

EFFICACY OF BYSTANDER CARDIOPULMONARY RESUSCITATION AND OUT-OF-HOSPITAL AUTOMATED EXTERNAL DEFIBRILLATION AS LIFE-SAVING THERAPY IN COMMOTIO CORDIS

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We report a child who sustained commotio cordis after being struck by a baseball, and offer documentation of the advantages of having readily available access to bystander cardiopulmonary resuscitation (CPR) and an automated external defibrillator (AED). We suggest that communities and school districts reexamine the need for accessible AEDs and CPR-trained coaches at organized sporting events for children. (*J Pediatr* 2005;147:863-6)

Sudden death during competitive sports in childhood is commonly due to cardiovascular causes. This phenomenon is most often linked to undiagnosed structural or electrical cardiac abnormalities, such as hypertrophic cardiomyopathy, coronary artery anomalies, myocarditis, and congenital prolongation of the QTc interval.¹ However, sudden death may also occur in individuals with no underlying cardiac disease who have been struck by a projectile over the anterior left hemithorax. In this phenomenon, known as commotio cordis (CC), the impact of the projectile generally triggers ventricular tachycardia or fibrillation and subsequent cardiac arrest.

Because of the sudden nature of this insult, as well as the relative lack of aggressive resuscitation in the immediate moments after the trauma, the survival rate for CC is only 16%.² Survival is more likely when bystander cardiopulmonary resuscitation (CPR) and the use of an automated external defibrillator (AED) is initiated within 3 minutes of the cardiac arrest. This sequence of events has been reproduced in an animal model, which demonstrated that AEDs had 98% sensitivity for detecting ventricular fibrillation and produced 100% termination of the arrhythmia in swine struck with a baseball.³

Because of the known pathophysiology of CC and the results of the aforementioned animal study, the practice of making AEDs available at competitive sporting events for children appears to be supported in the medical literature. However, for a number of reasons, including the cost of these devices, AEDs are rarely found in these settings. Clinical proof of these devices' efficacy in life-saving situations should support the widespread purchase of AEDs and training of personnel in their use. We report a case of CC in a child at a Little League baseball game with documented evidence of the effectiveness of rapid bystander CPR followed by prompt defibrillation using an AED, a combination that led to an excellent outcome.

CASE REPORT

A healthy 13-year-old male with a past medical history of an "innocent" heart murmur (and a structurally normal heart as documented by echocardiography) sustained a blow to the lateral chest wall from a pitch while batting in an organized baseball game. He was reported to have taken a few steps away from home plate, at which point he collapsed. Bystander CPR, including both chest compressions and mouth-to-mouth resuscitation, was immediately started by his coaching staff, who were trained in basic life support (BLS), and the emergency medical system was activated. The paramedics arrived 6-8 minutes after the event and immediately placed the child on an AED monitor. The child was determined to be in ventricular fibrillation (Figure 1), and the AED recommended

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AED	Automatic external defibrillator	CPR	Cardiopulmonary resuscitation
CC	Commotio cordis	PICU	Pediatric intensive care unit

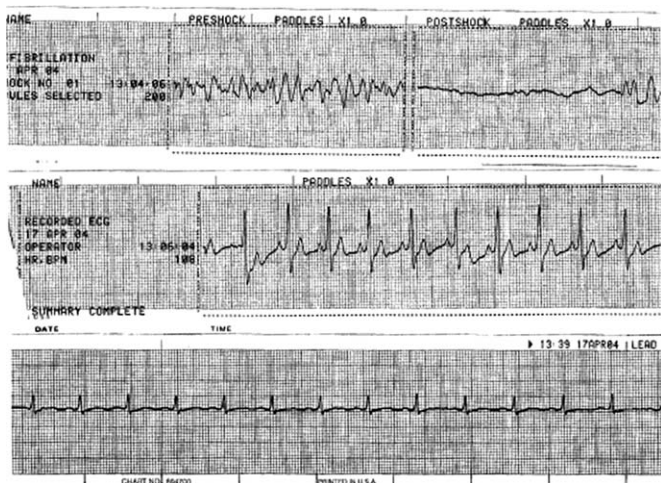


Figure 1. Initial rhythm strip demonstrating ventricular fibrillation and subsequent conversion to sinus rhythm after defibrillation with 200 joules.

defibrillation, which was then delivered (at 200 joules). Subsequently, the child converted to sinus rhythm (Figure 1). At this point he also regained a palpable pulse with a rate of 80 bpm. Two minutes later, his rhythm strip demonstrated normal sinus rhythm with ST depression. Because of continued unresponsiveness, the child was intubated and transported to a local emergency room, where he initially displayed decerebrate posturing. He was stabilized and transferred to our pediatric intensive care unit (PICU) for further treatment. Physical examination on admission revealed unremarkable cardiac findings, except for a soft systolic murmur. His left lateral chest wall had an area of ecchymosis measuring approximately 4 cm in diameter (Figure 2). Within 1 hour after his arrival at our PICU, he was awake and following commands, and he was extubated soon thereafter. His neurologic examination at that point was normal, and it remained normal throughout his remaining hospital course. His initial laboratory evaluation revealed a creatinine phosphokinase level of 471 U/L (normal, 30 to 180 U/L) with an MB mass of 9 ng/mL (normal, 0 to 5 ng/mL). His serum troponin-I level was 5.4 ng/mL (normal, < 2.0 ng/mL), which peaked at 8.0 ng/mL 7 hours after admission. Within 60 hours of PICU admission, all of these cardiac markers were within normal ranges (Figure 3).

The patient's initial echocardiogram revealed a structurally normal heart with normal biventricular function. A cardiac magnetic resonance imaging study revealed no findings suggestive of right ventricular dysplasia. A maximal exercise stress test performed on hospital day 3 was within normal limits. A 24-hour Holter monitor was placed before discharge and demonstrated only a single premature ventricular contraction. The patient was discharged on hospital day 3. Of note, he has subsequently been found to have persistence of Q-wave voltage consistent with anterior myocardial loss and/or damage; however, subsequent echocardiograms have not found any regional wall motion abnormalities consistent with this entity. Furthermore, no further ventricular ectopy has been noted.

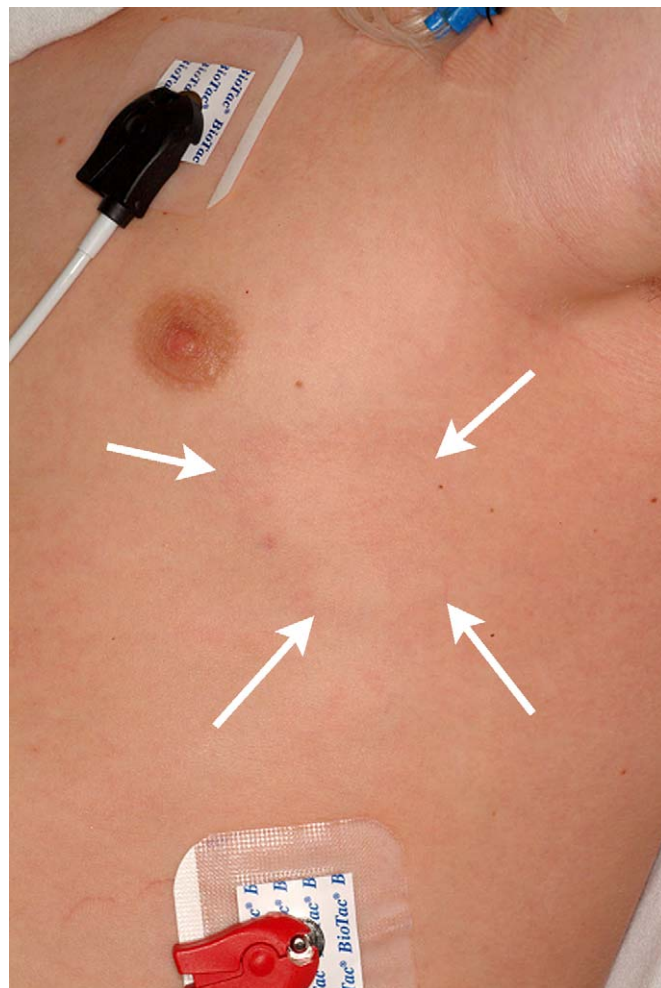


Figure 2. Ecchymotic area over the anterior left hemithorax (outlined by arrows). (Available in color online at www.jpeds.com.)

DISCUSSION

Although there have been two other on-field cases (a 13-year-old batter and a 38-year-old umpire) in which ventricular fibrillation caused by CC was terminated by an AED,² there is a lack of electrocardiographic documentation in the present literature to support this successful intervention. As of 2001, 128 cases of CC had been reported to the U.S. CC Registry.² Although CC has been reported in patients ranging in age from 3 months to 45 years, it occurs most commonly in children age 4 to 16 years; only 22% of cases occur in persons over age 18 years. According to the data collected by the U.S. CC Registry, 87% of those affected are white and 95% are male. Of the 128 reported cases, 62% occurred during organized competitive sports (eg, baseball, softball, lacrosse, football, hockey, karate), and 38% occurred during normal daily activities or recreational sports.² In most instances, a baseball or softball traveling at an estimated speed of 30 to 50 mph was the object inflicting the trauma.⁴

Because of the high mortality rate in CC, evaluation of patients with CC has been limited mainly to postmortem

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