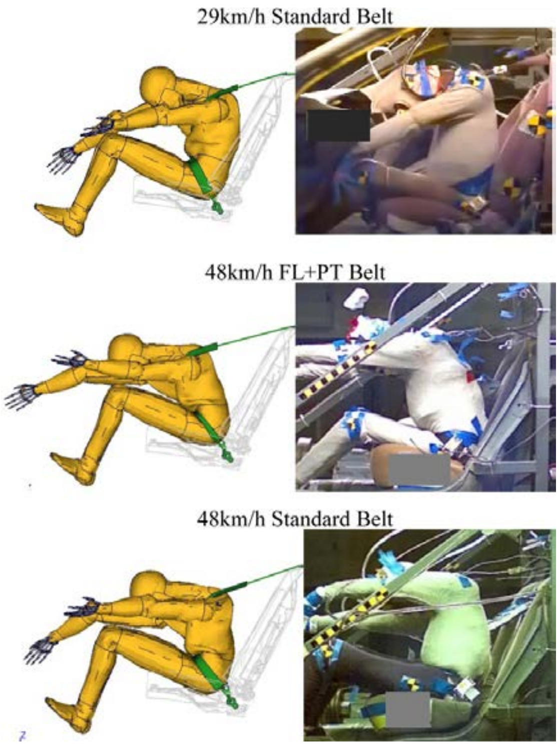
Center for Applied Biomechanics

Richard Kent

Professor
rwk3c@virginia.edu
www.centerforappliedbiomechanic.org

Dept. of Mechanical & Aerospace Engineering
University of Virginia
Charlottesville, VA
434.296.7288 x.133

"Improving automobile safety."



Our group is interested in the area of injury biomechanics, with a focus on the identification of tolerance indices for human tissues and characterization of the mechanical responses of biological materials and structures. Applications of this research include the development of physical and computational models of the human body for optimizing vehicle restraints and other injury mitigation systems. One particular focus has been to study the changes in the mechanical characteristics of biological tissues during pediatric development and aging into senescence. This work has included the identification of age-related trends in structural anatomy at both macro- and micro-length scales, non-linear and viscoelastic material properties, and the application of this fundamental response data toward the optimization of restraint systems. Examples of our work are described below.

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Improvements to pediatric safety restraint systems

Pediatric biomechanics has been a focus of the CAB since the early 1990s, when the widespread introduction of airbags necessitated a new paradigm of knowledge regarding the injury tolerances and mechanisms of children, and an enhanced set of tools for the assessment of injury risk and the design of safety systems. Our research in this area ranges from the most fundamental studies of tissue development and mechanical behavior to the most applied assessments of child restraint and booster seat design and enhanced performance specifications for pediatric test dummies. We have been particularly active in recent years studying restraint mis-use scenarios, such as placing the shoulder belt behind a child's back, and developing guidelines to help parents with the transition from rear-facing to forward-facing booster seats and finally to adult belts. We are also leading the way toward improved protection for child pedestrians through our research on the biomechanics of the interaction between vehicle structures and the developing human body.

Biomechanics of injury and computer modeling

The thorax is one of the most commonly injured body regions in automobile collisions. The thorax accounts for approximately 30% of injuries to belted drivers over the age of 34 fatally injured in frontal collisions. The most common types of skeletal thoracic injuries sustained by restrained occupants in frontal collisions are rib fractures. We have developed the first strain-based probabilistic method to predict rib fracture risk with whole-body finite element (FE) models, and described a method to combine the results with collision exposure information to predict injury risk and potential intervention effectiveness in the field. We are currently using this analytical framework to incorporate additional subject and collision factors for multi-variable probabilistic injury prediction.

Biomechanics of lower extremity injuries in elite athletes

Sprains of the first metatarsophalangeal (MTP) joint, referred to colloquially as 'turf toe', are a debilitating sports injury because the hallux is pivotal to an athlete's ability to accelerate and cut. Severe sprains may require weeks to fully recovery, and injuries requiring surgery may prevent an athlete from full athletic participation for months. Whereas the diagnosis and treatment of turf toe are well documented in the literature, less is known about the biomechanics of this joint and the mechanical properties of the structures that compose it. Nevertheless, this information is vital to those, such as equipment designers, who attempt to develop footwear and surfaces intended to reduce the likelihood of injury. In an effort to better understand this debilitating injury, we have developed a test device capable of reproducing clinically relevant turf toe in cadaver limbs via hyperextension of the first MTP.

RECENT RESEARCH DEVELOPMENTS

- Developed the world's most anatomically accurate and detailed computational model of the human thorax. This incorporates details such as small changes in the thickness of bones and in the stiffening of cartilage. These details have been ignored in previous models, but have profound effects when optimizing a restraint system for an elderly person.
- Developed injury risk functions for foot injuries that occur during athletics and determined guidelines for designing shoes that reduce the risk of foot injuries without impeding athletic performance.

RECENT GRANTS

- TEMA – Injury Simulation of Occupant Impacts
- Global Human Body Models Consortium, LLC – Thorax Center of Expertise
- Biocore, LLC – Lisfrane Fractures and Turf Toe - Determination of Injury Mechanism and Thresholds for Elite Athletes
- DOD/Army – Comparative Evaluation of Head Forms for Blast Injury Assessments

SEAS Research Information
Pamela M. Norris, Associate Dean
University of Virginia
Box 400242
Charlottesville, VA 22903
pamela@virginia.edu
434.243.7683

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