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Penetrating Cardiac Injuries

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Abstract: Objectives: To present our experience of penetrating cardiac injuries treated at Atatürk University hospital; in 17 years 38 patients were analyzed.

Methods: Patients were classified into three groups: group A (stable), 12; group B (shock), 21; and group C (agonal), five. Five patients were treated by pericardial window and three by pericardiocentesis. Two patients in group C, 19 patients in group B and five patients in group A underwent median sternotomy or thoracotomy in the operating room. Emergency room thoracotomies were performed in four patients.

Results: There were 12 patients in group A, of which 11 survived (92 %). Of the 21 patients who were in group B on admission, 19 survived, a survival rate of 90 %. There were five patients in group C, of which three survived (60 %). Four patients required emergency room thoracotomy, of which two survived (a survival rate of 50 %), whereas 26 patients underwent operating room thoracotomy or sternotomy, all of which survived (a survival rate of 100 %).

Conclusions: Cardiac injury can lead to a life-threatening hemodynamic instability that mandates prompt and clear diagnostic and therapeutic approaches. In agonal patients, and in patients transported late to the hospital, it may be necessary to begin emergency room thoracotomy or emergency room sternotomy.

Key Words: Emergency treatment, Heart injuries, Cardiac tamponade

Introduction

There has been an increase in rural violence since terrorism began in Southeast Anatolia. Thus, penetrating cardiac injuries have shown a progressive increase over the past two decades. In this study, our 20-year experience in treating penetrating cardiac injuries at the Atatürk University Research Hospital was reviewed in order to determine the best approach for the treatment of these injuries.

Materials and Methods

Thirty-eight patients with penetrating cardiac injury were operated on at Atatürk University Research Hospital between 1984 and 2001. Exluded from this series were patients who were pronounced dead on arrival at hospital after chest trauma. Twenty-six patients had gunshot wounds and 12 patients had stab wounds. The patients ranged in age from 10 to 62 years (mean age: 26.6 years). There were 34 male and four female patients. Patients were brought to the emergency room area between 10 min and 6.4 h after injury (mean time: 3.2 h).

They were classified into three groups according to their clinical status on admission. Group A (stable): systolic blood pressure more than 80 mm Hg, alert; Group B (shock): systolic blood pressure 80 mm Hg or less, conscious; Group C (agonal): semiconscious, gasping respiration, no measurable blood pressure. The distribution in each group is summarized in Table 1, which also includes the number of patients in each category.

Lifeless patients were excluded because there was no emergency room thoracotomy in our hospital in the early years of this series and mortality was 100 %.

Five patients were treated by pericardial window and three by pericardiocentesis, all from the earlier years of the study. Two patients in group C, 19 in group B and five in group A underwent median sternotomy or thoracotomy in the operating room. Emergency room thoracotomies were performed in three patients in group

C and one in group B, all from the later years in the series.

In patients treated by surgical intervention, left anterolateral thoracotomy was used in 18 patients, and median sternotomy in 12. In summary, 30 patients underwent cardiorrhaphy (Table 1).

The right ventricle (RV) was the most commonly involved site of injury, followed by the right atrium (RA), left ventricle (LV) and left atrium (LA) (Figure 1). The site of heart injury could not be determined in two patients who were treated by pericardiocentesis alone. There was one RV + interventricular septum (IVS) injury. There were also 17 patients who had single or multiple major organ injuries (Tables 2-3). The liver was the most commonly injured intraabdominal organ (Table 3). Coronary vessels were lacerated in three patients. Emergency coronary artery bypass grafting was necessary in one of them.

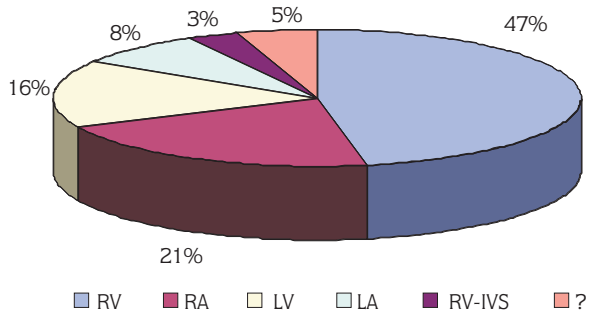

Figure 1. Site of heart injury
RV: Right ventricle
RA: Right atrium
LV: Left ventricle
LA: Left atrium
RV-IVS: Right ventricle - interventricular septum.

Most of the cardiac wounds were treated by simple suture repair over Teflon pledgets. One patient was found to have a ventricular septal defect that was repaired 6 months later. Only one patient required cardiopulmonary bypass for acute repair: injury of RV + circumflex coronary artery transection.

Table 1. Classification according to admission clinical status of patients.

Groups	Clinical Status	Gunshot	Stab	Total No. of Patients	Operating Room	Emergency Room	Pericardial Window	Pericardiocentesis
A	Stable	8	4	12	5	-	5	2
B	Shock	13	8	21	19	1	-	1
C	Agonal	5	-	5	2	3	-	-
		26	12	38	26	4	5	3

Table 2. Incidence of associated injuries.

Injuries	No.
Intraadominal	8
Pulmonary	9
Vascular	3
Internal mammary artery	4

Table 3. Associated injured intraabdominal organs.

Intra-Abdominal Organs	No.
Liver	3
Spleen	2
Stomach	1
Colon	1
Small bowel	1

Results

Group A (stable): There were 12 patients in this group, of which 11 survived (92 %).

Group B (shock): Of the 21 patients who were in shock on admission, of which 19 survived, a survival rate of 90 %.

Group C (agonal): There were five patients in this group, of which three survived (60 %) (Table 4).

As to the mechanism of injury, there were 12 stab wounds and 26 gunshot wounds with 23 surviving gunshot wounds (88 %) and 12 surviving stab wounds (100 %).

Table 4. Admission clinical status and survival.

	No. of Patients	Survival
Group A	12	11 (92 %)
Group B	21	19 (90 %)
Group C	5	3 (60 %)

Four patients required emergency room thoracotomy, of which two survived (a survival rate of 50 %), whereas 26 patients underwent operating room thoracotomy or emergency room sternotomy, all of which survived (a survival rate of 100 %). Three patients were treated by pericardiocentesis, of which two survived (a survival rate of 67 %).

The complications encountered in resuscitated patients are summarized in Table 5. Sixteen patients had complications, the majority of which were nonfatal. Two patients who had anoxic cerebral damage and one patient who had reexploration for bleeding (who had undergone pericardiocentesis) died.

Two patients required intraaortic balloon pulsation after the repair of cardiac injury. One survived.

Table 5. Complications in resuscitated patients.

Complication	No. of Patients
Sepsis	
Wound infection	5
Empyema	1
Pneumonia	2
Hemorrhagic	
Reexploration for bleeding	2
Gastrointestinal bleeding	2
Cardiopulmonary	
Ventricular septal defect	1
Respiratory insufficiency	3
Cerebral	
Anoxic encephalopathy	2
	18

Discussion

Mortality rates from penetrating cardiac injuries have declined over time in association with advances in prehospital care, speed of transport of injured victims and the concept of emergency room thoracotomy [1,2]. Recently, the management of penetrating injuries of the heart has evolved from initial pericardiocentesis, followed by operative intervention when necessary, to early surgical exploration.

In penetrating cardiac trauma, hemopericardium develops under pressure, and the body must necessarily compensate to maintain a central venous pressure (CVP) sufficiently higher than the intrapericardial pressure (IPP) to effect ventricular filling and sustain cardiac output. Cardiac tamponade occurs as these pressures equalize and the CVP/IPP gradient disappears. Iatrogenic contributions to a diminished CVP/IPP gradient include the use of analgesics and muscle relaxants, which decrease venous tone, the and use of positive – pressure ventilation, which increases IPP. Thus, if at all possible, these should be avoided until the surgical team is ready to decompress the pericardium.

Previous studies have shown that pericardiocentesis in patients with acute tamponade is unreliable [3,4]. False-negative and false-positive results are common due to inadvertent ventricular penetration, intraventricular aspiration and coronary artery lacerations. For these reasons, diagnostic pericardiocentesis was not used in our later patients. Although emergency pericardiocentesis may be lifesaving, the usually large amount of blood clotting in the anterior pericardium, which often cannot be aspirated, makes the success of pericardiocentesis unpredictable.

One of our group B patients underwent pericardiocentesis in the emergency room, but he died from ventricular fibrillation and cardiac tamponade during transportation. Thus, we have not used pericardiocentesis in diagnosis or therapy. However, we think that the subxiphoid pericardial window may be performed in a diagnostic approach for cardiac injuries in patients in only stable conditions.

Many patients were transported long distances by ground or air and others arrived in the emergency department within minutes of receiving their injuries. Patients in this study were brought to the emergency room area within 10 min and 6.4 h of the time of injury (mean time 3.2 h).

The reason for the long transportation period is that patients with gunshot injuries generally come from distant rural and mountainous areas.

The current series showed a concomitant increase in both gunshot and stab wounds, the implication being that gunshot wounds carry a worse prognosis [5]. All mortalities were in the gunshot group. There may be two reasons for this: 1) Gunshot injuries are more likely to produce cardiac hemorrhage and produce a small rent in the pericardium that seals off and produces cardiac tamponade; 2) Patients with gunshot injuries generally come from distant rural and mountainous areas. In our series, 21 (81 %) of the gunshot wounds demonstrated

cardiac tamponade, but only six (50 %) of stab wounds to the heart demonstrated cardiac tamponade when first seen.

When a cardiac injury is suspected, a left thoracotomy is the traditional surgical approach for the treatment of penetrating wounds of the chest. Adequate exposure of the heart through this incision is sometimes limited [6]. Because of the high incidence of associated thoracic injuries in our patients (Table 2), we think that a thoracotomy is the incision of choice in *agonal penetrating chest trauma*. The approach to the heart was left anterolateral incision in the majority of patients [7]. Median sternotomy was not used, since it involves a loss of time [7]. In the rare cases where the heart wound can not be controlled from the left anterolateral thoracotomy, it extended to the right, transversely through the sternum and the opposite intercostal space. Four patients in our series had to been treated in that fashion. In addition, left chest drainage had been established preoperatively in four patients who had right heart wounds. These patients were also treated by left thoracotomy. Recently, there have been reports of an increased use of median sternotomy for pulmonary surgery [8], but median sternotomy provides limited access to the thoracic cavities and posterior mediastinum. However, all cardiac injuries and open cardiac massage were managed easily when a median sternotomy was used. In contrast, exposure of the heart was occasionally difficult through a left thoracotomy. We feel that *in stable patients with penetrating chest trauma,* a median sternotomy is the incision of choice. Left thoracotomy is clearly the incision of choice in patients who are hemodynamically unstable or in patients in whom a posterior mediastinal injury is present. Thoracotomy incision offers rapid access to the thoracic cavity, evaluation of cardiac tamponade and open cardiac massage.

In our 38 patients with penetrating cardiac injuries, simple suture was used in 26 patients. We found that most cardiac wounds can be closed with a simple deep suture reinforced with Teflon felt. Large wounds can be repaired with brief periods of inflow occlusion.

In the group of patients we examined in our hospital the single most important factor in survival was the routine transfer of patients suspected of having a cardiac injury from the emergency room to the operating room. This transport time (about 8 min in our hospital) was very significant in terms of survival in our series. Because one group B patient (who had undergone pericardiocentecis) died during transportation, we agreed that our hospital should have a thoracotomy kit in the emergency room. Later, the emergency room of our hospital was designated for emergency thoracotomies and was fully equipped for this procedure. In this situation emergency room thoracotomy was performed in three patients in group C and one patient in group B; two survived (a survival rate of 50 %). Although we explain this mortality rate of emergency room thoracotomy by excluding the lifeless patients in our series, we agree that in agonal patients, and in the case of late transportation of the patients in the hospital, it is necessary to begin emergency room thoracotomy before general anesthesia [9]. Lifeless patients were excluded because there was no emergency room thoracotomy in our hospital in the early years and the mortality rate was 100 %.

In conclusion, cardiac injury can lead to a life-threatening hemodynamic instability, which mandates prompt and clear diagnostic and therapeutic approaches [10].

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References

1. Baker CC, Thomas AN, Trunkey DD. The role of emergency room thoracotomy in trauma. J Trauma 20: 848-55, 1980.
2. Ivatury RR, Nallathambi MN, Rohman M. Penetrating cardiac trauma. Ann Surg 205: 61-6, 1987.
3. Knott-Craig CJ, Thor M, Dalton RP et al. Penetrating cardiac trauma: Management strategy based on 129 surgical emergencies over 2 years. Ann Thorac Surg 53: 1006-09, 1992.
4. Brewster SA, Thirlby RC, Snyder WH. Subxiphoid pericardial window and penetrating cardiac trauma. Arch Surg 123: 937-41, 1988.
5. Attar S, Suter CM, Hankins R. Penetrating cardiac injuries. Ann Thorac Surg 51: 711-16, 1991.

6. Mitchell ME, Muakkassa FF, Poole GV. Surgical approach of choice for penetrating cardiac wounds. J Trauma 34: 17-20, 1993.

7. Steichen FM, Dargan EL, Efron G et al. A graded approach to the management of penetrating wounds of the heart. Arch Surg 103: 574-80,1971.

8. Watanabe Y, Ichihashi T, Iwa T. Median sternotomy as an approach for pulmonary surgery. Thorac Cardiovasc Surg 36: 227-30, 1988.

9. Baeshko AA, Kriuchok AG, Korsak SI et al. Treatment of heart wounds. Khirurgiia 11: 4-7, 2000.

10. Echevarria JR, San RA. Evaluation and treatment of cardiac injuries. Rev Esp Cardiol 53: 727-35, 2000.