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Hepatic enzyme decline after pediatric blunt trauma: A tool for timing child abuse?☆

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ABSTRACT

Objectives: Previous research in adult patients with blunt hepatic injuries has suggested a pattern of serum hepatic transaminase concentration decline. Evaluating this decline after pediatric blunt hepatic trauma could establish parameters for estimating the time of inflicted injuries. Deviation from a consistent transaminase resolution pattern could indicate a developing complication.
Methods: Retrospective review of pediatric patients with injuries including blunt liver trauma admitted to one of four urban level 1 trauma centers from 1990 to 2000. Cases were excluded for shock, death within 48 h, complications, or inability to determine injury time. Transaminase concentration decline was modeled by individual patients, by injury grade, and as a ratio with regard to injury time.
Results: One hundred and seventy-six patients met inclusion criteria. The rate of aspartate aminotransferase (AST) clearance changed significantly over time. Alanine aminotransferase (ALT) fell more slowly. Of the 118 patients who had multiple measurements of AST, for 112 (95%) the first concentration obtained was the highest. When ALT was greater than AST, the injury was older than 12 h (97% specificity (95% CI, 95–99%), sensitivity 42% (95% CI, 33–50%)). Patients with enzymes that rose after 14 h post-injury were more likely to develop complications (RR = 24, 95% CI 10–58).
Conclusions: Hepatic transaminases rise rapidly after uncomplicated blunt liver injury, then fall predictably. Persistently stable or increasing concentrations may indicate complications. ALT > AST indicates subacute injury.

Introduction

Inflicted trauma is an important cause of abdominal injury in young children (Trokel, DiScala, Terrin, & Sege, 2004), with abdominal injuries second only to central nervous system injury as a cause of death of children with inflicted injuries (Schnitzer & Ewigman, 2005). The ability to establish the age or timing of a child's injury can be helpful in discriminating accidental from inflicted injury. It has often been suggested that delay in seeking care is a red flag for inflicted trauma in young children (Canty, Canty, & Brown, 1999; Cooper et al., 1988; Feldman et al., 2001; Ledbetter, Hatch, Feldman, Fligner,

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& Tapper, 1988). While this suggestion has recently been questioned (Wood, Rubin, Nance, & Christian, 2005), the ability to objectively determine the timing of an injury can support or refute the history given by the child's caretaker. In cases where there is no question that the injuries were inflicted, establishing the age of an injury can establish who had responsibility for the child at the time of injury. Clinicians have attempted to establish predictable patterns of injury or healing for a variety of injuries common in victims of child abuse. Many of these patterns have been shown to be unreliable (Bariciak, Plint, Gaboury, & Bennett, 2003; Levin, 2002; Tung, Kumar, Richardson, Jenny, & Brown, 2006; Vinchon et al., 2004) or insufficiently precise (Prosser et al., 2005) to have broad utility.

Serum hepatic transaminase concentrations have been used to detect blunt liver injuries for over 40 years (Hellstrom, 1966; Nunes, Blaisdell, & Margaretten, 1970). Elevations of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) have a reported sensitivity of 100% and specificity of 92% for predicting hepatic injury in children (Hennes et al., 1990; Karaduman, Sarioglu-Buke, Kilic, & Gurses, 2003; Oldham, Guice, Kaufman, Martin, & Noseworthy, 1984), better than any other clinical or laboratory indicators (Holmes et al., 2002). Because of this, hepatic transaminases are often obtained in the setting of pediatric blunt trauma (Holmes, Sokolove, Land, & Kuppermann, 1999). The significant rate of occult liver injuries in children with suspected physical abuse (Coant, Kornberg, Brody, & Edwards-Holmes, 1992) has recently lead to the recommendation for broader screening of these children for abdominal injury (Jenny, 2006).

There has been some examination of hepatic transaminase concentration timing in adults with blunt abdominal injury. In adults, hepatic transaminases show a rapid, initial peak in concentration regardless of injury severity (Bruce, Todd, & Ledune, 1958; Kaku, 1987) followed by a subsequent gradual decline over days or weeks (Kaku, 1987). However, similar data is not available for a pediatric cohort. The objective of this study was to describe the temporal pattern of serum hepatic transaminase concentrations in pediatric blunt liver trauma, and to establish parameters for estimating time of injury. We hypothesized that the relative concentrations of AST and ALT change in a time-sensitive manner, and clearance curves could be defined which would aid in extrapolating the time of injury.

Materials and methods

Patients

The institutional review boards of Children's Hospital Medical Center, Cincinnati, Ohio, University of California Davis Medical Center, Eastern Virginia Medical Center, and University of Chicago Hospitals approved publication of the results of this retrospective study with waiver of informed consent. Patients aged 0–18 years of age with blunt hepatic injuries including lacerations, contusions or hematomas were identified by searching the trauma registries at each study site from the period January 1990 to March 2000 using ICD-9 codes (ICD9 codes 864.00–864.09 excluding 864.1x codes with penetrating wounds to cavity).

Patients were excluded if a reliable estimate of the time of injury to within 60 min could not be made, medical records were unavailable or incomplete, hepatic transaminase concentrations were not obtained, or if no independent method (abdominal CT, laparotomy, or laparoscopic evaluation) showed liver laceration, contusion, or hematoma. Patients were also excluded for clinical factors which could influence transaminase concentrations. These included hemodynamic shock (Garland, Werlin, & Rice, 1988), the patient expiring within 48 h from time of injury secondary to any cause other than traumatic brain injury (implying compensated shock), or development of an abdominal complication during the time period in which AST or ALT concentrations were elevated, including hemobilia, traumatic pancreatitis, or bile duct injury requiring surgery. Patients with concerns of abuse in the medical record, for instance those with ICD-9 codes including physical abuse, patients discharged into foster care, or caregiver admitting abuse, were excluded from analysis in order to optimize estimates of injury timing (see below).

Estimating time of injury

Estimates of the time of injury were used whenever they were noted explicitly in the medical record. Because these estimates were often provided by caregivers, and could therefore be intentionally misleading in cases of inflicted injury, cases of suspected child abuse were excluded (see above). When time of injury was not documented, and when the patient presented immediately from the scene of an acute injury, the time of injury was estimated according to the schema in Table 1. In order to test the congruency of transport time estimates embedded in this schema, a convenience sample of patients with

Table 1
Timing estimation model

Event documented in medical record	Estimated time of injury
Initial telephone call to Emergency Medical Services (EMS)	15 min prior to call
Emergency Department arrival time if transported from scene by EMS	45 min prior to arrival
Emergency Department arrival time if transported by private vehicle	1 h prior to arrival
Notification of EMS intent to transport patient to Emergency Department from outside facility	1 h prior to notification

Model used to estimate time of injury when exact time of event was not listed in the medical record, but other precise times were recorded and patient presented to the health care system immediately after event (EMS = Emergency Medical Services).