

Research article

## Outcome of major cardiac injuries at a Canadian trauma center

Khaled Alanezi, G Scott Milencoff, Frank GH Baillie, Andre Lamy and John D Urschel\*

Address: Department of Surgery, McMaster University, Hamilton, Ontario, Canada

E-mail: Khaled Alanezi - [alanezik@hotmail.com](mailto:alanezik@hotmail.com); G Scott Milencoff - [smilencoff@yahoo.com](mailto:smilencoff@yahoo.com); Frank GH Baillie - [Baillief@mcmaster.ca](mailto:Baillief@mcmaster.ca); Andre Lamy - [lanya@mcmaster.ca](mailto:lanya@mcmaster.ca); John D Urschel\* - [urschelj@mcmaster.ca](mailto:urschelj@mcmaster.ca)

\*Corresponding author

Published: 10 June 2002

Received: 8 May 2002

BMC Surgery 2002, 2:4

Accepted: 10 June 2002

This article is available from: <http://www.biomedcentral.com/1471-2482/2/4>

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### Abstract

**Background:** Canadian trauma units have relatively little experience with major cardiac trauma (disruption of a cardiac chamber) so injury outcome may not be comparable to that reported from other countries. We compared our outcomes to those of other centers.

**Methods:** Records of patients suffering major cardiac trauma over a nine-year period were reviewed. Factors predictive of outcome were analyzed.

**Results:** Twenty-seven patients (11 blunt and 16 penetrating) with major cardiac trauma were evaluated. Injury severity scores (ISS) were similar for blunt ( $49.6 \pm 16.6$ ) and penetrating ( $39.5 \pm 21.6$ ,  $p = 0.20$ ) injuries. Five of 11 blunt trauma patients, and 9 of 16 penetrating trauma patients, had detectable vital signs on hospital arrival ( $p = 0.43$ ). Ten patients underwent emergency department thoracotomy and 11 patients had cardiac repair in the operating theatre. Eleven patients survived and 16 died. Survivors had a lower ISS ( $33.7 \pm 15.4$ ) than non-survivors ( $50.4 \pm 20.4$ ;  $p = 0.03$ ). Two of 11 blunt trauma patients and 9 of 16 penetrating trauma patients survived ( $p = 0.06$ ). Eleven of 14 patients with detectable vital signs survived; all 13 without detectable vital signs died ( $p = 0.00003$ ). Ten of eleven patients treated in the operating theatre survived, while only one of the other 16 patients survived ( $p = 0.00002$ ).

**Conclusions:** Patients with major cardiac injuries and detectable vital signs on hospital arrival can be salvaged by prompt surgical intervention in the operating theatre. Major cardiac injuries are infrequently encountered at our center but patient survival is comparable to that reported from trauma units in other countries.

### Background

Major cardiac injuries can be defined as injuries that disrupt one or more cardiac chambers. Major cardiac injuries are less common than other forms of cardiac injury, such as myocardial contusions, but they are responsible for most of the deaths from cardiac trauma [1]. The incidence of major cardiac injuries varies considerably from country

to country. Trauma units in South Africa and the United States of America, for example, often have extensive experience with these injuries. Canadian trauma centers such as ours have relatively little experience with cardiac trauma. Patients with major cardiac injuries presenting to Canadian trauma centers may not be comparable to those reported from trauma units in other countries. Lack of ex-

perience with cardiac trauma could compromise patient outcomes in Canadian trauma centers. We reviewed our experience with major cardiac injuries and compared it to that published from trauma units in other countries.

### Patients and methods

The Hamilton General Hospital in Hamilton, Ontario, Canada is a regional trauma center serving a population of approximately 1.8 million people. A trauma registry (data collected prospectively) is maintained at our institution. We retrospectively reviewed patient records from this registry to identify all patients with a diagnosis of major cardiac injuries seen at our centre between January 1992 and January 2001 (nine-year period). Major cardiac injury was defined as a structural disruption of one or more cardiac chambers. Cardiac contusions were not included. Data was collected on age, sex, cardiac injuries, associated injuries, mechanism of injury, injury severity score, vital signs on arrival, emergency room treatment, operative treatment, and survival. Only patients discharged home from hospital were considered survivors. Continuous data are presented as means  $\pm$  standard deviations. A two-tailed t-test was used to compare means. Fisher's exact test was used to compare categorical data. Statsoft software (Tulsa, Oklahoma, USA) was used. A  $p < 0.05$  was considered significant.

### Results

Twenty-seven patients with major cardiac injuries were evaluated at our center over the nine-year study period. There were 21 males and 6 females. Age ranged from 14 to 88 years with a mean of  $38.5 \pm 19.1$  years. Eleven patients suffered blunt injuries and 16 suffered penetrating injuries. Blunt injuries were the result of motor vehicle accidents (7 patients), falls (2 patients), motorcycle accidents (1 patient), and bicycle accidents (1 patient). Penetrating injuries consisted of 13 assaults with a knife and 3 gunshot injuries. Injury severity score (ISS) ranged from 22 to 75 with a mean of  $43.6 \pm 20.0$ . Patients suffering blunt trauma had an ISS of  $49.6 \pm 16.6$  and those suffering penetrating trauma had an ISS of  $39.5 \pm 21.6$  ( $p = 0.20$ ). Thirteen patients received cardiopulmonary resuscitation (including endotracheal intubation) at the trauma scene or during ambulance transport. Vital signs (pulse and blood pressure) were detectable on arrival to the emergency room in 14 of 27 patients. Five of 11 blunt trauma patients, and 9 of 16 penetrating trauma patients, had detectable vital signs ( $p = 0.43$ ). Cardiac rhythms on arrival included sinus tachycardia (12 patients), asystole (11 patients), sinus bradycardia (2 patients), heart block (1 patient), and pulseless electrical activity (1 patient). Pericardiocentesis was done in 4 patients; it was used as a temporary treatment strategy in 3 patients and as a part of cardiopulmonary resuscitation in 1 patient. Ten patients underwent emergency department thoracotomy; one sur-

vived. Eleven patients had sternotomy or thoracotomy performed in the operating theatre for cardiac repair; ten survived. Cardiac wounds were repaired using a variety of non-absorbable sutures, with or without pledgets. Staples, balloon catheters, and cardiopulmonary bypass were not used. Twenty-one patients had an injury to one cardiac chamber and 6 had multi-chamber injuries. Twenty patients had ventricular injuries (right 12, left 8), ten had atrial injuries (right 7, left 3), and one had a septal rupture. Seven of 27 patients had an associated aortic injury.

Eleven patients survived and 16 died. All non-survivors died within 36 hours of admission. No late deaths from multiple organ failure or sepsis occurred. Length of hospital stay for surviving patients ranged from 4 to 52 days with a mean of  $15.6 \pm 14.9$  days. Survival was not related to patient age (survivors  $37.0 \pm 20.6$  years, non-survivors  $39.6 \pm 18.6$  years,  $p = 0.73$ ). Survivors had a lower ISS ( $33.7 \pm 15.4$ ) than non-survivors ( $50.4 \pm 20.4$ ;  $p = 0.03$ ). Two of 11 blunt trauma patients and 9 of 16 penetrating trauma patients survived ( $p = 0.06$ ). Eight of 13 stab wound and 1 of 3 gunshot wound patients survived ( $p = 0.40$ ). The presence or absence of vital signs on arrival in the emergency department was predictive of survival. Eleven of 14 patients with detectable vital signs survived; all 13 without detectable vital signs died ( $p = 0.00003$ ). Presenting cardiac rhythm was also predictive of survival. Ten of 12 patients with sinus tachycardia survived but only 1 with any other rhythm survived ( $p = 0.00008$ ). Cardiac repair in the operating theatre was associated with improved survival. Ten of eleven patients treated in the operating theatre survived, while only one of the other 16 patients survived ( $p = 0.00002$ ). Survival was not clearly influenced by the presence of single (10 of 21 survived) or multiple (1 of 6 survived) cardiac chamber injury ( $p = 0.19$ ). The combination of aortic and major cardiac injury (7 patients) was uniformly lethal ( $p = 0.02$ ).

### Discussion

Our trauma unit, like many Canadian units, has relatively little experience treating patients with major cardiac injuries [2]. We treated 27 patients (penetrating and blunt injuries) in a nine-year period. In contrast, many trauma units in South Africa and the USA treat a similar volume of patients in a period of months [3–7]. The mechanism of injury in our patients was fairly evenly divided between blunt and penetrating trauma. Patients seen at high-volume cardiac trauma units are predominantly penetrating trauma victims [3–5,8]. In many ways our Canadian trauma experience parallels that reported from European countries; there are few cases and gunshot wounds are infrequent [9].

Given the low volume of major cardiac injuries treated at our center the question of clinical competency and patient

survival is pertinent. Eleven of fourteen patients with detectable vital signs on arrival to our hospital survived. That is comparable to reports from high-volume trauma units. In one population-based study overall survival after penetrating cardiac injury was 19%, and survival of those who reached the hospital was 43% [5]. For major blunt cardiac trauma the survival is approximately 25% [10].

Although our series was small the prognostic factors that we identified are consistent with those reported from high-volume cardiac trauma units [1,2,6]. Predictors of survival in our patients included presence of vital signs on hospital arrival, early surgical exploration in the operating theatre, absence of associated aortic injury, and absence of other associated lethal injuries (lower Injury Severity Score). Most other investigators have shown that the mechanism of injury is important, with patients suffering penetrating cardiac injuries having better outcomes than blunt trauma patients [1,10,11]. We observed a trend towards higher survival in patients with penetrating injuries but it did not reach conventional statistical significance ( $p = 0.06$ ).

Our experience with emergency department thoracotomy for major cardiac trauma was disappointing; only one of 10 patients survived. We now follow the recently published American College of Surgeons' guidelines for emergency department thoracotomy [11] and forego this intervention in lifeless blunt trauma victims. On the other hand, the importance of early formal surgical exploration and cardiac repair in the operating theatre cannot be overstated [2]. It often proves lifesaving in patients with major cardiac trauma. We did not use cardiopulmonary bypass to facilitate cardiac repair in our patients, but we suspect that it may be useful in an occasional patient. Our perfusionists are not immediately available at all times, and that tends to limit the applicability of cardiopulmonary bypass for trauma patients in our unit.

Death secondary to major thoracic injuries usually fits into one of two familiar patterns: early death from massive injury and exsanguination, or delayed death secondary to sepsis and multiple organ failure [9,12]. In this series of 27 patients only the former lethal pathway was observed. The small number of patients and the tendency of survivors to have isolated cardiac injuries probably explain the absence of septic complications and multiple organ failure in this series.

## Conclusions

Although infrequent, major cardiac injuries treated at our trauma center had a survival similar to that reported from high-volume cardiac trauma units. Patients with detectable signs of life on hospital arrival can be salvaged by early surgical intervention in the operating theatre.

## Competing interests

None declared.

## Authors' contributions

KA, GSM, and JDU conceived the study. KA retrieved data from the database of FGHB. JDU and KA wrote the manuscript, which was revised by all authors. All authors read and approved the manuscript.

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## Pre-publication history

The pre-publication history for this paper can be accessed here:

<http://www.biomedcentral.com/1471-2482/2/4/prepub>

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