Reliability Of Clinical Findings And Diagnostic Methods in Potential Penetrating Cardiac Injuries

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Abstract

Objective: Penetrating cardiac injuries are fatal thoracic traumas. Many patients arrive at the hospital dead or in severe shock. Rapid hemodynamic deterioration may develop in patients exposed to cardiac trauma. Early diagnosis and rapid surgical intervention can determine the prognosis. The aim of this study was to analyze retrospectively false cases recognized postoperatively.

Methods: Thirteen false positive or negative cases detected as a result of the surgical intervention findings in our department were analyzed retrospectively. Demographic characteristics, causes of injury, time of arrival at the hospital, and emergency room examination findings, as well as the performance of the diagnostic methods used to demonstrate cardiac injury were evaluated.

Results: The male to female ratio in the 13 patients was 12:1, and the mean age was 26.30± 12.83 years (range 6-56 years). False positive or false negative cases constituted 22.41% of all potential penetrating cardiac injury cases operated on in our department. The hospital mortality rate was 15.4% (2 patients).

Conclusions: Early diagnosis and emergency thoracotomy are essential for the survival of patients after cardiac injury. There are no specific diagnostic methods to guide the diagnosis of potential penetrating cardiac injuries. Therefore, we think that all patients need to be assessed on an individual basis and patient-specific diagnostic strategies should be formulated accordingly.

Key words: Cardiac Injury; Emergency Room Thoracotomy; Echocardiography; Computed Thorax Tomography

Introduction

Cardiac injury should be suspected, until proven otherwise, in patients that have sustained penetrating trauma to topographic anatomical regions susceptible to cardiac injury. There is a time limitation concerning life and death for these patients. Only 6% of patients arrived at the hospital alive in spite of the recent improvements in pre-hospital first-aid and patient transport (1).

The clinical findings of patients exposed to cardiac trauma are related to the degree of hemorrhagic shock and/or cardiac tamponade (2). Imaging techniques such as chest x-ray, cardiac sonography/echocardiography and computed tomography (CT) can be helpful for the diagnosis of cases with an ambiguous clinical picture. However, these diagnostic methods can also yield false positive or negative results (3-7).

In this paper, we discuss the false positive and negative results in our cases of potential penetrating cardiac injury.

Material and Methods

Retrospective analysis was performed on the false positive or false negative cases detected as a result of the surgical intervention findings in our department, comprising 13 patients admitted to the Department of Cardiovascular Surgery, Dicle University School of Medicine between September 2002 and August 2006. In the same period, the number of true positive cases operated on for cardiac injury was 45.

Patients exposed to trauma to the topographic anatomical regions susceptible to cardiac injury and indicating signs of shock and/or tamponade were transferred directly to the operation room and underwent surgery immediately according to the location of the injury, primarily by anterior thoracotomy and if needed by anterolateral thoracotomy. Preoperative fluid infusion was administered to the patients who were prone to shock to keep the systolic blood pressure over 80 mmHg. Patients who were hemodynamically stable underwent chest x-ray, echocardiography and CT to support the diagnosis. Echocardiography evaluations were performed by a cardiologist.

Surgical interventions were performed under general anesthesia in all patients. According to the location of the injury, anterior thoracotomy was the preferred surgical approach through the 4th or 5th intercostal space. Subxiphoidal drainage or pericardiocentesis was not performed in any of the patients for diagnostic or therapeutic purposes. Intravenous antibiotics were administered to all patients for prophylaxis.

Frequency distribution, mean and standard deviations were used for the statistical analysis of the continuous variables.

Results

Fifty-eight patients were operated on for suspected penetrating cardiac injury between September 2002 and August 2006, and 13 (22.41%) of these had false positive or negative findings. In these 13 patients retrospectively analyzed, the male to female ratio was 12:1, and the mean age was 26.30± 12.83 years (range 6-56 years). Seven (53.8%) of the cases involved stab injuries, 4 (30.8%) involved firearm injuries and 2 (15.4%) involved airgun injuries. Mean time to reach the hospital was 126.15±169.73 minutes and all patients in shock underwent surgery within 30 minutes of arrival. The distance between the emergency room and the emergency operation room is 15 meters in our hospital, and emergency room thoracotomy (ERT) was performed in 5 cases (38.5%).

The initial evaluation of the patients in the emergency room revealed shock in 6 (46.2%) cases, hypotension in 4 (30.8%) and normal clinical findings in 3 (23.1%). Echocardiography was used in 7 (53.8%) cases, computed thorax tomography in 2 (15.45%) and chest x-ray in 11 (84.6%) as additional diagnostic methods. In patients examined by echocardiography, 5 false positive results, one false negative result and one true positive result were obtained. In two of the patients who were additionally examined by thoracic CT in order to support the diagnosis after echocardiography, one was found to be false positive and the other was false negative. The false negative CT case was found to be true positive by echocardiography (Table 1).

Table-1: Causes of Injury, Examination Findings, and Diagnostic Methods

Case	*COI*	*AT(min)*	*SBP*	*HR*	*BT*	*ERT*	*ECE(cm)*	*CTE*	*Accompaniment Injury*	*Result*
1	SWI	60	90	116	+	-	1,2 (F+)	-	RIMA	A
2	GSW	15	60	120	+	+ (F+)	-	-	Pulmonary	A
3	GSW	630	100	96	-	-	0,99 (F+)	-	Pulmonary	A
4	AGW	150	100	120	-	-	1,5 (F+)	-	-	A
5	SWI	60	100	108	-	-	1,4 (F+)	-	Pulmonary	A
6	GSW	240	140	100	-	-	1,6 (T+)	+ (F-)	Pericardial & diaphragm	A
7	SWI	30	70	110	+	+ (F+)	-	-	Abdominal & left thigh	A
8	SWI	35	60	110	+	+ (F+)	-	-	-	A
9	GSW	45	60	130	+	+ (F+)	-	-	Abdominal	E
10	SWI	40	40	125	-	+ (F+)	-	-	Pulmonary	A
11	SWI	240	90	100	-	-	0,63 (F+)	+(F+)	Pulmonary	A
12	SWI	60	40	130	-	-	-	-	Left vent.	E
13	AGW	35	80	120	-	-	+ (F-)	-	Abdominal & right vent.	A

COI: *Cause of injury,* ***AT:*** *Arrival time,* ***SBI:*** *Systolic blood pressure,* ***HR:*** *Heart rate,* ***BT:*** *Beck's Triad,* ***ERT:*** *Emergency room thoracotomy,* ***ECE:*** *Echocardiography examination,* ***CTE:*** *Computed tomography examination,* ***A:*** *Alive,* ***E:*** *Exitus*

In the 13 patients, the surgical approach chosen was left thoracotomy in 11 (84.6%), bilateral anterior thoracotomy in one and sternotomy in one. Adequate surgical visualization and repair were achieved in 8 of the thoracotomy patients (72.7%) by anterior thoracotomy. The cardiac injury was determined to be right ventricular injury in one patient and left ventricular injury in another. Hemothorax was determined in 12 patients (92.3%), and 5 patients (38.5%) had tamponade findings.

The injury locations were as follows: pulmonary injury in 5 patients, right internal mammary artery (RIMA) injury in one, diaphragm and pericardial injury in one, abdominal and left femoral injury in one, abdominal injury (spleen, colon, liver, pancreas) in one, left ventricular injury in one and abdominal and right ventricular injury in one.

During the postoperative period, left lobe atelectasis was documented in one case and left-sided pleural effusion in two cases. The hospital mortality rate was 15.4% (two patients). In these patients prolonged shock was established as the cause of mortality.

Discussion

The ERT approach, which has become increasingly popular in the last 3 decades, is the leading procedure of choice in the management of life-threatening thoracic trauma. Evacuation of the pericardial tamponade, direct control of intra-thoracic hemorrhage, control of massive air embolism, open cardiac massage and cross-clamping of the descending aorta can be accomplished by this procedure (8). All five patients with false positive ERT results (patients 2, 7, 8, 9 and 10) presented in our report were suspected of suffering from cardiac injury due to clinical signs and had clinical features of shock as well as extensive hemothorax. The vital signs of all of the patients indicated penetrating thoracic trauma and none of the patients had concomitant serious head injury. ERT was a life-saving procedure in four of these patients. Left ventricular injury was found in one patient (patient 12), who was in hypovolemic shock, but was not predominantly suspected of suffering from cardiac injury according to the initial clinical signs in the emergency room. This patient was lost due to prolonged shock even though the cardiac injury was repaired by thoracotomy performed after laparotomy.

Early diagnosis and treatment are crucial factors for the survival of patients sustaining cardiac and major thoracic injuries. In particular, rapid diagnosis of cardiac tamponade findings and timely operative treatment may be life saving (3,9). Therefore, in stable patients sonographic cardiac evaluations

in sustaining penetrating precordial injuries are an appropriate and fast diagnostic technique (3). However, this diagnostic method can produce false positive and false negative results. In their prospective multicenter study, Rozycki et al (3) reported false positive cardiac sonography findings in seven patients, while no false negative results were found. On the other hand, Meyer et al (10) reported false negative results in patients with extensive hemothorax and mild hemopericardium. Likewise, extensive hemothorax was present in three of the six false negative cases reported by Harris et al (11). No false positive cases were reported by these investigators. In accordance with the literature, extensive hemothorax was found in four of the echocardiographically false positive cases (patients 3, 4, 5,11) in our series. In the other false positive case (patient 1), hemorrhage originating from RIMA and passing through the injured pericardium was found to be the cause of the hemopericardium. Stiff pericardial adherence as well as abdominal transmission of the right ventricular hemorrhage was present in our false negative case (patient 13).

The use of computed thorax tomography in the diagnosis of patients sustaining penetrating thoracic trauma who are hemodynamically stable has become increasingly popular over the last decade. In a recent study consisting of 60 stable patients, Nagy et al (7) showed that the demonstration of hemopericardium by CT had a sensitivity of 100% and specificity of 96.6%. Moreover, Rotondo et al (12) documented increases in aortic and pulmonary enhancement despite decreases in aortic vessel, vena cava and cardiac chamber diameters in thoracic CT scans of patients exhibiting hypovolemic shock. In our cases, although pericardial injury, apical and anterior hematoma and hemothorax were reported in one (patient 11) of the cases evaluated by CT after echocardiographic examination, no cardiac injury was detected during the operation (Figure 1).

Figure 1: Increased epicardial fat deposition. No cardiac injury was detected during the operation.

Increased epicardial fat deposition was present in this patient, who was not obese. However, hemorrhagic fluid retention due to pericardial injury was identified in the patient with false negative results, who had normal CT findings despite the pericardial effusion, reported in echocardiography (patient 6, ECE: true positive).

ERT should not be avoided in cases where the clinical signs indicate potential cardiac injury, regardless of the possibility of a false positive outcome. This procedure should be executed without discretion in patients who are salvageable. Similar to cardiac sonography, echocardiographic investigations may also reveal false results in the diagnostic work-up of potential penetrating cardiac injuries. Although echocardiographic investigations may be more time consuming than cardiac sonography, they may be acceptable in hemodynamically stable patients. Similarly, false results may also be obtained by CT.

In conclusion, there are no specific diagnostic methods to guide the diagnosis of potential penetrating cardiac injuries. Therefore, we think that all patients need to be assessed on an individual basis and patient-specific diagnostic strategies should be formulated accordingly.

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