Editorial

Management of tracheobronchial ruptures in blunt chest trauma: pushing the boundaries towards a minimally invasive surgical approach

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In a recent issue of *AME Case Reports*, Yu and Laohathai [2023] reported on a case of a middle-aged male patient with a right main bronchus injury after blunt chest trauma (1). After diagnostics in the form of chest radiography and computed tomography (CT) scan, the patient underwent immediate surgical treatment using a minimally invasive video-assisted thoracoscopic surgery (VATS) approach.

As stated in the 10th edition of the Advanced Trauma Life Support (ATLS) Course Manual, traumatic tracheobronchial injuries are rare, with an incidence ranging from 0.2% to 5% in blunt and penetrating chest trauma (2-4). The incidence is difficult to measure due to high pre-hospital mortality. High mortality rates can be attributed to fatal injuries to the trachea, right, and left main bronchus, or other vital structures like the heart and large blood vessels located in the chest (5). The right mainstem bronchus is most affected (27%), followed by the distal part of the trachea (22%), the left mainstem bronchus (17%), the lobar orifices (16%), and the cervical trachea (4%). A combination of lesions to the trachea and bronchi is reported in 8%. Most tracheobronchial injuries are located within 2.5 cm (1 inch) of the carina (6).

Diagnosis of tracheobronchial injury can be difficult due to nonspecific clinical presentation, but it is of utmost importance to initiate adequate treatment in a timely fashion (2,3). Patients can present with respiratory distress and subcutaneous emphysema. Pneumothorax is often present, with persisting high air leakage after placement of multiple chest tubes (2,3,5). During initial patient management according to ATLS principles, chest radiography and CT-scan can provide signs of traumatic bronchial injury. In the case of complete transection of the main bronchus, a fallen lung sign can be seen. This is characterized by ipsilateral atelectasis with an absent hilum and collapsing of the lung away from the hilum to the diaphragm (5). CT-imaging could identify the location of the bronchial injury (2,5), though bronchoscopy confirms the diagnosis and is considered to be the "gold standard" in these injuries (2).

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Yu and Laohathai reported similar findings on conventional radiography and CT-scan images.

According to ATLS and Definitive Surgical Trauma Care (DSTC) guidelines, thoracotomy is the gold standard in patients with thoracic trauma requiring emergency surgery. Indications for emergency thoracotomy include hemothorax with >1,500 cc of hemorrhage immediately after chest tube placement, >1,500 cc of hemorrhage within 24 hours, or >200 cc of hemorrhage per hour, regardless of the mechanism of injury, the patient's condition or the expected underlying injury (7,8). Other indications for emergency thoracotomy are traumatic cardiac arrest, or specific injuries like aortic rupture, pericardial tamponade, or tension pneumothorax, possibly caused by tracheobronchial injury (8). However, some patients with thoracic injury might benefit from minimally invasive thoracic surgery. VATS-assisted surgical stabilization of rib fractures (SSRF) in patients with flail chest has been progressively used. Allowing to adjust the planned incision for rib fixation, and decrease the area of muscle destruction. Moreover, it provides possibilities to identify and treat other intrathoracic injuries, and evacuate hemothorax if necessary (9,10).

Traumatic bronchial injuries can be managed with conservative or surgical treatment (2,11). The treatment modality of choice strongly depends on the patient's condition and the extent of the bronchial injury (12,13). Cardillo *et al.* [2010] proposed a morphological classification of bronchial injuries to guide non-surgical or surgical treatment (4), however this classification was based on post-intubation tracheal injuries and has not been validated to guide therapeutic choices for traumatic bronchial injuries such as described in Yu and Laohathai (1).

Timing of surgery is strongly dependent on the patient's condition, and the expertise of the surgical team available. Immediate emergency surgery is only indicated if the patient's condition cannot be stabilized without surgical intervention (14). In most cases, surgical intervention can be postponed temporarily until the patient is stabilized and a dedicated thoracic operating team is available (6,14). An endotracheal tube can be passed distally to the rupture site during bronchoscopy as a bridge to surgery, or the lung can be isolated with a double lumen (15). If a patient cannot be mechanically ventilated by either of these two treatment modalities, extracorporeal membrane oxygenation may be required as a bridge to surgery (2). Balci *et al.* [2002] reported a significant increase in mortality if surgery is delayed for six hours or more after diagnosis (16). Additionally, there is a higher risk of progression of sepsis, anastomotic dehiscence, or stricture if surgery is delayed for more than 48 hours (14,15,17). In patients that are not fit for surgery, due to associated injuries, or comorbidities, rigid bronchoscopy with stenting of the laceration could be considered as alternative treatment for injuries actually requiring surgery (2,11). In patients with minor tracheobronchial injuries, without complete transection, but with involvement of the mucosa, submucosa, or muscular wall only, non-operative treatment options include antibiotic treatment, tracheostomy with T-tube placement, and frequent endoscopic follow-up (2,12).

All previous reports on bronchial trauma repair describe open approaches (6,14,15). Although thoracotomy is the gold standard for bronchial repair, Yu and Laohathai performed uniportal VATS (uVATS) via the right-sided fourth intercostal space, adhering to the recommendations for a right main bronchus repair using thoracotomy. They used a combination of running and interrupted sutures to create an end-to-end bronchial anastomosis, similar to most thoracotomy cases (72%) for bronchial repair as reported by van Roozendaal *et al.* [2018] (6). Similar anastomosis suturing techniques are described in minimally invasive pulmonary sleeve resections through uVATS (18). Luo *et al.* [2021] reported 3 cases of iatrogenic contralateral mainstem bronchial injury in patients undergoing uVATS lobectomy, which was repaired by running sutures without the need for conversion to thoracotomy (19).

Robot-assisted thoracic surgery (RATS) has contributed to minimally invasive sleeve resections (20). However, there are no known case reports of RATS in traumatic bronchial injury.

The benefits of minimally invasive thoracic surgery for elective surgical procedures are evident. In patients undergoing anatomical lung resections for non-small cell lung carcinoma, shorter hospital stay and chest tube duration have been reported when comparing VATS to thoracotomy, as well as fewer postoperative complications, reduced pain and better survival (21,22). Post discharge complications and readmission rates are also better in patients undergoing VATS (21). While all this holds true for elective surgery, this might not be the case in emergency setting surgical procedures. First of all, trauma patients are not optimized for surgery and might have multiple organ injuries and concomitant tissue trauma. Furthermore, multiple organ injuries might impede proper patient stabilization, meaning that the duration of surgery in trauma patients may negatively affect outcome. Additionally, the operating field might be ill-defined due to

injuries in the area that is being operated on (1,23). Hence, it is suggested that one should weigh the possible benefits and consider the drawbacks reported for trauma patients when considering VATS, even via an uniportal approach, for traumatic tracheobronchial repair. However, conversion to a thoracotomy can be executed under any circumstances.

The same principles hold true for abdominal trauma, in which the therapeutic role of laparoscopy remains controversial (24). In patients with a stable condition, laparoscopy could have many benefits over laparotomy, and, if needed, conversion to laparotomy can be done at any time (24,25).

The decision to perform repair through open or minimally invasive approach strongly depends on the team's experience. Certainly, emergency VATS bronchial restoration should only be performed by surgeons with broad proficiency in elective advanced VATS procedures.

If the patient's condition is stable, transfer to a tertiary care center specialized in minimally invasive thoracic surgery should be considered, in accordance with ATLS guidelines.

In conclusion, treatment plans for tracheobronchial injury should be tailored on a case-to-case basis and depend on the patient's condition, concomitant injuries, extent of the tracheobronchial injury, surgical skills of the operating team, and available local resources. The chosen treatment modality should be as minimally invasive as possible, under the strict condition that the patient's condition is stable enough, and the operating team experience and local resources are sufficient to do so.

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