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Cardiac magnetic resonance imaging in suspected blunt cardiac injury: A prospective, pilot, cohort study

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ABSTRACT

Introduction.: The aim of this study was to evaluate the incidence and severity of blunt cardiac injury (BCI) as determined by cardiac magnetic resonance imaging (CMR), and to compare this to currently used diagnostic methods in severely injured patients.
Materials and methods.: We conducted a prospective, pilot cohort study of 42 major trauma patients from July 2013 to Jan 2015. The cohort underwent CMR within 7 days, enrolling 21 patients with evidence of chest injury and an elevated Troponin I compared to 21 patients without chest injury who acted as controls. Major adverse cardiac events (MACE) including ventricular arrhythmia, unexplained hypotension requiring inotropes, or a requirement for cardiac surgery were recorded.
Results.: 6/21 (28%) patients with chest injuries had abnormal CMR scans, while all 21 control patients had normal scans. CMR abnormalities included myocardial oedema, regional wall motion abnormalities, and myocardial haemorrhage. The left ventricle was the commonest site of injury (5/6), followed by the right ventricle (2/6) and tricuspid valve (1/6). MACE occurred in 5 patients. Sensitivity and specificity values for CMR at predicting MACE were 60% (15–95) and 81% (54–96), which compared favourably with other tests.
Conclusion.: In this pilot trial, CMR was found to give detailed anatomic information of myocardial injury in patients with suspected BCI, and may have a role in the diagnosis and management of patients with suspected BCI.

Introduction

The incidence of blunt cardiac injury (BCI) in chest trauma ranges from 0–50%, and recent estimates suggest over 30,000 cases per year occur in the USA alone. Serious sequelae of BCI include malignant arrhythmia [1], heart failure [2,3] cardiac rupture [4–6], and death [7,8].

Current diagnostic tests in BCI and its complications achieve only moderate sensitivity and specificity [2,8]. These include troponin, creatinine kinase (CK), electrocardiogram (ECG), echocardiography and computerised topography (CT). There is currently no gold standard diagnostic test, making the investigation, diagnosis, risk stratification, and management of these patients challenging [4,5,9,10]. Furthermore, the increasing use of troponin as a screening tool in thoracic trauma, especially in the elderly population who also have risk factors for coronary arterial disease, can lead to patients being over investigated with invasive procedures to rule out acute coronary syndrome (ACS).

Cardiac magnetic resonance (CMR) imaging has been found to be highly effective in the diagnosis of structural heart disease, and is noted for its superior functional and morphological information [11,12], as well as tissue characterisation [10,13,14]. CMR has been demonstrated to effectively diagnose BCI in multiple case reports [6,15–17]. The most recent EAST trauma guidelines [18,19], and others [20,21], have recognised the potential benefits of using CMR, but to date there have been no prospective trials using CMR in BCI.

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The aim of this study was to investigate the incidence and severity of BCI as determined by CMR in non intubated, haemodynamically stable patients with major thoracic trauma, and then to compare this to other currently used diagnostic tests.

Materials and methods

Design

This is a prospective, observational cohort study. The study protocol was approved by the research and ethics committee of the Alfred Hospital, Melbourne, Australia.

Setting and population

The study was performed at the Alfred Hospital, a Level 1 Adult Major Trauma Centres in Victoria, Australia [22,23] with over 7000 trauma admissions per year. All patients admitted to hospital with major trauma (defined as ISS > 12) were screened on weekdays (Monday to Friday) for eligibility by the research team. Patients presenting out of hours, on weekends, or when the CMR scanner was not available were not included. Patients who were haemodynamically unstable, ventilated or who had a contraindication to CMR were excluded from the study. Enrolled patients were divided into two groups. The study group with chest trauma had elevated troponin levels [19,24], and corroborating evidence of thoracic injury, such as fractured ribs, sternum, or significant pulmonary contusions. A second, control group had major traumatic injuries but no evidence of chest trauma as defined by initial trauma CT scan. Demographic data were collected, and Injury Severity Score (ISS), Acute Physiology and Chronic Health Evaluation Score (APACHE) and Trauma Injury Severity Score (TRISS) calculated.

Study protocol

All patients underwent continuous cardiac monitoring from admission. Serum troponin, CK, as well as ECG were taken upon arrival, and then were repeated daily for three days or until stabilised [25]. ECGs were analysed and reported by clinicians blinded to the study aims for evidence of acute myocardial injury or conduction defects. A transthoracic echocardiogram (TTE) was performed as soon as was possible (usually <48 h). If the images were suboptimal, then the patient underwent transesophageal echocardiogram (TEE). All echocardiograms were reported by an experienced cardiologist blinded to the study aims.

CMR protocol

All patients underwent CMR as per the study protocol within one week of admission (Signa HD 1.5T; GE Healthcare, Waukesha, WI, USA). Patients were offered additional oral analgesia to complete the scan. After initial localiser scans, a contiguous steady state free precession cine stack was acquired to cover both ventricles from the atrioventricular groove to the left ventricular (LV) apex (slice thickness 8 mm). To assess myocardial oedema, a T2-weighted short-tau inversion recovery (STIR) sequence was acquired using the same coordinates as the cine stack, and in addition a T2-mapping sequence was acquired in 3 standardised short axis levels (basal, mid and apical). The T2-mapping sequence was a prototype multi-echo double inversion recovery-fast spin echo (MEFSE) technique (Global Applied Science Laboratory, GE

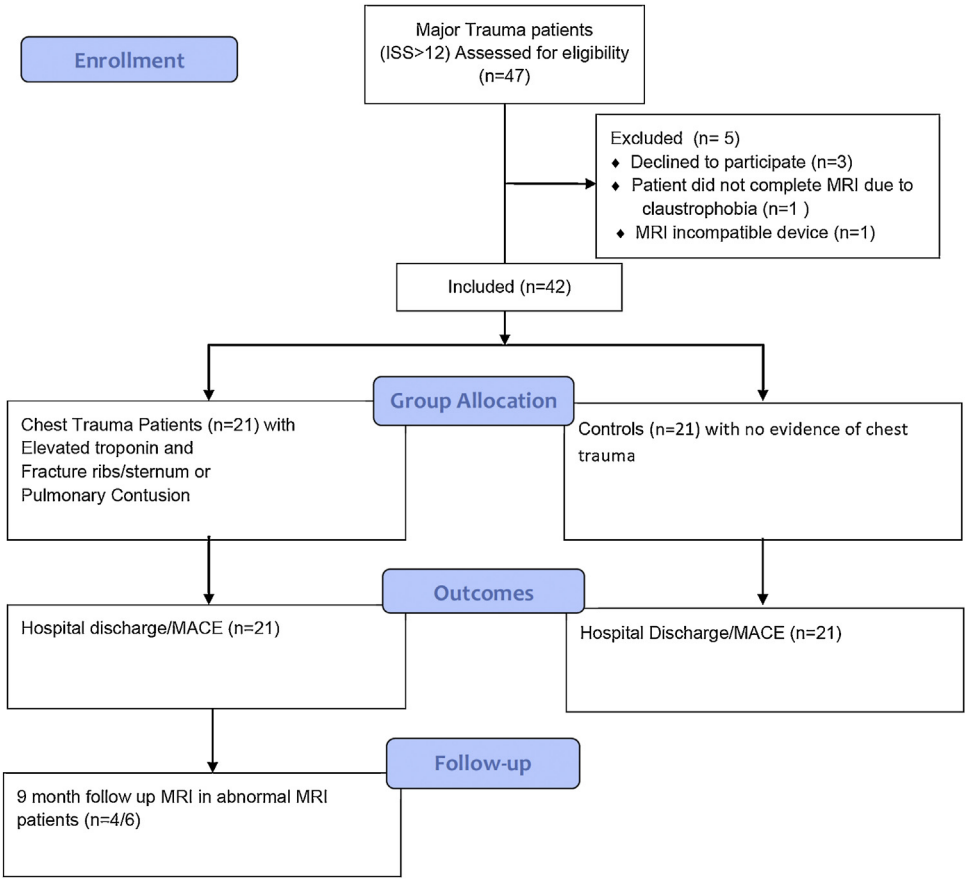

Fig. 1. Study flow diagram.

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