Our Surgical Management Strategy for Cardiac Injury

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ABSTRACT

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

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

Results: Eight patients who suffered from cardiac arrest underwent emergency surgery by thoracotomy. On admission to emergency service (ES), 22 patients were in shock. In ES, because the hemodynamic situation of six patients worsened despite fluid therapy, they underwent surgery without performing additional tests or imaging. The localization of the injuries were the right ventricle in 19 patients, left ventricle in 15 patients, right atrium in 2 patients, and both the right and left ventricles in 1 patient. In 34 patients, the primary suturing technique was sufficient for repair but two patients were operated on using cardiopulmonary bypass. The mean time from admission to surgery was 3.16 ± 2.37 h. The mean duration of intensive care unit stay was 2.37 ± 2.1 days. On an average, 5.16 ± 4.21 units of packed erythrocyte suspension were transfused. The mortality rate was 37.83% (n= 14).

Conclusion: Improvements in emergency interventions, transportation, and availability of echocardiography in the emergency departments have to be more appropriate and efficient for better outcome in the new series.

Key Words: Heart Injuries; in hospital mortality; early medical intervention

Kardiyak Yaralanmalarda Cerrahi Tedavi Stratejimiz

ÖZET

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

Bulgular: Sekiz hasta acil serviste kardiyopulmoner resüsitasyon eşliğinde acil torakotomi ile ameliyata alındı. Yirmi iki hastada şok tablosu mevcuttu. Altı 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. On dokuz hastada yaralanma sağ ventrikülde, 15 hastada sol ventrikülde, 1 hastada sağ ve sol ventrikülde, 2 hastada ise sağ atriyumdaydı. Otuz dört hastada yaralanmalar primer olarak süturasyon ile onarıldı. Bir hastada mitral kapak replasmanı, 2 hastada ise onarım kardiyopulmoner baypas altında yapıldı. Bir hastada sol internal mammarian arter yaralanması, 2 hastada femoral arter yaralanması ve 1 hastada ise vena kava inferior yaralanması vardı. Beş 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 observed in patients with trauma. However, high mortality rates increase the importance of this injury. Increase in domestic violence, community events, and road accidents in our country have also resulted in an increase in thoracic trauma rates[1,2]. The ratio of cases with chest trauma requiring emergency surgery is 10.4%, and cardiac injury represents 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 (ES) in an appropriate condition, establishment of an early diagnosis, hemodynamic status of the patient, presence of cardiac tamponade, and time from injury to surgery. Patients with suspected cardiac injury should be evaluated precipitously and accurately in ES. Emergency surgery is mandatory for reducing mortality and morbidity rates, when indicated[2]. In this study, we retrospectively reviewed patients who were diagnosed with cardiac injury and underwent emergency surgery.

PATIENTS and METHODS

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

Statistical Analysis

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

RESULTS

In our study, the mean age was 33.54 ± 12.6 years with a male-female ratio of 6/31. The demographic and clinical characteristics of the patients are described in Table 1. Eight patients were admitted to ES with cardiac arrest. These patients underwent emergency surgery with cardiopulmonary resuscitation, and thoracotomy was the preferred initial incision. Twenty-two patients were in shock on admission to ES. In six

Table 1. Demographic and clinical characteristics of the patients

Characteristic	n (%)
Age (mean ± standard deviation), 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)
The duration between ES admission and surgery, h	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)

ES: Emergency service.
* Because all cases with mortality were lost within the 1st day of surgery, they were excluded.

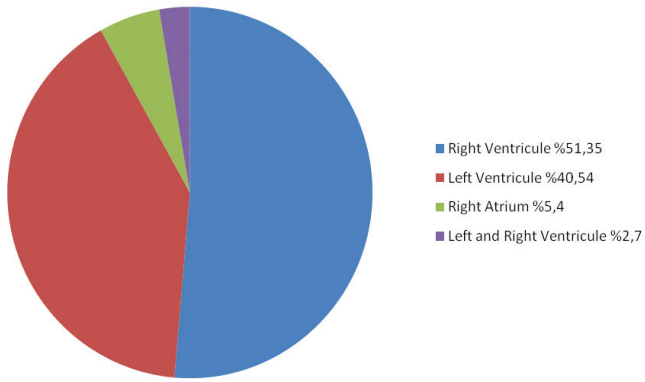

Figure 1. Localization of cardiac rauma.

patients, despite intravenous fluid resuscitation, deterioration in the shock state was detected and they were operated without waiting for additional tests or imaging modality. In patients with a hemodynamically stable status, the decision to operate was taken after echocardiography and CT. The localization of injury is revealed in Figure 1. The injury was repaired with primary suturing in 34 patients. Mitral valve replacement was performed in one patient, and the cardiac injury was repaired using cardiopulmoner bypass (CPB) in two patients. In addition to cardiac injury, left internal mammary artery, femoral artery, and inferior vena cava injuries were detected in one, two, and one patient, respectively. In five patients, the multidisciplinary approach with general surgery was performed because of associated gastric and intestinal injuries. The mean time from admission to surgery was 3.16 ± 2.37 h. The mean duration of intensive care unit was 2.37 ± 2.1 days. On an average, 5.16 ± 4.21 units of packed erythrocyte suspension were transfused. The mortality rate was 37.83% (n= 14). The risk factors associated with mortality are presented in Table 2. The patients who were admitted to the hospital with cardiac arrest have a significantly higher mortality rate (p< 0.001). The duration between ES admission and surgery was significantly shorter in the survival group (p= 0.045).

DISCUSSION

The thoracic trauma rate has been increasing because of the increase in domestic community violence and road accident rates. The ratio of cases with chest trauma requiring emergency

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)	0.357[b]
Stab	19 (82.6)	13 (92.9)	
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
The duration between ES admission and surgery, h	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

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

surgery is 10.4%. Cardiac injuries represent 1% of thoracic trauma[1]. The first case with heart injury was identified by Borch Oluff in 1676, and the 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 below 40 years and this is important for early interventions[4]. Approximately 5% patients who were operated on because of cardiac injury had an accompanying coronary artery injury. However, proximal coronary artery injuries are rare. Injuries are usually observed in the distal branches of the coronary arteries. Therefore, it is usually enough to ligate the coronary artery without the need for additional processing[5]. In our study, we did not observe any coronary artery injuries. Forty percent patients who died after thoracic trauma had associated cardiac injuries[1]. Cardiac injuries can result from a blunt or penetrating injury. The most common causes of blunt chest traumas are vehicle accidents, falls from a height, occupational accidents, and sports injuries. Therefore, patients with blunt chest trauma usually present with multiple trauma[6,7]. Penetrating cardiac injuries are most commonly caused by bullets, stab, bomb shrapnel and body, or pellet[3]. Although penetrating cardiac injuries are rarely, they have high mortality rates. In our study, 94.58% (86.48% stab wounds and 8.1% gunshot wounds) of patients were operated because of penetrating injury. The size, localization, and concomitant pathologies in terms of coronary artery and valve injuries are 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, hemodynamic status of the patient, presence of cardiac tamponade, and elapsed time between admission and surgery[9]. The 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 stab wounds[11]. In stab wounds, a single lesion is usually observed. Because the wound can be limited by tamponade, the survival rate of stab wounds is approximately 70%-80%. This ratio is considered approximately 30%-40% in gunshot wounds [5]. However, the mortality rate observed with stab wounds was 43.75%. In our opinion, exclusion of out-of-hospital deaths was the reason for this result. The overall mortality rate of patients who underwent surgery because of penetrating and blunt cardiac injury was 40.54%. On comparing with other studies, the overall mortality rate was 55% in a study conducted by Kaljusto et al. and was 27.3% in a study conducted by Aksoyek et al.[12,13]. Vital signs on admission can change from cardiac arrest to a completely stable status[14]. In our study, we found that the patients who were admitted to the hospital with cardiac arrest have a significantly higher mortality rate. The most common cause for cardiac arrest with cardiac trauma is cardiac tamponade. In addition to electrocardiographic changes, the Beck Triad in thoracic trauma should indicate cardiac injury and further examination is required even in patients with a stable hemodynamic status[15,16]. In penetrating injuries, in particular, cardiac tamponade can be observed in approximately 80% patients[5,15]. In penetrating and blunt cardiac injuries, the diagnosis of hemopericardium with echocardiography is crucial[10,17]. Transthoracic echocardiography is cheap, noninvasive, and easy to perform. Therefore, it is commonly used in ES to diagnose cardiac injury. In addition to hemopericardium, echocardiography can also provide information about valvar, atrial, and ventricular septal injuries[18]. Echocardiography has an accuracy of 86%, specificity of 97%, and sensitivity of 90% in recognizing cardiac injury[15]. Currently, echocardiography is more commonly used during emergency, and therefore, the mortality rate of patients with cardiac trauma has 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[12]. In patients with a hemodynamically stable status, if the diagnosis cannot be confirmed by transthoracic echocardiography, transesophageal echocardiography and CT will be useful for diagnosis. In a study conducted by Goz et al. 7.7% of patients were diagnosed with cardiac injury by CT[19]. In addition to the noninvasive methods, opening of a subxiphoid pericardial window is mentioned as an invasive method for diagnosis [10,15]. However, in patients with a hemodynamically unstable status with injuries in the danger zones, exploration should be performed without waiting for additional diagnostic procedures. In these patients, an incision should be made closest to the trauma region to explore the thorax or mediastinum without losing time. In emergency conditions, anterior thoracotomy may be the most appropriate method[15,20]. In our study, we used echocardiography as a diagnostic method in 23 patients but it was inadequate to determine 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 underwent emergency surgery 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 is usually preferred in patients with a stable status. Initiation of CPB through this incision is much easier. It also enables in achieving access to all regions of the heart, including the right heart and both the pleuras[3,21]. Kaplan et al. used median sternotomy as an initial incision in 28.57% of patients and Kaljusto et al. used it in 35% of patients[10,13]. Aksoyek et al. have preferred median sternotomy in all patients except one patient[12]. In patients who require urgent intervention, the right anterolateral thoracotomy approach to the heart from the fifth intercostal space can be performed[6,15]. When necessary, enlarging the incision to the left chest also provides access to both pleural spaces. In our study, median sternotomy was preferred in 48.64% of patients. As indicated in the literature, a patient's hemodynamic status and localization of cardiac injury should be taken into account when making this choice. It should not be forgotten that patients with cardiac trauma could

be treatable without using cardiopulmonary bypass support by early diagnosis[22]. In the 16th century, Fabricius 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 have reduced the mortality rates. Approximately 30% of patients with penetrating cardiac trauma can reach the hospital alive, and the mortality rate of these patients is approximately 50%[13]. With respect to the multidisciplinary approach, prior experience of the team surgical team and necessary medical treatment of the patient are the factors that affect 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 the knowledge of surgical management strategy for cardiac trauma. Although gunshot wounds seem to be more fatal in the previous literatures, our study showed that stab wound was more fatal. It has also been observed that multiple injuries have high mortality rates. Therefore, along with improvements in transportation, emergency interventions, and availability of echocardiography in ES, achieving better outcomes in these perplexing cases seems to be possible.

CONFLICT of INTEREST

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

AUTHORSHIP CONTRIBUTIONS

Concept/Design: MA, OS, VB, ST
Analysis/Interpretation: EE
Data Acquisition: MA, AAK
Writing: MA, OS, VB
Critical Revision: VB, MA, ES
Final Approval: All of authors

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