

PENETRATING CARDIAC INJURIES (AN ANALYSIS OF 66 CASES)

AÇAR TOKCAN*
BÜLENT KISACIKOĞLU*
ORHAN KEMAL SALIH*
TÜMER USUL*
SELİM TANSAL*
MUSTAFA K. OSKAY*

SUMMARY: During a 10 year period ending in July 1988, 66 patients with cardiac injury were operated at the department of Cardiovascular Surgery at Cukurova University, Faculty of Medicine. Sixty-three patients (95.45%) were male. Their ages ranged between 13 and 59 years. Fifty-four patients (81.81%) had stab wounds and nine (13.63%) gunshot wounds. Three patients (4.54%) had blunt trauma. Thirteen patients (16.69%) were in the terminal stage, 37 patients (56.60%) were in a shock state and 16 patients were hemodynamically stable (24.04%) upon hospitalization. Thirty-two patients (48.48%) had evidence of cardiac tamponade and 18 patients (22.27%) were in hemorrhagic shock at the initial examination. Overall mortality was 16.66 percent (11/66). Four of 54 patients (7.40%) with stab wounds died in comparison to 5 out of 9 patients (55.55%) with gunshot wounds ($P<0.05$). Mortality for the patients in terminal stage was 30.76 percent (4/13) and 13.51 percent (5/37) for those in shock stage. On the other hand, mortality rate in patients with cardiac tamponade was 9.37 percent (3/32) and 33.93 percent (6/18) for the patients with hemorrhagic shock ($P<0.05$).

Key Words: Cardiac injuries, hemorrhagic shock.

INTRODUCTION

Cardiac injuries in civilian life have often been regarded as an uncommon form of trauma. With the steady increase in the incidence of civilian trauma in recent years there has been a concomitant rise in cardiac injuries. Up to the end of 19th century this type of wound was thought to be invariably fatal. However rapid and accurate diagnosis leading to early or immediate operative intervention has resulted in a decrease in mortality and an increase in the recovery of patients with penetrating cardiac injuries who in the past would never have survived. It has been estimated that 80-90 percent of patients with stab wounds, who reach the hospital alive, can be saved now (3,5,7,11,13,14,15,17).

The present report reviews our experience 66 patients who had sustained penetrating cardiac injury during the 10 year period ending in July 1989.

MATERIALS AND METHODS

Sixty-six patients with cardiac injury has been reviewed in this article. Sixty-three (95.45%) of these patients were male and 3 (4.54) were female.

Their ages ranged between 13 and 59 years. Fifty-four patients (81.81%) were in the 20-40 age group.

According to hemodynamic status and clinical conditions, patients were classified into three categories in this study:

A) Terminal stage; no detectable arterial blood pressure and peripheral pulse.

B) Shock stage; initial systolic blood pressure of less than 80 mmHg.

C) Hemodynamically stable patients.

When peripheral circulatory failure was present and the control venous pressure was equal or greater than 14 cm H₂O, acute cardiac tamponade was considered. On the other hand if the central venous measurement was below 4 cm H₂O a diagnosis of acute hypovolemic shock was made.

Since the majority of these patients were emergency cases, and needed immediate surgery usually time consuming preop-

*From Department of Thoracic and Cardiovascular Surgery, Cukurova University, Faculty of Medicine, Adana, Türkiye.

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erative tests were not carried out. Patients with suspected cardiac injury were managed by emergency thoracotomy as well as rapid volume replacement. No patient underwent thoracotomy in the emergency room. Cardiopulmonary bypass was not required by any of the patients. All of the patients had left anterior thoracotomy through the 5th intercostal space. If necessary, transverse sternotomy and right thoracotomy were also carried out. The cardiac wounds were sutured with pledged silk sutures.

Statistical analysis

The chi-square test was used to compare the mortality in the different types of patients. Differences resulting in a (P) value less than 0.05 were considered significant.

RESULT

During the 10 year period ending in July 1988, 66 patients with cardiac injury were admitted to the department of Cardiovascular Surgery at Çukurova University Faculty of Medicine.

Sixteen of 66 patients (24.24%) were admitted the emergency room within the first 30 minutes after the injury, and 32 patients (48.48%) within the first hour. Fifty four patients (81.81%) had stab wounds and nine (13.63%) gunshot wounds. In 3 patients (4.54%) cardiac injuries were due to the inward displacement of rib fragments produced by blunt trauma of the chest. Penetrating wounds on the body surface were situated on the left hemithorax in 35 patients on the right hemithorax in 19 and bilateral in 6. In 3 patients the wounds were over the epigastrium.

Table 1: Clinical condition and related pathology in 66 penetrating cardiac injuries.

STAGE	Cardiac tamponade (%)*	Hemorrhagic shock (%)*	TOTAL (%)**
TERMINAL	4 (30.77)	9 (69.23)	13 (19.70)
SHOCK	28 (75.68)	9 (24.32)	37 (56.06)
STABLE	-	-	16 (24.24)
TOTAL	32 (48.48)	18 (27.27)	66 (100.0)

* row percentages

** column percentages

twenty-five patients had 45 associated injuries.

Thirteen patients (19.70%) were in terminal stage and 37 patients (56.06%) were in shock stage. Sixteen patients (24.24%) were hemodynamically stable. Cardiac tamponade in 32 cases (48.48%) and hemorrhage in 18 (27.27%) were responsible for hemodynamic instability (Table 1). These differences were statistically significant ($p < 0.01$).

Chest roentgenograms were obtained in 52 patients.

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Hemothorax, pneumothorax, hemopneumothorax were detected in 33 patients (64.07%) widened mediastinum in five (9.80%), pneumopericardium in two and bullet in cardiac silhouette in one. There was no significant radiologic abnormality in eleven patients (21.56%).

Only 38 patients had preoperative ECG and 1 of these had nonspecific (ST segment) changes.

The results of pericardiocentesis performed on 40 patients were positive in 21 (52.5%) and negative in 19 (47.50%). Out of 17 patients with cardiac tamponade only 3 (17.64%) happened to be negative in pericardiocentesis.

Cardiac injury identified at explorative thoracotomy for continuous excessive hemorrhage through drainage tubes in 20 patients. Two cardiac injuries were recognized during surgery for other traumas: in the first case oesophageal and bronchial lacerations secondary to blunt trauma was the indication for thoracotomy. The second patient had a stab wound on the epigastrium and paracentesis was positive. During the laparotomy, active bleeding through a diaphragmatic laceration was observed.

Table 2: Localisation of cardiac wounds in 66 patients.

LOCALISATION	PATIENT	%
Right Ventricle	27	40.90
Left Ventricle	24	36.36
Right Atrium	5	7.57
Isolated Pericardium	3	4.54
Left Ventricle and Right Ventricle	3	4.54
Left Ventricle Double	1	1.51
Right Ventricle Double	1	1.51
Right Ventricle and VCI	1	1.51
Left Ventricle and Left Atrial Appendix	1	1.51
TOTAL	66	99.94

In 66 patients there were 73 cardiac wounds i.e. seven patients had two separate cardiac injuries (Table 2).

The overall mortality was 16.66 percent with 11 deaths in 66 patients. Five patients (6.84%) died in the operating room. Out of the six postoperative deaths only one was directly related to cardiac injury. This patient was in irreversible shock and died on the third postoperative day. The cause of death in one patient who was potentially salvageable, was pulmonary edema due to iatrogenic excessive fluid infusion. The remaining four postoperative deaths were due to concomitant injuries rather than cardiac injuries.

Mortality was 30.76 percent (4/13) among the patients who were in terminal stage. For the shock state patients

whether secondary to cardiac tamponade or hemorrhage, mortality was 13.51 percent (5/37). In stable patients this rate was 12.51 percent (2/16). The difference in mortality in these three groups was not significant either ($P>0.05$).

On the other hand mortality in patients with cardiac tamponade was 9.37 percent (3/32) and 33.33 percent (6/18) for the patients with hemorrhagic shock. The difference was statistically significant ($p<0.05$). Mortality in patients who had a single cardiac was 13.55 percent (8/59) and 42.85 percent (3/7) for patients with two separate cardiac lesions. This difference was statistically significant too ($p<0.05$).

DISCUSSION

The increasing number in incidence of physical violence and high speed transportation has resulted in corresponding increase in the cardiac traumas. We presented 45 penetrating cardiac injuries in a paper in 1985 (20). During the last 4 years 21 new cases have been added.

In civilian life penetrating cardiac injuries are caused by a variety of mechanisms. Stab and gunshot wounds are most frequently encountered (3,5,6,7,11,13,14,17). In the present series of 66 penetrating cardiac injuries the incidence of stab wounds are foremost with 54 patients (81.81%) followed by gunshot wounds in nine patients (13.63%). This striking difference is probably due to government restriction and difficulties in the trade and carrying of guns in this country.

In this series 3 of 66 (4.5%) penetrating cardiac injuries were caused by blunt traumas. These three patients were polytraumatized and had serious cranial, abdominal and tracheo-bronchial concomitant injuries. These multiple injuries caused problems in diagnosis, treatment prognosis of the patients.

Penetrating injuries resulting from stab wounds contrary to gunshot wounds do not cause extensive cellular destruction adjacent to the wound. They are like surgical incisions and transmural wounds in the thick walled left ventricle may actually seal spontaneously and do not cause a large amount of blood loss (11,12,14,17).

The incidence of injury to each chamber of the heart is a reflection of the area of exposure in relation with the geometry of the anterior chest wall (5,7,13,14,15). This can also be seen in our series; the most commonly involved chamber was the right ventricle (45.20%), followed by in descending order of frequency, the left ventricle (41.09%), the right atrium (6.84%) and left atrium with vena cava inferior (1.34%) (Table 2).

The pathophysiological manifestations, initial presentation and clinical course of penetrating cardiac wound depends also upon the nature of the pericardial wound. If the pericardium remains open and allows free drainage of

extravasated blood, cardiac tamponade will not develop and the presenting signs and symptoms will be those of blood loss. However if the pericardial wound does not permit free drainage of blood pericardial tamponade may occur. Thus, the two principle immediate consequences of a penetrating cardiac injury are exsanguinating hemorrhage and acute cardiac tamponade. In both conditions peripheral circulatory failure i.e. shock is evident (5,7,14,15).

In our group 19.69 percent of the 66 patients were in terminal stage, 56.06 percent in shock stage and 24.04 percent were hemodynamically stable (Table 1). Cardiac tamponade was identified in 32 patients (48.48%) and hemorrhagic shock was encountered in 18 patients (27.27%). On the other hand, the pathology in terminal stage patients was caused by either exsanguinating hemorrhage (69.23%) or cardiac tamponade (30.76%) (Table 1).

In case of a possible cardiac injury, in order to avoid loss of valuable time, time consuming tests such as; prolonged serial roentgenographic studies, fluoroscopy, echocardiography, radioisotopic scanning or angiocardiology should be avoided (1,5,7,8,9,14,15). In this group preoperative chest roentgenography was done in 52 patients whose condition permitted. Only in two patients with pneumopericardium and one with foreign body on cardiac shadow the x-ray analyses were helpful in diagnosis. Hemothorax, pneumothorax and hemopneumothorax were nonspecific x-ray finding for cardiac injury and included 65 percent of our patients. On the other hand an enlarged cardiac silhouette or widened mediastinum may support the diagnosis, but is also nonspecific. In fact lack of the change of size of the cardiac shadow does not exclude the presence of cardiac injury (1,7,8,10,14,15).

All of the patients with positive pericardiocentesis prove to have cardiac injury, but a negative pericardiocentesis does not rule out the presence of cardiac injury or tamponade. Negative results have been observed up to the 25 percent of patients with documented blood in pericardial sac (7,10,15). This is supported by the present study. Pericardiocentesis was performed on 40 patients and 19 negative. However 3 of the negative results (17.6%) were false negative in patients with significant cardiac tamponade.

Median sternotomy and thoracotomy are used to approach to the cardiac injury (3,5,14,20). Since control of possible concomitant injuries of the chest wall, lungs, and posterior mediastinal structures could be difficult through a median sternotomy, appropriate anterolateral thoracotomy incision was preferred in our cases. In this approach incision can be extended to the contralateral thorax across sternum if necessary.

It is difficult to evaluate the result of cardiac injuries because several factors effect the survival and mortality of patients. In literature mortality rates are given in a wide range of 90 to 10 percent because of the reason stated above (4,5,7,9,14,16-19).

Overall mortality in this series was 16.66 percent with 11 deaths in 66 patients. Is mentioned above only 6 deaths (5 peroperative and 1 postoperative) were directly attributed to the cardiac trauma (9.09%). This is 54.54 percent of the total mortality. Cranial trauma, irreversible shock and infection (peritonitis and mediastinitis) were other causes of postoperative deaths.

Mortality in patients who reach at the emergency room alive but without detectable blood pressure and pulse (terminal stage patients) is between 50 and 80 percent (5,6,14,18). This is supported in this study ; stage patients had the highest rate of 30.76 percent while hemodynamically stable ones had only 12.50 percent. Mortality was 13.51 percent among the shock stage patients. But the difference in these groups was statistically not significant.

Up to a point pericardial tamponade contributes to the reduction or cessation of hemorrhage from cardiac wound and may be lifesaving. But beyond that point it produces profound shock which proves fatal unless promptly relieved (2,15,16). If there is a communication between atmosphere and the chest cavity or pleural cavity, hypovolemic shock rather than tamponade may be the initial presenting picture.

The limited life saving effect of pericardial tamponade has also been observed in this series. The mortality among the patients with pericardial tamponade is strikingly lower than the patients with hemorrhagic shock (9.37 and 33.33% respectively, $p < 0.05$).

Penetrating cardiac injuries continue to carry a significant mortality. Patients generally present with arterial hypotension and venous hypertension. Because it is potentially lethal if there is a slightest possibility of cardiac trauma in a local injury immediate thoracotomy for inspection of the heart and control of bleeding should be done.

REFERENCES

1. Asfaw I, Arbutu A: Penetrating wounds of the pericardium and heart. *Surg Clin N Am* 57, 1977.
2. Balonaviski PJP, Swaminattan PA, Newille EW, et al: Aggressive surgical management of penetrating cardiac injuries. *J Thorac Cardiovasc Surg* 66:1, 1983.
3. Beach MP Jr, Bognoto D, Huchthinson JE: Penetrating cardiac trauma. Experience with 34 patients in a hospital without cardio-pulmonary by-pass capability. *Am J Surg* 131:411, 1976.
4. Borja AR, Lansing AM, Rensdell HT: Immediate operative treatment for stab wounds of the heart. *J Thorac Cardiovasc Surg* 59:662, 1970.

5. Bozer AY, Böke E: Kalp ve damar yaralanmaları. Ankara, HÜ Basimevi 1983.
6. Carrasquilla C, Wilson RF, Walt AS, et al: Gunshot wounds of the heart. *Ann Thorac Surg* 13:208, 1972.
7. Cohn PF, Braunwald E: Traumatic heart disease in Heart disease. Ed: E Braunwald, WB Saunders Comp, London 1, 1980., 1583.
8. Griswold RA, Dryre JC: Cardiac wounds. *Ann Surg* 139:783, 1954.
9. Harvay JC, Pacifico DA: Primary operative management: Method of choice for stab wounds to the heart. *S Med J* 68:149, 1975.
10. Ivatury RR, Shah PM, Ito K, et al: Emergency room thoracotomy for the resuscitation of patients with "Fatal penetrating injuries of the heart". *Ann Thorac Surg* 32:377, 1981.
12. Jebara VA: Penetrating Wounds to the heart. A wartime experience. *Ann Thorac Surg* 47:250-253, 1989.
13. Lemos PCP, Akumura M, Azeveda AC, et al: Cardiac wounds: Experience based on a series of 121 operated cases. *J Cardiovasc Surg* 17:1, 1976.
14. Levitsky S: New insights in cardiac trauma. *Surg Clin N Am* 55: 43, 1975.
15. Marshall Wg r, Bell JL, Kouchoukcos NT : Penetrating cardiac trauma. *J Trauma* 24:147, 1984.
16. Mason LB, Warsouer SE, Williams RW : Stab wound of the heart with delayed hemopericardium. *J Thorac Surg* 29:524, 1955.
17. Mattox KL, Feliciano DV, Burch J, et al: Five thousand and seven hundred sixty cardiovascular injuries in 4459 patients. *Ann Surg* 209:698-705, 1988.
18. Sherman MM, Sami VK, Panoz MD, et al: Management of penetrating heart wounds. *Am J Surg* 135:533, 1978.
19. Sugg WL, Rae WJ, Ecker RR, et al: Penetrating wounds of the heart; an analysis of 459 cases. *J Thorac Cardiovasc. Surg* 56:531, 1968.
20. Tokcan A, Cekirdekci A, Ulus T, et al: Penetrating cardiac wounds (Analysis of 45 cases). *Ç.Ü Typ Fak Der (1,2,3,4) :14, 1985.*

Correspondence:

Acar Tokcan
Dept. of Thoracic and
Cardiovascular Surgery
Çukurova University
Faculty of Medicine
Adana, TÜRKİYE.