MILITANCY TRAUMA : PENETRATING AND NONPENETRATING CARDIAC INJURY

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ABSTRACT

Two hundred and eighty patients with serious chest injuries were treated at a service hospital during a period of 41 months. Out of 9 patients who suffered cardiac trauma 5 had penetrating cardiac injuries, 2 had penetrating pericardial injury and 2 patients had myocardial contusions. Myocardial contusions simulated myocardial infarction. All patients except one had polytrauma, associated injury to the lung or intra-abdominal organs. Early evacuation, resuscitation, high index of suspicion for cardiac injury and prompt surgical intervention were the keys to successful management in these patients. Thoracotomy was performed to repair the myocardial perforation and lacerated lung injuries. Associated infra-abdominal injuries were managed with laparotomy. Two patients died due to lack of cardiopulmonary bypass facilities and resistant cardiac arrhythmias. Seven patients had uneventful recovery.

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Wounds, nonpenetrating; Wounds, penetrating.

Introduction

Trauma to the heart and great vessels, though relatively uncommon, represents a leading cause of death in young adults [1,2]. Serious cardiac injury may be overlooked in patients with blunt chest trauma [3]. Increase in incidence of cardiac injury may be related to the rise in frequency of physical violence, militancy and automobile accidents [4]. The incidence of iatrogenic cardiac trauma is also increasing with greater use of intravascular and intracardiac catheters leading to penetrating injury of the heart and resuscitative cardiac massage causing nonpenetrating cardiac injury [5-7].

Cardiac and great vessel injuries constitute 4-5 per cent of major thoracic trauma. Cardiac trauma victims may not reach the hospital alive due to exsanguination and cardiac tamponade. Better pre-hospital care, faster critical-care transportation sys-

tems, and effective emergency and definitive management at trauma care centres has resulted in an increasing number of immediate survivors and has decreased incidence of sequelae such as myocardial infarction, ventricular and pseudoaneurysm, ventricular septal defect, valvular damage, and recurrent and constrictive pericarditis.

Material and Methods

A total of 280 patients with severe chest injuries were admitted to our hospital between 01 Jan 1990 and 31 May 1993. Of these 9 (3.2%) had cardiac injury. Five of these patients suffered penetrating cardiac injury while the remaining suffered non-penetrating injury. Cause of cardiac injury was gun shot wounds in 2 patients and grenade blast splinter injuries in 7 patients. All the patients could be evacuated from the site of incident to the hospital within 2 hours. All were male between the ages of 21 and 42 years. The

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casualties were managed in the intensive care unit by implementing a standard protocol based on management priorities as reported by us earlier [12]. Cardiac penetrating injury was suspected clinically when severe degree of shock was associated with missile injury of the chest or upper abdomen. It was also suspected whenever there was haemothorax, tamponade, pneumothorax and delayed response to adequate resuscitation. Non-penetrating cardiac trauma and myocardial contusions were suspected when pre-cordial pain, pericardial rub, and non-specific ECG changes were seen. Patients were resuscitated and simultaneously prepared for surgery.

CASE REPORTS

Case No 1

A 21-year-old soldier sustained mine blast injury and was evacuated to 92 Base Hospital within 2 hours by air. On arrival at the hospital he had unrecordable arterial pressure and pulse. Immediate resuscitation by endotracheal intubation with 100 per cent oxygen and administration of fluids improved the clinical state of the patient. Clinical signs of cardiac tamponade and haemothorax were observed. Tube thoracostomy drained 900 mL of blood from left thoracic cavity. Patient was taken up for thoracotomy under general anaesthesia; pericardiotomy drained 600 mL of blood, the torn internal mammary artery was ligated, and perforation of the left ventricle was repaired. Total blood loss was approximately 4000 mL which was replaced. Patients had an uneventful recovery.

Case No. 2

A 26-year-old male sustained multiple splinter injury (grenade blast) over the chest and abdomen. He had severe hypotension (BP 60/40 mmHg), dyspnoea, restlessness, pulse rate 130/min, peripheral cyanosis with pallor. He had signs of cardiac tamponade. Breath sounds on the left side of the chest were diminished. Clinically tension pneumothorax with cardiac tamponade was diagnosed. Immediate thoracostomy improved the clinical state of the patient. Thoracotomy was done, pericardiotomy drained 200 mL of blood, perforation of the lung was repaired. Contusion of the left ventricle was confirmed.

Case No. 3

A 42-year-old male sustained gun-shot wound of the chest. Wound of entry was the left axilla and exit wound was in the 8th intercostal space parasternal region. He was evacuated to hospital within 30 min in a critical state. He was in severe shock (arterial pressure 60/40 mmHg), unrecordable peripheral pulse, pallor with tachypnoea and breathlessness. He had peripheral cyanosis which could not be corrected even with 100 per cent oxygen via endotracheal tube. Resuscitation improved the haemodynamic status of the patient. Intercostal tube was placed to drain 1500 mL of blood. Thoracotomy (L) revealed haemopericardium (700 mL fresh blood), puncture of the anterolateral border of the left ventricle and tear of the ventricular septum. Patient could not be saved due to lack of cardiopulmonary bypass facilities.

Case No. 4

A 24-year-old male sustained multiple splinter injury (grenade blast) of the neck, chest and abdomen. He was brought to hospital within 40 minutes in a state of severe shock. During resuscitation he had a cardiac arrest from which he was revived. During surgery the pericardium was opened and blood clots from pericardial cavity were removed. Laceration of the lower lobe of the right lung was repaired. Contusion of the right ventricle was confirmed. Post-operatively, ECG showed ST depression and T wave inversion in anterolateral ECG leads. Laparotomy was done to repair the perforation of anterior wall of the stomach. Patient had an uneventful recovery.

Case No. 5

A 24-year-old male sustained splinter injury chest. Single small splinter injury was seen over the lower part of the sternum at fourth intercostal space. He had tachycardia, pallor, arterial pressure 90/60 mmHg. Signs of cardiac tamponade were seen. Pericardiocentesis was positive. Radiography of the chest was within normal limits. Thoracotomy revealed perforation of the left ventricle anteroinferior and anteroposterior borders with spurting of blood with each systole. These were repaired surgically. Patient had an uneventful recovery.

Case No. 6

A 25-year-old male sustained multiple splinter injury over the anterior wall of chest (L), left shoulder and hand in a grenade blast. He was brought to hospital within 30 minutes in a state of severe shock. He had bilateral haemothorax, perforation of the left ventricle (posterolateral wall) with bleeding coronary vessels and laceration of the left lung. Minilaparotomy did not reveal intra-abdominal injury. Bilateral intercostal drains were placed and surgical repair of the myocardium and the lung was done. Patient had an uneventful recovery.

Case No. 7

A 25-year-old male sustained multiple splinter injury (grenade splinters) over the face, chest, abdomen and upper limb. He was received within 1 hour in a critical shock state. He was resuscitated successfully. He was found to have cardiac tamponade. Pericardial aspiration showed blood in the pericardial cavity. He had haemothorax (L), multiple laceration of the (L) lung, haemopericardium and perforation of the anterolateral wall of the left ventricle. These were repaired with left thoracotomy. Abdominal laparotomy revealed haemoperitoneum 600 mL of blood, rupture of the left kidney, multiple perforations of small intestine, haematoma of the mesentery and retroperitoneal region. Estimated blood loss was 3.5 L. He had an uneventful recovery.

Case No. 8

A 26-year-old male sustained multiple gun shot wounds of the neck, chest, abdomen and hand. He was received within 3 hours with unrecordable arterial pressure and pulse. He was resuscitated successfully. He had a shattered thyroid cartilage, bleeding, and surgical emphysema of the neck. Tracheostomy was done and a bilateral haemothorax was drained. Laparotomy revealed haemoperitoneum and multiple injuries of abdominal viscera including a torn left lobe of liver. These were repaired surgically. On 1st postoperative day, patients became restless, dyspnoeic and complained of pericardial chest pain. His pulse rate was 130/min, respiratory rate was 46/min, and

arterial pressure was 100/60 mmHg, despite being on dopamine $8 \mu\text{gmin}^{-1}\text{kg}^{-1}$. A pericardial rub was heard over the precordial region. JVP could not be visualized due to surgical emphysema and jugular cannulae. ECG showed ventricular extrasystoles, nonspecific ST-T wave changes in the chest leads. Diagnosis of contusion of the heart was based on clinical findings. Pericardial rub disappeared on 10th post-operative day and patient made an uneventful recovery.

Case No. 9

A 30-year-old male sustained grenade blast injury abdomen and chest. On arrival 4 hours later was severely shocked. Examination of the abdomen revealed tenderness of the left lumbar region and guarding. Urinary catheter drained urine mixed with frank blood. Chest was normal clinically and radiologically. Exploratory laparotomy showed large retroperitoneal haematoma and laceration of the right kidney which was repaired surgically. One day later the patient complained of pain in the chest and retrosternal region. ECG showed ST elevation, T inversion in leads V3-V6, rate 75/min. SGOT/SGPT were normal. There were no arrhythmias or deterioration of haemodynamics. Patient was treated with morphine and sorbitrate. Repeated ECG did not show Q wave or any change from the 1st postoperative ECG. Myocardial contusion was confirmed. Patient was discharged after 3 weeks hospitalization.

Discussion

Penetrating cardiac injuries may occur due to bullets, missile fragments, stab wounds, inward displacement of ribs and sternal fragments in vehicle accidents, and during cardiac catheterization [10]. Penetrating wounds of the precordium may be associated with cardiac injury. Sometimes wounds of other areas of the chest as well as blast effects causing injury of the upper abdomen and neck are associated with penetration of the heart. Penetrating wounds of the heart may result in laceration of the pericardium alone or in association with lacerations of the myocardium. Laceration of the pericardium may produce herniation of the heart with compromised haemodynamics and arrhythmias. Cardiac tamponade may be life-threatening. The cardiac chambers most commonly involved are the right ventricle because of its anterior position, followed by, in descending order of frequency, the left ventricle, right atrium and left atrium [11]. Bullets and fragments cause extensive cellular destruction, transmural myocardial trauma and bleeding that is usually not self-limiting. Pulmonary lacerations along the path of the bullet or missile may be seen. Coronary artery injury may cause myocardial infarction.

Immediate life-threatening situations may either be due to cardiac tamponade or pericardial laceration

with herniation of the heart. When the pericardium remains open cardiac tamponade may not manifest but haemorrhage and haemothorax may be the presenting feature. On the other hand, if the pericardium does not permit free drainage because its opening has been obliterated by a blood clot, adjacent lung tissue, pericardial vent flaps, or other structures, tamponade occurs minutes or hours later. Sometimes blood may accumulate intra- and extra-pericardially manifesting as tamponade with haemomediastinum or haemothorax. Traumatic penetrating lesions of the heart are usually associated with injury to the lungs and other abdominal organs. Management priorities in trauma victims have been reported by us [12]. High degree of suspicion of cardiac penetrating in an apparently non-cardiac trauma will prevent unanticipated catastrophe. Echocardiography is extremely valuable in the recognition of pericardial effusion, foreign bodies and intracardiac shunts. Where such facilities are not available suspicion of cardiac injury in noncardiac trauma, the clinical findings and pericardiocentesis may be valuable for diagnoses. The definitive treatment of cardiac penetrating injury is immediate thoracotomy and cardiorrhaphy.

Anaesthesia may be challenging in these patients. Pre-operative resuscitation will improve the haemodynamics temporarily. Ketamine as an induction agent has been used by us in haemodynamically unstable patients. These patients were monitored by non-invasive cardiac monitor-cum-defibrillator, arterial pressure dynamap (Criticon), central venous pressure and urinary output intra and post-operatively. Many victims of penetrating cardiac injury were young and otherwise in good health and they could withstand relatively long periods of hypoperfusion without irreversible brain, renal or cardiac damage. After initial improvement in their haemodynamic state, surgery should be contemplated and may be life saving. Penetrating trauma to the great vessels [13] may result from bullets or missiles in the battle field. Massive haemothorax is usually the presenting clinical finding. Arteriovenous fistulas [14] may lead to development of congestive cardiac failure. Aortography may not be possible but immediate emergency thoracotomy, treatment of shock and tamponade is essential. Tears of descending aorta may often be repaired without cardiopulmonary bypass

as long as cross-clamp time is restricted to 30 minutes [15]. This may be facilitated by the intravenous administration of nitroprusside which can maintain proximal aortic systolic pressure < 100 mmHg. Penetrating injury at the root and ascending aorta may be repaired with cardiopulmonary bypass facilities.

Non-penetrating cardiac trauma may result from direct or indirect injury to the chest. The mechanisms of nonpenetrating injury to the heart may be direct force against the chest, bidirectional force against the thorax, indirect forces causing sudden increase in intravascular pressure such as compression of the abdomen decelerative forces, blast forces, concussive forces, and combination of these [1-7,10]. The effects of missile blasts with concussive forces may be the common cause of nonpenetrating cardiac trauma in the battle field. Pathological findings may be minute ecchymotic areas in the subepicardium or subendocardium or transmural contusions with oedematous, fragmented or necrotic muscle fibres surrounded first by red blood cells and invaded soon thereafter by polymorphonuclear leucocytes. The external appearance of the heart may be misleading in the case of nonpenetrating injury as large areas of intramural and subendocardial contusions may not be seen. Injury to the pericardium in blunt trauma of the chest may range from contusion to laceration or rupture. Traumatic pericarditis manifesting pericardial friction rub and ST-T wave changes on the electrocardiogram are the characteristic findings. Myocardial contusions are more common but remain silent, often masked by the injury to the chest wall or other organs [17,18]. The most common symptom of myocardial contusion is the pericardial chest pain resembling that of myocardial infarction. Pain from other sites may confuse the clinical picture. Pain fails to respond to the coronary vasodilators. ECG shows nonspecific ST-T wave abnormalities, diffuse ST segment elevation, short or depressed PR segment and rarely, pathological Q-wave which indicates deeper injury to the myocardium. Since cardiac trauma is usually not considered in trauma victims nor ECG is recorded immediately, diagnosis may be missed. High index of suspicion for cardiac injury is important during evaluation of trauma cases. Arrhythmias may be common with areas of extensive

contusion [19]. Atrioventricular and interventricular conduction defects, as well as sinus node dysfunction are also seen [20]. Cardiac contusion rarely leads to severe heart failure but decreased ventricular function as reflected by the depressed ejection fraction may be found [22,29]. However, minimum monitoring such as pulse oximetry, arterial pressure and ECG display may detect early deterioration. Management approach may be similar to myocardial infarction. Anticoagulants and thrombolytic agents are contraindicated because intramyocardial/intrapericardial haemorrhage may be exacerbated.

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