Blunt Tracheobronchial Trauma

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KEYWORDS

• Tracheobronchial • Blunt thoracic trauma • Bronchial trauma • Segment • Bronchial repair

KEY POINTS

- Most blunt tracheobronchial injuries occur within 2.5 cm of the main carina. The blunt traumatic forces resulting in such damage often result in lethal associated injuries.
- Fiberoptic bronchoscopy allows for the definite evaluation of such injuries, often suspected clinically or on imaging.
- Operative management is carried out on stable patients in either early or delayed fashions. Planning such repairs demands strong communication and cooperation with anesthesia. Also, the access incision should take into consideration the level of the tracheobronchial injury and of the associated intrathoracic injuries that may warrant synchronous repair.
- Primary repair of the mainstem bronchi can often be accomplished with debridement of the edges; in the presence of more significant airway damage, removal of all dead tissues with circumferential resection and reconstruction may be required.

HISTORY

Blunt chest trauma has been described as early as during the time of Hippocrates, as presence of hemothorax due to rib fractures. In the 19th century, Webb and Winslow shared the rare survival of tracheobronchial injuries being repaired in that era: the immense forces needed for blunt thoracic injuries make this a lethal injury, making premodern times reporting limited to autopsy reports.[1] Nissen, in 1930, described a successful pneumonectomy in the management of a posttraumatic bronchial stenosis as an example of early 20th century surgical management of this debilitating injury.[2,3] In 1945, Kinsella and Johnsrud reported a primary repair of a blunt airway injury.[4] Much of the decades that followed saw the emergence of successful surgical reconstructions for patients who presented alive with tracheobronchial injuries, a field that benefited both from advancements in trauma resuscitation and management as well as the development of airway surgical principles and techniques developed by Dr Pearson and his contemporaries. In the last 3 decades, the advent of computed tomography, flexible bronchoscopy, and airway stenting have facilitated the nonoperative management of some less severe injuries and to support those with associated "nonairway" injuries until their condition stabilized.

EPIDEMIOLOGY

Autopsy reports have provided immense information on this subset of thoracic trauma, because most of these patients do not survive; 80% die on the scene. In a large trauma autopsy series, Bertelsen and Howitz reported 2.8% rate of tracheobronchial injury in their 1178 autopsies, most of which are thoracic rather than cervical.[5] Even at busy regional trauma centers only 3 or 4 cases may be managed annually.[6] Mortality was reportedly close to 30% for those who arrive alive

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to the trauma bay. More recently, mortality rates have decreased dramatically to about 9%, with most of those deaths occurring within the first 24 hours. In the work described by Kiser and by Burke[7,8], fatal injuries to the right and left bronchus are 16% and 8% of the time, respectively.

The trachea is more vulnerable to direct injury in the cervical region. Penetrating injuries are more common to this location, more likely to be identified early and repaired immediately. Their management will not be discussed here.

Most blunt tracheal injuries are intrathoracic and affect the mainstem bronchi, usually within 2.5 cm of the carina. Symbas and coworkers noted the following incidence of injury sites: cervical trachea, 4%; distal thoracic trachea, 22%; right mainstem bronchus, 27%; left proximal mainstem bronchus, 17%; complex injuries involving the trachea and mainstem bronchi, 8%; and lobar orifices, 16%. Motor vehicle–related trauma causes 59% of injuries. Other mechanisms described include falls, crush injury, and hyperextension of the cervical trachea. A common motor vehicle mechanism of trauma is seen in the unseat-belted victim being thrown into the dashboard. A shoulder seatbelt injury that is too high can also lead to tracheal trauma.[9]

Kirsh and colleagues[2] described 3 traumatic mechanisms for blunt injuries:

1. A sudden anterior to posterior vector of force at the level of the carina can compress the thoracic cage.
2. If the glottis is closed, a closed high-pressure system can be susceptible to injury from compressive forces. This can lead to tracheal or bronchial rupture at the junction of the membranous and cartilaginous portions.
3. Rapid deceleration can exert shearing forces on the trachea around its 2 relative points of fixation, the cricoid and carina. Partial thickness injuries or even occult injuries may occur.

Associated injuries are seen with 40% to 100% of blunt tracheobronchial trauma, consistent with the theory that a great force is required to exert intrathoracic large airways damage; orthopedic injuries dominate. Close to half of patients will also have facial trauma, pulmonary contusions, and infradiaphragmatic injuries.[10]

The management, therefore, requires multiple assessments for other thoracic structures to be repaired. With cervical trauma, most commonly, we may see injuries to the esophagus, the recurrent laryngeal nerve, the cervical spine, the spinal cord, the larynx, the carotid arteries, and internal jugular vein. Associated with intrathoracic tracheobronchial trauma are injuries to the esophagus (reported in as high as 20%), the left recurrent laryngeal nerve, the spinal cord, and the great vessels. Bronchial injuries combined with great vessel injuries are often fatal.

ANATOMY

Salassa and colleagues[11] describes the intricate anatomy of the blood supply to the trachea. By radiolabeled evaluation of 21 cadaveric human tracheae, we have a deeper understanding of the vasculature outlined by Grillo's earlier work. The cervical trachea has a more constant blood supply than the thoracic. The major source to the cervical trachea is the inferior thyroid artery. The most distal portion of the trachea consistently receives its blood supply from the bronchial arteries. The rest of the thoracic trachea, however, has a more variable arterial supply with branches that may arise from the supreme intercostal artery, the subclavian artery, the right internal mammary artery, and the innominate artery. With the exception of the carina, the various arteries give off branches lateral to the trachea.[12]

Salassa outlined 5 goals of operative dissection of the trachea:

1. Leave the lateral pedicles intact when possible
2. Anterior dissection is safe over the cervical trachea but can disrupt the anastomosis between the bronchial and subclavian system over the thoracic trachea
3. One can ligate bronchial branches to the trachea at the level of the aorta because the subclavian system can continue to provide blood flow.
4. When mobilizing the cervical trachea, keep the thyroid gland intact to maintain the superior-inferior thyroid artery anastomosis.
5. The esophagus has independent pedicles from the trachea and can be separated from the trachea without compromising the blood supply.

DIAGNOSIS

Most patients with blunt tracheobronchial trauma will present with dyspnea and respiratory distress. Nearly half of them will also harbor hoarseness, subcutaneous emphysema, pneumothorax, or hemoptysis at presentation. On physical examination, several signs can hint at the presence of a tracheobronchial injury. Absent breath sounds and desaturation can lead to chest tube placement for pneumothorax evaluation. If a large air leak persists after tube thoracostomy, one may suspect an intrathoracic tracheobronchial injury and imaging