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Radio-Diagnosis

MULTIDETECTOR COMPUTED TOMOGRAPHY IN BLUNT CHEST TRAUMA SINGLE TERTIARY CARE TRAUMA CENTRE EXPERIENCE.

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ABSTRACT Thoracic injuries are significant causes of morbidity and mortality in trauma patients, second only to head injuries. In addition to conventional radiography, multidetector computed tomography (CT) is increasingly being used, since it can quickly and accurately help diagnose a wide variety of injuries in trauma patients. Furthermore, multiplanar and MiNIP, volumetric reformatted CT images provide improved visualization of injuries, increased understanding of trauma-related diseases, and enhanced communication between the radiologist and the referring clinician. **Aims:** To identify and accurately assess variety of injuries in blunt thoracic trauma with multidetector Computed Tomography (MDCT). To find commonest pattern of intrathoracic injury related to blunt chest trauma. **Method:** This retrospective observational study included 50 patients who underwent Multidetector CT examination during the period from November 2020 to April 2021 at tertiary care trauma centre, Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai. **Conclusion:** Blunt chest trauma injuries were classified into pleural injury, lung parenchymal injury, bony thorax, tracheobronchial and vascular injuries. The commonest injury detected was pleural (70%) followed by lung parenchymal injury (52%) and bony thorax injury in 50% cases. 50% of the pleural injury cases were associated with rib fractures. Multiple injuries were seen in the 47 patients, stating the importance of a detail evaluation of all chest components. No oesophageal and cardiac injury was detected in our CT studies' with its multiplanar, MinIP and volume reconstruction images increases the confidence in imaging diagnosis and play a critical role in understanding thoracic trauma related complications.

KEYWORDS : Blunt Thoracic trauma, MDCT Chest, pleural injuries, rib fractures, lung contusion.

INTRODUCTION

Injuries to the thorax are the third most common injuries in trauma patients, next to injuries to the head and extremities. Thoracic trauma has an overall fatality rate of 10.1%, which is highest in patients with cardiac or tracheobronchial-oesophageal injuries[1]. Furthermore, the presence of thoracic injuries in the setting of multisystemic trauma can significantly increase patient mortality. More than two-thirds of cases of blunt thoracic trauma in developing countries are caused by motor vehicle collisions. The remaining cases are the result of falls or blows from blunt objects and stab injuries. Conventional radiography is typically used for the initial imaging investigation; however, CT is more accurate than radiography for the evaluation of lung parenchymal injuries like contusion, thereby allowing early prediction of respiratory compromise.

METHODS

This retrospective observational study includes 50 patients, who underwent Multidetector CT (MDCT) during the period from November 2020 to April 2021 at a tertiary care trauma centre, Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai. All patients subjected to blunt chest trauma presented to the hospital during this given period and suspected chest trauma on clinical examination underwent CT examination.

Chest CT was performed in supine position with 0.9 mm minimum slice thickness, retrospective multiplanar and MinIP, volume reconstruction was done. Use of 120kV and 300 mA was done. Post contrast study was done with 60 ml of non-ionic contrast at a flow rate of 3 ml/s and delay of 25-40 s. in each patient as ruling out vascular injury is imperative.

CT data was analysed by Radiology Resident and Senior Radiologist with more than 10 years' experience.

AIM

- To identify and characterize with MDCT, the common patterns of chest involvement in trauma.
- To further categorize each component of the thoracic injury spectrum with MDCT and calculate its incidence.

Inclusion Criteria

- All patients with h/o blunt chest trauma.

Exclusion Criteria

- H/o previous chest /cardiac surgery.
- Age group below 18.
- Penetrating chest trauma patients were excluded.

Statistical analysis of data collected was done using SPSS 16.0 for Windows 7 utilizing descriptive statistics such as mean, median and mode. Quantitative data was analysed using Student's t test and qualitative data with Chi-square test. Confidence interval of 95% with p value of $< 0.05$was taken as statistically significant.

RESULTS

In this retrospective study of 50 cases, we observed and detected

- 47 patients had multiple injuries in terms of combination of pleural, parenchymal or bone involvement. Association of abdominal injuries with chest injury was seen in 16 patients, these included the 3 patients, who had isolated thoracic injury pattern.
- Pneumothorax as the commonest pleural injury and Lung contusion is the commonest parenchymal injury with a significant p-value of <0.05.
- The multiple injuries in a single patient was the predominant pattern. Only 3 cases were detected with a single thoracic injury pattern.
- Pleural injury with associated rib involvement was seen in 50% of cases with a significant p-value.
- Isolated pleural injury cases without fracture were seen more than isolated rib fractures however p-value was not significant due to insufficient data and limited cases.
- Rib fractures were the commonest bone involvement with a significant p-value.

Note that thoracic injuries were classified as per case basis i.e. 50 patients, not as per hemithorax, i.e right or left pleura and/or right or left lung.

CHARTS:

Chart 1: Gender And Age Distribution In Chest Trauma

Age Group	18-30		31-50		>50		Total
	Male	Female	Male	Female	Male	Female	
Chest Trauma	24	1	15	3	5	2	50

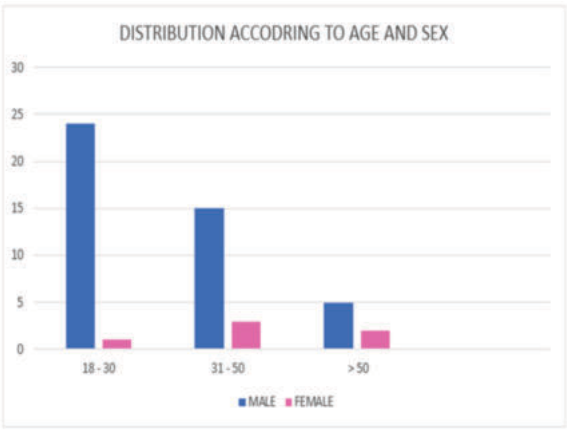

Chart 1: The Commonest Age Group Involved Was 18-30 Years And Males Were The Most Commonly Affected. Total Males Affected Were 46 I.e., 96% Of Total Cases. Only 6 Females Were Found Affected In Our Study.

Chart 2: Types Of Injuries In Chest Trauma

TYPE OF INJURY	PERCENAGE OF PATIENTS
PLEURAL	70
BONE	50
PARENCHYMAL	52
TRACHEOBRONCHIAL	4
VASCULAR	2

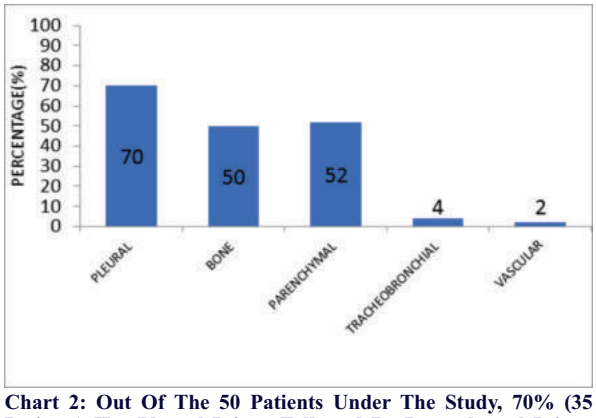

Chart 2: Out Of The 50 Patients Under The Study, 70% (35 Patients) Has Pleural Injury Followed By Parenchymal Injury 52% (26patients) And Bone Injury 50% (25 Patients). Only 2 Cases Of Tracheobronchial Injury And 1 Case Of Vascular Injury Was Seen In Our Study.

Chart 3A: Pleural Injuries In Chest Trauma

TYPE OF PLEURAL INJURY	NUMBER OF PATIENTS
PNEUMOTHORAX	23
HEMOTHORAX	20
HYDROPNEMOTHORAX	10

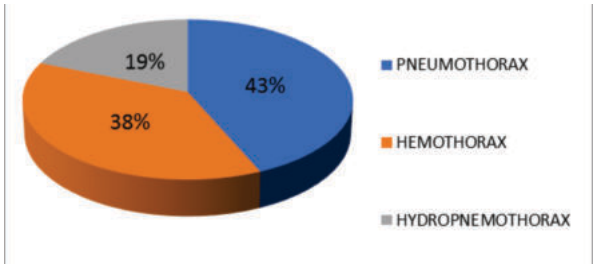

Chart 3A: Pneumothorax Is The Commonest Among Pleural Injuries (60%) Followed By 20 Patients With Hemothorax (42 %) And 4 Patients (8%) Of Hydropneumothorax.

Chart 3B: Association Between Rib And Pleural Injuries In Chest Trauma

ASSOCIATION BETWEEN RIB AND PLEURAL INJURIES	NUMBER OF PATIENTS
ISOLATED PLEURAL INJURY	9
PLEURAL INJURY WITH RIB INVOLVEMENT	20
ISOLATED RIB FRACTURE	4

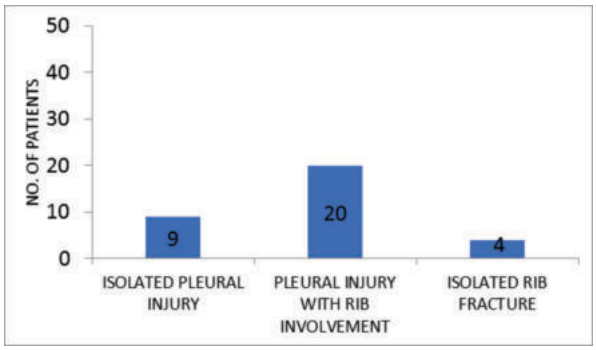

Chart 3B: Among The Pleural Injuries, Accompanying Rib Fracture Is Most Common, Seen In 25 Cases I.e., 50% Of Total Data. 11cases Of Pleural Injuries Were Not Associated With Rib Fractures.

Chart 4: Parenchymal Injury In Chest Trauma

PARENCHYMAL INJURIES	PERCENTAGE OF PATIENTS
CONTUSION	46
LACERATION	8
PNEUMATOCOELE	10
DIFFUSE ALVEOLAR HAEMORRHAGE	4

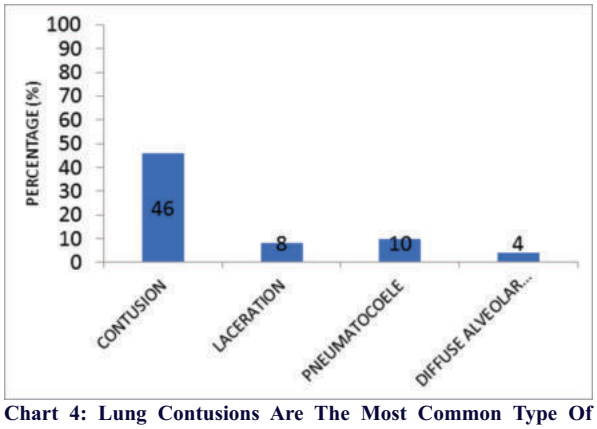

Chart 4: Lung Contusions Are The Most Common Type Of Parenchymal Injury Comprising Of 46% Of Patients.

Chart 5: Bone Injury In Chest Trauma

BONE INJURIES	PERCENTAGE OF PATIENTS
RIB	48
VERTEBRAE	23
SCAPULA	19
CLAVICLE	10
STERNUM	0

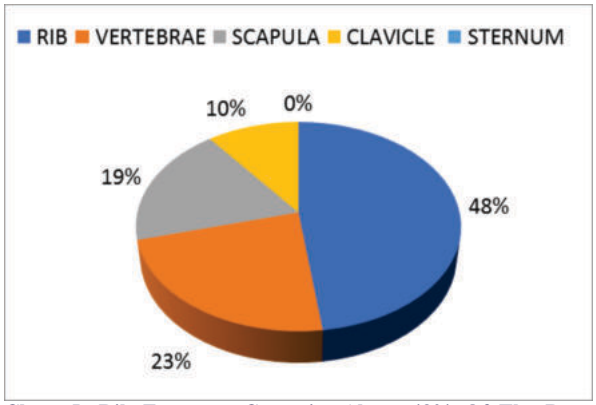

Chart 5: Rib Fractures Comprise About 48% Of The Bone Injuries Followed By Vertebrae

DISCUSSION

MDCT evaluation of chest trauma includes, injuries of the pleural space (pneumothorax, haemothorax), lungs (pulmonary contusion, pulmonary laceration, traumatic lung herniation), airways (tracheal lacerations, Macklin effect), heart (pericardial injuries, injuries to the heart valves and chambers), aorta and great vessels (thoracic aortic injury, injuries to the aortic arch branches), diaphragm, and chest wall (rib fracture, flail chest, fractures of the scapula, sternal fractures, sternoclavicular dislocations). It should be noted that multiple injuries may coexist in a single patient.

Injuries Of Pleural Space:

- Pneumothorax (Figure 1a, 4b, and 5c): Pneumothorax, an air collection in the pleural space, is a very common traumatic condition that is seen in 15%–40% [2] of all chest trauma patients. Pneumothorax may be caused by ruptured alveoli due to a sudden increase in intrathoracic pressure or to crushing force or deceleration force to the chest, with or without rib fractures.

  When air collects in the pleural space to the point where the intrapleural pressure exceeds that of the atmosphere, a tension pneumothorax occurs. CT imaging in these cases shows- (a) mediastinal shift to the contralateral side, (b) flattening or inversion of the ipsilateral hemidiaphragm, and (c) hyperexpanded ipsilateral chest.

  Tracheobronchial injuries are commonly associated with pneumothorax [3].

- Haemothorax (Figure 2a): Haemothorax represents blood in the pleural space, which may originate from a variety of thoracic injuries (Eg. involving the lung, chest wall, heart, or great vessels) or abdominal injuries (liver and splenic injuries with diaphragmatic rupture). Massive haemothorax is defined as a haemothorax exceeding 1 litre with clinical signs of shock and hypoperfusion. Acute haemothorax will show HU of 40-50 while clotted blood shows HU of 50- 90 on a plain scan. Sometimes "haematocrit effect" is seen with the layering of the blood of different ages.

- Hydropneumothorax: A hydropneumothorax is a term given to the concurrent presence of pneumothorax and pleural effusion (i.e. gas and fluid) in the pleural space (Figure 4d).

  In our study, 70% of cases had pleural injuries, 60% had pneumothorax and 42% had haemothorax. It is comparable with the other available studies for chest trauma. Only 8% i.e., 4 patients had hydropneumothorax. The incidence of hydropneumothorax related to trauma could not be compared due to the lack of data availability of such studies on an internet search for blunt chest trauma.

Injuries Of Lungs:

- Pulmonary contusion (Figure 1a): Pulmonary contusion is the most common lung injury from chest trauma, with a prevalence of 17%–70% [4]. It represents traumatic injury to the alveoli with alveolar haemorrhage, but without significant alveolar disruption at the site of trauma. Contusion may also occur in the opposite portion of the lung (counter-coup contusion). They are seen as geographic, non-segmental areas of ground-glass or nodular opacities with a lack of the lobar boundaries and sometimes have air bronchograms if the bronchioles are not filled with blood. Pulmonary contusion, inspite of the immediate diagnosis with imaging and supportive management with critical care medicine is a predictor of ARDS and has a significant mortality rate (10–25%) [5].
- Pulmonary laceration (Figure 3a and 3b): The incidence of pulmonary laceration in blunt chest trauma varies between 4.4% and 12%.[6] 160 Pulmonary laceration occurs when there is a disruption (tear, laceration) of the lung parenchyma, resulting in a cavity in the lung. Because of the normal pulmonary elastic recoil, lung tissues surrounding a laceration pull back from the laceration itself. This results in the laceration manifesting in CT as a round or oval cavity, instead of having the linear appearance typically seen in other solid organs. The traumatic cavity may be filled with air (traumatic pneumatocele- Figure 3a and 3b), blood (traumatic haematocele or pulmonary hematoma), or both air and blood (traumatic hematopneumatocele).

  Lacerations may be seen as a solitary lesion to multiple confluent small ones presenting a "Swiss cheese appearance" [7].

  Traumatic lung herniation: Traumatic lung herniation occurs when a pleura-covered part of the lung extrudes through a traumatic defect in the chest wall.

  Our study had a prevalence of 52% lung contusion injury as compared to the maximum prevalence being 70% as per other world studies while lung laceration was seen in 8% of cases that fall in the midrange of described incidence.

Injuries Of The Airway (figure 3a, 3b, 5c, And 5d):

- Macklin Effect: Alveolar ruptures, with air dissecting along bronchovascular sheaths and spreading into the mediastinum.
- Tracheal and Bronchial Laceration: Rarely seen in CT evaluation, approx. in 0.2-8% cases as most of these patients die within the first two hours from respiratory insufficiency and associated injuries [5]. Bronchial injuries are more common than tracheal, seen generally on the right side and within 2.5 cm from the carina [8]. 85% of tracheal lacerations occur 2 cm above the carina. Bronchial lacerations are noted parallel to the cartilage rings in contrast to tracheal ones that are vertical to the cartilage rings. Pneumothorax and/ or pneumomediastinum are commonly associated with these injuries.

  Our study detected only 2 cases of tracheobronchial injury.

Injuries of the Heart, Aorta, and Great Vessels (Figure 6a, 6b, and 6c):

- Injuries to the heart and vascular structures mainly include pericardial injuries, injuries to the heart valves and chambers, thoracic aortic injury, and injuries to the aortic arch and its branches. Types of vascular injuries include traumatic occlusion, dissection, pseudoaneurysm, and contrast material extravasation. It is important to diagnose these injuries at the earliest as they can be fatal. CT has very high sensitivity in diagnosing these vascular injuries but low sensitivity in diagnosing cardiac injury. The commonest imaging features are hemopericardium and pneumopericardium. These injuries are commonly seen with penetrating trauma. (RADIOGRAPHICS)

  Only a single case of vascular injury in form of aortic dissection was noted in our study.

Injuries Of The Chest Wall:

- Rib fracture (Figure 1a, 1c, 1d, 4d, and 6e): The most common skeletal injury in blunt chest trauma is rib fracture, which occurs in approximately 50% of patients. Simple rib fractures are usually not significant in isolation and are rarely life threatening. However, multiple or bilateral rib fractures may indicate more severe thoracic injury, which may result in increased morbidity and mortality. Rib fractures may serve as an external manifestation of possible coexisting thoracic or abdominal injuries. Soft tissue hematoma may be seen at the site of direct impact.
- Sternal fracture: Sternal fractures may result from deceleration injuries or direct blows to the anterior chest wall. Fractures commonly involve the sternal body and the manubrium. Although sternal fractures have been viewed as a marker for high-energy trauma, a simple sternal fracture may occur as an isolated injury. However, displaced sternal fractures and those with associated manubrio-sternal joint disruption frequently occur with thoracic, cardiac, and spinal injuries [10].
- Sternoclavicular fracture: Sternoclavicular dislocations may be either anterior or posterior. Posterior dislocations are more serious, since they may cause injuries to the mediastinal blood vessels, trachea, and oesophagus. They typically result from a posterior blow to the shoulder or a blow to the medial clavicle, resulting in a posteriorly displaced clavicular head relative to the manubrium. Posterior sternoclavicular dislocations may be subtle or not visualized in conventional radiography.[11] Therefore, when there is clinical suspicion for this entity, CT with intravenous contrast material administration can be used to confirm the diagnosis and evaluate for possible associated vascular injury [11].
- Scapular fracture (Figure 2b and 6d): Occurs in 3.7% of cases.[12] Associated with high-velocity trauma and therefore injuries to pleura, lung, subclavian vessels, or spine are often seen with these fractures [12].
- Thoracic spine fracture: Prevalence is 30% of all spine fractures.[9]

Most commonly involved are lower thoracic vertebrae i.e., 9th-12th vertebra. MRI is indicated if compressive myelopathy is observed.

- Flail chest: Flail chest is a traumatic condition in which there are three or more contiguous ribs with fractures in two or more places. Fractures usually occur in the anterior and anterolateral portions of the middle to lower ribs. [13]These fractures create a flail segment that can move paradoxically relative to the remainder of the chest during respiration in a spontaneously ventilating patient.
- Subcutaneous emphysema: Commonly seen with penetrating injuries like stab injuries resulting in a collection of air along the subcutaneous fascial planes and sometimes along the intermuscular plane depending on the depth of the injury.
- Injuries of diaphragm[14]: Diaphragmatic injuries are rare but morbid complications of trauma, occurring in 0.8% to 15% of all thoracoabdominal traumas. Up to 10% to 15% of penetrating traumas may involve the diaphragm, whereas only around 1.6% of thoracoabdominal blunt traumas will lead to diaphragmatic injuries. Gunshot wounds, when compared with stab wounds, have a higher incidence of diaphragmatic injury and eventual herniation[11].

The parenchymal injury and pain due to rib fractures caused by the flail chest deteriorate the patient's condition. Pain hampers the cough reflex and decreases the tidal volume, aeration increasing the chances of pneumonia and collapse. [13,15]. At the same time, paradoxical movement due to flail chest leads to difficulty in breathing and can cause respiratory failure. Therefore, prompt detection of flail chest is of utmost importance to decrease morbidity and mortality.

In our study, we found bony thorax fractures in 50% of cases and out of which multiple rib fractures were seen in 48% cases and vertebral fractures in 23% cases, these are comparable to world data of thoracic injury studies. 5 cases of flail chest injury were seen, all these cases were accompanied by lung and pleural injury

The commonest cause of intrathoracic injuries in chest traumas are due to bone fractures, however, there is a section of cases that have various other thoracic injuries without bone fractures.[13] According to the study by Shorr et al.,[16] 24.7% of cases had pleural injuries without bone fractures and the most common injury in those patient groups were pneumothorax and hemothorax. We found 11 cases of similar cases ie 22% of pleural injuries without rib fractures.

Our study is unique as it predicts the prevalence rate of different types of intrathoracic injuries in Indian patients, limited to Mumbai city - Single tertiary Trauma center experience by MDCT imaging and is found comparable to world data of blunt Chest trauma.

Our study indicates that multiple injury pattern of thoracic components is much more common than isolated injury pattern emphasizing the importance of detailed evaluation. Pleural injury being more common than lung parenchymal injury as well as the association of pleural injury with rib involvement is the commonest significant pattern.

It ascertains that MDCT and its various reconstruction methods, have increased the Radiologist's confidence of detecting major lung injury with precision whereby providing immediate assistance to the emergency trauma physician and surgeon in effective management.

The drawback of our study is that the mortality rate could not be calculated due to incomplete available data/follow-up of such patients. The second drawback being the small sample size of 50 cases, however, the incidence rate of these pleural, parenchymal, and bone injuries found in the study were in the range of world described data.

CONCLUSION

Our retrospective observational study reviews the MDCT imaging characteristics of the spectrum of blunt chest trauma. Multidetector CT can accurately and rapidly diagnose these varieties of thoracic injuries in trauma patients. These injuries can be clearly displayed with multiplanar and volumetric reformation. Knowledge and association of the various patterns of thoracic injuries are essential for the emergency radiologist to make precise, an immediate diagnosis that guides in further management thus decreasing the mortality rate.

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