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Original Research Article

Current trends of clinico-radiological findings, management and outcomes of chest trauma patients in a tertiary health care hospital in Western India

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ABSTRACT

Background: There has been a rapidly rising trend of trauma cases, especially chest trauma; necessitating an in-depth study of its complications and management.
Methods: We have studied 120 patients presenting to our emergency department for the demographics and etiology of their injury and recorded the results and outcomes of their radiological and clinical investigations and management protocol.
Results: Middle aged men were the primary victims of chest trauma, mostly having blunt injuries and presenting with respiratory distress. A range of pleural and visceral injuries were seen like hemothorax, pneumothorax, flail chest; the mainstay of treatment for them being minimally invasive tube thoracostomy. We encountered a low mortality rate of 1.66%.
Conclusions: Rapid intervention and resuscitation for all trauma cases prove to be lifesaving, amongst which focus on thoracic injuries must be primary. Ever increasing incidences of polytrauma cases indicate the requirement of strict vigilance and prevention of road traffic accidents.

Keywords: Chest trauma, Tube thoracostomy, Flail chest, Hemothorax, Road traffic accident

INTRODUCTION

Thoracic trauma is ubiquitous in our society; it is the third most common type of trauma, statistically 10-15%, following head and extremities injuries, and can lead to severe morbidity and even mortality, accounting for 25-30% of total traumatic deaths.[1] In India, majority of chest traumas are due to non-automobile injuries such as falls, falling off of the roof or inside a well, injury by cattle, blast injuries, and violence. An estimated 16,000 deaths occur annually due to chest trauma.[2]

However now, with the advent of increased motor vehicle usage in our country, and the transition in development, industrialization and related traffic, it is anticipated that the statistics related to road traffic accidents will increase. In most of the western hospitals, currently around 2/3 of the severe non-penetrating thoracic injuries are due to vehicular accidents.

Sometimes the most difficult decision a surgeon has to make is the prioritization of treatment modalities when more than one body system has been injured. Head injury, compound limb fracture, and chest injury compete for the surgeon's attention. Chest injury is potentially the most

dangerous of all; pneumothorax, hemothorax, flail chest, rib fractures, contusions, and airway injuries need to be tended to as an emergency. Threat to the vital transport of oxygen to the tissues occurs due to hypovolemia secondary to severe bleeding, and by interference with the respiratory apparatus itself. Hypoxia can also adversely influence the outcome of associated brain trauma.

In our study we have assessed the demographics, etiology, management, complications and outcomes of 120 patients with chest trauma in a tertiary health care hospital in west India, and have compared the findings with similar relevant studies.

Primary care is directed towards rapid evaluation of the extent of injury, estimation of the volume of blood lost and its replacement by transfusion, recognition of hypoxia and respiratory distress and its correction by assurance of a clear airway, full pulmonary expansion and mechanical support of ventilation when necessary.

The vast majority of chest trauma patients do not require thoracotomy and are successfully managed by tube thoracostomy.

The objective of our study is to determine the cause and presentation, to evaluate the mortality and morbidity, and to assess the management modalities of chest trauma.

METHODS

This was a single-centre, prospective study conducted on 120 patients with blunt or penetrating chest trauma in department of general surgery, S.S.G. Hospital, Vadodara, Gujarat, India over a period of 12 months- from August 2018 to August 2019. Institutional ethics committee approval was taken before initiating this study.

Inclusion criteria

The study population comprised of patients >12 years of age with a chest injury, diagnosed either clinically or radiologically, and all cases of penetrating chest trauma. Clinically the patients with subcutaneous emphysema, positive chest compression test, and flail chest were included. Radiological findings consistent with rib fracture, hemothorax/pneumothorax, fluid in the thoracic cavity, lung contusion, or a computed tomography (CT) scan visualized intrathoracic injury were included.

Exclusion criteria

Patients with cranial injury, isolated laryngeal or cervical injuries, trachea-esophageal injuries due to foreign body swallowing or aspiration, non-traumatic injury to the chest (burns, electric shock) and those who didn't complete treatment at our hospital were excluded from the study.

The patients presented to the emergency department. A detailed history including demographic data was taken, and clinical examination was done. Initial resuscitative measures were carried out, and then further radiodiagnostic investigations were performed after clinically stabilizing the patient.

Urgent CT chest was done when there was a discrepancy between the X-ray findings and clinical features, when there was little or no improvement following initial resuscitation, or when spinal or intra-thoracic organ injury was suspected. Intercostal drainage tube (ICD) was inserted if any one or more of pneumothorax, hemothorax, pyothorax or flail chest were present.

ICD insertion was done under local anesthesia with the patient in a 45-degree recumbent position, with the affected side's arm held over the head. Continuous monitoring of heart rate and SpO2 was done. Stab incision was placed in the 5th intercostal space at the level of the nipple; at the mid-axillary line. Intercostal muscles were split and the pleura was pierced with a pointed curved artery forceps and blocked ICD was inserted directing towards the apex up to the level of the 2nd intercostal space. Opening of the lock and air column movement were checked and stat ICD output was measured. ICD was fixed with a purse string suture with silk 1 (cutting) to the skin. Sterile dressing was applied and ICD output was measured at a regular interval. Dressing was changed every 3rd day if not soaked.

The patients were then admitted, and regularly monitored for vitals. Analgesics were administered to alleviate pain-diclofenac 50 mg BD, or capsule tramadol 50 mg QDS. If pain relief was inadequate, dose of tramadol was increased to 100 mg QDS. To the patients who were kept nil by mouth for bowel surgery, or were intubated, intravenous (IV) analgesics were given until oral drugs could be offered- aqueous diclofenac 75 mg IV 6-8 hourly, injection tramadol 50 mg IV 6 hourly.

Intercostal nerve block was given by injecting 1 to 3 ml of 0.5% bupivacaine at lower border of rib near the posterior angle.

The ICD was removed when full expansion of lungs was achieved, or there was <20 ml of drainage in 24 hours, or cessation of movement of air-filled level in drainage tube in response to respiration was observed.

The end point of the study was discharge, death, or referral of the patient to a higher centre.

The data was entered in Microsoft excel sheet and analyzed using statistical package for the social sciences (SPSS) software (version 27).

RESULTS

We studied the presentation, management, complications and outcomes of 120 chest trauma patients. Our study sample was characterized by a male predominance of 96.67%, with the majority of patients belonging to the 31-

40 years age group. Vast majority of the injuries were blunt traumas to the chest (95%). The leading cause of injuries was vehicular accidents, followed by assault.

Table 1: Demographic data, type and site of injury.

Parameter	No. of cases	% of cases
Age distribution (in years)		
11-20	12	0.92
21-30	33	27.5
31-40	40	33.33
41-50	18	15
51-60	12	10
61-70	04	3.33
71-80	01	0.83
Sex distribution		
Male	116	96.67
Female	04	03.33
Incidence of blunt and penetrating chest trauma		
Blunt chest trauma	114	95
Penetrating chest trauma	6	5
Site of injury		
Right	70	58.33
Left	40	33.33
Bilateral	10	8.33

Table 2: Etiology and associated injuries.

Parameter	No. of cases	% of cases
Etiology		
Vehicular accident	80	66.66
Assault	10	8.33
Fall from height	20	16.66
Animal injury	6	5
Wall collapse	4	3.33
Associated injury		
Blunt abdominal injury	8	6.66
Injury to extremities	5	4.16
Spine	3	2.5
Pelvis	2	1.66

Almost all patients presented with pain and tenderness of the chest, majority with decreased airway entry, and respiratory distress. More than half the study population had multiple rib fractures, with 16.66% having broken >5 ribs. Hemothorax was the leading pathology diagnosed by X-ray and CT scan, followed by comparable numbers of pneumothorax, hemopneumothorax, flail chest, and chest wall contusion.

Immediate management involved the administration of analgesics to alleviate pain and tenderness over the thorax. The drainage from the ICD tube did not vary significantly within 1 hour of tube insertion, apart from 2 patients in whom >500 ml drainage occurred.

Very few cases of thoracostomy were complicated, namely by local wound infection, and blockage.

Table 3: Clinical and radio-diagnostic findings.

Parameter	No. of cases	% of cases
Clinical findings and symptoms		
Pain and tenderness over chest	118	98.33
Subcutaneous emphysema	24	20
Decreased air entry	100	83.22
Paradoxical chest movement	10	8.33
Respiratory distress	74	61.66
Shock	8	6.66
Analysis of chest X-ray and CT scan chest		
Skeletal injuries		
Fracture solitary rib	10	8.33
2 to 5 ribs fractured	70	58.33
>5 ribs fractured	20	16.66
Flail chest	10	8.33
Fractured clavicle	8	6.66
Fractured scapula	3	2.5
Pleural and visceral injuries		
Hemothorax	60	50
Pneumothorax	12	10
Hemo-pneumothorax	10	8.33
Open pneumothorax	10	8.33

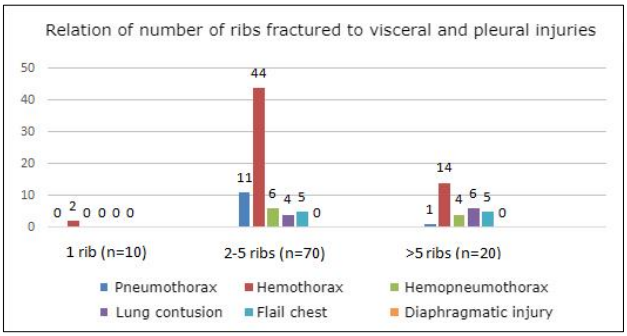

Figure 1: The relation of incidence of visceral and pleural injuries subsequent to the number of ribs fractured.

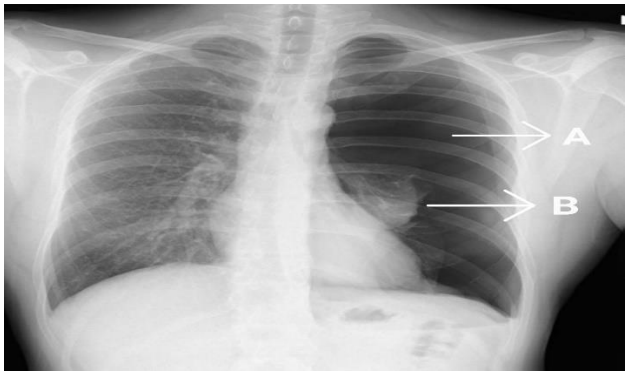

Figure 2: Massive pneumothorax (arrow A) with complete collapse of left lung (arrow B) is seen on this X-ray.

Figure 3: Left hydropneumothorax. Right basal contusions and mild pleural collection seen. Trachea is deviated to the right.

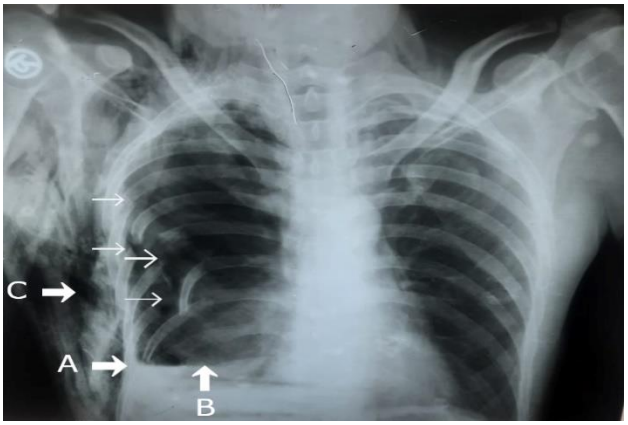

Figure 4: Multiple right rib fractures (5th, 6th, 7th, 8th, 9th ribs-indicated by small white arrows). Blunted costophrenic angle (arrow A), air fluid level (arrow B) and underlying lung collapse seen, consistent with hemopneumothorax with lung contusion. Subcutaneous emphysema on right side is seen (arrow C).

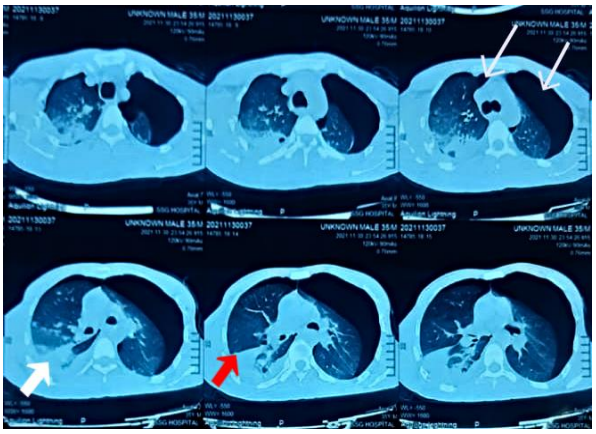

Figure 5: CT chest showing bilateral pneumothorax (thin white arrows), more on left side with collapse of underlying left lung. Right lung contusions (thick white arrow) with hydropneumothorax (red arrow).

Table 4: Management of pain, site, drainage and duration of insertion of tube thoracostomy.

Parameter	No. of cases	% of cases
Management of pain		
Analgesics	118	98.33
Intercostal nerve block	2	1.67
Tube thoracostomy-site		
Right	52	74.28
Left	18	25.71
Immediate drainage (within 1 hour of ICD insertion) (ml)		
Air leak	28	23.33
100 or less	10	8.33
100-200	24	20
200-300	16	13.33
300-400	10	8.33
400-500	2	1.66
Duration of ICD drainage (days)		
<3	4	5.71
3 to 15	42	60
>15	24	34.29

Majority of the patients were discharged within 5 days. 2 mortalities occurred, the causes of which were hemoperitoneum with flail chest, while the other patient had a D3/D4 spinal compression fracture with flail chest

Table 5: Complications, duration of hospital stay, ICU stay, ventilator requirement and mortality rate.

Parameter	No. of cases	% of cases
Complications of tube thoracostomy		
Wound infection at local site	5	7.14
Blockage	2	2.85
Hospital stay (days)		
0 to 5	54	45
6 to 10	34	28.34
11 to 20	24	20
21 to 30	6	5
>30	2	1.66
ICU stay	8	6.66
Ventilatory support	4	3.33
Mortality	2	1.66

DISCUSSION

The trend for chest trauma is on the rise, and has become a common occurrence due to widespread use of automobiles, especially in a developing country where the population places low emphasis on following traffic rules, there is lack of good road conditions, and driving under influence is prevalent. It has been consistently established that road traffic accidents are the leading cause of chest trauma in the current era, accounting for as many as

66.66% cases in our study. Assault is the next common cause, mostly encountered in regions with high unrest and communal or tribal violence, or during times of war.

Patients in our study range from age group of 13-75 years, the mean age being 34 years. Majority of them (33.33%) fell in the 30-40 years age group, and 60% in the 21-40 years bracket, the trend gradually decreasing with age. Similar observations were found in other studies as seen in Table 6, with mean age remaining in the 30s.

There was a male preponderance of cases, which may be attributed to the radical patriarchy prevalent in the Indian subcontinent, which restricts exposure of females to outdoors, hence reducing incidents of RTAs and assaults, which are the most common causes of injuries. We observed a male: female ratio of 29:1.

There was an overwhelming majority of blunt trauma in our study- 95%, giving a ratio of 19:1 versus penetrating injury; consistent with the data of most other studies (Table 6). However, there might not always be such a stark difference as noticed here. Okugbo et al in their study saw incidence of penetrating chest wounds as high as 43%, which included 25% of gunshot wounds, and the rest were mostly stab wounds.[5] On the contrary, penetrating injuries were the majority in Khorsandi et al's study, leading slightly with 54.1%.[6] High rates of penetrating wounds are seen commonly in areas of warfare, and in tribal areas, where swords, daggers and spears are used as weapons. If during such injury, the heart is penetrated, there is a less than 1% chance of survival. 60 ml to 200 ml clotted blood is sufficient to cause mortality.[9]

In our study 8 patients (6.66%) had associated abdominal injury, and exploratory laparotomy was done in 2 of them. 5 patients (4.17%) had injuries to the extremities and were all treated by orthopedic surgeons. 3 patients had injury to spine and were treated conservatively by bed rest and analgesic. 2 other patients had either fracture or contusion of pelvis and were treated by bed rest for 1 and ½ months out of which one was managed by suprapubic cystostomy. We had excluded the cases of head injuries in our study, whereas other studies reported significant associations. (Table 6).

Table 6: Results of our study vis-a-vis other similar articles.

Parameters	Our study (n=120)	Walia et al (n=184)[3]	Kant et al (n=100)[4]	Okugbo et al (n=73)[5]	Khorsandi et al (n=146)[6]	Dangi et al (n=102)[7]	Potey et al (n=246)[8]
Age (mean, years)	34	37±16	36.25	31.5	31.5	38.75	38.56
Sex ratio (M: F)	29:1	2.4:1	3.54:1	1.7:1	7.59:1	7.5:1	5.31:1
Blunt injury (%)	95	98	93	57	45.9	98.03	93.09
Etiology (%)							
RTA	66.66	58.69	63	52	-	-	71.14
Assault	8.33	42.39	15	43			11.79
Associated injuries (%)							
Head	-	59.78	25	8.2	13	1.96	25.20
Abdominal	6.66	8.69	6	12.3	33	1.96	6.10
Extremity	4.17	-	7	5.5	-	3.92	7.32
Spinal	2.5	-	-	4.1	4.1	-	-
Pelvic	1.66	-	2	1.4	-	-	1.63
Rib fractures (%)	83.33	16.30	25	9	36.3	100	26.83
Solitary fracture	8.33		-	-	-	14.7	-
Multiple fractures	75		-	-	-	75	-
Bilateral fracture	6.66		1	-	-	-	0.81
Other skeletal injuries (%)							
Flail chest (%)	8.33	4.34	1	5.5	-	5.88	0.41
Hemothorax (%)	50	16.30	7	49.3	36.3	38.24	7.32
Pneumothorax (%)	10	8.69	4	28.7	32.9	14.21	3.66
Hemopneumothorax (%)	8.33	-	6	-	-	-	5.7
Management							
Intercostal nerve block	1.67	-	8	-	-	-	5.3
Tube thoracostomy	58.33	36.96	15	51	-	37.25	12.19
Thoracotomy	0		3	9.6	-	0	1.22
Average hospital stay (days)	8	-	4.7	7		9.99	4.6
ICU requirement (%)	6.66	-	-	-		4.9	
Mortality	1.66	1.63	2	2.7	35.6	3.92	1.22

98.33% of our patients presented with chest pain and tenderness over chest, 61.66% with respiratory distress, 6.66% with signs and symptoms of shock, 20% with subcutaneous emphysema, and 8.32% with manifestation of other extra-thoracic injury like unconsciousness and vomiting. Respiratory distress can be identified during physical examination-nasal flaring, subcostal and suprasternal retractions, usage of accessory muscles and tachypnea are its common signs. Patients presenting with extra-thoracic injury were found to be more serious and in a state of shock.

In our study 10 (8.33%) patients had solitary rib fracture; multiple rib fractures were found in 90 (75%) cases and bilateral rib fractures were found in 8 (6.66%) cases. Majority of the patients (58.33%) had 2-5 rib fractures. Isolated rib fractures are hardly ever fatal; however, they may lead to complications like hemothorax, pneumothorax, puncture of pleura and pulmonary parenchyma. The first two ribs are relatively more difficult to break due to strong attachments, hence serving as good markers to indicate possible injury to the tracheobronchial and cardiovascular systems. Ribs 4 to 9 due to their location are frequently the target of traumatic fractures, leading to pulmonary contusions, lacerations, hemothorax or pneumothorax. The 'floating ribs' as their name suggests, have a higher degree of mobility, hence are less liable to be fractured. If, however, they do get fractured, they can damage the abdominal viscera like liver, spleen and kidneys.[10]

10 patients (8.33%) also had flail chest, of which 50% had it on right side and 50% on left. 7 patients had associated hemothorax and 3 had associated pneumothorax; all with multiple rib fractures. ICD insertion was done in all cases and 2 out of them were also treated by tracheostomy. No patient was treated with controlled positive pressure ventilation and internal fixation of flail segment. Flail chest is potentially very dangerous, due to their association with pulmonary contusions. This may lead to pulmonary edema, necrosis and eventual respiratory failure; therefore, it has a high predictive index for mortality.[10] As is standard, ABC management is done initially. Recent data shows that open reduction and internal fixation (ORIF) improves prognosis by shortening the duration of ICU admission and reducing potential complications.[10] 2 patients in our study with flail chest died, the cause of death being extra-thoracic organ injuries.

Hemothorax was the most common visceral injury, seen in 60 cases (50%), followed by pneumothorax in 12 patients (10%) and hemopneumothorax in 10 patients. Hemothorax was right sided in 50%, left sided in 23.34% and bilateral in 26.66%. Hemopneumothorax was right sided in 60%, left sided in 20%; remaining were bilateral. All of these patients were treated with tube thoracostomy.

Pneumothorax can be caused by a number of phenomena - alveolar rupture due to directly increased alveolar pressure; 'paperbag effect' (when there is a sudden increase in pressure in the tracheobronchial tree while the epiglottis is closed); during acceleration-deceleration; or penetration of the pleura by fractured ribs.[10]

In our study we encountered no patient with sternal fractures. They are seen in drivers of an automobile involved in an accident due to high velocity and pressure trauma of the chest against the steering wheel. This may cause severe vascular damage, or cardio-pulmonary contusion, leading to a rise in cardiac marker enzymes.[10] 8 (6.66%) of our patients had fractured clavicles. All were treated with clavicular bandages and the affected limb was supported by a triangular sling for 3 weeks. We had 3 cases (2.5%) having fractured scapula. As noted in Table 6, the associated thoracic musculoskeletal injuries are not uncommon.

X-ray chest and ultrasonography (USG) chest and abdomen were done in all 120 cases. CT chest was done in 10 cases which were suspicious for spinal and other intra-thoracic injuries. Spinal injury was detected in 3 cases and lung contusion was found in all 10 cases. Okugbo et al performed CT chest only for those in which there was suspicion of vascular and/or tracheobronchial and/or abdominal injury, revealing 7.7% to have lung contusions.[5]

Almost all our patients were administered analgesics (diclofenac 50 mg BD/capsule tramadol 50 mg QDS) 2 cases (1.67%) of rib fractures were given intercostal nerve block for pain relief. Epidural anesthesia was not given to any patient. One of the best means of managing severe degree of pain associated with rib fractures is intercostal nerve block with local anesthetic agents (1-3 ml of 0.5% bupivacaine), which provides relief for 12 or more hours. The procedure is associated with small but definite risk of pneumothorax, hence should be reserved for situations in which pain control is difficult or impossible to obtain by other measures.

Kant et al managed 89% patients and Potey et al managed 92.24% with analgesics alone.[4,8]

Kant et al observed that 8% of his patients required ICNB 5.3% of Potey et al's patients were given ICNB and 2.45% were given epidural anesthesia.[4,8]

In our study 74 cases (61.66%) patients presented with respiratory distress. Causes of respiratory distress in our series were pneumothorax, hemothorax, hemo-pneumothorax and flail chest. Transnasal O_2 was given to almost all our patients as per requirement. Two patients with flail chest were intubated; followed by tracheostomy. Tube thoracostomy was done in 70 cases (in 48 cases of hemothorax, 12 cases of pneumothorax, 7 cases of hemopneumothorax, and 3 cases of isolated flail chest), mean time for tube removal was 3-15 days. The earliest the tube was removed was after 3 days, and longest time for which tube was kept was for 24 days. None of our patients required a thoracotomy, the indications of which are initial

drainage volume of chest tube >1000 ml in a penetrating injury/>500 ml in a blunt injury, hourly drainage of >200 ml for 3 consecutive hours in non-coagulopathic patients, caked hemothorax inspite the placement of 2 chest tubes, great vessel injury, pericardial tamponade, cardiac herniation, tracheobronchial injury, open pneumothorax, esophageal perforation, or an air embolus.[11]

The treatment of blunt thoracic trauma has undergone dramatic evolution over the twentieth century; till 1950, the primary emphasis was on mechanical stabilization of bony injuries using external devices like sandbags or traction systems, and later by surgical methods like wires or screws.[12] Post-1950, the concept of "internal pneumatic stabilization" with positive pressure mechanical ventilation was developed which became the standard for chest wall trauma and is currently being practiced, as is made evident in Table 6.[13]

In our study 58.33% of cases were treated with tube thoracostomy among which 2.85% had blockage of tube and 7.14% patients' wounds got infected. All were treated conservatively. 2 patients (1.66%) developed atelectasis.

We did not encounter any of the following complications: empyema, lung abscess, pneumonia, post traumatic intercostal neuroma, severe pain and deformity at costochondral junction, acute respiratory failure, bronchopleural fistula, fibrothorax, delayed diaphragmatic hernia, arrhythmias, lung cyst, sternal dehiscence, pericardial herniation, pericardial effusion, chylothorax, and myocardial infarction.[4,6]

Some rare cardiovascular complications following blunt chest trauma are worth citing. Acute aortic valve rupture with a tear in right coronary cusp; rupture in the coronary sinus leading to cardiac tamponade and hemopericardium; left coronary artery dissection as seen in a restrained driver; chylothorax development five days after initial injury, contralateral to the side of rib fractures and rupture of the azygos vein.[14-18]

Average duration of hospital stay in our study was for 8 days. Patients who had only rib fracture/s and contusion to the chest wall were treated in the hospital for 2-3 days. Hospitalization duration ranged from 1-34 days following tube thoracostomy. 8 patients (6.66%) needed ICU admission out of which 4 required ventilatory support. Out of the 4 who required ventilatory support, 3 had associated hemoperitoneum and 1 had a compression spinal fracture of D3 and D4. In the study done by Dangi et al, 5 (4.9%) patients required ICU admission of which 3 needed ventilatory support, 1 for flail chest and the others for associated head injuries.[5]

In 1960 Griffith had recognized that severe crush injuries of the chest resulted in high mortality, owing to ill-management of respiratory implications, and that intermittent positive pressure ventilation (IPPV) suggested by Avery et al might help reduce these statistics. Paradoxical respiration and direct sequelae of injury such as pneumonia, sepsis and atelectasis lead to death; mechanical ventilation when used at this stage corrected the paradoxical motion, treated hypoxia and hypercapnia, resulting in a drastic improvement in prognosis.[19]

We encountered 2 cases of mortality (1.66%). One of them was associated with abdominal injury and one case was due to spinal injury-a compressed fracture of D3-4 vertebra with paraplegia and spinal shock. Majority of our patients were discharged in a satisfactory condition.

The limitation of our study is due to our centre not being equipped with a cardiothoracic and vascular surgical unit. Hence the patients requiring surgical interventions were referred to other centers after initial stabilization in our emergency room; their data could not be collected.

CONCLUSION

Middle aged males were found to be the prime victim of chest traumas, majorly as a result of road traffic accidents and assaults. Timely resuscitation and rapid management are the backbone of trauma management. Pain management is quintessential to enable patient comfort and reduce complications; maximum cases are managed by analgesics alone. Most of the cases can be managed by minimally invasive methods seldom requiring open chest thoractomy, and have low mortality.

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