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Subxiphoid pericardial window to exclude occult cardiac injury after penetrating thoracoabdominal trauma

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ABSTRACT:

Background: An occult cardiac injury may be present in patients with an acute abdomen after penetrating thoracoabdominal trauma. This study assessed the use of a subxiphoid pericardial window (SPW) as a diagnostic manoeuvre in this setting.

Methods: This was a retrospective review of a trauma database (2001–2009). Patients presenting with a penetrating thoracoabdominal injury with an acute abdomen, and in whom there was concern about a potential cardiac injury from the site or tract of the injury, were included.

Results: Fifty patients with an indication for emergency laparotomy underwent a SPW for a possible cardiac injury. An occult haemopericardium was present at SPW in 14 patients (28 per cent) mandating, median sternotomy. Nine cardiac injuries (18 per cent) were identified including five tangential injuries and four perforations. The specific complication rate relating to the SPW was 2 per cent.

Conclusion: The SPW is a useful technique at laparotomy to identify cardiac injuries in patients with penetrating thoracoabdominal injuries.

INTRODUCTION

The reported incidence of combined thoracic and abdominal injuries following penetrating chest trauma is between 6 and 42 per cent^{1–5}. This wide variation reflects the proportion of gunshot wounds (GSWs) included in a particular series. Patients with penetrating thoracoabdominal injuries have a 20–30 per cent risk of cardiac injury where the tract overlies the cardiac silhouette^{6–10}. The diagnosis of haemopericardium can be made by ultrasonography of the pericardial sac, but the sensitivity and specificity of the test is variable and there is concern about the number of false-negative reports, particularly in association with haemothorax¹¹. A subxiphoid pericardial window (SPW) can be performed at laparotomy if there is concern about an occult cardiac injury. The manoeuvre is quick, simple and easy to learn. However, it is invasive and the negative consequences have not been defined. This study investigated how often an occult haemopericardium occurs in patients with thoracoabdominal injuries, and determined adverse effects of SPW.

METHODS

All patients presenting to the Groote Schuur Hospital Trauma Centre between October 2001 and February 2009 with a penetrating thoracoabdominal injury in close proximity to the heart, and an indication for emergency laparotomy but no immediate indication for thoracotomy, were included in the study. All patients were resuscitated according to the Advanced Trauma Life Support (ATLS®) guidelines¹². The Revised Trauma Score (RTS) was calculated for each patient. Abdominal injuries were graded using the Penetrating Abdominal Trauma Index (PATI), and cardiac injuries by means of the Cardiac Injury Scale in accordance with the American Association for the Surgery of Trauma as outlined¹³. A thoracoabdominal injury was defined as an injury to both the thoracic and abdominal cavities, with or without a concomitant diaphragmatic injury, confirmed either clinically, radiologically or at operation. Indications for emergency laparotomy after penetrating thoracoabdominal trauma were: presence of an acute abdomen, complete spinal cord injury with a penetrating abdominal wound, an unconscious patient with a penetrating thoracoabdominal wound, bowel evisceration, and rectal blood loss. Pneumoperitoneum without abdominal signs was not considered an indication for exploration in a conscious patient in the absence of abdominal signs. Exclusion criteria were: suspicion of cardiac injury but no need for exploratory laparotomy, obvious cardiac injuries presenting with hypovolaemic shock and cardiac tamponade, emergency department thoracotomies, and any indication for urgent thoracotomy. Indications for urgent thoracotomy were: drainage of more than 1.5 litres of blood from an intercostal drain or ongoing bleeding

of more than 200 ml/h. A SPW was undertaken when there was concern about the possibility of a cardiac injury, based on the presence of a pericardial effusion on ultrasound examination, a bullet tract in close proximity to the heart, or clinical suspicion because of a raised central venous pressure (CVP) greater than 12cmH₂O, electrocardiographic changes, an enlarged heart on chest X-ray or unexplained haemodynamic instability. The SPW was performed via a 6-cm vertical midline incision over the xiphoid process. A Langenbeck retractor was placed under the sternum and elevated. A sponge on a stick was found to be particularly useful for wiping away the fat pad from the inferior portion of the pericardium. The pericardium was incised under direct vision vertically for approximately 4 cm. If the SPW was negative and the patient stable, this wound was closed before laparotomy to limit possible contamination of the pericardium. A positive SPW was defined as the presence of blood in the pericardial sac in the form of active bleeding, blood clots or blood staining of the pericardial fluid. A falsepositive ultrasound examination was defined as presence of fluid in the pericardial sac without haemopericardium at SPW and in the absence of pre-existing pericardial disease. A median sternotomy was performed if a haemopericardium was found at SPW in the acute setting. Sternotomy was done before laparotomy if there was active bleeding from the pericardial sac. If there was no active bleeding from the pericardium in a haemodynamically unstable patient, laparotomy was undertaken first, before sternotomy. When sternotomy was indicated, full inspection of the heart was carried out, including the posterior surface. The anaesthetist was warned before elevating the heart of the circulatory collapse that accompanies this manoeuvre.

RESULTS

Between October 2001 and February 2009, a total of 348 patients underwent surgery for an obvious or suspected penetrating cardiac injury. Some 157 patients required either an emergency department thoracotomy or emergency surgery. Fifty of the 157 patients had sustained thoracoabdominal trauma with an indication for emergency laparotomy, and underwent a SPW to exclude possible cardiac injury. The indication for the emergency exploratory laparotomy was an acute abdomen in 48 patients, bowel evisceration in one patient, and a penetrating abdominal injury in an unconscious patient. There were 47 men and three women, with a mean age of 25.6 (range 15–44) years. Forty-one patients (82 per cent) sustained GSWs and nine (18 per cent) had stab wounds in the thoracoabdominal region. The median RTS was 7.84 (range 2.93–7.84). The site of the stab wounds was: left thoracoabdominal (3), upper epigastrium (2) and multiple sites (4). The low-velocity GSWs were left thoracoabdominal (17), right thoracoabdominal (5), transmediastinal (5) and at multiple sites (14). Twenty-one patients were shocked on

Table 1 Indications for subxiphoid pericardial window

	No. of patients	SPW positive	SPW negative
Bullet tract in proximity to heart	22	2	20
Ultrasonography showing haemopericardium	6	5	1
Clinical suspicion based on ECG, CVP or chest X-ray	20	7	13
Unexplained haemodynamic instability	2	0	2
Total	50	14	36

SPW, subxiphoid pericardial window; ECG, electrocardiography; CVP, central venous pressure.

presentation, four had distended neck veins, 11 had a CVP greater than 12cmH₂O, five had an enlarged heart on chest X-ray, and non-specific ST-segment electrocardiographic changes were present in 13 patients. Pericardial ultrasonography (focused assessment with sonography for trauma, FAST) was performed in nine patients and in six there appeared to be blood in the pericardial sac. Indications for the SPW are shown in Table 1. The commonest reasons were a bullet tract in proximity to the heart (22 patients), clinical suspicion (20) and a positive ultrasound examination (6). The SPW was positive for blood in the pericardial sac in 14 of the 50 patients (28 per cent). Of these, two had multiple stab wounds, one had been stabbed in the epigastrium, seven patients had multiple GSWs, two had been shot in the left thoracoabdominal area and two had sustained a transmediastinal GSW. Nine patients had the SPW incision extended into a median sternotomy (Fig. 1). In these nine patients there were three tangential injuries to the right and two to the left ventricle (grade 2), three perforating injuries to the right ventricle (grade 4), and one hole in the left ventricle (grade 5). Median sternotomy was not undertaken in five of the 14 patients despite the SPW being positive for blood. Two patients had sustained stab wounds and three had GSWs. Three patients had a positive FAST, and in one computed tomography of the chest documented a pericardial effusion. In the three patients with GSWs the surgeon felt that the positive haemopericardium was due to a cardiac contusion as the tract of the bullet through the diaphragm was well away from the heart. One patient had a stab wound to the epigastrium with an acute abdomen, and FAST showed a 10-mm effusion. At laparotomy there were injuries to the stomach and left diaphragm. The SPW was positive for blood, but on irrigation of the sac there was no active bleeding and no injury to the anterior surface of the heart was visualized through the SPW wound. The other patient had multiple stab wounds with a 15-mm effusion on FAST and an acute abdomen. The laparotomy was negative but the SPW was positive for blood. There was no active bleeding on irrigation and the surgeon decided against a sternotomy. During laparotomy 110 intra-abdominal injuries were diagnosed. The liver was the most frequently injured organ (25 patients), followed

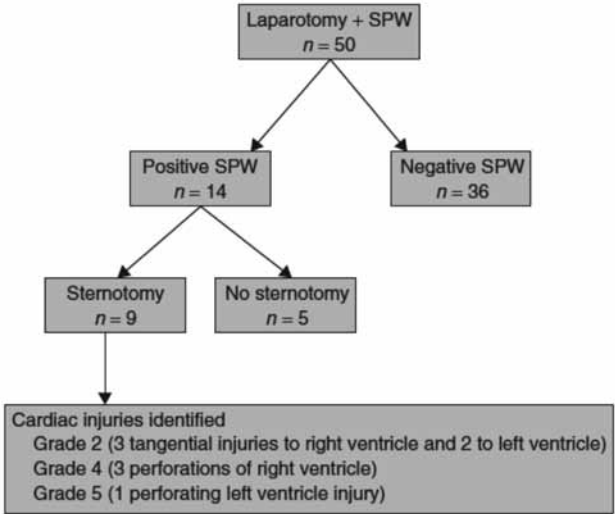


Fig. 1 Surgical management of the 50 patients. SPW, subxiphoid

by the colon (16) and the stomach (15). The mean PATI was 14.7 (range 0–37). Associated thoracic injuries were found in 37 patients (74 per cent), including 13 haemothoraces (26 per cent) and 11 pneumothoraces (22 per cent) (Table 2). The median duration of hospital stay for patients with a positive SPW was 7 (range 4–23) days, and the median length of ICU stay was 1 (0–20) days. The 36 patients who underwent a negative SPW had a median hospital stay of 6 (4–15) days, and the median ICU stay was 0 (0–9) days. One patient (2 per cent) suffered a cardiac-related complication (tension pneumopericardium) after a negative SPW. This necessitated a second SPW to relieve the cardiac tamponade. The patient was discharged after 6 days without the need for surgical intensive care. There were no cardiac complications among the five patients who merely had drainage of the pericardial sac after a positive SPW. Their mean hospital stay was 6 (4–7) days. One of these patients contracted pneumonia that responded to treatment, and another developed an ileus that settled with conservative management. The complication rate associated with the performance of SPW was 2 per cent. The overall mortality rate in this series was 8 per cent (4 patients). All of these patients died as a result of massive blood loss within 24 h after admission following a damage control strategy to deal with the major intra-abdominal injuries. One patient had a hole in the right ventricle, with an extensive parenchymal liver injury (grade 5) as well as stomach, colon and small bowel perforations. The other three had no cardiac injury.

Table 2 Thoracoabdominal injuries

	No. of patients
Chest	
Cardiac	14
Haemothorax	13
Pneumothorax	11
Abdomen	
Solid organ	32
Bowel	29
Diaphragm	19
Vascular	4
Other region	
Maxillofacial	4
Neurological	2

DISCUSSION

Diagnosing a cardiac injury can be difficult, especially in patients with hypovolaemia and associated abdominal injury. Beck's triad, the classical presentation of cardiac tamponade comprising hypotension, raised jugular venous pressure and muffled heart sounds¹⁴, may be present, and ultrasonography of the pericardial sac as part of the FAST is safe, precise and quick. The results of cardiac ultrasound examination depend on the experience of the investigator, machine resolution, and presence of chest wall injuries, surgical emphysema, obesity, pneumothorax and haemothorax¹⁵. Ultrasonography was used to detect pericardial effusion in only nine patients in the present series owing to lack of expertise in the emergency room. Asensio and colleagues¹⁶ published a series of thoracoabdominal trauma and only 16 per cent of their patients underwent ultrasonography before surgery. This low figure may also represent concern over whether a negative ultrasound examination was in fact truly negative, when over two-thirds of patients had associated haemopneumothoraces. According to the medical literature the sensitivity and negative predictive value for SPW is close to 100 per cent. The present study demonstrated a sensitivity of 100 per cent and a negative predictive value of 100 per cent for SPW in excluding cardiac injuries. The complication rate following a SPW has been described as negligible^{6,7,17,18}. In the present series the cardiac-related morbidity rate was 2 per cent with no negative chest explorations. The mortality rate was only 8 per cent despite the fact that 82 per cent of patients had sustained GSWs. Other studies have reported mortality rates as high as 59 per cent where there have been combined procedures, although this also obviously relates to the severity of the injury and the physiological status of the patient. Although it is not possible to draw firm conclusions from the data presented, the low mortality rate of 8 per cent may be related to the screening ability of the SPW to exclude cardiac injury and prevent the chest from being opened unnecessarily. There is concern over the fact that 72 per cent of the SPW procedures

were negative, but at the same time it was essential to exclude cardiac injury. It remains unresolved whether to have a two-team approach, with one managing the chest and the other the abdomen. Furthermore, it is unclear which cavity should be managed in the first instance if there is only one surgeon. Saadia and colleagues¹⁹ have suggested that intra-abdominal haemorrhage should take precedence over cardiac tamponade. Certainly any intra-abdominal bleeding should take precedence but, if this is not encountered, a cardiac reason for the shock should be considered with a proximity wound and a SPW done. The present authors favour the classical (as opposed to the transdiaphragmatic) approach because it may prevent contamination of the pericardial sac from peritoneal soiling. The authors have completed a randomized clinical study to determine whether a sternotomy is required in stable patients presenting with haemopericardium, or whether they can be managed purely with a SPW and washout of the pericardial sac. This study was conducted over the same interval as the present study and included a highly selected group of patients, namely haemodynamically stable individuals who could be observed for 24 h in a high-care unit after which a SPW was done. The results suggest that this specific group of stable patients can be managed successfully without a sternotomy, as documented previously in small pilot study²⁰. Thorson and co-workers¹⁰ from Miami in the USA have also questioned the need for mandatory sternotomy in every stable patient diagnosed with haemopericardium¹⁰. However, the present authors would like to stress, in patients presenting with an acute abdomen and a positive SPW, that sternotomy should be performed unless a very experienced surgeon is confident that the tract is away from the heart.

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