

Patterns of Cardiac Rupture in Blunt Cardiac Injuries and Coronary Artery Disease: A Retrospective Autopsy Study

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Abstract

Cardiac rupture is the most severe form of blunt chest injury and coronary artery disease and that leads to a devastating medical emergency, Becker and colleagues identified three types of myocardial rupture, in Govt Stanley medical college and hospital, 2017-2019 cases with the postmortem findings and hospital records suggestive of cardiac rupture, were studied retrospectively and the information were collected and analyzed. In the retrospective study population 426 cases had blunt chest trauma in that cardiac rupture seen in 28 cases amongst Becker type I rupture seen in 26 cases and type II rupture seen in 2 cases. Amongst 792 cases of coronary artery disease with myocardial infarction 13 cases had cardiac rupture in that Beckers type I rupture noted in 5 cases and type II were noted in 8 cases. Beckers type III rupture cases were not presented in the retrospective study population. Male cases were predominantly seen in both blunt chest injuries and in coronary artery disease and most of the cases were in the age group of 31-60 years. Among blunt chest injury traffic accidents were most common cause for cardiac rupture and in coronary artery disease left anterior descending artery occlusion was the most common cause for cardiac rupture, In the present study it has been proved that a diseased heart is more susceptible to traumatic injury than a normal one. The diseased heart is more likely to rupture at the fragile myocardium sites. The presence of fatal cardiac trauma in head on collision cases emphasizes the utility of safety belts while driving. The present study is undertaken to identify the exact pathophysiology and bio mechanism of cardiac rupture.

Key words: cardiac rupture, blunt cardiac injury, coronary artery disease, beckers classification, fragile myocardium.

Introduction:

Cardiac rupture is a devastating cardiovascular emergency that leads to immediate haemodynamic collapse and death. It may result from a variety of aetiologies, of which blunt chest injuries, penetrating chest injuries and coronary artery disease are most often reported. The review on road safety published

by the World Health Organization (WHO) in 2015 providing information from 180 countries indicates that worldwide the total number of road traffic deaths has plateaued at 1.25 million per year.¹ Of which most of the blunt cardiac injuries were unnoticed in poly trauma cases and that lead to a fatal outcome and unexplained deaths in traffic accident cases.

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Blunt cardiac injury (BCI) refers to injury sustained due to blunt trauma to the heart. The cardinal manifestations of such injury ranges from clinically silent to deadly cardiac wall rupture in contrast to the penetrating cardiac injuries, they most often reported with external injuries. Blunt chest trauma may produce great vessel and cardiac injuries, including the pericardium, myocardium, coronary arteries, and cardiac conduction system.² Blunt cardiac injury is the most clinically under diagnosed traumatic injury in the adult and pediatric population³, this kind of injuries significantly increases morbidity in poly trauma patients and in many cases, it leads to unexpected death.

In coronary artery disease cardiac rupture is most common complication of acute myocardial infarction, which include free-wall rupture (FWR) and ventricular septal rupture (VSR). They are considered to be a major lethal complication of coronary artery disease with uncertainty.

Rupture of the left ventricular (LV) free wall during acute myocardial infarction (AMI) is nearly always fatal, and a higher frequency has been reported in hypertensive compared with normotensive patients, and during the first AMI ventricular ruptures were most frequent than compared with second or third infarcts due to dense fibroblast and collagen accumulation over the infarct site.⁴

Becker and colleagues identified 3 types of myocardial rupture. Type 1 rupture is characterized as an abrupt, slit-like myocardial tear and corresponds to the acute phase of MI (<24 hours). In type 2 rupture, an area of myocardial erosion is evident, indicating a slowly progressive tear. Type 3 rupture has marked thinning of the myocardium and perforation in the central portion of aneurysm, which typically occurs during the late phase of MI (>7 days).⁵

The exact incidence and pattern of cardiac rupture after blunt chest trauma and coronary artery disease is unknown as rates reported vary significantly in the literature, and there is a significant number of cases with atypical presentation hence the present study is undertaken to identify the exact pathophysiology and bio mechanism of cardiac rupture.

Aims and Objectives

1. To estimate most common site of cardiac rupture in relation to blunt cardiac injury and in coronary artery disease.
2. To estimate most common biomechanics involved in cardiac rupture.
3. To estimate most common etiology involved in cardiac rupture amongst blunt cardiac injury and in coronary artery disease.

Study Design: Retrospective Cross Sectional Study done in cases with the postmortem findings and hospital records suggestive of cardiac rupture, subjected for post-mortem examination in Govt Stanley medical college and hospital, in the year 2017-2019.

Inclusion criteria:

Post-mortem records of death individuals with the cause of death as cardiac rupture, over the past three years.

Exclusion criteria:

1. Post-mortem records of individuals with cardiac disease other than rupture.
2. Cases with penetrating cardiac injuries, and blunt cardiac injuries with pericardial and cardiac contusions, coronary vessel dissections.
3. Iatrogenic cardiac rupture due to resuscitation and cardiac catheterization were excluded from the study group.

Material and Methodology

The incidence and clinical characteristics of Cardiac rupture in blunt cardiac injury and coronary artery disease will be documented and classified based on autopsy reports and hospital case sheet records for a period of 3 years from 2017 to 2019 and they will be analyzed retrospectively in Department of forensic medicine, Government Stanley medical college and hospital, Chennai using a standardized proforma based on previous studies.

The Etiology, biomechanics, anatomical location and type of myocardial rupture based on Becker's

classification will be identified and documented in the standardized study proforma based on the autopsy files and by the available clinical records.

Results and Discussion

In the retrospective study population a total of 1326 cases was died due to traffic accidents, fall from height , assault cases, in that 426 cases had a medical history and autopsy findings suggestive of blunt cardiac injury. And 1058 cases was died due to sudden cardiac arrest in that 792 cases had autopsy findings and histopathological findings suggestive of

coronary artery disease.

Of 426 cases of blunt chest trauma 28 cases had cardiac rupture, amongst Becker type I rupture seen in 26 cases and type II rupture seen in 2 cases due to delayed cardiac rupture (Image 1&2). Amongst 792 cases of coronary artery disease with myocardial infraction 13 cases had cardiac rupture in that Beckers type I rupture noted in 5 cases and type II were noted in 8 cases. Beckers type III rupture were not presented in the retrospective study population (Table 1 & 2)

Table 1: Shows number cases with cardiac rupture among study group

Study group	Total number of cases	Cases with cardiac rupture
Blunt chest trauma(traffic accidents, fall from height, assault)	426	28
Coronary artery disease with myocardial infraction	792	13
Total	1218	41

Table 2: Shows Beckers classification of cardiac rupture among study group

Study group	Type I rupture	Type II rupture	Type III rupture	Total cases
Blunt chest trauma(traffic accidents, fall from height, assault)	26	2	-	28
Coronary artery disease with myocardial infraction	5	8	-	13

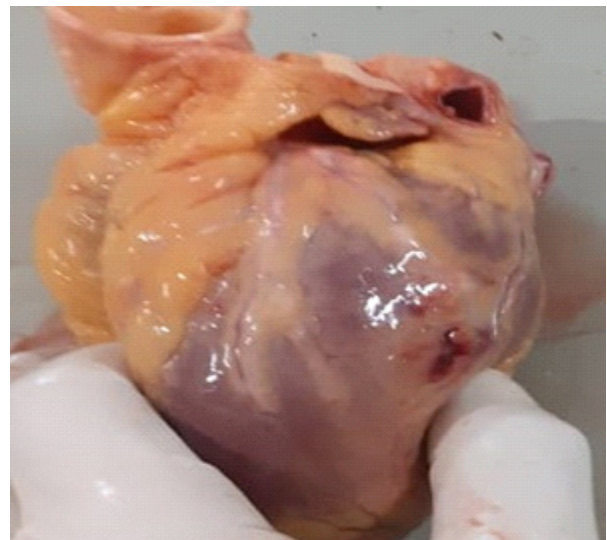


Image 1 and 2: Shows backers type I and II cardiac rupture

Table 3: Shows various type of biomechanical force involved in blunt chest injuries and coronary artery disease with myocardial infraction.

Types of biomechanical force	No of cases
Sudden acceleration/ Deceleration	11
Direct impact	4
compressive force by sternum and dorsal vertebraes	6
concussion	3
high ram effect	2
Low velocity injuries to the chest wall	2
hypertension	13

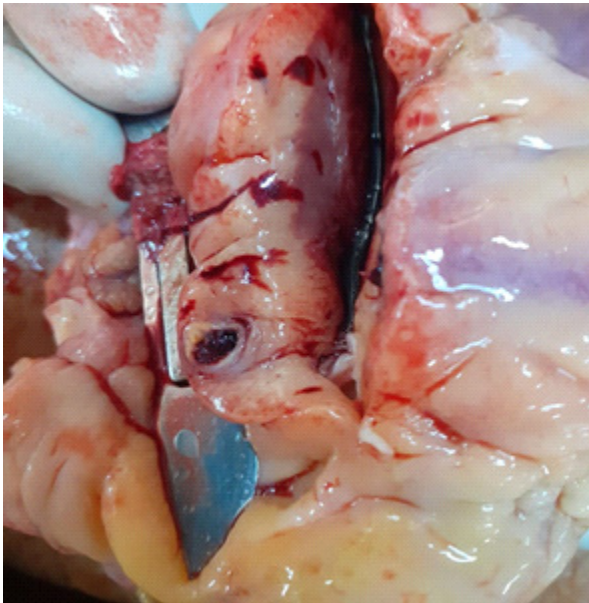


Image 3: Shows occlusion of left anterior descending artery.

In the study group, Male cases were predominantly seen in both blunt chest injuries and in coronary artery disease and most of the cases were in the age group of 31-60 years. And there is a significant association were noted between middle aged male and hypertension, in the study group hypertension was demonstrated in the form of clinical records, concentric left ventricular hypertrophy and by sclerosed blood vessels.

Amongst 426 cases of blunt chest trauma 298 cases were due to road traffic accident, 97 cases were due to fall from height and 31 cases were due to assault. Of 792 cases of coronary artery disease cases

atheromatous occlusion of left anterior descending artery (Image 3) were most commonly involved in 345 cases, next most commonly involved vessels were right coronary (254 cases) and left circumflex (143 cases) and , and in 50 cases there are involvement of both right and left coronary artery.

In cases of cardiac rupture due to blunt chest injuries 12 cases had rupture over right ventricle, 9 cases had rupture in left ventricle, 4 cases had rupture in interventricular septum , 2 cases at the level of arch of aorta and 1 case had rupture over annular margin of atrio ventricular valve. the most common site for cardiac rupture in blunt chest injuries were right ventricle and next most common sites were left ventricle, and interventricular septum. in blunt chest injuries no atrial ruptures were noted in the study group.

In blunt cardiac injury various pattern of thoracic injuries were identified in that rib fractures were most commonly noted in 266 cases, sternum fracture were seen in 81 cases, thoracic vertebrae fracture was seen in 62 cases and minimal soft tissue injury seen in 13 cases.

In a study conducted by Waele J.J.D. et. al.,⁶noticed that blunt cardiac injury was common after sternum fracture and the severity of the fracture was an indicator of possible myocardial damage. In the present retrospective study left side rib fractures was the most common thoracic Injury associated with cardiac rupture. 2 in 13 cases had no significant high velocity injuries like fractures and tissue lacerations. But in these cases the minimal blunt force chest injuries produces cardiac rupture in left ventricular free wall due to the pre existing cardiac disease and in sum cases delayed rupture were noted in concussion cardiac injuries due to delayed transmural necrosis of myocardium.

Furthermore, cardiac rupture may happen rarely in cardiac resuscitative procedure due to severe compressive injury to the thoracic cage and these injuries should be overlooked and excluded in the study population⁷. In some studie the authors did not exclude the influence of CPR or other iatrogenic factors during the process of cardiac rupture, in our study we excluded these cases in study population.

In coronary artery disease with myocardial infarction 11 cases had rupture in left ventricle free wall and 2 cases had rupture in interventricular septum. and in The present study showed that first MI, anterior infarct, male sex, and aged >40 years remain significant risk factors for Cardiac rupture and they are consistent with previous study findings done by Figueras J, Alcalde O et. al⁸ High blood pressure could play an important role in the development of Cardiac rupture since it dramatically increases intracavitary pressures and shear stress force against the necrotic area during myocardial contraction, leading to a tear.

In a study conducted by Bates RJ, Beutlers.. et. al.⁹ the incidence of myocardial hemorrhage in infarcted areas and the proportion of Becker type 1 and 2 ruptures were higher in patients undergoing cardiac catheterization and fibrinolysis than in those who did not receive reperfusion therapy. and our study findings were inconsistent with the above mentioned study.

The most common biomechanics noted in blunt chest injuries are due to traffic accidents were sudden deceleration and acceleration noted in 11 cases, compressive force by sternum and dorsal vertebrae's in 6 cases, concussion injury based on pascals law seen in 3 cases, low velocity injuries in 2 cases and high ram effect in fall from height cases were seen in 2 cases.

In a study conducted by Qi Wang, Lingyun Yang et. al. demonstrated more than one mechanism were involved in cardiac rupture. Ruptures can be sporadic or multiple and occur in atriums, ventricles, interatrial septum, interventricular septum, heart valves, blood vessels and papillary muscles.¹⁰ In our retrospective study also attributed multiple biomechanical factors were involved in cardiac rupture and in coronary artery disease hypertension is the most common biomechanical factor involved in cardiac rupture. (Table 3)

Conclusion

Cardiac rupture is the most severe form of blunt chest injury. as most of the cardiac rupture have associated with left side ribs and sternal fractures, a proper monitoring of these victims is desired in blunt thoracic trauma cases. Injuries associated with heart

rupture, like rib fractures, brain injury, contusions and etc, are used to judge the magnitude level, the direction and the characteristic of the force applied on the body. In the present study it has been proved that a diseased heart is more susceptible to traumatic injury than a normal one. The diseased heart is more likely to rupture at the fragile myocardium sites, Therefore, even a minor impact may be the triggering mechanism leading to cardiac rupture, and the lesion on the body surface may be minimal. In rare conditions, cardiac rupture may caused by a combination of the two mechanism like myocardial infarction and blunt chest injury and making the clinical picture confusing and misleading. And the forensic pathologists should define whether the victim had diseased heart or not by the comprehensive anatomy and by the microscopic examinations to avoid medico legal issues in the respected cases. The presence of fatal cardiac trauma in head on collision cases emphasizes the utility of safety belts while driving and the Forensic pathologists should be aware of the characteristic of CPR-related cardiac rupture.

Limitations

In the present retrospective study impact of Cardiac cycle on rupture has been not made out clearly and The complexity of cardiac structure and the variety of external forces makes it hard to explain the various mechanisms of cardiac rupture. Due to minimal autopsy based studies on biomechanics and pathophysiology. The Cardiac rupture remains a puzzle and needs to be decoded by further prospective studies.

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Conflict of interest: NIL

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