

Increasing numbers of penetrating cardiac trauma in a new center

Yeni bir merkezde artan penetran kardiyak travma vakaları

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BACKGROUND

Our aim was to express the importance of emergency diagnosis and surgical approach in penetrating cardiac trauma patients.

METHODS

Koşuyolu Heart and Research Hospital moved to its new location in Cevizli Kartal in June 2005. Due to its close proximity to the main roads of the city, the number of trauma cases has increased tremendously. We have retrospectively examined our penetrating cardiac trauma cases treated between June 2005 and September 2008.

RESULTS

Twenty-six trauma cases were admitted to our clinic with penetrating cardiac trauma. Twenty of them were operated on an emergency basis. One (5%) had a gunshot wound while the other 19 (95%) had stab wounds. Four were female (20%) and 16 were male (80%). Average age of the patients was 24.9±10.1 (12-49) years. Telecardiography and transthoracic echocardiography were used for diagnosis. Surgical approaches were median sternotomy in 14 and left anterolateral thoracotomy in 6 cases. The right ventricle was damaged in 12, left ventricle in 7 and pulmonary artery in 1. Additionally, 5 patients had lung injury, 1 had brachiocephalic vein injury and 1 had coronary artery injury. One patient was re-explored for bleeding. There were two mortalities (10%) postoperatively.

CONCLUSION

Rapid transfer to the emergency department, accurate and quick diagnosis and aggressive surgical approach will increase survival in penetrating cardiac trauma.

Key Words: Emergency surgery; penetrating cardiac trauma.

AMAÇ

Penetran kardiyak yaralanma nedeniyle cerrahi tedavi gören hastalarda tanı ve acil cerrahi yaklaşımın önemini vurgulamaktır.

GEREÇ VE YÖNTEM

Koşuyolu Kalp Eğitim ve Araştırma Hastanesi, Haziran 2005 tarihinde Cevizli Kartal'daki yeni hizmet binasına taşındı. Bu bölgede hizmet binasının şehrin ana arterlerine yakın konumlanması nedeniyle travmalı olguların sayısında artış söz konusudur. Bu çalışmada, Haziran 2005-Eylül 2008 tarihleri arasında penetran kardiyak yaralanma tanısıyla kliniğimize başvuran olgular retrospektif olarak incelendi.

BULGULAR

Penetran kardiyak yaralanma ön tanısıyla 26 hasta kliniğimize başvurdu. Bu hastaların 20'sine cerrahi onarım işlemi uygulandı. Olguların birinde (%5) ateşli silah, geri kalanında (%95) ise kesici delici alet ile yaralanma mevcuttu. Hastaların 4'ü (%20) kadın, 16'sı (%80) erkekti. Yaş ortalaması 24,9±10,1 (12-49) idi. Tanıda klinik bulgulara ek olarak telekardiyografi ve transtorasik ekokardiyografi kullanıldı. Cerrahi onarımda 14 hastada median sternotomi ve 6 olguda sol anterolateral torakotomi uygulandı. Hastaların 12'sinde sağ ventrikül, birinde pulmoner arter ve yedisinde sol ventrikül yaralanması vardı. İlave olarak beş hastada akciğer, bir hastada brakiosefalik ven ve bir hastada koroner arter yaralanması saptandı. Bir hasta kanama nedeniyle revizyona alındı. Postoperatif dönemde iki hasta (%10) kaybedildi.

SONUÇ

Penetran kardiyak yaralanma olgularında hastaların hızlı transferi, tanının doğru ve çabuk koyulması ve agresif cerrahi onarım uygulanması ile hayatta kalma oranları artacaktır.

Anahtar Sözcükler: Acil cerrahi; penetran kardiyak travma.

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Penetrating cardiac injuries become more frequent as violent assaults increase in the population. In fact, the highest contribution to the literature in this area comes from the United States and South Africa, where these events are highly prevalent.^[1] Cardiac injuries are one of the important causes of death in the young population. They were firstly reported in ancient Egypt 5000 years ago,^[1] whereas the first surgical repair was achieved by Rehn in 1897. Most of these cases die due to the delay in the emergency interventions, inadequate transportation and increased time to operation. Emergency interventions, rapid patient transportation, quick assessment, and forthwith operation are life-saving measures in cardiac trauma cases.

We have analyzed our experience in penetrating cardiac injuries, which have increased in our new center. Our Center's close relationship with a busy public hospital and the approach to these critically injured patients are discussed with a literature review.

MATERIALS AND METHODS

Our center moved to its new location in Cevizli Kartal from Koşuyolu Kadıköy in June 2005. The new center is in close proximity to the city's main roads and one of the largest public hospitals in İstanbul, with an intense patient population. For instance, İmamoğlu et al.^[2] reported 110 thorax trauma cases from a single clinic at this hospital. This has led to an increased number of cardiac trauma cases treated in our clinic. We have retrospectively reviewed the penetrating cardiac trauma cases referred to our clinic between June 2005 and September 2008. The blunt and iatrogenic trauma cases were not included in our analysis.

RESULTS

Between June 2005 and September 2008, 26 patients were referred to our hospital with suspected penetrating cardiac trauma. Six had no cardiac injuries and had only thoracic penetrating trauma and were treated accordingly. All patients were referred to our hospital with 112 ambulance service and the time from injury to the patients' first assessments was less than half an hour. Twenty patients were operated for their cardiac injuries. Sixteen (80%) were male and 4 (20%) were female, with an average age of 24.9±10.1 (12-49) years. The sites of injuries were on the right thoracic wall in 12 and left thorax in 8 patients. Seven patients had multiple stab wounds, which were insignificant clinically and did not cause an organ injury. Etiology in 19 (95%) patients was stab wounds and in the other (5%) was shotgun injury. We used clinical findings, telecardiography (TELE) and echocardiography in preoperative diagnosis. All patients were in stable condition except for the two victims who were in coma and in a deep hypotensive state, and they were transported directly to the operating theater from the

emergency service, while the others were initially admitted to the intensive care unit to be closely monitored and prepared for surgery. Clinical findings at their admittance to the hospital are listed in Table 1. Preoperative echocardiography showed tamponade in 12, left hemothorax in 4 and right hemothorax in 4. All the patients were quickly transported to the operation theater as they were diagnosed.

General anesthesia was used in all cases. The surgical approaches were planned according to the injury site. We used median sternotomy in 14 and left antero-lateral thoracotomy in 6 cases. Median sternotomy is the access of choice because of a probable use of cardiopulmonary bypass. In the six cases who underwent thoracotomy, there were doubts about the cardiac injury diagnosis despite the echocardiographic findings.

We did not use cardiopulmonary bypass in any of the cases. The list of procedures is given in Table 2. The patient with a right ventricle injury together with the left anterior descending (LAD) coronary artery injury had a single aorta-LAD coronary bypass grafting with saphenous vein graft using off-pump technique with Genzyme cardiac stabilizer.

Postoperatively, 1 patient was re-explored for bleeding. The 2 patients who were taken directly to the operating theater with external cardiac massage had hypoxic ischemic encephalopathy postoperatively and died on postoperative days 3 and 16. Considering these 2 cases, mortality was 10%. The rest of the cases were discharged without any problems. The mean duration of hospitalization was 6.5±2.9 (4-18) days.

DISCUSSION

Penetrating cardiac injuries are important not for their frequency but for their high fatality. It has been reported that of the emergency surgical operations,

Table 1. Patients' findings on admittance

| Findings | No | % |
|-----------------------------------|----|----|
| Increased central venous pressure | 12 | 60 |
| Tachycardia | 9 | 45 |
| Widened cardiac shadow on TELE | 12 | 60 |
| Ischemic EKG changes | 1 | 5 |

Table 2. Surgical procedures

| Procedure | No |
|-------------------------------------|----|
| RV Primary Repair | 12 |
| LV Primary Repair | 6 |
| PA Primary Repair | 1 |
| Brachiocephalic Vein Primary Repair | 1 |
| Lung Parenchymal Primary Repair | 5 |
| Ao-LAD Coronary Bypass Grafting | 1 |

RV: Right ventricle; LV: Left ventricle; PA: Pulmonary artery; LAD: Left anterior descending branch of the left coronary artery.

10.4% of them are for thoracic trauma and 1% of them have concomitant cardiac injuries.^[3] İmamoğlu et al.^[2] reported three cardiac injuries in their report of 110 thoracic traumas, but their total number included the blunt and iatrogenic traumas as well. Another study from Mersin reported 302 thorax trauma cases, with 18 (6%) of them having had cardiac repairs.^[4]

Cardiac traumas may be blunt or penetrating. Increasing violence also leads to a progressive increase in penetrating traumas. These injuries account for the most important causes of death in the young population. The young average age of our patients is also consistent with this current knowledge. Most of the patients were male, as also found in most other series.^[5] Of the penetrating traumas, the most frequent causes are stab wounds or gunshot wounds (GSWs).^[6] In the United States, 35-96% of penetrating cardiac traumas are due to GSWs. In developing countries, however, stab wounds are more frequent.^[7] Except for a single gunshot victim, all other cases in our study suffered stab wounds.

Between 2000 and 2005, while our center was located in Koşuyolu Kadıköy, we repaired only two cardiac injuries. The number of trauma cases has increased since the office moved to Kartal. We suspect this increase may be due to the office's close proximity to the main roads of İstanbul (especially Highway E-5) and the heterogenic socioeconomic structure of this region. The nearby public hospital is a well-known trauma center. The close proximity to the main roads and the huge number of emergency cases in that center have had a great impact on the tremendous increase in our trauma patients.

The clinical picture of cardiac injuries varies between "no sign of life" and a more stable patient. This variability is due to the site, extent, shape, and the pericardial involvement of the injury. If the pericardium surrounds and restricts the site of injury, tamponade may occur. In cases in which the pericardium drains to other cavities (pleural space especially), blood passes to these sites and shock may develop due to the continual blood loss. 60 to 100 cc blood may cause tamponade in the pericardial space. Eighty percent of stab wound cases are reported to have tamponade.^[8] Nevertheless, Beck triad is seen in only 10% of the cases. The most valuable findings are the high central venous pressure and narrowed pulse pressure. We had 12 (60%) tamponade cases in our series. In penetrating trauma patients, an aggressive fluid resuscitation preoperatively with correction of central venous/intracardiac pressure ratio, relief of intrapericardial pressure by drainage of pleural and pericardial collections of blood, empirical treatment of metabolic acidosis, and immediate transportation to the operating theater by avoiding unnecessary imaging studies are essential points.^[9,10]

In GSWs, bleeding and hypovolemic findings are common. Tamponade occurs in only 20% of the cases. The high kinetic energy in GSW causes more extensive damage in the pericardium, which then leads to a sudden and extensive blood loss and the higher mortality seen with GSW. This extensive pericardial damage is the reason for the inability to limit the cardiac injury and blood loss. GSW also leads to multiple injuries. We had a single patient with GSW. We repaired the injury on the right ventricle primarily by sutures. Among stab wounds, injuries with a skewer may differ from the others. Two of our patients had skewer injuries. One was injured three and the other 16 days before admission. The sharp, thin and long structure of a skewer may cause injuries that remain silent without any findings. After their discharge from their first hospitalization in another hospital, they were admitted to the emergency service with dyspnea and palpitation. We detected tamponade on echocardiography and proceeded with emergency operations. After successful drainage of the blood, we found pulmonary artery injury in one and left ventricle injury at the apex in the other, and both were primarily repaired.

Early diagnosis is as important as the surgical procedure in cardiac trauma. The injuries at the left anterior axillary line and right midclavicular line through the right nipple with jugular area upwards and upper epigastrium downwards must be considered for concomitant cardiac injury. Jugular venous distention, cardiac murmurs and ECG changes in a thorax trauma patient must alert the physician to a possible cardiac injury. The problem with the critically injured patient is the lack of time for any diagnostic studies. The fatality of cardiac traumas allows only a small portion of these victims to reach an emergency clinic. There is no doubt that a severely injured patient with labile hemodynamics or with cardiac arrest has to be considered for emergency surgery. In most such cases, anterolateral thoracotomy may be recommended for its ease and rapid access to the injured site. The main argument centers around the stable patient with a high index of suspicion.

Echocardiography is a non-invasive and inexpensive tool in the diagnosis of cardiac trauma, which greatly enhances accurate diagnosis. Echocardiography carries 97% specificity, 90% sensitivity and 96% accuracy in detecting cardiac injury.^[9] Transthoracic echocardiography cannot rule out major intrapericardial injury. A mild pleural effusion may be seen with a severe cardiac injury. Increased pleural effusion incidence in penetrating cardiac trauma was reported to decrease the diagnostic value of echocardiography.^[11]

Apart from the cardiac walls, intracardiac defects may be diagnosed with echocardiography as well. The presence of a hemopneumothorax decreases the

diagnostic value of echocardiography, and the need for a subxiphoid surgical approach emerges.^[11] In patients without hemopneumothorax, echocardiography is an accurate diagnostic tool. In myocardial injuries, troponin I measurements may be used for diagnosis. Angiography is helpful in undiagnosed stable patients. Intraoperative fluorescent angiography has been proposed to evaluate the diagnosis.^[12] In stable patients, in order to not misdiagnose occult injuries, transesophageal echocardiography and computerized tomography may also be helpful.^[13]

One may argue about the delay to the operation because the diagnostic procedures may leave a stable patient with a life-threatening condition. As we have stated before, in the patients with critical injuries and in a poor clinical condition, no tests were applied and they were transferred directly to the operating room. The stable patients were all taken to the intensive care unit. In the time necessary to prepare the patients for operation, all the necessary diagnostic tests were done. Any deterioration can be detected with close monitoring. If necessary, emergency transportation to the operation room can be fast and easy. The value of the diagnostic tests in such conditions must not be underestimated as they can change the operation plan. For example, in a patient with a penetrating thoracic trauma, echocardiography revealed cardiac tamponade; there was no change in blood counts but some tachycardia. We used an anterolateral thoracotomy and the pericardium was found to be intact. We avoided a sternotomy with the help of the diagnostic process.

In penetrating cardiac trauma, the frequency of the injured chamber has been reported in decreasing order as right ventricle, left ventricle, right atrium, and left atrium.^[14] Even though the free walls are most frequently injured, valvulae, papillary muscles, chordae tendinea, ventricular or atrial septum, and coronary arteries may also be affected. Rodrigues et al.^[8] reported a 70-patient series in which the right ventricle and right atrium were affected more than the left ventricle. They also stated that, considering non-survivors, the left ventricle is most commonly affected. In our analysis, 12 patients had right ventricle, 7 left ventricle and a single patient had a pulmonary artery injury.

In surgical repair, according to the site of the lesion, right or left thoracotomy or median sternotomy may be preferred. The common opinion for the surgical incision is the left anterolateral thoracotomy. Even if the patient has a trauma on the right side, the incision may be extended to the sternum and the operation may proceed with a sternotomy. For a better exposure of the heart, median sternotomy may be preferred.^[11] Median sternotomy is advantageous for the ease in institution of cardiopulmonary bypass if necessary. Simple suturing with a Teflon or pericardial support if necessary

and patch repair are recommended in cardiac injuries. Pesenti-Rozzi et al.^[15] reported a transcatheter closure of a ventricular septal defect after penetrating trauma as an alternative to surgery.

Mortality among penetrating cardiac trauma patients is high. The presence of tamponade affects survival. More than 50% of the victims die soon after the trauma. Buckman et al.^[16] reported that 78% of all mortality occurs within an hour after the trauma. Patients with no vital signs and who underwent thoracotomy for resuscitation carry a high mortality rate, whereas the patients who are taken to the operating theater in a stable state carry a more favorable prognosis. Survival is reported as 60% to 87%, but this rate decreases in GSW.^[17] The mean physiology index, penetrating thoracic trauma index and mean organ damage scores by the American Trauma Association are said to be correlated with mortality.^[11] Overall, mortality rates ranging from 8% to 47.4% have been reported in the literature.^[11]

Reoperation for a residual defect after their initial treatment was necessary in only two of the patients. Late sequelae are reported to be as high as 56%. Thus, a repeat echocardiography three to four weeks after the surgical repair is recommended. Harris et al.,^[18] who operated 24 patients with penetrating trauma over eight years, reported their experience in patients with delayed pericardial effusions. Patients were operated after a duration of 3 to 33 days. While infections constituted a serious problem, the most frequent cause in their experience was postpericardiotomy syndrome.

Increasing violence in the society causes a progressive increase in the incidence of cardiac trauma. Penetrating cardiac trauma is most commonly due to GSW in western countries whereas stab wounds are more common in developing countries. Most of the victims die in a very short time after the trauma. In these cases, early transportation, diagnosis and aggressive surgical approach decrease mortality significantly. Tamponade must be rapidly corrected, bleeding must be stopped, cardiac functions must be restored, and cardiography must be performed. In patients with shock, the closest incision to the lesion must be preferred to expose the thorax and mediastinum. Echocardiography is valuable in the diagnosis of cardiac injuries and postoperative residual sequelae. Subxiphoid window opening is a diagnostic procedure and reveals a silent cardiac damage. If echocardiography fails to diagnose and there is a suspicion of cardiac damage, the subxiphoid window may then be opened.

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