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Our Surgical Management Strategy In Cardiac Injury

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ABSTRACT

Introduction: The aim of this study was to retrospectively review the patients who were diagnosed with cardiac injury and received an emergency operation.

Materials and Method: Between January 2009 and December 2014, 37 patients diagnosed with cardiac injury were retrospectively evaluated. Patients were evaluated according to the demographics, the mean time from admission to surgery, the concurrent interventions, the type and localization of cardiac injury and the preoperative mean arterial blood pressure.

Results: Eight patients with cardiac arrest underwent emergency surgery through thoracotomy. On admission to emergency service (ES), 22 patients were in shock. In the ES, because the hemodynamic situation worsened in six patients despite fluid therapy, they were operated without performing additional tests or imaging. The localization of the injuries were the right ventricle in 19 patients, the left ventricle in 15 patients, the right atrium in two patients and both the right and left ventricles in one patient. In 34 patients, primary suturation technique was sufficient for repair but two patients were operated using cardiopulmonary bypass. The mean time from admission to surgery was 3.16 ± 2.37 hours. The mean duration of intensive care unit stay was 2,37±2,1 days. In average 5.16 ± 4.21 units of packed erythrocyte suspension were transfused. Mortality rate was 37.83% (n=14).

Conclusion: We hope, in pursue of a better outcome in the new series, the improvements in emergency interventions, transportation, and availability of echocardiography in the emergency departments have to be appropriate and efficient.

Keywords: Heart Injuries; In Hospital Mortality; early intervention

Kardiyak Yaralanmalarda Cerrahi Tedavi Stratejimiz

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ÖZET

Giriş: 2009-2014 yılları arasında acil serviste kardiyak yaralanma tanısı alan ve acil olarak operasyona alınan hastaları literatüre katkı sağlamak amacıyla retrospektif olarak inceledik.

Hastalar ve Metod: Kliniğimizde Ocak 2009- Aralık 2014 yılları arasında acil serviste kardiyak yaralanma tanısı alan ve acil olarak operasyona alınan 37 hasta retrospektif olarak incelendi. Hastalar demografik özellikleri, operasyona alınış süresi, ek girişim yapılıp yapılmadığı, yaralanma şekli,kalpte yaralanan bölge, operasyon öncesi arteryel kan basınçları, operasyonun yapılma şekline göre değerlendirildi.

Bulgular: 8 hasta acil serviste kardiyopulmoner resüsitasyon eşliğinde acil torakotomi ile ameliyata alındı. 22 hastada şok tablosu mevcuttu. 6 hasta sıvı tedavisine rağmen tabloda kötüleşme olması dolayısıyla ek tetkik beklenmeden operasyona alındı. Diğer hastalarda ise ekokardiyografi ve bilgisayarlı tomografi sonucunda kardiyak yaralanma olduğu saptanarak operasyona alındı. 19 hastada yaralanma sağ ventrikülde, 15 hastada sol ventrikülde, 1 hastada sağ ve sol ventrikülde, 2 hastada ise sağ atriyumdaydı. 34 hastada yaralanmalar primer olarak süturasyon ile onarıldı. 1 hastada mitral kapak replasmanı, 2 hastada ise onarım kardiyopulmoner baypas altında yapıldı. 1 hastada sol internal mammarian arter yaralanması, 2 hastada femoral arter yaralanması ve 1 hastada ise vena kava inferior yaralanması vardı. 5 hastada mide ve ince bağırsak yaralanmaları olduğu için genel cerrahi ile operasyona devam edildi. Hastaların ortalama ameliyata alınma süresi 3,16±2,37 saat olarak bulundu. Ortalama yoğun bakım ünitesinde yatış 2,37±2,1 gün olarak hesaplandı. Hastalarda ortalama olarak 5,6±4,21 ünite eritrosit süspansiyonu kullanıldı. Hastane mortalitesi 14 hasta ile %37,83 idi.

Sonuç: Hastane öncesi acil müdahale ve transport imkanlarının gelişmesi, ekokardiyografinin acil servislerde ulaşılabilirliğinin artmasıyla kalp yaralanmalarının daha yüz güldürücü sonuçlarla yeni serilerde karşımıza çıkacağını umut ediyoruz.

Anahtar Kelimeler: Kalp yaralanmaları; mortalite; acil girişim

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Introduction

Cardiac injury is not frequently seen in trauma patients. However, high mortality rates increase the importance of this injury. Parallel to increase in domestic violence, community events and road accidents in our country, thoracic trauma rates have also increased[1,2]. The ratio of chest trauma cases requiring emergency surgery is 10.4%, and the cardiac injury represent 1% of the thoracic traumas[1]. These injuries can be blunt or penetrating in nature. Emergency interventions are life-saving in cardiac injury. The most important factors that affect mortality are the transportation of the victim to the emergency service in appropriate condition, the establishment of early diagnose, the hemodynamic status of the patient, the presence of cardiac tamponade and time from injury to surgery. Patients with suspected cardiac injury should be evaluated precipitously and accurately in the emergency service (ES). Emergency surgical intervention is mandatory to reduce mortality and morbidity rates, when indicated[2]. In this study, we retrospectively reviewed the patients who were diagnosed with cardiac injury and underwent emergency operation.

Material and Method

Between January 2009 and December 2014, 37 patients diagnosed with cardiac injury were evaluated retrospectively. Patients were evaluated according to the demographics, the mean time from admission to surgery, the concurrent interventions, the type and localization of injury and the preoperative mean arterial blood pressure. All echocardiographies were performed by a cardiologist in the ES. Contrast-enhanced computed tomography was utilized in hemodynamically stable patients in whom sufficient diagnostic data could not be gained by echocardiography. In these patients, fluid resuscitation using blood products and volume expanders was performed in order to keep patients' systolic blood pressure above 90mmHg. For surgical exposure left thoracotomy in 17 patients, right thoracotomy in one patient, median sternotomy in 18 patients and clamshell exploration in one patient was performed. In 34 patients, the pericardium is opened in the classic form of inverted-T-fashion, and bleeding was manually controlled. The primary U-suture technique was performed with 3-0 Teflon pledged polypropylene. Mitral valve replacement was performed in one patient. Two patients were operated under cardiopulmonary bypass. This patients' mitral valve injury was not appropriate for mitral repair so mitral valve replacement was performed. Dual antibiotic prophylaxis was performed before the surgical operations (cefamezine 1 g. i.v. and gentamicin 80mg. i.v.). During postoperative period, all the patients were followed in the cardiovascular intensive care unit until hemodynamic states were suitable for service follow-up.

Statistical Analysis

Statistical analyses were performed using Number Cruncher Statistical System (Kaysville, Utah, USA). The Continuous variables were presented as mean ± standard deviation (SD). The categorical variables were displayed as frequency and percentage. While comparison between two groups with continuous variables were done using Student t test, Pearson Chi-square test or Fisher's exact test were used in comparison of categorical variables.

Results

In our study, the mean age was 33.54 ± 12.6 years with the male-female ratio of 6/31. The demographic and clinical characteristics of the cases were revealed in table 1. Eight patients were admitted to the ES with cardiac arrest. These patients underwent emergency operations with cardio-pulmonary resuscitation, and thoracotomy was the preferred initial incision. Twenty-two patients were in shock on admission to ES. In six patients, despite intravenous fluid resuscitation, deterioration in shock state was detected and they were operated without waiting for additional tests or imaging modality. In patients with stable hemodynamics, the operation decision was taken after echocardiography and computed tomography scans. The localization of injury were revealed in graphic 1. The injury was repaired with primary suturation in 34 patients. Mitral valve replacement was performed in one patient, and in 2 patient's cardiac injury was repaired using CPB. In addition to cardiac injury left internal mammary artery injury in one patient, femoral artery injury in two patients and inferior vena cava injury in one patient was detected. In five patients, multidisciplinary approach with general surgery was performed because of the associated gastric and intestinal injuries. The mean time from admission to surgery was 3.16 ± 2.37 hours. The mean duration of intensive care unit was 2,37±2,1 days. In average, 5.16 ± 4.21 units of packed erythrocyte suspension were transfused. Mortality rate was 37.83% (n=14). The risk factors associated with mortality was presented in table 2. The patients who admitted to hospital with cardiac arrest have significantly higher mortality rate ($p<0.001$). Duration between ES admission and operation is significantly shorter in the survival group ($p=0.045$).

Discussion

The thoracic trauma rate has been increasing due to the increase in domestic community violence and the road accident rates. The ratio of chest trauma cases requiring emergency surgery is 10.4%. The cardiac injuries represent 1% of the thoracic trauma[1]. The first heart injury case was identified by Borch Oluff in 1676, and first cardiac repair was performed in 1897 by Rehn[3]. Cardiac injuries are not very common in thoracic traumas, but the patient population is usually under 40 years of age and this is important for early interventions [4]. About 5% of the patients who were operated due to cardiac injury had an accompanying coronary artery injury. However, the proximal coronary artery injuries are rare. Injuries are usually observed in the distal branches of the coronary arteries. Therefore, it is usually enough to perform ligation of the coronary artery without need for additional processing [5]. In our study we didn't observe any coronary artery injuries. 40% of patients, who died after thoracic trauma have had associated cardiac injury [1]. Cardiac injuries can result from a blunt or penetrating injury. The most common causes of blunt chest traumas are vehicle accidents, falls from heights, occupational accidents and sports injuries. Therefore, patients with blunt chest trauma are usually presented with multiple trauma [6,7]. Penetrating cardiac injuries are most commonly caused by bullets, stab, bomb shrapnel and body or pellet[3]. Although it is rare, penetrating cardiac injuries have high mortality rates. In our study, 94.58% (86.48% stab wounds, 8.1% gunshot wounds) of patients were operated as a result of penetrating injury. The size, localization and concomitant pathologies in terms of coronary artery and valve injuries are the major indicators of mortality in penetrating cardiac injuries

[8]. The most important life-saving factors are; convenient and fast transport to the emergency room, early diagnosis, the hemodynamic status of the patient, the presence of cardiac tamponade and the elapsed time of admission to surgery [9]. Study conducted by Kaplan et al. also emphasized the importance of these factors [10]. In penetrating cardiac injuries, gunshot wounds have higher mortality rates than the stab wounds [11]. In stab wounds single lesion is usually seen in stab injuries. Because the wound can be limited by tamponade, the survival rate of stab wounds is about 70-80%. This ratio is considered about 30-40% in gunshot wounds[5]. However, the mortality observed in stab wounds were 43.75%. In our opinion, exclusion of the out-of-hospital deaths was the reason of this result. Overall mortality rate of patients who underwent surgery due to penetrating and blunt cardiac injury were 40.54%. Considering the other studies, overall mortality rate was 55% in a study conducted by Kaljusto et al.[20], and 27.3% in a study conducted by Aksoyek et al.[17]. Vital signs on admission can change from cardiac arrest to completely stable status [12]. In our study we found that the patients who admitted to hospital with cardiac arrest have significantly higher mortality rate. In cardiac trauma, the most common cause for cardiac arrest is cardiac tamponade. In addition to the electrocardiographic changes, the Beck Triad in thoracic trauma should be cautionary for cardiac injury, and further examination was required even in patients with stable hemodynamic status[13,14]. Especially in penetrating injuries, cardiac tamponade can be observed around 80% [5,13]. In penetrating and blunt cardiac injuries, the diagnosis of hemopericardium with echocardiography is crucial[10,15]. Transthoracic echocardiography is cheap, non-invasive and easy to apply. Therefore, it is commonly used in ES to diagnose cardiac injury. In addition to the hemopericardium, echocardiography can also provide information about valvar, atrial and ventricular septal injuries[16]. Echocardiography has the accuracy of 86%, the specificity of 97% and the sensitivity of 90% in recognition of cardiac injury[13]. Today echocardiography is more commonly used in emergency and as a result of this, mortality rate of patients with cardiac trauma have been decreased. Aksoyek et al. have used transthoracic echocardiography in 11 patients with suspected cardiac injury. In all patients except one false positive, a pericardial effusion was detected[17]. In hemodynamically stable patients, if the diagnosis cannot be confirmed by transthoracic echocardiography, transesophageal echocardiography and computed tomography (CT) will be useful in diagnosis. In a study conducted by Goz et al. 7.7% of patients were diagnosed with cardiac injury by CT[18]. In addition to the non-invasive methods, opening of a subxiphoid pericardial window is mentioned in the literature as an invasive method for diagnosis[10,13]. However, in hemodynamically unstable patients with the danger zones of injury, exploration should be performed without waiting for additional diagnostic procedures. In these patients, closest incision to the trauma region should be performed in order to explore the thorax or mediastinum without losing time. In emergency conditions, anterior thoracotomy may be the most appropriate method[13,19]. In our study, we used echocardiography as a diagnostic method in 23 patients but it was inadequate to determine the pericardial effusion in three patients. These patients were hemodynamically stable and CT was performed as an additional diagnostic mean. In our study, 14 patients with cardiac arrest or with unstable hemodynamic status were underwent emergency operation without waiting for an additional examination. Generally median sternotomy and left anterolateral thoracotomy were the preferred surgical incisions in patients with suspected cardiac injury. Median sternotomy can be

preferred in stable patients. Initiation of CPB through this incision is much easier. It also enables to achieve all the regions of the heart, including the right heart and both the pleuras [3,21]. Kaplan et al. [10] used median sternotomy as an initial incision in 28.57% of patients, and Kaljusto et al. used it in 35% of patients [20]. Aksoyek and friends have preferred median sternotomy in all patients except one[17]. In patients who need urgent intervention, the right anterolateral thoracotomy approach to heart from fifth intercostal space can be performed[6,13]. When necessary, enlarging the incision to the left chest also provides to reach to both pleural spaces. In our study the median sternotomy was preferred in 48.64% of patients. As indicated in the literature, patient's hemodynamic status and localization of cardiac injury should be taken into account in making of this choice. It should not be forgotten that cardiac trauma patients could be treatable without using cardiopulmonary bypass support by early diagnosis[22]. Fabricius in the 16th century reported that, cardiac injury will result in sudden death and treatment of this injury would not be possible[23]. Today, improvements in early diagnosis and aggressive surgical approach reduce the mortality rates. Approximately 30% of patients with penetrating cardiac trauma can reach the hospital alive, and the mortality rate of these patients is around 50% [20]. Especially multidisciplinary approach, prior experience of the team surgical team and necessary medical treatment of the patient are the factors that affecting mortality.

Conclusion

Cardiac trauma can lead to a wide spectrum of conditions ranging from asymptomatic to life threatening. In our study we aimed to improve knowledge of surgical management strategy in cardiac trauma. Although gunshot wounds seem more fatal in the previous literatures our study showed that stab wound was found to be more fatal. It has also been observed that multiple injuries have high mortality rates. As a result, along with the improvements in transportation, emergency interventions and availability of echocardiography in the ES, achieving better outcomes in these perplexing cases seems to be possible.

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Tables

Table 1. Demographic and clinical characteristics of the cases.

Characteristic	n (%)
Age (mean ± standard devition), years	33.54 ± 12.6
Male	31 (83.3)
Injury pattern	
Firearm	3 (8.1)
Stab	32 (86.5)
Blunt trauma	2 (5.4)
Systolic blood pressure	
>90 mmHg	9 (24.3)
<90 mmHg	28 (75.7)
Cardiac arrest in ES	8 (21.6)
Duration between ES admission and operation, hours	3.16 ± 2.37
Injured cardiac region	
Right ventricle	19 (51.4)
Left ventricle	15 (40.5)
Right atrium	2 (5.4)
Both right and left ventricle	1 (2.7)
Initial surgical approach	
Left thoracotomy	17 (45.9)
Right thoracotomy	1 (2.7)
Median sternotomy	18 (48.6)
Clamshell incision	1 (2.7)
Packed erythrocyte suspension	5.16 ± 4.21
Hospital stay, days*	4.39 ± 2.64
Mortality	14 (37.8)

Abbreviations: ES: emergency service. *Because all cases with mortality were lost within the first day of surgery, they were excluded.

Table 2. Comparison of clinical characteristics between the survivors and the dead.

Variable	Survivors (n=23)	Dead (n=14)	p value
Age, years	33.04 ± 13.30	34.36 ± 11.76	0.756
Male	21 (91.3)	10 (71.4)	0.173[a]
Injury pattern			
Firearm	3 (13)	0 (0)	
Stab	19 (82.6)	13 (92.9)	0.357[b]
Blunt trauma	1 (4.3)	1 (7.1)	
Systolic blood pressure			
>90 mmHg	7 (30.4)	2 (14.3)	0.434[a]
<90 mmHg	16 (69.6)	12 (85.7)	
Cardiac arrest in ES	0 (0)	8 (57.1)	<0.001
Duration between ES admission and operation, hours	3.70 ± 2.68	2.29 ± 1.43	0.045
Injured cardiac region			
Right ventricle	13 (56.5)	6 (42.9)	
Left ventricle	9 (39.1)	6 (46.2)	0.549[b]
Right atrium	1 (4.3)	1 (7.7)	
Both right and left ventricle	0 (0)	1 (7.7)	
Initial surgical approach			
Thoracotomy	11 (47.8)	7 (50)	0.898[b]
Median sternotomy	11 (47.8)	7 (50)	0.898[b]
Packed red blood cell	5.04 ± 4.32	5.36 ± 4.16	0.828

Abbreviations: ES: emergency service. [a]Fisher's exact test, [b]Pearson Chi-square test.

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Graphic 1. Localization of Cardiac Traumas