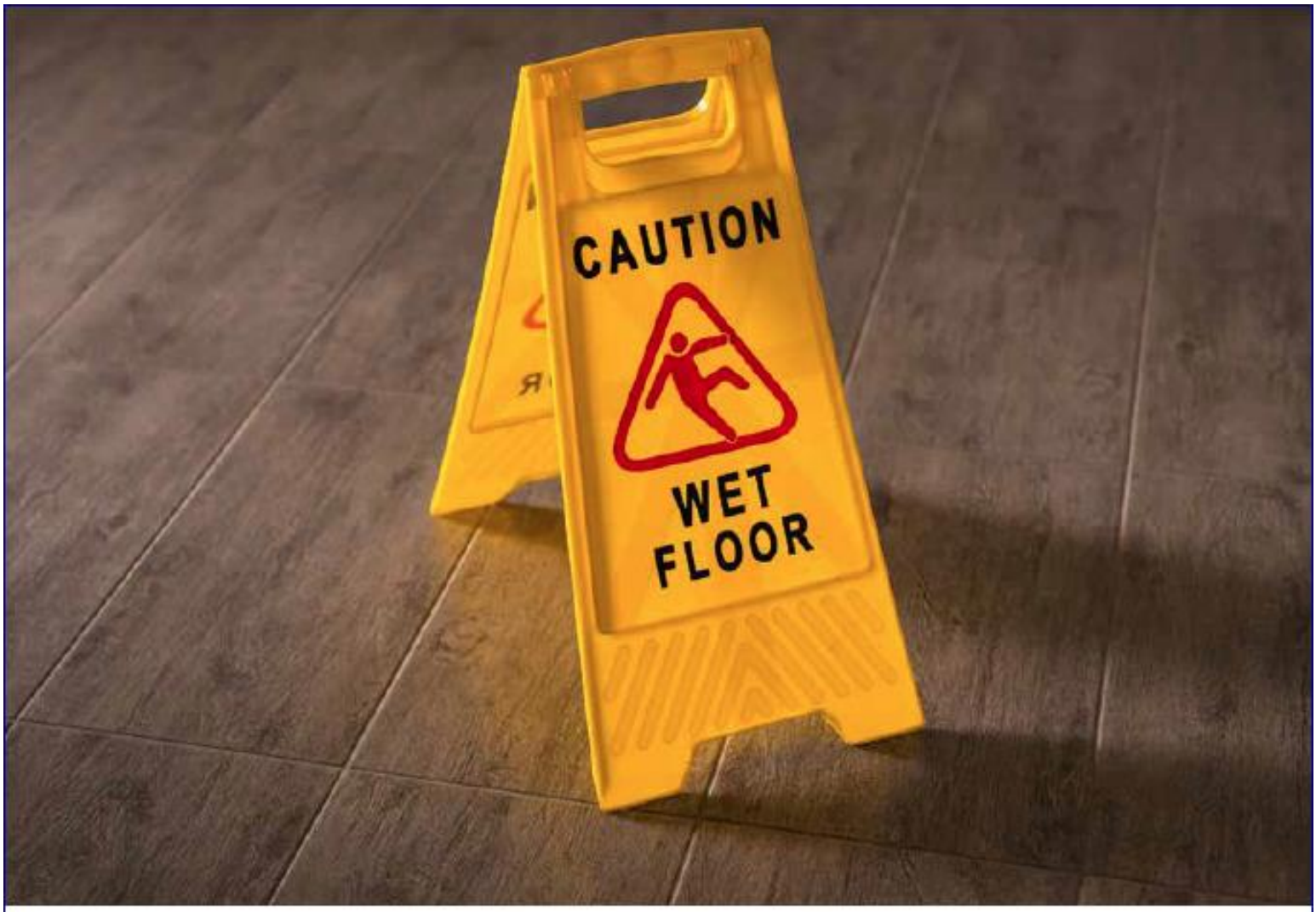


BIOMECHANICAL AND KINEMATIC EVALUATIONS OF SLIP, TRIP AND FALL ACCIDENTS

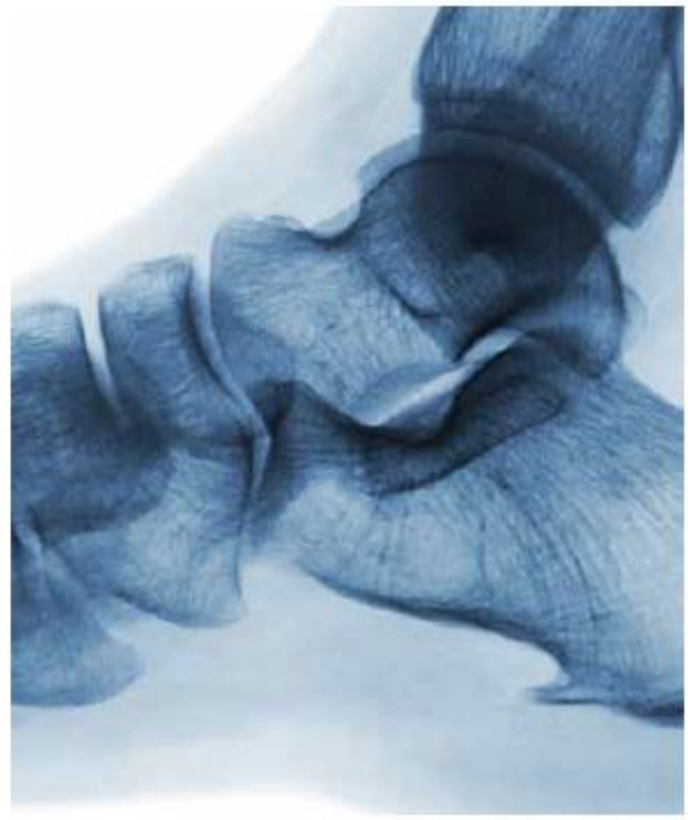
Andrew Rentschler, Ph.D.

The danger of slip or trip and fall events is well documented and a leading cause of both accidental deaths and injuries in the United States. Per the National Floor Safety Institute, falls account for over eight million hospital emergency room visits per year representing the leading cause of visits (21.3%). Furthermore, slips and falls account for over one million visits representing 12% of total falls. When an individual is allegedly injured due to a slip or trip and fall event, the ensuing investigation commonly focuses on the reported hazard and whether or not any relevant building or property codes or regulations were violated. However, in cases of fraud, it can be difficult to mount an effective defense based solely on codes and regulations. The use of an expert qualified in

the areas of biomechanics and kinematics can provide invaluable insight into the fall event and what factors may or may not have contributed to the alleged fall. The purpose of a biomechanical and kinematic analysis of a slip or trip and fall incident is twofold.

A biomechanical analysis can determine whether the necessary injury mechanisms were produced to result in the claimed injuries. A proper biomechanical injury analysis is based on a well-established and sound scientific methodology that has been subjected to peer-review and publication and has been generally accepted by the scientific community. From a biomechanical perspective, the relationship, or lack thereof, between an event and an injury is determined by the presence or absence of an injury mechanism. An injury mechanism is the fundamental mechanical process that leads to tissue failure or biomechanical failure. The presence or absence of an injury mechanism is addressed by answering two critical questions. First, did the subject incident load the body in a manner known to damage the body part? Second, did the subject incident load the body with sufficient magnitude to exceed the tolerance or strength of the body part? If forces were applied in the proper manner and with sufficient magnitude to exceed the tolerance or strength of a body part, then an injury mechanism was present and causation between the subject incident and the injury cannot be ruled out. If an injury mechanism was not present (i.e. a force was not applied in the proper manner and/or with sufficient magnitude), then causation between the subject incident and the injury cannot be established. This means that even if a hazard did exist and contributed to or caused a slip or trip and fall incident, the alleged injuries may not be related to the actual event.

Consider an individual who slips and falls backwards onto his buttocks and back on an icy sidewalk. The claimant then alleges that his left foot slid forward and he sustained a meniscal tear of the left knee as a result of the fall. The injury mechanism responsible for a meniscal tear involves twisting of the knee joint during weight-bearing flexion (paired compression and torsion) that produces loads in excess of physiologic limits. In the absence of this acute injury mechanism, scientific literature has demonstrated that meniscal pathologies are often chronic in nature and associated with the normal aging process. During the slip phase of a slip and fall incident, the leading foot/leg that undergoes forward translation due to a hazard or slippery surface becomes non-weight bearing. As an individual falls rearward onto his buttocks and back, the left knee is also not exposed to any type of significant loading or twisting. As such, during the subject slip and fall event, the claimant's left knee is neither loading in the correct manner nor with sufficient force to produce a meniscal tear. Therefore, the claimed left knee meniscal tear is not causally related to the slip and fall incident. However, sometimes causation between the injuries and the incident are not in question. For instance, one would be hard pressed to prove that an ankle fracture was not the result of a fall event. In such a case, a kinematic analysis can prove useful in determining liability.



A kinematic analysis of a slip or trip and fall incident evaluates how a claimant's body would move based on the description of the incident. The kinematics of gait analysis and slip and fall events have been well established through research and human subject testing. During normal gait, as the rear leg is swung

forward, the heel of the now leading foot is the first to contact the walking surface. It is at this time, referred to as "heel strike," and the weight of the body begins to be transferred from one leg to another. If there is insufficient friction between the heel of the foot and the ground, the foot can slip forward, resulting in a loss of balance and possible fall event. As the leading foot slides forward, the center of mass of the individual begins to fall and move rearward of the body's base of support resulting in the rearward rotation of the body. Therefore, most slip and fall events result in a rearward fall where the individual rotates backward and impacts his buttocks on the ground.

Fundamentally, a trip event occurs when the forward progress of the lower extremity is unexpectedly impeded to the extent that it causes the body's center of mass to move forward beyond its base of support. Ultimately, the body's dynamic equilibrium can be compromised. Generally, this mechanism requires the toes or front part of a person's foot to interact with an obstacle in an abrupt manner as the leg swings forward. The obstacle must be elevated above the plane of the walking surface given the kinematics during the swing phase of the gait cycle. The swing phase begins with toe-off where the foot is lifted upward and forward off the ground, transitions into mid-swing where the foot clears the ground with approximately a ½ inch and then ends at foot contact. Contrary to a slip event, a trip and fall incident will commonly result in an individual falling forward onto his hands and knees.

Traditionally, a kinematic analysis can be utilized to critique the description of an incident based upon the statements or deposition testimony of a claimant. For instance, an individual might claim that he slipped on water and fell forward onto his knees. This description contradicts how a person would move as the result of a slip, namely rearward onto his buttocks. Often times individuals involved in fraudulent claims are unaware of fall kinematics and how the body will actually respond to a given hazard. Furthermore, the advent of affordable and portable digital surveillance equipment has meant that many businesses and properties are now under constant surveillance, and fall incidents are often captured on video. In these cases, the video surveillance provides an unbiased record of what actually happened to the claimant. A biomechanical engineer can analyze the video and accurately and reliably determine whether the fall incident was caused by a true hazard. In cases of fraud, a claimant's kinematics captured on video can demonstrate how the incident was staged. The video also provides powerful evidence during presentation at trial. The biomechanical engineer can slow down the video and go frame by frame to explain to the jury exactly how the claimant moved during the incident and whether or not his movements were consistent with a slip or trip event. For instance, in one such case an individual claimed that she slipped and fell due to water on the ground in a grocery store. However, the surveillance video demonstrated that the claimant began to bend at the knees and her pelvis and torso dropped straight down to the floor. There was clearly no rearward rotation of the claimant's center of mass as would be expected during a slip event. Furthermore, while the claimant testified that her left foot slid forward initiating the slip event, the video clearly showed that just prior to dropping down to the ground, the claimant swung her left foot forward where it remained stationary during the rest of the event. In this case, the jury was presented with compelling evidence, including a breakdown of the incident video, which the claimant was unable to counter. ARCCA has performed numerous such investigations evaluating fall events from videos of retail stores, hotels, and apartments, and has successfully defended many of these cases at trial.

There can be several important aspects to a slip or trip and fall event. In addition to researching any applicable codes and regulations, a biomechanical engineer can also evaluate the biomechanical and kinematic aspects of a fall case. Performing a biomechanical injury analysis can appraise whether a claimant's injuries are causally related to the fall event. Determining how an individual would physically fall during an alleged gait disruption event can provide valuable insight into whether the incident was staged or whether any reported hazards actually contributed to the fall. Analysis of surveillance video of a fall event can also be utilized to provide powerful and compelling evidence for the defense. Therefore, the use of a biomechanical expert to assist in evaluating a slip or trip and fall event can provide several different avenues of investigation to help determine how or if a fall event happened and what the subsequent injuries truly are.

Andrew Rentschler, Ph.D. is a biomechanist specializing in the study of forces and mechanics associated with injuries to the human body. He applies this work to all segments of the human body involved in collisions and other impact-producing events.