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Penetrating cardiac injury: factors affecting outcomes in a developing country

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ABSTRACT

The purpose of this investigation was to evaluate factors affecting the outcome following penetrating cardiac trauma in a developing country and to compare our results with others in developed countries. Analysis of the cause of trauma, age, sex, different tools of investigations used, concomitant organ injuries, SBP, GCS, ISS, RTS, TRISS and mortality were performed. This study included 35 patients; all were males. Mortality rate was 22.8%. It was significant with low SBP (p =0.021), GCS < 9 (p =0.02), non-presentation with tamponade (p = 0.023), low ISS (p =0.02), low RTS (p =0.007), low TRISS (p = 0.003), less blood transfusion (p =0.001) and longer time before entrance to OR (p= 0.019). Meanwhile, mortality were not significant with age (p =0.33), mechanism of injury (p =0.16), other associated injuries (p =0.16) or associated intra-abdominal injuries (p= 0.16). Rapid assessment and prompt surgical intervention may reduce mortality. Even in a developing country, mortality rates could reach those in developed countries depending on clinical skills and accessible technology tools.

Key words: Thoracic injuries, penetrating cardiac injuries, thoracic trauma

INTRODUCTION

Penetrating thoracic traumas are the major causes of cardiac injury. (Tariq et al., 2011; Cury at al., 2009) It is mostly attributed to violence and it has a higher mortality rate than that of the blunt chest trauma. Penetrating cardiac injuries are associated with high mortality rates. The majority of patients with penetrating cardiac injuries die on scene despite aggressive resuscitation attempts. Moreover, those who do survive the initial assault pose a difficult challenge to trauma surgeons (Alexander and Dan, 2012). The survival rate in patients with penetrating cardiac injuries has been improved because of advances in pre-hospital care (PHC), fast transportation to trauma-referenced facilities, and advances in pre-operative trauma surgery (Bruno et al., 2013) .

PATIENTS AND METHODS

Patients:

The trauma registry for patients presented to the Alexandria Main University hospital, Egypt, with penetrating cardiac injury in a period of one year (June 2013 - June 2014) was retrospectively reviewed. The medical records of those patients were individually reviewed. Only the patients who had penetrating cardiac injuries were included in this study. The cardiac diamond is bounded by the sternal notch superiorly, the nipples laterally, and the umbilicus inferiorly. Any injury with an entrance wound within this area must draw the attention to the possibility of cardiac injury (Niall and Kieran, 2011). Patients with chest penetration out of the cardiac diamond area

were excluded from this study. Additionally, patients with blunt injuries were also excluded.

Methods:
Analysis of the cause of trauma, age, sex, different tools of investigations used, concomitant organ injuries, Systolic Blood Pressure (SBP), Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Revised Trauma Score (RTS), Trauma Revised Injury Severity Score (TRISS), methods of assessment, type of surgical intervention, morbidity and mortality were performed.

Statistical analysis:
The results were expressed as means, standard deviation (SD), counts and percentages. Univariate analysis was performed using a $\chi 2$ test for categorical data. Fisher's exact test was used when a data table had at least one cell with an expected frequency of < 5. An independent t-test and f test were used for continuous variables. When a significant main effect was detected, the means were separated by Duncan's multiple range tests. Differences were considered to be significant at the ($p \leq 0.05$) probability level. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS 14) for Windows (SPSS, 2005).

RESULTS AND DISCUSSION

One thousand one hundred and twenty patients were admitted at ED with different types of thoracic trauma during the one year period of this study. Four hundred-nine patients of them had penetrating thoracic injuries from which 35 patients had penetrating cardiac injuries (8.6%) and were included in this study.

The overall mortality was 22.8%. This value was lower than the value (39%) reported by Ceviker et al., (2014) and higher than the value (10%) reported by Clarke et al. (2011). This variation in mortality rate is attributed to the difference of the surgical skills between surgical teams in the three hospitals in addition to the other factors which may not be mentioned in the three studies like time elapsed between injury and arrival to the ED, time elapsed from the arrival to ED and transfer to operating room, postoperative complications and presence of other pre-operative co-morbidities.

Factors significantly affect mortality:
Three patients arrested on arrival, all of them had SBP $\leq$ 90 mmHg, while five patients arrested intra-operatively with mean SBP was 58±34.93mmHg, all of them had SBP $\leq$ 90 mmHg which was significantly lower ($p = 0.021$) than the other twenty-seven patients who survived (Mean SBP 81.11±36.83 mmHg (Table 1 and Fig 1). This was in accordance to many authors as Ceviker et al (2014) they reported that the systolic blood pressure was the only consistent predicting factor in the outcome as 59.4% of the patients, blood pressure was below 80 mmHg and the mortality rate in his group of study was 97.3%. Meanwhile, Serdar et al. (2011) reported that patients who died had a significantly lower systolic blood pressure (SBP) on presentation at the ED (42.94±36.702 mm Hg) than those who survived (83.96±27.842 mmHg; $p = 0.001$).

Two patients from those who were presented by tamponade were arrested intra-operatively which was significantly lower ($p = 0.023$) than the six patients who survived (Table 1 and Fig 2). This was in favor with the theory stating that tamponade had a protective effect and increases survival rate in those patients. Contrary to the study of Ceviker et al. (2014) they reported that the mortality rate was higher in the patients who had cardiac tamponade. The cardiac tamponade may generally indicate presence of cardiac penetration. This may necessitate immediate surgery. Uncertainties in the undefined period in which tamponade is providing a protective effect by preventing the bleeding and thereby preventing hypovolumic shock, could lead to a harmful effect. After this undefined period of time, tamponade itself induces adverse effects on cardiac function which is critical and the cardiovascular collapse may induce an exhaustion of cardiac reserve irrespective of whether the surgery was successful or not.

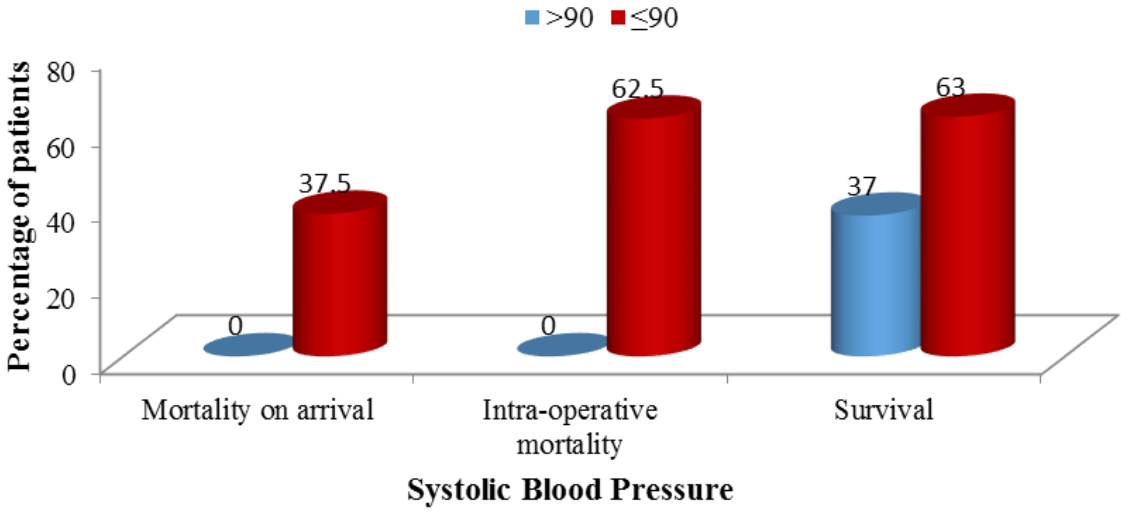

Figure 1: Effect of systolic blood pressure on mortality

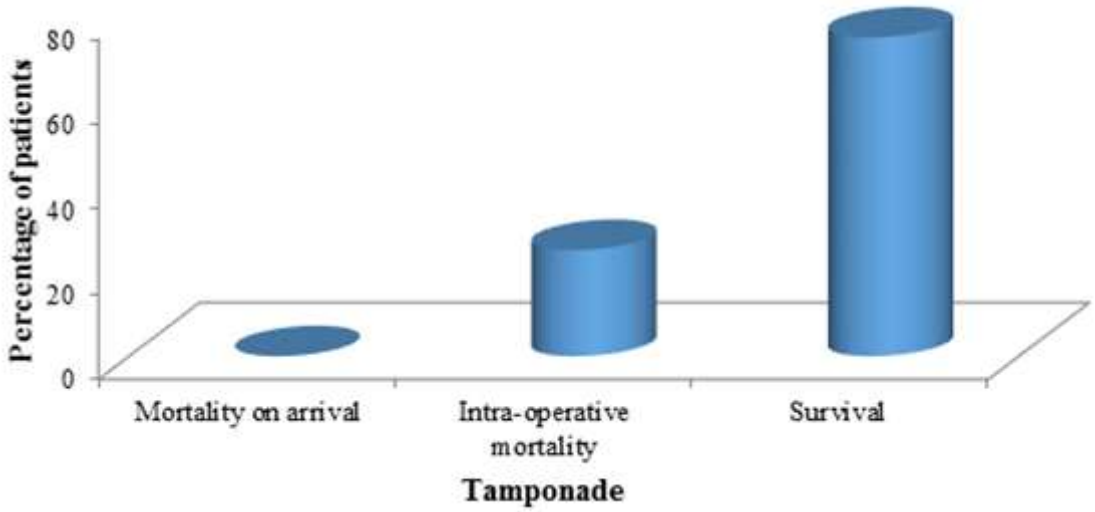

Figure 2: Effect of tamponade on mortality

Three patients were arrested on arrival with mean GCS 5±3.46, while five patients arrested intra-operatively with a mean GCS of 10.6 ± 4.98, which was significantly lower (p = 0.025) than the twenty-seven patients who survived with a mean GCS of 13.19±3.91 (Table 1 and Fig 3). This means that high score of GCS is a one of the good outcome determining factors. This result agree with those reported by Bruno et al., (2013) they reported that GCS < 8 (p = 0.0005) is significantly associated with mortality. Moreover, O'Connor et al., (2009) reported that patients who are unconscious on admission may have mortality rate reaching 94%. Unfortunately, they didn't specify the level of consciousness on GCS. Ceviker et al., (2014) reported that GCS was significantly lower in his study than those of the previous studies in the literature.

The three patients who arrested on arrival had ISS 16, RTS 4.49±3.91 and TRISS 68.46±46.85, while five patients who arrested intra-operatively had ISS 16, RTS 3.72±2.72 and TRISS 47.76±45.68, which was significantly lower (p = 0.026, 0.007, 0.003 respectively) than the twenty- seven patients who survived (ISS 20.07±3.91, RTS 6.27±1.66

and TRISS 91.64±16.93), (Table 1). This result was in accordance with Bruno et al., (2013) they reported that the low RTS is significantly associated with mortality. On the contrary, Serdar et al., (2011) reported that high ISS is significantly associated with mortality. Meanwhile, none have mentioned TRISS and its relation to mortality.

The five patients who arrested intra-operatively had blood transfusion (Mean 3250±1500 ml, which was significantly lower (p = 0.001) than that in the twenty-seven patients who survived (Mean 3772.7±2483.1 ml). This was mainly one of the causes of death in these patients as blood loss is highly expected in such operations and unavailability of blood products to transfuse will definitely lead to exsanguinations in the patients (Table 1). This differed from the results of Serdar et al. (2011) they reported that the mean amount of transfused blood to the non-survivor was7.18±4.87 L in comparison to the survivor group (Mean 3.36±1.80), (p = 0.005).

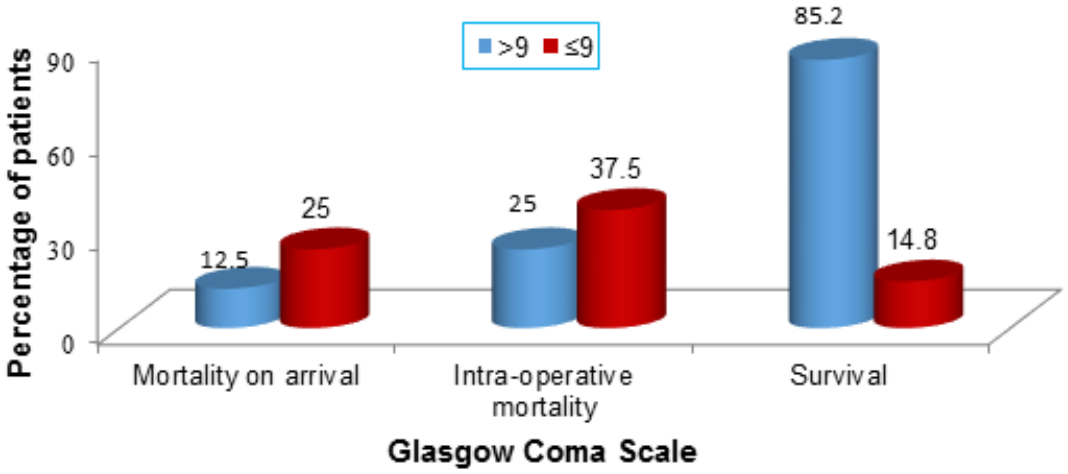

Figure 3: Effect of Glasgow coma scale on mortality

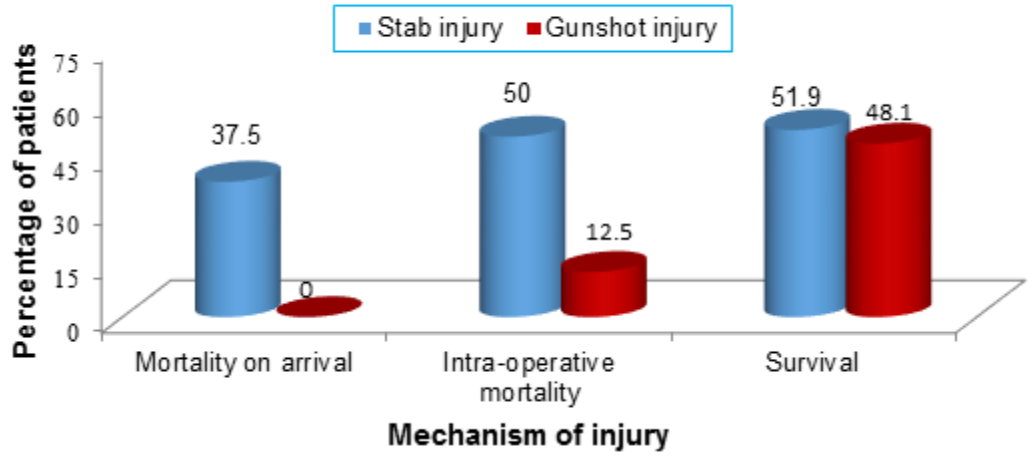

Figure 4: Effect of type of injury on mortality

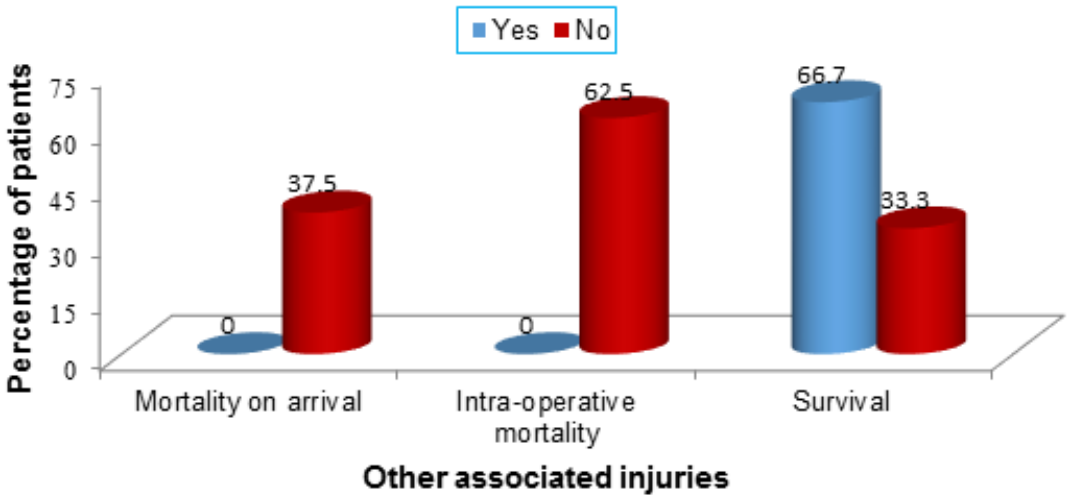

Figure 5: Effect of other associated injuries on mortality

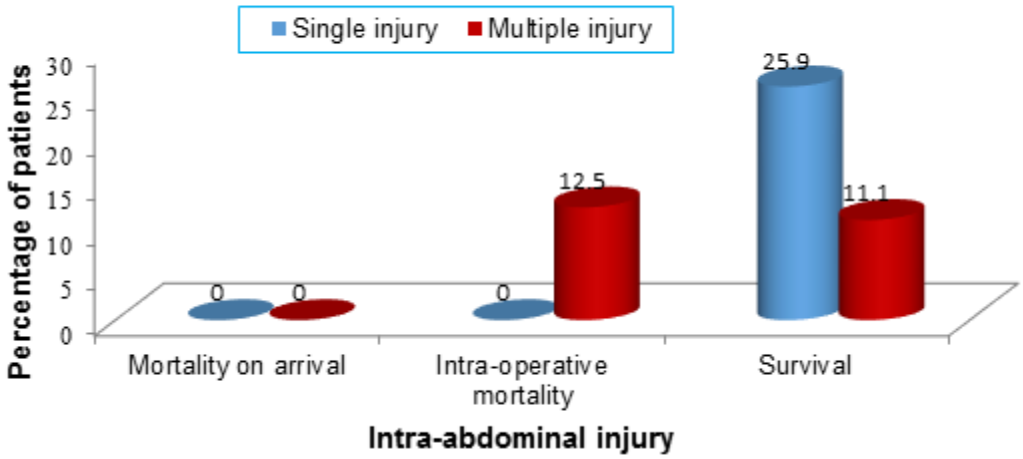

Figure 6: Effect of intra-abdominal injuries on mortality

The five patients who arrested intra-operatively, all of them 62.5% had > 3 h to go to the operating theater with a mean of 7±1.22 h, which was significantly higher (p = 0.019) than that of the twenty-seven patients who survived (18.5% had 3 h or less to go to the operating theater and 44.4% had > 3 h with a mean of 4.32±1.77 h). Unavailability of skillful surgeon and delay in the diagnosis of the injury were the main causes for delay in those patients and hence the cause of their death. This result differed from the result reported by Serdar et al., (2011) they found that the mean time to the OR for the non-survivor was 1.94±1.71 in comparison with 3.30±3.58 for the survivors, but the difference was insignificant (p = 0.125). This could be explained by severity of injury or presences of other sever associated injuries or could be attributed to problems encountered at intra-operative room.

Factors non-significantly affect mortality:

Mortality was not related to age (p = 0.33), mechanism of injury (p = 0.16), presence of other associated injuries (p = 0.16) or presence of other associated injuries encountered intra-operatively (p = 0.16), (Table 1 and Fig 4, 5, 6). These results were in accordance with Serdar et al., (2011) they reported that mortality for patients with stab wounds was (8.6%) compared with (13.8%) for patients with gunshot wounds (p = 0.29). The mean age in non-survivors was

	Mortality						Survival			*p-value*
	Mortality on arrival			Intra-operative mortality						
	N	Mean	±SD	N	Mean	±SD	N	Mean	±SD	
SBP (mm Hg)	3	0[c]	0	5	58	34.93[b]	27	81.11[a]	36.83	0.021*
GCS	3	5[c]	3.46	5	10.6[b]	4.98	27	13.19[a]	3.91	0.035*
ISS	3	16.00[b]	0.00	5	16.00[b]	0.00	27	20.07[a]	3.91	0.026*
RTS	3	4.49[b]	3.91	5	3.72[c]	2.72	27	6.27[a]	1.66	0.007**
TRISS	3	68.46[b]	46.85	5	47.76[c]	45.68	27	91.64[a]	16.93	0.003**
Time to OR (h)	NA	NA	NA	5	7.00[a]	1.22	17	4.32 [b]	1.77	0.190*
Blood transfusion (ml)	NA	NA	NA	4	3250.0	1500.0	22	3772.7	2483.10	0.001***
Initial chest tube loss preoperatively (ml)	NA	NA	NA	NA	NA	NA	6	700.00	903.32	NA
Ongoing chest tube loss at conservative management (ml)	NA	NA	NA	NA	NA	NA	4	575.00	221.73	NA

Table 1: The parameters affecting mortality in penetrating cardiac injury
a–c Mean in the same row with different letters are significantly different p ≤ 0.05.
N: Number of patients, SD: Standard deviation, NA: Non-applicable, SBP: Systolic Blood Pressure, GCS: Glasgow Coma Scale, ISS: Injury Severity Score, RTS: Revised Trauma Score, TRISS: Trauma Injury Severity Score.
*p-value less or equal to 0.05 is significant.

24.18±7.09 years in comparison with the mean of the age in the survivors (25.90±9.57 years) (p = 0.373). But it was differed from Serdar et al., (2011) they reported that mortality was significantly associated with diaphragmatic injury (p = 0.01), associated abdominal injury (p = 0.01). Onan et al., (2011) reported that a high mortality risk was related to presence of associated injuries. Ceviker et al., (2014) reported that a high mortality rate depends on the mechanism of the injury and the presence or absence of associated lesions. We think that some factors related to the trauma and injury could be missed during history taken from those patients and inaccuracy in this data collected could be reflected on the result analysis.

The information about the time elapsed between incidence of trauma and arrival to the hospital, the amount of bleeding and the treatment received prior to the arrival at the hospital were not available for analysis. Hence, their relation to the morbidity and mortality was not determined in this study although we believe that they could have an important impact on the outcome in those patients.

Investigations could help in rapid diagnosis of those critically injured patients. Majority of patients in this study had FAST examination while Chest X-ray and CT-Chest were performed in about half of the patients. None had echocardiography or angiography. Most of those patients were diagnosed on clinical basis with a help of the available and rapid investigative tool present at the hospital according the stability of the patient. We think that rapidity and accurate diagnosis in those

patients and levitation of time consumption between investigations is the reason of the low mortality in this study.

CONCLUSION

In conclusion, penetrating cardiac injuries were associated with a high mortality rate. Mortality was significantly associated with patients who had low SBP, GCS less than 9 on presentation, presence of tamponade, low ISS, low RTS, low TRISS, less blood transfusion and with patients who had longer period of time elapsed before going to the OR. On the other hand, mortality was not linked to age, mechanism of injury, or presence of other associated injuries. Even in a developing country, rapid prompt diagnosis based on clinical skills and the results of available investigative tools could have low mortality rate in patients with penetrating injuries. Prospective multi-center study nation-wide could help to get better analysis for each factor mentioned in this study.

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