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Early Detection of Myocardial Contusion and Its Outcomes in Patients with Blunt Chest Trauma

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ABSTRACT

Background: Polytrauma has a significant impact on the wellbeing and provided healthcare for the populations. More than fifteen percent of emergency room admission worldwide are due to blunt chest trauma (BCT), which comes in second most common cause of death in vehicle collisions after head injuries. Exposure of anterior chest wall to an abrupt high-speed deceleration injury results in thorax compression, which is a common cause of BCT. The trauma may cause damage to all thoracic structures.

Objective: In patients with acute chest injuries, the goal of this study was to identify the early onset of myocardial contusion and its consequences.

Patients and methods: This study was carried out over the course of a year in the Emergency Department of the Mansoura University Hospital. The research comprised 153 individuals who presented with solitary BCT.

Results: When compared to patients without myocardial contusions, the mean heart rate was statistically significantly greater in the cases with myocardial contusions. The global circumferential strains (GCS) and the mean arterial pressure (MAP) were statistically significantly lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions. In patients with myocardial contusions, the length of hospital as well as the length of intensive care unit (ICU) stays were statistically significantly longer.

Conclusion: The diagnosis of blunt chest trauma is exceedingly difficult since it can result in a broad variety of clinical manifestations and damage. Patients may arrive at the hospital with stable hemodynamics and no symptoms.

Keywords: Myocardial Contusion, Blunt Chest Trauma, Electrocardiograms**,** ICU.

INTRODUCTION

The term "myocardial contusion" refers to bruising or microscopic bleeding into the heart muscle brought on by forceful thoracic trauma. Myocardial contusion incidence among individuals with blunt thoracic trauma extends from zero to seventy six percent varying according to which diagnostic criteria was utilized[(1)].

The severity of a myocardial contusion may vary depending on the injury's scope and when it occurred. When it affects individuals who have experienced acute thoracic trauma, it can be fatal. The diagnostic strategy is still up for discussion. It should be suspected during triage in the emergency room as a primary cause of sudden mortality following traumatic chest injuries. The ability to safely release patients with suspected myocardial contusions who have normal electrocardiograms (ECGs) and biomarker testing has been proven [(2, 3)].

Because the patient's symptoms are vague and there is no optimum diagnostic test, diagnosing myocardial contusion is highly challenging. For detection, cardiologists use cardiac biomarkers, echocardiography, nuclear cardiac imaging, as well as electrocardiography (ECG); although none of these is hundred percent sensitive[(2)].

Suspected myocardial contusion approach will be very helpful in reducing the number of trauma patients admitted to hospitals and the frequency of unnecessary diagnostic procedures. Research indicated that the diagnostic tests, e.g. ECG, are useful in identifying those who are at risk of experiencing a severe thoracic trauma (traumatic contusion) on the chest[(4)].

Major thoracic trauma includes multiple rib fractures, concomitant pulmonary contusions, and hemothorax. It is highly advised avoiding adding biomarkers to the ECG under these circumstances. However, by assessing biomarkers at the start of the hospitalization and again 4-6 hours later, the negative predictive value of this approach alone in situations with an irregular ECG will be enhanced. A component of the class II predictive negative value is biomarker measurement [(4)].

Stages 1 and 2 test findings that are abnormal, the patient being in shock, or cardiac factors being taken into consideration call for an echo or long-term monitoring (twenty-four to forty-eight hours). Investigations have reduced the requirement for echocardiography in sternal fractures. Therefore, recommending regular echocardiograms is of very little use[(5, 6)].

In the emergency room, diagnosing myocardial contusion in trauma patients is still difficult, and the used procedures are the most expensive diagnostic procedures [(2)].

In patients with acute chest injuries, the goal of this study is to identify the early onset of myocardial contusion and its short-term consequences.

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PATIENT AND METHODS

This study, which was cross-sectional and descriptive and analytical, was carried out for a year at the Mansoura University Emergency Hospital in Mansoura, Egypt, from May 2021 to May 2022. The current study involved 153 cases with isolated blunt chest trauma who were selected according to the following criteria:

Inclusion criteria: Age ≥ 18 years to 60 years old, both males and females were included.

Exclusion criteria: less than 18 years old, polytrauma cases, cases with cardiac diseases, and refusal of the patient.

Ethical consideration:

The Institutional Review Board (IRB), Mansoura University's Faculty of Medicine, gave its approval to the entire study design. At every stage of the investigation, confidentiality and personal privacy were observed. Before being included in the study, each participant or their parents/guardians gave written informed permission that included information about the importance of the study as well as the steps that would be taken. The Declaration of Helsinki, the World Medical Association's code of ethics, was followed when conducting this research on humans.

Methods:

- **The primary survey:**

The first resuscitation and main evaluation happened simultaneously. Before going on to the next phase, any life-threatening problem detected had prompt remedial action performed, and its consequences were assessed. The "ABCDE" technique was used for the primary evaluation.

A. **Airway and cervical Spine:** The airway was the first priority in the resuscitation phase. GCS score ≤8 during the initial evaluation was an indication for intubation.
B. **Breathing and ventilation:** Adequate gas exchange was required to prevent hypoxia and hypercapnia as causes of secondary brain injury.
C. **Circulation and bleeding control:** Adequate cerebral perfusion pressure (CPP) was tried to be maintained by keeping adequate blood pressure and avoiding hypotension. For adults, systolic BP was maintained >100 mmHg.
D. **Disability and neurologic assessment:** The state of awareness was determined using a quick neurological evaluation that took into account the GCS, the size, symmetry, and responsiveness of the pupils, as well as any lateralizing signals.
E. **Exposure and environment control:** The patients were completely undressed by cutting off the clothes to allow complete examination. After examination, heat loss was prevented with warming devices, warmed blankets, etc.

To complete the 1ry survey and resuscitation: (i) Electrocardiography (ECG), (ii) Insertion of urine catheter (urine output, color) if not contraindicated, and (iii) Nasogastric tube if indicated.

- **The secondary survey:**

I. Following the initial resuscitation attempt, all patients had a thorough history taking process that included age, gender, the type and timing of the trauma, the time of arrival, and the resuscitation.

II. **AMPLE History taking:** **A** = **A**llergies. **M** = **M**edication currently used. **P** = **P**ast illnesses/**P**regnancy. **L** = **L**ast meal. **E** = **E**vents/**E**nvironment related to injury.

III. **Clinical examination** of the patients at the trauma room including: **(1) Vital signs:** respiratory rate and pattern, blood pressure, as well as pulse. **(2) Full general examination:** complete check from head to toe to identify any additional or hidden injuries. **(3) Local chest examination:** Inspection, palpation, percussion, and auscultation were among the procedures used.

IV. **Laboratory Investigations:** Complete blood count. Blood urea (mg/dl), serum creatinine (mg/dl), serum sodium (mmol/l), and serum potassium (mmol/l). Serum albumin and random blood glucose (mg/dl), and arterial blood gases (with calculation of base deficit).

V. **Radiological investigations:**
   1. **Focused Assessment with Sonography for Trauma (FAST scan):** The primary objective of FAST was to identify the presence of hemoperitoneum in a patient with suspected intra-abdominal injury.
   2. **X-ray:** Chest, pelvis, spinal and extremities X-ray: Anteroposterior and lateral view as possible.

Specific investigations:

1. **Electrocardiogram (ECG)** [7, 8]: Within 10 minutes of first medical contact (FMC), a standard 12-lead ECG was performed in accordance with ESC recommendations, which included: (limb leads I, II, III, aVR, aVL, aVF, and Chest leads from V1 to V6) for all patients on admission to the hospital. Right pericardial leads (V3R, V4R, V5R, V6R) and posterior chest leads (V7 to V9) were done for some patients to detect posterior wall and right ventricular infarction.

2. **Echocardiography:** Every study was conducted utilizing an M4S transducer with a 4 MHz frequency, a GE Vivid Seven cardiac ultrasound phased array system.
3. **Cardiac enzymes:** Using an electrochemiluminescence immunoassay, highly sensitive cardiac troponin (Hs-cTnT) was assessed (Cobas e601; Roche Diagnostics, Indianapolis, IN, USA).

Diagnosis of cardiac contusions:

An increased hs-cTnT level together with aberrant ECG or echocardiogram results were necessary for the diagnosis of blunt cardiac injury (BCI).

Follow Up and outcome: Length of hospital stay, ICU admissions, mechanical ventilation, and mortality rate.

Statistical analysis:

Utilizing SPSS (Statistical Package for the Social Sciences) version 26 for Windows, the gathered data were coded, processed, and analysed (SPSS Inc, Chicago, IL, USA). The Shapiro Wilk test was used to check the data for normal distribution. Frequency distributions and relative percentages were used to display qualitative data. The difference between qualitative variables was determined using the chi square test. The mean SD (Standard deviation) format as well as median and range were used to convey quantitative data. The Mann Whitney U test was used for non-normally distributed data, whereas the t-test was used to compare two independent groups of regularly distributed variables. Results from significance tests are shown as two-tailed probability. P values below 0.05 and below 0.001 were considered significant and highly significant, respectively.

RESULTS

The study included 153 cases with isolated blunt chest trauma. Demographic data and mode of trauma are shown in table 1. Automobile accidents were the most frequent kind of trauma.

Table (1): Demographic and mode and trauma data (n=153)

Age (years)		
Mean ± SD	38.34 ± 15.1	
Median (Min-Max)	36 (18-59)	
Gender	**Frequency**	**Percentage**
Male	126	82.4%
Female	27	17.6 %
Mode and trauma		
Road traffic accidents	117	76.5 %
Falling from height	21	13.7 %
Assault	15	9.8 %

The items of initial examination in the cases of the study are shown in table 2. Myocardial contusion was detected by diagnostic criteria in 34 cases (Table 2 and figure 1).

Table (2): Items of general examination, analysis of the X-ray findings, and findings suggestive of myocardial contusions in cases included in the study (n=153)

Pulse		
Mean ± SD	88.19 ± 17.48	
Median (Min-Max)	86 (55-150)	
MAP		
Mean ± SD	95.72 ± 22.68	
Median (Min-Max)	90 (40-150)	
Cause of the trauma	**Frequency**	**Percentage**
GCS < 8	29	18.9 %
GCS 9-12	81	52.9 %
GCS 13-15	43	28.2%
X-ray findings		
Fracture ribs	76	49.7%
Lung contusions	43	28.1%
Obliteration of costophrenic angles	17	11.1%
Tension pneumothorax	38	24.8%
Myocardial contusions		
ECG findings		
Negative	116	75.8 %
Positive	37	24.2 %
Echo findings		
Negative	125	81.7 %
Positive	28	18.3 %
Cardiac enzymes (cTn)		
Negative	106	69.3 %
Positive	47	30.7 %
Myocardial contusions		
No myocardial contusions	119	77.8 %
Myocardial contusions	34	22.2 %

Cases mean age with myocardial contusions was statistically significantly higher as compared with cases with no myocardial contusions (Table 3).

Table (3): Demographic data in the cases according to myocardial contusions

Items	**Group I (Myocardial contusions) (n=34)**	**Group II (No myocardial contusions) (n=119)**	**p-value**
Age (years)	43.9 ± 8.27	35.28 ± 7.61	**< 0.001***
Sex			
-Male	**27 (79.4%)**	**99 (83.2%)**	
-Female	**7 (20.6%)**	**20 (16.8%)**	**0.363**

*: Statistically significant

Regarding mode of trauma, in patients with and without myocardial contusions, there was no statistically significant difference (Table 4).

Table (4): Comparison of the mode of trauma in the cases according to myocardial contusions

	Group I (Myocardial contusions) (n=34)		Group II (No myocardial contusions) (n=119)		P value
Road traffic accidents	25	73.5%	92	77.3%	0.142
Falling from height	5	14.7%	16	13.4 %	
Assault	4	11.8%	11	9.2 %	

When compared to patients without myocardial contusions, the heart rate was statistically significantly greater in the instances with myocardial contusions. The GCS on admission was statistically significant lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions group. The MAP was statistically significantly lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions (Table 5).

Table (5): Analysis of items of general examination on admission in the cases according to myocardial contusions

	Group I (Myocardial contusions) (n=34)	Group II (No myocardial contusions) (n=119)	P value
HR	99.34 ± 22.48	82.14 ± 17.17	0.005*
MAP	81.64 ± 19.09	94.33 ± 21.23	< 0.001*
GCS	9 (3-13)	13 (8-15)	< 0.001*

*: Statistically significant

The length of hospital stay and length of ICU stay were statistically significant longer in the cases with myocardial contusions. The percentage of cases who required mechanical ventilation was statistically significant higher in the cases with myocardial contusions. When compared to instances without myocardial contusions, the death rate was statistically considerably greater in the cases with myocardial contusions (Table 6).

Table (6): Analysis of outcome variables in the cases according to myocardial contusions

	Group I (Myocardial contusions) (n=34)	Group II (No myocardial contusions) (n=119)	P value
Length of ICU stay	8 (3-12)	2 (1-7)	< 0.001*
Length of hospital stay	12 (5-19)	3 (1 - 10)	< 0.001*
Requirement for mechanical ventilation	23 (67.6%)	32 (26.9%)	< 0.001*
Mortality	13 (38.2%)	12 (10.1%)	< 0.001*

DISCUSSION

153 patients with isolated blunt chest injuries who were recruited from Mansoura University Emergency Hospital over the course of a year were included in the current research. The study included 153 cases with isolated blunt chest trauma. There were 27 women and 126 men (82.4, 17.6 percent) with mean age of 38.34 ± 15.1 years with range between 18 and 59 years.

Our findings were similarly consistent with those of **Vargas *et al.*** [9] who revealed that 60 of the 76 patients with chest injuries who were included in their research were men (79 percent). There were people ranging in age from 18 to 82, with a mean age of 32. The results of the current study also came in agreement with **Ianniello *et al.*** [10] who included a total of 3320 consecutive major traumatic patients (1844 males and 1476 women, ages 18 to 81, with a median of 41 years) who were admitted to their emergency department. Similar findings were reported by **Cortés-Samacá *et al.*** [11] who found that the mean age of the 196 trauma patients included in their study was 30 years old, and that 91.84 percent of the patients were men.

The high prevalence of male gender in all of these studies could be explained by the results reported by **de Vasconcelos and Ribeiro** [12] who revealed that most of trauma victims are males due to their challenging behavior, with more involvement in high-risk activities.

In the current study, traffic accidents were the most frequent kind of trauma in the cases that were included (76.5 percent), falling from height in 21 cases (13.7%), and assault in 15 cases (9.8%). This agreed with **Link** [13], who demonstrated that high-speed car collisions were the most common reported cause of blunt chest injuries, followed by falls from a height or

instances involving crushing. Also, in accordance with our results, **Emet *et al.*** [14] showed that motor vehicle accidents (MVAs) and falls from a height were the most frequent causes of trauma (71 percent each), with other causes accounting for the remainder of the cases (6 percent).

In the current study, among the included cases, there was 18 asymptomatic cases (11.8%) and 135 symptomatic cases (88.2%). The symptoms included chest pain in 115 cases (85.2%), palpitation in 43 cases (31.9%), cyanosis in 22 cases (16.3%) and orthopnea in 16 cases (11.9%). The signs included tenderness in 111 cases (82.2%), hypoxia in 34 cases (25.2%), shocked in 52 cases (38.5%), tachypnea in 63 cases (46.9%) and tachycardia in 48 cases (35.6%).

Similar findings were made by **Salama *et al.*** [15], who demonstrated that chest pain (88 percent) and dyspnea are the most frequent symptoms presented by patients with chest injuries (72 percent).

In the current study, the X-ray findings in the study's cases revealed 76 instances (49.7%) of fractured ribs, 43 cases (28.1%) of lung contusions, 17 cases (11.1%) of obliterated costophrenic angles, and 38 cases (38%) of tension pneumothorax (24.8 percent).

In the **Joseph *et al.*** [16] investigation, all trauma patients with BCI diagnoses were subjected to an 8-year retrospective examination. Rib fractures made up 57% of all thoracic injuries (n=67), followed by pneumothoraxes (36%, n=43), and hemothorax (29%, n=35). Our findings are consistent with earlier research that found a slightly increased rate of rib fractures in individuals who had acute chest trauma [17, 18]**. Awais *et al.*** [19] observed a lower incidence of rib fractures, showing that 36.2 percent of patients with chest injuries overall had rib fractures in their research group.

The discrepancy might be attributed to different selection criteria since our study only included cases of blunt chest trauma whereas the subsequent study included patients with both blunt and penetrating chest injuries. Blunt chest trauma has a greater frequency of rib fractures.

In this study, lung contusions in 43 cases (28.1%) were detected by X-ray. Pulmonary contusion is thought to be a relatively benign lesion that, if treated appropriately, does not increase the morbidity or mortality of patients with acute chest injuries, according to **Rashid *et al.*** [20]**. Huber *et al.*** [21] found that lung injuries such contusions or lacerations were only a reliable indicator of death if they were large or bilateral.

In the current study, positive (elevated) cardiac enzymes (cTn) were detected in 47 cases (30.7%). This was slightly lower than that reported by **Joseph *et al.*** [16] who showed that Troponin I levels were increased in 43% (n=49) of the patients.

However, in the study conducted by **Keskpaik *et al.*** [22], which included 147 patients, on admission, 82 patients (55.8%) had serum troponin levels measured, and 65.9% had high HscTnT levels. The difference between the two studies could be explained as the later study didn't analyze all the cardiac enzymes in all the included cases, but only in the cases with high suspicion for cardiac contusions and this could explain the higher incidence of positive elevated enzymes. Additionally, the inclusion criteria may be to blame for the difference in the occurrence of high cardiac enzymes since elevated hs-cTnT levels are linked to a number of characteristics, such as age, gender, renal insufficiency, and heart failure.

There is debate concerning troponin I's place in the BCI diagnosis. In their investigation, **Biffl *et al.*** [23] discovered that troponin I levels were insensitive for identifying BCI. However, a number of investigations, including the current study, have indicated that troponin I can be used to determine the degree of myocardial injury.

In the current study, according to ECG findings, myocardial contusion was detected in 37 cases (24.2%). This was similar to **Keskpaik *et al.*** [22] who showed that admission of 34 of the 73 individuals (49.7%) who had an ECG; had abnormal results (46.6 percent). Nine individuals had abnormal results among the 24 (16.3 percent) patients who had echocardiography (37.5 percent). Much higher positive rate was reported by **Joseph *et al.*** [16] who showed that 88 percent (n=105) of the population had a heartbeat that wasn't normal (ECG).

The electrocardiogram is a crucial diagnostic tool for detecting BCI in patients with recent chest trauma (ECG). The ECG following a BCI might be normal or show general abnormalities [24]. It's possible that individuals with thoracic trauma who don't have elevated troponin levels have cardiovascular concussion, the mildest kind of cardiac damage, which doesn't include either a pathological or chemical myocardial cell injury.[3].

Our investigation revealed that an extremely wide variety of abnormal ECG findings, including various atrial and ventricular rhythms, bundle branch blockages, and dysrhythmias, were present in 30-75 percent of individuals with BCI after blunt thoracic trauma (BTT)[25]. This wide range demonstrates how unreliable ECG findings are.

In the current study, according to echocardiographic findings, myocardial contusion was detected in 28 cases (18.3%). According to **Velmahos *et al.*** [26] research, half of the individuals with substantial BCI had abnormalities discovered during echocardiography. **Salim and co-authors** observed similar findings [27]**.** Similarly, **Boeken *et al.*** [28] discovered that 7 out of 17 patients who experienced acute chest injuries had an abnormal echocardiogram.

According to a prior study, the rate of cardiac damage following blunt chest trauma varied greatly,

ranging from 8% to 86% [29]. In the current study, according to the combination of diagnostic criteria, myocardial contusions were detected in 34 cases (22.2%). Our results were almost equal to **Emet *et al.*** [14] who showed that 22 patients made comprised the BCI group, and the prevalence of thoracic injuries was 25%.

Histologically, myocardial muscle cell necrosis is a hallmark of cardiac trauma. As a result, the best diagnostic tools for identifying myocardial damage are cardiac enzymes.[30]. For the purpose of identifying individuals who run the risk of complications from myocardial contusion, the use of troponin in combination with ECG is also advised[31].

In the current study, the heart rate was statistically significantly lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions. The GCS on admission was statistically significantly lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions group. The MAP was statistically significantly lower in the cases with myocardial contusions as compared with the cases with no myocardial contusions.

This agreed with **Emet *et al.*** [14] who showed that the mean heart rate was 107.9 ± 24.2 b/min and 82.8 ± 15.8 b/min in the cases with and without cardiac injury respectively with statistically significant difference between the two groups. Also, the mean GCS was 14.1 ± 1.7 and 14.7 ± 1.2 in the cases with and without cardiac injury respectively, with a difference between the two groups that is statistically significant.

The rate of death in the current research was 16.3% (25 cases). Our findings were comparable to those of **Fokin *et al.*** [32] who reported a death rate of 16% in their BCI patients. This was in accordance with the findings of **Keskpaik *et al.*** [22] who demonstrated that the total in-hospital death rate was 17.0 percent (25/147). In the same context, our findings were likewise comparable to the 19 percent death rate in blunt trauma patients with BCI described by **Grigorian *et al.*** [33].

Additionally, the incidence of death in the current research was statistically substantially greater in patients with myocardial contusions than in cases without myocardial contusions. Higher incidence of mortality was reported by **Emet *et al.*** [14] who showed that the incidence of mortality in their study was 25% and all the cases who died had cardiac injuries with no mortality detected in the cases without cardiac injury.

CONCLUSION

Based on the results of the current study, it could be concluded that:

- The diagnosis of blunt chest trauma (BCT) is quite difficult since it can result in a broad variety of clinical manifestations and damage. Patients may arrive at the hospital with stable hemodynamics and no symptoms.
- The myocardial contusions represent a serious complication associated with blunt chest trauma.
- Presence of myocardial contusions lead to serious outcomes including increased duration of hospital admission and higher incidence of mortality.

RECOMMENDATIONS

- Early management and stabilizations of patients presented with polytrauma and especially blunt chest trauma for prevention of related complications.
- Utilization of other diagnostic tools for early detection of myocardial contusions.

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