**Department of Anesthesia, Intensive care and Pain management**

# Anesthetic Considerations for Penetrating Thoracic Trauma

## An Essay

Submitted for partial fulfillment of Master Degree
in Anesthesiology

Submitted by

**Mohamed Rabie Mohamed Ali**
(M.B, B.Ch)

Supervised by

**Prof. Dr. Ahmed Ibrahim Ibrahim**
Professor of Anesthesiology, Intensive care and Pain management
Faculty of Medicine, Ain Shams University

**Ass. Prof. Dr.Yasser Ahmed Abd El Rahman**
Assistant Professor of Anesthesiology, Intensive care and Pain management
Faculty of Medicine, Ain Shams University

**Dr.Rania Magdy Mohamed**
Lecturer of Anesthesiology, Intensive care and Pain management
Faculty of Medicine, Ain Shams University

**Faculty of Medicine**
**Ain Shams University**
**2016**

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

# Acknowledgement

*First of all, thanks to* **Allah** *for helping and guiding me in accomplishing this work and for everything else I have.*

*Words are not sufficient to express my sincerest appreciation and my deepest gratitude to* **Prof. Dr. Ahmed Ibrahim Ibrahim,** *Professor of Anesthesiology, Intensive care and Pain management, Faculty of Medicine, Ain Shams University, for his continuous encouragement, and his precious remarks which guide me to present this work in its proper way.*

*I would like to thank* **Ass. Prof. Dr. Yasser Ahmed Abd El Rahman,** *Assistant Professor of Anesthesiology, Intensive care and Pain management Faculty of Medicine, Ain Shams University, for his guidance and suggestions which were of great value to me.*

*I would like to thank* **Dr. Rania Magdy Mohamed,** *Lecturer of Anesthesiology, Intensive care and Pain management, Faculty of Medicine, Ain Shams University, for her guidance and suggestions which were of great value to me.*

**Mohamed Rabie Mohamed Ali**

# Contents

# List of Abbreviations

| Abbrev. | Full term |
| --- | --- |
| **ABG** | : Arterial blood gas |
| **ATLS** | : Advanced Trauma Life Support |
| **COPD** | : Chronic obstructive pulmonary disease |
| **CT** | : Computed tomography |
| **CXR** | : Chest x-ray |
| **DLT** | : Double-lumen endotracheal tube |
| **ED** | : Emergency department |
| **EDT** | : Emergency department thoracotomy |
| **ETI** | : Endotracheal intubation |
| **FAST** | : Focused abdominal sonography for trauma |
| **FFP** | : Fresh frozen plasma |
| **GCS** | : Glasgow coma score |
| **PEA** | : Pulseless electric activity |
| **ROTEM** | : Rotational thromboelastometry |
| **RSI** | : Rapid sequence induction |
| **SBP** | : Systolic blood pressure |
| **TEE** | : Transesophageal echocardiography |
| **TEG** | : Thrombelastography |
| **TTV** | : Trans-tracheal jet ventilation |
| **VATS** | : Video-assisted thoracoscopic surgery |

# List of Tables

# List of Figures

# Introduction

Penetrating trauma is most commonly caused by assault or self-inflicted injuries with firearms or knives. The thorax is one of the most commonly injured structures resulting from trauma. The chest wall, lung parenchyma, trachea, esophagus and vascular structures may be involved, individually or in combination. Severe chest injuries are responsible for 25% of all trauma deaths, and in a further 25% they are a contributing cause of mortality ***(Chandola, 2007).***

The management of the thoracic trauma victim starts right from the site of occurrence and the victim should be transported immediately to a trauma center. Trauma anesthesiology is a unique subspecialty. Anesthesiologists are involved in the care of trauma patients beginning with airway and resuscitation management in the casualty room and proceeding through the operating room to the intensive care unit ***(Aydin et al., 2008).***

In the operating room, priorities include definitive airway management, monitoring of hemodynamics, support of vital signs and organ perfusion, a high suspicion for associated injuries, measurement of pertinent laboratory values, provision of general anesthesia and treatment of injuries ***(Dutton et al., 2010).***

The anesthesia techniques and skills used to treat penetrating thoracic injuries patients are identical to the ones providing anesthesia to scheduled surgical patients, however there are significant differences and challenges. The trauma patient, especially in the context of penetrating injuries, may already arrive exsanguinating and in profound hemorrhagic shock. The case requires a much different, much quicker, and sometime improvised approach to the patient ***(Round and Mellor, 2010).***

There is a paucity of trauma anesthesia-related research and many studies are performed by other specialties such as emergency medicine and surgery, often without any input by anesthetists. Often, similar studies show different, if not completely opposite, results. There exists considerable variation and heterogeneity in traumatic injury and delivery of trauma care which confounds such clinical studies ***(Sheffy et al., 2014).***

Aim of this essay is to cover principles of attending to penetrating thoracic trauma victims starting at the pre-operative level and continuing into the operating theatre highlighting on major issues regarding airway control, severe bleeding treatment and postoperative considerations.

# Chapter (1)
# Anatomy of the thorax

The thorax is the upper part of the trunk. It consists of an external musculoskeletal cage, the thoracic wall, and an internal cavity that contains the heart, lungs, esophagus, trachea, thymus, the vagus and phrenic nerves and the right and left sympathetic trunks, the thoracic duct and major systemic and pulmonary blood vessels. Inferiorly the thorax is separated from the abdominal cavity by the diaphragm, superiorly it communicates with the neck and the upper limbs ***(Michael, 2009).***

## I. Musculoskeletal framework

### A – Bones and muscles

The skeleton of the thoracic wall is formed by the twelve thoracic vertebrae posteriorly, the sternum anteriorly and, on each side, by the twelve ribs and the respective costal cartilage (**fig.1**). The spaces between the ribs are filled by the intercostal musculature, which consists of three layers. The intercostalis externus muscle, with fibers oriented inferoanteriorly. The intermediary layer is formed by the intercostalis internus muscle. The intercostalis intimus muscle is the deepest layer of the intercostal musculature, and is the least developed of the three. The bony cage is covered by muscles as pectoralis major and minor anteriorly, the latissmus dorsi and serratus anterior laterally and posteriorly (**fig.2)** ***(Drake et al., 2005).***

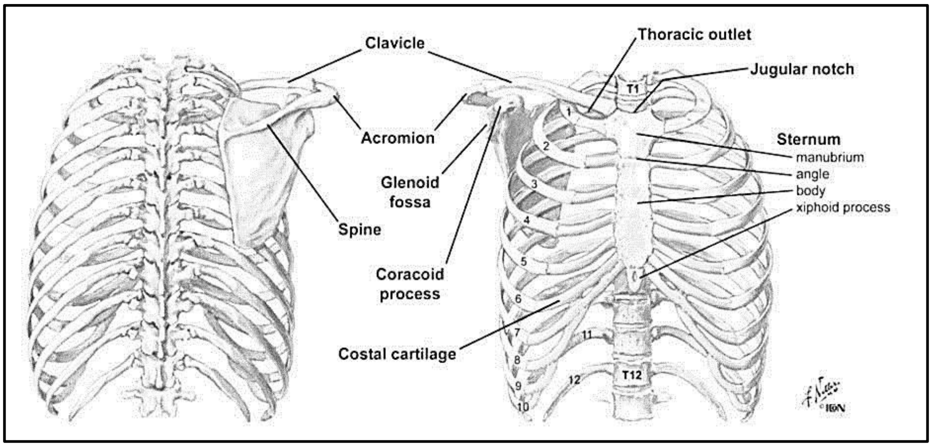


**Figure (1):** The bones of the thorax. The left panel illustrates the bones of the thorax from a posterior view. The right panel is an anterior view of the bony thorax ***(Netter, 2003).***

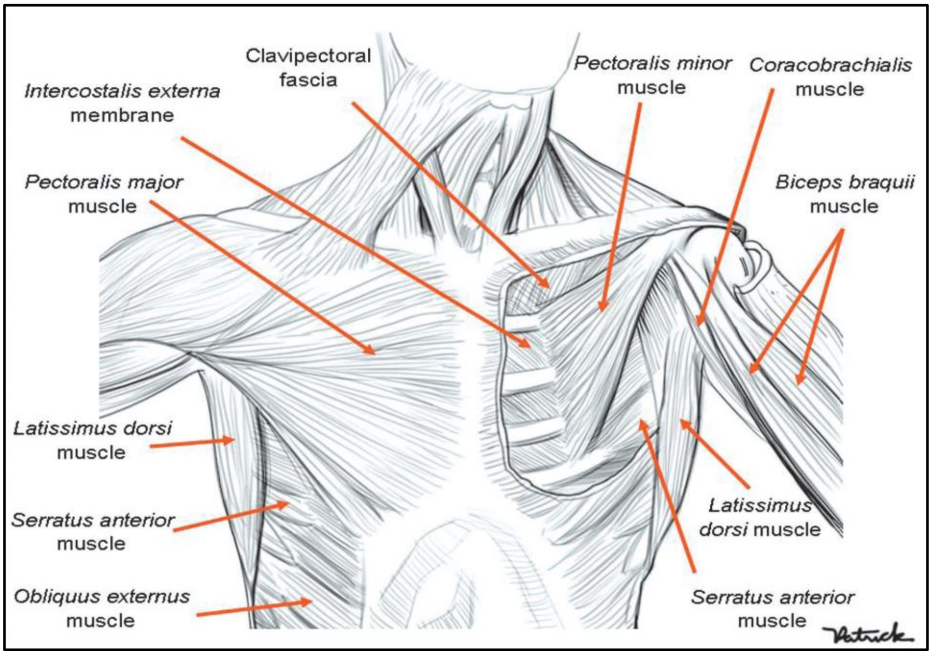


**Figure (2):** Muscles of the trunk. On the right side of the figure, the pectoralis major muscle has been extracted in order to view the pectoralis minor muscle (anterior view of the trunk) ***(Macéa and Fregnani, 2006).***

**B- The diaphragm**

The diaphragm is a dome shaped musculofibrous septum separating the thoracic from the abdominal cavity. Its muscular fibers may be grouped according to their origin into three parts sternal, costal and lumbar (**fig.3**). The lumber part originates from the lumbo costal arches and from the lumbar vertebrae by two pillars or crura at their origin the crura are tendinous in structure and blend with the anterior longitudinal ligament of the vertebral column. The right crus larger and longer than the left, arises from the anterior surface of the bodies and the intervertebral fibrocartilages of the upper three lumber vertebrae while the left crus arises from the corresponding parts of the upper two only ***(Standring, 2008).***

Innervation of the diaphragm is provided by the right and left phrenic nerves, which originate from cervical nerves C3–C5 and facilitate both sensory and motor function ***(Maish, 2010).***

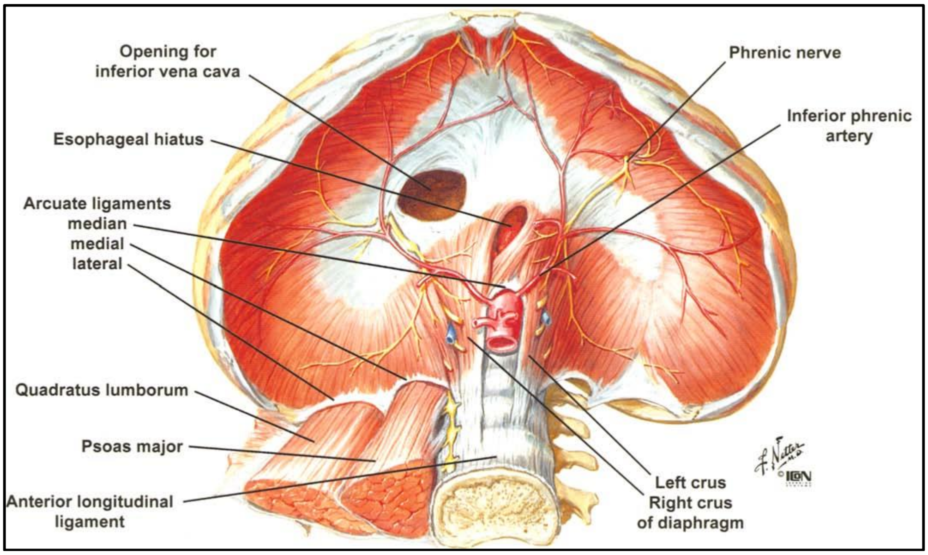


**Figure (3):** The abdominal side of the respiratory diaphragm illustrating the origins of the muscle ***(Netter, 2003).***

# II. Thoracic cavity

### A-Trachea, Pleura, lungs and bronchi

**Trachea**

The trachea initiates at the level of the cricoid cartilage in the neck (C6). It terminates at the level of the angle of Louis (T4/5), where it bifurcates into the right and left main bronchi. It is a rigid fibroelastic structure. Incomplete rings of hyaline cartilage continuously maintain the patency of the lumen. The trachea is lined internally with ciliated columnar epithelium. Behind the trachea lies the esophagus. The second, third and fourth tracheal rings are crossed anteriorly by the thyroid isthmus. The trachea receives its blood supply from branches of the inferior thyroid and bronchial arteries (**fig.4)** ***(Williams, 2001).***

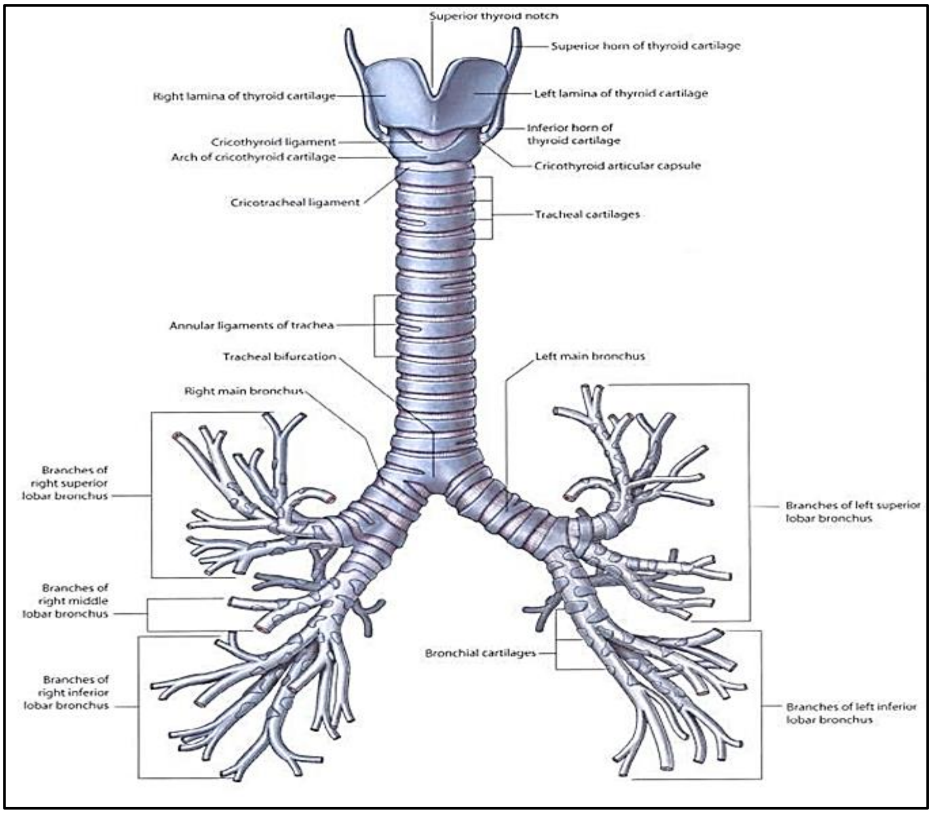


**Figure (4):** Anatomy of the tracheal and bronchial tree ***(Drake et al., 2005).***

## <u>The Pleura</u>

Each lung, in its development, invaginates the coelomic cavity to form a double- walled serous-lined sac. The pleura comprise a visceral layer, which invests the lung itself and passes into its fissures, and a parietal layer, which clothes the diaphragm, the chest wall, the apex of the thorax and the mediastinum. The two layers meet at the site of invagination, which is the lung root or hilum, and here the pleura hang down as a fold, rather like an empty sleeve, termed the pulmonary ligament. Between the two layers of the pleura is a potential space, the pleural cavity, which is moistened with a film of serous fluid ***(Harold, 2008).***

**The Lungs and bronchi**

In adults, the lungs provide an alveolar surface area of approximately >40 square meters for gaseous exchange. Each lung has: an apex that reaches above the sternal end of the first rib; a costovertebral surface that underlies the chest wall; a base overlying the diaphragm; and a mediastinal surface that is molded to adjacent mediastinal structures ***(Murlimanju et al., 2012).***

The right lung is divided into upper, middle and lower lobes by oblique (or major) and horizontal (or minor) fissures. The lower lobe is commonly incomplete and completely absent in 10–50% of the population. The left lung has only an oblique fissure (incomplete in 18% of cases) and no middle lobe. The lingular segment (anatomical part of the upper lobe) represents the left-sided equivalent of the right middle lobe (**fig.5**) ***(Murlimanju et al., 2012).***

Structures enter or leave the lungs by the lung hilum, which is wrapped in a loose pleural coat. Bronchial arteries,