

Demographic Profiling of Cases of Blunt Thoracic Trauma Presenting With Rib Fractures

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Abstract

Background: One of the most common sequelae of blunt thoracic trauma is rib fractures. The detection of rib fractures is important to detect associated injuries such as pneumothoraces, hemothoraces, pulmonary contusion, flail chest, pneumonia, vascular and nerve damage, abdominal organ injury, to prevent complications such as atelectasis and acute respiratory failure, to document the injury for medical-legal purposes, to detect pathologic fractures, to count how many ribs are broken etc.

Aim of the study: This research study was done to study the relationship between the rib fractures and various variables such as age, sex, manner of injury, type of road traffic accident, position in the vehicle, seatbelt use and airbag deployment in case of 4 wheeler accidents, weapon of assault, number of assailants, height of fall etc.

Material & method: To achieve the objectives of this study we focused only on individuals who sustained rib fractures who presented in the emergency of our hospital.

Conclusion: By, correctly construing the injury patterns, we can gather useful information for reconstruction of the circumstances at the time of the alleged incident.

Keywords: Trauma, Rib Fractures, Blunt Thoracic Trauma, Road Traffic Accident, Assault, Fall.

Introduction

A Fracture is a break in continuity of a bone as a result of application of blunt or sharp weapon/object to the body.¹ The thorax is susceptible to all kinds of injuries especially blunt and penetrating thoracic trauma.²⁻⁶ Forensic experts especially those involved in an emergency setting have to on a regular basis, deal with cases of rib fractures associated with road side accidents, assaults, falls, railway accidents etc. Any insult to the thoracic cage that causes disruption of integrity of chest wall, may result in traumatic asphyxia and is sometimes associated with deaths making the mechanism and pattern of rib fractures an important area of consideration, both because of associated mortality as well as, clues that it can provide to help a forensic expert opine regarding the manner of injury.

Energy possessed by a body in motion is referred to as 'Kinetic Energy'. Kinetic energy depends upon the mass and velocity of body.

It is known that,

$$E = mv^2$$

Where, K.E is the kinetic energy possessed by the body. As can be inferred from the above equation, if a massive object and a light object have the same momentum, the light one will have a lot more kinetic energy and if, a light

object and a heavy one have the same velocity, the heavy object will have more kinetic energy.⁷

Biomechanics of rib fracture – The ribs are quite different from other bones in the sense that their cortical thickness is quite thin. This increases their elasticity but also makes them more susceptible to fracture. Due to irregular cross-section and curvature, there exist regional differences in bone mechanical properties.⁸ This cumulates into increased pliability of ribs, which in return facilitates transfer of force along the bone which causes its fracture, to be away from the site of impact.

A pattern can be deduced by studying the various parameters involved which may also be useful to build upon the present knowledge of forensic medicine. This research study investigates the relationship between the rib fractures and various variables such as age, sex, manner of injury, type of road traffic accident, position in the vehicle, seatbelt use and airbag deployment in case of 4 wheeler accidents, weapon of assault, number of assailants, height of fall etc.

Identifying patterns of injuries and associated variables including demography can aid in understanding the pathophysiological processes leading to the injuries in question.

Materials and methods – On receiving clearance from the Institutional Ethics and Research Committee, this prospective study was conducted in the Department of Forensic Medicine and Toxicology in collaboration with Department of General Surgery and Department of Radiodiagnosis, Government Medical College & Hospital, Chandigarh, and was analytical in nature encompassing a hundred cases of blunt trauma chest and abdomen who presented in the surgery emergency. Data collection regarding the particulars of the case along with the injuries was done from patient and relative interview, treatment records and was subject to detailed analysis.

Inclusion criteria:

- i. Cases with known history of blunt trauma chest/abdomen involving fracture of ribs in whom X-ray and USG had been done.

Exclusion criteria:

- i. Cases with known history of blunt trauma chest and abdomen involving fracture of ribs which were referred to other centres or went LAMA or absconded.
- ii. Cases with known history of firearm injuries and injuries with sharp/pointed weapon over chest/abdomen.
- iii. CPR cases with known history of previous rib fractures.
- iv. Cases of bony pathology/diseased condition, as patients afflicted with such conditions are more prone to fractures.
- v. History of prolonged steroid administration.
- vi. All unknown cases without any proper history of illness/medication.

The detailed information regarding the cases such as identification, date, time, place of incidence, manner and circumstance of injury caused, and previous treatment history for the said injures like referral history, date and time of admission in GMCH, Chandigarh; past history of patient in relation to any previous trauma, bony pathology and steroid intake was collected from different sources, including:

- Interviewing the patient.
- Asking relevant details from relatives or identifiers accompanying the patient/decedent.
- Case files and treatment records of concerned patients and decedents from Medical Records Department of the hospital.
- The number, date and time of medico-legal report number as per the department register.

The patients fulfilling the above criteria were carefully chosen. Complete history, detailing the manner and circumstance of injury were noted. Location and number of rib fractures were noted from only the treatment X-rays done for the patients to prevent any ethical obligations.

Observations & results

Sex wise distribution of cases – Of the total number of 100 cases, males (96 cases) outnumbered females, who constituted only 4 per cent of all the cases (Figure 1).

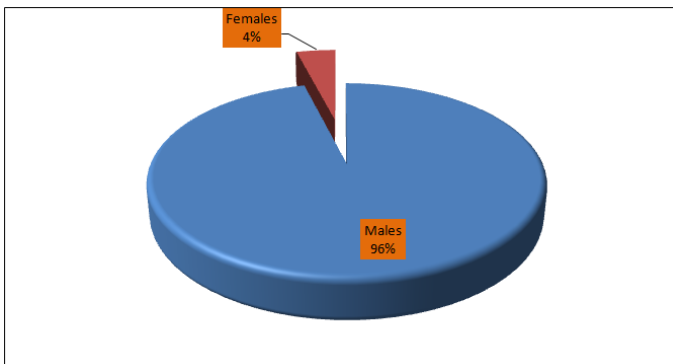


Figure 1 – Distribution of cases as per sex

Age wise distribution of cases – Table 1 show the age wise distributing of cases. A minimum age of 21 years and the maximum of 85 years was recorded. The mean age was 47.6 years with a standard deviation of ±14.2 years. Age group 41- 50 years constituted the maximum number of cases, and together the age groups 31- 40, 41- 50 and 51- 60 constituted 71 % of all the cases (Table. 1). No cases were reported in the age group 0-10 and 11-20.

Age in years	No. of cases involved (n=100)	Percentage
0-10	0	0 %
11-20	0	0 %
21-30	13	13.0 %
31-40	20	20.0 %
41-50	30	30.0 %
51-60	21	21.0 %
61-70	9	9.0 %
71-80	6	6.0 %
>90	1	1.0 %
Total	100	100 %

Distribution of cases as per Manner of injury

Road traffic accidents accounted for most of the cases at 64 % of the total, followed by fall from height and physical assault. The breakdown of the cases as per the Manner of Injury is represented in Table 2.

	No. of cases involved (n=100)	Percentage
RTA	64	64 %
Physical assault	17	17 %
Fall from height	19	19 %
Others	100	100 %

Age vs Manner of Injury

When age was extrapolated against the manner of injury, the following observations were noted

- Overall maximum cases lay in the 41 – 50 age group (n = 30).
- Maximum RTA cases lay in the 41-50 age group (n = 20).
- Maximum physical assault cases lay in the 41- 50 age group (n =5).
- Maximum cases of fall from height lay in the 51-60 age group (n=7).

The detailed distribution of cases is given below in the bar diagram representation in Figure 2.

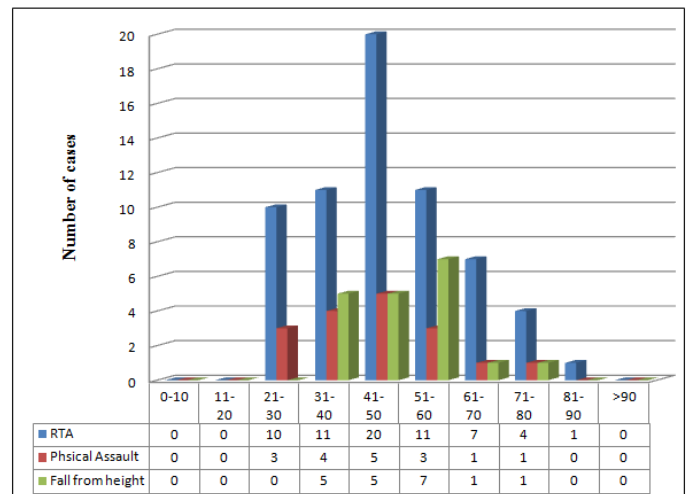


Figure 2 – Bar diagram depicting age wise distribution of cases

Role of victim in RTA cases

As is clear from Table 3, maximum victims were two wheeler riders in 45 % of the RTA cases, followed by pedestrians (28 %) and four wheeler occupants (16%).

	No. of cases involved (n=64)	Percentage
Pedestrian	18	28.1 %
Two wheeler	29	45.3 %
Three wheeler	2	3.1 %
Four wheeler	10	15.6 %
Heavy vehicle	5	7.8%
Total	64	100 %

Position of the victim in 2 wheeler vehicles

The 2 wheeler cases were then sorted according to the position of victim and the data thus obtained can be seen in the Table 4 below.

	Frequency (n=29)	Percentage within the group	Percentage among total patients
Driver	16	55.2%	16%
Pillion rider	11	38%	11%
Unknown	2	6.9%	2%

In around 55 % cases the victims were the drivers, followed by pillion riders in 38 % cases. In 2 cases (6.9%), the position of victim could not be ascertained. From among the pillion riders, 3 victims were riding cross-legged and 3 were sitting sideways at the time of incident. In 5 cases sitting posture of victim could not be ascertained.

Position of victim in 4 wheeler vehicles

Similarly, the 4 wheeler cases were sorted according to the position of victim in the vehicle, and the data was compiled, which can be seen in the Table 5 below.

	Frequency (n=10)	Percentage within the group	Percentage among total patients
Driver	8	80%	80%
Front passenger	1	10%	10%
Back left passenger	1	10%	10%
Back right passenger	0	0%	0%

A total of 10 cases were recorded. As can be seen, in 80% cases the victim was driving the vehicle. Front passenger and back right passenger sustained rib fractures in one case each. However, no pattern of rib fractures could be ascertained from the recorded data.

Type of offending vehicle

Four wheeler and heavy vehicles were jointly the most common culprits followed by two wheelers (Table 6). In 5 cases, the patients had either hit some stray cow or a stationary object/vehicle or the offending vehicle could not be ascertained. Cumulatively, four wheeler and heavy vehicles were the offending vehicles in 44 cases, which constituted almost two-thirds of the total RTA cases.

	Frequency	Percentage within the group	Percentage among total patients
Two wheeler	10	15.6 %	10%
Three wheeler	5	7.8 %	5 %
Four wheeler	22	34.4 %	22 %
Heavy vehicle	22	34.4 %	22 %
Others	5	7.8 %	5 %

Type of RTA

Collision between a two wheeler- four wheeler was the most common type of RTA followed by Pedestrian – Four wheeler and Two wheeler – Heavy vehicle. The frequencies for various types of RTA’s can be seen in Table 7.

Table 7 – Distribution of cases according to the type of RTA.

Type of RTA	Frequency
Pedestrian – Two wheeler	4
Pedestrian – Three wheeler	1
Pedestrian – Four wheeler	8
Pedestrian – Heavy vehicle	5
Two wheeler – Two wheeler	7
Two wheeler – Three wheeler	2
Two wheeler – Four wheeler	10
Two wheeler – Heavy vehicle	8
Three wheeler – Three wheeler	0
Three wheeler – Four wheeler	2
Three wheeler – Heavy vehicle	0
Four wheeler – Four wheeler	6
Four wheeler – Heavy vehicle	3
Heavy vehicle – Heavy vehicle	4
Other RTA's	4

Type of collision

Figure 3 summarise the type of collisions in the RTA cases. Maximum cases were of frontal impact, followed by right sided impact.

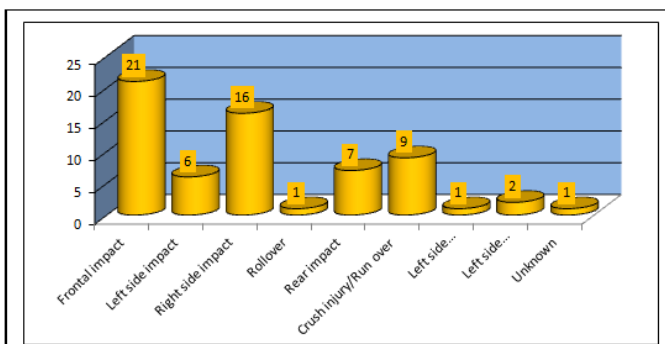


Figure 3 – Distribution of cases according to the type of collision in RTA cases

Physical assault cases

Assault cases constituted 17 cases of the total, and were analysed according to the alleged kind of weapon used and the alleged number of assailants. For this, the weapons were divided into light blunt weapons and heavy blunt weapons. Use of heavy blunt weapons was recorded in 47 % cases, followed by light blunt in 35 % cases and least was the use of a combination of heavy blunt and light blunt weapons in 18 % cases. Total number of ribs fractured in assault cases were 28. One case of multiple

rib fractures to the same rib was recorded. There were no cases of bilateral rib fractures to the same rib. (Table 8)

Table 8 – Distribution of physical assault cases as per the kind of weapon used

Type of weapon	No. of cases involved (n=17)	Number of ribs fractured (Total)	Number of cases with bilateral rib fractures	Number of ribs with multiple fractures
Light blunt weapon	6	9	0	0
Heavy blunt weapon	8	14	0	1
Combination of both	3	5	0	0
Total	17	28	0	1

Fall from height cases

Patients with alleged history of fall from height were 19 in number. Floor number or the height of fall from ground was recorded. In the cases where only the floor number was recorded and not the height of fall, the height of each floor was taken as 13 ft. as per the Indian standards. The height of fall ranged from 0 to 39 ft. The sample group was divided into 5 groups of increasing height. Height of fall was not available in 3 cases. Maximum cases fell in the 14-26 ft. group (Table 9). All cases were attributed to workplace or accidental injuries. No mortality was recorded in this group.

Table 9 – Distribution of cases of fall, as per the height of fall

Height of fall	No. of cases involved (n=19)	Percentage within the group	Percentage among total patients
Not known	3	15.8%	3%
0 – 13 ft.	2	10.5%	2%
14 – 26 ft.	9	47.4%	9%
27 – 39 ft.	5	26.3%	5%
>40 ft.	0	0%	0%
Total	19	100%	19%

Discussion

Of the total cases, males outnumbered the female patients (Figure 1). Table 1 shows the age wise frequency of cases of rib fracture. The age groups of 31 - 40, 41 - 50 and 51 - 60 constituted 71 % of all the cases, which concurs with the present knowledge that rib fractures are less common in the young population due to more elasticity of the ribs.

In the study done by Karadayi, et al, the age of reported cases ranged from 18 to 96.⁹ Similarly, in the study done by Kelbaugh, the age ranged from 18 to 94 years.¹⁰ In our study, a minimum age of 21 years and the maximum of 85 years was recorded with a mean age of 47.6 years, which is similar to 49 years in study by Kelbaugh and 51.5 in the study by Karadayi, et al. Kessel, et al studied 6995 cases of rib fractures and had reported just 328 cases in the age group 0 to 14 years, which was just 4.7 % of the total.¹¹ Also they had excluded patients with age greater than 65 years.

In our study, RTA was the most common cause of sustaining rib fractures followed by fall from height and physical assault (Table 2). Karadayi, et al, in their study, encountered 64 % cases of traffic accidents, 24.3 % fall from height and 3.3 % assault cases. Similar findings have been reported by other studies. In our study the physical assault cases were more. The reason for this may be that majority of such patients gave proper history, and thus fulfilled the pre-defined inclusion criteria. On the other hand, many cases of RTA and Fall from height were at times reluctant to get a medico legal case registered and gave insufficient history, thus not fulfilling the inclusion criteria. Overall, maximum cases lay in the 41 – 50 age group (Table 1). When age was extrapolated against manner of injury, it was found that maximum cases of RTA and physical assault lay in the age group of 41 to 50 years while that of fall from height lay in the age group of 51 to 60 years (Figure 2).

Among the RTA cases, two wheeler riders were the victims in maximum cases (Table 3). Pedestrians and four wheeler occupants were the other two most commonly involved groups in that order. In cases where the victims were on a two wheeler, 16 were the drivers while 11 were pillion riders (Table 4). In two cases, the position of victim could not be ascertained. In cases where the victim

was an occupant of a four wheeler, 8 were drivers. In 1 case each, the victim was either a front passenger or a back left passenger (Table 5). This finding is similar to that by Kelbaugh, who encountered 77.1 % drivers, followed by 11.4 % front passengers and 3.81 % back seat passengers. He suggested that it was because every car involved in an accident has a driver and may not necessarily have co-passengers. Due to the small sample size, no association could be construed between the sitting position in 4 wheelers and pattern of rib fractures.

Four wheeler and heavy vehicles were jointly the most common offending vehicles, followed by two wheelers (Table 6). Cumulatively, four wheeler and heavy vehicles were the offending vehicles in 44 cases, which constituted 69% of the total RTA cases. Collision between a two wheeler – four wheeler was the most common type of RTA, followed by collision between two wheeler and heavy vehicle and between pedestrian and a four wheeler (Table 7). Cases of frontal impact outnumbered other cases, and were followed by those of right side impacts (Figure 3). In one case, the victim did not remember the side of impact and in 3 cases, a combination of types of collisions were recorded.

Cases of physical assault constituted 17 % of the total cases. The kind of weapon used in all cases of physical assault was recorded and the resultant findings can be seen in (Table 8). Stomping with feet was categorised with heavy blunt weapons. Assailants used heavy blunt weapons like boulders, repeated stomping in 8 cases, followed by use of light weapons such as ‘lathi’, ‘danda’ and the like in 6 cases. In 3 cases, the assailants had used a combination of heavy and light weapons. Maximum rib fractures were noted corresponding to the use of heavy blunt weapons. No case of bilateral rib fractures was recorded. Also, only a single case of multiple fracture of

same rib was recorded. No mortality was recorded in this group.

Patients with alleged history of fall from height were 19 in number (Table 9). Floor number or the height of fall from ground was recorded. The height of fall ranged from 0 to 39 ft. The sample group was divided into 5 groups of increasing height. Height of fall was not available in 3 cases. Maximum cases fell in the 14-26 ft. group. All cases were attributed to workplace or accidental injuries. No mortality was recorded for cases with fall from height.

Summary and conclusions

The following results were obtained for the study group –

- Males constituted 96 % of cases with females being just 4 % of the total.
- RTA was the most common manner of Injury at 64 %, followed by falls at 19 % and physical assaults at 17 %.
- The frequency of rib fractures was less at either extremes of age, with maximum cases in the 41 -50 age group.
- As per the manner of injury, maximum RTA and physical assault cases were in the 41 to 50 age group, while the falls had maximum number in the 51 to 60 age group.
- Two wheelers followed by pedestrians were the victims in 45 % and 28 % cases respectively with least cases of three wheelers.
- Heavy vehicles and two wheelers topped the list of offending vehicles at 34 % each. Most two wheeler victims were drivers, at 55 % followed by pillion riders at 38 %.
- Four wheeler occupants were mostly drivers, at 80 % followed by 1 case each of a front passenger and one that of left backseat passenger.

- Maximum incidence of collision was reported between two wheelers and four wheelers, followed by collision between pedestrians – four wheelers and two wheelers – heavy vehicles.
- Frontal impact had the maximum incidence with 32.8 % cases, followed by 25 % cases of right side impact and 14.1 % cases of crush injury/ run overs.
- Physical assault cases were assorted according to the type of weapon reported. Maximum cases reported use of heavy blunt weapons in 47 % and light blunt in 35 % followed by 18 % cases of combination of light and heavy blunt weapons.
- The cases of rib fractures due to falls were interviewed to find the height of fall. Maximum cases reported a fall from a height of around 14 to 26 ft.

Understanding the pattern of injuries and applying that knowledge in a medico legal setting is needed in cases that go to courts, where questions regarding the circumstances of injury, especially in cases of interpersonal violence need to be answered. By, correctly construing the injury patterns, we can gather useful information for reconstruction of the circumstances at the time of the alleged incident.

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