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Case Report: Complete Right Main Bronchus Rupture after Blunt Chest Trauma: Diagnostic Challenges and Surgical Repair

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ABSTRACT

Introduction

Tracheobronchial injuries (TBI) represent a rare but potentially life-threatening condition requiring prompt recognition and multidisciplinary management. Clinical signs may include subcutaneous or mediastinal emphysema, hemoptysis, and increased airway resistance, especially in intubated patients. Rapid diagnosis using CT and bronchoscopy is essential to guide treatment. Management strategies vary depending on the etiology, ranging from conservative approaches in iatrogenic injuries to surgical repair in cases of blunt or penetrating trauma. Early airway stabilization and treatment of associated life-threatening injuries are critical. The objective of this article is to present a rare case of complete right main bronchus rupture following blunt trauma and highlight diagnostic and surgical challenges.

Case Presentation

A 35-year-old male presented with dyspnea and chest pain following blunt chest trauma. Initial evaluation revealed a right-sided tension pneumothorax with subcutaneous emphysema, which was managed by chest tube drainage. Persistent air leakage prompted a chest CT on day 8 post chest tube insertion, raising suspicion of right main bronchus rupture. Flexible bronchoscopy performed on day 9 post chest tube insertion demonstrated bronchial stenosis without an obvious defect. Definitive diagnosis was established intraoperatively on day 10 post chest tube insertion, confirming a complete circumferential rupture of the right main bronchus. The patient underwent right posterolateral thoracotomy with end-to-end bronchial reimplantation, followed by an uneventful recovery. Follow-up bronchoscopy showed a well-healed bronchial anastomosis.

Conclusion

This case underscores the practical challenges clinicians face in recognizing and diagnosing tracheobronchial injuries after blunt trauma. When a pneumothorax persists despite adequate chest tube drainage, frontline providers must consider early advanced imaging and bronchoscopy, even in resource-limited settings, because definitive diagnosis may sometimes only be confirmed intraoperatively. Early surgical intervention, once diagnosis is suspected or confirmed, can yield excellent outcomes.

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Keywords: Tracheobronchial injuries (TBI), Blunt chest trauma, Bronchial rupture, Thoracotomy, Airway repair

Introduction

Tracheobronchial injuries (TBI) are rare but life-threatening, representing less than 2% of all chest trauma cases (1). Due to the central role of the tracheobronchial tree in oxygen delivery, disruptions particularly near the carina can rapidly lead to respiratory failure, persistent pneumothorax, or massive subcutaneous emphysema. Therefore, prompt recognition and airway management are critical, as delayed or missed diagnoses occur in up to 80% of cases (2), significantly increasing morbidity and mortality.

The clinical presentation and severity of TBI vary on depending on the mechanism of injury (iatrogenic, blunt, or penetrating trauma), each requiring distinct evaluation and treatment strategies. However, most current knowledge stems from retrospective case reports and series, as no prospective studies exist. Here, we report a rare case of a complete circumferential rupture of the right main bronchus following blunt thoracic trauma in a young male, emphasizing the challenges of diagnosis, surgical management, and successful recovery.

Case Presentation

The patient sustained the trauma on January 7, 2025, at approximately 18:50 and arrived at the Calmette Hospital Emergency Department at 23:30 after a high-impact blunt thoracic injury from a collision with a walking tractor while riding a motorcycle. Upon arrival, he was alert but in acute respiratory distress, reporting severe dyspnea, chest pain, and tightness across the chest.

Physical examination revealed tachypnea (respiratory rate: 32/min), oxygen saturation of 88% on ambient air, Glasgow Coma Scale (GCS) of 15, and subcutaneous emphysema over the right hemithorax and neck. Breath sounds were reduced on the right. The extended focused assessment with sonography for trauma (eFAST), performed at 23:50 on the day of arrival, showed no evidence of free fluid in the abdomen or lacerations of abdominal organs.

An urgent chest X-ray confirmed the diagnosis of right-sided tension pneumothorax with extensive subcutaneous emphysema, and tracheal deviation to the left was noted, without apparent rib fractures or mediastinal shift **(Figure 1)**. A chest tube thoracostomy was performed, resulting in rapid decompression and improvement in oxygenation. The patient was transferred to a regular surgical ward for close monitoring **(Figure 2)**. Residual pneumothorax persists in the upper right hemithorax, with continued evidence of subcutaneous emphysema along the right chest wall and neck. The chest tube is well-positioned in the pleural space. After emergency tube thoracostomy, the patient remained under close surveillance in the surgical ward, the patient remained hemodynamically stable, but the air leak persisted, and the right lung failed to fully expand on serial chest radiographs.

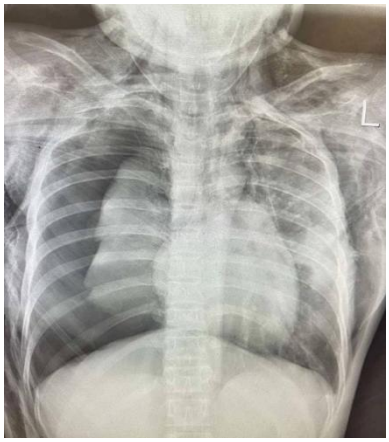

Figure 1: An urgent chest X-ray by portable medical X-ray machine.

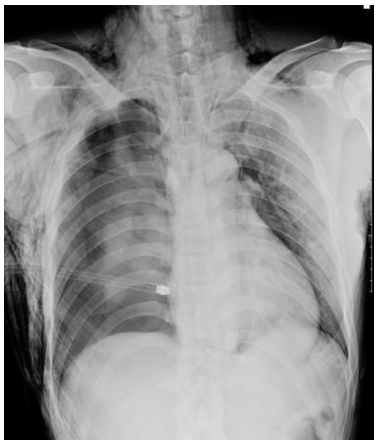

Figure 2: Chest radiograph on day 1 post-chest tube insertion shows a partially re-expanded right lung following emergency tube thoracostomy.

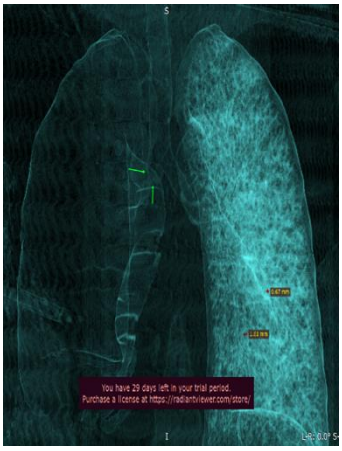

Figure 3: The coronal 3 D of CT shows a pneumothorax on the right side and non-specific trauma-associated alterations in the right proximal bronchus tree.

By day 7 post chest tube insertion, significant residual pneumothorax and subcutaneous emphysema persisted. Despite good tube function and patient compliance, pulmonary re-expansion was incomplete. A contrast-enhanced CT scan was performed, revealing an irregular and narrowed right main bronchus, with persistent pneumothorax, peri-bronchial air, and extensive emphysema (**Figure 3**). These findings raised strong suspicion of a traumatic rupture of the right main bronchus. The patient was referred for diagnostic bronchoscopy to the Pneumology Department

Day 8 post chest tube insertion, flexible bronchoscopy was performed under sedation via the endotracheal tube. The trachea and carina appeared normal, with no active bleeding, defect, or dehiscence. A concentric narrowing at the origin of the right main bronchus was observed, suggesting edema, hematoma, or early fibrosis. These findings were consistent with stenotic pseudo-membrane of the right main bronchus, correlating with the persistent air leak and imaging evidence of airway injury **(Figure 4**). Given the high clinical suspicion and failure of conservative measures, the surgical team proceeded with exploratory thoracotomy.

Figure 4: Bronchoscopic view demonstrates a stenotic pseudo-membrane of the right main bronchus

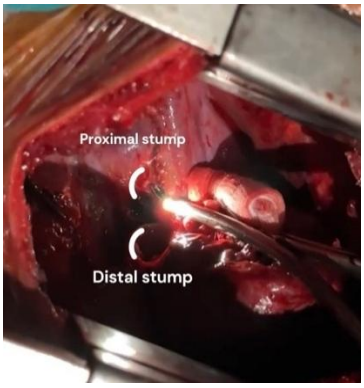

Figure 5: Complete circumferential rupture of the right main bronchus

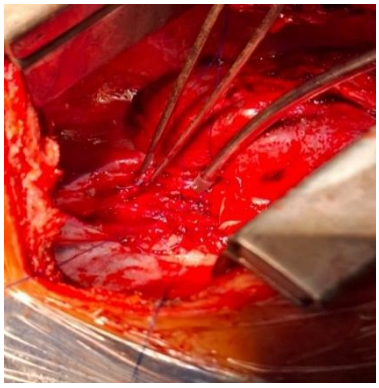

Figure 6: We performed an end-to-end bronchial reimplantation

On day 10 post chest tube insertion, the patient underwent a right posterolateral thoracotomy through the fifth intercostal space under general anesthesia with single-lung ventilation, positioned in the left lateral decubitus position. The preoperative diagnosis was a suspected right main bronchus injury, which was confirmed intraoperatively as a complete circumferential rupture of the right main bronchus approximately 1 cm distal to the carina **(Figure 5).**

Intraoperative findings included sero-hematic pleural effusion, visceral pachy-pleuritis, and complete collapse of the right lung. The proximal bronchial stump was identified about 2 cm from the carina, while the distal stump was located approximately 0.5 cm proximal to the upper and intermediate bronchial bifurcation. The bronchial edges were viable and minimally debrided. An end-to-end bronchial anastomosis was performed using interrupted 3-0 absorbable sutures with meticulous mucosa-to-mucosa approximation **(Figure 6)**. Anastomotic integrity was tested under saline immersion with positive-pressure ventilation, confirming the absence of air leakage. Full re-expansion of the right lung was achieved, and chest drains were placed before closure.

The patient remained intubated after surgery and was transferred to the ICU for postoperative monitoring. He was extubated on postoperative day 1, with normal oxygenation and stable spontaneous breathing. Chest radiography confirmed full right lung expansion without air leak. the patient was discharged from the ICU postoperative on day 3 to the surgical ward **(Figure 7)**.

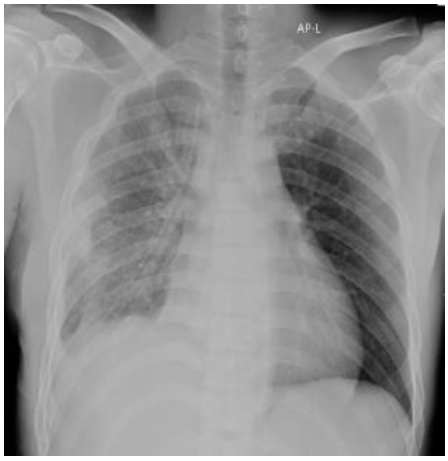

Figure 7: Chest radiograph on postoperative day 1 shows expansion of the right lung with no residual pneumothorax or subcutaneous emphysema. The chest tube is in place and functioning.

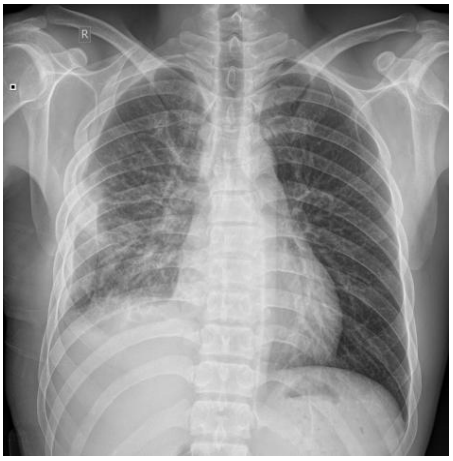

Figure 8: Chest radiograph on discharge day full right lung re-expansion with clear costophrenic angles and no evidence of residual pneumothorax or subcutaneous emphysema. No postoperative complications are seen, confirming favorable recovery prior to discharge.

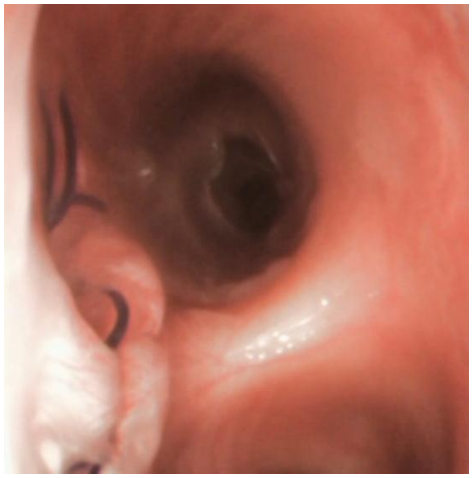

Figure 9: Bronchoscopic view demonstrates a well-healed bronchial anastomosis at the right main bronchus without evidence of stenosis, granulation tissue, or airway narrowing.

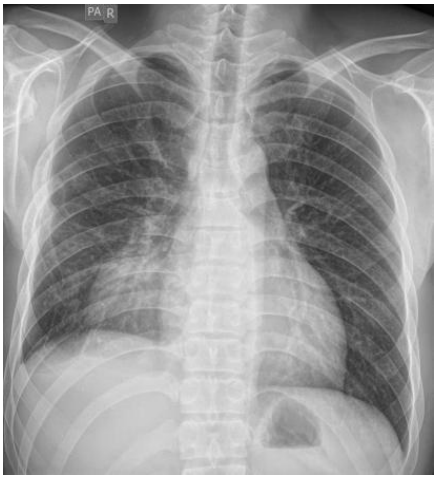

Figure 10: Chest radiograph at 6-week follow-up reveals normal lung fields with full right lung expansion and no signs of postoperative complications. The patient remained asymptomatic at this visit.

His postoperative recovery was supported by structured respiratory physiotherapy, including diaphragmatic breathing exercises, incentive spirometry, mucus mobilization, and postural drainage. After chest tube removal on postoperative day 8, he continued rehabilitation focused on airway clearance, progressive ambulation, and breathing training. He was discharged on postoperative day 18 with a clear rehabilitation plan and instructions for respiratory exercises to be continued at home **(Figure 8)**.

At the first outpatient follow-up on postoperative day 19, the patient was briefly admitted for a routine bronchoscopy. The examination revealed a well-healed bronchial anastomosis with mild mucosal thickening, without stenosis, granulation, or dehiscence **(Figure 9)**. He was discharged the following day in good general condition. At home, he followed a simple primary-care program including breathing exercises, incentive spirometry, regular ambulation, and chest physiotherapy techniques taught prior to discharge, which helped maintain airway clearance and supported his smooth recovery leading up to the follow-up visit.

At the second follow-up visit, one and a half months after discharge, the patient remained completely asymptomatic, with no dyspnea, cough, or chest discomfort. He had resumed daily activities and physical movement without limitations. Clinical examination and chest X-ray were normal **(Figure 10)**. This case illustrates the complex diagnostic trajectory, the value of surgical exploration in uncertain cases, and the successful outcome achieved through timely anatomical repair and structured follow-up.

Discussion

TBI after blunt chest trauma are rare and often difficult to diagnose early due to non-specific symptoms. In this case, the patient presented with dyspnea and subcutaneous emphysema, which initially led to the diagnosis of tension pneumothorax managed by chest tube insertion. However, persistent pneumothorax beyond the first week, despite adequate drainage, raised clinical suspicion for a deeper airway injury.

According to the Cardillo system, which categorizes tracheobronchial injuries based on depth and extent of airway wall involvement. Grade I injuries involve only the mucosa or submucosa, Grade II injuries include partial-thickness lacerations with some cartilaginous involvement, Grade IIIA injuries represent full-thickness tears without complete discontinuity of the bronchial wall, and Grade IIIB corresponds to

complete transection (3). In our case, intraoperative findings demonstrated a full circumferential rupture of the right main bronchus, consistent with a Grade IIIB injury. Such severe lesions mandate immediate anatomical repair, aligning with the surgical approach undertaken in this patient.

CT imaging on day 8 post chest tube insertion suggested disruption of the right main bronchus, although bronchoscopy performed the next day revealed only a stenotic segment with no obvious defect. This highlights the diagnostic limitations of single-modality assessment. As reported by Aliev et al. (4), similar delays occurred in their cases due to inconclusive bronchoscopy or subtle CT findings. Welter et al (5). recommend combining bronchoscopy with advanced CT techniques, such as minimum-intensity projection (MinIP), which were unavailable in our setting but may have improved early detection. In our case, the 10-day preoperative period reflected persistent pneumothorax requiring ongoing monitoring, the need for clinical stabilization, delayed availability of advanced imaging and bronchoscopy, and preoperative optimization before thoracotomy.

Surgical exploration was ultimately required and revealed a complete circumferential rupture of the right main bronchus, located just distal to the carina. The bronchial ends were viable, and end-to-end anastomosis was successfully performed without the need for resection. This approach is consistent with both Aliev et al (4) and Welter et al (5), who emphasized primary repair and anatomical preservation as the optimal strategies for main bronchus injuries, especially in young patients without irreversible parenchymal damage. Our patient did not require the extra-corporeal membrane oxygenation, unlike in two of Aliev's cases, further illustrating the benefit of prompt but carefully timed surgery.

Postoperative recovery was smooth, with no recurrence of air leak or signs of infection. Follow-up bronchoscopy at 19th day post-operatively showed a well-healed anastomosis without stenosis or granulation. This outcome contrasts with one of Aliev's cases, where delayed healing and denervation-related secretion retention led to prolonged ICU stay. The favorable prognosis in our patient can be attributed to early surgical repair, meticulous anastomotic technique, and structured postoperative follow-up. No signs of airway obstruction or functional compromise were observed at six weeks, confirming successful restoration of bronchial continuity and function.

Conclusion

The management of tracheobronchial injuries after blunt chest trauma requires high clinical suspicion, timely imaging, and coordinated multidisciplinary care. Persistent pneumothorax or subcutaneous emphysema despite adequate chest drainage should prompt early CT evaluation and bronchoscopy, even if initial findings appear inconclusive. As demonstrated in this case and supported by current literature, lung-preserving repair through end-to-end bronchial anastomosis remains the optimal approach when feasible, followed by structured postoperative monitoring. Minimizing diagnostic delays depends not only on standardized evaluation protocols and surgical readiness but also on the knowledge, vigilance, and decision-making capacity of frontline healthcare staff involved in day-to-day patient management.

Abbreviation

CT: Computed Tomography; ED: Emergency department; ICU: Intensive Care Unit
TBI: Tracheobronchial injuries; X-ray: Radiography

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Author contributions

The manuscript was written by Sim Pichdavong, editing and surgical data contribution by Dr. Chuon Sophanith and Dr. Vin Penglong, manuscript revision by Dr. Tuo Sothunea, Dr. Lay Nhork.
All the authors have read and approved the final manuscript.

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Declaration

All data collection was made only after agreement at the Calmette Hospital and the University of Health Sciences, Phnom Penh, Cambodia. The patients' identifications are not shown.

Conflicts of Interest

The authors declare that they have no competing interests.

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