

# Design and Development of a Surrogate Bruising Detection System to Describe Bruising Patterns in Children

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## ABSTRACT

*Child abuse is a leading cause of fatality in children aged 0-4 years. An estimated 1,760 children died as a result of child abuse of which three-quarters (75.7%) of the children were younger than 4 years old (DHHS 2007). Infants (younger than 1 year) had the highest rate of fatalities among the group. Additionally, there were approximately 150,000 children that are permanently disabled each year in association with child abuse (DHHS 2006). Many of the serious injuries and fatalities could have potentially been prevented if clinicians and child protective services were able to better distinguish between injuries associated with abuse versus those caused by accidents. Missed cases of child abuse have been shown to be as high as 71%, where children were presented to hospitals for their injuries and not evaluated for abuse (Alexander, Crabbe et al. 1990). Additionally, when child abuse is legally prosecuted, little more than half of the cases move forward to prosecution as opposed to being screened out for reasons including the need for further investigation or insufficient evidence (Cross, Walsh et al. 2003). Therefore there is a need to provide clinicians, child protective services and law enforcement personnel with improved knowledge related to the types of injuries that are possible from common household accidents that are often reported to be the underlying cause of injury in child abuse. Bruising is an early sign of abuse, and can be an effective indicator of child abuse. Although not life threatening, bruising characteristics and bruising patterns provide a “roadmap” documenting a child’s exposure to impact. Previous research has relied upon the use of instrumented anthropomorphic test devices, or test dummies, to investigate injury risk in common childhood falls and accidents (Bertocci, Pierce et al. 2003; Bertocci, Pierce et al. 2004; Deemer, Bertocci et al. 2005; Thompson, Bertocci et al. 2009). However, the ability to predict bruising patterns occurring in association with falsely reported events in child abuse does not exist, and could prove extremely useful in the distinction between abusive and accidental injuries ( Maguire, Mann et al. 2005 ). We provide a novel way of studying soft tissue injury and address the need for a test dummy with the ability to record points of impact or contact. Our study adapted an existing pediatric test dummy with custom developed pressure sensors integrated into a conformable skin. The sensors were coupled to a data acquisition system capable of displaying recorded force data on a computerized body mapping image system. This modified test dummy will be capable of being used in mock laboratory experiments replicating common household injury events while the “sensing skin” measures and records levels of impact force/pressure and locations of impact on the human surrogate. These tests would allow for the prediction of potential bruising location, size and patterns in children during common household fall events that are often stated as false scenarios in child abuse.*