Pulmonary War Injury in Yemen

Ali Mohamed. A. Saleh , M.D ,CAIRO *, Arafat Ali Mohammed Al-absi , M.B.B.Ch

ABSTRACT

Chest injuries is a common injuries encountered during war period which is one of the leading cause of death. The majority of Chest war injuries can managed non-operatively by simple surgical procedures Some chest war injuries can cause major morbidity and even death if there is delay in the presentation ,diagnosis or proper management of these injuries. The importance of acknowledgement of chest war injuries and the management of each injuries is due to the danger and the simple procedure for treatment of many of these injuries if they detected and managed in the proper time. ***Objective:*** *The aim of this study is general assessment of surgical management for Chest war injuries for patients at Al-Thawra modern general hospital - Sana'a and 48 medical compound- Sana'a from July 2015 to February 2016.* ***Method:*** *This is retrospective study for fifty- two patients with chest war injuries that admitted into surgical department in Al-Thawra General Modern Hospital Sana'a and 48 medical compound- Sana'a in Yemen, from July 2015 to February 2016.* ***Results:*** *fifty- two patients chest war injuries were included in this research 19 patients (36.5%) were less than 21 years, 22 patients (42.3%) from 21-30 years,9 patients (17.3%) from 31-40 years, and 2 patients (3.9%) more than 40 years old. 48 of patients (92.3%) had unilateral injury , 4 patients (7.7%) had bilateral injury. 22 patients (42.31%) had left side injury , 26 patients (50%) had right side injury , and 4 patients (7.7%) injured in both sides. 30 patients (57.7%) injured by shell fragments , 21 patients (40.4%) by gunshot , 1 patient (1.9%) by blunt injury. 26 patients (50%) had pneumothorax, 24 patients (46.2%) had haemothorax ,3 patients (5.8%) had lung contusion ,13 patients (25%) had rib fracture , and one patient(1.9%) had flail chest. 22 patients (42%) had an associated injuries, and 30 patients (58%) with no associated injuries. 8 patients (36.4%) with head and CNS injuries ,4 patients (18.2%) with neck injuries , 7 patients (31.8%) with abdominal and pelvic injuries , 6 patients (27.3%) with upper extremity injuries , and 9 patients (40.1%) with lower extremity injuries. 5 patients (9.6%) admitted for less than 6 days , 22 patients (42.3%) 6 – 10 days , 13 patients (25%) 11-15 days , 6 patients (11.5%) 16 - 20 days , 4 patients (7.7%) 21- 25 days , and 2 patients (3.9%) for more than 26 days. 3 patients (5.6%) underwent thoracotomy and for other 49 patients (94.4%) no thoracotomy needed .*

Key Words : *Pulmonary War Injury (PWI)*

INITIAL MANAGMENT OF ACUTELY INJURED PATIENT[1+2]

Primary survey (Steps In The Initial Resuscitation and management) [1]+[2]

Airway. The crucial first step in managing an injured patient is securing an adequate airway. The mechanical removal of debris and the chin lift or jaw thrust maneuvers, both of which pull the tongue and oral musculature forward from the pharynx, are often useful in clearing the airway of less severely injured patients. However, if there is any question about the adequacy of the airway, if there is evidence of severe head injury, or if the patient is in profound shock, more definitive airway control is appropriate. In the vast majority of patients this involves endotracheal intubation. Unfortunately, control of the airway is sometimes more complex than simply placing an endotracheal tube. The presence of cervical spine injury in the unconscious patient is always a possibility, and injudicious movement of the neck in the process of endotracheal intubation can be devastating.

In a few patients, a surgical airway may be required. Although classic tracheostomy may be indicated in select patients, such as those with laryngeal injuries, cricothyroidotomy is generally the preferable emergency procedure.

Breathing. If there is decreased respiratory drive or an unstable chest wall, assisted ventilation is usually necessary. The three most common reasons for ineffective ventilation following successful placement of an airway are malposition of the endotracheal tube, pneumothorax, and

***Corresponding Author:** 48 model hospital - Sana'a – Yemen - Tel: 00967 1 619010 - Web Site : www.48mh.com

hemothorax. Therefore, palpation and auscultation of the chest are necessary diagnostic adjuncts at this point. A supine (anteroposterior [AP]) chest x-ray examination can validate the physical examination and better define chest wall and plural abnormalities. Although there is usually time to perform a chest radiograph prior to invasive therapeutic procedures, in the patient with profound hemodynamic instability and a high suspicion of tension pneumothorax, a needle catheter decompression can be both diagnostic and therapeutic. Under these circumstances decompression of the chest before the radiograph is appropriate.

Circulation. When possible, control of the hemorrhage precedes placement of the intravenous lines. This may be as simple as a compressive dressing over a bleeding wound or large vessel or may require broader compression, such as application of a pneumatic antishock garment in the patient who has an obvious pelvic fracture. Intravenous cannulas are usually placed percutaneously in the arm or groin. They should be large bore, and a minimum of two should be placed. Alternatives are cut-down by either the antecubital or saphenous route, or intraosseus in children under the age of 3. Fluid resuscitation begins with a 1000-ml. bolus of lactated Ringer's solution for an adult, or 20 ml. per kg. for a child. Response to therapy is monitored by skin perfusion, urinary output, and central venous pressure readings when that line has been placed.

Disability/Neurologic Assessment. At this juncture, a brief examination to determine level of consciousness, pupillary response, and movement of extremities is a necessary prelude to the determination of severity of neurologic injury. In addition, this information becomes initial data in the computation of the Glasgow Coma Scale (GCS), which is a method of both following the evolution of neurologic disability and prognosticating future recovery. It is worth noting that pupillary response can still be assessed in the paralyzed patient. In recording the GCS in intubated and paralyzed patients, the authors have added the modifiers T and P (intubated and paralyzed, respectively) to signify that the score may be inaccurate.

Exposure for Complete Examination. By this point, most injuries that are either exigent or emergencies have been recognized and treated. The next step is to completely, but expeditiously, re-examine the patient to diagnose other injuries. Complete physical examination is typically done in a head-to-toe manner and includes ordering and collecting data from appropriate laboratory and radiologic tests. Data accumulated can then be used to reset priorities. This time period also allows for the placement of additional lines, catheters (nasogastric, Foley), and monitoring devices. When the patient is oxygenating, ventilating, and perfusing adequately, a priority plan should be established for subsequent treatment.

Life-threatening injuries associated with thoracic injuries are often identified in the primary survey by carefully assessing the patient's ABCs. The injuries to be identified and treated during the primary survey are:

1- Airway obstruction
2- Tension pneumothorax
3- Open pneumothorax
4- Flail chest and pulmonary contusion
5- Massive hemothorax
6- Cardiac tamponade

Secondary Survey

The secondary survey is a more detailed and complete examination, aimed at identifying all injuries and planning further investigation and treatment. Chest injuries identified on secondary survey and its adjuncts are:

1. Rib Fractures & flail chest
2. Pulmonary contusion
3. Simple pneumothorax
4. Simple haemothorax
5. Blunt aortic injury
6. Blunt myocardial injury

RECOGNITION AND MANAGEMENT OF SPECIFIC INJURIES

Pneumothorax – Simple

Pneumothorax is the collection of air in the pleural space. Air may come from an injury to the lung tissue, a bronchial tear, or a chest wall injury allowing air to be sucked in from the outside.

A simple pneumothorax is a non-expanding collection of air around the lung. The lung is collapsed, to a variable extent. Diagnosis on physical examination may be very difficult. The classical signs of reduced air entry and resonance to percussion are often difficult or impossible to appreciate. Careful

palpation of the chest wall and apices may reveal subcutaneous emphysema and rib fractures as the only sign of an underlying pneumothorax.

A chest X-ray is usually diagnostic, but may miss small pneumothoraces, especially with the patient supine. The presence of rib fractures on a chest X-ray should prompt a careful search for a pneumothorax

CT Scanning is more sensitive for the presence of pneumothorax than plain chest X-ray. However the significance of these small pneumothoraces is unknown.

Management

Most simple pneumothoraces will require placement of an

intercostal chest drain as definitive treatment. Small pneumothoraces, especially those visible only on CT, may be watched expectantly. The decision to observe is based on the patient's clinical status and subsequent planned procedures. Chest tube placement may be appropriate in these cases if there are multiple injuries, if a patient is due to undergo prolonged anaesthesia, or if a patient is due to be transferred a significant distance - where detection of an increasing or tension pneumothorax may be difficult or delayed.

Tension Pneumothorax

Tension pneumothorax is the progressive build-up of air within the pleural space, usually due to a lung laceration which allows air to escape into the pleural space but not to return. Positive pressure ventilation may exacerbate this 'one-way-valve' effect.

Progressive build-up of pressure in the pleural space pushes the mediastinum to the opposite hemithorax, and obstructs venous return to the heart. This leads to circulatory instability and may result in traumatic arrest. The classic signs of a tension pneumothorax are deviation of the trachea away from the side with the tension, a hyper-expanded chest, an increased percussion note and a hyper-expanded chest that moves little with respiration. The central venous pressure is usually raised, but will be normal or low in hypovolaemic states.

However these classic signs are usually absent and more commonly the patient is tachycardic and tachypnoeic, and may be hypoxic. These signs are followed by circulatory collapse with hypotension and subsequent traumatic arrest with pulseless electrical activity (PEA). Breath sounds and percussion note may be very difficult to appreciate and misleading in the trauma room.

A tension pneumothorax may develop while the patient is undergoing investigations, or operation. Whenever there is deterioration in the patient's oxygenation or ventilatory status, the chest should be re-examined and tension pneumothorax excluded.

The CT scan also shows why the tension is not visible on the plain chest X-ray - the lung is compressed posteriorly but extends out to the edge of the chest wall, so lung markings are seen throughout the lung fields. However there is midline shift compared to the previous film.

Initial chest film

Right tension pneumothorax

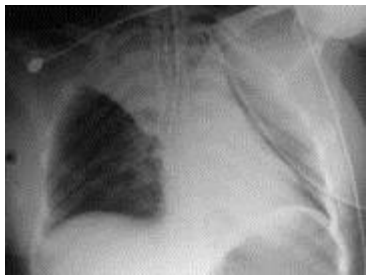
Tension pneumothorax may also persist if there is an injury to a major airway, resulting in a bronchopleural fistula. In this case a single chest tube is cannot cope with the major air leak. Two, three or occasionally more tubes may be needed to manage the air leak. In these cases thoracotom is usually indicated to repair the airway and resect damaged lung.

Beware also the patient with bilateral tension pneumothoraces. The trachea is central, while percussion and breath sounds are equal on both sides. These patients are usually haemodynamically compromised or in traumatic arrest. Emergent bilateral chest decompression should be part of the procedure for traumatic arrest where this is a possibility.

This (rare) chest X-ray shows the characteristic apparent 'disappearance of the heart' with bilateral tension pneumothoraces.

Management

Classical management of tension pneumothorax is emergent chest decompression with needle thoracostomy. A 14-16G intravenous cannula is inserted into the second rib space in the mid-clavicular line.



[4]Many texts will state that a tension pneumothorax is a clinical diagnosis and should be treated with needle thoracostomy prior to any imaging. Recently this dogma has been called into question. Needle thoracostomy is probably not as benign an intervention as previously thought, and often is simply ineffective in relieving a tension pneumothorax. If no rush of air is heard on insertion, it is impossible to know whether there really was a tension or not, and whether the needle actually reached the pleural cavity at all. Some heavy-set patients may have very thick chest walls.

In the absence of haemodynamic compromise, it is prudent to wait for the results of an emergent chest X-ray prior to intervention. [5+6]This will avoid patients such as that shown at right, where a right upper lobe collapse due to endobronchial intubation resulted in hypoxia and tracheal deviation - mimicking a tension pneumothorax on the opposite side The patient received an unnecessary left chest tube.

Chest tube placement is the definitive treatment of traumatic pneumothorax

Rarities

[7+8+9]Tension gastrothorax has been described and may be confused with a tension pneumothorax. There is haemodynamic compromise, tracheal & mediastinal deviation, and decreased air entry in the affected hemithorax (usually left). Tension gastrothorax occurs in spontaneously breathing patients with a large diaphragmatic tear (usually blunt trauma). This emphasises the importance of blunt dissection and examining the pleural space with a finger prior to chest tube insertion

Haemothorax

Haemothorax is a collection of blood in the pleural space and may be caused by blunt or penetrating trauma. Most haemothoraces are the result of rib fractures, lung parenchymal and minor venous injuries, and as such are self-limiting. Less commonly there is an arterial injury, which is more likely to require surgical repair.

[10+11+12] Most small-moderate haemothoraces are not detectable by physical examination and will be identified only on Chest X-ray, FAST or CT scan. However, larger and more clinically significant haemothoraces may be identified clinically. If a large haemothorax is detected clinically it should be treated promptly.

Chest examination may indicate the presence of significant thoracic trauma with external bruising or lacerations, or palpable crepitus indicating the presence of rib fractures. There may be evidence of a penetrating injury over the affected hemithorax. Don't forget to examine the back!

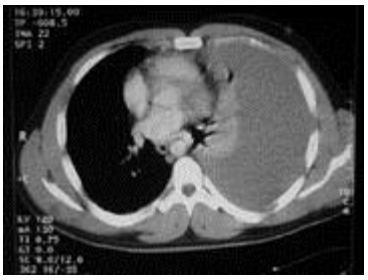
The classic signs of a haemothorax are decreased chest expansion, dullness to percussion and reduced breath sounds in the affected hemithorax. There is no mediastinal or tracheal deviation unless there is a massive haemothorax. All these clinical signs may be subtle or absent in the supine trauma patient in the emergency department, and most haemothoraces will only be diagnosed after imaging studies.

Chest X-ray remains the standard test for diagnosis of thoracic trauma in the emergency department. In the erect patient (penetrating injury), the classical picture of a fluid level with a meniscus is seen. Although the erect film is more sensitive, it takes approximately 400-500mls of blood to obliterate the costo-phrenic angle on a chest radiograph.

In the supine position (most blunt trauma patients) no fluid level is visible as the blood lies posteriorly along the posterior chest. The chest X-ray shows a diffuse opacification of the hemithorax, through which lung markings can be seen. It may be difficult to differentiate a unilateral haemothorax from a pneumothorax on the opposite side.

[13]It may be difficult to detect small amounts of blood (< 200mls) on the plain chest radiograph. Emergency room ultrasound examination can detect smaller haemothoraces, although in the presence of a pneumothorax or subcutaneous air ultrasound may be difficult or inaccurrate. When examining the right and left upper quadrants, the examiner can usually view above the diaphragms to identify any fluid collections. The significance of small haemothoraces that are not visible on plain films is not entirely clear.

[14+15]Most cases of thoracic trauma do not require computed tomography (CT). CT is more sensitive than the plain chest radiograph in diagnosing haemothoraces. However, CT can be invaluable in determining the presence and significance of a haemothorax, especially in the blunt, supine trauma patient who may have multiple thoracic injuries. Small amounts of blood are detectable and can be localised to specific areas of the thoracic cavity. [16]The significance of CT-only detectable haemothoraces



Methods

The hospital records of a total of fifty-two patients identified with war chest trauma were reviewed retrospectively from July 2015 to February 2016 . Our study included patients with pulmonary war trauma and excluding other chest injuries. We also recorded details of other injuries sustained along with chest war trauma were calculated for individuals. Relevant clinical data were acquired from the files.

PATIENTS AND METHODS

Patients who sustained pulmonary war injuries and subjected to surgical management was identified and included in this retrospective study.

The inclusion criteria:

Patients of all ages were included when they met the following criteria

1. Patients with single or multiple pulmonary war injuries (whether isolated or associated with other region injury).
2. Violation of chest cavity was established based on physical examination, location of injuries, investigative studies, chest tube output, operative findings or delayed presentation of injury.

Data collection

We collected the data using a previously prepared questionnaire. Data were obtained by reviewing of medical records (files) of the cases.

The collected data included demographics, information about injury, patient status on arrival, response to resuscitation, result of investigations, management, operative data (for operated cases),

in-patient follow up, hospital stay and the final outcome.

Site and mechanism of injuries

All cases were examined and investigated to identify the exact location of the external wounds, the bullet inlet and exit and the location of the bullet if there is no exit. The number and mechanism (gunshot, pump explosion,blunt...etc) of injury were recorded. In addition, any associated injury to other body regions was recorded.

Assessment and resuscitation

In the ED, a multidisciplinary trauma team of emergency physicians and trauma surgeons treats patients with war trauma. Resuscitation consisted of rapid infusion of warm fluids and blood (if indicated). Patients with evidence of pneumothorax, hemothorax or both had a chest tube inserted in the fifth intercostal space at the mid axillary line. Patients received antibiotics , as well as tetanus prophylaxis when indicated.

All patients were resuscitated utilizing Advanced Trauma Life Support (ATLS) protocols. To record patients' status and management in the emergency department,

Decision on admission

In all cases, violation of chest injuries was established based on physical examination, location and trajectory of injuries, investigative studies, chest tube output, operative findings or delayed presentation of injury.

Based on their diagnosis on admission,. we recorded the decided initial management plan (conservative v/s operative) and the cause for subsequent change in the initial diagnosis or management plan.

Inpatient follow up

Subjective and objective parameters were applied for daily follow up of admitted patients. Postoperative patients were monitored for early postoperative complications while those admitted for conservative therapy were followed for identification of indication to discontinue conservative management. In addition, indications f or reoperation or another operation were recorded.

Final outcome

Outcome was measured by calculating, morbidity, total length of hospital stay and status at discharge. Length of stay was defined as the interval between presentation to the emergency room and hospital dismissal.

RESULTS

In our research 52 patients sustaining pulmonary war injuries and admitted to the surgical ward had met our inclusion criteria and included in our study.

Age of patients

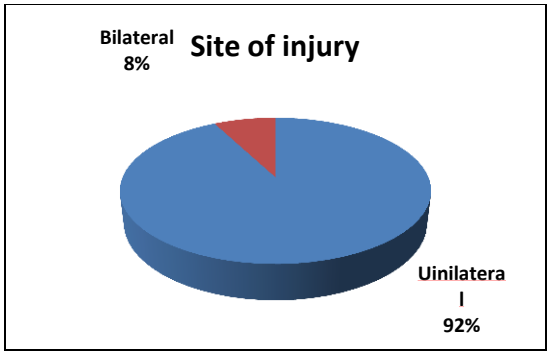
Here we will divide the patients into main categories19 patients (36.5%) were less than 21 years, 22 patients (42.3%) from 21-30 years,9 patients (17.3%) from 31-40 years, and 2 patients (3.9%) more than 40 years old.

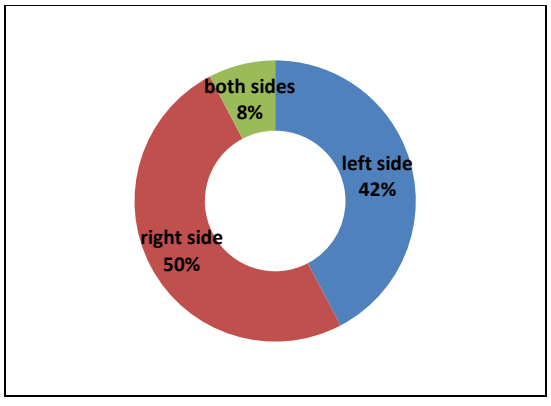
Age group	Number of pt.	Percentage
<21 years	19	36.5%
21-30 years	22	42.3%
31-40 years	9	17.3%
>40 years	2	3.9%
Total	52	100%

Most of patients were adults belonged to group aged 21- 30 years .

Site of injury

48 of patients (92.3%) had unilateral injury , 4 patients (7.7%) had bilateral injury





Mechanism of injury

30 patients (57%) injured by shell fragments , 21 patients (40.4%) by gunshot , 1 patient (1.9%) by blunt injury.

Diagnosis	Number of pt.	percentage
Pneumothorax	26	50%
Haemothorax	24	46.15%
Lung contusion	3	5.8%
Rib fracture	13	25%
Flail chest	1	1.9%

22 patients (42.31%) had left side injury, 26 patients (50%) had right side injury , and 4 patients (7.7%) injured in both sides.

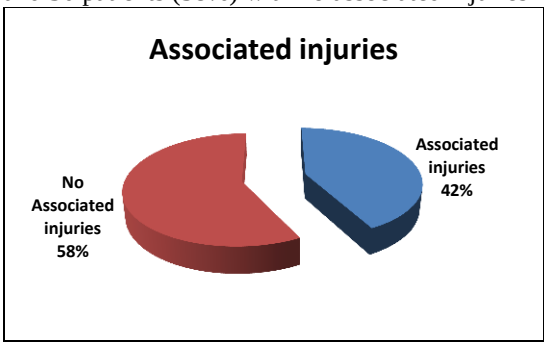
Mechanism of injury	Number of pt.	Percentage
Shell fragments	30	57.7%
Gun shot	21	40.4%
Blunt	1	1.9%
Total	52	100%

Diagnosis

- 26 patients (50%) had pneumothorax, 24 patients (46.15%) had haemothorax ,3 patients (5.8%) had lung contusion ,13 patients (25%) had rib fracture , and one patient had flail chest.
- Note :Some patients presented with more than one pulmonary injuries (as rib fracture + pneumothorax, haemopneumothorax , and so on).

Associated injuries

22 patients (42%) had an associated injuries, and 30 patients (58%) with no associated injuries



Associated injuries are classified anatomically in which

8 patients (36.4%) with head and CNS injuries ,4 patients (18.2%) with neck injuries , 7 patients (31.8%) with abdominal and pelvic injuries , 6 patients (27.3%) with upper extremity injuries , and 9 patients (40.1%) with lower extremity injuries.

Associated injury	No. of patients	Percentage
Head and CNS	8	36.4%
Neck	4	18.2%
Abdominal and pelvic	7	31.8%
Upper extremity	6	27.3%
Lower extremity	9	40.1%

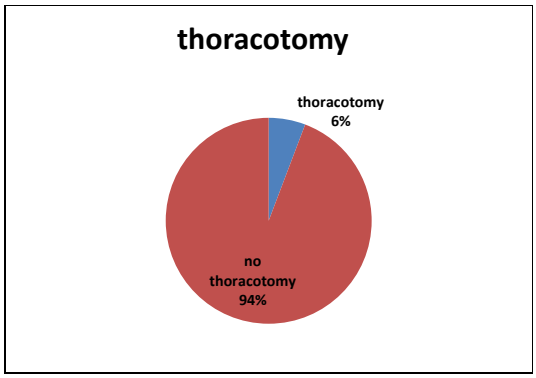
Hospital stay

We divide the hospital stay in to several categories:

Hospital stay	No. of patients	percentage
< 6 days	5	9.6%
6 – 10 days	22	42.3%
11 – 15 days	13	25%
16 – 20 days	6	11.5%
21- 25 days	4	7.7%
> 26 days	1	3.9%

Thoracotomy

- Only 3 patients (5.6%) underwent thoracotomy and for other 49 patients (94.4%) no thoracotomy was done
- This is less than the global percentage (10%-15%).



DISCUSSION

Most of patients were adults belonged to group aged 21- 30 years 22 patients (42.3%) , Our results go hand in hand with the result of Kumar A, Verma ,KSrivastava 2006 who had 60 patients with penetrating chest trauma , 26 (43.33%) of the patients is from 21-30 years of age, then from 31-40 and 41-50 years of age group i.e., 28.33% & 15% cases respectivelyIn other results of Ahmed Ibraheem Al-Azzawi 2010 in in Iraqi Kurdistan Region who had 48 patients with Penetrating chest trauma most of patients32(66.7%) belonged to group aged 21- 39 years ,then 9 patients(18.9%)aged less than 20 years ,and 7 patients (14.7%) aged between40-50 years

Right side of chest was affected slightly more than the left side i.e., 22 patients (42.31%) had left side injury, 26 patients (50%) had right side injury , and 4 patients (7.7%) injured in both sides. in comparison to study of Kumar A, Verma ,KSrivastava 2006; 33 patients (55 %) injuries were present on the left side , followed by right side of chest in 20 patients (33.3%) , both right and left side of chest in 7 patients (11.7%).

Most of patients in our study injured by shell fragments , followed by gunshot i.e., 30 patients (57%) injured by shell fragments , 21 patients (40.4%) by gunshot , 1 patient (1.9%) by blunt injury. This go with other study in Vietnam war that show the cause of injury was Shell fragments 38.9 %, Bullets 23.8%, Booby traps, mines, grenades 27.7%.For other study which was not going with our study for Ahmed Ibraheem Al-Azzawi 2010 in in Iraqi Kurdistan Region for 48s patients with Penetrating chest trauma 21 patients(43.75%) injured by stabbing, 19 patients (39.6%) by gunshots , 5 patients (10.4%) by shell fragments , and 3 patients (6.25%) by Sharp objects (RTA, Falling)

Pneumothorax was the commonest pathology in our study then haemothorax i.e., 26 patients (50%) had pneumothorax , 24 patients (46.15%) had haemothorax, 3 patients (5.8%) had lung contusion ,13 patients (25%) had rib fracture , and one patient had flail chest .In study of 426 patients with Penetrating chest injuries Inci I, Ozcelik C, Tacyildiz I, et May 1998 the distribution of pathology was: Haemothorax 44.6% , Pneumothorax 33.8%, Pulmonary contusion 11.4% , Rib fracture 6.8% , Flail chest 3.1%.

Patients with isolated chest injuries was more than those with other associated injuries i.e., 22 patients (42%) had an associated injuries, and 30 patients (58%) with no associated injuries

In which Lower extremity is the commonest associated injuries followed by Head and CNS injuries i.e., 9 patients (40.1%) with lower extremity injury , 8 patients (36.4%) with head and CNS injuries , 7 patients (31.8%) with abdominal and pelvic injuries , 6 patients (27.3%) with upper extremity injuries 4 patients (18.2%) with neck injuries,, and In other study of 133 patients with chest penetrating injury the associated injuries were : Head and Neck (23%) , Upper Limb, (31%) , Lower Limb , (68%) , Abdominal (8%) .

Most of patients were admitted for period between 6-10 days and The average of hospital stay was 10 days i.e. 22 patients(42.3%) hospitalized for 6-10 days, 13 patients (25%) stay for 11-15 days , 6 patients (11.5%) stay for 16-20 days , 5 patients (9.6%) stay for period less than 6 days , 4 patiens (7.7%) stay for period between 21-25 days' and one patient stay for 30 days. In other study for fifty patients with chest penetrating injury J Ayub Med Coll Abbottabad. 2008 Oct the length of hospital stay was 12 +/- 3 days.

Most of patients treated with simple surgical procedure and no thoracotomy needed, This is less than the global percentage for patients need thoracotomy which is (10%-15%).

CONCLUSION

- Penetrating chest injuries were seen in the cases of injuries caused by war injuries.
- Majority of patients of were young adult males between 21-40 years of age.
- These penetrating injuries were mostly present unilaterally and more in the right side.
- Most of injuries were due to Shell fragments, then gun shot.
- The most common injuries were pneumothorax and haemothorax.
- Sporadic lungs injuries were present in more cases, but associated injuries were less common and the most common associated injuries encountered in lower extremity then head and CNS.

- All the patiens were admitted to hospital and the majority of them admitted for 6-15 days.
- The great majority of patiens treated by simple surgical procedure for pulmonary injuries and no thoracotomy needed for the great majority of them.

REFERENCES

1. Bernardin, B. & J.M. Troquet. (2012). Initial management and resuscitation of severe chest trauma.*Emergency Medicine Clinics of North America 30*, 377.
2. ATLS: Advanced Trauma Life Support for Doctors (Student Course Manual). Ninth ed. American College of Surgeons; 2013.
3. Kirkpatrick AW, Ng AK, Dulchavsky SA, J Trauma. 2002 Oct;225(1):210-4.
4. Cullinane DC, Morris JA Jr, Bass JG, Rutherford EJ Injury. 32(10):749-52, 2001
5. Eckstein M . Suyehara D. Prehospital Emergency Care. 2(2):132-5, 1998
6. Britten S; Palmer SH; Snow TM. Needle thoracocentesis in tension pneumothorax: insufficient cannula length and potential failure.
7. Tadler SC, Burton JH. Intrathoracic stomach presenting as acute tension gastrothorax.Am J Emerg Med 1999;17:370-1
8. Slater RG. Tension gastrothorax complicating acute traumatic diaphragmatic rupture. J Emerg Med 1992;10:25-30
9. Acute gastric distension: a lesson from the classics. Hospital Medicine Volume 62 Number 3
10. Feliciano DV, Rozycki GS. 'Advances in the diagnosis and treatment of thoracic trauma.' Surg Clin North Am. 1999;79:1417-29
11. Rozycki GS, Feliciano DV, Davis TP 'Ultrasound as used in thoracoabdominal trauma.' Surg Clin North Am. 1998;78:295-310
12. Abboud PA, Kendall J. 'Emergency department ultrasound for hemothorax after blunt traumatic injury.' J Emerg Med. 2003;25:181-4
13. Ma OJ, Mateer JR. 'Trauma ultrasound examination versus chest radiography in the detection of hemothorax.' Ann Emerg Med. 1997;29:312-5
14. Parry GW, Morgan WE, Salama FD. 'Management of haemothorax.' Ann R Coll Surg Engl 1996;78:325-326
15. Trupka A, Waydhas C, Hallfeldt KK, Nast-Kolb D, Pfeifer KJ, Schweiberer L. Value of thoracic computed tomography in the first assessment of severely injured patients with blunt chest trauma: results of a prospective study. J Trauma. 1997 Sep;43(3):405-11; discussion 411-2
16. Guerrero-Lopez F, Vazquez-Mata G, Alcazar-Romero PP, et al. Evaluation of the utility of computed tomography in the initial assessment of the critical care patient with chest trauma. Crit Care Med. 2000 May;28(5):1370-5.
17. Mowery et al. "Practice Management Guideline for Management of Hemothorax and Occult Pneumothorax" *J Trauma* 2011;70(2):510-8
18. Hunt et al. "Emergency thoracotomy in thoracic trauma – a review" *Injury* 2—6; 37:1-19
19. Meyer DM, Jessen ME, Wait MA, Estrera AS. 'Early evacuation of traumatic retained hemothoraces using thoracoscopy: a prospective, randomized trial.' Ann Thorac Surg. 1997;64:1396-400
20. Vassiliu P, Velmahos GC, Toutouzas KG. 'Timing, safety, and efficacy of thoracoscopic evacuation of undrained post-traumatic hemothorax.' Am Surg. 2001;67:1165-9
21. Watkins JA, Spain DA, Richardson JD, Polk HC Jr. 'Empyema and restrictive pleural processes after blunt trauma: an under-recognized cause of respiratory failure.' Am Surg. 2000;66:210-4
22. Velmahos GC, Demetriades D, Chan L et al. 'Predicting the need for thoracoscopic evacuation of residual traumatic hemothorax: chest radiograph is insufficient.' J Trauma. 1999;46:65-70
23. Inci I, Ozcelik C, Ulku R. 'Intrapleural fibrinolytic treatment of traumatic clotted hemothorax.' Chest 1998;114:160-5
24. Cohn SM. 'Pulmonary contusion: review of the clinical entity.' J Trauma 1997; 42:973–979
25. Trinkle JK, Furman RW, Hiushaw MA et al. 'Pulmonary contusion: pathogenesis and effect of various resuscitative measures.' Ann Thorac Surg 1973;16:568

26. Bongard FS, Lewis FR. 'Crystalloid resuscitation of patients with pulmonary contusion.' Am J Surg 1984;148:145
27. Miller PR, Croce MA, Bee TK et al. 'ARDS after pulmonary contusion: accurate measurement of contusion volume identifies high-risk patients.' J Traum 2001;51(2):223-8
28. Tyburski JG, Collinge JD, Wilson RF et al. 'Pulmonary contusions: quantifying the lesions on chest X-ray films and the factors affecting prognosis.' J Trauma 1999;46(5):833-8
29. Ziegler DW, Agarwal NN. 'The morbidity & mortality of rib fractures.' J Trauma 1994;37:975
30. Dubinsky I, Low A. 'Non-life-threatening blunt chest trauma: appropriate investigation and treatment.' Am J Emerg Med 1997;15:240
31. Lee RB, Bass SM, Morris JA jr et al. 'Three or more rib fractures as an indicator for transfer to a level 1 trauma center: a population-based study.' J Trauma 1990;30:689
32. Clark GC, Schecter WP, Trunkey DD. 'Variables affecting outcome in blunt chest trauma: Flail chest vs. pulmonary contusion.' J trauma 1990;30:93
33. Freedland M, Wilson RF, Bender JS. 'The management of flail chest injury: Factors affecting outcome.' J Trauma 1990;30:1460
34. Pelosi P, Cereda M, Foti G. 'Alterations of lung and chest wall mechanics in patients with acute lung injury: effects of positive end-expiratory pressure.' Am J Resp Crit Care Med 1995;152:531
35. Craven KD, Oppenheimer L, Wood LD. 'Effects of contusion and flail chest on pulmonary perfusion and oxygen exchange.' J Appl Physiol 1979;47:729
36. Landercasper J, Cogbill T, Lindesmith L. 'Long-term disability after flail chest injury.' J Trauma 1984;24:410
37. Hedderich R, Ness T. 'Analgesia for trauma and burns.' Crit Care Clin 1999;15:167
38. Desai P. 'Pain management & pulmonary dysfunction.'. Cri Care Clin 1999;15:151
39. Mackersie RC, Shackford SR, Hoyt DB et al. 'Continouous fentanyl analgesia: ventilatory function improvement with routine use in treatment of blunt chest injury.' J Trauma 1987;27:1207
40. Tanaka H, Yukioka T, Yamaguti Y et al. 'Surgical stabilization of internal pneumatic stabilization? A prospective randomized study of management of severe flail chest patients.' J Trauma 2002;52:727
41. Ahmed Z, Mohyuddin Z. 'Management of flail chest injury: internal fixation versus endotracheal intubation and ventilation.' J Thorac Cardiovasc Surg 1995;110:1676
42. Voggenreiter G, Neudeck F, Aufm'Kolk M et al. 'Operative chest wall stabilization in flail chest - outcomes of patients with and without pulmonary contusion.' J Am Coll Surg 1998;130:187
43. Mattox KL, Allen MK. Systematic approach to pneumothorax, haemothorax, pneumomediastinum and subcutaneous emphysema. Injury. 1986;17:309-312. Symposium paper
44. Etoch SW, Bar-Natan MF, Miller FB, Richardson JD. Tube thoracostomy. Factors relating to complications. Archives of Surgery. 1995;130:521-525
45. Milikan JS, Moore EE, Steiner E, Aragon GE, Van Way CW 3rd. Complications of tube thoracostomy for acute trauma. Am J Surgery. 1980;140:738-741
46. Bailey RC. Complications of tube thoracostomy in trauma. J Accid Emerg Med. 2000;17:111-114
47. Baldt MM, Bankier AA, Germann PS, Poschl GP, Skrbensky GT, Herold CJ. Complications after emergency tube thoracostomy: assessment with CT. Radiology. 1995;195:539-43