Multiple Trauma Part IV: Specific trauma

face, neck and thorax

Table of Contents

Multiple Trauma Part IV: Specific trauma face, neck and thorax

2026 Update **2026**

Authors

Nikolai Kaltschmidt
Manuel Kühner
Arthur James
Tobias Gauss MD, *CHU Grenoble Alpes, Boulevard de la Chantourne, Grenoble, France*

Reviewers

Xavier Jean Taverna

Co-Ordinating Editor

Lina Grauslyte MD, *Locum consultant in Intensive care medicine Critical care Department Whipps Cross University Hospital Barts Health NHS Trust*

Part IV First Edition **2023**

Authors

Sigrid Beitland MD, *Institute of Clinical Medicine, University of Oslo, Post Box 1072, Blindern, N-0316, Oslo, Norway. 2. Department of Anaesthesiology, Division of Emergencies and Critical Care, Oslo University Hospital, Post Box 4956, Nydalen, N-0424, Oslo, Norway.*
Emiliano Cingolani MD, *UOSD Shock e Trauma Azienda Ospedaliera San Camillo Forlanini Roma -Italia*
Sophie Hamada MD, MSc, *Specialist in Anaesthesia and Intensive Care, Neurosurgical and Surgical Intensive Care Unit, Bicêtre University Hospital; President and co-founder of Traumabase national registry (traumabase.eu), and responsible for the " Security, Protection and Quality of Data" Group, Paris, France*
Claudio Sandroni MD, *Department of Anaesthesiology and Intensive Care, Policlinico Universitario Agostino Gemelli, Rome, Italy*
Markus Skrifvars MD, *Department of Emergency Care and Services, Helsinki University Hospital and University of Helsinki, Finland*

Executive Editor

Nathan D. Nielsen MD, MSc, *Associate Professor, Division of Pulmonary, Critical Care and Sleep Medicine, University of New Mexico School of Medicine, Albuquerque, United States; Editorial Board and Sepsis Section Editor, ESICM Academy*

Second Edition **2018**

Authors

Maria Grazia Bocci MD, *Fondazione Policlinico Universitario A. Gemelli - IRCCS - Roma (Unità di Rianimazione, Terapia Intensiva e Tossicologia - Dipartimento di Emergenza)*

Sophie Hamada MD, MSc, *Specialist in Anaesthesia and Intensive Care, Neurosurgical and Surgical Intensive Care Unit, Bicêtre University Hospital; President and co-founder of Traumabase national registry (traumabase.eu), and responsible for the " Security, Protection and Quality of Data" Group, Paris, France*

Aurore Rodrigues MD, *Université paris Sud Department of Anesthesia and Critical Care Surgical and Trauma ICU APHP Bicêtre Hospital- Hôpitaux Paris Sud Le Kremlin Bicêtre*

Christian Laplace MD, *Université paris Sud Department of Anesthesia and Critical Care Surgical and Trauma ICU APHP Bicêtre Hospital- Hôpitaux Paris Sud Le Kremlin Bicêtre*

Anatole Harrois MD, PhD, *Université paris Sud Department of Anesthesia and Critical Care Surgical and Trauma ICU APHP Bicêtre Hospital- Hôpitaux Paris Sud Le Kremlin Bicêtre*

Nathalie Delhaye MD, *Sorbonne Université Department of Anesthesia and Critical Care AP-HP, Hôpital Pitié-Salpêtrière, Hôpitaux Universitaires Pitié-Salpêtrière Paris*

Claudio Sandroni MD, *Department of Anaesthesiology and Intensive Care, Policlinico Universitario Agostino Gemelli, Rome, Italy*

Sharon Einav MSc, MD, *Shaare Zedek Medical Center; Hebrew University faculty of Medicine, Jerusalem, Israel*

Sigrid Beitland MD, *Institute of Clinical Medicine, University of Oslo, Post Box 1072, Blindern, N-0316, Oslo, Norway. 2. Department of Anaesthesiology, Division of Emergencies and Critical Care, Oslo University Hospital, Post Box 4956, Nydalen, N-0424, Oslo, Norway.*

Emiliano Cingolani MD, *UOSD Shock e Trauma Azienda Ospedaliera San Camillo Forlanini Roma -Italia*

Tobias Gauss MD, *CHU Grenoble Alpes, Boulevard de la Chantourne, Grenoble, France*

Nils Oddvar Skaga MD, PhD, *Senior Consultant, Department of Anaesthesiology, Division of Emergency Medicine, Oslo University Hospital Ullevål; Leader of Oslo University Hospital Trauma Registry, Oslo, Norway*

Reviewers

Luke Leenen MD, PhD, FACS, FEBS (Emerg Surg), *Professor of Trauma, Acute Care Surgery and Intensive Care, Department of Trauma, University Medical Centre Utrecht, Utrecht, The Netherlands*

Kjetil Sunde MD, PhD, FERC, *Professor, Senior Consultant, Surgical ICU Ullevål, Department of Anaesthesiology, Division of Emergencies and Critical Care, Oslo University Hospital and Institute of Clinical Medicine, University of Oslo, Oslo, Norway; Chair, Trauma and Emergency Medicine (TEM) Section, ESICM*

Jacques Duranteau MD, PhD, *Professor in Anaesthesiology and Intensive Care and Head of the Neurosurgical and Surgical Intensive Care Unit of Bicêtre Hospital University, Paris, France*

Editor

Sophie Hamada MD, MSc, *Specialist in Anaesthesia and Intensive Care, Neurosurgical and Surgical Intensive Care Unit, Bicêtre University Hospital; President and co-founder of Traumabase national registry (traumabase.eu), and responsible for the " Security, Protection and Quality of Data" Group, Paris, France*

Assessments Editors

Anna Sarah Messmer MD, *Junior Consultant in Intensive Care Department of Intensive Care Medicine Inselspital, Bern University Hospital, Bern Switzerland*

Filippo Sanfilippo MD, PhD, *Anesthesia and Intensive Care Medicine Institute: Azienda Ospedaliera Universitaria Policlinico Vittorio Emanuele*

Joana Berger Estilita MD, *Department of Anaesthesiology and Intensive Care, Salem Spital, Hirslanden Medical Group; Institute for Medical Education, University of Bern, Bern, Switzerland*

CoBaTrICE Mapping Contributors

Cristina Santonocito MD, *Dept. of Anesthesia and Intensive Care, IRCSS-ISMETT-UPMC, Palermo, Italy*

Victoria Anne Bennett MD, MBBS, FFICM, FRCA, *Anaesthetic and Intensive care registrar, University Hospital Lewisham, London, United Kingdom*

Co-Ordinating Editor

Stephanie C. Cattlin MBBS, BSc, FRCA, FFICM, *Consultant in Intensive Care, Imperial College Healthcare NHS Trust, London, UK*

Executive Editor

Mo Al-Haddad MBChB, FRCA, FFICM, EDIC, MSc (Clinical Education), *Consultant in Critical Care and Anaesthesia, Queen Elizabeth University Hospital Honorary Professor at the University of Glasgow*

First Edition **2005**

Authors

Peter Oakley , *Department of Anaesthesiology and Intensive Care University Hospital of North Staffordshire Stoke-on-Trent, United Kingdom*
Kay Stricker , *Department of Anaesthesiology and Department of Intensive Care Medicine, University Hospital Bern, Bern, Switzerland*

Reviewers

Nino Stocchetti , *Milan, Italy*
Mary-Rose Curran , *Dublin, Ireland*
Bernhard Walder MD, *Department of Anesthesiology, Hôpitaux Universitaires de Genève, Geneva, Switzerland*
Jeannie Wurz , *Dept. of Intensive Care Medicine, Bern University Hospital and University of Bern Bern, Switzerland*
Dermot Phelan , *Consultant in Intensive Care Medicine, Mater Misericordiae University Hospital, University College Dublin, Ireland*
Janice Zimmerman Dr., *Dept of Internal Medicine Division of Critical Care The Methodist Hospital Houston, Texas, USA*

Medical Illustrator

Kathleen Brown , *Triwords Limited, Tayport, UK*

Intended Learning Outcomes

Multiple Trauma Part IV: Trauma care in the ICU and beyond

1. Identify the anatomy and biomechanics of maxillary and facial trauma
2. Identify the classification of facial fractures and their implications for management
3. Recognize clinical signs and symptoms associated with maxillary and facial injuries
4. Explain the epidemiology, mechanisms and presentation of thoracic trauma
5. List the investigations to undertake among stable and unstable patients with thoracic trauma
6. Explain the critical management of patients with thoracic trauma

eModule Information

Relevant Competencies from CoBaTrICE

Multiple Trauma Part IV: Trauma care in the ICU and beyond

- **1.5** Assesses and provides initial management of the trauma patient
- **2.1** Integrates clinical findings with laboratory investigations to form a differential diagnosis
- **3.1** Manages the care of the critically ill patient with specific acute medical conditions
- **3.4** Recognises and manages the patient with, or at risk of, acute kidney injury
- **6.1** Manages the pre- and post-operative care of the high-risk surgical patient
- **6.5** Manages the pre- and post-operative care of the trauma patient

1. Maxillofacial Trauma

1. 1. Anatomy of the Viscerocranium

The facial skeleton is defined as the bones without contact to intracranial space. It consists of the zygomatic bones(1), maxillae (2), palatine bones(3), lacrimal bones(4), inferior nasal conchae(5), nasal bones (6), vomer(7) and mandible(8).

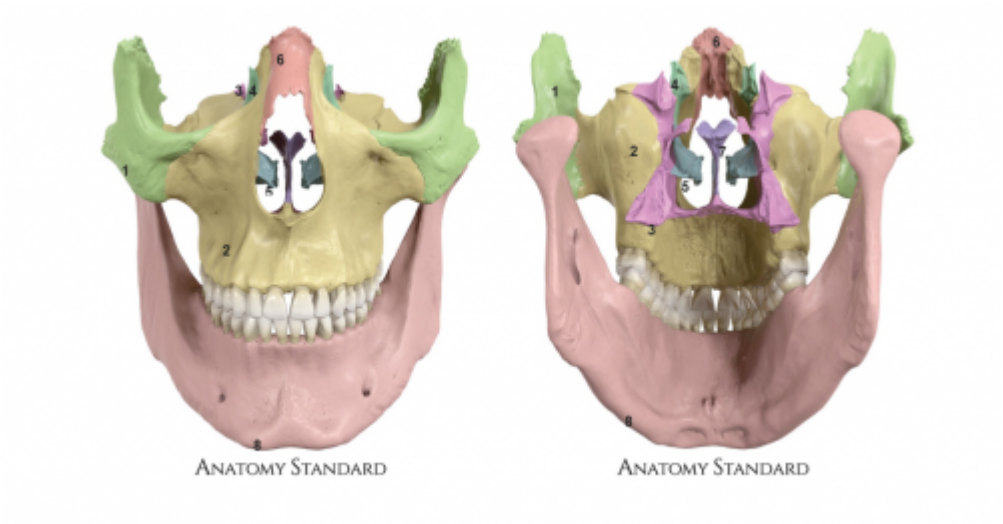

Figure 1: Bones of the viscerocranium - colour coded - left anterior view, right: posterior view. Available: https://www.anatomystandard.com/ossa-et-juncturae/cranium/ossa-viscerocranii.html

1. 2. Mechanisms of injury (blunt versus penetrating trauma)

Blunt trauma results from a forceful impact by a blunt object, that does not primarily penetrate the skin. Blunt trauma can occur from falls, collisions, or blunt instruments. Blunt trauma injuries often lead to contusions, fractures, and organ damage without external penetration. However, with excessive force and energy transfer secondary skin lesions due to shear stress are possible and frequent. In the context of maxillary and facial trauma, common injuries include fractures of the mandible and maxilla, zygomatic arch fractures, nasal fractures, and soft tissue contusions. Furthermore, airway compromise due to deformity, swelling or bleeding are a dangerous complication.

Penetrating trauma occurs when an object pierces the skin and enters the body. This can include injuries from knives, bullets, or other sharp objects. This type of trauma may lead to complex injuries such as lacerations of oral and facial structures and potential injuries to major vascular structures (i.e., carotid or facial artery and jugular veins) and nearby organs (e.g., eyes, trachea, esophagus) in the neck.

In both blunt and penetrating maxillofacial and neck trauma, the mechanisms of injury dictate the type of clinical approach required. Blunt trauma often focuses on stabilization and monitoring for complications, while penetrating trauma necessitates urgent surgical evaluation and intervention to address the risks of significant internal damage and hemorrhage. Understanding these distinctions is crucial in emergency and critical care settings to provide effective and timely treatment.

1. 3. Classification of Facial Fractures

1. 3. 1. Le Fort Fractures

Le Fort Fractures are complex midface fractures, resulting from blunt trauma and involving the maxilla as a main structure, following structural “lines of weakness” (Hohman, Patel and Waseem. 2024).

Le Fort I: Horizontal maxillary fracture.
Resulting from a downward force at the lower maxilla, Le Fort I fractures cause palate-facial separation.

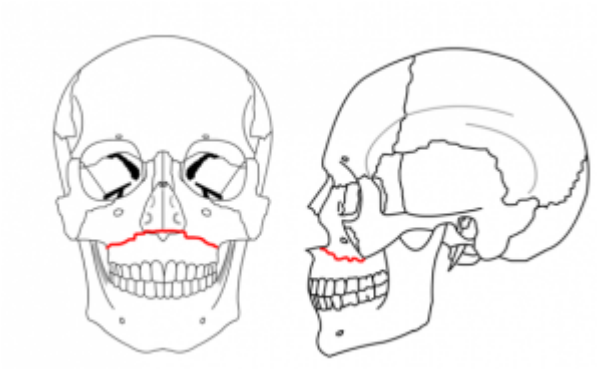

Figure 2: Le Fort I Fracture. Available: https://upload.wikimedia.org/wikipedia/commons/9/9e/LeFort1a.png

Le Fort II: Pyramidal fracture involving the maxilla and nasal bones.
In contrast to Le Fort I, the fracture line in Le Fort II runs more cranially and involves the orbits and the nasal bone after a blunt force to the lower or mid maxilla. The zygomatic bones however are not involved in Le Fort II.

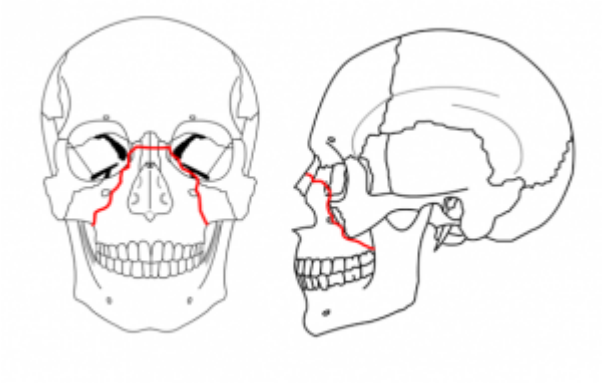

Figure 3: Le Fort II Fracture. Available: https://upload.wikimedia.org/wikipedia/commons/7/70/LeFort2a.png

Le Fort III: Craniofacial separation.
Like the Le Fort II, these fractures are also involving the nasal bone but then extending more posteriorly along both medial, floor and lateral wall of the orbits and also the zygomatic bones causing a complete separation of the midface from the cranial base. They result from blunt force to the nasal bridge or upper maxilla.

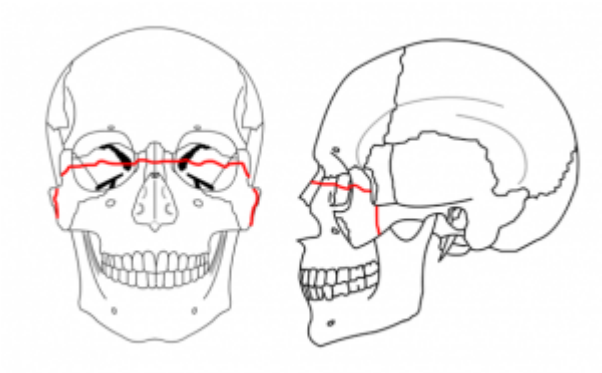

Figure 4: Le Fort III Fracture. Available: https://upload.wikimedia.org/wikipedia/commons/d/da/LeFort3a.png.

Other fractures (mandibular, zygomatic, orbital).
These include any other facial fractures not meeting the Le Fort patterns and may vary significantly in complexity, severity and the necessary interventions depending on the actual injury pattern as a whole.

References

- Hohman MH, Patel BC, Waseem M., Le Fort Fractures., 2024, PMID:30252316

1. 4. Clinical Presentation

Clinical sign and symptoms vary and include facial deformity, pain, soft tissue swelling, bleeding (e.g. epistaxis), as well as malocclusion or trismus, periorbital hematoma or impaired vision such as diplopia. Pulsatile exophthalmos should raise suspicion for a carotid–cavernous fistula (CCF). Especially for EMS, anaesthesia as well as

emergency- and intensive care, most importantly, airway concerns resulting from the above symptoms are relevant and possibly life-threatening complications and therefore a difficult airway should always be expected in these patients. Difficulty in airway management results mainly from upper airway bleeding as well as altered anatomy. Furthermore, due to the often significant energy transfer, accompanying, possibly life threatening injuries should always be suspected and a standardized, multidisciplinary approach (ABCDE) should be applied to avoid missing relevant injuries.

1. 5. Diagnostic Imaging

Computed tomography (CT) scans play a crucial role in the diagnosis and planning of surgical interventions of maxillofacial trauma. Due to the generally good availability in countries with high socio-economic index and their ability to rapidly provide detailed images of bone and soft tissue structures it is the imaging technique of choice in most cases. 3D volume-rendering images in addition to axial, coronal and sagittal plane images can further improve diagnostic accuracy (Sandeep Reddy, Naik and Kenkere. 2023).

In specific circumstances depending on scenario, injury pattern and availability of imaging techniques, alternative modalities such as x-ray, ultrasound or magnetic resonance imaging (MRI) might be considered alternatively or in addition to CT scans.

References

- Sandeep Reddy B, Naik D, Kenkere D., Role of Multidetector Computed Tomography in the Evaluation of Maxillofacial Trauma., 2023, PMID:36938234

1. 6. Management Strategies

The management strategy should follow the ABCDE approach. During upper airway management, suctioning dental debris and secretions, as well as the use of a nasopharyngeal airway, may help improve oxygenation.
In the management of patients with facial trauma, emergency airway considerations are paramount. A difficult airway should always be anticipated in these patients. Induction and intubation must follow a standardized approach, tailored to the patient's physiological and anatomical needs, and should be performed by an experienced airway provider and team.

Pre-induction airway evaluation should include assessment of the following parameters: mouth opening, Mallampati grading, nasal patency, dentition, edema, and, if possible, an understanding of the extent of maxillofacial injuries along with any accompanying injuries (e.g., head, thoracic, or cervical spine injuries).

In cases of reduced mouth opening or as indicated by the surgical team, a nasal approach for airway management may be necessary. Videolaryngoscopy or awake fiberoptic intubation should be considered as a first-line strategy, depending on the patient's presentation. However, active bleeding may impair visualization in devices reliant on indirect visualization.

Due to the potential for soft tissue injuries and the risk of tissue emphysema, bag-mask ventilation, if required, should be performed cautiously, ideally employing a two-handed technique and minimal airway pressures, while wearing appropriate personal protective equipment (PPE) (e.g., eye protection and a mask).

Surgical airway management via the front of the neck serves as an emergency backup strategy but might rarely also be a primary approach, depending on the patient's presentation and clinical circumstances (Piepho et al. 2024; Saini, Singhal and Prakash. 2021).

In instances of severe hemorrhage, resuscitation with crystalloids and/or blood products may be necessary before, during, and after induction to achieve hemodynamic stability, following current guidelines (Rossaint et al. 2023).

Surgical management may include initial stabilization through the reduction of fractures and fixation techniques, as part of an interdisciplinary damage control surgery approach, contingent upon accompanying injuries and the patient's overall condition (Kanala et al. 2021).

Postoperative care must emphasize close clinical observation of airway patency, particularly during and after extubation. Adequate postoperative analgesia is also critical. Careful intraoperative placement of e.g. gastric tubes should be undertaken based on the specific injuries and surgical procedures to avoid further trauma or misplacement during blind placement. Hemorrhage should be anticipated. Initial control may include nasal packing (including balloon tamponade catheters), while refractory or arterial bleeding may require selective endovascular embolization in coordination with interventional radiology?

References

- Rossaint R, Afshari A, Bouillon B, Cerny V, Cimpoesu D, Curry N, Duranteau J, Filipescu D, Grottke O, Grønlykke L, Harrois A, Hunt BJ, Kaserer A, Komadina R, Madsen MH, The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition., 2023, PMID:36859355

- Piepho T, Kriege M, Byhahn C, Cavus E, Dörges V, Ilper H, Kehl F, Loop T, Raymondos K, Sujatta S, Timmermann A, Zwißler B, Noppens R., German guidelines for airway management 2023., 2024, PMID:38753159
- Saini S, Singhal S, Prakash S., Airway management in maxillofacial trauma., 2021, PMID:34759538
- Kanala S, Gudipalli S, Perumalla P, Jagalanki K, Polamarasetty PV, Guntaka S, Gudala A, Boyapati RP., Aetiology, prevalence, fracture site and management of maxillofacial trauma., 2021, PMID:32808805

1. 7. Take Home Messages

1. Maxillofacial trauma are heterogenous injuries with a broad spectrum of possible clinical presentations and accompanying injuries are common.
2. During the acute phase airway management and (fluid) resuscitation are the intensivist’s main focus together with orchestrating damage control or definite care in a multidisciplinary team.
3. Postoperative considerations also involve airway patency and safe extubation alongside with standard intensive care medicine procedures in coordination with the treating surgical specialties.

2. Management of Neck Injuries Including Penetrating Trauma and Airway Management

Neck injuries, especially penetrating neck trauma, represent a high-stakes clinical emergency due to the complex anatomy and the presence of vital structures in a compact space. These include the **airway, major blood vessels, spinal cord, oesophagus**, and **nerves**. Timely and organized evaluation and intervention are essential to minimize mortality and prevent long-term morbidity.

2. 1. Initial Assessment and Prioritization

As with all trauma cases, management begins with the primary survey, according to Advanced Trauma Life Support (ATLS) principles. Airway, breathing, and circulation must be stabilized prior to definitive management of neck injuries.

Key steps include:

1. C-spine immobilization (especially in blunt trauma or unexplained neurological signs).
2. Airway evaluation: Assess patency, voice changes, stridor, subcutaneous emphysema, or expanding hematoma.
3. Hemodynamic status: Hypotension, pulsatile bleeding, or shock indicate possible vascular injury.
4. Rapid bleeding control, including compression and temporary vascular clamps if required.

A "hard signs" vs "soft signs" approach helps in the decision-making process (Table 1).

Table 1: A "hard signs" vs "soft signs" approach

Hard Signs (Indication for Immediate Surgery)	Soft Signs (Require Further Workup)

1. Active arterial bleeding 2. Expanding or pulsatile hematoma 3. Air bubbling from wound 4. Airway obstruction 5. Hematemesis (suggesting esophageal/tracheal injury) 6. Shock unresponsive to fluids 7. Neurological deficit suggestive of cord injury	1. Minor hemoptysis or hematemesis 2. Non-expanding hematoma 3. Dysphonia or dysphagia 4. Subcutaneous emphysema 5. Neurological symptoms without instability

2. 2. Anatomical Zoning of Neck Injuries

Traditionally, the neck is divided into three **anatomical zones** to guide surgical access and diagnostic priorities:

1. **Zone I:** From the clavicle to the cricoid cartilage – includes subclavian vessels, apex of lungs, esophagus, trachea, thoracic duct.
2. **Zone II:** From cricoid cartilage to the angle of the mandible – contains carotid and jugular vessels, larynx, trachea, esophagus, recurrent laryngeal nerves.
3. **Zone III:** From angle of mandible to skull base – includes distal internal carotid artery, jugular vein, cranial nerves, and parotid gland.

Historically, **Zone II injuries** were explored surgically more often due to ease of access, but with modern imaging (e.g. CT angiography), **selective non-operative management** is now widely accepted.

2. 3. Imaging and Diagnostic Workup

For **hemodynamically stable patients**, high-resolution imaging is crucial.

1. **CT Angiography (CTA):** Gold standard to evaluate vascular injuries, used in all zones.
2. **Flexible nasopharyngolaryngoscopy:** Assesses airway and vocal cords, detects laryngeal or pharyngeal injury.
3. **Esophagoscopy or contrast esophagography:** Used if esophageal injury is suspected.
4. **Bronchoscopy:** Used to evaluate tracheal or bronchial tree disruption.

5. **Plain radiography:** Limited utility, but may detect foreign bodies, air in soft tissue, or gross skeletal injury.

2. 4. Airway Management in Neck Trauma

Airway compromise is a critical concern in neck trauma and may be imminent or rapidly progressive.

Indications for Immediate Airway Intervention:

1. Airway obstruction (e.g., stridor, hoarseness, dyspnoea)
2. Massive subcutaneous emphysema
3. Expanding neck hematoma
4. Active bleeding into the airway
5. Complex facial trauma preventing mask ventilation

Preferred Airway Techniques:

1. Awake fiberoptic intubation (if cooperative and partial obstruction)
2. Rapid sequence intubation (RSI) (if full obstruction is not imminent)
3. Surgical airway (cricothyrotomy or tracheostomy) if:
    1. Massive trauma with distorted anatomy
    2. Inability to intubate or ventilate
    3. Airway bleeding obscures endotracheal tube (ETT) placement

Special Considerations:

1. Avoid blind intubation through neck wounds.
2. Video laryngoscopy is useful but may be limited in distorted anatomy.
3. Cricothyrotomy is the first-line emergency surgical airway in adults.
4. Tracheostomy may be preferred in controlled settings or where the cricoid cartilage is disrupted.

2. 5. Penetrating Neck Injuries: Management Strategy

Penetrating injuries may be stab wounds, gunshot wounds, or shrapnel injuries.

Immediate Exploration Is Required If:

1. Hard signs of vascular or aerodigestive injury are present
2. Hemodynamic instability or massive bleeding occurs
3. Impalement or active bleeding is visible

Selective Non-Operative Management (SNOM):
This is now favored in hemodynamically stable patients without hard signs, supported by high-quality imaging and endoscopy/bronchoscopy when needed. SNOM reduces unnecessary surgical exploration and associated complications.

Table 2: Common Injury Patterns and Interventions

Injury	Management
Carotid artery injury	Ligation (if distal), repair (if proximal and accessible) or temporary shunting
Jugular vein injury	Ligation often sufficient
Tracheal/laryngeal injury	Surgical repair + tracheostomy if airway unstable
Esophageal injury	Surgical repair within 24h + antibiotics, drain placement
Thyroid injury	Hemostasis and observation or resection if devascularized
Spinal cord injury	Immobilization, neurosurgical consultation

2. 6. Blunt Neck Trauma

Though less common, **blunt neck trauma** can be deceptive and life-threatening.

Mechanisms include:

1. Motor vehicle accidents with seatbelt-related injury
2. Strangulation or hanging
3. Direct blow to neck (e.g., assault, sports injuries)

Potential complications:

1. Laryngeal fracture or tracheal disruption
2. Carotid or vertebral artery dissection → risk of stroke (overall incidence 5-10 %) (Tran et al. 2024)
3. Retropharyngeal hematoma → delayed airway compromise

4. Esophageal perforation

Workup in blunt trauma includes:

1. CTA of neck vessels (for dissections)
2. Flexible laryngoscopy (for airway trauma)
3. Bronchoscopy and esophagoscopy if clinically indicated

References

- Tran A, Fernando SM, Rochwerg B, Hawes H, Hameed MS, Dawe P, Garraway N, Evans DC, Kim D, Biffl WL, Inaba K, Engels PT, Vogt K, Kubelik D, Petrosoniak A, Joos E., Prognostic factors associated with risk of stroke following blunt cerebrovascular injury: A systematic review and meta-analysis., 2024, PMID:38277875

2. 7. Airway Management in Tracheal or Laryngeal Trauma

Clinical signs:

1. Subcutaneous emphysema
2. Hoarseness
3. Hemoptysis
4. Respiratory distress

Airway strategies:

1. Avoid RSI if laryngeal injury is suspected—may worsen the disruption.
2. Secure airway via awake tracheostomy or cricothyrotomy if distortion present.
3. Surgical repair may be required for tracheal transection or laryngotracheal separation.

2. 8. Postoperative and ICU Management

1. Close monitoring for **airway obstruction, hematoma**, or **re-bleeding**.
2. Use of **tracheostomy** may aid in airway management and secretion clearance.
3. Regular assessment of **neurologic status, vocal cord function**, and **swallowing**.
4. Early **speech and swallow evaluation** to reduce aspiration risk.

5. Antibiotic prophylaxis in pharyngeal/esophageal injury or when aerodigestive contamination is suspected.
6. Anticoagulation or antiplatelet may be required for **vascular dissections**, with neurologic monitoring.

2. 9. Conclusion

Neck trauma requires rapid recognition, structured assessment, and decisive airway management to prevent catastrophic outcomes. Advances in imaging and a selective operative approach have improved outcomes and minimized unnecessary surgical exploration. In all cases, securing the airway, controlling hemorrhage, and maintaining cervical spine precautions form the backbone of effective care. Interdisciplinary collaboration between trauma surgery, ENT, anesthesia, and radiology is essential for optimal outcomes.

In Chapter References

(Shiroff et al. 2013; Bryan and Richardson 2000)

References

- Shiroff AM, Gale SC, Martin ND, Marchalik D, Petrov D, Ahmed HM, Rotondo MF, Gracias VH. , Penetrating neck trauma: a review of management strategies and discussion of the 'No Zone' approach., 2013, PMID:23317595
- Bryan RM, Richardson JD, Injuries to the neck. In Mattox KL, Moore EE, Feliciano DV (Eds.), Trauma (4th ed.). McGraw-Hill., 2000, ISBN10:0071365087

3. Thoracic trauma

Trauma is the leading cause of death in the world for people up to 45 years old. Chest trauma accounts for 25% of annual overall trauma cases. It is the third most common cause of death after abdominal injury and head trauma.
The most common mechanism of injury is blunt trauma involving viscera laceration by dislocated skeletal fractures. Rib fractures are the most common as they account for 43% of blunt injuries. Penetrating trauma on the other hand causes a laceration of surrounding viscera in the trajectory of the weapon.

3. 1. Anatomy

The thorax is the superior part of the trunk. It is closed in its inferior part by the diaphragm and in its superior part by the root of the neck. The thoracic wall is formed by 12 pairs of ribs, 12 thoracic vertebrae, and the sternum (Figure 5). The thoracic cavity is divided in three areas, two pleural cavities separated by the mediastinum. The thoracic cavity is home to key anatomical structures such as: cardio-pulmonary organs, the oesophagus, the trachea, and major blood vessels (e.g aorta).

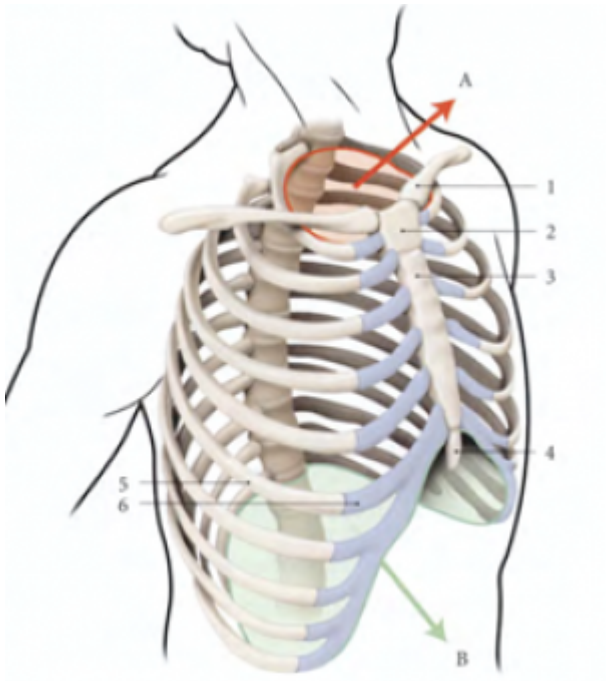

Figure 5: Thoracic wall antero-lateral view (From Clinical anatomy n3 : Thorax and Abdomen 4th edition Kamina) .1.Superior opening of thorax, B. Inferior opening of thorax 1. Clavicle, 2. Sternum (manubrium), 3. Sternum (body), 4. Sternum (xyphoid process), 5. Rib, 6. Rib (cartilage)

3. 2. Clinical presentation

3. 2. 1. Patients with signs of shock

The clinical presentation of thoracic trauma among patients with signs of shock is the result of one or a combination of lesions affecting either:

1. vascular structures (in the mediastinum, on the thoracic wall)
2. bones (rib, sternal and clavicular fractures)
3. pleuras (blood or gas effusion)
4. tissues (pulmonary and myocardial contusion)

Such lesions can jeopardise hemodynamic status and lead to a severe state of shock. Table 3 summarizes the main causes of thoracic trauma induced shock depending on the type of shock.

Table 3: Main causes of thoracic trauma induced shock depending on the type of shock.

Type of shock	Cause
Hemorrhagic shock	• Lesion to heart and major blood vessels • Aortic isthmus rupture • Thoracic wall artery rupture
Cardiogenic shock	• Myocardial contusion • Traumatic cardiac valve lesion
Obstructive shock	• Gaz tamponade (pneumothorax) • Liquid tamponade (heart injury, rupture of pericardium) • Diaphragmatic herniation
Neurogenic shock	• Vertebro-medullar trauma
Hypovolemic shock	• Rhabdomyolysis

e-FAST assessment and thoracic X-rays are the primary investigations to undertake when faced with a trauma patient in a state of shock. A CT-scanner can be realized once the patient in stabilized to fully assess potential supplementary lesions.

3. 2. 2. Patients with no sign of shock

Among patients with no sign of shock upon admission, CT-scanner is the first investigation to undertake.
Secondary respiratory complications are the main cause of death among these patients. The pathophysiology of respiratory complications is based on the occurrence of a restrictive syndrome due to rib fractures, pain, and pleural effusions leading to hypoventilation and inefficient cough efforts. Such restrictive syndrome can lead to pulmonary atelectasis and pulmonary infections and in extreme cases acute respiratory distress syndrome.
Observational studies identified high risk populations for chest trauma complications:

1. patients older than 65 years old
2. patients with preexisting cardio-pulmonary diseases
3. patients with congenital of acquired coagulation issues
4. penetrating trauma and/or high velocity trauma

Identifying high risk patients, monitoring them and preventing the occurrence of a restrictive syndrome is of the essence to reduce mortality.

3. 3. Diagnostic imaging

3. 3. 1. Radiography & ultra-sonography

X-rays were historically used as first line imaging examination as they are easily feasible among unstable patients. They allow for swift identification of fractures (ribs, sternum), severe pleural effusions (liquid and/or gas), diaphragmatic herniation, and some pulmonary contusions.

Ultrasonographic extended focused assessment of trauma patients (eFAST) has recently become a cornerstone of initial trauma management. It has even been introduced in the prehospital setting. Pleuro-pulmonary ultrasonography is superior to radiography to diagnose gas or liquid intrathoracic effusions (pleural or pericardial). Among stable patients, US allows for identification of sternal and rib fractures that may have been overlooked by chest radiography.

3. 3. 2. CT

Computed tomography with injection is the gold standard investigation to identify post traumatic thoracic lesions. In the case of a major trauma, the thoracic CT is realized within a body CT sequence. Body CT sequences for patients suspected of suffering from multiple traumas have drastically reduced in-hospital mortality.

3. 4. Management strategies

Effective management of thoracic trauma is crucial to reduce early mortality and prevent complications. The approach varies based on the patient's hemodynamic stability and the specific injuries sustained.

3. 4. 1. Initial Assessment and Resuscitation

Immediate evaluation follows the principles of Advanced Trauma Life Support (ATLS), focusing on airway, breathing, and circulation. Rapid identification and management of life-threatening conditions are paramount.

In case of traumatic cardiac arrest: Bilateral thoracostomies are performed to relieve tension pneumothorax, a reversible cause of arrest.

3. 4. 2. Thoracic Trauma Score

The Thoracic Trauma Severity Score (TTSS) is a validated tool that helps stratify the risk of complications in patients with blunt chest trauma. It incorporates variables such as age, number of rib fractures, pulmonary contusion severity, pleural involvement, and PaO_2/FiO_2 ratio. Scores ≥5 are associated with higher risk for mechanical ventilation, ICU admission, and mortality. TTSS aids in decision-making regarding ICU monitoring, need for regional analgesia, and early surgical fixation of ribs. It complements clinical judgment and imaging in tailoring interventions for high-risk patients and has shown correlation with morbidity and length of stay.

3. 4. 3. Airway and Breathing

Ensure a patent airway. In cases of respiratory distress or compromised airway, early intubation may be necessary.

Non-invasive ventilation (NIV) can be beneficial for hemodynamically stable patients with adequate mental status. NIV is preferred in stable patients with mild respiratory distress; invasive ventilation is required for severe respiratory compromise or failed NIV.

3. 4. 4. Circulation

Identify and control sources of bleeding. In cases of significant hemorrhage, resuscitative endovascular balloon occlusion of the aorta (REBOA) may be considered as a temporizing measure to control non-compressible torso hemorrhage, but should

be reserved for highly expert centers and research as indicated by the UK REBOA trial

Administer crystalloids judiciously to maintain tissue perfusion. Avoid excessive fluid administration to prevent exacerbation of pulmonary contusions.

3. 4. 5. Chest Drain Thoracostomy

Anterior or lateral approach depending on the injury; large-bore drains for hemothorax, small-bore for pneumothorax; no routine antibiotic prophylaxis.

Indicated for:

- Pneumothorax: Especially if large or causing respiratory compromise.
- Hemothorax: Drainage is recommended for hemothoraces >500 mL to prevent complications such as fibrothorax or empyema

3. 4. 6. Surgical interventions

Thoracostomy is indicated in cases of:

- Initial chest drain output >1500 mL
- Persistent bleeding >200 mL/hour over 3 hours
- Hemodynamic instability despite resuscitation

Rib Fixation: Surgical stabilization of rib fractures, especially in flail chest, can reduce ventilator days and improve pulmonary function.

3. 4. 7. Pain Management

Effective analgesia is essential to facilitate adequate ventilation and prevent pulmonary complications.

Epidural Analgesia: Recommended for severe rib fractures, unless contraindicated (coagulopathy, infection, or raised intracranial pressure). Serratus anterior block provides effective regional analgesia with fewer complications.

Multimodal Analgesia: Combines systemic analgesics with regional techniques to optimize pain control

3. 4. 8. Monitoring and Support

Continuous monitoring in an intensive care setting is often required, with attention to respiratory function (regular assessment to detect early signs of respiratory compromise) and hemodynamic status (Monitoring for signs of ongoing bleeding or shock).

3. 4. 8. 1. Diaphragmatic Injury

Diaphragmatic injury, typically resulting from high-energy blunt or penetrating trauma, is often underdiagnosed during the initial evaluation. Left-sided injuries are more common due to hepatic protection on the right. These injuries can lead to herniation of

abdominal contents into the thoracic cavity, resulting in respiratory compromise, bowel obstruction, or strangulation. Diagnosis may be missed on initial imaging, so CT scan with coronal and sagittal reconstruction is the gold standard. Surgical repair, usually via laparotomy or thoracotomy, is indicated to prevent delayed complications such as herniation or incarceration.

3. 4. 8. 2. Oesophageal Injury

Traumatic oesophageal injuries are rare but carry high mortality due to mediastinitis and sepsis from delayed diagnosis. Most are caused by penetrating trauma to the neck or thorax, with blunt trauma being less frequent. Symptoms may include subcutaneous emphysema, dysphagia, or hematemesis. Diagnostic tools include contrast esophagography, CT scan with oral contrast, and esophagoscopy. Management depends on the location, size, and timing: early surgical repair is preferred within 24 hours, while delayed presentations may require drainage, diversion, and antibiotics. High suspicion is crucial due to the non-specific presentation.

3. 4. 8. 3. Myocardial Injury

Myocardial contusion is most commonly caused by blunt thoracic trauma (e.g., motor vehicle collisions). It may range from asymptomatic minor injury to life-threatening arrhythmias or cardiac rupture. Clinical suspicion is key, especially with sternal fractures or direct chest impact. Initial workup includes ECG and troponin levels. Echocardiography helps assess wall motion abnormalities or pericardial effusion. Continuous cardiac monitoring is advised for at least 24–48 hours in suspected cases. Severe cases may require inotropic support or surgical intervention if associated with valvular injury or cardiac chamber rupture.

3. 4. 8. 4. Tracheobronchial Injury

Tracheobronchial injuries, though rare, are serious consequences of blunt or penetrating trauma and often present with pneumothorax, subcutaneous emphysema, or persistent air leak despite chest tube placement. Blunt trauma typically causes injuries within 2 cm of the carina. Bronchoscopy is the diagnostic gold standard and should be performed early in suspected cases. CT may show air tracking or discontinuity. Minor injuries may be managed conservatively with intubation distal to the injury; however, surgical repair is generally required for complete transection or large tears, especially with respiratory compromise or air leaks.

4. Aortic Injuries in Trauma: Pathophysiology and Management

Aortic trauma, particularly blunt thoracic aortic injury (BTAI), is a life-threatening condition most commonly caused by high-energy deceleration trauma such as motor vehicle accidents or falls from height. These injuries are associated with high pre-hospital mortality, and among patients who reach the hospital alive, prompt diagnosis and management are essential.

4. 1. Mechanisms and Classification

Aortic injuries typically occur at fixed points of the aorta, especially the isthmus (just distal to the left subclavian artery), due to shearing forces. BTAI is categorized into four grades:

1. Grade I: Intimal tear
2. Grade II: Intramural hematoma
3. Grade III: Pseudoaneurysm
4. Grade IV: Free rupture

Penetrating injuries (e.g., stab or gunshot wounds) can involve the thoracic or abdominal aorta and are often fatal if not rapidly addressed.

4. 2. Diagnosis

CT angiography (CTA) is the gold standard for diagnosing aortic trauma. It offers high sensitivity and specificity and allows assessment of other thoracic and abdominal injuries. Chest X-ray may show a widened mediastinum, but it lacks sensitivity and should not delay definitive imaging.

4. 3. Management

The mainstay of therapy depends on injury severity and patient stability. The Society for Vascular Surgery recommends the following:

1. Grade I-II: Often managed conservatively with blood pressure and heart rate control (e.g., beta-blockers).
2. Grade III-IV: Require urgent repair due to risk of rupture.

Thoracic endovascular aortic repair (TEVAR) has become the preferred method over open surgery due to lower perioperative morbidity and mortality. TEVAR can often be delayed to allow stabilization of other injuries, provided blood pressure is controlled.

For abdominal aortic injuries, management typically involves urgent surgical repair, particularly if associated with haemorrhagic shock.

4. 4. Prognosis and Follow-up

The prognosis of aortic injuries depends on the grade and presence of associated trauma. With prompt diagnosis and TEVAR, mortality rates have significantly decreased. Long-term surveillance with CTA is recommended to monitor endograft integrity and aortic remodelling.

4. 1. Conclusion

Management of thoracic trauma requires a systematic approach tailored to the individual patient's injuries and physiological status. Early intervention, appropriate surgical management, and effective pain control are key components to improve outcomes.

Key messages:

- Chest trauma accounts for 25% of annual trauma cases
- Blunt injury is the most common mechanism of injury
- Unstable patients must be assessed using thoracic X ray and e-FAST if unstable
- Thoracic trauma can lead to secondary pulmonary complications
- CT is the gold standard investigation for thoracic trauma

In Chapter References

(Hisamune et al. 2024; Kamina. 2014; Noll, Meaudre and Godier. 2022; SFAR and 2015; Chan et al. 2020; Lewis and Georgoff. 2024; Slobogean et al. 2013; Estrera et al. 2013; Fox et al. 2012)

(Simon et al. 2005; Apampa et al. 2022; Van Waes et al. 2012; Mladenovic et al. 2022; Dehghan et al. 2014; Lamont et al. 2009; Bouzat et al. 2017)

References

- Hisamune R, Kobayashi M, Nakasato K, Yamazaki T, Ushio N, Mochizuki K, Takasu A, Yamakawa K., A meta-analysis and trial sequential analysis of randomised controlled trials comparing nonoperative and operative management of chest trauma with multiple rib fractures., 2024, PMID:38504282
- Lewis MR, Georgoff P., Minimally invasive management of thoracic trauma: current evidence and guidelines., 2024, PMID:38646032
- Van Waes OJ, Van Riet PA, Van Lieshout EM, Hartog DD., Immediate thoracotomy for penetrating injuries: ten years' experience at a Dutch level I trauma center., 2012, PMID:23162671
- Chan KK, Joo DA, McRae AD, Takwoingi Y, Premji ZA, Lang E, Wakai A., Chest ultrasonography versus supine chest radiography for diagnosis of pneumothorax in trauma patients in the emergency department., 2020, PMID:32702777
- Kamina P., Clinical anatomy n3 : Thorax and Abdomen 4th edition, 2014, ISBN:2224033826
- Noll E, Meaudre E, Godier A., Manuel de traumatismes graves, ALR, transfusion et hémostase appliqués, 2022, ISBN:2869068816
- SFAR, SFMU, Traumatisme thoracique: prise en charge des 48 premières heures, 2015, https://sfar.org/wp-content/uploads/2015/10/2_AFAR_Traumatisme-thoracique-_prise-en-charge-des-48-premieres-heures.pdf
- Simon BJ, Cushman J, Barraco R, Lane V, Luchette FA, Miglietta M, Roccaforte DJ, Spector R, Pain management guidelines for blunt thoracic trauma., 2005, PMID:16385313
- Apampa AA, Ali A, Kadir B, Ahmed Z., Safety and effectiveness of surgical fixation versus non-surgical methods for the treatment of flail chest in adult populations: a systematic review and meta-analysis., 2022, PMID:33547910
- Mladenovic J, Erskine RN, Riley B, Mitchell A, Abi-Fares C, Basson W, Anstey C, White L., The association between erector spinae plane block timing and reduced rib fracture related respiratory complications: A cohort study., 2022, PMID:35917775
- Dehghan N, de Mestral C, McKee MD, Schemitsch EH, Nathens A., Flail chest injuries: a review of outcomes and treatment practices from the National Trauma Data Bank., 2014, PMID:24458051
- Lamont T, Surkitt-Parr M, Scarpello J, Durand M, Hooper C, Maskell N., Insertion of chest drains: summary of a safety report from the National Patient Safety Agency., 2009, PMID:19955139
- Bouzat P, Raux M, David JS, Tazarourte K, Galinski M, Desmettre T, Garrigue D, Ducros L, Michelet P; Expert's group; Freysz M, Savary D, Rayeh-Pelardy F, Chest trauma: First 48hours management., 2017, PMID:28096063

- Slobogean GP, MacPherson CA, Sun T, Pelletier ME, Hameed SM., Surgical fixation vs nonoperative management of flail chest: a meta-analysis., 2013, PMID:23219148
- Estrera AL, Miller CC 3rd, Guajardo-Salinas G, Coogan S, Charlton-Ouw K, Safi HJ, Azizzadeh A., Update on blunt thoracic aortic injury: fifteen-year single-institution experience., 2013, PMID:23260456
- Fox N, Rajani RR, Bokhari F, Chiu WC, Kerwin A, Seamon MJ, Skarupa D, Frykberg E, Evaluation and management of penetrating lower extremity arterial trauma: an Eastern Association for the Surgery of Trauma practice management guideline., 2012, PMID:23114487