Research Square

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Management of thoracic trauma and analysis of risk factors in thoracic trauma patients

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Abstract

Objectives:

Thoracic trauma (TT) is the third most common cause of death after abdominal injury and head trauma in polytrauma patients. Its management is still a very challenging task. The purpose of this study was to analyse the epidemiological finding, risk factors affecting the outcome in a high volume trauma centre.

Patients and methods:

Between January 2003 and December 2012 data of all patients admitted to the Accident and Emergency (A&E) were prospectively collected at the German Trauma Registry (GTR) thereafter retrospectively analysed.

Patients with chest trauma and Injury Severity Score (ISS) ≥18 and Abbreviated Injury Scale (AIS) >2 in more than one body region were included. Patients were divided into two groups; group I included patients with thoracic trauma between January 2003 to December 2007. The results of this group were compared with the results of other group (group II) in a later five years period (Jan. 2008-Dec. 2012). Univariate and multivariate analysis was done, Statistical difference with $P<0.05$ were considered significant.

Results:

There were 630 patients (56%) with thoracic trauma. 540 patients (48%) had associated extra thoracic injuries. Group I consisted of 285 patients (197 male, mean age 46 years). Group II consisted of 345 patients (251 male, mean age 49 year). Overall 90 days mortality was 17% (n=48) in group I vs. 9% (n=31) in group II (p=0.024). Complication rates were higher in group I (p=0.019). Higher injury severity score (ISS), and higher abbreviated injury score (AIS) thoracic showed higher rate of mortality (p<0.0001). Young patients (< 40 years) were frequently exposed to severe thoracic injury but showed less mortality rates (p=0.014). Patients with severe lung contusions (n=94) (15%) had higher morbidity and mortality (p<0.001). 23 (8%) Patients had emergency thoracotomy in group I vs. 14 patients (4%) in group II (p=0.041). Organ replacement procedures were needed in 18% in group I vs. 31% in group II (p=0.038).

Conclusions:

The presence of severe lung contusion, higher ISS and $AIS_{thoracic}$ and advanced age are directly related to higher mortality rate. Instantly management of blunt chest trauma with corrected chest tube insertion, optimal pain control and chest physiotherapy resulted in good outcome in the majority of patients. Optimal management with better survival rates is achievable in specialized centre with a multidisciplinary teamwork and the presence of thoracic surgical experience.

Introduction

Trauma continues to be a major public health problem worldwide as it is associated with high morbidity and mortality both in developed and developing countries with around 5.8 million deaths worldwide. Trauma also reported to be the leading cause of death, hospitalization, and long-term disabilities in the first four decades of life [1, 2]. Thoracic trauma comprises 20-25% of all traumas worldwide and it constitutes the third most common cause of death after abdominal injury and head trauma in polytrauma patients [3, 4]. It directly accounts for approximately 25% of trauma related mortality and is a contributing factor in another 25% [5]. Blunt thoracic injuries are more common than penetrating injuries, with the most frequent causes being motor vehicle accidents, falls, and crush injuries [6].

Penetrating injury causes a laceration of anatomic structures in the trajectory of the weapon. A knife injury is typically limited to the length of the blade and the corresponding depth of the wound, assuming that the entire blade had penetrated in each instance [7]. Blunt injury on the other hand is much more common and usually compounded by dislocated skeletal fracture, which may lacerate underlying viscera with sharp fragments. Although most injuries caused by blunt thoracic trauma are usually managed by chest tube drainage, surgical interventions are occasionally required in severe cases [8]. Blunt thoracic trauma especially after motor vehicle accidents is usually associated with higher abbreviated injury scale $(AIS)_{thoracic}$, and injury severity score (ISS). Therefore, they are susceptible to more risk of morbidity and mortality after thoracic trauma [9, 10].

Time management is a very important task especially in patients with high ISS and $AIS_{thoracic}$. During the first hour after hospital admission, thoracic vascular and neurologic trauma are the most common causes of death [11, 12]. The presence of interdisciplinary team with high experience in anaesthesia, critical care as well as surgical disciplines especially Neurosurgery, trauma surgery, abdominal surgery, and thoracic surgery is mandatory to ensure high quality management with low morbidity and mortality rates in these patients. The purpose of this study was to investigate the epidemiology, characteristics, incidence, management and risk factors affecting the outcome of polytrauma patients with chest injury admitted to our tertiary care facilities' level I trauma centre in order to indicate factors influencing management, possible complications and patient mortality.

Patients And Methods

Study design:

Data of all patients admitted to the A&E centre in our institution, Protestant Hospital of Bethel Foundation (EvKB) were collected prospectively using the German Trauma Register (GTR) database. Patients were either brought directly or transferred from another hospital. Once arrived, patients were taken to one of the available shock rooms, surveyed by the trauma teams according to Manchester triage system (MTS), thereafter managed according to the Advanced Trauma Life Support (ATLS) guidelines. The initial Resuscitation initiated by the emergency transport team was continued or extended to intubation if needed according to the stability of the vital signs. Those who were not intubated and with more stable vital signs underwent complete medical history with detailed physical examinations. After initial Chest

and pelvic X-rays and stabilization of the hemodynamic and respiratory situation, CT-scan was routinely performed (if no need for emergency operation at once) for further evaluation. After completion of the resuscitation and shock room procedures; patients were either admitted to the intensive care unit (ICU) for further stabilization or underwent surgical interventions in the operating room (OR). Blood loss over chest tubes was recorded initially and continued over the following several hours. Prospective data collection was done during the in-hospital time for age, gender, trauma mechanisms, type of transport, time of evacuation needed to free the patients, ISS, AIS, operative procedures, ICU procedures, length of intubation, complications, hospital stay, and outcome were recorded and retrospectively analysed. We analysed the data of all patients using our A&E collecting data system and the data of the GTR. In this study only data of the subgroup of patients with thoracic trauma over a ten years period were analysed. To better compare and understand the differences, we decided to divide the patients into 2 groups in 10 years period (the cut point was the implementation of a new division of thoracic surgery with two dedicated thoracic surgeons at our institution).

Inclusion criteria:

We included all patients with complete medical records who thoracic trauma in a 10 years period. There were 630 patients included. Patients were divided into two groups; group I included patients with thoracic trauma between January 2003 to December 2007 (no dedicated thoracic surgeons were available). The results of this group were compared with the results of other group (group II) in a later five years period (Jan. 2008-Dec. 2012 after establishment of the division of general thoracic surgery). 48 Patients with thoracic trauma were excluded due to incomplete data.

Statistical analysis:

For univariable analysis, the Chi-squared (X^2-Test) or Fisher exact test, and the numerical variables were compared by the *t*-test or the Wilcoxon ran-sum test and used for categorical variable. Simple means were used for frequency and percentages for the categorical variables, while standard deviations (SDs), the Mann-Whitney U test was used for the comparison of continuous variables. For multivariable analysis, a Cox regression model was used with a forward stepwise selection of covariates. Data analysis were performed using SPSS software (Version 16;SPSS,Inc., Chicago, IL, USA). Statistical difference with $P<0.05$ were considered significant.

Results

Overview:

Between January 2003 and December 2012 there were 1122 patients were admitted to our institution due to trauma. Out of them 1070 patients (95%) had blunt trauma. 630 patients (56%) had thoracic trauma (TT). Group I (between Jan. 2003-Dec. 2007) consisted of 285, group II (between Jan. 2003-Dec. 2007) consisted of 345 patients. Patient's characteristics are summarized (table 1). Out of them, there were 90 patients (14%) with isolated TT, but 540 patients (48%) had associated extra thoracic injuries. 392 (34%)

had two systems affected. 311 patients (27%) had three or more organs affected. The associated injures included: 505 (80%) head and maxillo facial trauma, 271 (43%) extremity injuries, 127 (20%) abdominal injuries, 184 (29%) pelvic fractures, 67 patients (10%) had urological trauma, 45 (7%) spine injuries, 30 (3%) with considerable soft tissue injury (table 2). Most of the patients in both groups had blunt thoracic trauma (88% vs. 92%). 55% (n=352) had loss of conscious at the accident place with Glasgow coma scale (GCS) ≤ 8 (57% in group I vs. 54% in group II). Most of the patients arrived intubated in both groups (84% in group I vs. 85% in group II). 8% had signs of aspiration in group I vs. 7% in group II. Gastric tube was inserted in 41% in group I vs. 46%. There were 68% (n=196) arrived with chest tube in group I vs. 60% (n=208). A new chest tube was inserted, or the old one was corrected or a second chest tube was inserted in 10 % (n=29) in group I vs. 23% (n=80) in group II. Young patients under 40 years were frequently exposed to severe thoracic injury with higher ISS and AIS thoracic but showed less mortality rates (p=0.014). Overall morbidity was 52%, n=331 (58% in group I vs. 43% in group II). In both groups; higher mortality rates was noticed in patients with higher $AIS_{thoracic}$ especially due to respiratory complications (p<0.0001). In this sub group of patients with higher $AIS_{thoracic}$, higher incidence of acute pulmonary failure which needed long time respiratory support with or without extra corporeal membrane oxygenation (ECMO) as well as extra corporeal CO2 elimination using interventional lung assist (iLA) Novalung® (p=0.031) was noticed. Univariate and multivariate analysis showed higher mortality rates in patients with severe lung contusions (p<0.001). In this sub group higher occurrence of pneumonia and ARDS was noticed especially in patients with more than 50% involvement of both lungs. Intubation time was 15 days vs. 11 in group II. 8% (n=23) Patients had emergency thoracotomy vs 4% (n=13) patients in group II (p=0.042). Much more VATS procedures as well as surgical chest wall fixation were done in group II (p=0.014) (table 2). Mean ICU stay was 29 days (range 3-58) in group I vs. 34 days (range 2-67) in group II, mean hospital stay was 34 days (range 5-86) vs. 31 days (range 6-94)in group II with no statistical difference. As well as no statistical difference was noticed between patients in both groups in form of sex, type of transport, type accident, blood transfusion, or accompanied injuries of other organs. Overall 90 days mortality rate was 16% (n=48) in group I vs. 9% (n=31) in group II (p=0.024).

Injury Severity Score (ISS):

The ISS is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) and is allocated to one of six body regions (head, face, chest, abdomen, extremities (including pelvis). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. The ISS score takes values from 0 to 75. If an injury is assigned an AIS of 6 (un survivable injury), the ISS score is automatically assigned to 75. The ISS score is virtually, and it is the only anatomical scoring system in use and correlates linearly with mortality, morbidity, hospital stay and other measures of severity. Its weaknesses are that any error in AIS scoring increases the ISS error, many different injury patterns can yield the same ISS score and injuries to different body regions are not weighted. Also, as a full description of patient injuries has not known prior over full investigation & operation, the ISS (along with other anatomical scoring systems) is not useful as a triage tool. 555

Patient (88%) with severe thoracic trauma had ISS ≥ 16. ISS is summarized and compared in both groups (table 4). Mean ISS score was 32 (28 in Group I vs. 33 in group II). Univariate and multivariate analysis showed higher morbidity with higher risk of respiratory and cerebral complications in patients ISS > 30 (p=0.026). Higher mortality rate in patients with ISS > 30 (p<0.0001) was also identified.

Abbreviated Injury Scale ($AIS_{Thoracic}$):

The $AIS_{thoracic}$ is an anatomical-based coding system created by the Association for the Advancement of Automotive Medicine to classify and describe the severity of specific individual injuries. There were 124 patients (43%) with AIS thoracic 4 and 5 in group I comparing to 154 (45%) in group II. Summary of the patient's $AIS_{thoracic}$ Score in both groups was analysed and compared (table 5). Higher mortality rate in patients with AIS thoracic > 3 (p<0.0001) was identified in both groups.

Mechanism of injury:

The most frequent mechanism of injury in the overall study population was Road Traffic Accidents (RTAs) 57%. Car crashes being the most frequent cause among RTAs (36.4%) followed by motorcycle crashes (16.8%) and injured pedestrians (7.4%). Falls made up for most of the remaining injuries (23.9%). Injuries caused by bicycle were represented by 7.3%. There were 6% (n=37) in whom no defined mechanism could be obtained.

Type of associated non thoracic injures:

Associated extra thoracic injuries were most frequently in the head and neck region, lower then upper extremities, followed by abdominal injuries, followed by pelvic injuries. An overview is summarized an compared in both groups (table 2).

Type of thoracic injuries:

The most common thoracic injuries were lung contusion followed by hemothorax, rib fractures, and then pneumothorax. The prevalence of common thoracic injuries was analysed and compared in both groups (in table 6).

Degree of lung contusion:

322 patients (51%) had mild lung contusions, 138 patients (22%) had moderate, and 94 patients (15%) had severe lung contusion. The presence of pneumoceles and other signs of lung lacerations were frequently seen in both moderate and severe lung contusion, but on itself, did show significant difference neither on complication nor on mortality rates.

The degree of lung contusions was classified according to the findings on CT-scan of the lung. The volume of lung contusion was calculated according to the relation of the affected volume to the non affected lung volume (Fig. 1). Following classification was done:

Mild lung contusion: less than 20% of the whole lung volume affected. There were 146 patients in Group I (two patients died, 1,3%) and 176 patients in group II (one died, 0,56%)

Moderate lung contusion: 20-50% of the whole lung volume affected. There were 65 patients in Group I (four died, 6%) and 73 patients in group II (five died, 6,8%)

Severe lung contusion: more than 50% of the whole lung volume affected. There were 33 patients in Group I (18 died, 54%) and 61 patients in group II (13 died, 21%); (p<0.001).

Morbidity/mortality:

Complications were documented, analysed and compared in in both groups. 22 patients (7%) had nosocomial pneumonia in group I vs. 10 patients (2,8%) in group II (p = 0.033). More patients with atelectasis in group I (n=34) than in group II (n=12) were observed (p = 0.019). ARDS was more noticed in group I (n=16) vs group II (n=5) (p = 0.016). Organ replacing procedures e.g. ECMO, Novalung, Jet ventilation as well as renal dialysis were frequently used in group II (n=109) than in group I (n=51) (p = 0.038). The overall 90 days mortality was 13% (n=79). Higher mortality in group I (n=48) than group II (n=31) with lower incidence in younger patients under 40 years old (p = 0.024) and p = 0.014) respectively was noticed. Other complications like: Re operation, pleural empyema, cardio vascular, lung emboli and neurological complications were higher in group I but did not show statistical differences.

Discussion

Thoracic trauma is one of the leading causes of death in Germany and many other countries all over the world. It is responsible for one third of all traumatic deaths in the United States. Blunt thoracic trauma is much more common than penetrating trauma and it is increasing worldwide (1, 13). We agree with Veysi et al that Patients with higher ISS, $AIS_{thoracic}$ showed significant risk of developing multi organ failure (MOF) with higher morbidity and mortality rates. In contrast to Chrysou at al our results showed that the severity of chest trauma, based on the AIS with the presence of severe lung contusion correlates with the hospital and ICU length of stay, the time of mechanical ventilation, complications and mortality rates. We explain this finding by the fact that in patients with an $AIS_{thoracic}$ of a score 4 and especially 5 even without other associated injuries such as head and abdominal injuries suffered from serious complications especially MOF. The use of ECMO, Novalung® and Jet ventilation are effective tools to overcome temporary acute cardio and respiratory failures [13, 14]. Causes of death were ARDS, sepsis, aspiration, and multiple organ failure. Our results showed in agreement with other reports that younger patients (< 40 years old) have less mortality rates, although there was no significant difference in ISS, AIS thoracic, or severity of lung contusion in different age groups (15). The overall mortality in group II was significantly lower as compared to group I and previously reported studies [14, 16]. Furthermore, there were more sophisticated thoracic surgical procedures done in group II. We explain these findings by establishing a well-developed network of pre-hospital trauma management, improved intensive care resuscitation, establishment of a new A&E unite as well as a new department of thoracic surgery, which

all together may result in a better survival for trauma patients. Interestingly about third of all deaths in our study were attributed to the chest trauma itself, showing the importance of immediate thoracic surgical treatment if possible, in order to reduce mortality in polytrauma patients. However, it must also considered that a significant proportion of deaths attributed to severe chest trauma occur in the prehospital setting [17]. Although the majority of our patients with blunt chest injury could be treated without surgery (85,8%), most of them required chest tube thoracostomy (93%). In our study 64% of the chest tubes were placed through the emergency team at the injury place or during the transport, due to unstable haemodynamic conditions, especially in case of tension pneumothorax, suspicion of pneumothorax or haemothorax. In accordance with other studies only 8% of our polytrauma patients required surgical treatment for their chest injuries due to unsuccessful non-operative treatment such as non-resolving pneumothorax despite thoracic drainage, late haemothorax, persisting air leak or late pleura empyema. Patients with bilateral flail chest with paradoxical movement and/or the need for positive pressure ventilation for more than 48 h was considered as an indication for immediate surgery [10, 18]. In case of flail chest, early stabilization is an effective way to avoid long time intubation [19].

The degree of lung contusion plays an important role on developing respiratory complications for example pneumonia and acute respiratory distress syndrome (ARDS). Our results support the hypothesis by Clark et al that the presence of severe pulmonary contusion is one of the important prognostic factors leading to long time intubation with risk of development of pneumonia and ARDS. In their series the mortality rate was more than doubled when a combined pulmonary contusion and flail chest were present (20). Accordingly, we may assume that a new classification for lung contusion using zone affected, is needed (Fig. 3).

We identified a high incidence of left-sided ruptured diaphragms, similar to other publications [19, 21, 22]. In contrast to Rodriguez and colleges, there were less patients who had right sided diaphragmatic rupture in our study. Small diaphragmatic rupture is usually difficult to diagnose and many stay occult especially on the right side [23].

Emergency thoracotomy (ET) plays an important role in case of penetrating trauma but continue to be controversial in blunt trauma. All patients (n=4) in this study who had absent vital signs in the emergency room died despite aggressive resuscitative measures included emergency room left thoracotomy. ET might be effective in the treatment of a ruptured cardiac chamber or severe pulmonary parenchymal laceration [24]. Our general philosophy in case of doubt is to do ET as it is better to err on the side of resuscitation rather than declaring the patient dead on arrival. However, we agree with other reports that if the patient has no vital signs at the scene or has been without vital signs for 30 minutes, this represents a non-salvageable patient [24, 25]. Emergency thoracotomy was frequently performed in group I comparing with group II, these ratios are similar to previously published results [13, 26, 27]. Our results showed a significant decrease in the number of ET in group II in the presence of a dedicated thoracic surgeon. This demonstrates that the importance of specialized thoracic surgeon in a high frequency trauma centre.

VATS as a minimal invasive surgery is an effective method to explore intrathoracic injuries in case of stable patients. Many reports identified the efficacy of VATS in case of thoracic trauma. We agree with Freeman et al about the indications for VATS in case of abnormal chest radiograph, associated intra-abdominal injuries, high-velocity mechanism of injury, entrance wound inferior to the nipple line or scapula, and right-sided entrance wound [19, 28, 29].

Atelectasis and Pneumonia are two of the most common causes of death in multiple injured patients in the ICU, every effort has to be done for its management. Development of nosocomial pneumonia especially in patients with known COPD or emphysema has an adverse prognostic effect on outcome. At our institution the concept of: “hit hart and early” using bronchoscopic examination and broad spectrum antibiotics showed its efficacy. In this study there was significant less in mortality rate (4%) due to pneumonia in group II, which is lower than reported in other series [30]. We postulate that early and complete drainage of haemothorax or pneumothorax, repeated bronchoscopy, early mobilization, aggressive analgesia, vigorous physical and respiratory therapy, early use of antibiotic therapy in case of infection are the most important factors to improve the outcome of blunt thoracic trauma.

Conclusions

Mortality rates in polytrauma patients with blunt chest trauma correlates with the severity of chest injury. High ISS more than 30, high $AIS_{thoracic}$ more than 4, elderly patients as well as severe lung contusion were independent predictor factors of mortality in our study. Thoracic surgical treatment through experienced surgeons is mandatory. Instantly management of blunt chest trauma with corrected chest tube insertion, optimal pain control and chest physiotherapy resulted in good outcome in the majority of patients.

Abbreviations

A&E: accident and emergency

AIS: abbreviated injury scale

ARDS: acute respiratory distress syndrome

CT: computed tomography

ICU: intensive care units

ISS: injury severity score

GCS: Glasgow coma scale

GTR: German trauma register

MTS: Manchester triage system

OR: operating room

RTAs: Road traffic accidents

TT: thoracic trauma

Declarations

Ethics approval and consent to participate: as a retrospective analysis, no patients confidentiality were used, therefore there was no ethics approval needed. The authors have no ethical conflicts to disclose. The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper. All patients included in this study were admitted as emergency cases. No consent was obtained.

Consent for publication: Our study does not contain any individual person's data in any form. All author are signing a consent for publication in case of acceptance

Availability of data and materials: All data generated or analysed during this study are included in this published article

Competing interests: We don't have any competing of interest on the study or any part of it

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Authors' contributions:

Study conception, design and overall analysis and interpretation of data, drafting, revising the manuscript (M.B., H.W.K., M.R., D.B.), Data analysis and interpretation (M.B., H.W.K., D.B), manuscript preparation (M.B., H.W.K., F.B, F.M., D.B.), conceptual contributions and manuscript revision (R.A.S., M.R., T.V.).

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Tables

Table 1: Patients characteristics

Patients characteristics	Group I	Group II
Age		
Mean	46	49
Range	16-89	15-93
< 40 years	Total:160 Died:1 Survived:159	Total:198 Died:1 Survived:197
40-70 Years	Total:71 Died:7 Survived:74	Total:88 Died:9 Survived:79
>70 years	Total:54 Died:40 Survived:14	Total:59 Died:21 Survived:38
Gender		
Male	197	251
Female	88	94
Type of transport		
Air transport	36%	42%
Intubation through the emergency team	84%	85%
Time of transport (min.)	78 ± 52	71 ± 49
Time from arrival to chest X-ray (min.)	9 ± 5	7 ± 4
Time from arrival to CT-scan (min.)	26 ± 10	22 ± 8
Number of patients received blood transfusion	33%	31%
Bronchoscopy	3%	16%
Blunt trauma	93%	95%
Associate injuries	87%	84%

Table 2: Type of associated non thoracic injures

Accompanied injuries	Group I	Group II
Head & Neck	231	254
Subdural hematoma (SDH)	167	178
Subarachnoid hematoma (SAH)	80	97
Brain laceration (BL)	16	21
Cerebral edema (CE)	198	222
Skull Fracture (SF)	183	197
Maxillofacial fracture (MF)	48	61
Vertebral column fractures (VCF)	18	27
Abdomen:	91	113
Splenic injury (SI)	41	46
Liver injury (LI)	26	31
Retro peritoneal Hemorrhage (RPH)	15	23
intestinal Injury (II)	5	6
Urinary tract injury (UTI)	32	35
Skeletal System:	278	322
Fracture of upper extremities (FUE)	36	42
Fracture lower extremities (FLE)	98	95
Pelvic fractures (PF)	86	98
Calvicula fracture (CF)	42	64
Scapula fracture (SF)	16	23
Soft tissue:		
Open wound (OW)	104	113
Muscular laceration (ML)	18	24
Large subcutaneous hematoma (LSH)	29	35
Compartement Syndrom (CS)	5	6
Peripheral nerve Injury (PNE)	14	17
Vascular injury (VI)	12	16

Table 3: Thoracic operative procedures

Procedure	Group I	Group II
Tracheostomy	139	183
Dilatative	62	99
Surgical	77	84
Chest tubes	225	288
Single	122	136
Double	63	90
On both sides	40	62
Time of removal	18 days	12 days
Emergency thoracotomy	23	14
Open cardiac massage	7	2
Suture of lung laceration	4	5
Intercostal artery ligation	9	3
Repair of cardiac rupture	2	2
Repair of diaphragmatic rupture	1	2
Elective thoracotomy	15	2
Evacuation of hematoma	11	1
Decortication for empyema	4	1
Removal of foreign bodies	1	0
VATS	2	14
Evacuation of hematoma	1	9
Decortication for empyema	1	2
Removal of foreign bodies	0	3
Thoracic wall stabilization	1	6

Table 4: Injury Severity Score (*ISS)*

ISS	Group I	Group II
<16	33 Died: 0 Survived: 33	42 Died: 0 Survived: 42
16-30	188 Died: 11 Survived: 177	226 Died: 8 Survived: 218
>30	64 Died: 36 Survived: 25	77 Died: 20 Survived: 57

Table 5: Abbreviated Injury Scale (AIS) Thoracic

AIS	Description	Chest	Head	Abdomen	Extrimities	Group I	Group II
0	Not injured	0	125	503	175	0	0
1	Minor	30	178	47	135	14 Died: 0 Survived: 14	18 Died: 0 Survived: 18
2	Moderate	87	146	20	89	59 Died: 1 Survived: 58	68 Died: 0 Survived: 68
3	serious	169	118	38	217	94 Died: 7 Survived: 90	108 Died: 2 Survived: 106
4	Severe	278	14	16	10	107 Died: 28 Survived: 79	125 Died: 12 Survived: 113
5	Critical	66	5	6	4	17 Died: 12 Survived: 4	26 Died: 17 Survived: 9

Table 6: Type of thoracic injuries

Type of thoracic injury	Group I	Group II
Blunt trauma	217	295
Penetrating trauma	12	9
Soft tissue injuries total:	62	119
Thoracic wall laceration	7	10
Thoracic wall hematoma/contusion	15	23
Diaphragmatic injury	6	17
Subcutaneous emphysema	34	69
Skeletal injuries total:	227	291
Rib fracture:		
- single	12	16
- multiple	157	186
- Flial chest	19	27
- 1st Rib fracture	5	9
Sternal fracture	6	11
Vertebral fracture	28	42
Thoracic trauma total:	285	345
Lung contusion	209	296
Hemothorax	198	286
Pneumothotax	145	221
Tension pneumothorax	14	17
Intra pul. Hematoma	23	34
Lung laceration	22	41
Intra pul. Pneumocyst	7	16
Cardiac/Vascular injuries total:	30	68
Myocardial contusion	18	41
Pericardial effusion	5	8
Pericardial tamponade	2	5
Myocardial perforation	1	2
Aortic rupture	3	5
Pulmonary artery injury	0	3
Lung veins injury	1	2
Azygus vein injury	0	2
Mediastinal injuries total:	51	86
Tracheal/broncheal rupture	2	6
Esophageal rupture	2	2
Mediastinal hematoma	15	33
Pneumomediastinum	27	41
Thoracic duct	2	0
Phrenic nerve	3	4

Figures

Fig. 1: Distribution of $AIS_{Thoracic}$

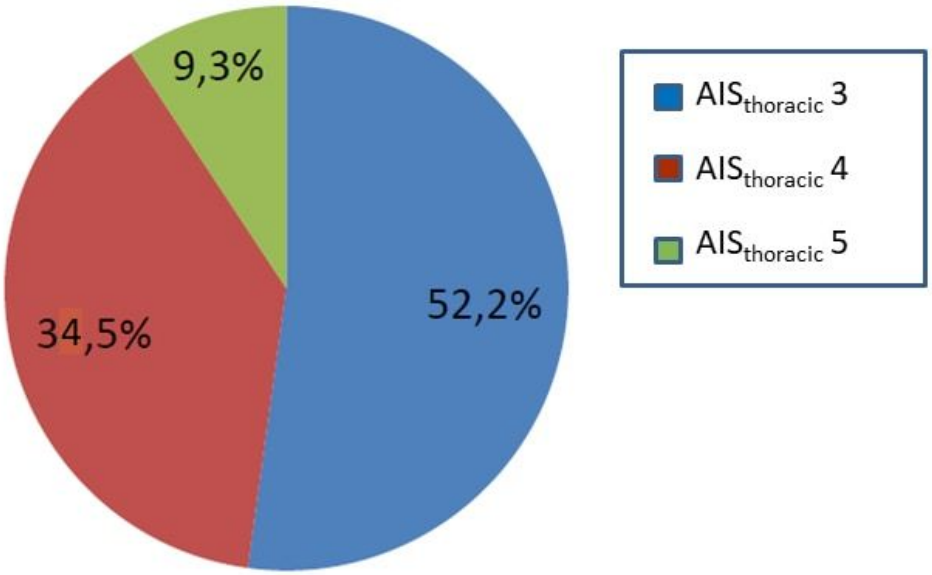

Figure 1

Fig. 2: Distribution of pulmonary contusion on
X-ray and the corrosponding CT-scan

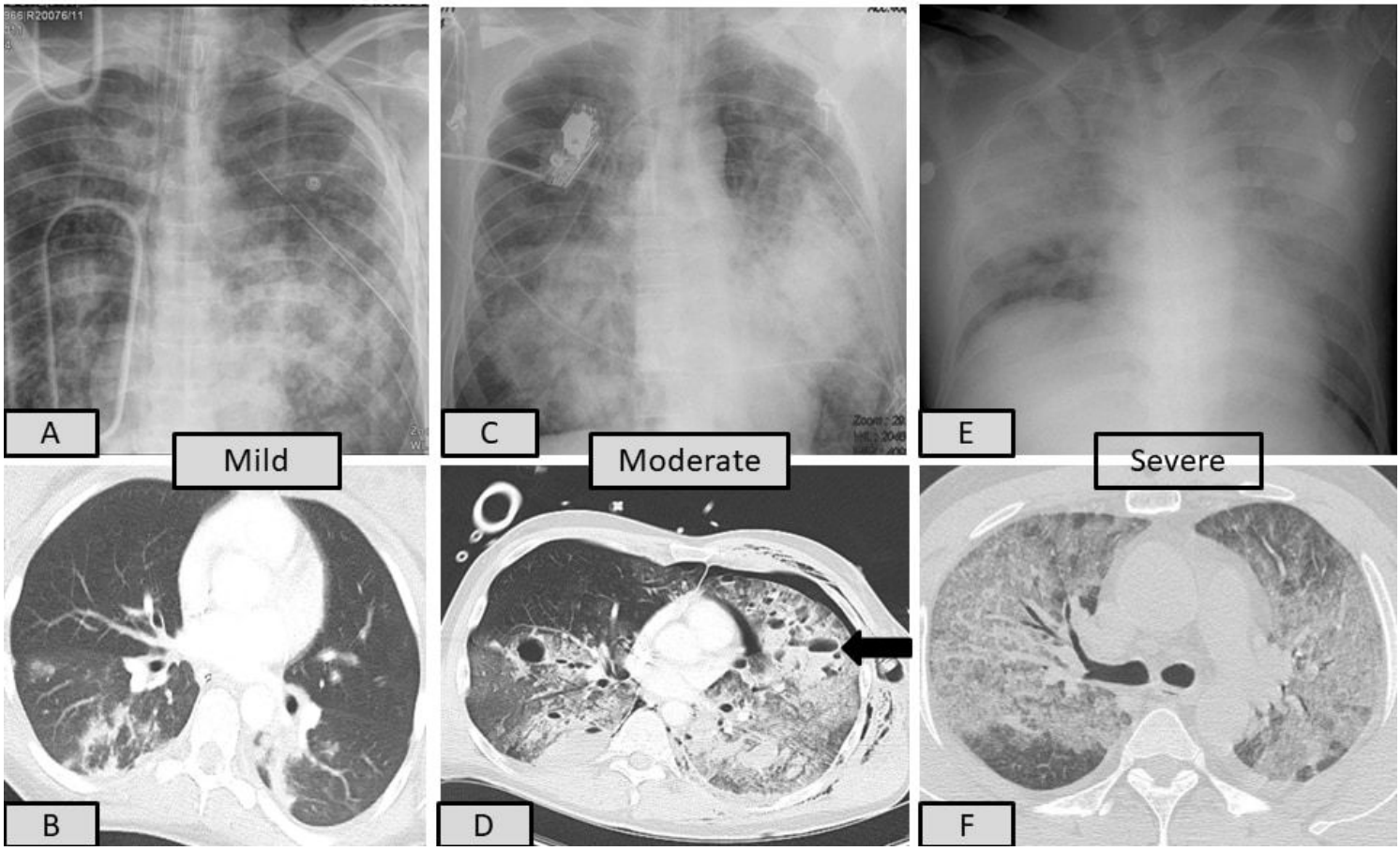

Figure 2

Fig. 3: Schematic illustration of Pulmonary contusion

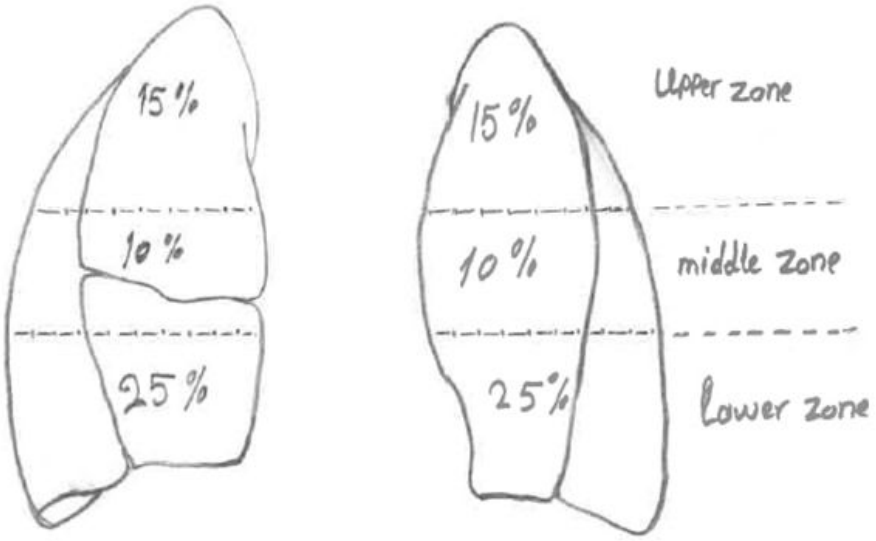

Figure 3

Fig. 4: Distribution of age and gender

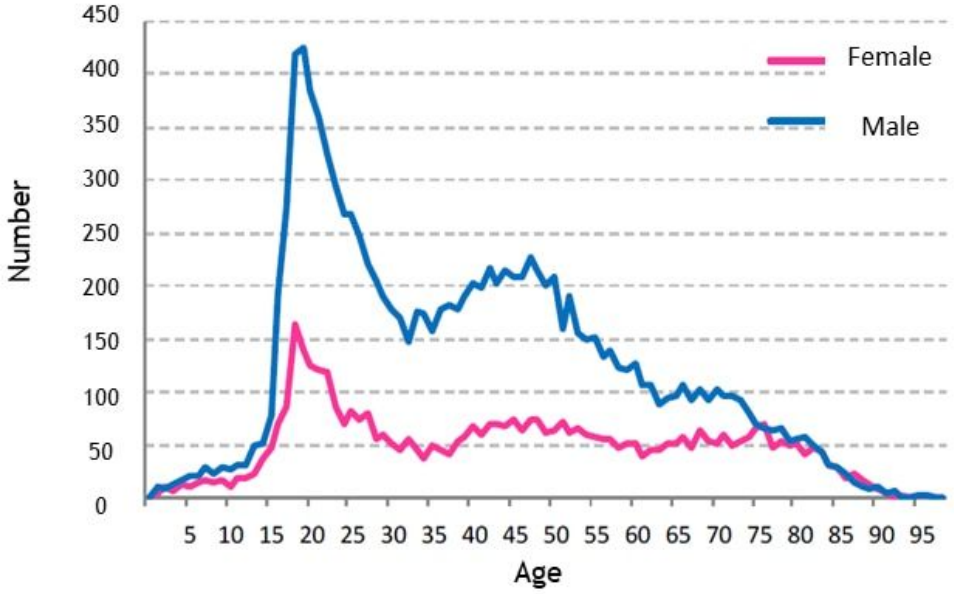

Figure 4