

# Navigating Blunt Chest Trauma: A Narrative Review of Clinical Manifestations, Diagnostic Modalities and Management Strategies

PANKAJ KATARIYA<sup>1</sup>, SWATI DESHPANDE<sup>2</sup>, MANSI NAKUM<sup>3</sup>, BHAGYESH SAPKALE<sup>4</sup>, AMOL GUPTA<sup>5</sup>

## ABSTRACT

Blunt Chest Trauma (BCT) is an essential and often seen clinical entity in emergency and trauma surgical medicine, primarily associated with road traffic accidents, falls, and direct impacts during sports and warfare. BCT includes a variety of injuries (ranging from rib fractures, pulmonary contusion, pneumothorax, haemothorax, cardiac injury, and injuries that involve the great vessels). If these injuries can be recognised and treated rapidly, morbidity and mortality associated with BCT can be reduced. It is also essential to assess the advances in both conservative and surgical management, ranging from new minimally invasive endoscopic techniques to comprehensive treatment pathways. Early presentation, multidisciplinary team management, and establishing pathways based on high-quality evidence will lead to the best results. This narrative review examines the aetiology, mechanisms, classification, clinical features, and the role of imaging and modern biomarker technology in the diagnosis of BCT.

**Keywords:** Biomarkers, Chest injury, Emergency care, Imaging modalities, Thoracic injuries

## INTRODUCTION

In Blunt Chest Trauma (BCT), injury occurs in the thoracic area without penetrating the skin or chest wall, and it is most often caused by the impact of a car crash, a fall from a tower, a physical assault, or a dangerous sporting moment [1]. BCT accounts for more than 15% of all trauma admissions to emergency departments worldwide [2]. Contrary to penetrating injuries, BCT does not involve injury to the chest wall by a physical object, but can cause significant internal damage, such as rib fractures, pulmonary contusions, pneumothorax, haemothorax, cardiac injury, and injury to great vessels [1,3]. The danger in the blunt trauma patient is that the presentation is often misleading; patients may present stable but are at risk for rapid clinical decompensation, often due to unknown underlying thoracic injuries that may cause significant injuries, decompensation, and/or death [2,4]. The present review aimed to provide a comprehensive narrative overview of the mechanisms, clinical features, diagnostic strategies, and management approaches for BCT, while highlighting emerging advances that can improve early recognition and outcomes.

## DISCUSSION

### Clinical Manifestations and Symptoms of BCT

The BCT refers to a spectrum of injuries sustained from non-penetrating forces to the torso or thorax [5]. The initial signs and symptoms may be subtle, or none at all; however, eventually, the patient may manifest signs of injury, including chest pain, dyspnoea, and hypoxia [2,5]. In severe forms of BCT, there can be complex cardiac arrhythmias, hypotension, or distended jugular veins as potential markers of there being some cardiac compromise [6]. Pulmonary contusions, another common finding of BCT, can result in impaired gas exchange, facilitating the development of cyanosis, tachypnoea, or decreased breath sounds; symptoms that may manifest over 24-48 hours following injury, highlighting the importance of continued surveillance [7,8].

Injuries to the tracheobronchial tree, though less frequent, present with distinctive signs such as subcutaneous emphysema, haemoptysis, and sternal tenderness [7,9]. Radiographic evaluations may reveal pneumothorax or pneumomediastinum, which necessitate prompt intervention [10]. Myocardial contusions are also serious

complications, which can further manifest as cardiogenic shock or arrhythmias [11,12]. Chronic chest pain, usually neuropathic in type, continues to persist in many patients, even months after the initial injury [13]. Respiratory disabilities such as persistent dyspnoea and decreased pulmonary function may also occur in patients with previous conditions, such as smoking-related lung issues [13,14].

Coronary artery injury (with possible dissection or thrombosis) is a rare complication of BCT that can cause a myocardial infarction in severe cases [15]. Chylothorax is another rare manifestation characterised by the accumulation of lymphatic fluid in the pleural space [16]. Symptom onset may be delayed by up to 11 weeks post-injury [16]. In addition, tension pneumopericardium, which results from air in the pericardial sac, mimics cardiac tamponade and requires prompt recognition and treatment [14,17]. Subarachnoid-pleural fistulas, although exceedingly rare, involve the leakage of cerebrospinal fluid into the pleural cavity, leading to respiratory distress and necessitating high clinical suspicion for the diagnosis of BCT [18]. In addition, BCT may lead to valvular injuries, manifested by tricuspid valve rupture that routinely presents as either severe regurgitation or heart failure symptoms [19]. Mitral perivalvular leaks can also occur, sometimes years after the initial injury [2,19]. Rare as these injuries may be, they serve as a reminder to evaluate thoroughly and maintain a high index of suspicion for any complications with a history of BCT, even if the initial manifestations may be vague or delayed [7,19].

### Aetiology and Mechanism of BCT

The predominant cause of BCT is motor vehicle accidents, which expose the chest to significant deceleration and compressive forces, causing many different types of thoracic injuries [20,21]. Falls, particularly from a substantial height, are also significant causes of BCT, which is especially relevant for the older population due to lower bone density and an increased risk of fractures [22]. Mechanisms and causes of BCT has been described in [Table/ Fig-1] [20-28].

### Classification Systems in BCT

The BCT encompasses all thoracic injuries resulting from non-penetrating forces, and its classification is crucial for designing effective management and predicting outcomes. The American

Causes	Description	Mechanisms of injury	Common resulting injuries
Motor vehicle accidents [20-24]	Most common cause; involves rapid deceleration and impact with internal structures.	Deceleration injury, impact with steering wheel/seatbelt	Rib fractures, pulmonary contusions, cardiac injuries
Falls [22,25]	Especially relevant in the elderly due to frailty and low bone density	Axial loading, impact on hard surfaces	Rib/sternal fractures, haemothorax, pneumothorax
Assaults [26,27]	Direct trauma from punches, kicks, or blunt objects	Localised blunt force trauma	Contusions, rib fractures, soft-tissue injuries
Sports injuries [26,27]	Occurs in contact sports (e.g., football, hockey, martial arts)	Collision or impact trauma	Pulmonary contusions, rib/sternal fractures
Occupational injuries [25,26]	Trauma from industrial or construction-related accidents	Fall from height, crush injuries, machinery-related trauma	Rib fractures, crush chest, pneumothorax
Warfare/explosive injuries [26,28]	Military or terrorist-related trauma	Blast wave transmission through the thorax without visible chest wall trauma	Pulmonary contusions, barotrauma
Crush injuries [25]	Compression due to heavy objects or structural collapse	Direct compressive force on thorax	Flail chest, soft-tissue injury, visceral damage
Blast injuries (explosions) [26,28]	Shock waves cause internal injury without external signs	Transmission of energy waves through air-filled structures (lungs), no visible external trauma	Pulmonary contusion, alveolar haemorrhage, pneumothorax

**[Table/Fig-1]:** Mechanisms and causes of BCT [20-28].

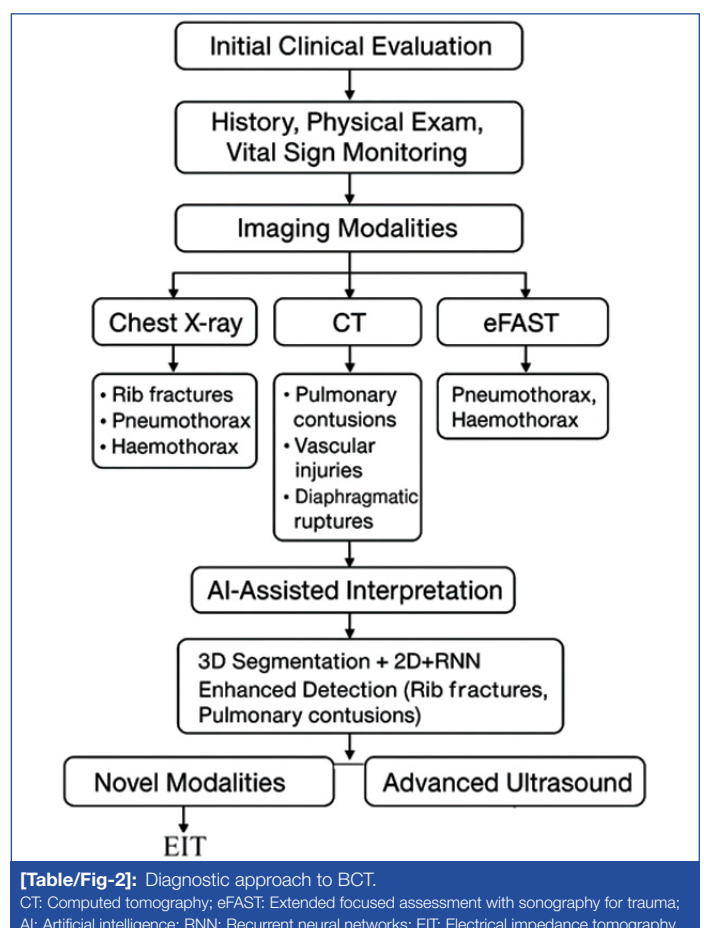
Association for the Surgery of Trauma (AAST) Thoracic Injury Scale is one of the most commonly known scales. It anatomically classifies thoracic injuries from Grade 0 (no injury) to Grade V (most severe injury) depending on the location and severity of damage to thoracic structures such as lung parenchyma, heart, great vessels, diaphragm, and chest wall [29]. However, there are a few limitations in predicting outcomes. When directly compared with other trauma scoring systems, AAST-based scales, such as the Lung Injury Scale (LIS), were outperformed by composite models, including the Trauma and Injury Severity Score (TRISS) and the LIS, for mortality and morbidity prediction, respectively [29]. A recent review identified both the Thoracic Trauma Severity Score (TTSS) and the Score for Trauma Triage in the Elderly (STUMBL) as demonstrating better discrimination and external validation than many other models; however, both still require recalibration and further evaluation for broader clinical and cost-effective applicability [30].

The most common injury, pulmonary contusion, can be classified based on the amount of lung involved [31]. This classification has precise clinical application, as contusions involving over 18-24% of the lung volume are associated with increased morbidity and mortality [31]. Myocardial contusions, a serious injury due to blunt cardiac injury, have also been classified using stages from 0 (suspected) to IV (catastrophic), a system with advantages in both clinical monitoring and medico-legal evaluation, but one that remains limited by the variable sensitivity of diagnostic tools [32]. Pulmonary lacerations, are classified according to mechanism and imaging into four types: Type 1 (compression-rupture), Type 2 (compression-shear of the spine), Type 3 (rib penetration adjacent to fractures), and Type 4 (adhesion tears due to shearing at sites of pleuropulmonary adhesion) which aids in radiologic diagnosis, surgical planning, and prognostic assessment, though variability in imaging interpretation may restrict universal application [32]. Overall, these classification systems improve diagnostic precision, communication, and structured treatment planning, but also have limitations in predictive validity and external generalisability. This highlights the need for integrated models combining anatomical severity with physiological and demographic factors to optimise outcome prediction for BCT [29].

### Diagnostic Strategies and Imaging Innovations in BCT

Chest X-ray is often the first imaging study considered due to the speed and availability. X-ray findings of rib fractures, pneumothorax, and haemothorax can usually be identified. However, because X-rays have limited sensitivity for subtle injuries, Computed Tomography (CT) is currently the gold standard for BCT evaluation. CT is more sensitive than X-ray in detecting pulmonary contusions, vascular injuries, and diaphragmatic ruptures [33].

The extended Focused Assessment with Sonography for Trauma (eFAST) can provide a rapid bedside assessment for pneumothorax and haemothorax, and is particularly valuable in haemodynamically unstable patients [34]. Furthermore, some promising developments in Artificial Intelligence (AI) will enhance imaging interpretation, as AI may help recognise thoracic injuries such as rib fractures and pulmonary contusions that can assist clinicians with critical decision-making once diagnosed [35]. Also, AI architectures that merge 3D segmentation with 2D convolutional and Recurrent Neural Networks (RNN) are being tested for injury assessment in abdominal trauma, and those will be applied to thoracic injuries [35,36]. Conventional imaging remains the foundation of evaluation; however, novel modalities, such as Electrical Impedance Tomography (EIT) and more advanced ultrasound, are becoming increasingly common [37]. EIT is a non-invasive bedside device with potential for identifying post-trauma pneumothorax and assessing it in real-time without radiation [37]. The diagnostic approach to BCT is described in [Table/Fig-2].



**[Table/Fig-2]:** Diagnostic approach to BCT.

CT: Computed tomography; eFAST: Extended focused assessment with sonography for trauma; AI: Artificial intelligence; RNN: Recurrent neural networks; EIT: Electrical impedance tomography

### Biomarkers in BCT for Prognostic Implications

Biomarkers are becoming increasingly important in the diagnostic evaluation and prognostication of BCT, especially in terms of myocardial contusions, as well as pulmonary injury [38]. Cardiac troponins, especially I and T, are sensitive and specific markers of myocardial injury that have been widely used for BCT [38,39]. Troponin elevations correlate with myocardial contusion severity and provide predictive value for adverse cardiac events such as arrhythmias and cardiogenic shock [39]. Additionally, Brain Natriuretic Peptide (BNP) is a marker of cardiac wall stress and may have some success in diagnosing blunt cardiac injury as well [39]. If BNP is elevated, it can be suggestive of myocardial dysfunction and assist in risk-stratifying patients with BCT [39].

D-dimer levels can also help to diagnose thrombotic problems (e.g., PE), which may complicate severe BCT [40]. Similarly, increased C-reactive Protein (CRP) and interleukins may reflect the extent of pulmonary contusions and predict pulmonary injury complications such as Acute Respiratory Distress Syndrome (ARDS) [41,42]. Biomarkers in BCT and their prognostic utility is described in [Table/Fig-3].

Biomarker	Clinical relevance	Prognostic implications	Limitations
Troponin I and T	Specific markers of myocardial injury	Correlate with contusion severity; predict arrhythmias, cardiogenic shock	Elevated levels may occur due to other cardiac or traumatic causes
BNP	Reflects cardiac wall stress	Suggests myocardial dysfunction; assists in risk stratification	It can be elevated in heart failure or other systemic conditions
D-dimer	Indicates thrombotic activity	May detect complications like pulmonary embolism	Non specific; elevated in many inflammatory or traumatic states
CRP	Acute-phase reactant; marker of inflammation	Reflects the extent of pulmonary contusion; may predict ARDS	Not specific to pulmonary injury; affected by systemic inflammation
Interleukins	Inflammatory cytokines (e.g., IL-6, IL-8)	Associated with the severity of lung injury; a predictor of ARDS	Elevated in various inflammatory responses, not specific to BCT

[Table/Fig-3]: Biomarkers in BCT and their prognostic utility.

### Management of BCT

The BCT refers to a wide range of injuries. Most injuries can be managed with supportive care (pain management, oxygen support, and pulmonary hygiene) and typically do not require any definitive treatment [43]. It has been stated that multimodal approaches to pain management, including epidural analgesia and regional nerve blocks, are helpful for BCT [44,45]. Thoracic epidural analgesia remains the standard, while new fascial plane blocks, such as erector spinae and serratus anterior blocks, are emerging, showing reasonable pain relief with fewer complications [44].

In addition to managing pain caused by BCT, specific strategies are essential. Small, asymptomatic pneumothoraces may be managed conservatively with oxygen and close monitoring, while larger or symptomatic cases require tube thoracostomy with suction drainage [46]. Haemothorax, depending upon volume, can be present in a patient. Most cases mandate chest tube insertion, with urgent thoracotomy indicated for massive or ongoing bleeding, and Video-assisted Thoracoscopic Surgery (VATS) favoured for retained collections [47,48]. Pulmonary contusions are generally treated supportively with fluid balance, oxygen supplementation, and mechanical ventilation as needed to prevent progression to ARDS [5,43]. Rib fractures, when they are multiple and displaced or cause flail chest, may be treated using surgical stabilisation, which provides better pain control, facilitates ventilation, and reduces morbidity compared to conservative measures [43].

### Advances in Surgical Management of BCT

Surgical stabilisation of rib fractures has increasingly gained attention as an essential treatment option for patients requiring this procedure after blunt trauma to the chest [49]. This method is mainly recommended for individuals with a flail chest or multiple rib fractures with displacement, who are experiencing respiratory distress [49,50]. Rib fixation enables mechanical stability, pain control, early mobilisation, and weaning from mechanical ventilation, which may not be possible with non-surgical management [50,51]. Because most rib fractures are displaced, if fracture stabilisation is to be initiated, rib fixation can increase pain management; however, the size of the machines used is still a concern for healthcare professionals [50]. Newer plating systems provide an anatomical contour to the rib curvature, and stouter hardware is used, resulting in reduced complications related to rib fixation hardware [52].

Recently, Robotic-Assisted Thoracic Surgery (RATS) for traumatic injury emerged and is being used more frequently with promising technology [53]. The improvement of the visual platform through the robotic method enables three-dimensional visualisation of organs, greater dexterity not offered by simple instruments, and precision that is only limited by the use associated with the robotic platform [53]. Although RATS is a relatively new process in BCT, early case series reports decreased blood loss, improved operative time, and a shorter length of stay or more effective postoperative recovery [53]. VATS represents a minimally invasive approach to managing retained haemothorax and other complications, and appears to reduce hospital length of stay and the need for thoracotomy [47,54]. There has been a randomised controlled trial looking at an intervention using yoga to improve pulmonary function and quality of life in chest trauma recovering patients, which suggests that there might be a place for complementary care interventions in rehabilitation [55]. Surgical interventional strategies for BCT are detailed in [Table/Fig-4] [47,49-54].

Intervention	Indications	Benefits	Limitations/Concerns
Surgical Stabilisation of Rib Fractures (SSRF)	Flail chest, multiple displaced rib fractures with respiratory distress [49,50].	Mechanical stability, pain control, early mobilisation, and early weaning from ventilation [50,51].	Concerns regarding equipment size and usability [50].
Modern rib fixation systems	Patients requiring SSRF [52].	Anatomical plating systems have been shown to reduce complication rates [52].	May not be available in all settings [52].
Robotic-assisted Thoracic Surgery (RATS)	Select cases of traumatic chest injury [53].	3D visualisation, enhanced precision and dexterity, reduced blood loss, shorter operative time [53].	Limited availability; operator learning curve [53].
Video-assisted Thoracoscopic Surgery (VATS)	Retained haemothorax, thoracic complications [47,54].	Minimally invasive, reduced hospital stay, avoids open thoracotomy [54].	Case selection is crucial [54].

[Table/Fig-4]: Surgical interventional strategies for BCT [47,49-54].

### Tailored Approaches to BCT in Vulnerable Populations

In special populations, such as children, elderly individuals, and pregnant women, BCT requires appropriate assessment along with proper management approaches [56-58]. Children mostly lack rib fractures despite undergoing significant injury because their compliant chest wall transmits force to mediastinal structures [58]. In older-aged individuals, age  $\geq 65$  years itself is an independent predictor of worse outcomes. Hence, supporting older patients with aggressive analgesia, pulmonary hygiene, and early higher-acuity monitoring is of utmost important [56]. For pregnant women,

the standard Advanced Trauma Life Support (ATLS) protocol can be used, along with pregnancy-specific modifications: immediate left uterine displacement to mitigate aortocaval compression, and chest tube placement 1-2 interspaces higher when indicated [57]. Pregnant population with BCT also requires liberal usage of necessary imaging despite fetal radiation concerns, continuous fetal monitoring once viable, and consideration of resuscitative hysterotomy for refractory maternal arrest near 22-24 weeks [57].

### Rehabilitation and Long-term Outcomes in BCT

Physiotherapy plays a vital role in the rehabilitation process of BCT, which typically begins with early assessment and emergency management, followed by acute care planning, patient education, and post-acute follow-up to optimise functional recovery [59]. In terms of long-term outcomes, survivors frequently experience impaired pulmonary function (such as reduced exercise capacity and persistent abnormalities on pulmonary function tests and imaging) [60]. Long-term follow-up also reveals decreased physical performance, including diminished 6-minute walk distance, ongoing dyspnoea, and persistent pain or functional limitations that persist for one year or more after the injury [13,60]. Future research should focus primarily on developing standardised protocols for rehabilitation, conducting multicentre validation of scoring systems, and integrating modern diagnostic and therapeutic methods to achieve better outcomes for patients undergoing BCT.

### CONCLUSION(S)

The BCT continues to be an essential contributor to both morbidity and mortality in traumatic cases that require prompt recognition and timely intervention. A thorough understanding of the mechanisms of injury, the clinical presentation of blunt thoracic injuries, and the evolution of diagnostic imaging and biomarkers is crucial for assessing and managing blunt thoracic injuries. More research and training are required to improve prognosis and eliminate the complications associated with BCT.

### REFERENCES

- Stewart DJ. Blunt chest trauma. *J Trauma Nurs Off J Soc Trauma Nurses*. 2014;21(6):282-84; quiz 285-86.
- Eghbalzadeh K, Sabashnikov A, Zerliouh M, Choi YH, Bunck AC, Mader N, et al. Blunt chest trauma: A clinical chameleon. *Heart Br Card Soc*. 2018;104(9):719-24.
- Freixinet Gilart J, Ramirez Gil ME, Gallardo Valera G, Moreno Casado P. Chest trauma. *Arch Bronconeumol*. 2011;47 Suppl 3:9-14.
- Yuan SM. Sternal fractures due to blunt chest trauma. *J Coll Physicians Surg--Pak JCPSP*. 2022 Dec;32(12):1591-96.
- Dogrul BN, Kiliccalan I, Asci ES, Peker SC. Blunt trauma related chest wall and pulmonary injuries: An overview. *Chin J Traumatol Zhonghua Chuang Shang Za Zhi*. 2020;23(3):125-38.
- Kao CC, Kao MW, Yang PJ. Man with blunt chest trauma. *Ann Emerg Med*. 2023;82(2):153-66.
- Adegboye VO, Ladipo JK, Brimmo IA, Adebo AO. Blunt chest trauma. *Afr J Med Med Sci*. 2002;31(4):315-20.
- Gosser C, Nix K. Man with blunt chest trauma. *Ann Emerg Med*. 2024;83(5):496-97.
- Mühling B. Blunt and penetrating thoracic trauma. *Chir Z Alle Geb Oper Medizen*. 2017;88(9):807-16.
- Wicky S, Wintermark M, Schnyder P, Capasso P, Denys A. Imaging of blunt chest trauma. *Eur Radiol*. 2000;10(10):1524-38.
- Kyriazidis IP, Jakob DA, Vargas JAH, Franco OH, Degiannis E, Dorn P, et al. Accuracy of diagnostic tests in cardiac injury after blunt chest trauma: A systematic review and meta-analysis. *World J Surg WJES*. 2023;18(1):36.
- Sağlam Gürmen E, Tulay CM. Attention: Cardiac contusion. *Ulus Travma Ve Acil Cerrahi Derg Turk J Trauma Emerg Surg TJTES*. 2022;28(5):634-40.
- Carrie C, Guemmar Y, Cottenecau V, de Mollens L, Petit L, Sztark F, et al. Long-term disability after blunt chest trauma: Don't miss chronic neuropathic pain! *Injury*. 2019;50(1):113-18.
- Chu SC, Lin CH. Young man with blunt chest trauma. *Ann Emerg Med*. 2021;77(1):e66-e67.
- Maheshwari A, Thenappan T, Das G. Adding fuel to the fire: Coronary artery dissection complicating blunt chest trauma. *Am J Emerg Med*. 2017;35(7):1041.e5-1041.e6.
- Kakamad FH, Salih RQM, Mohammed SH, HamaSaeed AG, Mohammed DA, Jwamer VI, et al. Chylothorax caused by blunt chest trauma: A review of literature. *Indian J Thorac Cardiovasc Surg*. 2020;36(6):619-24.
- Pearl L, Kerby E, Pansuriya S, Alnajjar R, Lim J. Tension pneumopericardium causing cardiogenic shock due to blunt injury to the chest. *Am Surg*. 2023;89(9):3889-90.
- Rena O, Della Corte F, Papalia E, Mazza M, Oliaro A, Casadio C. Subarachnoid-pleural fistula due to blunt chest trauma. A case report. *J Cardiovasc Surg (Torino)*. 2005;46(5):519-21.
- Patel KM, Kumar NS, Desai RG, Mitrev L, Trivedi K, Krishnan S. Blunt trauma to the heart: A review of pathophysiology and current management. *J Cardiothorac Vasc Anesth*. 2022;36(8 Pt A):2707-18.
- Zreik NH, Francis I, Ray A, Rogers BA, Ricketts DM. Blunt chest trauma: Soft tissue injury in the thorax. *Br J Hosp Med Lond Engl*. 2005. 2016;77(2):78-83.
- Wang HY, Yang MC, Yang PJ. Boy with blunt chest trauma. *Ann Emerg Med*. 2022;80(6):e99-e100.
- Fokin AA, Wycech Knight J, Abid AT, Yoshinaga K, Alayon AL, Grady R, et al. Sternal fractures in blunt trauma patients. *Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc*. 2022;48(4):2987-98.
- Greve M. Acute cycling injuries. *Phys Med Rehabil Clin N Am*. 2022;33(1):135-58.
- Kara H, Bayir A, Degirmenci S, Yildiran H, Kafali ME, Ak A. Sternal fractures in blunt chest trauma: Retrospective analysis of 330 cases. *J Coll Physicians Surg--Pak JCPSP*. 2022;32(6):799-803.
- Williamson F, Warren J, Cameron CM. Rib fractures in blunt chest trauma: Factors that influence daily patient controlled opiate use during acute care. *Injury*. 2022;53(1):145-51.
- de Lesquen H, Beranger F, Berbis J, Boddaert G, Poichotte A, Pons F, et al. Challenges in war-related thoracic injury faced by French military surgeons in Afghanistan (2009-2013). *Injury*. 2016;47(9):1939-44.
- Chrysou K, Halat G, Hokscho B, Schmid RA, Kocher GJ. Lessons from a large trauma center: Impact of blunt chest trauma in polytrauma patients--still a relevant problem? *Scand J Trauma Resusc Emerg Med*. 2017;25(1):42.
- Wanek S, Mayberry JC. Blunt thoracic trauma: Flail chest, pulmonary contusion, and blast injury. *Crit Care Clin*. 2004;20(1):71-81.
- LaGrone LN, Stein D, Cribari C, Kaups K, Harris C, Miller AN, et al. American Association for the Surgery of Trauma/American College of Surgeons Committee on Trauma: Clinical protocol for damage-control resuscitation for the adult trauma patient. *J Trauma Acute Care Surg*. 2024;96(3):510-20.
- Battle C, Cole E, Carter K, Baker E. Clinical prediction models for the management of blunt chest trauma in the emergency department: A systematic review. *BMC Emerg Med*. 2024;24(1):189.
- Van Diepen MR, Wijffels MME, Verhofstad MHJ, Van Lieshout EMM. Classification methods of pulmonary contusion based on chest CT and the association with in-hospital outcomes: A systematic review of literature. *Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc*. 2024;50(6):2727-40.
- RuDusky BM. Classification of myocardial contusion and blunt cardiac trauma. *Angiology*. 2007;58(5):610-13.
- L'Huillier JC, Carroll HL, Zhao JY, Jalal K, Yu J, Guo WA. Plain chest film versus computed tomography of the chest as the initial imaging modality for blunt thoracic injury. *Am Surg*. 2025;91(1):12-21.
- Devadoss H, Sharma P, Nair VV, Rehsi SS, Roy N, Rao PP. Diagnostic accuracy of e-FAST in stable blunt trauma chest: A prospective analysis of 110 cases at a tertiary care center. *Indian J Crit Care Med Peer-Rev Off Publ Indian Soc Crit Care Med*. 2021;25(10):1167-72.
- Zhao T, Meng X, Wang Z, Hu Y, Fan H, Han J, et al. Diagnostic evaluation of blunt chest trauma by imaging-based application of artificial intelligence. *Am J Emerg Med*. 2024;85:35-43.
- Lynch SD, Taylor SL, Greene KA, Devane KS, Weaver AA. Characterizing thoracic morphology variation to develop representative 3D models for applications in chest trauma. *Comput Biol Med*. 2023;163:107211.
- Wang YJ, Tsai YM, Kuo YS, Lin KH, Wu TH, Huang HK, et al. The application of electrical impedance tomography and surgical outcomes of thoracoscope-assisted surgical stabilization of rib fractures in severe chest trauma. *Sci Rep*. 2024;14(1):9669.
- Shoar S, Hosseini FS, Naderan M, Khavandi S, Tabibzadeh E, Khavandi S, et al. Cardiac injury following blunt chest trauma: Diagnosis, management, and uncertainty. *Int J Burns Trauma*. 2021;11(2):80-89.
- Wang N, Huang J, Fang Y, Du H, Chen Y, Zhao S. Molecular biomarkers of blunt cardiac injury: Recent advances and future perspectives. *Expert Rev Mol Diagn*. 2024;24(11):1023-31.
- Penn JL, Martindale JL, Milne LW, Marill KA. Aortic dissection associated with blunt chest trauma diagnosed by elevated D-dimer. *Int J Surg Case Rep*. 2015;10:76-79.
- Gupta AK, Ansari A, Gupta N, Agrawal H, B M, Bansal LK, et al. Evaluation of risk factors for prognosticating blunt trauma chest. *Pol Przegl Chir*. 2021;94(1):12-19.
- Favre PA, de Mollens L, Petit L, Blais M, Carrié C. May the neutrophil-to-lymphocyte ratio at admission predict the occurrence and the severity of ARDS after blunt chest trauma patients? A retrospective study. *Am J Emerg Med*. 2021;39:137-42.
- Griffard J, Kodadek LM. Management of blunt chest trauma. *Surg Clin North Am*. 2024;104(2):343-54.
- Gamberini L, Moro F, Dallari C, Tartaglione M, Mazzoli CA, Allegri D, et al. Regional anesthesia modalities in blunt thoracic trauma: A systematic review and Bayesian network meta-analysis. *Am J Emerg Med*. 2025;89:199-208.
- van Zyl T, Ho AMH, Klar G, Haley C, Ho AK, Vasily S, et al. Analgesia for rib fractures: A narrative review. *Can J Anaesth J Can Anesth*. 2024;71(4):535-47.
- Hefny AF, Kunhivalappil FT, Matev N, Avila NA, Bashir MO, Abu-Zidan FM. Management of computed tomography-detected pneumothorax in patients with blunt trauma: Experience from a community-based hospital. *Singapore Med J*. 2018;59(3):150-54.

- [47] Huang JF, Ou Yang CH, Cheng CT, Hsu CP, Wen CT, Liao CH, et al. Could video-assisted thoracoscopic surgery be feasible for blunt trauma patients with massive haemothorax? *Injury*. 2023;54(1):44-50.
- [48] Huang FD, Yeh WB, Chen SS, Liu YY, Lu IY, Chou YP, et al. Early Management of Retained Hemothorax in Blunt Head and Chest Trauma. *World J Surg*. 2018;42(7):2061-66.
- [49] Tarrng YW, Liu YY, Huang FD, Lin HL, Wu TC, Chou YP. The surgical stabilization of multiple rib fractures using titanium elastic nail in blunt chest trauma with acute respiratory failure. *Surg Endosc*. 2016;30(1):388-95.
- [50] Bemelman M, de Kruijff MW, van Baal M, Leenen L. Rib fractures: To fix or not to fix? an evidence-based algorithm. *Korean J Thorac Cardiovasc Surg*. 2017;50(4):229-34.
- [51] Azuma Y, Iyoda A. Chest wall injury. *Kyobu Geka*. 2022;75(10):878-82.
- [52] Suen HC, White TW. Surgical stabilization of rib fractures. *J Thorac Dis*. 2019;11(Suppl 8):S1022-S1023.
- [53] Hofmann HS. Robotic-assisted thoracic surgery: Currently available standard systems and future developments. *Zentralbl Chir*. 2023;148(S 01):S11-S16.
- [54] Bae CM, Son SA, Lee YJ, Lee SC. Clinical outcomes of minimally invasive surgical stabilization of rib fractures using video-assisted thoracoscopic surgery. *J Chest Surg*. 2023;56(2):120-25.
- [55] Gunjiganvi M, Mathur P, Kumari M, Madan K, Kumar A, Sagar R, et al. Yoga-an alternative form of therapy in patients with blunt chest trauma: A randomized controlled trial. *World J Surg*. 2021;45(7):2015-26.
- [56] Battle C, Carter K, Newey L, Giamello JD, Melchio R, Hutchings H. Risk factors that predict mortality in patients with blunt chest wall trauma: An updated systematic review and meta-analysis. *Emerg Med J EMJ*. 2023;40(5):369-78.
- [57] Jain V, Chari R, Maslovitz S, Farine D, Maternal Fetal Medicine Committee, Bujold E, et al. Guidelines for the management of a pregnant trauma patient. *J Obstet Gynaecol Can JOGC J Obstet Gynecol Can JOGC*. 2015;37(6):553-74.
- [58] Goodwin G, Bengio M, Ryckeley CB, Marin MN. Emergency department management of pediatric blunt thoracic injuries. *Pediatr Emerg Med Pract*. 2023;20(Suppl 11):1-30.
- [59] Baker E, Barnett J, Driscoll T, Hutchings H, O'Neill C, Price M, et al. The role of the physiotherapist in the assessment and management of blunt mechanism chest wall injury: A systematic integrative review and narrative synthesis. *Injury*. 2025;56(6):112355.
- [60] Leone M, Brégeon F, Antonini F, Chaumoitre K, Charvet A, Ban LH, et al. Long-term outcome in chest trauma. *Anesthesiology*. 2008;109(5):864-71.

#### PARTICULARS OF CONTRIBUTORS:

1. Junior Resident, Department of General Surgery, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
2. Associate Professor, Department of General Surgery, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
3. Junior Resident, Department of General Surgery, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
4. Undergraduate Student, Department of Medicine, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
5. Junior Resident, Department of General Surgery, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.

#### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Pankaj Katariya,  
Gate No. 2, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha-442001, Maharashtra, India.  
E-mail: pankajkatariya1997@gmail.com

#### PLAGIARISM CHECKING METHODS: [\[Jain H et al.\]](#)

- Plagiarism X-checker: Jun 04, 2025
- Manual Googling: Nov 14, 2025
- iThenticate Software: Nov 17, 2025 (4%)

#### ETYMOLOGY: Author Origin

EMENDATIONS: 6

#### AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jun 03, 2025**

Date of Peer Review: **Aug 28, 2025**

Date of Acceptance: **Nov 20, 2025**

Date of Publishing: **May 01, 2026**