Prospective Validation of Protocol for Occult Penetrating Cardiac Injury

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ABSTRACT

Objective. Preliminary studies done at the Philippine General Hospital have documented the reliability of pericardial ultrasound in the diagnosis of occult penetrating cardiac injury. This study sought to validate a protocol formulated from these studies in a larger trauma patient population at a high-volume center.

Methods. Over a 2-year period, all hemodynamically stable patients with penetrating injury to the precordial area were managed according to the occult penetrating cardiac injury protocol. Patients with a negative result on pericardial ultrasound were admitted for 24-hour observation. Those with minimal fluid or equivocal findings underwent a subxiphoid pericardiotomy. Patients with moderate to large amounts of fluid on ultrasound, as well as those with positive results on subxiphoid pericardiotomy, underwent definitive surgery. Demographic data, wounding patterns, and clinical course were studied.

Results. Three hundred forty patients were analyzed. Majority (91%) had *negative* ultrasound results, and were either discharged after 24-hour observation, or were treated for other associated injuries. None developed signs or symptoms of cardiac tamponade on follow-up. Twenty-six patients (8%) had either *minimal* fluid or equivocal findings. These underwent subxiphoid pericardiotomy, of which 10 had positive cardiac injury while nine had serous fluid. Three had *moderate* amount of fluid on ultrasound and underwent immediate thoracotomy; all had significant cardiac injury. There were no late complications noted.

Conclusion. Our data provides further validation that subxiphoid pericardial ultrasound is effective as an initial tool in ruling out cardiac injury. Because of a significant number of false positives in Filipino patients, those with minimal fluid should undergo subxiphoid pericardiotomy. The finding of moderate fluid is an indication for definitive surgery.

Key Words: penetrating cardiac injury, pericardial ultrasound, subxiphoid pericardiostomy

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Introduction

Prompt detection and management of cardiac injury in patients with penetrating precordial wounds are critical for optimal outcome. However, diagnosis by history and physical examination alone has been shown to be grossly unreliable and may delay definitive surgical management.[1,2,3,4,5] The subxiphoid pericardial window is considered the gold standard for diagnosing occult cardiac injury but is invasive and entails general anesthesia.[6,7] Transthoracic echocardiography and more recently, pericardial ultrasonography, have been shown to be accurate and effective in demonstrating the presence of acute hemopericardium.[2,4,5,8,9,10] Use of these noninvasive procedures in hemodynamically stable patients is now advocated due to their accessibility, rapidity, repeatability, and cost-effectiveness.

Recognizing these developments, the Divisions of Thoracic and Cardiovascular Surgery and the Division of Trauma at the University of the Philippines–Philippine General Hospital embarked on a prospective cross-sectional study to determine if pericardial ultrasonography is predictive of significant cardiac injury in hemodynamically stable patients with penetrating wounds to the precordium. The preliminary results revealed that a negative ultrasound reading, in the absence of hemothorax, is highly specific in ruling out cardiac injury.[10]

From these studies, a treatment protocol for occult penetrating cardiac injury was formulated, and data were collected prospectively. The aim of this study is to assess the validity of this protocol in larger set of patients at a busy trauma center.

Methods

Over a two-year period, all hemodynamically stable patients with penetrating wounds to the precordial area were managed according to the occult penetrating cardiac trauma protocol. The precordial area or the "cardiac box" was defined by the clavicles superiorly, the midclavicular lines laterally and the costal margins inferiorly (Figure 1). Briefly, the protocol stipulates that in hemodynamically stable patients (i.e., systolic blood pressure ≥90 mmHg without inotropic support, heart rate < 120 beats/minute, and RR ≤20 breaths/min) with penetrating wounds to the cardiac box and without any outright indication(s) for surgery, an immediate pericardial ultrasound is performed with the

patient in a supine position by a trained radiology resident or the senior surgery resident using an Acuson 128XP or Diasonic 2D Gateway FX with 3.5MHz probe to view the pericardial space through the subxiphoid area. Patients with negative ultrasound results are admitted for 24-hour observation, and/or management of other associated injuries. If the ultrasound reveals minimal fluid, a subxiphoid pericardiotomy is performed under general anesthesia followed by definitive surgery if positive (i.e., blood is confirmed present in the fluid). Immediate surgery (thoracotomy/median sternotomy) is mandated for moderate to large amounts of fluid.

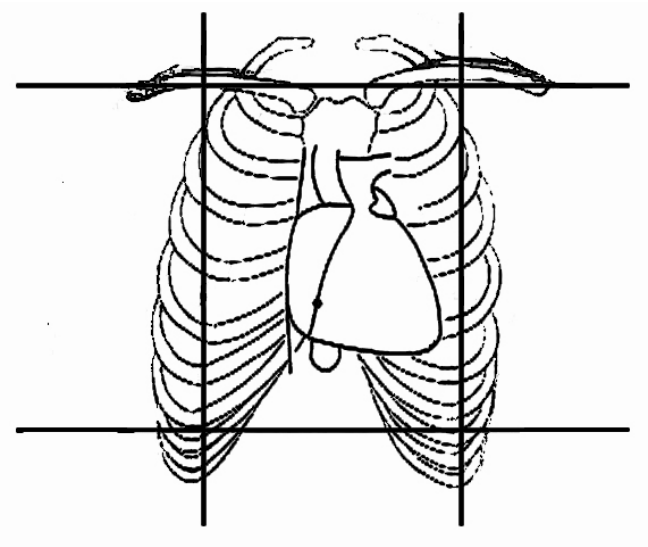

Figure 1. Graphic illustration of the borders of the precordium, or the "cardiac box"

Results

Three hundred fifty-six patients with penetrating injuries to the precordial area were managed following protocol. Majority of the patients were male (91.5%), with ages ranging from 16 to 60 years old (mean of 38). Almost all of the injuries were due to stab wounds (98%). Sixteen patients refused further management and were discharged against medical advice. The remaining 340 patients constitute the study population.

Figure 2 summarizes the pericardial ultrasound findings. Among those with minimal fluid on ultrasound, half had false positive results (serous fluid noted on subxiphoid pericardiotomy). Thirteen patients underwent definite surgery, either because of moderate fluid noted on ultrasound, or positive blood on subxiphoid window. Eight of these patients were approached via an anterolateral thoracotomy while five had median sternotomy, followed by suture repair of the cardiac injury.

None of the patients with negative ultrasound results became hemodynamically unstable during the 24-hour observation period, and none developed complications during follow up. There were no operative morbidities or mortalities. All patients with significant cardiac injury underwent transthoracic two-dimensional echocardiography prior to discharge, and none had any structural abnormalities.

All patients who underwent surgery were followed up at the outpatient clinic a week after discharge. No complications were noted.

Discussion

Prompt recognition and immediate intervention for occult cardiac injury has been shown to significantly decrease mortality and morbidity.[1,2,3,4,5,6,11,12] While the subxiphoid pericardial window remains the gold standard for diagnosing cardiac injury, noninvasive diagnostic modalities are now being advocated for hemodynamically stable patients to decrease the incidence of negative explorations, shorten hospital stay, and lessen costs without sacrificing accuracy and expediency. The effectiveness and advantages of pericardial ultrasound in the diagnosis and management of occult penetrating cardiac injury have been well documented and supported in the literature.[4,5,8,9,10]

As the largest and busiest trauma center in the country, the need to develop a protocol for the management of cardiac injuries was recognized in order to facilitate and standardize the delivery of quality, efficient and cost-effective care. The present protocol is the result of a clinical trial conducted in our institution and incorporates the different principles in diagnosis and management of penetrating cardiac injuries as studied and practiced in high-volume trauma centers abroad. Validation of this protocol arose from the need to evaluate its application in a larger set of patients and to formulate modifications based on this experience.

Our findings underscore the high specificity and negative predictive value of pericardial ultrasound in the detection of hemopericardium. This data supports previous conclusions that a negative reading on ultrasound is highly accurate in ruling out the presence of cardiac injury.[4,5,10,12] The variable results observed in patients with minimal fluid probably reflect the nature of the subject population. Fifty percent (50%) of patients with minimal fluid turned out to have serous effusions on subxiphoid pericardiotomy. Although the fluid was not tested specifically for acid-fast bacilli, it is the opinion of the authors that this may be secondary to an inflammatory process, especially tuberculosis (which is endemic in the Philippines). The presence of equivocal ultrasound findings may be due to several factors, including ultrasonographer training and patient factors such as a narrow subxiphoid space or the presence of an associated hemothorax or subcutaneous emphysema.

The findings on subxiphoid pericardiotomy determined the course of management in patients with minimal fluid

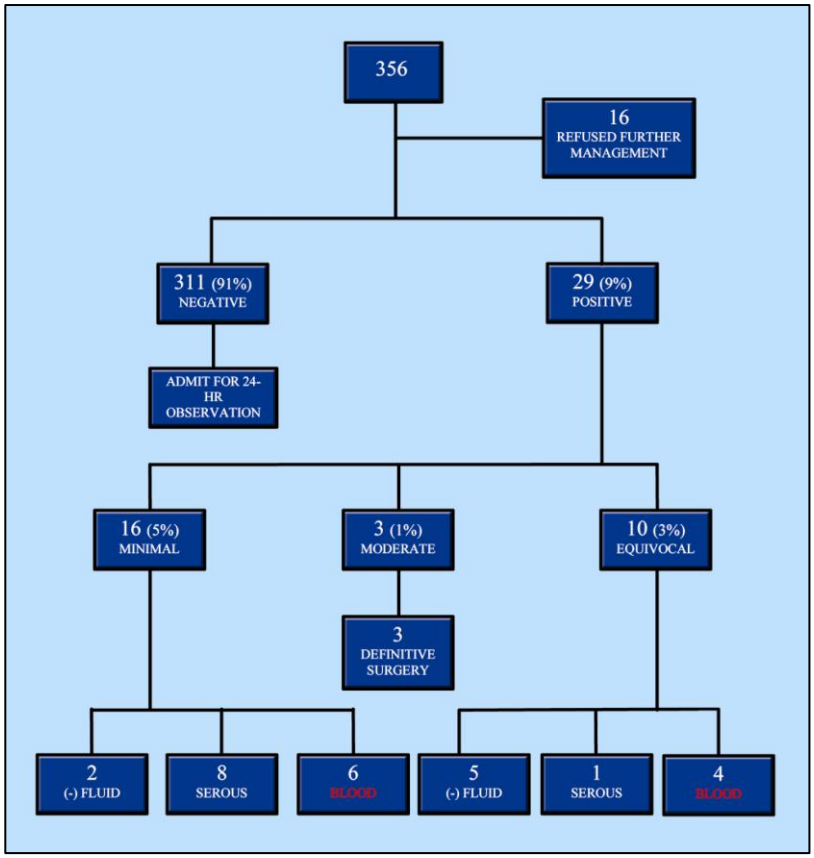

Figure 2. Summary of pericardial ultrasound results and clinical course

and also in patients with equivocal findings. The procedure thus remains an indispensable diagnostic tool. The only indication for outright surgery based on ultrasound findings was a moderate to large amount of fluid; the small number of patients with moderate fluid noted in this study suggests that most patients with significant pericardial fluid fall into the subset of patients who present with cardiac tamponade or who are already hemodynamically unstable.

Conclusion

The current study validates in a large sample of trauma patients that pericardial ultrasound, as an initial diagnostic tool in hemodynamically stable patients with penetrating wounds to the precordium, is effective in ruling out cardiac injury. However, because of a significant number of false positives in Filipino patients, those with minimal fluid should undergo subxiphoid pericardiotomy. We recommend continued implementation of the protocol in our institution. We also recommend that this protocol be initiated in other centers to incorporate a broader diversity of patients.

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