Surgical Management of Cardiac Penetrating Injuries in a Hospital without Cardiopulmonary By-Pass Pump

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ABSTRACT

Penetrating cardiac injuries are one of the most lethal types of trauma. Early diagnosis, appropriate approach in the emergency department (ED), early resuscitation and immediate surgical intervention are essential in the management of penetrating cardiac injuries. In this study we retrospectively evaluated five patients with penetrating cardiac injuries in a 1-year period before an open heart surgery center was set up in our hospital; and we aimed to underline the importance of an appropriate and early surgical intervention without cardiopulmonary by-pass on survival. Median age of our patients was 26 years (range, 17-42 years) and all of the patients were males. Two patients were presented as cardiac arrest and they could not be survived. Three of our patients presented to our ED with cardiogenic shock and all of them recovered after the operation. Right ventricle injury was determined in two patients and both of them survived after the operation. In 3 patients, left ventricle injury was observed and 2 of them died. While 3 patients presented with gunshot injury, 2 of them presented with sharp object injury. One patient in each group was died. Three patients recovered without any complications, however 2 patients- one before operation and 1 during operation- died (survival rate: 3/5). Those 3 patients did not develop any major stationary sequela with normal LVEF in the follow-up at first and third.
Key Words: Heart injury; cardiac tamponade; stab injury; gunshot injury

Penetran Kardiyak Yaralanmaların Kalp Akciğer Pompası Olmayan Bir Hastanede Cerrahi Tedavisi

ÖZET

Penetran kalp yaralanmaları, travma çeşitleri arasında en öldürücü olanlardır. Penetran kalp yaralanmalarına uygun yaklaşımda erken tanı, acil serviste (AS) doğru müdahale, erken resüsitasyon ve acil cerrahi müdahale önemlidir. Biz bu çalışmamızda hastanemizde açık kalp cerrahisi yapılmaya başlanmasından önceki 1 yıl içerisinde, penetran kardiyak yaralanma ile AS'ye getirilen beş hastayı retrospektif olarak inceledik ve kardiyopulmoner by-pass yapılamadığı durumlarda bile, erken ve doğru cerrahi müdahalenin sağkalım üzerine olan önemini vurgulamayı amaçladık. Çalışmaya alınan hastaların ortalama yaşı 26 (17-42) yıl idi ve tümü erkekti. İki hasta AS'ye kardiyak arrest olarak getirilmişti ve bu hastalar kurtarılamadı. Üç hasta ise AS'ye kardiyojenik şok ile getirildi ve bu hastaların tümü ameliyat sonrası iyileşti. İki hastada sağ ventrikül yaralanması tespit edildi ve bu hastaların her ikisi de operasyon sonrası hayatta kaldı. Üç hastada sol ventrikül yaralanması saptandı ve bu hastaların 2'si öldü. Üç hasta ateşli silah ile yaralanırken, 2 hasta kesici alet ile yaralanmıştı. Her iki grupta birer hasta öldü. Üç hasta herhangi bir komplikasyon olmadan taburcu edildi. İki hasta, biri operasyon öncesi ve biri operasyon sırasında olmak üzere öldü (sağkalım oranı: 3/5). Bu 3 hastanın yapılan birinci ve üçüncü ay kontrollerinde sol ventrikül ejeksiyon fraksiyonları normal olarak hesaplandı ve herhangi bir major sekel oluşturan komplikasyon gelişmedi.
Anahtar Kelimeler: Kalp yaralanması; kardiyak tamponad; kesici alet yaralanması; ateşli silah yaralanması

INTRODUCTION

Penetrating cardiac trauma is one of the most lethal types of trauma. Early diagnosis, appropriate approach in the emergency department (ED), early resuscitation and immediate surgical intervention are essential in the management of penetrating heart injuries[1]. Penetrating heart injuries may occur due to stab wounds with knives or daggers. Life-threatening injuries may also occur due to firearms, bomb splinters and bone fragments[2]. The degree of an injury may vary from pericardial laceration to transmural injury[3]. In this series, we represent five patients with penetrating cardiac injuries in a 1-year period before an open heart surgery center was set up in a state hospital; and underline the importance of an appropriate and early surgical intervention without cardiopulmonary by-pass on survival.

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PATIENTS

Patient 1

A 32-year-old male presented to our ED with a gunshot injury on the chest. He was hit by a pellet on the inferolateral region of the xyphoid process of the sternum. On admission, the patient was hypotensive (BP:60/40 mmHg), tachycardic (120 b/min) and complaining of shortness of breath. A computerized tomography (CT) of the chest was performed. On CT, a metallic foreign body in pericardium and pericardial fluid were observed. A transthoracic echocardiography (ECHO) confirmed excessive pericardial fluid and a pellet in pericardium (Figure 1A). The patient had undergone median sternotomy. The pericardium was tense due to tamponade and arterial blood pressure increased from 70 mmHg to 100 mmHg after pericardiotomy. Pericardial fluid was discharged and the hole on the acute margin of right ventricle was repaired with teflon pledged 4.0 prolene suture. Postoperative echocardiography and CT were performed and no foreign body was seen in pericardium. Patient was extubated in the postoperative 8th hour and discharged from the hospital after 7 days with total recovery.

Patient 2

A 26-year-old male patient was admitted to our ED due to a gunshot wound on chest. On admission, patient was unconscious with no measurable BP. On auscultation, lung sounds were normal and heart sounds were silent. Patient was intubated, resuscitated and transferred to the operation room with a diagnosis of cardiac tamponade. During resuscitation, sternotomy was performed. Pericardial fluid was discharged and open cardiac massage was performed. There were huge defects on the both anterior and posterior walls of the left ventricle which also had included coronary vessel paths. During the procedure, ventricular fibrillation had developed and patient was defibrillated. However, rhythm was not obtained. After 1 hour of resuscitation, patient had died.

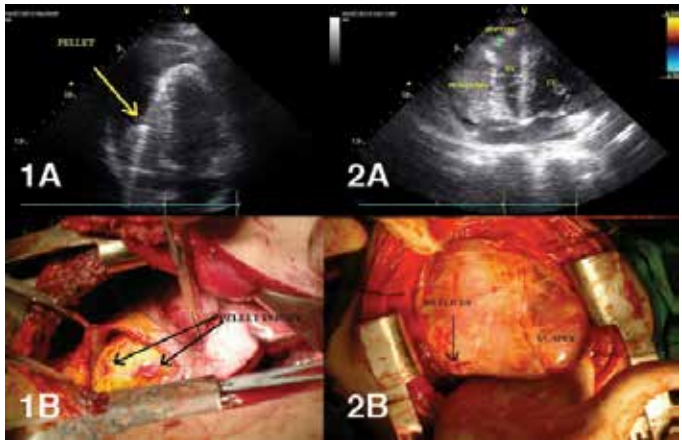

Figure 1A. Echogenicity of a pellet on the free wall of the right ventricle and pericardial effusion nearby the right ventricle and apex (Patient number 1)
Figure 1B. Myocardial pellet injuries on the left ventricle and apex nearby coronary paths (Patient number 3)
Figure 2A. Myocardial laceration on the right ventricle near to the apex and pericardial hematoma nearby the right ventricle with similar echogenicity of myocardium (Patient number 4)
Figure 2B. Repaired myocardium with teflon pledged 4.0 prolene sutures on the free wall of the right ventricle (Patient number 4)
RV: Right ventricul, LV: Left ventricul

Patient 3

A 42-year-old male patient with a gunshot injury on his chest was brought to our ED. Multiple pellet wounds were determined on the left hemithorax, the left arm and the left hand. Patient was hypotensive (BP:80/50 mmHg) on admission. A CT was performed and a left hemo-pneumothorax was observed. Tube thoracostomy was performed. After tube thoracostomy, patient has undergone left anterolateral thoracotomy in the operation room (OR) due to a massive hemothorax. During thoracotomy, pericardial lacerations and pericardial fluid were observed, in addition to a lung laceration and lung contusion in the left upper lobe. After suturation of the lung injury, the pericardium was opened and the heart was explored. There were two pellet injuries nearby left anterior descending coronary artery (LAD) on the left ventricle (Figure 1B). Apical pellet injury was the major bleeding source. Pericardial fluid was discharged and cardiac lacerations were suturated with pericardia pledged 5.0 prolene sutures. The next day, vital signs of the patient were stabilized and the patient was extubated. In the postoperative Day 2, the thoracic drains were excluded and the patient was discharged in the postoperative Day 5.

Patient 4

A 17-year-old male patient was brought to our ED because of a stab wound on left hemithorax. On admission, patient was unconscious and hypotensive (BP:50/0 mmHg). Patient was transferred to the operation room with a diagnosis of cardiac tamponade. During arterial and central venous canulation, a transthoracic echocardiography was performed to confirm the diagnosis. Bedside transthoracic echocardiography showed a 4 mm defect on the free wall of the right ventricle near to the apex, in diastole, so the defect was compressing in systole. Extensive pericardial effusion was also seen adjacent to the right ventricle (Figure 2A). After median sternotomy, pericardium was opened and hemorrhagic fluid more than 1000 cc was aspirated. A 2 cm laceration on anterior wall of the right ventricle was repaired with teflon pledged 4.0 prolene sutures (Figure 2B). Patient was discharged from the hospital with a total recovery on the postoperative Day 7.

Patient 5

A 20-year-old male patient was admitted to our ED because of a stab wound on the left hemithorax. Patient had been unconscious with no measurable BP for more than 45 minutes since arrival. Patient was resuscitated but rhythm was not obtained and after 1 hour of resuscitation, patient had died.

RESULTS

Median age of our patients was 26 years (range, 17-42 years). All of the patients were male. Two of them presented to our ED

with cardiac arrest. One of these patients could be transported to operating room but one had died before arrival. The other patient who could be transported to OR died during the operation due to multiple cardiac damages. Three of our patients presented to our ED with cardiogenic shock and all of them recovered after the operation (100%). Right ventricle injury was determined in two patients and both of them survived after the operation. In 3 patients, left ventricle injury was observed and 2 of them died. While 3 patients presented with gunshot injury, 2 of them presented with stabbing. One patient in each group has died. Median troponin I level of the patients, when 2 patients to whom Cardiopulmonary resuscitation (CPR) was performed were excluded, was 1.2 ng/ml (range, 0.19-2.2). Due to emergent statues of the patients, ECGs could not be obtained on admission. In postoperative ECGs of 3 patients who survived, nonspecific ST-T changes were determined. Coronary angiography was not performed, because 1 patient with coronary artery involvement has died. Three patients recovered without any complications, however 2 patients-one before operation and 1 during operation-have died (survival rate: 3/5). Those 3 patients did not develop any major stationary sequela with normal left ventricular ejection fraction (LVEF) in the follow-up at first and third months. Demographical, clinical features and biochemical data of the patients were given in Table 1 and Table 2.

DISCUSSION

Patients with penetrating heart injuries rarely survive. Early diagnosis and early surgical intervention are essential because of its high mortality[4]. Diagnosis is based on anamnesis, physical examination, injury site and clinical findings of the patient. Majority of the patients admitted to EDs with penetrating cardiac injury is hemodinamically unstable and associated with high mortality. In our series, all patients were hemodynamically unstable on admission. Advanced diagnostic tests in such patients usually could not have been performed. Rarely, in a small group of hemodynamically stable patients, those tests such as CT or ECHO can be obtained[5]. In our study, CT was performed in two patients; ECHO was performed in two patients in ED, and in one patient during resuscitation. Of the trauma patients requiring surgical intervention, 10.4% is thorax traumas and only 1% of these are cardiac injuries[6]. In the literature, penetrating cardiac injuries are frequently seen in young males[2,7]. This results from higher exposure rates of young males to violence. In our series, all patients were male, with a median age of 26 year and all of them had exposed to violence. Number of penetrating cardiac injuries admitted to EDs, particularly those caused by firearms is increasing in recent years[8]. Firearm injuries are related to larger defects on pericardium and they cause greater damage on myocardium when compared to stab wounds. Pericardial tamponade occur 80%-90% of the stab wounds and 20% of the firearm injuries[9]. In our series, 3 patients were admitted due to gunshot injuries and two patients had stab wounds and all patients presented with pericardial tamponade. Occurrence of tamponade increases the rate of survival. In a study, 66% of the patients with tamponade survived while this was 53% of the patients without tamponade[10]. During emergent surgical interventions involving the heart and other related organs of the anterior chest, patients are more susceptible to the development of a pericardial tamponade and they have a better survival rate than patients who have no signs of a tamponade[11]. In a sense, pericardial tamponade is a two-edged sword; although it may prolong life by reducing the initial blood loss, the tamponade itself can be fatal by interfering with diastolic filling of the heart[12]. Initially, there may be a beneficial effect of the pericardial tamponade by limiting the hemorrhage into the thoracic cavity, but a sudden surge of blood increases the pressure within the pericardium above the level

Table 1. Demographic and physiological data of patients, mechanism and location of cardiac injuries, prognosis

Patient	Age (year)	Gender	Injury Type	Admission	Location	Operation	Prognosis
1	32	Male	Gun Shot Pellet	Shock	Right Ventricle	Median Sternotomy	Alive
2	26	Male	Gun Shot Bullet	Arrest	Left Ventricle	Median Sternotomy	Death
3	42	Male	Gun Shot Pellet	Shock	Left Ventricle	Left Thoracotomy	Alive
4	17	Male	Stab Wound	Shock	Right Ventricle	Median Sternotomy	Alive
5	20	Male	Stab Wound	Arrest	Left Ventricle	No	Death

Table 2. Biochemical and clinical data of patients

Patient	Troponin I (ng/ml)	CK/CKMB (IU/L)	HB	Coronary Injury	Blood Pressure	Cardiac Tamponade
1	2.2	715/88	11.8	No	60/40	Yes
2	1.2	1052/125	13	Yes	No Pulse	Yes
3	---	----	13	Nearby LAD	80/50	Yes
4	0.19	771/28.7	12.1	No	50/0	Yes
5	---	--	12	Unknown	No Pulse	Yes

CK: Creatine kinase, HB: Hemogram, CKMB: Creatine kinase isoenyzme in heart, LAD: Left anterior descending coronary artery

of the filling pressure of the right ventricle first. Then, the left ventricular filling becomes compromised, with a final result of decreased stroke volume and cardiac output. This, in turn, increases the cardiac workload with increased coronary oxygen demand to a point where the heart fails to pump[13]. In our series, all patients survived had cardiac tamponade (Table 1). This finding is in accordance with the literature. In a study, the authors reported that, in penetrating cardiac injuries, the physiologic status of the patient at presentation, mechanism of the injury, and presence of a tamponade were significant prognostic factors. It has been also reported that type and number of multiple-chamber injuries, especially with great vessel involvement, were associated with a high mortality rate[14]. In our series, in patients who have died, multiple cardiac chamber injury was determined in only one patient. In cardiac penetrating injuries, the involvement site has been reported in decreasing order as right ventricle, left ventricle, right atrium, and left atrium. Even though the free walls are most frequently damaged, valvulae, papillary muscles, chordae tendinea, ventricular or atrial septum, and coronary arteries may also be injured[7]. In our series, coronary involvement proximal to LAD was observed in 1 patient. In a series of 26 patients, Mataraci et al. have found coronary involvement in only one patient[7]. In our study, in all of our patients, we determined a single-chamber involvement. Tyburski et al. also reported that cardiac injuries of the heart requiring thoracotomy in the ED increases mortality rate[14]. According to the site of the lesion, right or left thoracotomy or median sternotomy may be preferred for surgical repair. Emergent thoracotomy is defined as the thoracotomy performed in the scene of accident, emergency department for patients arriving in extremis or in the OR with no previous plan. Emergent thoracotomy has an important role in emergency department of high-volume hospitals and can be a life-saving procedure. Outcome can be improved by increasing the learning curve and the integrated cooperation of the emergency and surgical teams. It is recommended that emergency department thoracotomy should be performed in patients with penetrating non-cardiac thoracic injuries and also in patients suffering from exsanguinating abdominal vascular injuries. Emergency medicine education programmes should focus on rapid diagnosis of traumatic injuries with early intervention, and adequate hemodynamic and respiratory support[15]. In penetrating cardiac injuries, a large variation in survival rates ranging from 19% to 65% has been reported[14]. In our series of 5 patients, 4 patients were operated and three of them have survived (Table 1). Even our group of patients is small, and considering the limited facilities of a state hospital, a survival rate of 60% was achieved by early surgical intervention without cardiopulmonary bypass pump support. Importance of cardiac troponin measurement in MI is well-known; however there are insufficient data about usefulness of troponin in cardiac injuries. The relation between troponin and cardiac damage load is inevitable and non-traumatic increasing levels of troponin have a role in estimating adverse events. This finding may be applied to traumatic injuries. We cannot estimate the importance of troponin in such patients because a long time is needed for troponin to increase. In our series, accordingly, troponin levels could be determined in three patients. It is more complicated to interpret the troponin levels because of the associated skeletal muscle involvement and the facts that majority of injuries occur in the right ventricle which has smaller muscle mass than left ventricle and that coronary artery is rarely involved.

CONCLUSION

Cardiac injuries due to gunshot or stab wounds represent an ongoing challenge to trauma surgeons. In penetrating cardiac injuries, good outcome can be obtained by early diagnosis, rapid evaluation and surgical intervention even in a state hospital without cardiopulmonary by-pass pump. The most common cause of cardiac injuries in our country is exposure to violence. While localization of injury and hemodynamic findings are predictors for mortality, further systematic investigations are needed to determine the importance of troponin in prognosis and outcome.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

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