

AIM OF THE WORK

The aim of this study was to evaluate patients with penetrating cardiac injuries who were admitted to Alexandria Main University Hospital (AMUH) during one year period (June 2013 – June 2014). Aspects of the study included the mode of injury, clinical presentation, various ways of management, complications and follow up.

PATIENTS

This randomized prospective clinical study included patients with penetrating cardiac injury who were admitted to the Emergency Department of Alexandria Main University Hospital during one year period (June 2013 – June 2014).

Inclusion criteria

- All cases of penetrating cardiac trauma.
- Age: all age groups were included.
- Sex: both males and females.

Exclusion criteria

- Blunt trauma to the chest.
- Chest penetration out of the cardiac diamond area.

METHODS

After approval of Ethics Committee the current prospective study was carried out on all patients suffering from penetrating cardiac trauma, who were admitted to the Emergency Department (ED) of Alexandria Main University Hospital within one year (June 2013 – June 2014).

The following points were searched for:

1- Inflicting agent

- a- Type of the agent
- b- Number of injuries

2- Clinical presentation

- a- Vital signs: Blood Pressure (BP), Pulse, Respiratory Rate (RR)
- b- Examination: Glasgow Coma Scale score (GCS), conditions of the neck veins and chest examination findings.

The Glasgow Coma Scale provides a score in the range 3-15. The lowest possible GCS is 3 (deep coma or death), while the highest is 15 (fully awake person). The scores are as follows:

Eye Opening Response	Spontaneous--open with blinking at baseline	4 points
	Opens to verbal command, speech, or shout	3 points
	Opens to pain, not applied to face	2 points
	None	1 point
Verbal Response	Oriented	5 points
	Confused conversation, but able to answer questions	4 points
	Inappropriate responses, words discernible	3 points
	Incomprehensible speech	2 points
	None	1 point
Motor Response	Obeys commands for movement	6 points
	Purposeful movement to painful stimulus	5 points
	Withdraws from pain	4 points
	Abnormal (spastic) flexion, decorticate posture	3 points
	Extensor (rigid) response, decerebrate posture	2 points
	None	1 point

- c- Trauma Scoring system : Injury severity score (ISS), Revised Trauma Score (RTS) and Trauma Revised Injury Severity Score (TRISS).

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. The Revised Trauma Score is a physiological scoring system that made up of a three categories: Glasgow Coma Scale, Systolic blood pressure, and respiratory rate. TRISS is a combines anatomic and physiologic measures of injury severity (ISS and RTS, respectively) and patient age in order to predict survival from trauma.

3- Investigations

In selected patients:

- a. FAST
- b. CT- Chest
- c. Electrocardiogram (ECG)
- d. Arterial Blood Gases (ABGs)
- e. Chest X-ray (CXR)

4- Treatment

This included the treatment received by the patients

- a. Conservative
- b. Operative.

5- Intra operative findings

- a. Site of the injury
- b. Surgical approach
- c. Associated injuries
- d. Intra-operative complications
- e. Amount of blood loss intra-operatively
- f. Intra-operative blood transfusion

6- Postoperative follow up

Follow-up of the patients and documentation of the complications by echocardiography and ECG were performed. The follow-up visits were organized in immediate post-operative period, one and two months later following the surgery.

The results were expressed as means, standard deviation (SD), counts and percentages. Univariate analysis was performed using a χ^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

This study included 35 patients, with penetrating cardiac injury, who were admitted to the Emergency Department of Alexandria Main University Hospital within one year from June 2013 till June 2014. The total numbers of the patients with thoracic injury during this period were 1120 patients, 409 patients had penetrating thoracic injury, and only 35 patients had isolated penetrating cardiac injury (8.6%).

All patients were male. Table 1 shows the age distribution of the patients according to the mechanism of injury. Twenty-one patients (60%) had stab injury, their mean age was 24.66 ± 9.61 . The age distribution in this group was as the following: 3 patients (8.5%) were ≤ 18 years (mean age was 14.33 ± 2.99), 16 patients (45.71%) were between 18-40 years (mean age was 24.1 ± 5.06), and 2 patients (5.7%) were > 40 years (mean age was 39.75 ± 8.98). On the other hand, 14 patients (40%) had gunshot injury, their mean age was 29.07 ± 10.37 , one patient (2.9%) was ≤ 18 years, 11 patients (31.4%) were between 18-40 years, their mean age was 24.78 ± 2.16 , and 2 patients (5.7%) were > 40 years, their mean age was 42.25 ± 10.10 .

Table 1: Age distribution of the patients according to the mechanism of injury

Age (year)	Stab injury				Gunshot injury				p-value
	N	%	Mean	±SD	N	%	Mean	±SD	
≤ 18	3	8.5	14.33	2.99	1	2.9	15	0	0.760
18-40	16	45.71	24.1	5.06	11	31.4	24.78	2.16	
> 40	2	5.7	39.75	8.98	2	5.7	42.25	10.10	
Total	21	60	24.66	9.61	14	40	29.07	10.37	

*N: Number of patients, SD: Standard deviation.
p-value less or equal to 0.05 is significant.*

Results

Table 2, Table 3 and Figure 13 show the changes in the physiological parameters of the patients and their percentages according to the mechanism of injury. The mean systolic blood pressure (SBP) and pulse of the patients with stab injury were 60.47 ± 37.87 mmHg and 85.24 ± 56.35 b/min, respectively. Eighteen patients (85.7%) were shocked (SBP was ≤ 90 mmHg and pulse was < 60 or > 100 b/min) and three patients (14.3%) had SBP > 90 mmHg and normal pulse (60-100 /min). While the mean SBP and pulse of the patients with gunshot injury was 82.14 ± 48.86 mmHg and 96.43 ± 41.62 b/min, respectively. 12 patients (85.7%) were shocked (pulse < 60 or > 100 b/min), 7 patients of them had SBP ≤ 90 mm Hg.

The mean respiratory rate (RR) of patients with stab injury was 28.23 ± 19.88 breath/min, 19 patients (90.5%) had abnormal respiratory rate (< 12 and > 20 breath /min) and 2 patients (9.5%) had respiratory rate within normal range. On the other hand, the mean RR of patients with gunshot injury was 25.79 ± 13.34 breath/min, 9 patients (64.3%) had abnormal respiratory rate (< 12 and > 20 breath /min) and 5 patients (35.7%) had respiratory rate within normal range.

The mean Glasgow coma scale (GCS) of patients with stab injury was 11 ± 5.05 , 8 patients (38.1%) of them had critical GCS ≤ 9 , while 13 patients (61.9%) had GCS > 9 . On the other hand, the mean GCS of patients with gunshot injury was 13 ± 3.7 , one patient (7.1%) had GCS ≤ 9 and 13 patients (92.9%) had GCS > 9 .

Central venous catheter (CVC) was inserted in 11 patients with stab injury and the mean CVP was 17.55 ± 10 cm H₂O, 3 patients (27.3%) had CVP reading within normal range (3-8 cm H₂O) and 8 patients (38.1%) had CVP reading (< 3 or > 8 cm H₂O). Meanwhile, it was inserted in 8 patients with gunshot injury. The mean CVP was 14.13 ± 7.06 cm H₂O. Five patients (62.5%) had CVP reading within normal range and 3 patients (37.5%) had CVP reading (< 3 or > 8 cm H₂O).

The mean injury severity score (ISS) of patients with stab injury was 18.23 ± 4.16 , while patients with gunshot injury was 20.50 ± 2.93 . The mean revised trauma score (RTS) of patients with stab injury was 5.07 ± 2.67 , while the patients with gunshot injury was 6.41 ± 2.10 . The mean trauma revised injury severity score (TRISS) of patients with stab injury was 79.21 ± 33.01 , while patients with gunshot injury was 89.63 ± 22.08 .

Results

Table 2: Changes in the physiological parameters of the patients according to the mechanism of injury

	Stab injury			Gunshot injury			<i>p-value</i>
	N	Mean	±SD	N	Mean	±SD	
SBP (mm Hg)	21	60.47	37.87	14	82.14	48.86	0.022*
PULSE (b/min)	21	85.24	56.35	14	96.43	41.62	1.000
RR (breath/min)	21	28.23	19.88	14	25.79	13.34	0.040*
GCS	21	11	5.05	14	13	3.70	0.046*
CVP (cm H ₂ O)	11	17.55	10	8	14.13	7.06	0.039*
ISS	21	18.23	4.16	14	20.50	2.93	0.087*
RTS	21	5.07	2.67	14	6.41	2.10	0.124
TRISS	21	79.21	33.01	14	89.63	22.08	0.309

N: Number of patients, *SD*: Standard deviation, *SBP*: Systolic Blood Pressure, *b/min*: beat per minute, *RR*: Respiratory Rate, *GCS*: Glasgow Coma Scale, *CVP*: Central Venous Pressure, *ISS*: Injury Severity Score, *RTS*: Revised Trauma Score, *TRISS*: Trauma Revised Injury Severity Score.
p-value less or equal to 0.05 is significant.

Results

Table 3: Percentages of the physiological parameters of the patients according to the mechanism of injury

Physiological parameters		Stab injury		Gunshot injury		p-value
		N	%	N	%	
SBP (mm Hg)	>90	3	14.3	7	50	0.022*
	≤ 90	18	85.7	7	50	
Pulse (b/ min)	60-100	3	14.3	2	14.3	1.000
	>60-100<	18	85.7	12	85.7	
RR (breath/min)	12-20	2	9.5	5	35.7	0.050*
	>12-20<	19	90.5	9	64.3	
GCS	> 9	13	61.9	13	92.9	0.040*
	≤ 9	8	38.1	1	7.1	
CVP (cm H ₂ O)	3-8	3	27.3	5	62.5	0.125
	>3-8<	8	72.2	3	37.5	

N: Number of patients, SBP: Systolic Blood Pressure, b/min: beat per minute, RR: Respiratory Rate, GCS: Glasgow Coma Scale, CVP: Central Venous Pressure.
p-value less or equal to 0.05 is significant.

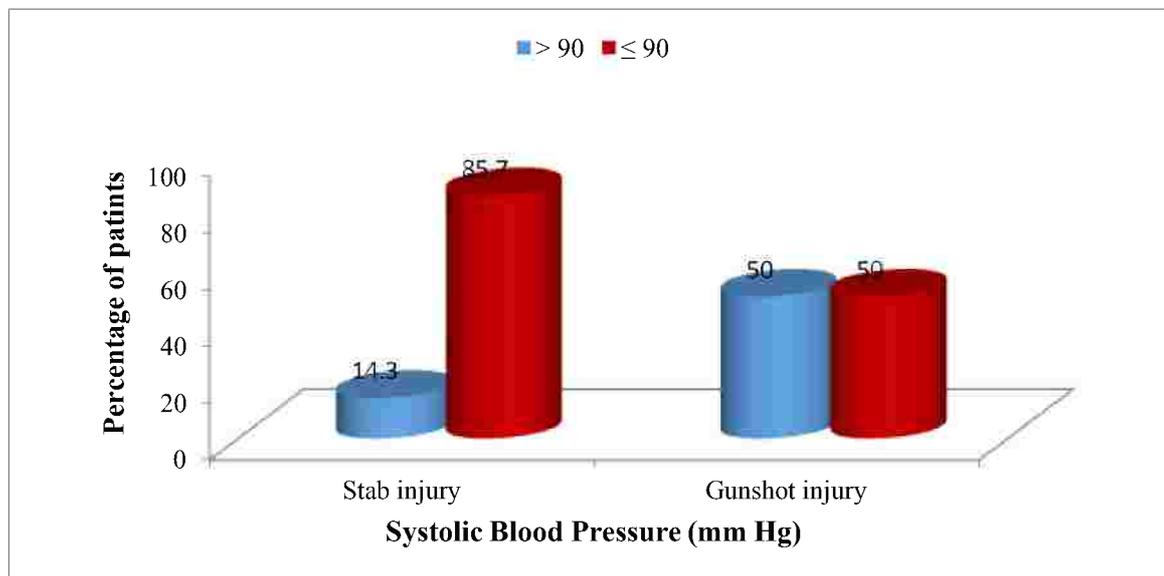


Figure 13-A: Percentages of the patients according to systolic blood pressure and the mechanism of injury

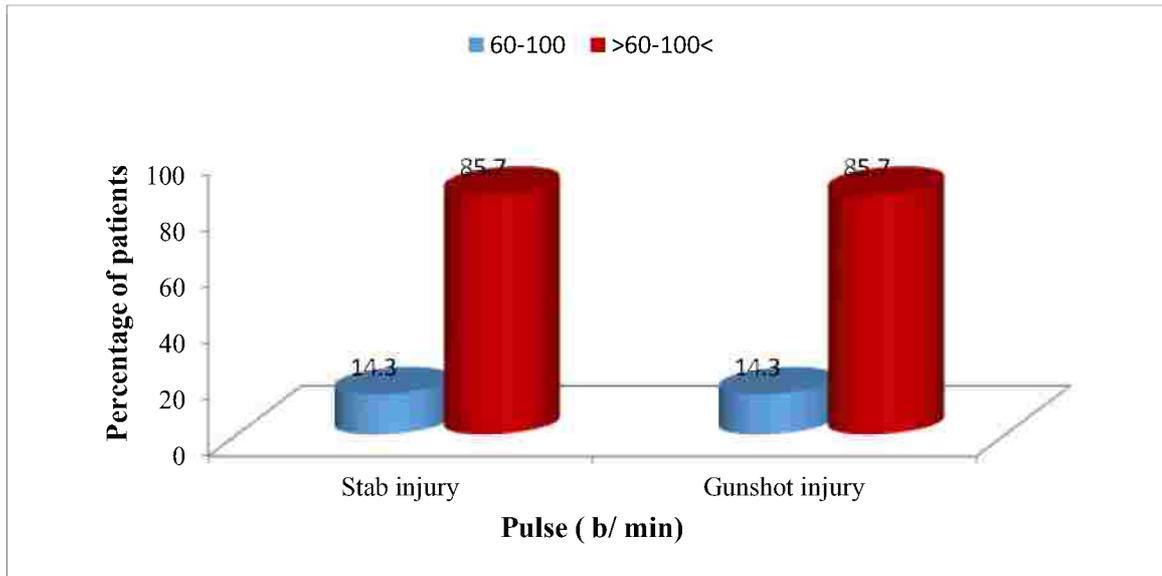


Figure 13-B: Percentages of the patients according to pulse and the mechanism of injury

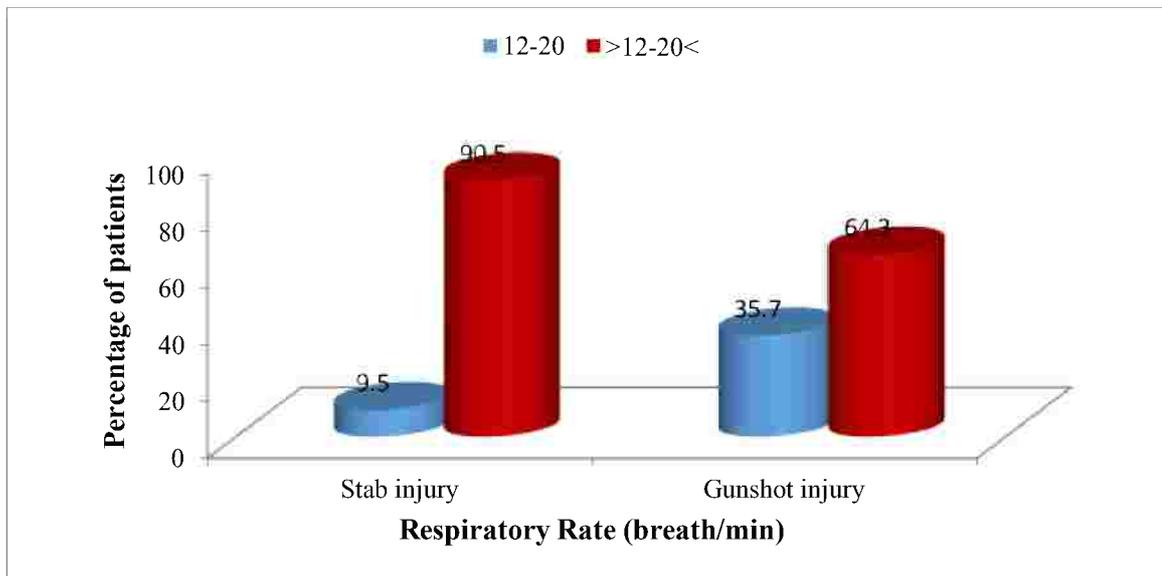


Figure 13-C: Percentages of the patients according to respiratory rate and the mechanism of injury

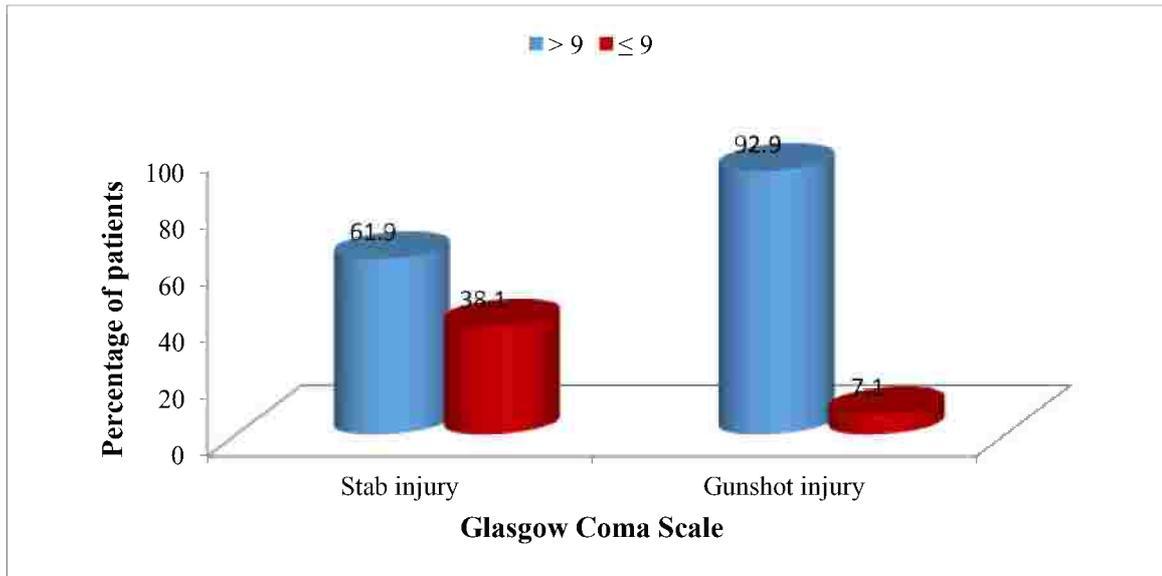


Figure 13-D: Percentages of the patients according to Glasgow coma scale and the mechanism of injury

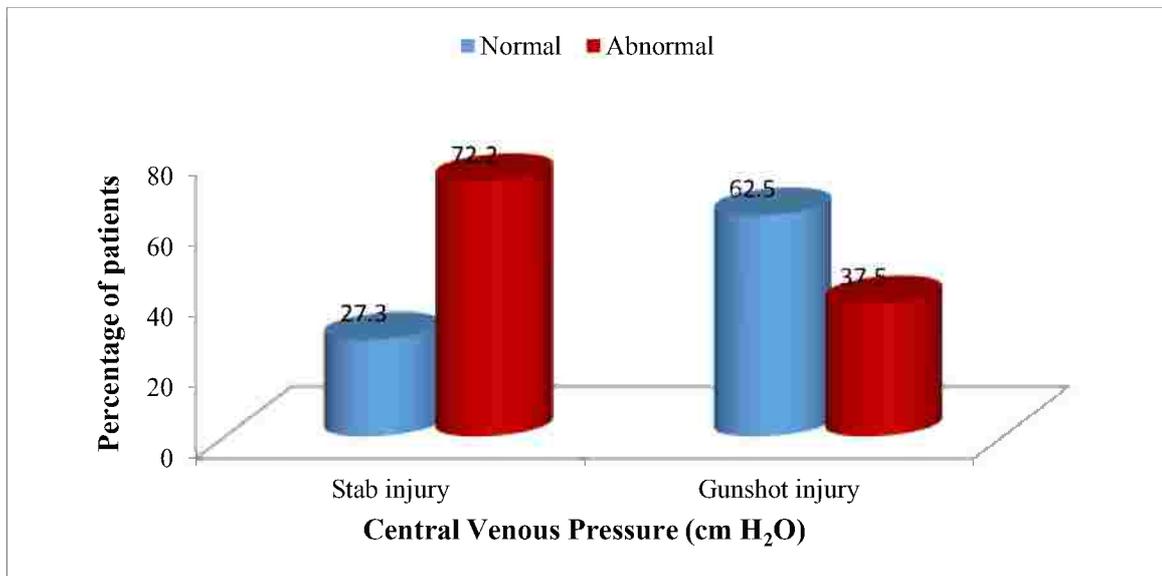


Figure 13-E: Percentages of the patients according to central venous pressure and the mechanism of injury

Results

Table 4, Table 5 and Figure 14 show the changes in the physiological parameters and their percentages according to the age. Four patients were ≤ 18 years. In this group, the mean SBP and pulse were 55 ± 35.46 mmHg and 80 ± 66.96 b/min, respectively. All of them were in shock (SBP ≤ 90 mmHg and pulse < 60 and > 100 b/min). On the other hand, the age of 27 patients was between 18-40 years. In this age group, the mean SBP and pulse were 75.21 ± 45.31 mmHg and 89.31 ± 48.70 b/min, respectively. Eighteen patients (51.42%) of them were in shock and 9 patients had SBP and pulse within normal range. Finally 4 patients were > 40 years. Their mean SBP and pulse were 77.5 ± 27.54 mmHg and 87.5 ± 59.65 b/min, respectively. Three patients were in shock and one patient had SBP and pulse within normal range.

The mean RR of patients with age ≤ 18 years was 22.5 ± 17.32 breath/min. Two patients (5.7%) had RR within normal range (12-20 breath/min) and other 2 patients had abnormal respiratory rate (> 20 and < 12 breath/min). Meanwhile, the mean RR of patients between 18-40 years was 28.09 ± 17.59 breath/min, 9 patients (25.7%) of them had RR within normal range and 18 patients (51.42%) had an abnormal respiratory rate. On the other hand, the mean RR in patients with age > 40 years was 30 ± 18.26 breath/min. One patient had RR within normal range and the other 3 patients had an abnormal respiratory rate.

The mean GCS of patients with age ≤ 18 years was 10.5 ± 5.32 . Two patients had GCS > 9 , and 2 patients had GCS ≤ 9 . On the other hand, the mean GCS of patients between 18-40 years was 12.44 ± 4.57 . Twenty-one patients had GCS > 9 and 6 patients had GCS ≤ 9 . Finally the mean GCS of patient > 40 years was 12 ± 6 , 3 patients of them had GCS > 9 and one patient had GCS ≤ 9 .

CVC was inserted in 2 patients with age ≤ 18 years. Their mean CVP was 13 cm H₂O. All of them had CVP < 3 or > 8 cm H₂O, while it was inserted in 15 patients with age between 18-40 years. Their mean CVP was 14.8 ± 8.27 cm H₂O. Eight patients had a reading in between 3 to 8 cm H₂O and 7 patients had a reading < 3 or > 8 cm H₂O. In addition, CVP was inserted in 2 patients with age > 40 years. Their mean CVP was 17.5 cm H₂O. All of them had readings < 3 or > 8 cm H₂O.

The mean ISS of patients with age ≤ 18 years was 18.62 ± 3.73 . While the mean ISS of patients with age between 18-40 years was 18.95 ± 3.09 and finally, the mean ISS of patients with age > 40 years was 21.25 ± 7.54 . The mean RTS in patients with age ≤ 18 years was 4.76 ± 3.01 , while in patients with age between 18-40 years was 5.78 ± 2.52 , and in patients with age > 40 years was 6.34 ± 1.02 . The mean TRISS in patients with age ≤ 18 years was 74.41 ± 37.12 , while in patients with age between 18-40 years was 84.93 ± 28.80 , and in patients with age > 40 years was 92.45 ± 6.32 .

Results

Table 4: Changes in the physiological parameters of the patients according to the age

	Age (year)									<i>p-value</i>
	≤ 18			18-40			> 40			
	N	Mean	±SD	N	Mean	±SD	N	Mean	±SD	
SBP (mm Hg)	4	55	35.46	27	75.21	45.31	4	77.5	27.54	0.012*
PULSE (b/min)	4	80	66.96	27	89.13	48.70	4	87.5	59.65	0.041*
RR (breath/min)	4	22.5	17.32	27	28.09	17.59	4	30	18.26	0.027*
GCS	4	10.5	5.32	27	12.44	4.57	4	12	6	0.005*
CVP (cm H ₂ O)	2	13	0	15	14.8	8.27	2	17.5	0	0.038*
ISS	4	18.62	3.73	27	18.95	3.09	4	21.25	7.54	0.509
RTS	4	4.76	3.01	27	5.78	2.52	4	6.34	1.02	0.524
TRISS	4	74.41	37.12	27	84.93	28.80	4	92.45	6.32	0.562

N: Number of patients, *SD*: Standard deviation, *SBP*: Systolic Blood Pressure, *b/min*: beat per minute, *RR*: Respiratory Rate, *GCS*: Glasgow Coma Scale, *CVP*: Central Venous Pressure, *ISS*: Injury Severity Score, *RTS*: Revised Trauma Score, *TRISS*: Trauma Revised Injury Severity Score.
p-value less or equal to 0.05 is significant.

Results

Table 5: Percentages of the physiological parameters of the patients according to the age

		Age (year)						<i>p-value</i>
		≤18		18-40		>40		
		N	%	N	%	N	%	
SBP (mm Hg)	>90	0	0	9	25.7	1	2.9	0.381
	≤90	4	11.4	18	51.42	3	8.6	
Pulse (b/ min)	60-100	0	0	9	25.7	1	2.9	0.381
	>60-100<	4	11.4	18	51.42	3	8.6	
RR (breath/min)	12-20	2	5.7	9	25.7	1	2.9	0.867
	>12-20<	2	5.7	18	51.42	3	8.6	
GCS	>9	2	5.7	21	60	3	8.6	0.271
	≤9	2	5.7	6	17.14	1	2.9	
CVP (cm H ₂ O)	3-8	0	0	8	42.1	0	0	0.158
	>3-8<	2	10.5	7	36.8	2	10.5	

N: Number of patients, *SBP*: Systolic Blood Pressure, *b/min*: beat per minute, *RR*: Respiratory Rate, *GCS*: Glasgow Coma Scale, *CVP*: Central Venous Pressure.
p-value less or equal to 0.05 is significant.

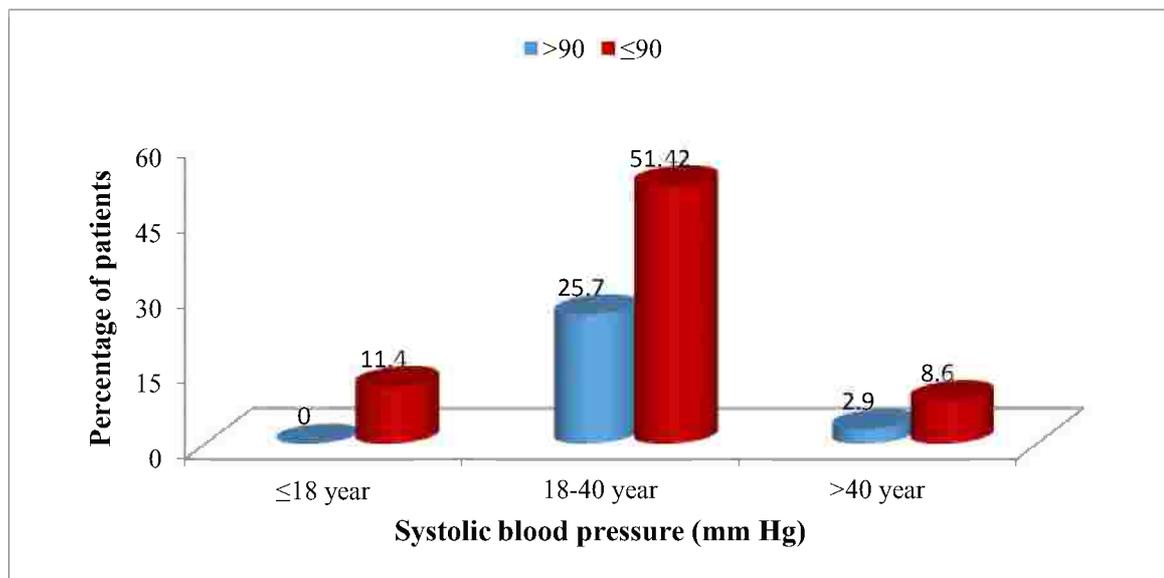


Figure 14-A: Percentages of the patients according to systolic blood pressure and the age

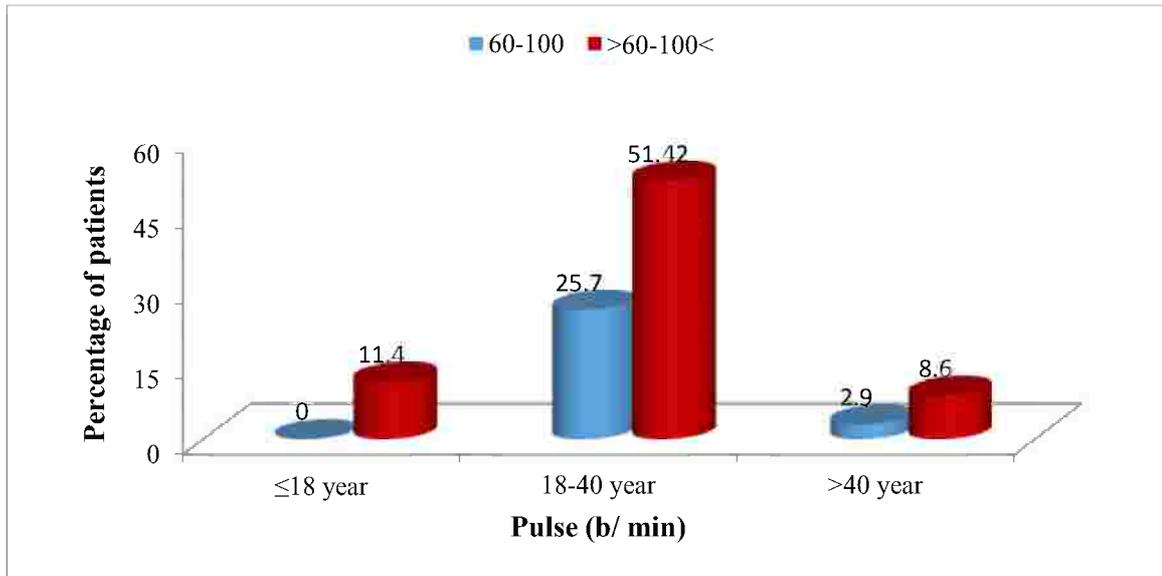


Figure 14-B: Percentages of the patients according to pulse and the age

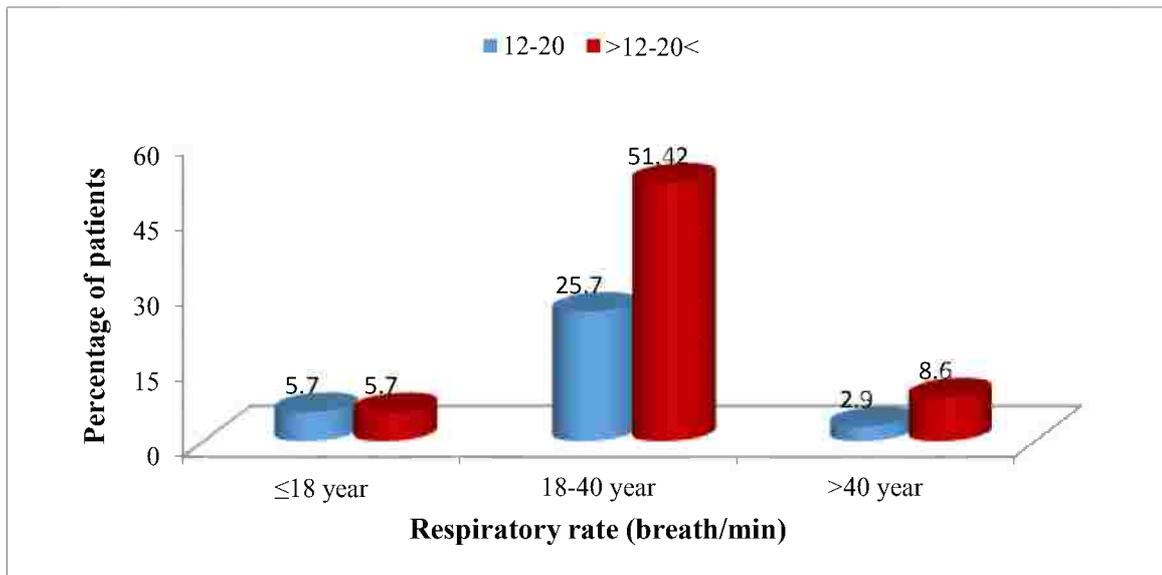


Figure 14-C: Percentages of the patients according to respiratory rate and the age

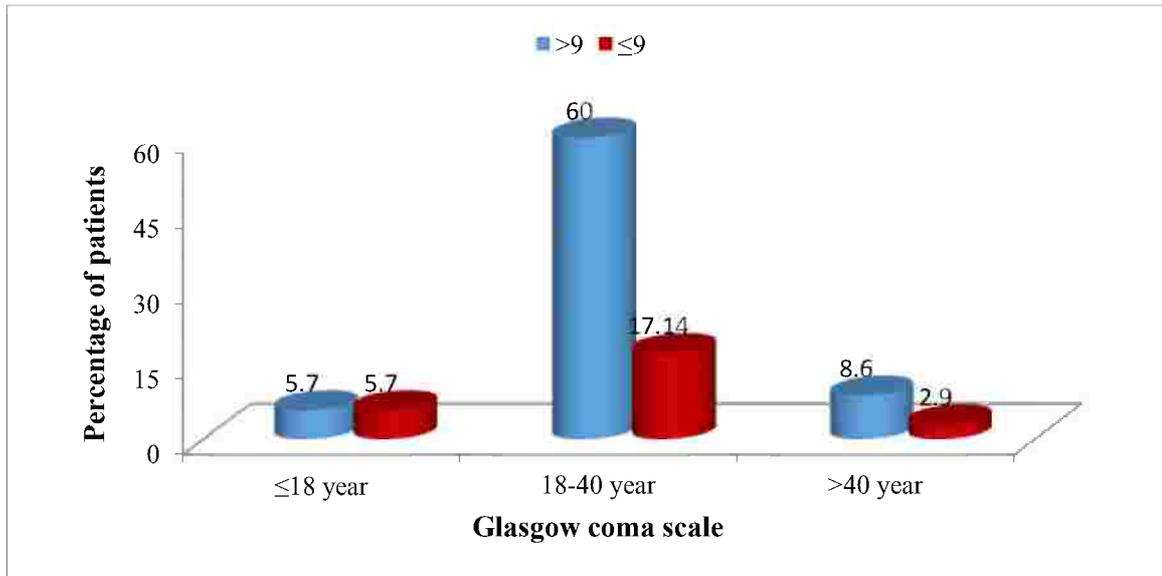


Figure 14-D: Percentages of the patients according to Glasgow Coma Scale and the age

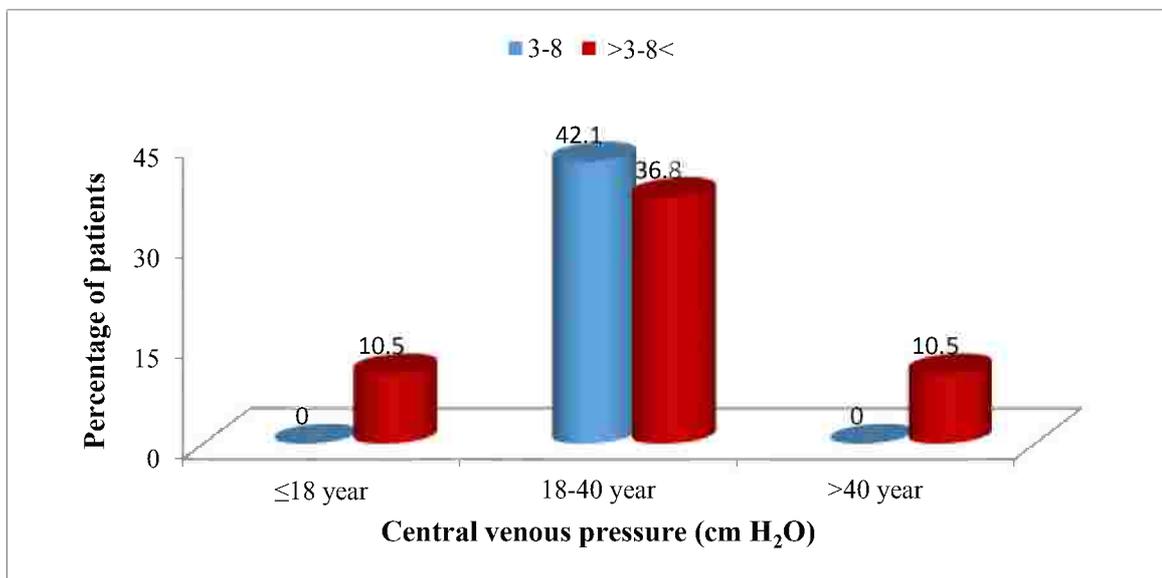


Figure 14-E: Percentages of the patients according to central venous pressure and the age

Results

Table 6 and Figure 15 show the percentages of the patients according to the clinical signs and the mechanism of injury. Fourteen patients (66.7%) with stab injury had congested neck veins, while 11 patients (78.6%) with gunshot injury had congested neck veins. Nineteen patients (90.5%) with stab injury had decrease air entry at the site of the lesion, while 10 patients (71.4%) with gunshot injury had decrease air entry at the site of the lesion. Seven patients (33.3%) with stab injury had other associated injuries, while 11 patients (78.6%) with gunshot injury had other associated injuries.

Table 6: Percentages of the patients according to clinical signs and the mechanism of injury

Clinical signs		Stab injury		Gunshot injury		p-value
		N	%	N	%	
Neck veins	Congested	14	66.7	11	78.6	0.445
	Not	7	33.3	3	21.4	
Chest auscultation	Decrease air entry	19	90.5	10	71.4	0.143
	Equal bilateral	2	9.5	4	28.6	
Other associated injuries	Present	7	33.3	11	78.6	0.0464*
	Absent	14	66.7	3	21.4	

N: Number of patient.

p-value less or equal to 0.05 is significant.

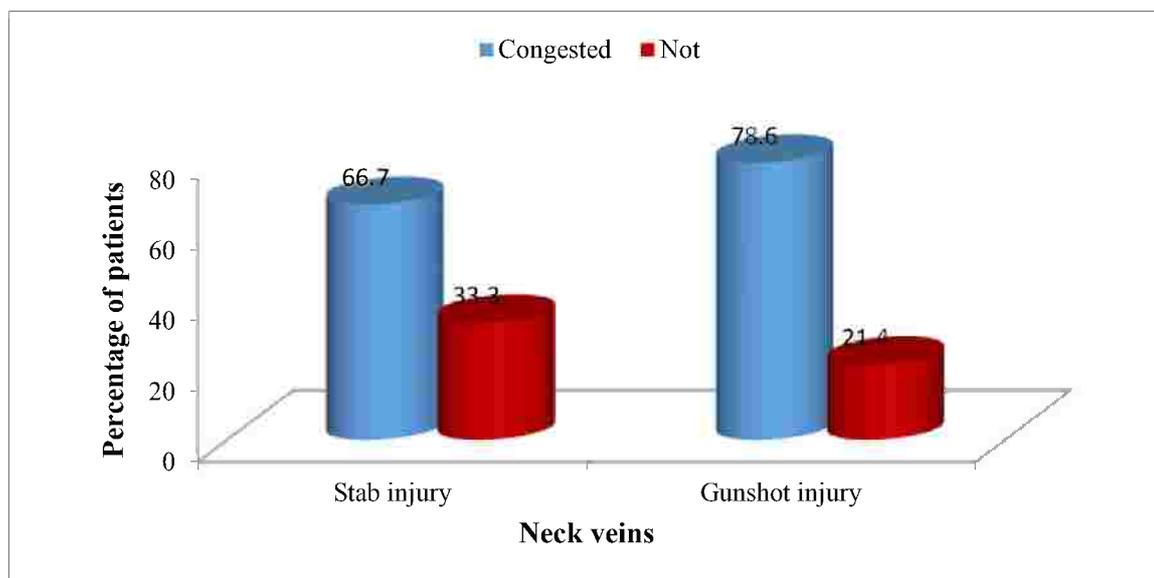


Figure 15-A: Percentages of the patient according to clinical changes on neck veins and the mechanism of injury

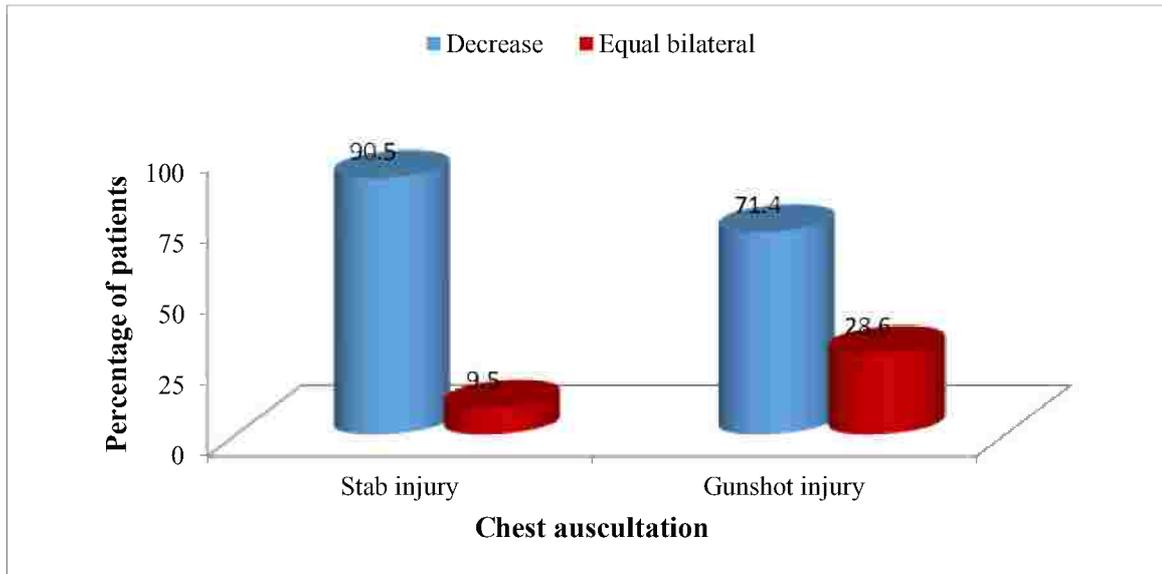


Figure 15-B: Percentages of the patients according to chest auscultation findings and the mechanism of injury

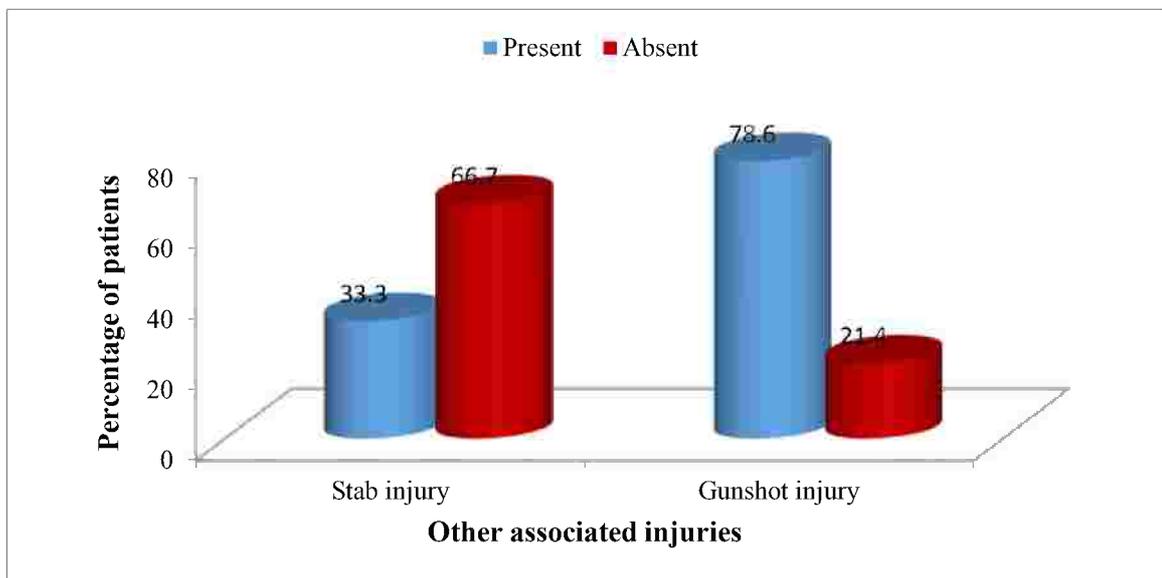


Figure 15-C: Percentages of the patients according to other associated injuries and the mechanism of injury

Results

Table 7 and Figure 16 show the percentages of the patients according to clinical signs and the age. Two patients (5.7%) with age ≤ 18 years had congested neck veins, while 19 patients (54.28%) with age in between 18-40 years had congested neck veins and all the 4 patients with age > 40 years had congested neck veins.

All the 4 patients with age ≤ 18 years had decreased air entry at the site of the lesion, while 21 patients (60%) with age between 18-40 years had decreased air entry at the site of the lesion and all the 4 patients with age > 40 years had decreased air entry at the site of injury.

One patient (2.8%) with age ≤ 18 years had other associated injuries. On the other hand, 15 patients with age between 18-40 years had other associated injuries and 2 patients with age > 40 years had other associated injuries.

Table 7: Percentages of the patients according to clinical signs and the age

		Age (year)						<i>p-value</i>
		≤ 18		18-40		> 40		
		N	%	N	%	N	%	
Neck veins	Congested	2	5.7	19	54.28	4	11.4	0.284
	Not congested	2	5.7	8	22.85	0	0	
Chest auscultation	Decrease air entry	4	11.4	21	60	4	11.4	0.342
	Equal bilateral	0	0	6	17.1	0	0	
Other associated injuries	Present	1	2.8	15	42.85	2	5.7	0.520
	Absent	3	8.5	12	34.28	2	5.7	

N: Number of patients.

p-value less or equal to 0.05 is significant.

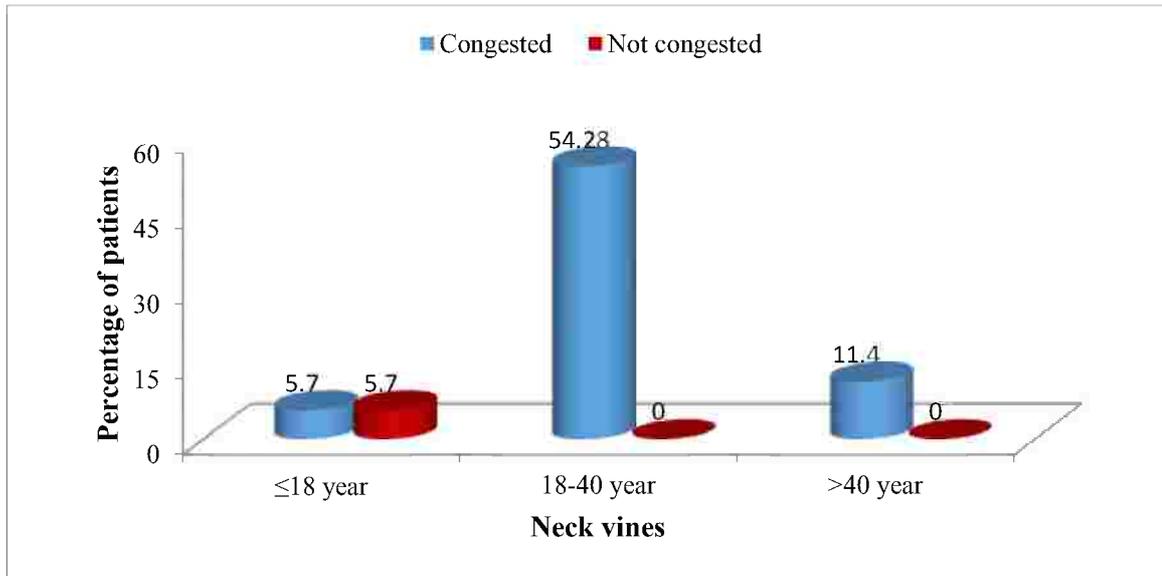


Figure 16-A: Percentages of the patients according to clinical changes on neck veins and the age

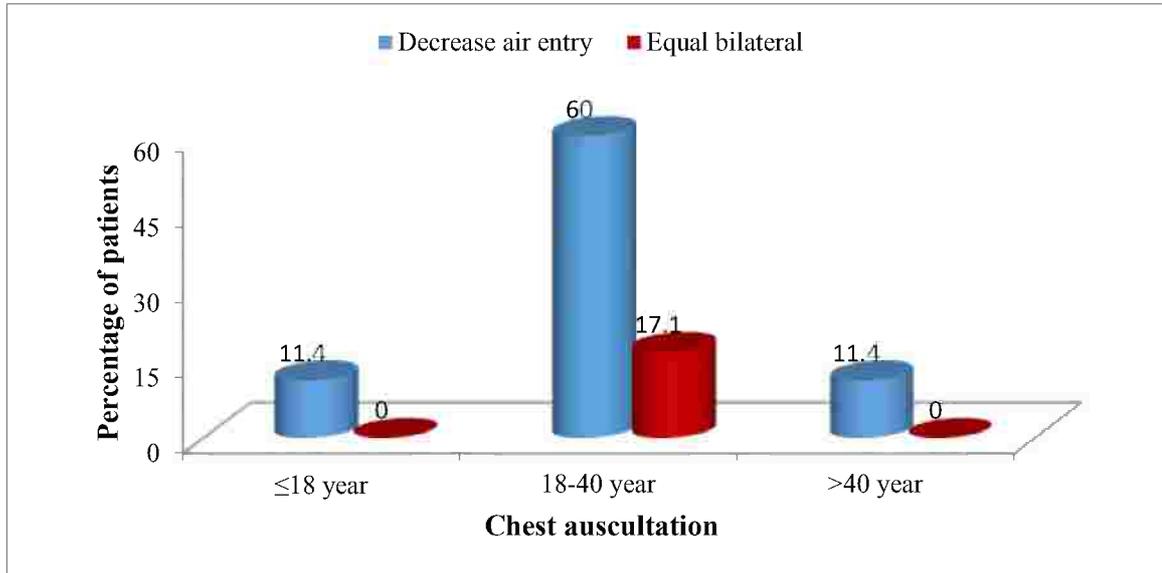


Figure 16-B: Percentages of the patients according to chest auscultation findings and the age

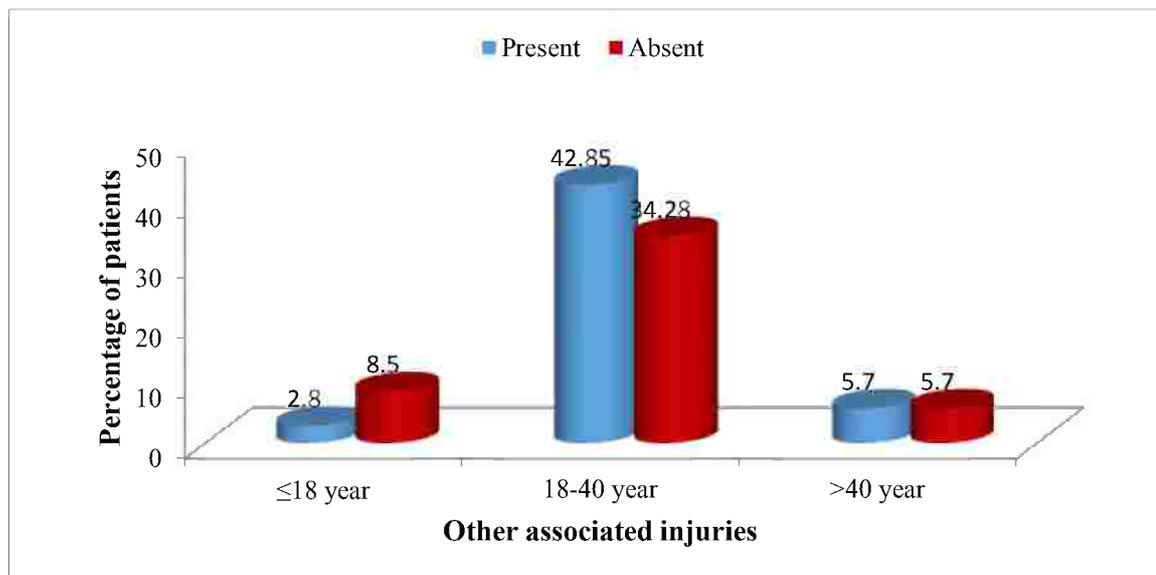


Figure 16-C: Percentages of the patients according to other associated injuries and the age

Table 8 shows other associated injuries in patients with penetrating cardiac injuries according to the mechanism of injury. Patients with stab injury had 2 patients (5.7%) with abdominal injury, 5 patients (14.2%) each scalp injury and extremities, and one patient (2.8%) with neck injury. On the other hand, patients with gunshot injury had 5 patients (14.2%) with abdominal injury, 6 patients (17.1%) with extremities injury, one patient (2.8%) with scalp injury and 9 patients (25.7%) with neck injury.

Table 8: Other associated injuries in the patients with penetrating cardiac injuries according to the mechanism of injury

Other associated injuries	Stab injury		Gunshot injury		<i>p-value</i>
	N	%	N	%	
Abdominal	2	5.7	5	14.2	0.028*
Extremities	5	14.2	6	17.1	
Scalp lesion	5	14.2	1	2.8	
Neck lesion	1	2.8	9	25.7	
Total	13	37.1	21	60	

N: Number of patients.

p-value less or equal to 0.05 is significant.

Results

Table 9 and Figure 17 show the investigations performed preoperatively for the patients according to the mechanism of injury. FAST was performed on 18 patients with stab injury, 76.1% of them had positive findings and 14.2% did not have FAST. On the other hand, FAST was performed on 13 patients with gunshot injury, 85.7% of them had positive findings and 7.1% did not have FAST.

CT-Chest was performed on 5 patients with stab injury. All of them had positive findings. While 10 patients with gunshot injury had CT-Chest, 64.2% had positive findings and 28.5% did not have CT-Chest. Chest X-ray was performed on 5 patients only with stab injury, while it was performed on 9 patients with gunshot injury. ABGs were done for 5 patients with stab injury, while it was done for 4 patients with gunshot injury. ECG was done for 2 patients with stab injury while it was done for 3 patients with gunshot injury.

Table 9: Investigations performed pre-operatively according to the mechanism of injury

Investigations		Stab injury		Gunshot injury		p-value
		N	%	N	%	
FAST	Positive	16	76.1	12	85.7	0.751
	Negative	2	9.5	1	7.1	
	Not done	3	14.2	1	7.1	
CT-Chest	Positive	5	23.8	9	64.2	0.464
	Negative	0	0	1	7.1	
	Not done	11	52.3	4	28.5	
Chest x ray	Done	5	23.8	9	64.2	0.283
	Not done	16	76.1	5	35.7	
ABG	Done	5	23.8	4	28.5	0.371
	Not done	16	76.1	10	71.4	
ECG	Done	2	9.5	3	21.4	0.557
	Not done	19	90.4	11	78.5	

N: number of patients, FAST: Focused Assessment with Sonography for Trauma, CT: Computed Topography, ABG: Arterial Blood Gases, ECG: Electrocardiogram.
p-value less or equal to 0.05 is significant.

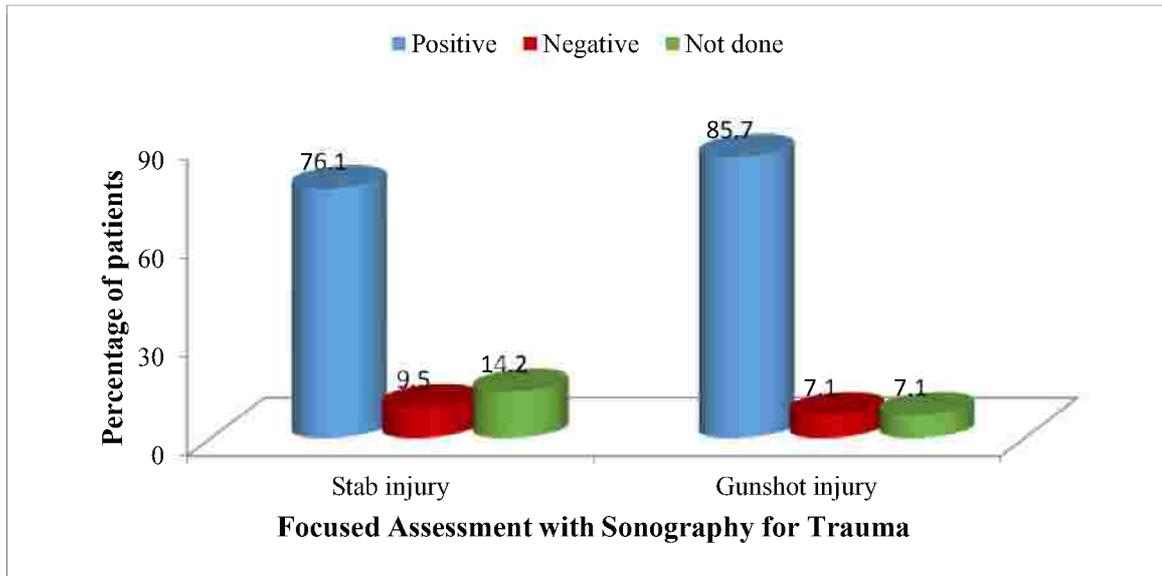


Figure 17-A: Percentages of the patients according to pre-operative focused assessment with sonography for trauma and the mechanism of injury

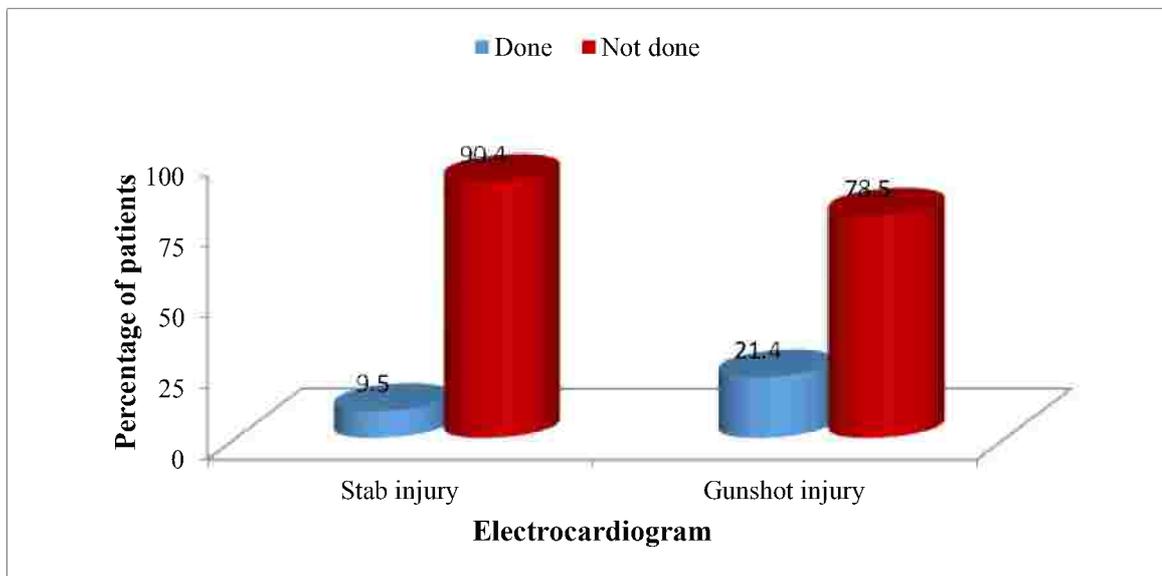


Figure 17-B: Percentages of the patients according to pre-operative electrocardiogram and the mechanism of injury

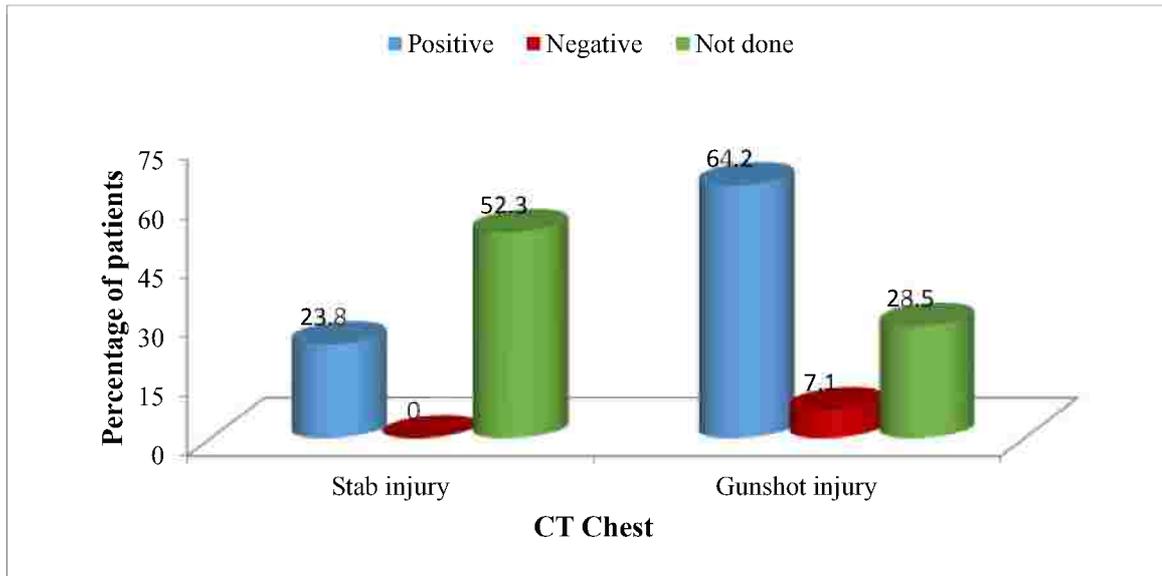


Figure 17-C: Percentages of the patients according to pre-operative CT-Chest and the mechanism of injury



Gunshot injury



Stab injury

Figure 17-D: CT-Chest of patients with penetrating cardiac injury by gunshot and stab

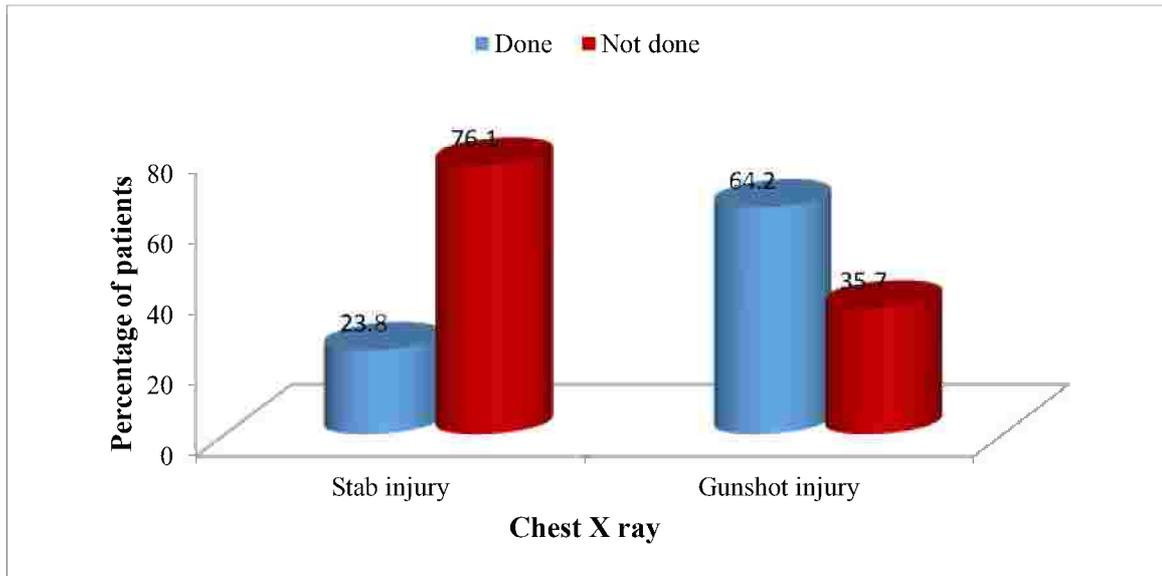
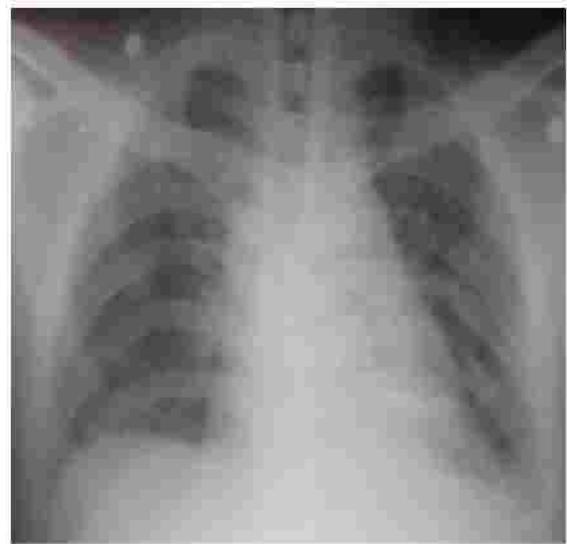


Figure 17-E: Percentages of the patients according to pre-operative Chest X-ray and the mechanism of injury



Gunshot injury



Stab injury

Figure 17-F: Chest X-ray of patients with penetrating cardiac injury by gunshot and stab

Results

Table 10 and Figure 18 show the arterial blood gases interpretation of the patients with penetrating cardiac injury. Three patients (33%) had metabolic acidosis and no one had metabolic alkalosis, another 3 patients (33%) had respiratory acidosis and 2 patients (22%) had respiratory alkalosis, while one patient had mixed metabolic and respiratory acidosis problem.

Table 10: Arterial blood gases interpretation

	Acidosis		Alkalosis		<i>p-value</i>
	N	%	N	%	
Metabolic	3	33	0	0	0.357
Respiratory	3	33	2	22	
Mixed	1	12	0	0	

N: number of patients.

p-value less or equal to 0.05 is significant.

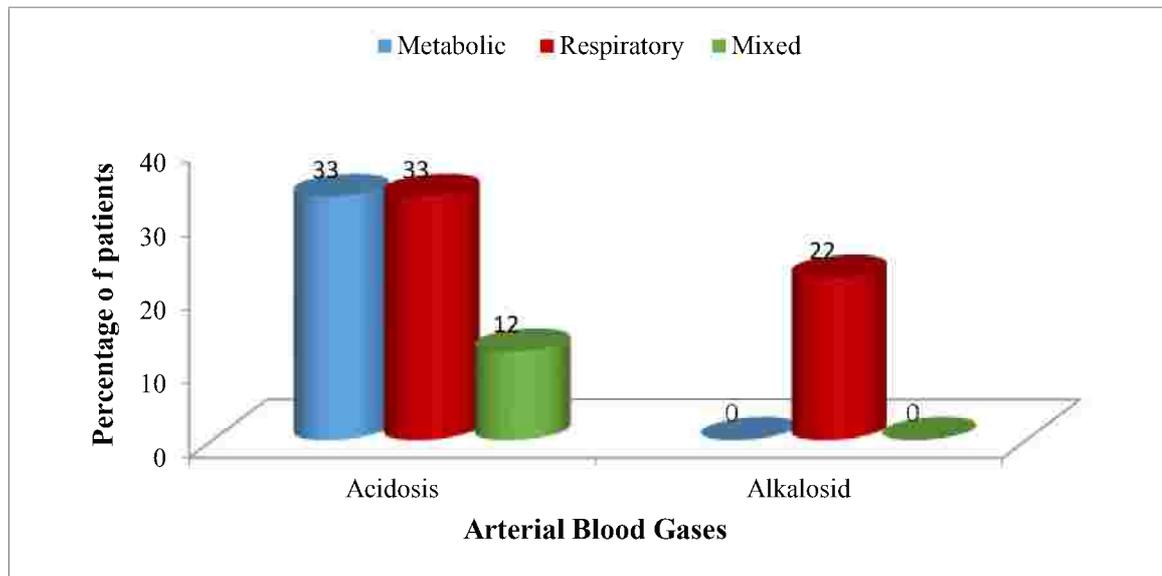


Figure 18: Arterial blood gases interpretation

Results

Table 11 and Figure 19 show investigations performed pre-operatively on the patients according to the age. FAST was performed on 4 patients with age ≤ 18 years, (8.5%) had positive findings. While FAST was performed on 23 patients with age between 18-40 years, (60%) had positive findings. Finally, FAST was performed on 4 patients with age > 40 years, all of them had positive findings.

CT-Chest was performed on 2 patients with age ≤ 18 years, all of them had positive findings. While it was performed on 11 patients with age between 18-40 years, (28.5%) had positive findings. Finally, CT-Chest was performed on 2 patients with age > 40 years, all of them had positive findings.

Chest X-ray was done for one patient with age ≤ 18 years, while chest X-ray was done for 12 patients with age between 18-40 years and finally chest X-ray was done for one patient with age > 40 years.

ABG was done for one patient with age ≤ 18 years, while ABG was done for 7 patients with age between 18-40 years and finally it was done for one patient with age > 40 years.

ECG was not done for patients with age ≤ 18 years, while it was done for 3 patients with age between 18-40 years and finally ECG was done for 2 patients with age > 40 years.

Table 11: Investigations performed pre-operatively according to the age

		Age (year)						<i>p-value</i>
		≤ 18		18-40		> 40		
		N	%	N	%	N	%	
FAST	Positive	3	8.5	21	60	4	11.4	0.465
	Negative	1	2.8	2	5.7	0	0	
	Not done	0	0	4	11.4	0	0	
CT-Chest	Positive	2	5.7	10	28.5	2	5.7	0.823
	Negative	0	0	1	2.8	0	0	
	Not done	2	5.7	16	45.71	2	5.7	
Chest x ray	Done	1	2.8	12	34.2	1	2.8	0.615
	Not done	3	8.5	15	42.85	3	8.5	
ABG	Done	1	2.8	7	20	1	2.8	0.961
	Not done	4	11.4	20	57.14	3	8.5	
ECG	Done	0	0	3	8.5	2	5.7	0.039*
	Not done	4	11.4	24	68.5	2	5.7	

N: Number of patients, *FAST*: Focused Assessment with Sonography for Trauma, *CT*: Computed Topography, *ABG*: Arterial Blood Gases, *ECG*: Electrocardiogram.
p-value less or equal to 0.05 is significant.

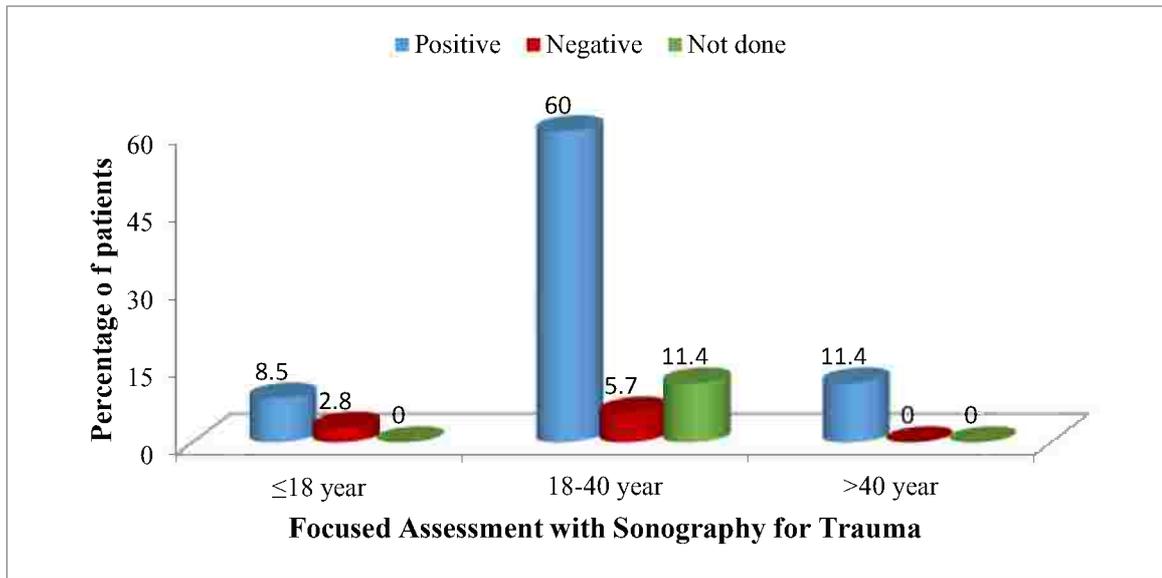


Figure 19-A: Percentages of the patients according to pre-operative focused assessment with sonography for trauma and the age

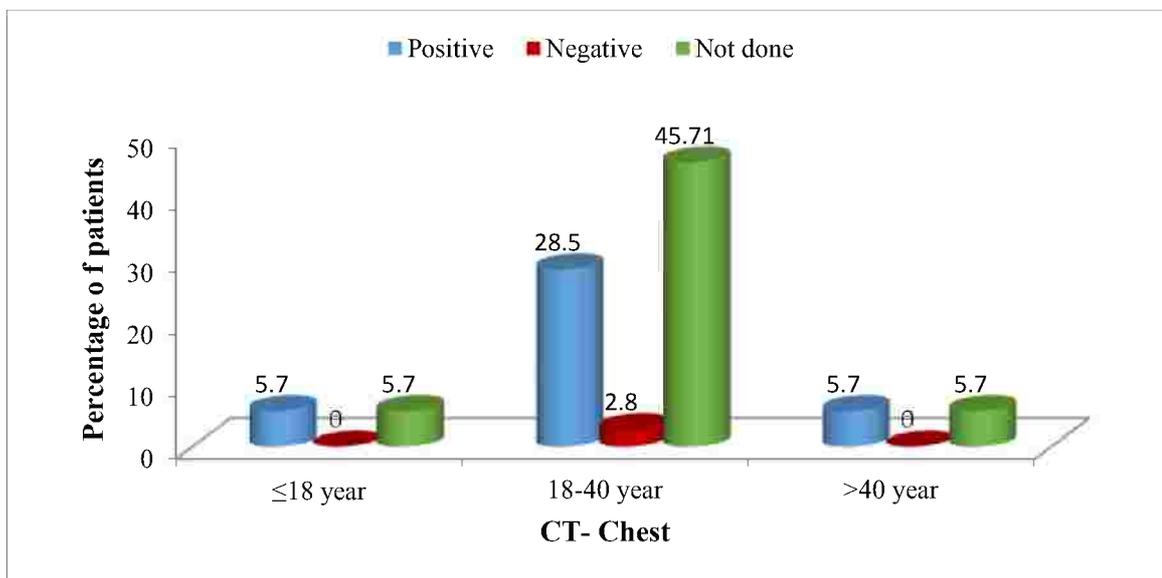


Figure 19-B: Percentages of the patients according to pre-operative CT-Chest and the age

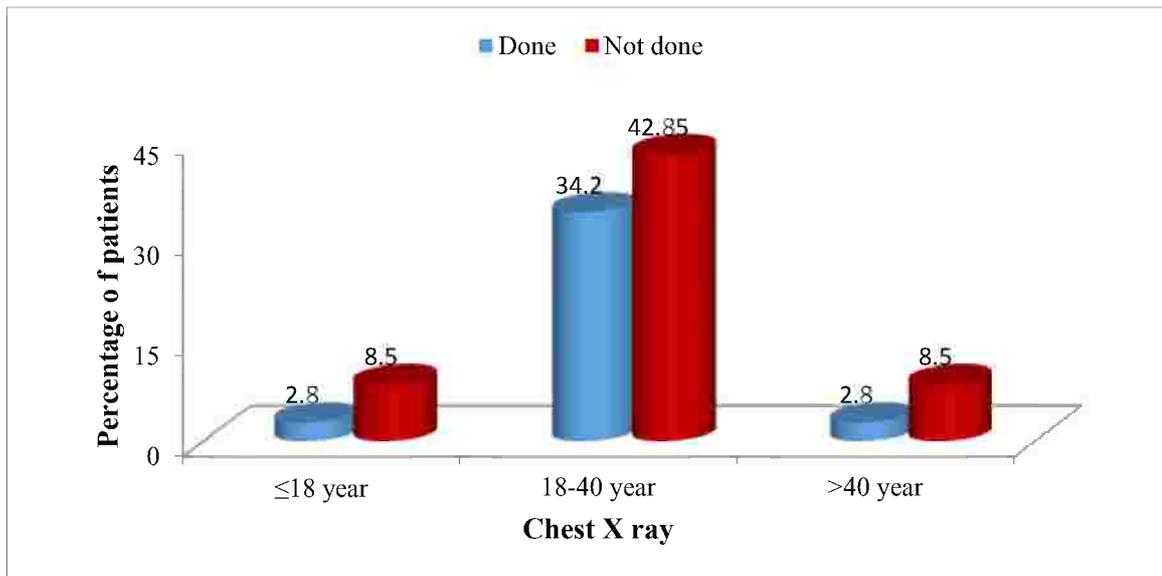


Figure 19-C: Percentages of the patients according to the pre-operative Chest X-ray and the age

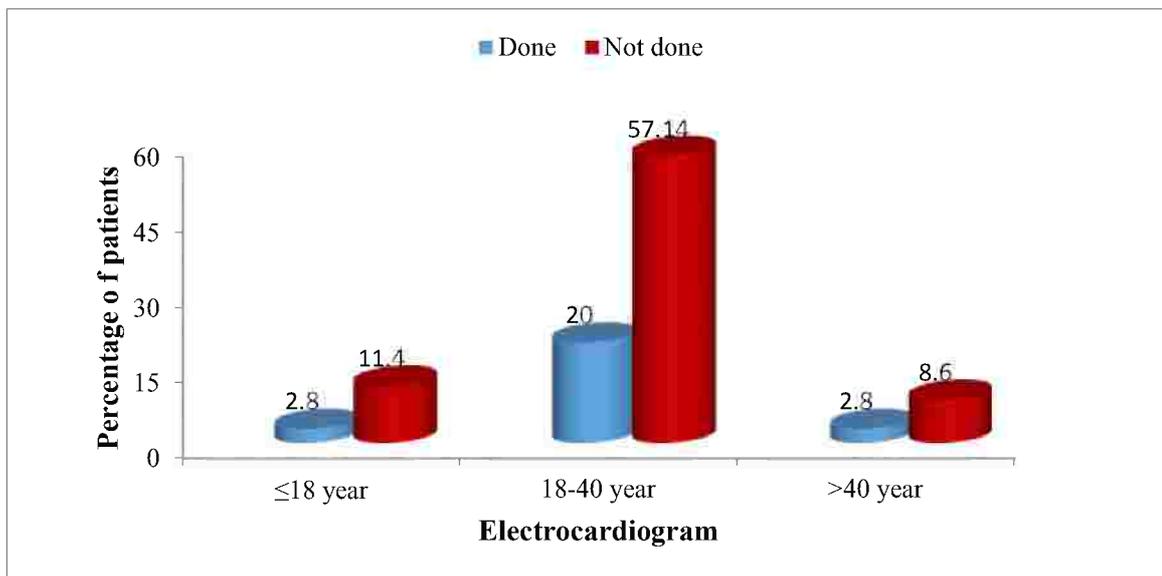


Figure 19-D: Percentages of the patients according to pre-operative electrocardiogram and the age

Results

Table 12 shows indications for operative interventions in the patients according to the mechanism of injury. Shock was an indication for operative intervention in 13 patients, 33.3% had stab injury and 19.1% had gunshot injury. On the other hand, tamponade was an indication in 8 patients, 14.2% had stab injury and 23.8% had gunshot injury. Lastly, massive hemothorax was an indication in one patient with stab injury. Massive air leak was an indication in another patient with gunshot injury.

Table 12: Indications for operative intervention

Indication	Stab injury		Gunshot injury		<i>p</i> -value
	N	%	N	%	
Shock	7	33.3	4	19.1	0.350
Tamponade	3	14.2	5	23.8	
Massive hemothorax	1	4.7	0	0	
Massive air leak	0	0	1	4.7	

N: Number of patients.

p-value less or equal to 0.05 is significant

Results

Table 13 and Figure 20 show percentages of patients according to the type of management and the mechanism of injury. Five patients had no operative management, one patient (4.7%) with stab injury and 4 patients (28.5%) with gunshot injury. Six patients had operative management in the form of chest tube insertion (one patient with stab injury and 5 patients with gunshot injury). Seventeen patients had left anterior thoracotomy (14 patients with stab injury and 3 patients with gunshot injury). One patient with gunshot injury had median sternotomy. Three patients had laparotomy (2 patients with stab injury and one patient with gunshot injury).

Table 13: Percentages of the patients according to the types of management and the mechanism of injury

Management		Stab injury		Gunshot injury		p-value
		N	%	N	%	
Operative	Chest tube	1	4.7	5	35.7	0.019*
	Lt. anterior thoracotomy	14	66.6	3	21.4	
	Median sternotomy	0	0	1	7.1	
	Laparotomy	2	9.5	1	7.1	
Observation	1	4.7	4	28.5		

N: number of patients.

p-value less or equal to 0.05 is significant.

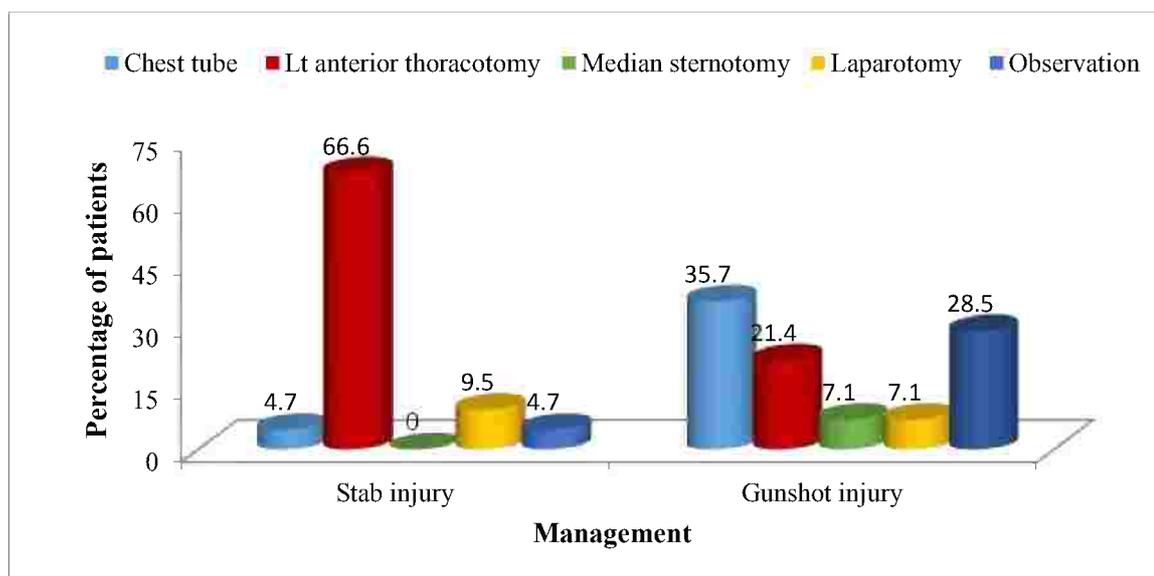


Figure 20: Percentages of the patients according to the types of management and the mechanism of injury

Results

Table 14 and Figure 21 show the percentages of patients according to the type of management and the age. Five patients had no operative intervention, 4 patients of them were between 18-40 years and one patient was > 40 years. On the other hand, 6 patients had operative management in the form of chest tube insertion, 5 patients of them were between 18-40 years and only one patient was > 40 years. Meanwhile, 17 patients had left anterior thoracotomy, 2 patients of them were ≤ 18 years, while 13 patients were between 18-40 years and 2 patients were > 40 years. One patient had median sternotomy. His age was between 18-40 years, while 3 patients had laparotomy and all of them were between 18-40 years.

Table 14: Percentages of the patients according to the types of management and the age

Management		Age (year)						<i>p-value</i>
		≤ 18		18-40		>40		
		N	%	N	%	N	%	
Operative	Chest tube	0	0	5	18.5	1	3.7	0.026*
	Lt. ant. thoracotomy	2	7.4	13	48.14	2	7.4	
	Median sternotomy	0	0	1	3.7	0	0	
	Laparotomy	0	0	3	11.1	0	0	
Observation	0	0	4	28.5	1	4.7		

N: Number of patients.

p-value less or equal to 0.05 is significant.

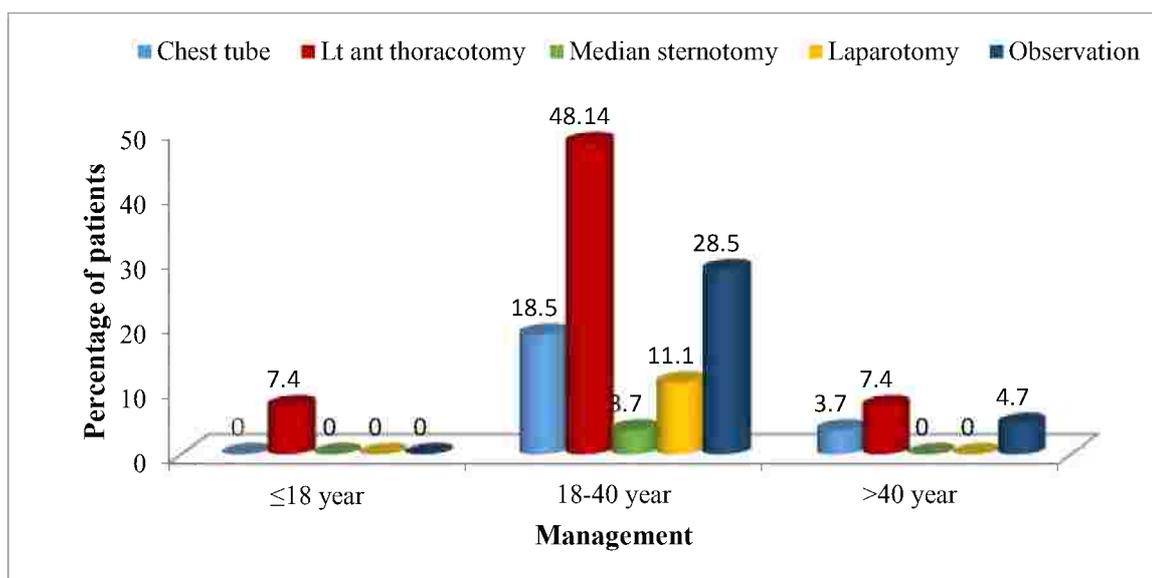


Figure 21: Percentages of the patients according to the types of management and the age

Results

Table 15, Table 16 and Figure 22 show the percentages of patients according to the time spent before going to the operating theater and the mechanism of injury. Seventeen patients (77.3%) with stab injury had mean time to operating room 4.79 ± 2.19 h (range 1.5-9 h), 22.7% had ≤ 3 h and 54.5% had time > 3 h. Meanwhile 5 patients (22.7%) with gunshot injury had mean time 5.40 ± 1.14 h, range 5-7 h, all of them had time > 3 h.

Table 15: Percentages of the patients according to the time spent before going to operating theater and the mechanism of injury

		Stab injury		Gunshot injury		<i>p</i> -value
		N	%	N	%	
Time to OR	≤ 3 h	5	22.7	0	0	0.168
	> 3 h	12	54.5	5	22.7	
Total		17	77.3	5	22.7	

N: Number of patients.

p-value less or equal to 0.05 is significant.

Table 16: Distribution of the patients according to the time spent before going to operating theater and the mechanism of injury

	Stab injury			Gunshot injury			<i>p</i> -value
	Range	Mean	\pm SD	Range	Mean	\pm SD	
Time to OR (h)	1.5-9	4.79	2.19	5-7	5.40	1.14	0.047*

SD: Standard deviation.

p-value less or equal to 0.05 is significant.

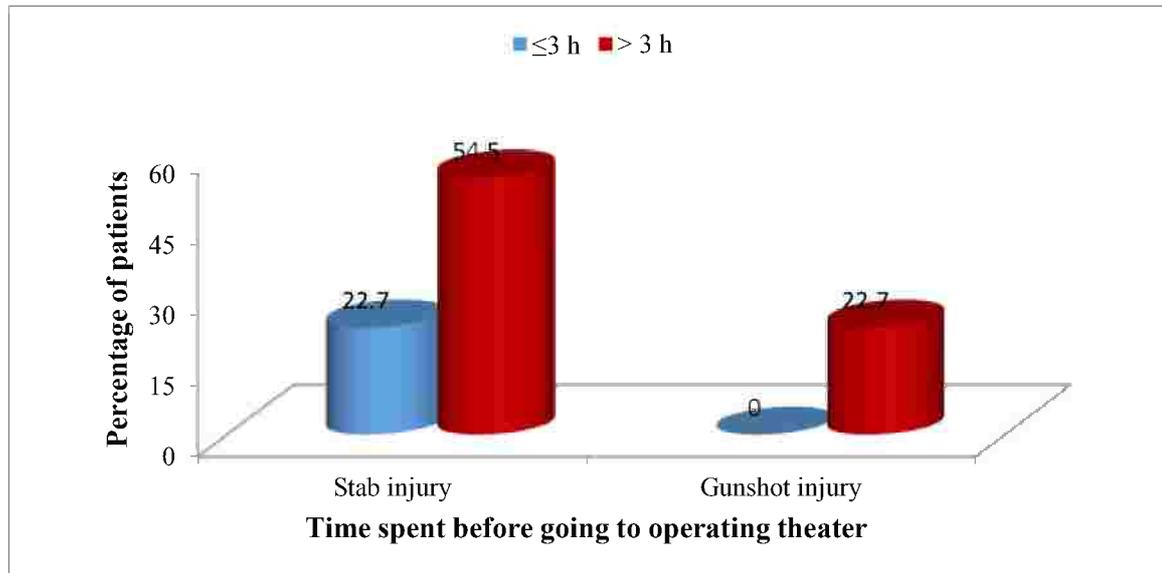


Figure 22: Percentages of patients according to the time spent before going to operating theater and the mechanism of injury

Results

Table 17 and Figure 23 show percentages of patients according to time spent before going to operating theater and the age. Five patients spent ≤ 3 h before going to operating theater, 2 patients of them were between 18-40 years, 2 patients were > 40 years, and one patient was ≤ 18 years. Seventeen patients waited > 3 h before going to the operating theater, one of them was ≤ 18 years and 16 patients were between 18-40 years.

Table 17: Percentages of patients according to the time spent before going to operating theater and the age

Time to OR	Age (year)						<i>p</i> -value
	≤ 18		18-40		> 40		
	N	%	N	%	N	%	
≤ 3 h	1	4.5	2	9.1	2	9.1	0.010**
> 3 h	1	4.5	16	72.7	0	0	

N: Number of patients, *Time to OR*: Time spent before going to operating theater.
p-value less or equal to 0.05 is significant.

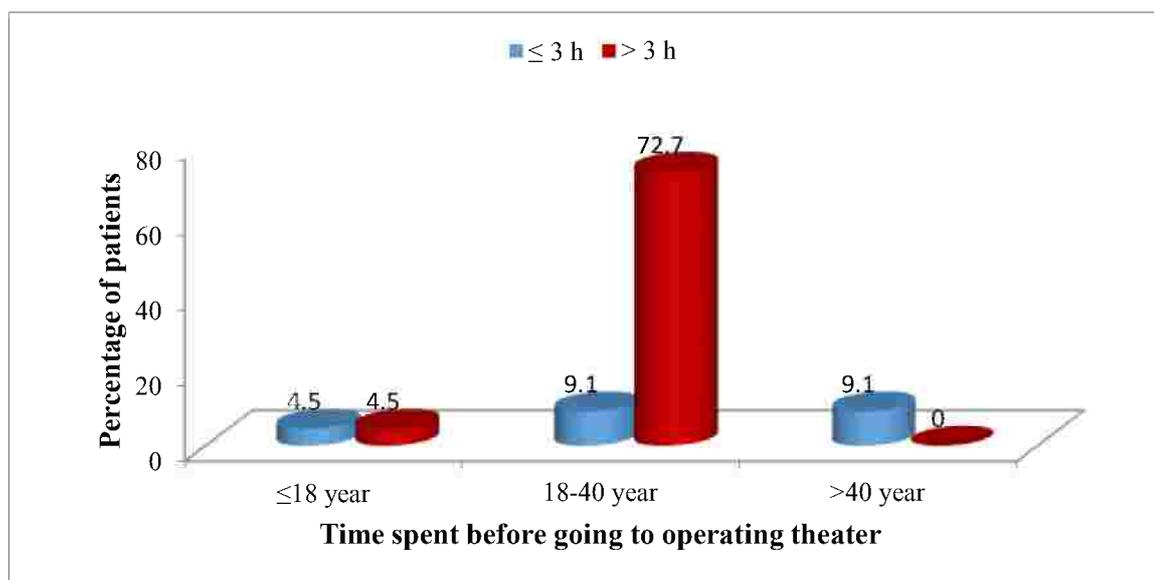


Figure 23: Percentages of patients according to the time spent before going to operating theater and the age

Results

Table 18 and Figure 24 show percentages of internal cardiac injuries according to the mechanism of injury. The right ventricle was injured in 9 patients, 7 patients of them had stab injury and 2 patients had gunshot injury. The left ventricle was injured in 4 patients, 3 of them had stab injury and one patient had gunshot injury. Complex injury was seen in one patient with stab injury.

Table 18: Percentages of internal cardiac injuries of the patients according to the mechanism of injury

	Stab injury		Gunshot injury		<i>p-value</i>
	N	%	N	%	
Right Ventricle	7	50	2	14.3	0.858
Left Ventricle	3	21.4	1	7.1	
Complex	1	7.1	0	0	

N: Number of patients.

p-value less or equal to 0.05 is significant.

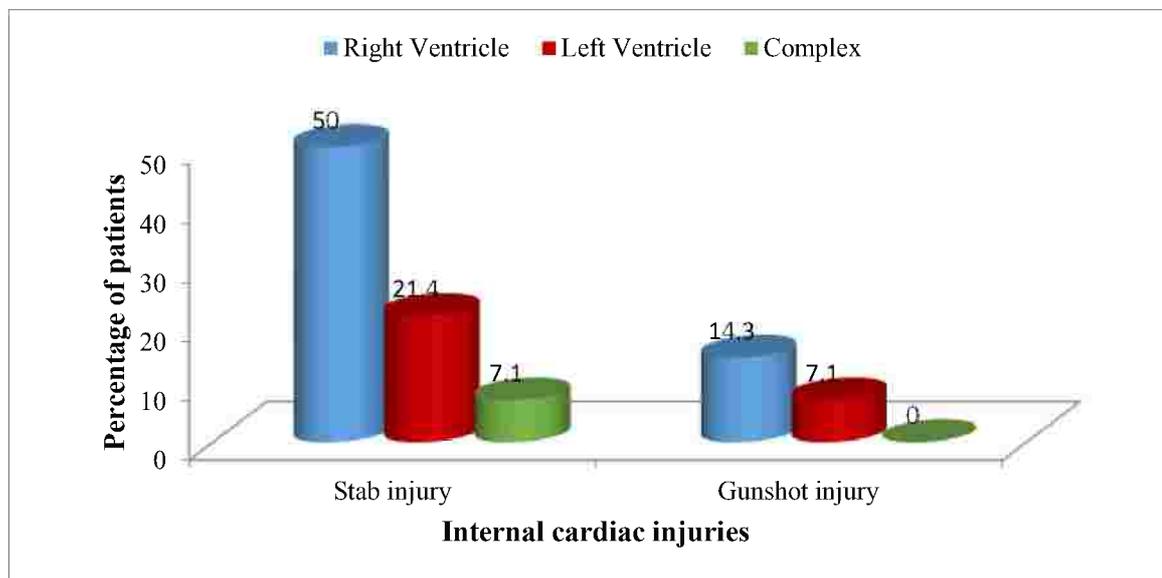


Figure 24: Percentages of internal cardiac injuries of the patients according to the mechanism of injury

Results

Table 19 and Figure 25 show percentages of internal cardiac injuries according to the age. The right ventricle was injured in 9 patients, one of them was ≤ 18 years, 7 patients were between 18-40 years and one patient was > 40 years. The left ventricle was injured in 4 patients, one of them was ≤ 18 years and 3 patients were between 18-40 years. Meanwhile, complex injury was seen in one patient > 40 years.

Table 19: Percentages of internal cardiac injuries of the patients according to the age

	Age (year)						p-value
	≤ 18		18-40		> 40		
	N	%	N	%	N	%	
Rt ventricle	1	7.1	7	50	1	7.1	0.038*
Lt ventricle	1	7.1	3	21.4	0	0	
Complex	0	0	0	0	1	7.1	

N: Number of patients.

p-value less or equal to 0.05 is significant.

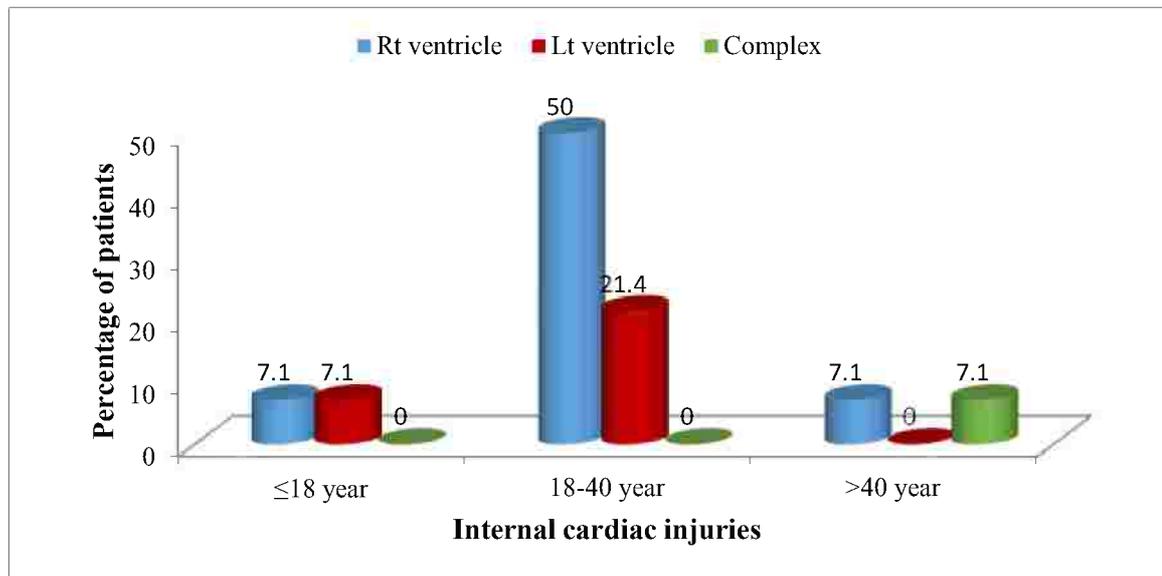


Figure 25: Percentages of internal cardiac injuries of the patients according to the age

Results

Table 20 shows percentages of intra-abdominal injuries of the patients according to mechanism of injury. Single intra-abdominal injury was seen in 7 patients, 4 patients of them had stab injury, while 3 patients had gunshot injury. Multiple intra-abdominal injury was seen in four patients with stab injury.

Table 20: Percentages of intra-abdominal injuries of the patients according to the mechanism of injury

Intra-abdominal injuries	Stab injury		Gunshot injury		<i>p-value</i>
	N	%	N	%	
Single	4	36.36	3	27.27	0.237
Hepatic injury	1		0		
Splenic injury	1		0		
Renal injury	1		0		
Intestinal injury	0		1		
Diaphragmatic injury	1		2		
Multiple	4	36.36	0	0	

N: number of patients.

p-value less or equal to 0.05 is significant.

Table 21 and Figure 26 show percentages of intra-abdominal injuries of patients according to the age. Single intra-abdominal injury was seen in 7 patients. One of them was ≤ 18 years and had diaphragmatic injury. While 6 patients were between 18-40 years, one patient for each type of injury (hepatic, splenic, renal, and intestinal) and 2 patients had diaphragmatic injury. Multiple intra-abdominal injuries were seen in 4 patients, 3 of them were between 18-40 years and one patient was > 40 years.

Results

Table 21: Percentages of intra-abdominal injuries of the patients according to the age

	Age (year)						<i>p-value</i>
	≤18		18-40		>40		
	N	%	N	%	N	%	
Single	1	9.1	6	61.9	0	0	0.035
Hepatic injury	0		1		0		
Splenic injury	0		1		0		
Renal injury	0		1		0		
Intestinal injury	0		1		0		
Diaphragmatic injury	1		2		0		
Multiple	0	0	3	27.3	1	9.1	

N: Number of patients.

p-value less or equal to 0.05 is significant

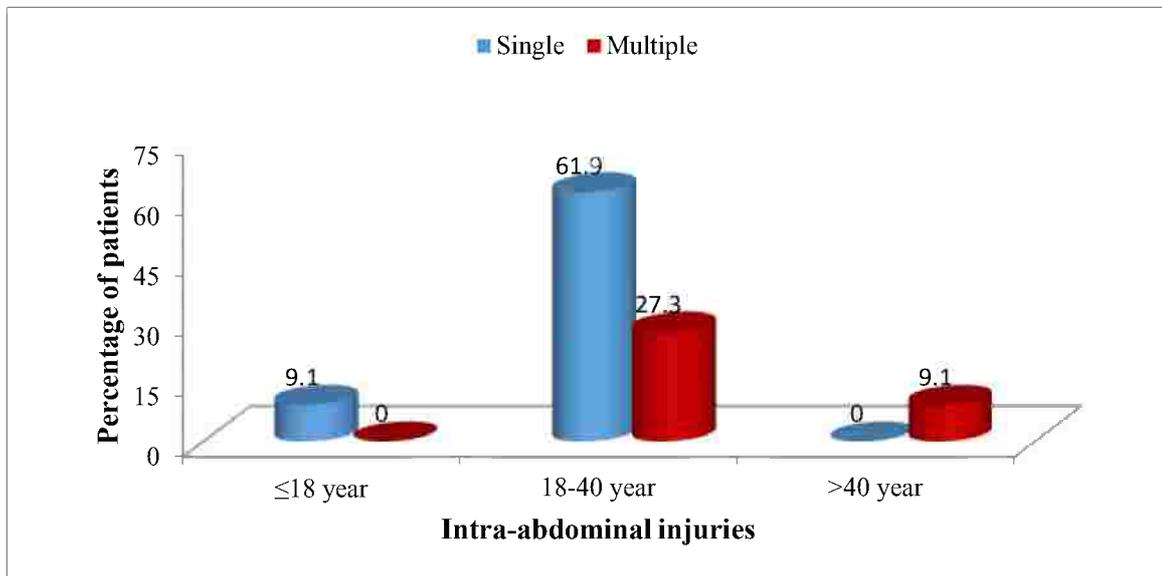


Figure 26: Percentages of intra-abdominal injuries of the patients according to the age

Results

Table 22 shows the amount of blood transfusion and blood loss according to the mechanism of injury. Twenty-six patients had blood transfusion, 16 patients of them had stab injury (mean 4437.5 ± 2632.33 ml), while 10 patients had gunshot injury (mean 2500 ± 2121.32 ml). Six patients had initial chest tube loss, one patient had stab injury (mean 2500 ml), while 5 patients had gunshot injury (mean 340 ± 219.9 ml). Four patients with gunshot injury had ongoing chest tube loss (mean 575 ± 221.74 ml).

Table 22: Amount of the blood transfusion and blood loss according to the mechanism of injury

	Stab injury			Gunshot injury			<i>p-value</i>
	N	Mean	\pm SD	N	Mean	\pm SD	
Blood trans- fusion	16	4437.5	2632.33	10	2500.0	2121.32	0.062
Initial chest tube loss	1	2500.0	0	5	340.0	219.90	0.415
Ongoing chest tube loss	0	0	0	4	575.0	221.74	0.001***

N: Number of patients, *SD*: Standard deviation.
p-value less or equal to 0.05 is significant.

Results

Table 23 and Figure 27 show the amount of blood transfusion and the amount of blood loss according to the age. Twenty-six patients had blood transfusion, 2 patients with age ≤ 18 years transfused 2500 ± 1224 ml and 21 patients with age between 18-40 years transfused 4000 ± 2500 ml. Finally, 3 patients with age > 40 years had 4333 ± 1932 ml. Six patients had initial chest tube loss, five patients of them were between 18-40 years (mean 954 ± 620 ml) and one patient was > 40 years (mean 100 ml).

Table 23: Amount of the blood transfusion and blood loss according to the age

	Age (year)									<i>p-value</i>
	≤ 18			18-40			> 40			
	N	Mean	\pm SD	N	Mean	\pm SD	N	Mean	\pm SD	
Blood transfusion	2	2500	1224	21	4000	2500	3	4333	1932	0.046*
Initial chest tube loss	0	0	0	5	954	620	1	100	0	0.529
Ongoing chest tube loss	0	0	0	3	633	230	1	400	0	0.474

N: Number of patients, *SD*: Standard deviation.
p-value less or equal to 0.05 is significant.

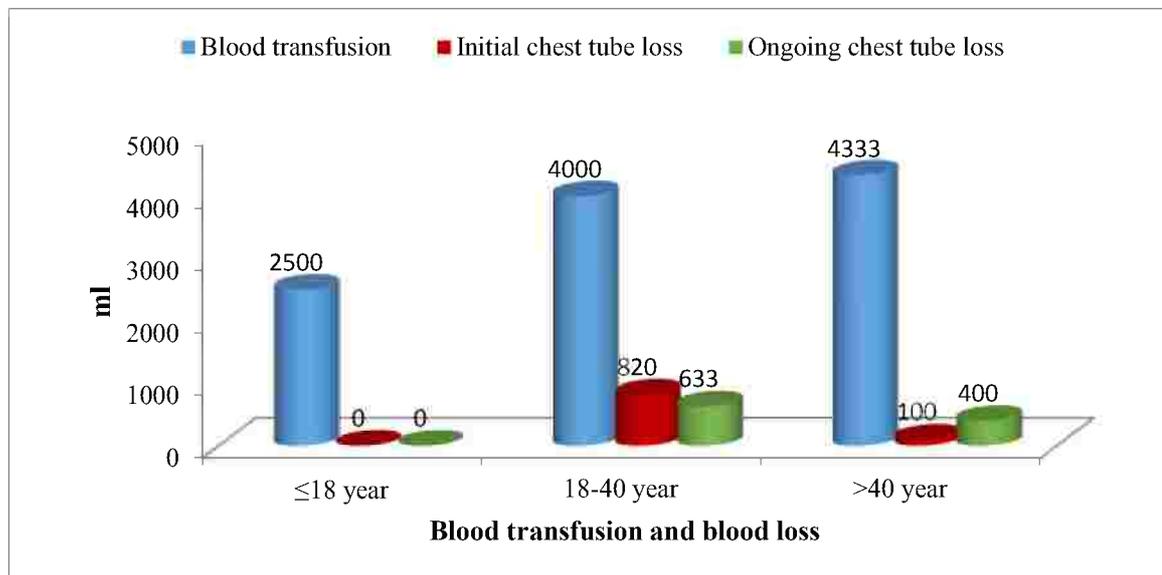


Figure 27: Amount of the blood transfusion and blood loss according to the age

Results

Table 24 shows the post-operative hospital and ICU stay in relation to the mechanism of injury. Patients with stab injury had total hospital stay ranged from 5-10 days with a mean of 5.61 ± 1.55 , and the ICU stay ranged between 3-5 days with a mean of 3.15 ± 0.55 . Meanwhile, patients with gunshot injury had total hospital stay ranged between 5-30 days with a mean of 12.5 ± 11.73 , and the ICU stay ranged from 3-10 days with a mean of 5 ± 3.3 days.

Table 24: Postoperative hospital and ICU stay in relation to the mechanism of injury

	Stab injury			Gunshot injury			<i>p-value</i>
	Range	Mean	\pm SD	Range	Mean	\pm SD	
Postoperative hospital stay	5-10	5.61	1.55	5-30	12.5	11.73	0.014*
ICU stay	3-5	3.15	0.55	3-10	5	3.3	0.039*

SD: Standard deviation. ICU: Intensive Care Unit

p-value less or equal to 0.05 is significant

Table 25 shows the most common post-operative complications in relation to the mechanism of injury. All patients with stab injury and gunshot injury had post-operative pain. Ten patients (77%) with stab injury had post-operative fever. In contrary, all patients (100%) with gunshot injury had post-operative fever. One patient (8%) with stab injury had post-operative persistent pneumothorax, while 3 patients (74%) with gunshot injury had post-operative persistent pneumothorax. Two patients (50%) with gunshot injury had post-operative pneumonia.

Table 25: Postoperative complication in relation to the mechanism of injury

Postoperative complication	Stab injury		Gunshot injury		<i>p-value</i>
	N	%	N	%	
Pain	13	100	4	100	0.042*
Fever	10	77	4	100	
Pneumothorax	1	8	3	75	
Pneumonia	0	0	2	50	

N: Number of patients.

p-value less or equal to 0.05 is significant

Results

Table 26 and Figure 28 show the parameters affecting mortality in penetrating cardiac injuries. Three patients arrested on arrival to ED, 2 patients (25%) of them were ≤ 18 years and one patient was between 18-40 years. Meanwhile, 5 patients arrested intra-operatively, one of them was ≤ 18 years and 4 patients were between 18-40 years. The three arrested patients on arrival had stab injury, while the 5 arrested patients intra-operatively divided between both injuries, 4 patients of them had stab injury and one patient had gunshot injury. The eight arrested patients had SBP ≤ 90 mmHg. The three arrested patients on arrival had unrecorded SBP and the 5 arrested patients intra-operatively had mean SBP 58 ± 34.93 mmHg. While the twenty seven survived patients had mean SBP 81.11 ± 36.83 mmHg. 63% of them had SBP > 90 mmHg and 37% of them had SBP ≤ 90 mmHg.

The 3 arrested patients on arrival had a mean GCS 5 ± 3.46 , one patient had GCS > 9 and 2 patients had GCS ≤ 9 . While the 5 arrested patients intra-operatively had mean GCS 10.6 ± 4.98 , 2 patients of them had GCS > 9 and 3 patients had GCS ≤ 9 . In contrary, the survived 27 patients had a mean GCS 13.19 ± 3.91 . In all of the 3 arrested patients on arrival had no other associated injuries. The same finding was encountered in the 5 arrested patients intra-operatively. While in the survived 27 patients, 18 patients of them (66.7%) had other associated injuries while 9 patients of them (33.3%) had no other associated injury.

All the 5 arrested patients intra-operatively took > 3 h to go to the operating theater with a mean of 7 ± 1.22 h. Meanwhile, in the survived 27 patients, five patients of them waited 3 h or less to go to the operating theater and 12 patients had > 3 h with a mean of 4.32 ± 1.77 h. Two patients (25%) presented by tamponade arrested intra-operatively, while 6 patients (75%) presented by tamponade survived. One patient from those who arrested intra-operatively had multiple intra-abdominal injuries, while 3 patients from those who survived had multiple intra-abdominal injuries. The 3 arrested patients on arrival had ISS 16, RTS 4.49 ± 3.91 and TRISS 68.46 ± 46.85 , while the 5 arrested patients intra-operatively had ISS 16, RTS 3.72 ± 2.72 and TRISS 47.76 ± 45.68 . In the survived 27 patients, the ISS, RTS and TRISS were 20.07 ± 3.91 , 6.27 ± 1.66 and 91.64 ± 16.93 , respectively.

Four patients from those who arrested intra-operatively had blood transfusion (mean 3250 ± 1500 ml), while 22 patients from those who survived had blood transfusion (mean of 3772.7 ± 2483.1 ml).

Table 26: The parameters affecting mortality in penetrating cardiac injury

	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)	0	0	0	5	7.00 ^a	1.22	17	4.32 ^b	1.77	0.0190*
Blood transfusion (ml)	0	0	0	4	3250.0	1500.0	22	3772.7	2483.10	0.001***
Initial chest tube loss preoperatively (ml)	0	0	0	0	0	0	6	700.00	903.32	0
Ongoing chest tube loss at conservative management (ml)	0	0	0	0	0	0	4	575.00	221.73	0

a-c Mean in the same row with different letters are significantly different $p \leq 0.05$.

N: Number of patients, SD: Standard deviation, SBP: Systolic Blood Pressure, GCS: Glasgow Coma Scale, ISS: Injury Severity Score, RTS: Revised Trauma Score, TRISS: Trauma revised Injury Severity Score.

p-value less or equal to 0.05 is significant.

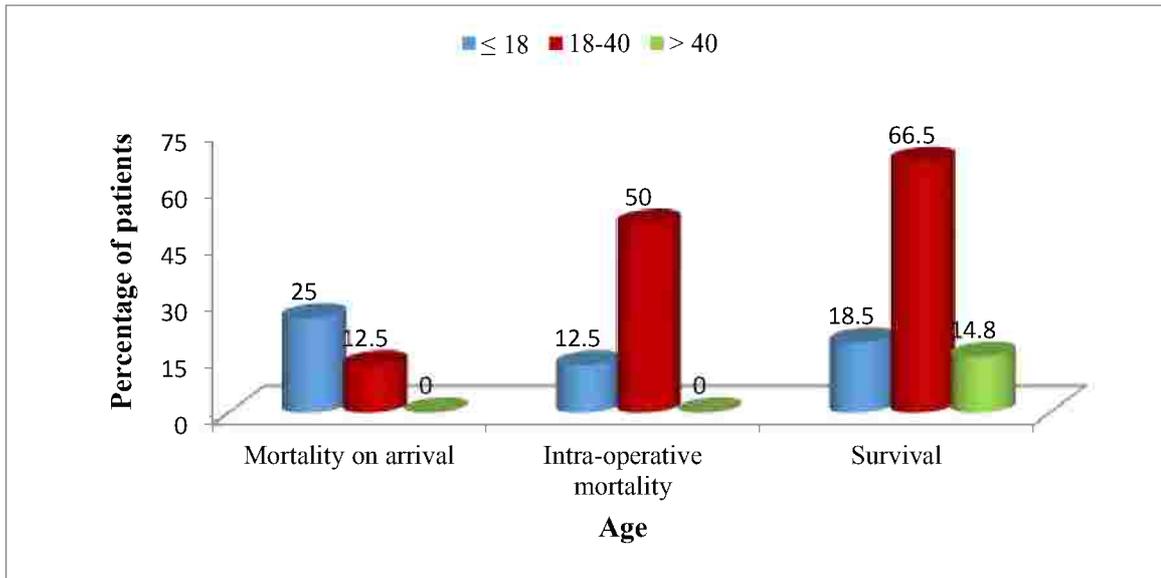


Figure 28-A: Effect of age on mortality

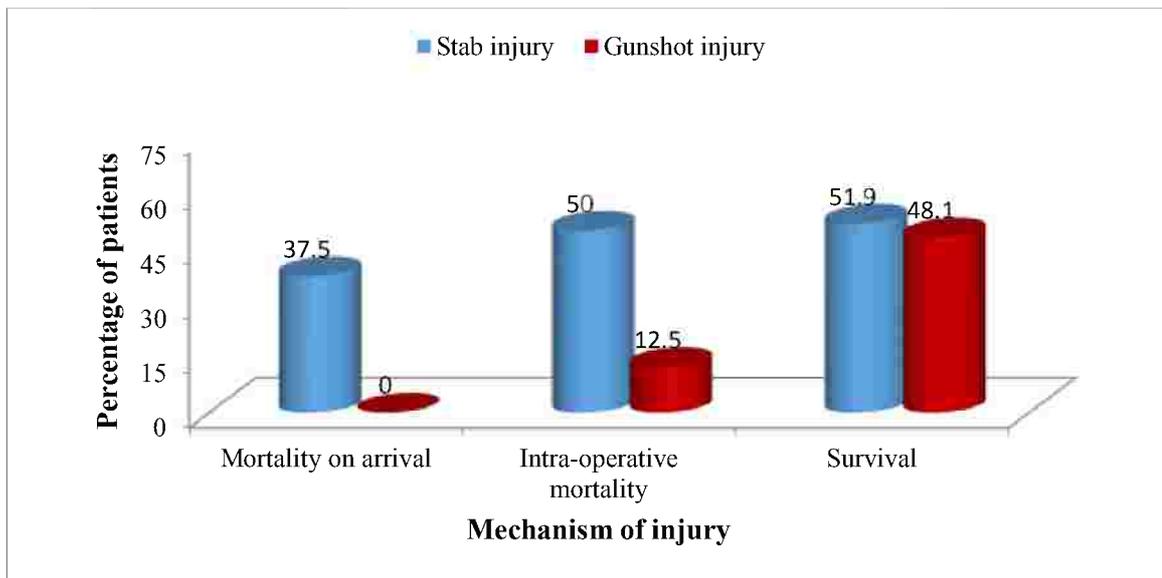


Figure 28-B: Effect of mechanism of injury on mortality

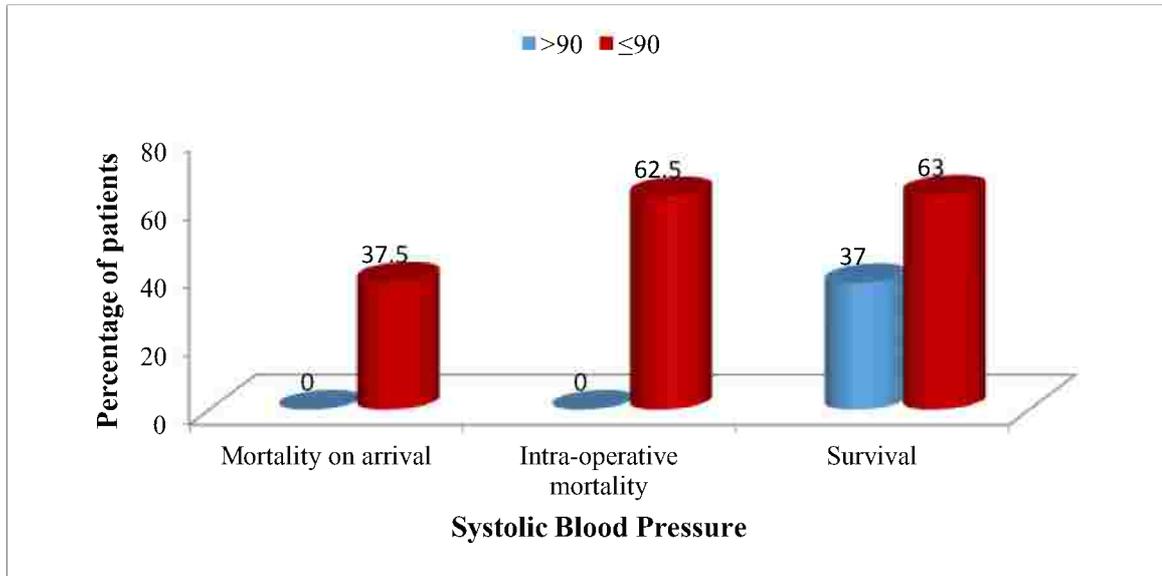


Figure 28-C: Effect of systolic blood pressure on mortality

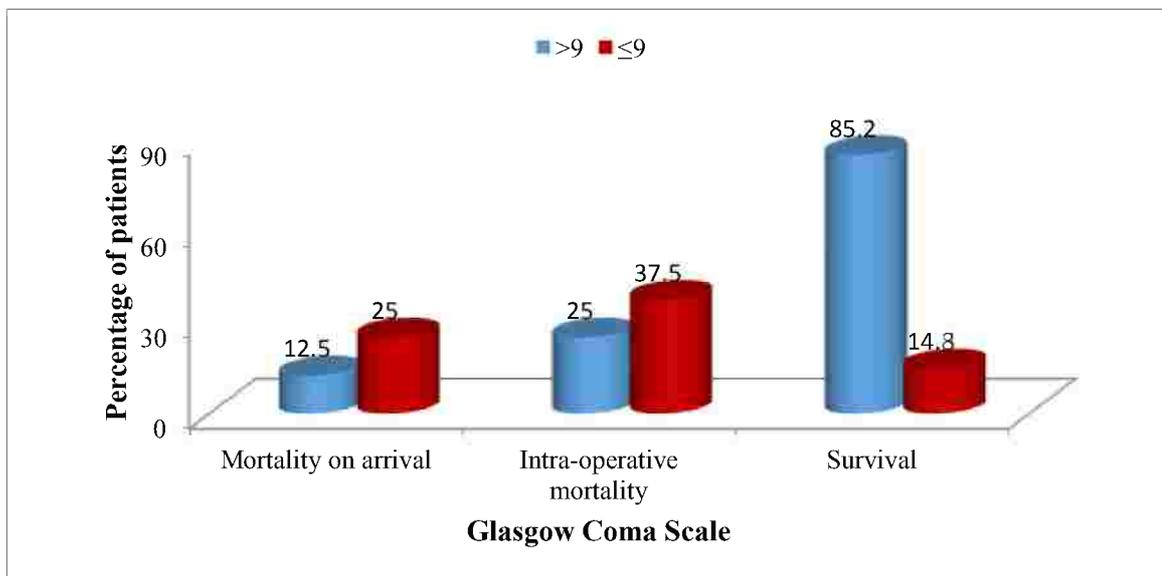


Figure 28-D: Effect of Glasgow coma scale on mortality

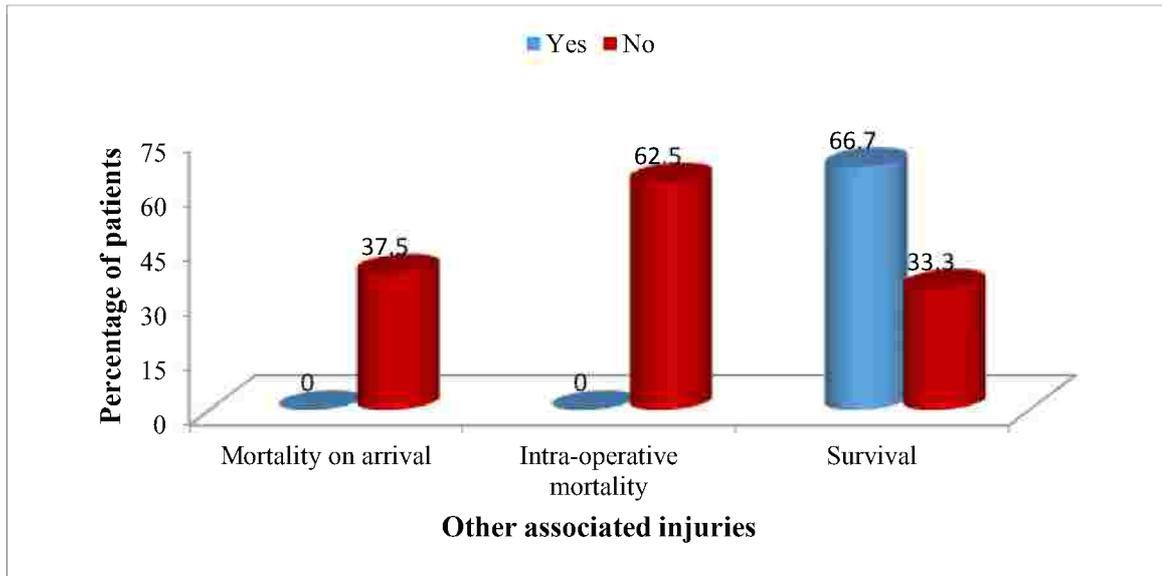


Figure 28-E: Effect of other associated injuries on mortality

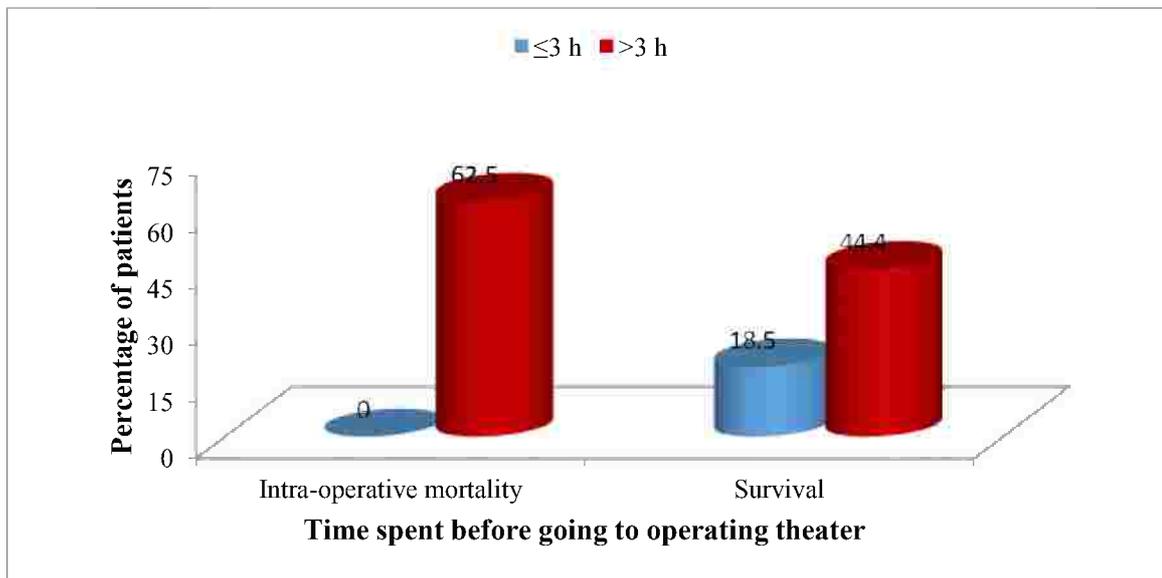


Figure 28-F: Effect of time spent before going to operating theater on mortality

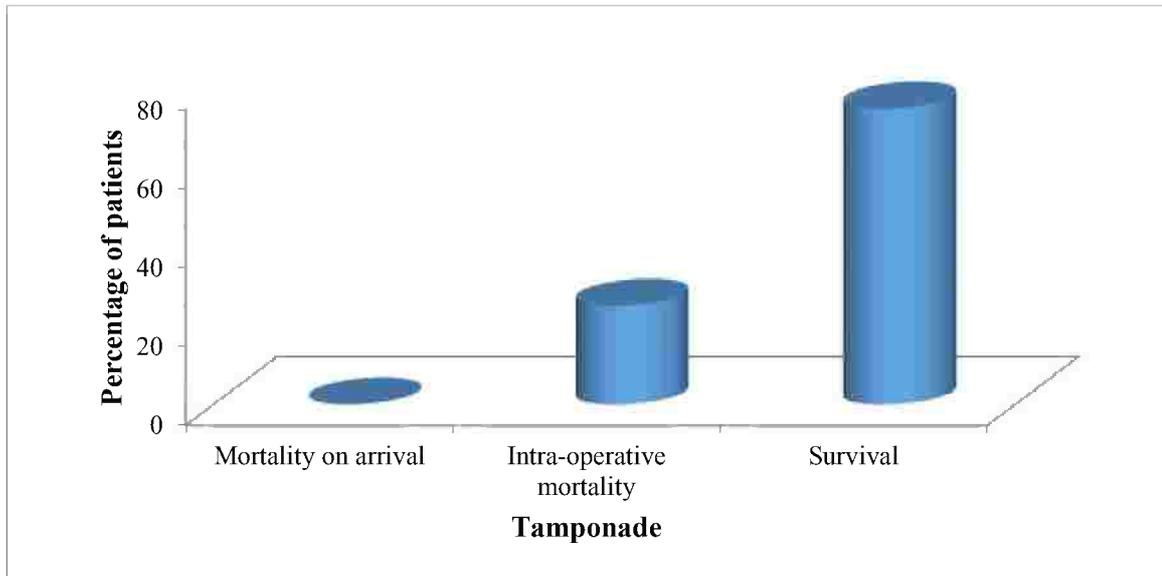


Figure 28-G: Effect of Tamponade on mortality

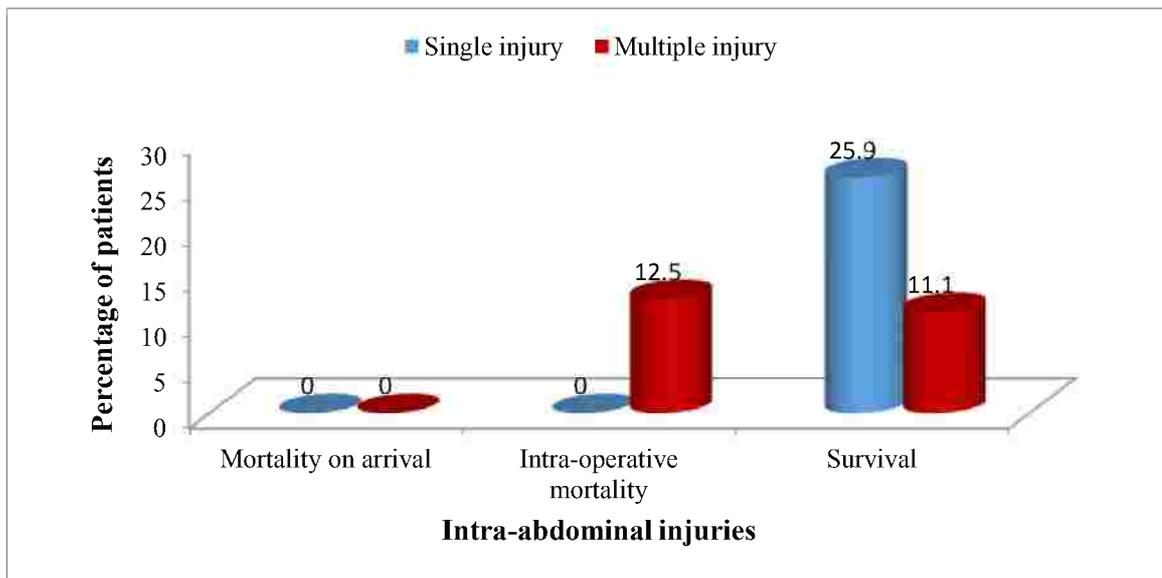


Figure 28-H: Effect of intra-abdominal injuries on mortality

Results

Table 27, Figure 29 and Figure 30 show the postoperative follow up investigation in the form of ECG and Echo in relation to mechanism of injury. From the 27 survived patients, 14 patients (51.9%) with stab injury and 13 patients (48%) with gunshot injury had ECG. No one of them did Echo. While at the one month follow up visit, only 2 patients (7.4%) with stab injury had ECG. On the other hand, no one of the patients with gunshot injury had ECG and Echo. Finally at the 2 month follow up, only one patient (3.7%) with stab injury had ECG and Echo. While no one of the patients with gunshot injury had ECG and Echo.

Table 27: Postoperative follow up ECG and Echo findings in relation to the mechanism of injury

Postoperative follow up		Stab injury		Gunshot injury	
		N	%	N	%
Immediate postoperative	ECG	14	51.9	13	48.1
	Echo	0	0	0	0
One month postoperative	ECG	2	7.4	0	0
	Echo	2	7.4	0	0
Two month postoperative	ECG	1	3.7	0	0
	Echo	1	3.7	0	0

N: Number of patients.



Figure 29-A: ECG shows sinus tachycardia



Figure 29-B: ECG shows normal sinus rhythm

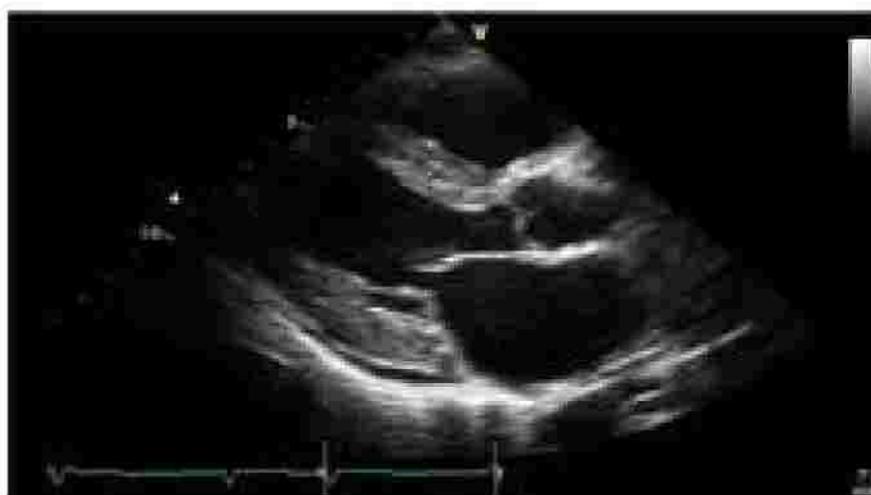


Figure 30: Echo show minimal pericardial effusion