

CASE REPORT

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Homicidal Commotio Cordis in Two Children*

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ABSTRACT: This paper's objective is to describe two cases of fatal commotio cordis resulting from the deliberate striking of children's chests by adults with their fists. These deaths involve two male children, ages 3 years and 14 months. The clinical histories, events in the households prior to the deaths, behaviors of the children, autopsy findings, and investigation results are all similar. In both cases, fatal blows were delivered to the anterior chest with a closed fist. Both children collapsed immediately, unable to be resuscitated. Confessions were obtained in both cases by investigators soon after the children's deaths. Autopsies showed chest contusions in only one child, presumably due to knuckle impact. The cardiac rhythms noted by paramedics were ventricular fibrillation and asystole. Due to the lack of physical findings, an immediate and thorough investigation is critical. An accurate history of events preceding death must be obtained.

KEYWORDS: forensic science, commotio cordis, child abuse, homicide

Commotio cordis, or blunt trauma to the precordial chest, is a concussive low energy impact injury that disrupts the electrical activity of the heart, without cardiac contusion or laceration (1). It is distinguished from cardiac contusion by the lack of visible or chemical heart injury (2). Commotio cordis was first accepted as a legitimate diagnosis in 1932 when Schlomka and Hinrichs were able to induce ventricular fibrillation experimentally in animals (3). The exact mechanism of death was thought to be either a coronary artery spasm or an abnormal autonomic response. Commotio cordis is commonly due to an accidental injury sustained in children and adolescents during sporting events, such as baseball, softball, hockey, or lacrosse (4,5). It has also been reported in low speed motor vehicle accidents without multiple blunt force injuries (6). The precordial blow causes the victim to collapse suddenly, and despite prompt resuscitation, ventricular fibrillation persists with hypotension. Death is the usual outcome, although there are rare survivors (7). We present two cases from the Office of the Medical Examiner of Cook County involving fatal blows to the chests of children. The clinical and autopsy findings in these two cases are presented in the light of recent experiments defining the arrhythmogenic mechanism of commotio cordis (8).

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Case 1

A 14-month-old black male child, well developed and well nourished, above the 95th percentile for height and weight for age, was reportedly crying after he was given a bath by his mother. There was no history of prenatal problems, birth trauma, heart defects, or recent illness. She placed him on a firm changing table lying on his back. She dried him off and stepped out of the room to get a diaper as he continued to cry. The child's father in the next room was irritated by the crying. The father approached the prone child and struck him once on the chest with a closed fist on its medial soft side. He described the punch as "hard." The child's eyes rolled upwards and he immediately became unresponsive with short gasping breaths. The mother immediately summoned the paramedics, who determined that his heart rhythm was in ventricular fibrillation. Aggressive resuscitative and electroconversion attempts were unsuccessful and the child died in the emergency room. At autopsy, there was no evidence of injury to the skin, subcutaneous tissues, or musculature. Complete external and internal examinations were unremarkable. Total body radiographs with cone-down views of joints, toxicology screening, and histologic studies were all negative. After a review of additional investigative reports, the cause of death was certified as commotio cordis.

Case 2

A well developed and well nourished 3-year-old black male child was in the care of his mother's boyfriend. The child was standing in a bedroom crying while the mother's boyfriend was watching a basketball game on TV. The child had recent cold symptoms and was irritable. There was no history of any other illness. The boyfriend became upset at the crying, went into the adjoining bedroom to tell the child to stop crying, then hit the child on the left side of the chest with his fist. The boyfriend left the bedroom, but when the child continued to cry, the boyfriend returned and struck the child on the mid chest over the sternum. The child fell backwards onto his buttocks on the floor, stood up, then collapsed unresponsive. The boyfriend immediately called paramedics, relating the above events. The child was asystolic when paramedics arrived a few minutes later. The aggressive resuscitation attempt was unsuccessful. Two areas of bruising were noted during the autopsy. These bruises were consistent with the boyfriend's account of the inflicted injuries to the chest. On the mid chest, there were patterned faint circular contusions consistent with knuckle marks. The contusions also contained scattered petechiae. On the left lateral chest, there were similar contusions that appeared darker in color. The subcutaneous tissue and musculature

showed a small amount of red hemorrhage. The contusions were not artifacts of resuscitation. There was a subcutaneous red bruise in the right buttock, consistent with the backwards fall after the first punch. Histology sections of these areas showed acute hemorrhage with intact red blood cells without inflammation. The remaining examinations, both external and internal, were unremarkable. Total body radiographs with cone-down views of joints, toxicology screening, and extensive histologic studies of all organs were negative. After a review of the investigative reports, the cause of death was certified as commotio cordis.

Discussion

The above two cases demonstrate that a blow to the chest can cause death in children. The striking of a child's chest with a fist should be added to the list of causes of commotio cordis. These two cases are significant for several reasons: There was reliable accountings of the events that preceded the punches, prompt medical care was obtained, cardiac rhythms of ventricular fibrillation and asystole were documented, and autopsy findings were consistent with commotio cordis. These autopsy findings range from absence of injuries, as in the 14-month-old, to chest contusions of a knuckle pattern on the 3-year-old. Both hearts were without gross or microscopic injury, consistent with a cardiac concussion (1). A similar case of commotio cordis has been reported in a 23-month-old male child who received a blow to either his back or chest by a babysitter and died (9). No back or chest contusion was found.

The exact mechanism of commotio cordis has been the subject of much speculation and research (10). Recent experiments with a porcine model have consistently and convincingly induced commotio cordis with blows precisely timed to the cardiac electrical cycle (8). Two distinct outcomes were documented: one involving ventricular fibrillation, the other involving asystole. During cardiac monitoring, immediate ventricular fibrillation was induced if the blow was precisely timed to the upstroke of the T wave. This phenomenon was consistently reproducible during a 30 milisecond window of ventricular repolarization. Additionally, if the blow was timed to the peak of the QRS complex of ventricular depolarization, asystole was immediate with subsequent ST elevation. Autopsy findings in these animals were consistent with those of commotio cordis. This new research defining the mechanism of commotio cordis can be applied to the information and findings in our two children's deaths. Our first child presented with ventricular fibrillation, consistent with a blow during ventricular repolarization (upstroke of the T wave). In the case of the second child, the impact may have occurred during ventricular depolarization (QRS complex), resulting in asystole. However, because the exact period of time needed for ventricular fibrillation to degenerate to asystole is unknown, there is another possibility. If the child was left unconscious without care following the precordial blow, the blow may have occurred during ventricular repolarization. It is possible that the initial cardiac rhythm was ventricular fibrillation with degeneration over time to asystole.

Since the findings of commotio cordis in children are few, the importance of performing a thorough and careful autopsy documenting the absence or presence of subtle abnormalities cannot be over stated. Radiographs with cone down views of joints, toxicology screening, histology sections, and vitreous electrolyte analysis

are important ancillary studies to exclude other possible causes of death. It is possible that commotio cordis could present as Sudden Infant Death Syndrome in an infant. Scene investigation is therefore critical, and any comments made by adults about the infant at the time of death must be obtained. In the cases documented, the paramedic reports were available, along with emergency department records and initial police interview statements. Review of this information is essential prior to beginning the autopsy. It is also necessary to obtain the complete medical history of the child, paying special attention to any events of prior fainting spells, illnesses or heart problems.

After analyzing the results of ancillary studies and obtaining copies of the investigative reports, the manners of death in these two cases were certified as commotio cordis (blunt trauma to the chest), with the manner homicide. The ruling of homicide is justified by the fact that the intentional punches were the direct cause of these children's deaths.

Conclusion

These two cases show that an adult can cause fatal commotio cordis by punching a child's chest. Chest contusions may or may not be found. A thorough investigation, autopsy examination, and follow up studies are necessary to confirm this important medicolegal diagnosis.

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