RESEARCH ARTICLE

Videothoracoscopic cardiac exploration: a useful tool for diagnosing and treating thoracic wounds

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Abstract

Objectives: To evaluate the role of videothoracoscopic cardiac exploration (VCE) to diagnose and treat stable patients with a chest wound in 'the cardiac box'.

Methods: All hemodynamically stable patients, with a penetrating chest wound close to the heart, were proposed for videothoracoscopy. Pericardoscopy was carried out by introducing the videoendoscope into the pericardium.

Results: Eight male patients, average age 25 years (range: 22-42 years), were investigated using VCE. All wound-entry points were in the left hemithorax, and the wounds were inflicted by knives (*n*=6), a Tahitian arrow (*n*=1), and an air-compressed nail (*n*=1). Pericardoscopy was carried out in three patients. Recurrence of active bleeding was found in two patients and a healed right-ventricular wound without active bleeding in one patient. Myocardial suture was performed through a sternotomy to repare a left-ventricular wound and through an anterolateral thoracotomy to control the left anterior descending coronary artery at the apex.
Associated procedures were removal of a dagger under direct vision (n=1), removal of an intra-thoracic foreign body (*n*=1), Endo-GIA stapling of lung wounds (*n*=4), direct suturing of diaphragmatic wounds (*n*=1), and hemostasis of the intercostal artery (*n*=2). No deaths and no significant complications occurred in the immediate postoperative period or after follow-up at 3 months.

Conclusions: Videothoracoscopic cardiac exploration may be a reliable method for diagnosing and treating thoracic wounds.

Keywords: thoracoscopic cardiac exploration, thoracic wound, video,

Introduction

Cardiac wounds have a poor prognosis, less than 20% of patients are still alive at arrival at the hospital [1,2]. Among the survivors, 30% may have no signs of cardiac lesions [2-4]. Faced with a missed diagnosis, tamponade can occur suddenly or up to 4 weeks after injury, with two primary causes: delayed hemorrhage or delayed pericarditis with effusion [5-8]. Precise diagnosis must be achieved without delay: a transthoracic echocardiograph (TTE) or a subxyphoid pericardial window are accepted as first-line approaches. Even though the ultrasound is a good screening test, it can give false negatives, especially in the presence of a hemopneumothorax [9]. Thoracoscopy, with or without video control, may represent a reliable option in hemodynamically stable patients with penetrating injuries in proximity to the heart [3,10]. The purpose of this study was to evaluate the role of videothoracoscopic cardiac exploration (VCE) to diagnose and treat stable patients with a chest wound in 'the cardiac box'.

Materials and methods

During a 3-year –period, all hemodynamically stable patients, with a penetrating chest wound close to the heart, were proposed for videothoracoscopy, and pericardoscopy was performed when required. To be included in this study, the entry point was defined as a penetrating stab injury located in an area limited to being superior to the clavicles, inferior to the costal margin, and lateral to the midclavicular lines. Blunt thoracic trauma and gunshot were excluded.

All patients had a preoperative chest radiograph, and echocardiography was performed each time where possible when it did not delay surgery. Tomodensitometry was done when there was suspicion of thoraco-abdominal involvement.

All patients with hemothorax or pneumothorax had a chest tube inserted before leaving the emergency room.

Under general anaesthesia and selective tracheal intubation, installation was done in supine position with the chest rotated 30° with the help of a cushion under the hemithorax. The sternum was left in the operative field so that a median sternotomy could be performed**.** A 0° or 30° videoendoscope was introduced into the 4th or 5th intercostal space in the anterior axillary line. According to the location of the injury, the procedure was performed through three ports (five patients) and two ports (three patients).

The pericardium was opened and the cavity washed when the tract of the injury was unclear and there was intra-pericardial involvement.

Pericardoscopy was carried out by introducing the videoendoscope into the pericardium. This searched for a myocardial injury when the pericardial window revealed any doubt regarding myocardial involvement or hematic effusion with no active bleeding.

A median sternotomy conversion was performed whenever an active bleed was revealed.

During the procedure, the entire hemithorax was explored so that reparation of a lung or a diaphragmatic lesion, aspiration of a clotted hemothorax, hemostasis of a parietal vessel, or removal of foreign body could be performed, if required.

All patients had echocardiography before discharge. The clinical and imaging data were prospectively recorded and each patient had a follow-up visit at 3 months in a surgical clinic.

Results

Preoperative data

Eight male patients, average age 25 years (range: 22-42 years), were investigated using VCE. At admission, all patients were clinically stable (systolic blood pressure >90 mmHg), had no significant administration of intravascular solution (<500 ml), no oro--tracheal intubation, and no objective signs of a heart wound.

All wound-entry points were in the left hemithorax, and the wounds were inflicted by

knives (*n*=6), a Tahitian arrow (*n*=1), and an air-compressed nail (*n*=1).

Six patients had a preoperative echocardiograph that found one pericardial effusion, one doubtful pneumopericardium, and four normal examinations. Chest radiographs from the seven patients showed mild to moderate hemothorax, two patients had associated pneumothorax, and one patient had an intrathoracic foreign body (the air-compressed nail). Thoracoabdominal CT was performed two times and revealed no obvious signs of intra-abdominal involvement.

Operative and postoperative data

Seven patients were operated on within 24 hours of trauma, and one patient on the 5th day after trauma, but within 24 hours of admittance.

All procedures were carried out on the left-hand-side. The pericardium was opened in four patients; in the other four patients, a pericardial window was not performed because there was no doubt about the pericardial entry point in these patients.

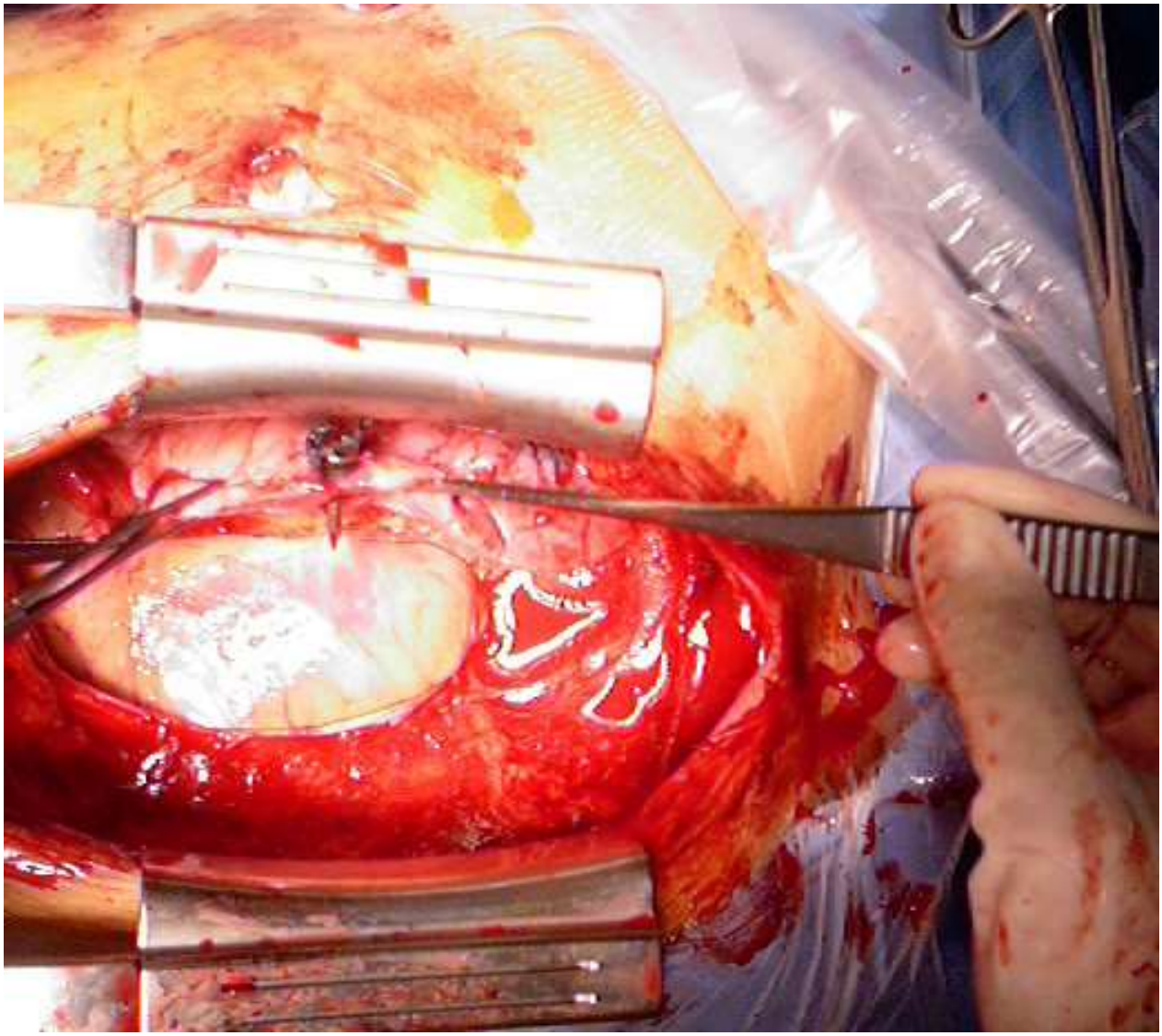
Pericardoscopy was carried out in three of the eight patients by introducing the videoendoscope into the pericardium to search for myocardial injury. Recurrence of active bleeding was found in two patients (one with a stab wound and the other with an air-compressed nail) (Figure 1a-c). Pericardial effusion was very mild in these patients, and echocardiography failed to diagnose these two myocardial injuries (one doubtful pneumopericardium and one normal examination). In these cases, we found recurrence of active bleeding after opening the pericardium, washing the cavity, and exploring with a pad. These two patients received a myocardial suture through a sternotomy to repare a left-ventricular wound and through an anterolateral thoracotomy to suture the left anterior descending coronary artery at the apex. The third patient had a pericardial effusion diagnosed by echocardiography: he was suffering from drug abuse with delirium, and had shot himself with a Tahitian arrow causing a punctiform precordial wound. A pleuropericardial window removed 200 ml of hematic effusion, and pericardoscopic exploration found a healed right-ventricular wound without active bleeding: no other surgical procedure was performed.

One patient had VCE for an impaled weapon, and this allowed us to rule out myocardial injury and to remove a dagger under direct vision.

Associated procedures were removal of an intra-thoracic foreign body (*n*=1), Endo-GIA stapling of lung wounds (*n*=4), direct suturing of diaphragmatic wounds (using a thoracoscope) (*n*=1), a limited thoracotomy (*n*=1), and hemostasis of the intercostal artery (*n*=2). All patients had the left hemothorax aspirated, plus drainage at the end of the procedure.

The average operative time was 35 ± 19 minutes (range: 15--75 minutes), and the length of hospitalization was 10 days for patients with a heart wound and 5 days for the others. No deaths and no significant complications occurred in the immediate postoperative period, or after follow-up at 3 months.

Figure 1a-c. Precordial wound with an air-compressed nail. ETT identification was doubtful with a pneumopericardium. VCE found the nail impaled in the lung and an unclear tract of injury. Pericardoscopy found very mild effusion that was potentially caused by the procedure herself, but washing and exploring with a pad revealed an active bleed from the left ventricle, which led to conducting a sternotomy.



Discussion

Thoracoscopy is being increasingly utilized in stable patients to manage penetrative chest injuries. In our series, three of the eight patients (37.5%) had a myocardial injury without any objective clinical signs at admission. Detecting these patients can be challenging, despite the use of ultrasound. Videothoracoscopy allowed precise diagnosis and treatment of myocardial injuries in two of the patients. This technique has many advantages: it is more precise than ultrasound, especially in the presence of a left hemopeumothorax [9], it can avoid a sternotomy (and risks linked with an impaled weapon, and delayed effusion of a healed wound), it prevents clotted hemothorax by allowing the cavity to be washed and allows treatment of associated injuries (lung and diaphragmatic wounds) [10].

All stable patients who suffer a penetration injury near to the heart should be considered at risk for brutal or delayed hemodynamic decompensation; delaying diagnosis and surgery can be fatal [4-7]. Full assessment cannot be based on the patient's clinical status on admission. Diagnosis by imaging or by a surgical procedure is mandatory to know whether there is a cardiac wound or not. Morales [3] described 108 patients with penetration wounds close to the heart, and yet

had no obvious signs of cardiac injury. These patients underwent examination through a thoracoscopic pericardial window. The procedure was precise, rapid, and safe, and identified hemopericardium in 33 patients (30.6%), without causing any deaths or complications due to the procedure.

A pericardial window performed using a subxiphoid approach was the gold standard in the management of thoracic wounds within the 'cardiac box', and its use has been a major factor in reducing the mortality rate from penetrating heart wounds [11-14]. The procedure is fast, can be performed under local anesthesia, and its precision, sensitivity, and specificity are nearly 100% [11-15]. However, it does not allow exploration of the thoracic cavity, visualisation of the injury tract, or of any intrapericardial damage. The presence of a mild hematic pericardial suffusion potentially caused by the window procedure itself may sometimes lead to a false-positive interpretation, thus we recommend washing and visual inspection of the cavity.

Some authors advocate the use of pericardoscopy to improve exploration [16,17]. Stephens and Fichtner described a subxiphoidal approach using a mediastinoscope. They found that a hemopericardium was present in three patients and could be treated without the need for a sternotomy. Exploration and washing permitted these doctors to rule out significant active bleeding by actually seeing the injury [17].

As described, in our limited experience, pericardoscopy was useful in three of the eight patients, and included the identification of unusual trauma in two of the patients (a Tahitian arrow and a air-compressed nail). It allowed exploration with a pad, the pericardium to be washed to detect any recurrence of active bleeding (n=2), and could confirm the absence of any active bleeding due to direct visualisation of the myocardial wound (n=1).

In contrast to chest radiographs, echocardiography is considered of primary importance in imaging because of its ease of use and its excellent accuracy in the diagnosis of cardiac wounds. Chest CT can be of value to diagnose a hemopericardium, to evaluate the tract of the injury, to localise foreign bodies, and to evaluate associated injuries. However, it can be time consuming and thus may risk sudden hemodynamic deterioration in a non-appropriate setting [18]. Nowadays, in cardiac pathology, echocardiography is of interest whatever the etiology but, in "a real-life" trauma setting, its effectiveness can be questionable because it's frequent non-optimality. Many confounding factors can be present, such as the experience of the operator, the delay in obtaining an ultrasound examination, agitation of the patient, presence of sub-cutaneous emphysema, pneumothorax, hemothorax, or chest tubes. As described by Meyer et al. [9], the results of an ultrasound vary depending on the presence of a hemothorax, which can reduce its sensitivity to 20%. False positives are also possible in the context of trauma, giving a specificity of 50 to 100% [9,15]. If there is the slightest risk that a lethal event can occur up to 4 weeks after injury, detection of a myocardial injury using a non optimal ultrasound is not acceptable; instead, surgical exploration is indicated. In the presence of a surgeon who is trained and experienced in thoracoscopic procedures related to trauma and cardiac surgery, the videothoracoscopic procedure is an effective alternative to performing a pericardial window and may be the procedure of choice to reveal occult cardiac injury, especially if it is unusual, as described herein. From a technical viewpoint, we recommend washing and visualising the pericardial cavity because, as previously described, the absence of a significant pericardial hematic effusion does not rule out a secondary haemorrhage [7].

Another issue concerning thoracic wounds is that the patient presents with an impalement injury. We have described a patient who presented with a knife impaled in his chest. The knife could be removed under thoracoscopic guidance, thus avoiding a thoracotomy and rib retraction, which may have disturbed the impaled knife. Usually, the standard approach to manage a patient in

whom the foreign object remains in situ is to only remove it under circumstances where any injury can be controlled. On removal, direct vision of the tract is advisable to evaluate any vascular injury. In this setting, thoracoscopic retrieval of foreign bodies after a penetrating chest trauma has proved to be valuable and averts the need for a thoracotomy [19-21].

The use of videothoracoscopy can be controversial in patients with suspected penetrating cardiac injury [22], and pericardoscopy is not recommended for some [10]; however, in our experience, it can improve the clinical status of some patients. Actually, because TTE can be realised on admission, we recommend its usage in our centre as first process in the examination after evacuation of a hemothorax, if present. VCE is performed, rather than a subxiphoid pericardial window or a sterno/or thoracotomy, in instances such as when there is a doubtful echocardiography, suspicion of an associated injury that needs to be treated, an impalement injury, or an unusual mechanism of injury. Pericardoscopic exploration with a pad and washing is performed each time the tract of the injury is unclear or may have intra-pericardial involvement, including the absence of significant effusion. Conversion to a sternotomy is performed each time an active bleed is found with VCE.

Conclusion

We recommend an active search for cardiac wounds in stable patients and for victims of chest wounds that occur near the heart, even several days after the trauma. Videothoracoscopic cardiac exploration may be a reliable method to diagnose and treat these patients, and eliminates the need for a useless sterno/thoracotomy. At our institution, the use of VCE is systematic when a pericardial ultrasound examination is doubtful in a patient with stab trauma near the heat. However, a larger study is warranted before this procedure can be recommended as the standard diagnostic approach for stable patients with cardiac injuries.

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