

Cardiac concussion (commotio cordis)

Rahim Valani, MD;* Angelo Mikrogianakis, MD;† Ran D. Goldman, MD†

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ABSTRACT

Blunt chest trauma in pediatric patients can result in various injuries to the myocardium. Cardiac concussion (commotio cordis) is seen in patients in whom the precordium has been struck with relatively little force at a vulnerable period of the cardiac cycle. These patients have no predisposing cardiac problems, and autopsy reveals no evidence of heart damage. The usual clinical presentation is that of immediate collapse secondary to a lethal arrhythmia. Prevention is the cornerstone of potentially decreasing the incidence with the aid of safety equipment and, possibly, immediate defibrillation.

Key words: commotio cordis; chest trauma, pediatric; defibrillation; resuscitation

RÉSUMÉ

Un traumatisme contondant au thorax chez les patients pédiatriques peut causer diverses lésions au myocarde. On constate une commotion cardiaque (commotio cordis) chez les patients dont la région précordiale a subi un choc relativement faible à un moment vulnérable du cycle cardiaque. Ces patients n'ont aucun problème cardiaque prédisposant et l'autopsie ne révèle aucun signe de dommages cardiaques. Sur le plan clinique, le phénomène se manifeste habituellement par un effondrement immédiat secondaire à une arythmie mortelle. La prévention constitue la pierre angulaire de la réduction possible de l'incidence au moyen de matériel de sécurité, et peut-être, d'une défibrillation immédiate.

Introduction

Although trauma, in general, is the leading cause of mortality in children worldwide^{1,2} clinically significant isolated blunt chest trauma in children is rare. Chest injuries range from benign chest wall contusions to life-threatening conditions such as cardiac rupture, coronary artery laceration, valvular disruption, cardiac contusion and cardiac concussion (commotio cordis). Of these, the most distressing may be cardiac concussion because it occurs with relatively little force, its victims have normal underlying cardiac anatomy, and because there is no appreciable structural

heart damage, even at autopsy.^{3,4} Emergency physicians, particularly those interested in injury prevention, should be familiar with cardiac concussion because its mortality rate is as high as 85% and because it is often preventable.⁵

Epidemiology

Minneapolis' Commotio Cordis registry, established in 1998, has documented only 128 cases in the United States, but because of rarity and underreporting, the true incidence is unknown.⁵⁻⁹ Most reported cases were the result of being struck in the chest with a baseball,^{7,8,10} but cardiac concussion has occurred in ice hockey, lacrosse, softball, soccer,

*Fellow, and †Staff Physician, Division of Pediatric Emergency Medicine, Hospital for Sick Children, Toronto, Ont.

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karate and football,^{7,11–14} and may even occur after non-accidental trauma.^{15–19} Nearly two-thirds of cases involve children <16 years of age.^{12,20,21} The oldest patient we identified was 20 years old, and the youngest was a 7-week infant whose father, frustrated with the infant's crying, fatally struck his child on the chest.¹⁵

Clinical presentation

The majority of patients with commotio cordis lose consciousness and collapse immediately, after a precordial injury.^{8,12,20} Occasional reports describe a lucid interval in which the child is struck in the chest, falls to the ground, and then stands up briefly only to promptly collapse again.^{12,20} If a monitor or defibrillator is immediately available, it will most likely reveal ventricular fibrillation.^{12,20} Cardiac concussion is not a delayed phenomenon.

Pathophysiology

Cardiac concussion occurs only when specific conditions are met. These involve force, exact timing and location of impact, and a compliant chest wall. Impact force must be sufficient to induce a ventricular dysrhythmia, but not so great as to result in structural myocardial damage.²² In experimental animal studies and retrospective case reviews, the ideal circumstances arise when a baseball strikes the chest wall at about 65 k/h, approximately the pitch speed achieved by 11- and 12-year-old boys who play ball at the competitive level.^{8,23} Force transmission is directly related to the hardness of the object, and in experimental studies the use of softer baseballs decreases the rate of ventricular fibrillation induction from 69% to 11%.⁸ Ventricular fibrillation is most common when the injury occurs directly to the chest wall overlying the heart.^{21,24} Attempts to refine this localization have not been convincing.²²

In animal models, induced cardiac concussion has led to a variety of electrocardiographic findings, including complete heart block, bundle branch blocks, ST-segment changes and atrial fibrillation.^{20,25–27} Ventricular fibrillation is most likely when the impact occurs just prior to the peak of the T-wave.²⁰ A compliant chest wall, as seen in most children, increases the susceptibility to cardiac concussion.^{28,29}

Prevention and treatment

Given the rarity of this condition, studies of prevention and treatment may not be feasible; however, based on our current understanding, various safety measures have been recommended, including softer, age-appropriate baseballs^{7,8,20,30} and chest wall protectors.^{7,8,12,20,21,30,31} Ventricular

fibrillation management consists of immediate basic life support and prompt defibrillation.^{7,8,20,21,30} In 2001, automated external defibrillators (AEDs) specifically modified to provide appropriate voltages (approximately one-third) to children ≤8 years of age or <55 lb (25 kg) became available (www.fda.gov/cdrh/mda/docs/k003819.pdf). The paddles are positioned differently (i.e., anterior/posterior placement) for these patients. However, the best way to implement public access defibrillation programs in anticipation of rare events such as cardiac concussion remains controversial.^{32,33}

Summary

Cardiac concussion is an uncommon but devastating result of seemingly insignificant chest trauma. Most documented cases have occurred in children and adolescents during sporting events such as baseball and ice hockey. The terminal event is usually ventricular fibrillation that results in death if not promptly treated with defibrillation. Emergency physicians can play a major role in awareness and prevention campaigns and in evolving public access defibrillation programs.

Competing interests: None declared.

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Correspondence to: Dr. Ran D. Goldman, Division of Emergency Services, Hospital for Sick Children, 555 University Ave., Toronto ON M5G 1X8; 416 813-4915, fax 416 813-5043, ran.goldman@sickkids.ca