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Motor vehicle crash brain injury in infants and toddlers: A suitable model for inflicted head injury?☆

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Abstract

Objective: Children involved in motor vehicle crash (MVC) events might experience angular accelerations similar to those experienced by children with inflicted traumatic brain injury (iTBI). This is a pilot study to determine whether the progression of signs and symptoms and radiographic findings of MVC brain injury (mvcTBI) in children of the age at greatest risk of iTBI could be evaluated with retrospective data. The ultimate goal was to examine the association of subdural hematoma (SDH) with initial loss of consciousness (LOC) and outcome.
Methods: Retrospective review of records was conducted of 51 patients involved in a MVC, between birth and 36 months, admitted to Harborview Medical Center between January 1996 and December 2001. Radiographs were reviewed. Simple descriptive statistics and Fisher's exact test were used.
Results: Ambulance reports were available for 57% of the patients, while Glasgow Coma Scale (GCS) scores (from any source) were only available for 76% of patients. Thirty-nine percent of patients sustained skull fractures, 8% long bone fractures, 20% thoracic injuries, and 8% intra-abdominal injuries. Twenty-four percent of the patients had SDHs; half of these experienced LOC. SDH patients without initial LOC had computed tomography findings and clinical courses indicative of focal impact injury, not angular acceleration.

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Conclusions: Initial LOC and subsequent evolution of GCS scores are inconsistently documented in retrospective records. Seven of the 12 patients with SDHs had simple contact injuries, while 5 exhibited diffuse brain injury. Initial LOC was associated with diffuse brain injury and poor outcome. Due to the high rate of simple contact injury, mvcTBI may be a difficult model for iTBI.

Keywords: Motor vehicle crash; Head injury; Infants and toddlers; Child abuse; Subdural hemorrhage; Concussion

Introduction

The problem

Accurate and timely identification and diagnosis of child abuse are essential steps in the protection of child victims. Clinicians examining an injured child must be able to judge the plausibility of the history offered to explain the injury. They also must estimate the time of injury based upon the clinical and radiographic findings observed. Without understanding the timing of the event, it is often impossible to identify the child's assailant and protect the child from future injury. A better understanding of the sequence of symptoms and biological events after severe head injury in infants and toddlers would allow clinicians to perform these tasks with greater confidence and accuracy.

When children suffer inflicted or abusive traumatic brain injury (iTBI), the child's abuser often falsifies the history and obscures the time of injury. Alternatively a non-offending caretaker, bringing the child to medical care, may be naïve to the cause and timing of the child's injury. However, there are few empiric reports of the time course of clinical and neurologic behavior following iTBI (Gilles & Nelson, 1998; Gilliland, 1998; Starling et al., 2004). Trauma to children who are passengers in motor vehicle crashes (MVC) might result in angular accelerations of the head on an axis in the neck, a mechanism similar to that occurring in most serious iTBI. As such, it might be a suitable model to understand the clinical course following iTBI.

Background from past studies

The current understanding of the sequence of neurological symptoms after significant head injury comes from extensive clinical experience, biomechanical studies of animals experiencing single whiplash events and case series of the consequences of unintentional traumatic brain injuries (uTBI) in children and adults. These studies commonly involve injury mechanics, which only approximate the type and severity of force infants are felt to experience with child abuse. Although most iTBI occurs between birth and 3 years of age and few occur after the third birthday (Duhaime, Christian, Rorke, & Zimmerman, 1998), studies of uTBI have included few children in this 0- to 3-year-old age range. Reports often involve other species or older humans, who may have different injury propensities due to differences in the shape and size of the skull and brain. The brain of an infant also exhibits different viscous and elastic responses to shear strain than a mature animal's due to its immature myelination (Thibault & Margulies, 1998).

There is a need for studies regarding the evolution and time course of clinical and radiographic findings among children less than 3 years old, who experience head injuries similar to those of inflicted trauma.