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Research Article

A prospective randomized trial on trauma thoracic cage with rib fracture especially first rib fracture and associated complications

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ABSTRACT

Background: Thoracic cage is an osseocartilaginous cavity which not only protects and supports vital organs but also has dynamic role in mechanism of respiration. The aim was to study the mechanism of first rib fracture, incidence and complications of first rib and other ribs' fracture and their sequelae.
Methods: A prospective randomized trial was conducted on 300 patients of trauma thoracic cage having rib fracture with or without associated injuries at NIMS Medical College and Hospital, Jaipur, Rajasthan, India from April 2013 to March 2016. All patients were examined on a fixed protocol (age, sex, mode of injury, vital status, number and site of rib fracture) with associated injury and complications.
Results: Maximum patients (including males and females both) with first and other rib fractures were in the age group of 11-30 years. The most common mode of trauma was roads traffic accident (RTA). First rib fractured at shaft by indirect trauma mostly. Commonly reported chest, abdomen and associated injury complications were haemothorax, haemoperitoneum and head injury respectively. Most of the patients were treated conservatively except 1% patients who required thoracotomy.
Conclusions: Most common cause of chest trauma with rib fracture was RTA and first rib fracture was indirect trauma. The most common cause of mortality was an associated head injury.

Keywords: Chest trauma, Rib fracture, First rib fracture, Associated injury

INTRODUCTION

Thoracic cage is an osseocartilaginous cavity which not only protects and supports vital organs but also has dynamic role in mechanism of respiration. Twelve obliquely placed ribs run parallel to each other on either side. The first seven ribs are vertebrosternal (true ribs) and last five are false ribs of which 8th, 9th and 10th are vertebrochondral and 11th and 12th are floating ribs. 3rd to 9th are typical and remaining are atypical ribs.

A rib fracture is a disruption which may be a single fracture of one or multiple ribs or compound fracture and it is caused by blunt/open trauma to the chest resulting from road traffic accidents (RTA), fall, crush or sport injuries (discus or javelin throw). Elderly people are most prone to rib fracture due to osteoporosis and osteopenia while children are least.[1,2]

First rib fracture is rarest of other rib fracture as first rib is well protected by neck muscles, shoulder and clavicle. If it occurs then is usually associated with severe trauma. The weakest part of the first rib is the subclavian groove. In road traffic accidents, there is a sudden forward movement of head and neck leading to violent

contraction of scalene and sternocleidomastoid muscle, thus fracture of first rib.

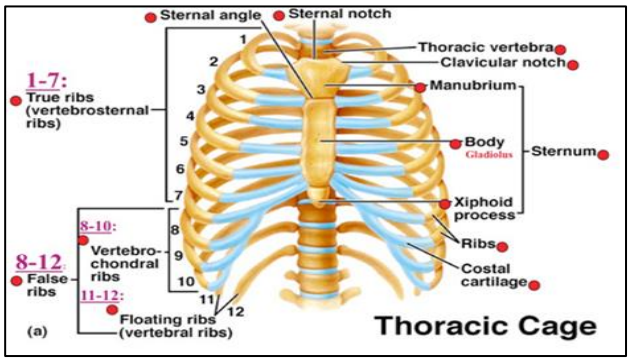

Figure 1: Thoracic cage.

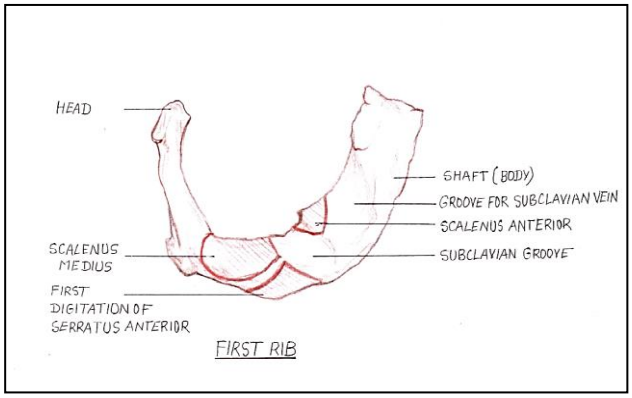

Figure 2: First rib.

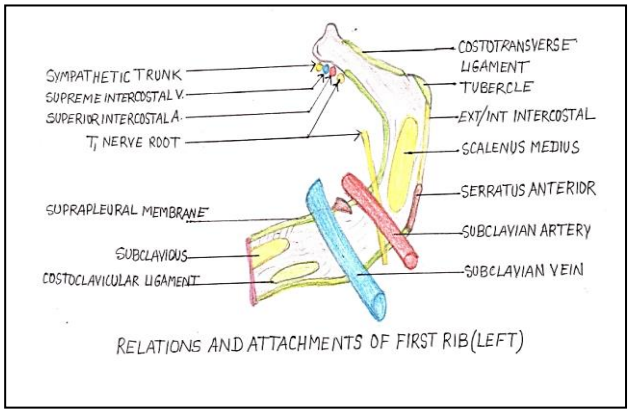

Figure 3: Relations and attachments of left first rib.

Most commonly fractured ribs are 4^{th}-9^{th}, generally at the weakest area (posterior angle). Flail/stove in chest lead to paradoxical respiratory movements. Lower ribs fracture is usually associated with injury to diaphragm and abdominal organs (fracture of left lower ribs-spleen, right lower ribs-liver, floating ribs-renal injuries). Chest injuries are usually life threatening, either on their own or in conjunction with other system injuries. Ribs fracture may compromise ventilation, pain can cause respiratory splinting and fragments of fractured ribs can act as penetrating objects. Threats to life are;

Immediate

Pneumothorax, haemothorax, flail/ stove in chest, airway injuries, pericardial tamponade.

Potential

Pulmonary contusion, oesophageal/ aortic/ tracheobronchial/ myocardial injuries, rupture of diaphragm.

The aim was to study rib fractures' mechanism, incidence and complications especially the first rib and their sequelae.

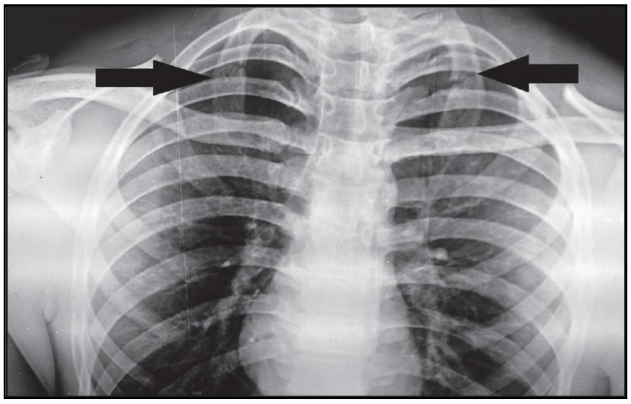

Figure 4: X-ray showing B/L first rib fracture.

METHODS

The study was conducted on 300 patients at NIMS Medical College and Hospital, Jaipur, Rajasthan, India, during the period April 2013 to March 2016, admitted in various departments mainly department of orthopaedics and neurosurgery having rib fracture with or without associated injuries. All patients were examined on a fixed protocol (age, sex, mode of injury, vital status, number and site of rib fracture) with associated injury and their complications were recorded. All patients underwent routine blood profile (CBC, ESR, BS, RFT's, LFT's, S. electrolytes, BT, CT, blood group, HBsAg, HIV, VDRL) and relevant investigations like X-ray chest, ECG, CT scan, MRI were recorded.

RESULTS

Maximum patients (including males and females both) with first and other rib fractures were in the age group of 11-30 years. The common mode of trauma was RTA followed by fall from height, where RTA was found to be 70% while fall from height was 15% in the cases studied. First rib fractured at shaft, mostly by indirect trauma. Middle ribs (four to nine) fractured the most, amounting to 76% of the total cases studied by us. Commonly

reported chest, abdomen and associated injury complications were haemothorax, haemoperitoneum and head injury respectively.

Table 1: Age and sex distribution of patients having rib fracture.

Age(Years)	Male	Female	Total	%
<10	19	2	21	7.00
11-30	84	53	137	45.66
31-50	62	34	96	32.00
>50	24	22	46	15.34
Total	189	111	300	100

Table 2: Age and sex distribution of patients with first rib fracture.

Age(Years)	Male	Female	Total	%
<10	-	-	-	-
11-30	8	4	12	4.00
31-50	5	-	5	1.66
>50	1	-	1	0.33
Total	14	4	18	6.00

Table 3: Mode of injury with rib fracture.

Mode	Male	Female	Total	%
RTA	133	75	208	69.33
Assault	7	4	11	3.66
Fall from height	29	15	44	14.66
Animals	13	14	27	9.00
Others	7	3	10	3.33
Total	189	111	300	100

Table4: Sex distribution and site of first rib fracture.

Part	Male	Female	Total	%
Anterior	-	-	-	-
Posterior	3	1	4	22.22
Shaft (body)	11	3	14	77.78

Table 5: Number of ribs fractured.

No of ribs fractured	No of patients	%
1-2	124	41.33
3-6	154	51.33
7-10	22	7.33
11-12	-	-

Table 6: Mechanism of first rib fracture.

Mechanism	Number	%
Direct	5	27.77
Indirect	13	72.22

Table 7: Location of ribs fracture.

Site	Number	%
Upper (1-3)	54	18
Middle (4-9)	229	76.34
Lower (10-12)	17	5.66

Table 8: Chest complications and associated injuries with rib fracture.

	Number	%
Chest complications-surgical emphysema	43	14.33
Flail chest	17	5.66
Pneumothorax	33	11.00
Haemothorax	71	23.66
Lung injury	29	9.66
Airway injury	8	2.66
Diaphragm injury	3	1.00
Associated injuries head injury	24	8.00
Abdominal injury	23	7.66
Cardiac and vascular injury	5	1.66
Spine injury	4	1.33
Other fracture	47	15.66

Table 9: Abdominal injuries associated with ribs fracture.

Injury	Number	%
Haemoperitoneum	17	5.66
Spleen	06	2.00
Liver	11	3.66
Gut	05	1.66
Mesentry	04	1.33
Omentum	04	1.33
Pancreas	01	0.33
Urinary system	03	1.00
Retroperitoneal haematoma	02	0.66

Table 10: Treatment opted with rib fracture.

	Number	%
Conservative	197	65.66
Intercostal drainage	113	37.66
Thoracotomy	3	1.00

Table 11: Final outcome of patients.

Outcome	Number	%
Discharged	261	87
Complications	22	7.33
Death	17	5.66

Most of the patients were treated conservatively except 1% patients who required thoracotomy. Out of a total of three hundred cases, 87% were discharged without any complications, 7.33% were found to have complications

requiring further intervention and the remaining 5.67% patients died.

DISCUSSION

Trauma is the leading cause of morbidity and mortality especially during most productive phase of life. In this study most patients with rib fracture fall in the age group of 11-30 years. RTA is the most common cause of blunt trauma of the chest causing ribs fracture, followed by fall from height, animal attacks (cow, bull, dog and other wild animal), assault like stabbing and athletic injuries.[3-5] A similar study was conducted by Mehmet et al, increasing number of vehicles and population, speed, violating traffic rules and road conditions were all responsible for increasing accident percentage; similar results were found in the study of Helling et al.[6,7] As first rib is deeply placed and well protected, in majority of cases it was fractured due to indirect trauma.[8,9] Most common complaint was pain lying deeply under scapula, shoulder or clavicle.[10-12] Pain was aggravated by shoulder movement mainly beyond 90 degree abduction.[13,14] In this study the first rib was fractured at shaft in 14 patients and at posterior end in 4 patients, 5 patients had a direct blow to the anterior chest wall resulting in fracture at shaft along with other ribs fracture in continuity. 3 patients had fracture at posterior end of first rib due to head on collision with the back of the front seat or dash board of car. The probable mechanism was a sudden forward movement of the head, neck and trunk. The movement of the head is stopped on collision while the trunk continues to move forward and downward. This results in hyperextension of the neck and violent contraction of sternocleidomastoid and scalene muscle. This produces a bending strain resulting in a fracture just behind the attachment of the scalene medius muscle. A similar probable mechanism was suggested by Joshi SG et al.[15] 5 patients were injured due to a fall on an outstretched hand (4 from RTA and 1 from height) resulting in fracture at shaft of first rib on the same side. This was probably due to strong violent contraction of the scalenus anterior muscle combined with traction on the arm. The scalenus anterior and upper fibres of the serratus anterior exert opposite traction on each side of the subclavian sulcus, thus causing severe bending strain at the relatively thinner subclavian groove.

Complications of first rib fracture i.e. lung injury, haemothorax, pneumothorax, emphysema, airway and subclavian artery injury, abscess formation above and below the clavicle were encountered but no case of brachial plexus injury and Horner's syndrome was reported.[7,8,16-18] Incidence of isolated first rib fracture isolated first rib fracture with other ribs and with flail chest was 6.00%, 1.66% and 5.66% respectively.[8,19-21] Middle ribs were most commonly fractured (76.33%), almost all patients of flail chest were found in this group. Majority of patients of lower ribs fracture (5.66%) were reported with abdominal organs injury. Abdominal injury was seen in 23 patients of which 11 had liver injury with associated right lower ribs fracture, 6 had spleenic laceration with associated left lower rib fracture, 4 had other abdominal organ injury and 2 patients had renal injury with massive retroperitoneal haematoma.[22,23] Regarding treatment profile, 65.66% patients were treated conservatively. ICD with underwater seal drainage or with syringe was required in 37.66%.[24] Average time required to remove the tube was 6.5 days after full expansion of lungs. Thoracotomy was required in 1% and blood transfusion in 13.66% patients. Residual haemothorax was reported in 8 patients, repeat ICD was required in 6 and simple syringe aspiration was needed in 2 patients.[25] 17 patients died, most of the patients had multiple ribs fracture associated with head/spine/abdominal/other bony injuries. In this study only 4 patients expired solely because of chest injury.[6,26,27]

CONCLUSION

Severely injured patients require thorough evaluation of thoracic injuries as an important aspect of total assessment. In immediate life threatening situations both therapeutic and diagnostic measures were carried out simultaneously. After comprehensive review it was concluded that-

- Chest injury accounts in a maximum number of trauma patients and both sex groups are equally affected in most productive age of life with RTA being the most common mode of injury.[7,8]
- Incidence of first rib fracture was 6.00% which was comparable with literature.
- Most common dominating mechanism of first rib fracture was indirect trauma. The probable mechanism seems to be a violent contraction of scalene and stercleidomastoid muscle producing a severe strain at the weakest subclavian groove of first rib.
- First rib fracture in itself was not a life threatening pathology.
- Middle ribs were most commonly fractured and flail/stove in chest occurred mainly in this region with high mortality rate.
- Lower ribs fracture commonly had associated intra-abdominal injuries.
- Most commonly haemothorax accounted for pulmonary complications.
- Most of the patients with rib fracture were managed conservatively, a few required ICD or simple aspiration and only 1% required thoracotomy.
- Mortality rate was 5.66% due to associated injuries mainly due to head injury and 1.33% patients expired due to chest injury.

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