential resection and end-to-end anastomosis remains to be a highly effective treatment for a tracheal reconstruction. There are situations where this procedure carries a high risk, so, a partial resection and the use of autologous tissue graft for the repair of the tracheal defect will be needed. Several studies have described and established the feasibility of using pericardium and cardiopulmonary bypass for tracheal repair defects in the pediatric population.

We present a case of blunt chest trauma in a pediatric patient with massive tracheal laceration, repaired with an autologous pericardial patch, using extracorporeal circulation with a beating heart.

## Keywords

Airway Lesion; Pericardium Patch; Tracheal Blunt Trauma; Tracheal Reconstruction

## Introduction

Tracheobronchial Injuries (TBI) due to blunt trauma are rare but can be life-threatening. The mortality rate is 30% and, early intervention is key to survival [1]. Clinical features are non-specific and can vary from dyspnea, cough, cyanosis, surgical emphysema to stridor, hemoptysis, mediastinal emphysema or pneumothorax. Diagnosis include X ray, bronchoscopy and CT. The management of TBI can be operative or non- operative depending of the severity of the trauma. Tracheal reconstruction can be challenging based on the amount of tissue lost from the trauma which may impede primary closure making the use of autologous tissue for repair necessary [2-4].

## Case Presentation

A 6-year-old female patient, without relevant clinical history presents with blunt chest trauma of 10 hours of evolution. On initial assessment the patient was asymptomatic, pulse oximetry > 90% and right apical hypoventilation. X-ray and CT thorax showed pneumomediastinum without

pneumothorax. Bronchoscopy showed a pars membranous tracheal laceration from the fourth tracheal ring to the carina. The rupture seemed to be contained by the mediastinal pleura (Figure 1).

## Surgical Technique

We performed a right anterolateral thoracotomy, under cardiopulmonary bypass, with normothermia and a beating heart with ascending aortic cannulation and, right atrial for venous drainage. We explored and located the site of the tear, observing a thin layer of mediastinal pleura covering the traumatic lesion, debrided the edges of the tracheal rupture following the conservative principle of tracheal blood supply and, looking over the recurrent laryngeal nerve; the ovoid defect extended from the fourth tracheal ring to the carina (12 mm wide), the pars cartilaginous was undamaged (Figure 2).

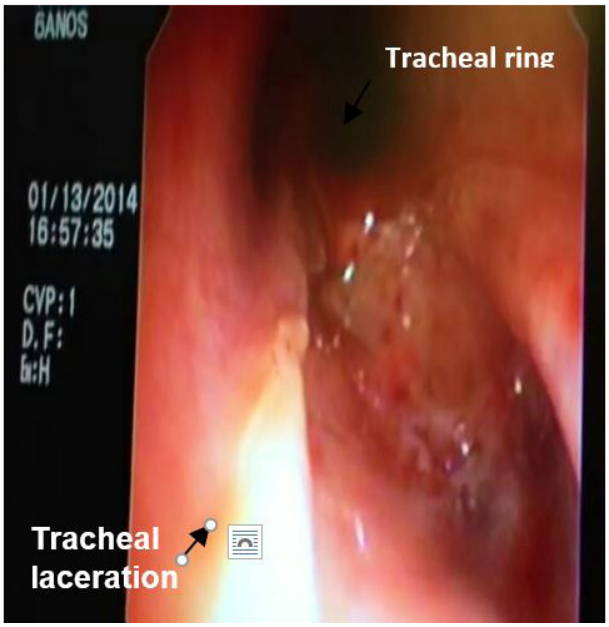


**Figure 1:** Bronchoscopy showing massive longitudinal laceration in pars membranosa.

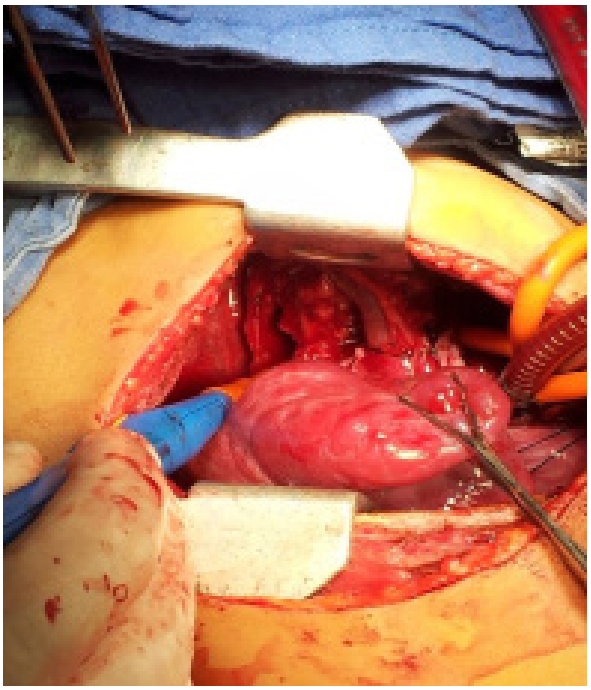

**Figure 2:** Tracheal defect in pars membranosa after debridement.

Direct suture repair or resection and anastomosis were not feasible, we decided to repair it with autologous pericardium using a continuous 6-0 prolene suture; with a cardiopulmonary bypass time of 40 min without complications.

The patient was extubated 48 hours after the procedure. On day 15 post-extubation bronchoscopy showed an optimal tracheal lumen with no stenosis, without collapse of the patch during the respiratory cycle and, adequate luminal healing of the pericardial patch (Figure 3).

correlated with the clinical presentation of the patient [3]. Like in this case, our patient had a massive tracheal laceration, with a contained rupture of the pars membranosa, and her symptoms were virtually absent. Usually, a laceration and/or important tracheal perforation develops with severe dyspnea, cyanosis, and immediate emphysema and, sometimes with hemoptysis [4,7,10].

Bronchoscopy is the cornerstone for diagnostic evaluation. Based on the findings and physical examination, traumatic

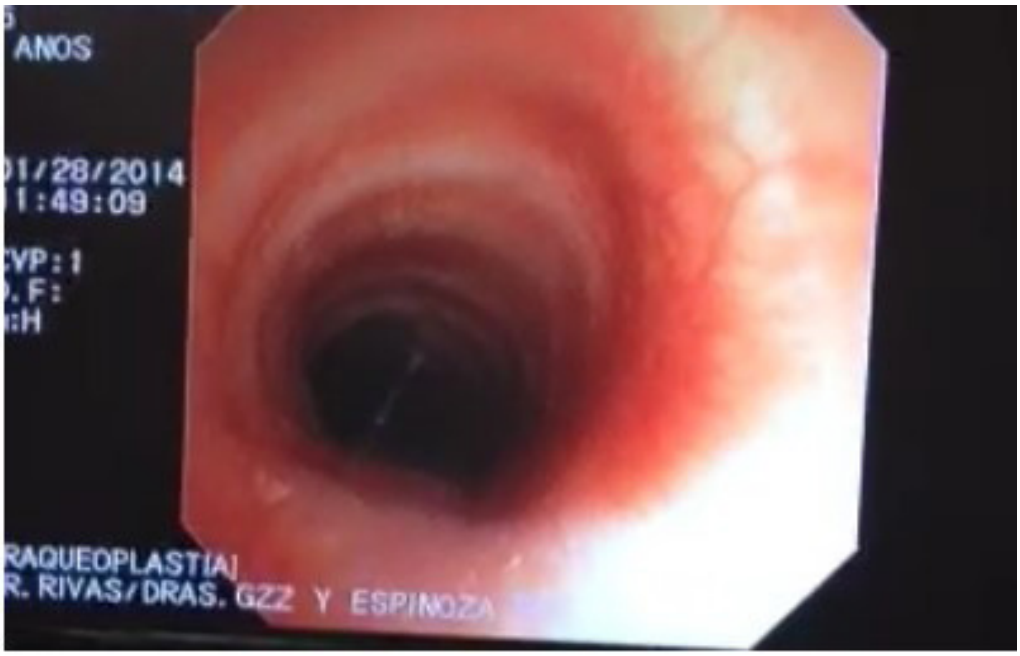


**Figure 3:** 15 days post-extubation bronchoscopy showing pericardial patch completely healed in pars membranosa.

## Discussion

Secondary tracheal injury due to blunt trauma is rare in the pediatric population, with an incidence between 0.3 to 1.5% [5-7]. Ninety percent are intrathoracic, distal trachea or main stem bronchi within 2.5 cm of the carina [6]. The tracheal anatomy and biomechanics in children provide certain protective factors. The kinetics of tracheal blunt trauma originate from two major mechanisms, from external compression applied directly to the anterior of the neck or chest, with a closed glottis, crushing cartilage and the transmission of this force to the rear wall, as was the case of our patient. The second mechanism of blunt tracheal damage are chest deceleration forces, that can result as a shear effect in the posterior fixed points of the airway, like the carina [4,7-9].

Tracheal lacerations represent the effect of severe traumatic forces, often the extent and depth of the damage is not

airway lesions can be classified according to Schaefer and Close [11], in one of four groups:

1. Laryngeal edema and minor lacerations without detectable fractures.
2. Disruption of the mucosa without exposure of cartilage, moderate edema, lacerations, no displaced fractures.
3. Massive edema, mucosal disruption, displaced fractures, without instability.
4. Edema and massive mucosal disruptions, with two or more fractures and instability of the airway.

According to the above classification, our patient was classified as a type 4 lesion. Conservative treatment and close observation with proper antibiotic therapy is recommended in patients with incomplete rupture (less than 1/3 of the tracheal circumference) or subsequent longitudinal tears that show good opposition of the edges, all associated with no or little assisted ventilation

requirements without positive pressure [12]. Most of these children belong to group 1 of Schaefer's classification [4]. Group 2 (minor lacerations) usually require endotracheal intubation. Many of the cases can be managed conservatively and have shown good results with fewer long-term complications. Some will require direct closure of the defects [5-6,8-10].
Surgery is usually indicated in groups 3 and 4, in the setting of an uncontrolled air leakage [5,7,8,13]. The universal principles of surgery which are: debridement of all necrotic tissue and macroscopic direct closure of the affected edges with an absorbable suture, ensuring tightness but with no tension, so vascularity of the tissue involved is not compromised. A closure with separate stitches in a transverse rupture is recommended (leaving the knot outside the lumen), and a continuous longitudinal closure [12].

Sometimes total circumferential tracheal resection of a segment, with termino-terminal anastomosis is the best option [8]. In our patient, unfortunately, this procedure was not possible, since the extension of the rupture contraindicated the resection of the large involved segment. In this and in other similar cases where a traditional repair carries a high risk of complications, it is necessary to use an autologous graft to seal the defect, fulfilling the requirements previously specified for surgical repair. The tissues that have been described to be successful in tracheal repair are muscle [3,12], thymus [14,15], aorta [16], bovine pericardium [4,17,18] and, as in our case, the pericardium [2,19].

The use of pericardium for repair of tracheobronchial injuries has been reported in the literature since 1964 [20]. Subsequent papers published on the logistics and the use of the pericardium, are mostly in relation to the anatomic portion in which it is to be placed (either on the cartilage or membranous pars), because it requires a supporting structure in the anterior part of the trachea. Pericardium used like a composed patch [2,21] or using autologous costal cartilage segments are other tissues that have been used to help with structural support [19,22].

Our patient had the lesion in the pars membranosa, so there was no need to use a supporting structure. The transoperatory airway management in pediatric patients with severe tracheal lesions is always challenging. In our case we decided to use extracorporeal circulation, because if the mediastinal pleura would tear at the time of dissection then we would no longer be able to adequately ventilate the patient [16,19,23-25]. Cardiopulmonary bypass was carried out with a beating heart, aortic cannulation, and normothermia; allowing to expose, visualize and repair the entire rupture.

In conclusion, even though tracheal blunt trauma is uncommon, it should be suspected even with the absence of classic symptoms, and the treatment relies directly on a successful and timely diagnosis through bronchoscopy. Resources like cardiopulmonary bypass and a pericardium patch are highly feasible and reproducible, and should be part of the arsenal of any surgeon and a tool in planning the treatment of these difficult cases.

## Conflict of Interests

All authors declare no conflicts of interest in this article.

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