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Challenges in the Management of Penetrating Cardiac Injuries in Taiz, Yemen

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ABSTRACT

Ten patients with penetrating heart injury were admitted to the emergency room (ER) of Yemen International Hospital, Taiz, Yemen in the period 2011–2013. Nine patients were males and one was a female, with mean age of patients was 27.6 years old. All mechanisms of injuries were gunshot wounds except for one, which was a stab wound. Patients were classified into three groups according to their hemodynamic states and consciousness level. The first group includes five patients who were hemodynamically unstable and conscious. These patients were transferred immediately to the operating room. Patients with various heart injuries survived. The second group includes three patients who were in shock with no detectable blood pressure and semiconscious. Because there was no response to resuscitation, they were highly indicated for emergency thoracotomy, which could not be performed due to the presence of their firearms-carrying relatives in the ER. Therefore, these patients died. The third group includes two patients who were hemodynamically stable and conscious. They underwent pericardial window opening. In conclusion, penetrating cardiac injuries seen in our hospital are consistent with the available literature. However, it is believed that country security instability is one of the important factors that affects the management of such cases according to the international guidelines.

Keywords: Penetrating cardiac injury, Emergency thoracotomy, Cardiac surgery

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1. Introduction

Penetrating cardiac injuries are among the most lethal of all traumatic injuries, with many studies reporting mortality rates of 70–90% (1–3). The number of such injuries is a very small proportion of annual trauma admissions (0.1%) in most reports (4, 5). Limited facilities to manage penetrating cardiac injuries in most parts of Yemen, coupled with political and security instability, pose major challenges to the optimal management of these injuries. Current understanding of penetrating cardiac injuries is largely based on case series due to their rarity (6). This study contributes to the understanding of penetrating cardiac injuries among Yemeni people by analyzing the results and clinical outcomes of treating such injuries.

2. Methods

2.1. Patients

The present study included ten patients with penetrating heart injuries admitted to Yemen International Hospital in Taiz in the period 2011–2013. Patients who have undergone thoracotomy for blunt trauma of the heart were excluded. Informed consent was obtained from all cases.

2.2. Methods

Data about patients' age and sex, date and mechanism of injury, method of hospital transportation, initial clinical presentation, preoperative investigations (if present), surgical modalities for cardiac repair, survival, and cardiac outcomes were collected from patients' records. This study was ethically approved by Yemen International Hospital-Taiz and informed consent was obtained from patients or their relatives. Patients were classified into three groups as follows:

- *First group*: Five patients who were hemodynamically unstable (systolic blood pressure (BP) <90 mmHg) and conscious. Resuscitation was started with some response. Chest X-ray and quick echocardiography were performed, and then patients were immediately transferred to the operating room without any other investigations.

- *Second group*: Three patients who were in shock with no detectable BP and semiconscious. Because there was no response to resuscitation, they were highly indicated for emergency thoracotomy. Unfortunately, the procedure could not be performed due to the presence of their firearms-carrying relatives in the emergency department.

- *Third group*: Two patients who were hemodynamically stable and conscious. They were transferred to cardiothoracic intensive care unit for further evaluation and additional investigations. This group of patients had cardiac contusion resulting in hemopericardium without myocardial lesion. They underwent pericardial window opening, which was performed through a midline laparotomy incision as the patients had associated abdominal injuries. Follow-ups confirmed that there was no need for additional surgical interventions.

3. Results

Ten wounded patients sustaining penetrating cardiac injury who arrived alive at the emergency room (ER) of Yemen International Hospital in the period from 2011 to 2013 were included. The mean age of wounded patients included in the present study was 27.6 years old (range, 10–56 years old). Nine patients were males and only one patient was a female. Nine patients were delivered into our hospital by their firearms-carrying relatives while one was transferred from another hospital by am-

bulance. Six patients presented with isolated penetrating chest injuries while four suffered from multiple chest and abdominal injuries (but without injuries of visceral organs). Regarding the mechanisms of injuries, all of them were gunshot wounds except for one, which was a stab wound.

Clinical evaluation in the ER showed that all penetrating injuries were within the borders of the "cardiac box". Classic cardiac tamponade with Beck's triad (muffled heart sounds, increased jugular vein distention and hypotension) was noted in two patients (Figure1). Management in the ER was carried out according to the hemodynamic states and consciousness level of the patients (Table1).

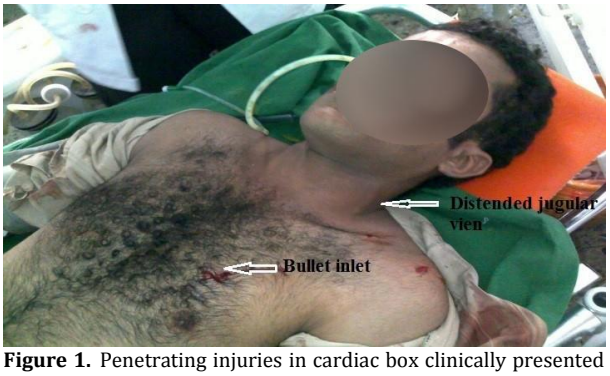

Figure 1. Penetrating injuries in cardiac box clinically presented with cardiac tamponade

Table 1. Distribution of patients according to clinical findings, method of management and survival

Hemodynamic status and consciousness level of patients	Management	Survival	No.
Hemodynamically unstable and conscious	ER resuscitation followed by cardiac injury repair in operation room through sternotomy	Yes	5
Shock with no detectable BP and semiconscious	ER resuscitation	No	3
Hemodynamically stable and conscious	Pericardial window opening after full investigations	Yes	2

Concerning the operative findings, injuries were in the right ventricle in two patients, in the left ventricle in one, and in the right atrium in one patient while in two patients there was heart contusion without any myocardial lesion. In addition to cardiac wounds, there were wounds in the pulmonary parenchyma in two patients, abdominal injuries in two patients, and internal thoracic artery injury in one patient.

Sternotomy was performed for five patients. Findings by sternotomy included hemopericardium under tension and evacuation of a huge clot. Additionally, in two patients, cardiopulmonary bypass (CPB) machine was needed to remove the bullets and to repair the injuries of the papillary muscle of the tricuspid valve and interatrial septum (Figure 2A, 2B & 2C). In three patients, cardiac injuries were repaired using 2-0 prolene pledgeted mattress sutures without using the CPB machine (Figure 3).

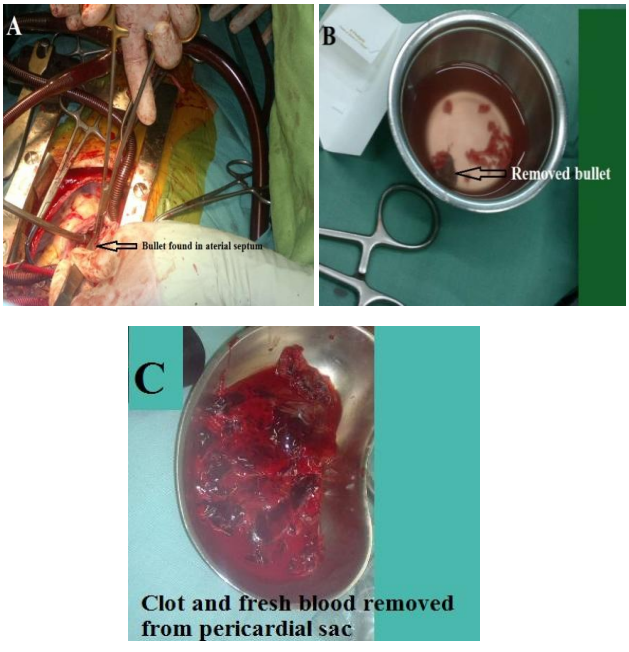

Figure 2. Bullet fragment removal from right atrium with atrial septal defect, which was repaired using CPB machine (A, B, C)

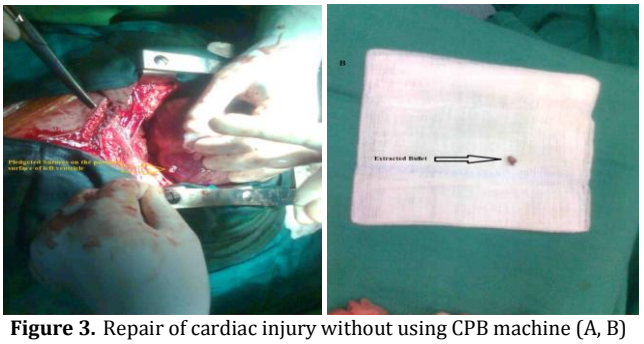

Figure 3. Repair of cardiac injury without using CPB machine (A, B)

Post-operative complications were observed in three patients: the bullet was localized in the inferior vena cava in one patient, who was referred abroad for endovascular removal because it was not possible in Yemen (Figure 4). Two patients developed atrial fibrillation on the second post-operative day after right ventricle injury repair. Patients recovered with medical treatment by amiodarone and anticoagulation. No death was met intra-operatively or in the postoperative period. Regular echo every six months showed normal cardiac chamber and function within a two-year follow-up period.

Figure 4. Bullet in inferior vena cava

4. Discussion

In spite of great advances in pre-hospital care as well as in operative and intensive care procedures, penetrating cardiac injuries are still highly fatal leading to a high mortality rate compared to other traumatic injuries (1). Similar to the findings of previous studies (7, 8), the results of the present study showed that the victims of penetrating cardiac injuries are predominantly young males.

Penetrating cardiac injuries are rare. For example, Feliciano et al. (9) described a one-year experience of cardiac injuries in a single institution consisting of 48 patients in Houston, United States in 1983. In 1989, Mattox et al. (10) presented a 30-year experience of 5,760 cardiovascular injuries, of them cardiac injuries were just 539 patients (18 cardiac injuries per year). A more recent review focusing on the National Trauma Data Bank of the American College of Surgeons identified only 2016 patients sustaining penetrating cardiac injuries, with a nationwide incidence of 0.016% for these injuries (4). Available data indicate that penetrating cardiac injuries are indeed rare. Similarly, in our referral trauma hospital, which is the only center performing open-heart surgery for 10 million people, only 10 cases of such injuries were managed. Due to the critical nature of cardiac injuries, up to 90% of victims with penetrating cardiac injuries die before hospital admission (11). In a similar pattern, it is believed that most Yemeni patients with firearm cardiac injuries are lost before arriving to emergency departments, particularly with the absence of trauma data bank in the country.

In this study, the main mechanism of penetrating cardiac injuries was gunshot wound. This was related to the fact that a large majority of households in Yemen has at least one gun, and possession of firearms is common (12). Frequency and etiology of penetrating cardiac injuries is a reflection of the society in which they happen (13). For instance, more than 60% of such injuries in the United States are mainly due to gunshot wounds because of the easy obtaining and accessibility of firearms by civilians (4).

It is noted that all the penetrating injuries were within the borders of the cardiac box. Among cardiac traumas following penetrating injuries to the thorax, those within the "cardiac box" are considered the most worrisome, but this does not exclude the possibility of cardiac injury in case of wounds outside this "box" (14). Although the patients included in the present study had typical presentation of cardiac injury, i.e., gunshot in the "cardiac box", hypotension and shock, the clinical presentation of their injuries varied from a stable hemodynamic status to a rapid circulatory collapse. Poor prognostic factors include low BP, absence of pulse and cardiac rhythm, dilated and fixed pupils and loss of motion in extremities (15–17).

Patients with penetrating cardiac injuries can be classified into five groups: lifeless, critically unstable, cardiac tamponade, thoracoabdominal injury and those with a benign presentation (18). In this study, five patients belonged to the second group, three to each of the first and second groups and two to the fifth group.

Only 20% of cases in the present study were diagnosed with cardiac tamponade. Available data in the literature regarding the survival benefit from tamponade after cardiac surgeries remains contradictory. While increased survival from tamponade has been reported in a number of studies, some reports have shown the absence of such a benefit (1, 16, 19). Moreover, the cardiovascular condition and consciousness status of victims upon hospital arrival significantly contribute to the predictable outcome of penetrating cardiac injuries (13).

Survival rates following emergency thoracotomy for penetrating thoracic trauma is 9–12% (up to 38% with signs of life) (20, 21). In contrast to urgent thoracotomy, emergency thoracotomy is performed immediately in the emergency department as an integral part of the initial resuscitation process shortly after presentation (22). The indications for emergency thoracotomy were penetrating trauma in three patients in extremis (BP <60 mmHg; not responding to fluid resuscitation) on arrival to the ER. The presence of firearms-carrying relatives of patients and their entry into the ER was the major obstacle in saving their lives. The instability of security situations in developing countries, particularly in Yemen, makes it difficult to follow all international guidelines apart from the capabilities of hospital facilities and cardiac surgical teams.

Pericardial window opening may be lifesaving in patients with tamponade but is usually only a temporizing maneuver while they await definitive surgical therapy. Historically, sub-xiphoid window was the "gold standard" to evaluate for hemopericardium. However, echocardiography has now become the modality of choice. It was found that echocardiography had a sensitivity, specificity and accuracy of 90%, 97%, 96% respectively (23). However, in two patients, who had occult cardiac-associated abdominal injuries, echocardiographic results were equivocal. Therefore, pericardial window opening was done during laparotomy exploration operation. A pericardial window opening can be performed to diagnose hemopericardium if ultrasound is not available or the results are equivocal. Previous studies confirmed the accuracy of this technique (24, 25) and its usefulness in occult cardiac injuries (26).

All cardiac injuries in the five patients of the first group underwent sternotomy, which we use daily in our elective open-heart surgery. In penetrating cardiac injuries, Mitchell et al. (27) recommended the usage of median sternotomy because it gives access to the heart and great vessels, to other structures in the mediastinum and to both pleural cavities

CPB was used to remove the bullet fragments and to repair injured intra cardiac lesions. Rupture of a papillary muscle was repaired in one patient. In addition, a fragment was removed from the right atrium and the inter-atrial septal defect was repaired in another one (Figure 3). CPB has been only occasionally used to treat proximal lesion of coronary arteries as well as to treat multiple-chamber wounds and to repair intracardiac lesions (28, 29). Moreover, several trauma centers do not have around-the-clock cardiac surgery staff and consider CPB as a discouraging life-saving procedure (29). Thus, further studies are still required to confirm the role of the early use of CPB in the treatment of penetrating cardiac injuries.

The survival rates after cardiac injury repair operations in our hospital are impressive in this series and compares well with other recent reports. In my opinion, this was due to the fact that the surgical team is made up of cardiac surgeons.

Kamali et al. (13) published their experience in treating 23 penetrating cardiac injuries in Istanbul Okmeydani Training and Research Hospital between 1995 and 2009. Ten of 23 patients were lost, and in six of the lost cases, the patients represented the first experience for the operating surgeon. The authors attributed that to the lack of experience of the surgeon as a main determinant of the outcome of penetrating cardiac injuries, where general surgeons usually have less experience in thoracic procedures, including cardiac surgeries, compared to abdominal procedures (13).

5. Conclusions

Based on the present findings and those of previous studies, penetrating cardiac injuries present clinical challenges to surgeons in developing countries. Despite the consistency between the characteristics of penetrating cardiac injuries in this study and those previously reported in the literature, it is believed that security instability in the country is one of the important factors affecting the management of such cases according to the international guidelines. However, the results of penetrating cardiac injury management in this study are encouraging.

Competing interests

The author declares that he has no competing interests associated with this article.

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