

The Impact of Trans-thoracic Ultrasound on Cardiac Injuries

JM Plummer, M Condell, D Ferron-Boothe, P Johnson, PA Leake, AH McDonald

ABSTRACT

Objective: To determine the impact of trans-thoracic ultrasound (TTUS) in patients with chest trauma and potential cardiac injuries and to determine the outcome of patients with cardiac injury detected on TTUS.

Method: Data were obtained from the Trauma Registry for all patients presenting alive to the University Hospital of the West Indies during the 10-year period commencing January 1, 2001 and who were subjected to a TTUS or emergency thoracotomy for cardiac injuries, or had cardiac injuries at postmortem. In addition to demographics, variables analysed included mechanism and site of injury and outcome.

Results: Of 405 patients being subjected to a TTUS during the period, 12 (3%) had cardiac injuries. During the same period, 63 patients in the Trauma Registry had proven cardiac injuries. Trans-thoracic ultrasound was thus conducted on 19% of all patients with cardiac injuries. Three patients had positive TTUS but no cardiac injuries. Of the patients with injuries, the mean age was 30.4 years, 92.1% were male and 65% were as a result of stab wounds, while 22% were as a result of gunshot wounds. The right ventricle was the most common site of injury, accounting for 41% of cases, while the left ventricle, both ventricles and other sites accounted for 27%, 17% and 14%, respectively. Ninety per cent of the group was subjected to emergency thoracotomy; mortality of the entire group was 48%, including one patient who had TTUS.

Conclusions: This review demonstrates that cardiac injuries remain lethal, diagnosis is largely clinical and TTUS may be over-utilized, having little impact on clinical outcome of patients presenting with this injury.

Keywords: Cardiac injury, outcome, ultrasound

Impacto del Ultrasonido Transtorácico en las Lesiones Cardíacas

JM Plummer, M Condell, D Ferron-Boothe, P Johnson, PA Leake, AH McDonald

RESUMEN

Objetivo: Determinar el impacto del ultrasonido transtorácico (USTT) en pacientes con traumatismo torácico y lesiones cardíacas potenciales, y determinar la evolución clínica de los pacientes con lesión cardíaca detectada mediante USTT.

Método: Se obtuvieron datos del Registro de Traumatismos para todos los pacientes que se presentaron con vida al Hospital Universitario de West Indies durante un período de 10 años, comenzando el 1ero de enero de 2001, y que fueron sometidos a un USTT o una toracotomía de urgencia por lesiones cardíacas, o que tuvieron lesiones cardíacas post mortem. Además de los datos demográficos, las variables analizadas incluyeron el mecanismo y lugar de la lesión, y el resultado.

Resultados: De 405 pacientes sometidos a un USTT durante el período, 12 (3%) tenían lesiones cardíacas. Durante el mismo período, 63 pacientes en el Registro de Traumatismos tenían lesiones cardíacas comprobadas. Así, se realizó una ecografía transtorácica al 19% de todos los pacientes con lesiones cardíacas. Tres pacientes tuvieron USTT positivo, pero no presentaron lesiones cardíacas. Entre los pacientes con lesiones, la edad promedio fue 30.4 años, 92.1% eran varones, y el traumatismo en el 65% fue consecuencia de heridas de arma blanca, mientras que en el 22% se produjo como

consecuencia de heridas de bala. El ventrículo derecho fue el lugar más común de la lesión, correspondiendo al 41% de los casos, mientras que el ventrículo izquierdo, ambos ventrículos y otros lugares representaron el 27%, 17% y 14%, respectivamente. El noventa por ciento del grupo fue sometido a toracotomía de urgencia; la mortalidad del grupo en conjunto fue de 48%, incluyendo a un paciente que tuvo USTT.

Conclusiones: *Esta revisión demuestra que las lesiones cardíacas siguen siendo letales, que el diagnóstico es principalmente clínico, y que el USTT puede ser sobreutilizado, por lo cual tiene poco impacto en los resultados clínicos de los pacientes que presentan esta lesión.*

Palabras claves: Lesión cardíaca, resultado clínico, ultrasonido

West Indian Med J 2014; 63 (3): 259

INTRODUCTION

Trauma is an important cause of morbidity and mortality in both the developed and developing countries and a leading cause of preventable deaths in the young. Thoracic trauma in particular is an important subgroup, with approximately 10% of all trauma admissions to the University Hospital of the West Indies (UHWI) requiring a tube thoracostomy (1). It is agreed that the haemodynamically unstable patient should undergo prompt surgical exploration whilst continuing resuscitation. It has also been suggested that in the Caribbean and other resource restricted setting, even in the haemodynamically stable patient, if there is doubt, given limitations in the ready availability of imaging, exploration may be recommended (2). Emergency room thoracotomy is rare in this setting but when used, is associated with significant mortality and the few survivors will have 100% morbidity (3).

Penetrating cardiac injury accounts for the minority of patients with penetrating thoracic injuries but it remains highly lethal with little improvement in survival over several decades (4). The most recent publication on penetrating cardiac injury from the region was over two decades ago and the mortality then was 12% (5). A significant factor contributing to the high mortality is the time from injury to intervention at an appropriate surgical facility. The prompt recognition and essential role of emergency surgical intervention cannot be overstated. Increasingly, however, the role of various investigative tools is being defined in the management of patients with thoracic trauma and suspected cardiac injury. Ultrasound, whether transoesophageal, trans-thoracic or Focused Assessment for the Sonographic examination of the Trauma patient (FAST), is used to determine the presence of pericardial blood, and this is an important tool in the management of these patients (4, 6–8).

Cardiac injury with the potential for tamponade should be considered in all patients with a history of precordial injury. Less than a quarter of patients with a penetrating cardiac injury reach the hospital alive, but of those who do and are operated on, up to 90% will survive (9). Historically, the subxiphoid window was the gold standard to evaluate for haemopericardium, however, echocardiography has now become the modality of choice (4). Compared to subxiphoid

window, echocardiography has a sensitivity of 90% and specificity of 97% (10). Subxiphoid window is still advocated for stable patients where emergency echocardiography is not available, as is often the case in the Jamaican setting (11) or the echocardiography is positive but the patient is haemodynamically normal (8). Where available, a surgeon-performed FAST has also been shown to be an acceptable investigative tool, obviating the need for a pericardial window in the haemodynamically abnormal patient (12).

At the UHWI, haemodynamically normal patients with precordial injuries are usually evaluated by a trans-thoracic cardiac ultrasound (TTUS) performed by a radiologist. The presence of a pericardial effusion usually mandates surgical exploration. Normal examinations are taken at face value and cardiac injuries are usually considered ruled out. Cardiologist-performed trans-thoracic or trans-oesophageal echocardiography is not available on an emergency basis. The sensitivity of the TTUS done in this setting is not known, neither is the number of patients benefiting from this investigation compared to those who progress to exploration based on clinical means. The objectives of this report were to review the outcome of cardiac injuries and to determine the impact of TTUS on the management of these patients.

SUBJECTS AND METHODS

Data were obtained from the Trauma Registry at the Department of Surgery, Radiology, Anaesthesia and Intensive Care for all patients presenting to the UHWI with thoracic trauma during the period January 1, 2001 to December 31, 2010 and were subjected to TTUS. Data were extracted from the Trauma Registry using the search International Classification of Diseases 10th revision (ICD-10) code terms for: trans-thoracic ultrasound, emergency thoracotomy and cardiac injury. Patients needing emergency thoracotomy for cardiac tamponade based on clinical diagnosis, or trauma patients arriving alive but who died prior to surgery with cardiac injury confirmed at postmortem were also included. The course and outcome of the TTUS group were compared to trauma patients who underwent exploration based solely on clinical means. Exclusion criteria included:

- i) Patients presenting to the Accident and Emergency Department with no signs of life and resuscitation

was not attempted, even if their postmortem revealed a cardiac injury.

- ii) Patients with a FAST unless it was positive for pericardial blood and the patient went on to thoracotomy.
- iii) Patients who underwent exploratory thoracotomy for injuries other than cardiac in nature.

Variables evaluated included patient demographics, mechanisms of injury, clinical state on presentation, radiologic investigations, intervention and outcome.

Using the definitions outlined by Rozycki *et al* (12), the results of TTUS were categorized as true positive, true negative, false positive and false negative.

RESULTS

There were 456 patients included in this study. This comprised 405 trauma patients who had a TTUS performed during the period under review. During this same period, 69 patients were coded in the Trauma Registry with a diagnosis of cardiac injuries, but of this group, 51 were not subjected to TTUS. Six patients were excluded from further analyses because their diagnosis was not supported by radiological evaluation or operative finding. Among this group were three patients with a positive TTUS, but cardiologist-performed echocardiography in two cases and video-assisted thoracoscopic surgery in the other proved negative (false positive). The basis of this report of cardiac injuries was the remaining 63 patients. Cardiac injuries were confirmed in 3% of the patients having TTUS (12/405); TTUS was not conducted on 81% of patients with cardiac injuries. No patient with a negative TTUS needed surgical intervention because of clinical deterioration or had a positive additional investigation for cardiac injury. The sensitivity of TTUS during the period under investigation was 100%, with a specificity of 99%.

The mean age of patients with cardiac injuries was 30.4 years. These patients were predominantly males (92.1%), and 65% were as a result of stab wounds, while 22% were as a result of gunshot; blunt trauma accounted for the rest. The most common site of injury was the right ventricle accounting for 41%, then the left ventricle (27%), both ventricles (17%) and other cardiac sites such as the atria or pulmonary outflow tract (14%).

Of the group, six patients (10%) died in the emergency room prior to any surgical intervention other than a tube thoracostomy, at a minimum time of 15 minutes after presentation. However, 90% were subjected to thoracotomy, even though in five patients this was emergency room (ER) thoracotomy, four of whom died in the ER. Overall, 48% of patients died within 30 days of presentation. This included 39% (16/41) with stab wounds, 71% (10/14) from gunshot wounds and 50% (4/8) with blunt trauma. One patient who died was subjected to a TTUS, and this was positive. Thirteen patients (plus the five subjected to ER thoracotomy) had cardiac arrest before their formal thoracotomy in the

operating room, and 12 had other extra-cardiac injuries that could have also contributed to death.

The mean length of hospital stay was 10 days, with the median being four days, and a range of 0–194 days. Statistically, there was a difference in the age of persons who had TTUS when compared to those who did not, with persons who had the procedure being mean 10 years younger than those who did not ($p < 0.05$). There was also an association between discharge dispositions among patients who had TTUS; those who did were more likely to be discharged home when compared to those who did not have the procedure ($p < 0.01$). The number of deaths per year was relatively constant despite the increasing use of TTUS (Figure).

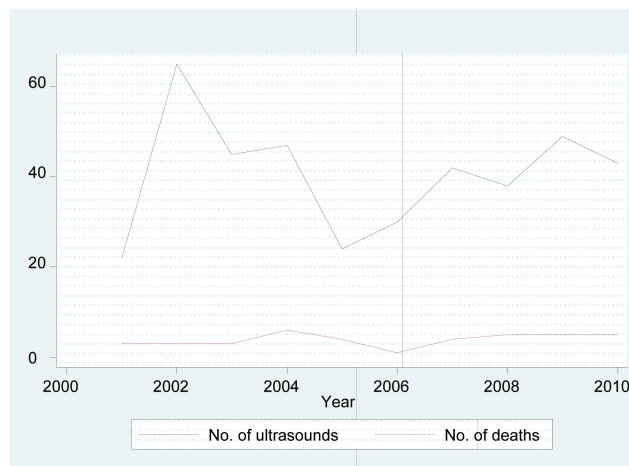


Figure: The relationship between cardiac ultrasounds and number of deaths over the period of review.

DISCUSSION

Identifying and surgically intervening on patients with cardiac injuries in a timely manner is critical for optimal outcome. Blunt or penetrating cardiac injury continues to have a high mortality and, not surprisingly, it remains a disease of the young male. The majority of patients presenting to the ER alive will have overt features of shock or cardiac injury necessitating urgent surgical intervention, without the need for further investigations. This was demonstrated in this report where approximately 80% of patients with injuries had a clinical diagnosis of cardiac injury and surgical intervention. However, there is a distinct role for radiological evaluation in the haemodynamically normal patient with blunt or penetrating precordial injury. Echocardiography has been shown to be a quick and sensitive investigation in this regard. This is achieved in our setting in the form of a TTUS. Based on results in the present study, TTUS has been shown to be sensitive – no patient screened as negative for a cardiac injury on TTUS was diagnosed with same. It also has an acceptable low false positive rate. Still, that only 3% of patients subjected to TTUS had the diagnosis of cardiac injury suggests that further refining the indications for this test may be necessary, so as to maximize our resources. This might be difficult to

achieve as these stable patients probably will not have any other clinical indicator of cardiac injury apart from mechanism/location of injury. In this sense, TTUS serves as an acceptable screening tool. Our finding that patients with cardiac injury and subjected to TTUS were less likely to die is more likely a selection bias as the haemodynamically normal patients, perhaps with less lethal injuries, are likely to fall into this group. Yet, if the use of TTUS led to the saving of one additional life, it would be significant and, given the average age of these patients, it translates to a greater number of 'patient-years' saved.

The death rate was high in our series. The 39% mortality rate seen in patients with stab wounds is surprising especially when compared to a 12% mortality seen in a prior similar publication (5). While this poor outcome is likely related to the severity of the injuries, the time to definitive intervention is also a likely important contributing factor. The aim should be formal urgent thoracotomy as ER thoracotomy continues to have limited success. High clinical suspicion and surgical intervention cannot be over-emphasized.

During the period under study, there was an overall increase in the number of TTUS performed, increasing from 20 patients in 2001 to 40 in 2010. The death rate remained relatively constant per year. For the group of patients with cardiac injuries, it could be argued that the real benefit was minimal, as while there was an increasing trend in the use of TTUS, the majority of patients with cardiac injury did not have this investigation and the death rate was unaffected. This review demonstrated that significant cardiac injuries have a low prevalence in the chest injury population, but when present is lethal. Diagnosis is largely clinical and

TTUS, although a good screening test for the haemodynamically normal patient, has limited impact on reducing mortality of patients presenting with this injury.

REFERENCES

1. Plummer JM, Brown H, Ferron-Boothe D, Watson-Jones K, Meeks-Aiken N, McDonald AH. Trauma: the burden of a preventable problem. *West Indian Med J* 2010; **59**: 26–8.
2. Ramphal PS, Irvine RW, Spencer HW. Penetrating injuries to the great vessels: case reviews and management approaches for West Indian surgeons. *West Indian Med J* 2000; **49**: 134–7.
3. Cawich SO, Mitchell DI, Williams EW, McFarlane ME, Martin A, Plummer JM et al. Emergency department thoracotomy in Jamaica: a case controlled study. *Int J Surg* 2007; **5**: 311–15.
4. O'Connor J, Ditillo M, Scalea T. Penetrating cardiac injury. *J R Army Corps* 2009; **155**: 185–90.
5. McFarlane M, Branday JM. Penetrating injuries of the heart. *West Indian Med J* 1990; **6**: 74–9.
6. Varin DS, Ringburg AN, van Lieshout EM, Patka P, Schipper IB. Accuracy of conventional imaging of penetrating torso injuries in the trauma resuscitation room. *Eur J Emerg Med* 2009; **16**: 305–11.
7. Onan B, Demirhan R, Oz K, Onan IS. Cardiac and great vessel injuries after chest trauma: our 10-year experience. *Turk J Trauma Emerg Surg* 2011; **17**: 423–9.
8. Nagy KK, Lohmann C, Kim DO, Barrett J. Role of echocardiography in the diagnosis of occult penetrating cardiac injury. *J Trauma* 1995; **38**: 859–62.
9. Clarke DL, Quazi MA, Reddy K, Thomson SR. Emergency operation for penetrating thoracic trauma in a metropolitan surgical service in South Africa. *J Thorac Cardiovasc Surg* 2011; **142**: 563–8.
10. Jimenez E, Martin M, Krukenkamp I, Barrett J. Subxiphoid pericardiectomy versus echocardiography: a prospective evaluation of the diagnosis of occult penetrating cardiac injury. *Surgery* 1990; **108**: 676–9.
11. Valentine C, East J. Subxiphoid pericardial window in stable cardiac proximity injuries. *West Indian Med J* 2003; **52**: 296–9.
12. Rozycki GS, Ballard RB, Feliciano DV, Schmidt JA, Pennington SD. Surgeon-performed ultrasound for the assessment of truncal injuries: lessons learned from 1540 patients. *Ann Surg* 1998; **228**: 557–67.