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Pulmonary Contusion: Evaluation of Associated Injuries, Clinical Course, and Outcomes; Self-Experience from a Tertiary Care Center

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Abstract

Background:Even with current advances in our consideration of the pathophysiology, therapy, and long-term outcomes of lung injuries, still, statistics on the frequency, associated injuries, clinical course, and outcome of pulmonary injuries in Iraq insufficient. Henceforth, this self-experience study aimed to fill this gap.Methods: The study' data were taken retrospectively, from the archives of 100-admitted lung contusion patients. History, clinical examination, radiographic, operative and post-mortem findings were used.Results: A total of 100 patients with chest trauma met the criteria of this study, with a mean age of 31.4 years, most were males (92%) included. The average hospitalization duration was 23 days. The in-hospital death rate was 14%. Pneumothorax was detected in 40% of the patients, 22% hemopneumothorax and 12% of them showed hemothorax alone. Half of the patients had no associated rib fractures and 32% reported > 4 rib fractures while 20% had < 4 fractured ribs. There was a nearly equal incidence of penetrating and non-penetrating injuries. Around 50% of the pulmonary contusion cases were associated with extra-pulmonary associated injuries. Almost all of the cases of lung contusion required chest tubes (74%), 62% required bilateral chest tubes, and only 12% had unilateral tubes. Seventy-four percent required RCU care, 28% needed endotracheal intubation, and 13% ended with thoracotomy. More than half of the patients required surgery.Conclusion: The clinical course of pulmonary contusion remains unpredictable. Considerable morbidity and mortality are linked with pulmonary contusion despite the recent progress in respiratory care and ventilation services.

Keywords
Pulmonary contusion, blunt chest trauma, Rib fractures, Pneumothorax, Hemothorax, thoracic.

Introduction

Chest trauma is a protean clinical condition, particularly with the rise of roads traffic accidents forming for nearly 15% of all trauma cases (Battle et al., 2014). Though most of the fractures of the chest bones are non-life threatening and might be managed without admission, thoracic injuries can be the principal cause of mortality in cases with multiple traumas and their squeals account for up to 25% of deaths of blunt trauma (Hoff et al., 1994). Chest trauma has classically happened when a high-energy impact distresses the thoracic cage. The risk of mortality and disability is greater with the increased number of fractured thoracic ribs (Rendeki & Molnár, 2019).

The extent of organ injury depends on some factors, like the site, path, heaviness, degree of force, chest wall flexibility, overall thoracic structural state, position, and steadiness of the body at the instant of the accident (Rendeki & Molnár, 2019).

Though the precise mechanism of pulmonary contusion is indefinite, nevertheless, it refers to alveolar vascular damage without lung parenchymal injury. Disrupted capillaries of the alveolar walls and septa will worsen the affected patients progressively during the early 24-48 hours causing blood and fluids leakage into the peri-alveolar areas near the injured lung parenchymal tissue. Moreover, the consequent edema intensifies the injury to the pulmonary structures and disrupted gas exchange, and perfusion-ventilation matching (Matuschak & Lechner, 2010; Viano, 1991).

Even with current advances in our consideration of the pathophysiology, therapy, and long-term outcomes of lung injuries, still, statistics on the frequency, associated injuries, clinical course, and outcome of pulmonary injuries in Iraq have not been available. Henceforth this tertiary care, single-center, the self-experience study aimed to fill this gap.

Materials and methods:

The data of this study were taken retrospectively, from the registered archives of 100 consecutive admitted patients with traumatic lung contusion (of any kind) diagnosed and treated by the authors in our institution of "Al-Imamain Al-Kadhymain Medical City" at the wards of the department of vascular surgery and RCU throughout the duration from May 2021 to May 2022. Asymptomatic cases with evidence of lung contusion only seen on CT examinations were excluded from the study since they are typical of no clinical significance. The cases were collected from files of surgical wards or intensive care units. History, clinical examination, chest X-rays, chest computed tomography (CT), and operative and post-mortem findings were used to identify the pulmonary contusion. The radiographic analysis of lung contusion was described by both radiologists and thoracic surgeons. Pulmonary contusion was evaluated by size and intensity following the "Hounsfield scale" and the grade of isolated lung involvement was assessed individually. Likewise, CT findings of pulmonary contusion and associated findings like pneumothorax, hemothorax, vascular injuries, ruptured diaphragm, and rib fractures were assessed and verified at the same time.

The primary relevant outcome of the study was pulmonary complications like pneumothorax, hemothorax, or ICU admission, and any requirement for intubation or tracheostomy was assessed and registered. Whereas the secondary outcome was in-hospital death.

The patients with a pulmonary contusion in the present study were categorized according to the extent of contusion into mild, moderate, and severe, which have been described by "Wagner et al and Miller" et al. (Miller et al., 2001; Wagner & Jamieson, 1989). The data collected from patients also included any associated other non-thoracic injuries including abdominal viscera, liver, spleen, and others. Factors like the Glasgow Coma Scale

(GCS) during RCU or ICU admission were also recorded.

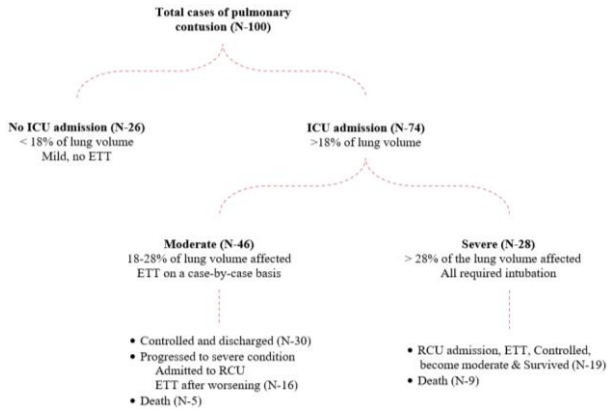

Figure-1: Flow-chart of the fate of the hospitalized patients with pulmonary contusion (N-100)

The data were collected, arranged, and transferred to an excel worksheet and analyzed, and expressed as number/percent or range/mean. All patients' private data were well-preserved with high caution and respect after an informed consent. The study was performed after an institutional review committee agreement, following Helsinki Declaration.

Results

Table 1 revealed that the study data involved 100 patients with younger age groups of patients, mean age of 31.4 years (range1.5-60 years). Most of the patients were male (92%), with a female-to-male ratio of 1:11.5. Average hospitalization duration was 23 days. Pneumothorax was detected in 40% of the patients, 22% revealed hemopneumothorax and only 12% of them showed hemothorax alone. Nearly half of the patients presented with right-sided lung contusion, 32% with the left side, while bilateral lung involvement was found in 16% of the total. Around half of the lung-contusion patients had no associated rib fractures and 32% reported more than 4 rib fractures while 20% had less than 4 fractured ribs. Both chest sides were involved but the left was less involved (8%). 76% of entire patients have no associated chronic medical illness like diabetes or hypertension together.

The mechanism of lung contusion was either penetrating or non-penetrating (blunt) injuries with nearly equal incidence.

Approximately half of the pulmonary contusion cases were associated with extra-pulmonary associated injuries (48%) like upper and lower limbs, abdominal, head, and neck as well as pelvic organs.

Table-1: Main characteristics of the patients with pulmonary contusion involved in the study

Variation	Number	Percentage
Age (years)	Range 15-60 year	Mean 31.4 years
	Less than 30	56 (56%)
	30-40	18 (18%)
	41-50	18 (18%)
	More than 50	8 (8%)
Sex	Males 92 (92%)	Females 8 (8%)
Type of contusion		
Hemothorax	44	44%
Pneumothorax	16	16%
Hemopneumothorax	40	40%
Side of lung contusion		
Left side	32	32%
Right side	52	52%
Bilateral	16	16%
Associated illnesses		
Hypertension	12	12%
Diabetes	8	8%
Hypertension and Diabetes	4	4 %
No associated illness	76	72%
Rib fracture		
No rib fracture	48	48%
More than 4	32	23%
Less than 4	20	20%

Side of fractured ribs		
Left	8	8%
Right	24	24%
Bilateral	20	20%
Mechanism of Injury		
Penetrating injury	44	44%
Blunt injury	46	46%
Extrathoracic injury		
No injury	48	48%
Upper limbs injury	24	24%
Lower limbs injury	10	10%
Head & neck injury	10	10%
Abdominal injury	6	6%
Pelvic injury	2	2%

Almost all of the cases of lung contusion required chest tubes (74%), 62% required bilateral chest tubes, and only 12% had unilateral tubes. Seventy-four percent of the total admitted to the RCU, 28% required endotracheal intubation, and 13% ended with thoracotomy. More than half of the patients required surgery, and the survival rate was excellent (86%), (table 2).

Table-2: In-hospital fate of the cases of lung contusion

Variations	Number	Percentage
Chest tube placement	74	74%
Bilateral chest tube	62	62%
Unilateral chest tube	12	12%
RCU admission	28	28%
ETT placement	28	18%
Surgical operation	54	54%
Thoracotomy	13	13%
Survival	86	86%
Death	14	14%

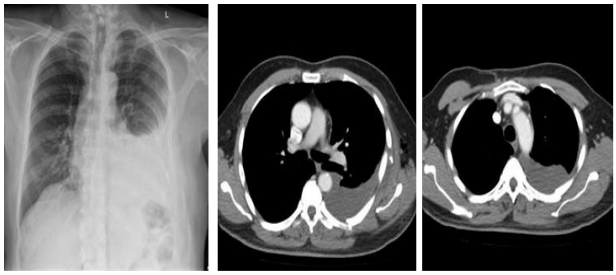

Figure-2: 41years old male fell from the roof of an incomplete structure steel building and presented with trauma to the left side of the chest. There is evidence of displaced left rib fractures, moderate left hemothorax, and small apical pneumothorax identified on CXR.

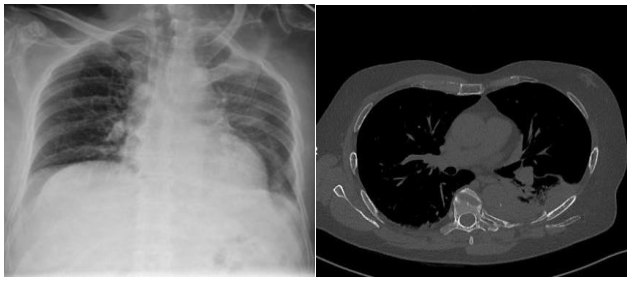

Figure-3: 44 years old male presented with a road traffic accident with multiple rib fractures on radiological depiction. There is left side pleural effusion hemothorax without evidence of pneumothorax.

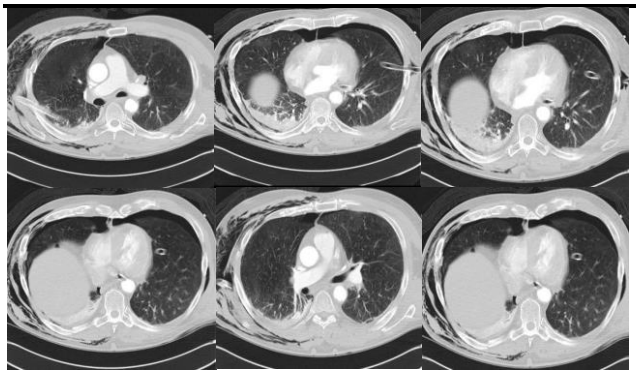

Figure-4: 38years old male had RTA with a high-speed motorcycle. CT shows multiple rib fractures from 4th to 10th, with bilateral pneumothorax and bilateral chest tube in the situs extending to the mediastinum. The 4th and 5th ribs are moderately displaced and the 9th rib is fractured anteriorly and posteriorly.

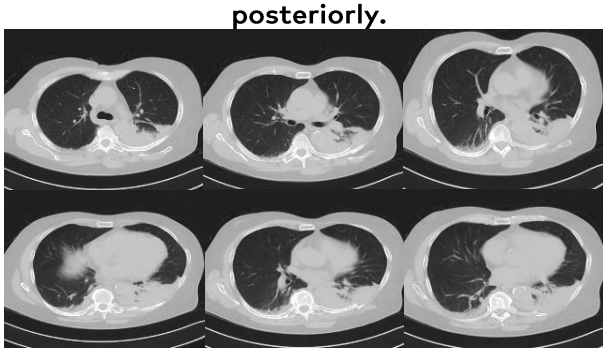

Figure-5: 60 years old male patient had fallen from stairs. CXR revealed multiple displaced rib fractures on the left side and suspicion of right-side pleural effusion/hemothorax. On CT, multiple anteriorly and posteriorly displaced and un-displaced rib fractures, moderate to large hemothorax, and no pneumothorax.

Discussion

Lung contusion is the commonest injury type of blunt trauma, with an incidence rate of 25–75% reported in several studies (Mardani et al., 2021). Lung contusion is parenchymal damage defined as alveolar bleeding and edema producing failure of pulmonary function (Miller et al., 2001). The condition matures 24 hours after blunt pulmonary trauma, and induces perfusion/ventilation mismatching due to increased pulmonary vascular resistance and decreased lung compliance (Cobanoglu, Melek, & Edirne, 2010).

Severe inflammatory responses in cases with significant lung contusion lead to ARDS in 50-60% of patients (Dushianthan et al., 2011). These responses could be either localized in the perialveolar space or the general circulation (Ganie et al., 2013). Loss of physiological compartmentalization of the lung might cause advanced multi-organ failure (Ferring & Vincent, 1997), the major cause of death in cases with respiratory distress syndrome (RDS), which could be further complicated by intra-alveolar hemorrhage and increase the death rate by severe hypoxia (Ganie et al., 2013). Alternatively, healing of simple uncomplicated lung contusions commences at 24-48hrs with a comprehensive resolution during the next 3-14days (Wanek & Mayberry, 2004).

The current advances in understanding the mechanism, management, and longstanding prognosis of pulmonary contusion have been extended. Nonetheless, data on the prevalence and consequence of pulmonary contusion in Iraq have not been covered sufficiently. Attributing to these and other data suggesting an increasing prevalence of traumatic pulmonary contusion, which is the most common pulmonary damage resulting from blunt trauma, this retrospective study was intended.

This work aimed to identify the clinical course of admitted patients with a primary diagnosis of lung contusion at Al-Imamain Al-Kadhymain Medical City for the period from May 2021 to May 2022.

Flail chest or thoracic fractures exaggerate the chance of underlying parenchymal damage by around 15%, though significant pulmonary injury without thoracic fracture can also ensue (Mardani et al., 2021). In the current series, 52% of the patients presented with rib fractures distributed as follows: 24% right-sided, 8% left-sided and 20% had bilateral rib fractures.

Patients with lung contusion generally complain of multiple associated injuries caused by severe trauma, and these injuries can be lethal and

more severe than respiratory manifestations. Hence, a multidisciplinary approach is desirable for these patients. In several cases, delayed radiological assessment of traumatic lung, necessitate monitoring and re-evaluation of injured patients for the identification of lung contusion (Bruner, Gustafson, & Visintainer, 2011). In the current study, 52% of the cases presented extrapulmonary injuries, mostly in the upper and lower limbs (34%), followed by the head (10%), abdomen (6%), and pelvic injuries (2%).

Several preceding studies have described a frequency reaching 35% of lung blunt trauma, which could be lethal in 25% of cases (Allen & Coates, 1996). RCU admission and death caused by associated damages are increased in several studies (Mardani et al., 2021), consistent with the outcomes of this study. 46% of the lung contusions patients in the current study resulted from blunt injuries, and 14% died. Although the majority of death reported in the current series were in those with associated extrapulmonary injuries, 31% of the registered cases of death suffered diabetes, hypertension (or both), more than 4 fractured ribs, or bilateral involvement, and critically hypotensive.

It is noteworthy that, despite the prominent advances which have been achieved in all areas of surgical knowledge during the last decades, the death rate associated with lung contusion has not changed dramatically. The death rate of lung contusion was expected to range from 6.5 to 40%, in preceding studies depending on the contusion severity and accompanied injuries (Gavelli et al., 2002; Trinkle et al., 1975). However, other studies documented no significant variations in death rates between patients with lung contusion and those without (Dhar et al., 2018). In the current series of 100 patients, seven died shortly after their admission emergency room because of extensive traumatic pulmonary injuries and at the time of presentation. Three patients died because of associated polytrauma. Two patients died with multiple rib fractures and flailed chest. One patient died two days after admission with septicemia after tracheobronchial injury complicated by mediastinitis and head injury. ARDS was the reported cause of death in an elder patient who died of acute traumatic lung injury 72 hours after RCU admission. Slipped endotracheal tube and aspiration pneumonitis was the last cause of death in a young irritable male admitted to the ICU and was comatose. Mechanical bronchial obstruction by the endotracheal tube and tube erosion over the anterior wall of the trachea into the innominate artery resulted in the death of one patient who died on the tenth day of admission.

Of the 100 included patients with lung contusion, 74 patients were referred to the ICU, with a mean duration of 15.67 days ICU stay. In a prior Canadian study, results exposed that 84% of ICU admitted cases had an average interval of 9.9 days (Dehghan et al., 2014). Parviz M. et al. described a mean duration of 7.69 days of ICU stay in their study that included 434 Iranian patients with pulmonary contusion (Mardani et al., 2021). The count of patients referred to the ICU was higher in the present study, which might be owing to the different severity of trauma in Iraq compared with Canada or Iran. On the other hand, another study from the USA by Sakshi M. et al. displayed no significant variations between patients with lung contusions and those with not, after substantial chest injury in terms of death rates and the duration of hospitalization (Dhar et al., 2018).

Rickardson et al. exposed the effective management of lung contusion, in which 80% of them were treated without intubation (Richardson, Adams, & Flint, 1982). Irrespective of trauma mechanisms and severity besides its disparities among countries, surgeons should follow a policy to eliminate the rate of tracheal intubation. Thus far, the cases with a risk of respiratory failure are better intubated immediately before aggravation of the

manifestations (Ganie et al., 2013). In the current study, tracheostomy has no specific scientific indication in pulmonary contusion patients.

Of note, the avoidable in-hospital death rate in traumatic patients is ranged from 4% to 60% globally (Roy et al., 2017). It is reported that about 1/4th of pulmonary contusion cases are established with aggravation of manifestations in the ED within the first 24 hours of hospitalization, despite the large fluid amounts in the pulmonary parenchyma 72 hours after injury. Conventional chest radiographs tend to undervalue the degree of lung injuries and not until 4-6 hours after injury for the findings to be detected and may need to 48hours to become apparent (Lively, 2011). Hence, the majority of patients recovered during 7-14 days with trivial long-term influences (Tyburski et al., 1999). Only 5 patients in this study revealed increased severity of pulmonary injury on re-examination, which is dissimilar to the outcomes of the previous study.

In the current series of lung contusions, 13% of the patients required thoracotomy. However, the indication of thoracotomy in blunt pulmonary traumas is still controversial, and some guidelines have been anticipated to decrease the morbidity and mortality of patients given the cost-effect of the surgical procedure (Segalini et al., 2019). Thoracotomy was the optimum final surgical decision for three cases who presented with massive air leaking, two cases with persistent ear leak, three cases who developed massive hemothorax, two cases who presented with associated traumatic diaphragmatic injury, and finally three patients who required thoracotomy because of multiple bony fractures and flail chest.

All pulmonary contusions which are presented with hemothorax salvaged by ED were intubated, excluding those rescued in the RCU for severe pulmonary contusion and/or flail chest requisite insertion of chest tube after a barotrauma pulmonary injury by the ventilator. Those who were more than one week in the RCU required tracheostomy.

Several risk factors affected the morbidity and mortality of patients with blunt chest injuries in the present study. Some associated factors like chest skeletal fractures, mechanical ventilation, skull injury, circulatory hypotension, and extrathoracic involvement. Furthermore, a low Glasgow coma scale score was highly predictive of mortality.

Of note, in most significant lung contusions, the diagnosis was based on plain chest radiography, nevertheless, the plain chest frequently undervalues the volume of pulmonary contusion and generally delays after the clinical presentation. On occasion, the true size of contusion is not obvious on chest X-ray 'til 24-48 hours of injury. CT is superior to plain X-ray owing to its sensitivity to diagnosing lung contusion size, and volume, and to excluding other differential diagnoses (Ganie et al., 2013).

Clinical implications

The frequency and intensity of lung contusion in chest trauma are associated with the number of fractured ribs beside the related extrapulmonary injuries.

Conclusions

Parenchymal injuries of the lung are a common result of severe trauma to the chest wall. The authors present a series of pulmonary contusion cases, most of them associated with a wide clinical spectrum. However, the clinical course of pulmonary contusion remains unpredictable. Considerable morbidity and mortality are linked with pulmonary contusion despite the recent progress in respiratory care and ventilation services. There is a necessity to deliver a national guideline for highly qualified care and optimized management derived from population-based future epidemiologic cohorts.

Limitations

In the current study, the authors faced some

limitations. Due to the retrospective design of this case series, it is not reflecting the exact evaluations of case frequency since not all centers in the capital were included in the study. Further, the presence of demographic and premorbid conditions can increase the effect of confounding variables. Likewise, this survey was single-center owing to the lack of all archives of pulmonary contusion data of the whole capital. Secondly, it was hard to exactly describe the causal relation since the study was cross-sectional.

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