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INJURY CAUSATION ANALYSIS

by
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Typically, a biomechanical injury analysis will seek to identify the mechanism by which an injury occurred and whether or not the injury was caused by a particular event. If too many possible scenarios are included in the analysis, they can obscure the actual injury causation. Therefore, whenever possible, the analysis should be simplified and better focused by eliminating as many alternatives as possible. One basis for elimination is if an injury or condition was "pre-existing," that is, in existence before the crash event occurred. In this context, a "pre-existing condition" can be broadly defined as any process or condition that had it's origin before the event being studied. This would include a previous injury, a previous disease process, and a previous condition that required medication that produced relevant side effects.

The following provide examples of 1) previous injury, 2) previous disease process and 3) a previous condition that required side-effect producing medication. 1) In the absence of a "before" x-ray, a pre-existing (but previously undiagnosed) bulging intervertebral disc was mis-characterized as post-traumatic. 2) In the absence of a "before" test, hearing loss detected after an airbag deployment was originally thought to be "post-traumatic," due to a single exposure to airbag deployment noise. Rather, the hearing loss was due to occupation- and hobby-related noise exposure over a period of years. (It is also noted that the noise produced by the crash per se can be significant.) (Rouhana, 1994) Hiatial hernia may be detected after a chest or abdomen impact. However, this hernia is a very common condition – it is present, often without symptoms, in more than 60% of the population that is over 60 years of age. (Goyal, 1987). As another example, degenerative joint disease may worsen over time, even without any new joint trauma. 3) Medicines can adversely affect alertness (e.g. sleeping pills) or judgment (e.g. stimulants) and thereby, may affect a driver's propensity to be involved in a crash. Also, if a condition like asthma requires long-term steroid use, that could result in weakened bone structure and thereby make the individual more susceptible to bone fracture. In at least one instance, high blood pressure has been hypothesized to be post-traumatic, but was in fact a side effect of (coincidental) resumption of oral contraceptive use.

Rather than causing an injury per se, a pre-existing condition may be a contributing factor. Examples include pre-existing disease, structural anomalies, syndromes and aging. Pre-existing diseases, such as tuberculosis and osteoporosis, compromise the strength/flexibility of the spine and thereby can increase the risk of traumatic injury (Pike 2002.) Other pre-existing structural anomalies of the spine, such as spinal bending or twisting (e.g. non-physiologic lordosis, scoliosis) or the presence of a transitional vertebra (a hybrid vertebra, that possesses some of the structure characteristic of its own region e.g. lumbar, and some structure characteristic of an adjacent region) can also affect the spine's biomechanical tolerance to trauma. Turner's syndrome may include structural anomalies of the chest wall and aorta, which could affect the biomechanical tolerance to chest injury. Turner's syndrome may also include spatial orientation symptoms, which may be related to crash avoidance capability. Pre-existing structure may also cause or pre-dispose to repetitive use injury (sometimes referred to as "cumulative microtrauma".) For example, a part of the shoulder, the acromion, may be shaped in such a way as to be confining and cause excessive frictional wear of the tendons and other soft tissue, during everyday shoulder movements. In particular, tears of the supraspinatous tendon (part of the "rotator cuff") are frequently associated with an anteriorly hooked (type III) acromion (Steinbach, 1998). Meniere's syndrome can affect hearing, produce ringing and dizziness and may worsen over time. Thus, if not diagnosed pre-event, a hearing loss detected post-event may be due to natural disease progression, without any contribution of the crash. Age may also contribute to injury occurrence and injury outcome. In general, an older individual has less accident-avoidance capability, is more frail and hence will have a lower threshold for injury to occur and is less likely to recover from a given injury (Pike 1990, Pike 2004). A previous injury may also be relevant if like the current injury, it was produced as the result of risk-taking behavior. It could be especially significant if the patient had a number of previous injuries, which, even if not directly related to the type or site of current injury, may demonstrate a pattern of risk-taking behavior.

Even if a condition is first noted after an event occurs, injury analysis may determine that it is not causally related to the event being studied. For example, if an airbag deployed during a crash and the vehicle occupant in that seating position was found to have an eye injury, it does not necessarily mean that the airbag deployment caused the eye injury, e.g. the eye injury may have been caused by contact with the vehicle interior. (It should be noted that many eye injuries occur in vehicle crashes that do not involve airbag deployments.) (Duma, 2003) Injury also may be caused or exacerbated post-event, by a "Good Samaritan." For example, an injury may be produced by neck movement in conjunction with extraction from a vehicle and/or as part of mouth-to mouth resuscitation. Similarly, rib fractures caused by resuscitative efforts, e.g. chest "thumping"/chest compression, may be incorrectly

attributed to chest impact during a traumatic event (and thereby may lead to the formulation of non-applicable injury mechanisms.)

Very often, patient-provided history provides a basis for the impressions formed by clinicians and the opinions formulated by consultants. Thus, if a patient forgets to mention a previous injury, the clinician may reasonably (but incorrectly) conclude that the current signs and/or symptoms are due to a recent event, e.g. crash or fall, when in fact, they were pre-existing. Similarly, if a patient is unaware of the significance of improper seat belt usage (e.g. worn behind the back or under the arm) and therefore does not mention it, the resulting injuries may be ascribed to the wrong mechanism. In many instances, comparing clinical notes with patient-provided history can provide a useful measure of consistency. In some instances, the two sources will have the same focus and in other instances, the clinical notes may be applied indirectly, e.g. to establish time of onset regarding a clinical condition that is different from the condition that was being "tested." For example, a notation from an exam shortly post-incident, noting that the "cranial nerves were grossly tested and all intact with no complaints of pain," was used, in retrospect, to addresses the existence of TMJ pain at the time of the exam. Although TMJ injury was not a complaint at the time of the exam, the cranial nerve testing involved moving the jaw and examiner contact with the jaw (Rovit, 1993) and so later complaints, that described the TMJ pain as starting immediately after the event and continuing for several months, could be compared with the cranial nerve test results.

The usual injury sequence may even get reversed, that is, rather than causing an injury, a crash may be caused by an injury or disease. For example, an event such as a heart attack or epileptic seizure while driving may cause the driver to lose control of his vehicle and crash into another vehicle and/or a roadside object. In some instances, an apparent injury may turn out to not be an injury at all. For example, a relatively straight appearance of the spine on lateral cervical x-ray may be interpreted as indicating (trauma-induced) neck muscle spasm. However, the straightening may merely be reflecting the normal population variability in spine straightness or a transient chin-on-chest head position that tended to straighten-out the neck at the time of imaging (Harris, 1993).

In summary, we have seen some examples of how a biomechanical analysis can help to determine the cause of an injury and how factors like pre-existing conditions and correlated but non-causally-related conditions can greatly complicate the analysis.

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Much of the material in this paper has been derived from a Society of Automotive Engineers (SAE) seminar, "Forensic Analysis of Medical Records in Injury Biomechanics and Accident Reconstruction." This two-day seminar is presented several times each year (www.sae.org) and may be of interest to those seeking to expand on this discussion.

ABOUT THE AUTHOR

Forcon Consultant Jeffrey A. Pike, formerly Senior Technical Specialist for Injury Mechanisms and Biomechanics at Ford Motor Company, is a new member of Forcon's consulting and expert witness team. Mr. Pike spent thirty-two years of service with Ford Motor Company including serving as a corporate spokesman.

He is the author of textbooks on Automotive Safety and on Neck Injury, a Adjunct Professor of Biomedical Engineering at Wayne State University, and a society of Automotive Engineers (SAE) conference organizer and speaker on topics including Vehicle Rollovers, Older Drivers, Occupant Protection , Lower Limb Injury and Airbags.

Mr. Pike is also Course Director and Principal Lecturer for more than fifty SAE Professional Development Automotive Safety seminars, and a Member of SAE Human Biomechanics Simulation Subcommittee Injury Criteria Task Force and Occupant Protection Committee.

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FORCON News

FORCON International's Virginia office has opened it's Marine Investigation Division! Walter S. Laird, P.E., C.M.I. is responsible for managing FORCON's Virginia engineering team.

Walter has two Marine Architecture degrees from MIT-Massachusetts Institute of Technology and a degree in Materials Science from Johns Hopkins University. He is a registered Professional Mechanical Engineer and Certified Marine Investigator. Walter is retired from the Nuclear Power Program of the United States Navy and is a certified Naval Nuclear Engineer. Since his active service, he has practiced engineering in the heavy equipment field, and both the marine and amusement industry. Walt is involved in the following types of marine investigations:

- Marine vessel and equipment analysis
- Failures of plastic and metallic components
- Marine materials and parts failures
- Boat accident reconstruction and analysis
- Welding failures and analysis
- Corrosion failure analysis

"MV WHISTLE"

MV Whistle, a 1985 37' Lord Nelson Victory Tug, is the marine division headquarters for the East Coast region. This vessel boasts a hand-laid solid fiberglass hull with a 100 horsepower Cummins engine, beautiful teak and holly interior, SI TEX electronic systems and four 250 gallon capacity fuel tanks.

To contact Walter Laird, P.E., please call our Richmond, Virginia engineering office at 804-788-9003

NEW MECHANICAL ENGINEER - Roanoke, Virginia

FORCON International welcomes Hank Simpson, P.E. our new mechanical engineer out of Roanoke, Virginia! Hank has been a licensed professional engineer for 17 years and has more than 25 years experience in engineering design, engineering management, and production management. In the course of this career, he has investigated countless cases of equipment and component failures, and numerous personal injuries.

Most of Hank's career was spent with a Class I railroad, which provided a broad range of engineering experience including stress analysis and structural design, welding and fastening, corrosion, brake equipment, castings and forgings, engineering documentation and standards, and engineering management. He served on Association of American Railroads technical committees that developed industry regulations for a number of equipment issues including wheels, bearings, lubrication, and fatigue analysis. In a management role, he directed engineering staff in the development of rail car and related design, modification, and maintenance projects exceeding $50 million in annual expenditure.

Hank also has hands-on experience in production management, and served as Assistant Manager of the railroad's flagship manufacturing facility, which employed more than 400 people. He was responsible for all facets of operation including production, personnel, safety and environmental, facilities maintenance, and facilities planning.

More recently, Hank has served as Engineering Manager for a manufacturer of precious and specialty metal products. His responsibilities have included oversight of design and maintenance for a variety of specialized mechanical, hydraulic, and electromechanical equipment.

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FORCON SEMINARS CONTINUE TO BE WELL RECEIVED

This has been a busy year for two FORCON seminars.

The first entitled "CRASH SCENE MANAGEMENT TECHNIQUES FOR COMMERCIAL VEHICLE LITIGATION SUPPORT" is presented by Stephen B. Chewning, Forcon's Accident Reconstruction Coordinator. This seminar deals with the importance of early documentation of the crash scene evidence and the proper way of gathering the facts.

The second seminar entitled "ANALYZING AND EVALUATING SAME LEVEL FALL CLAIMS USING FORENSIC BIOMECHANICS" is presented by Michael L. Romansky, Ph.D., J.D. and John P. Leffler, P.E. CXLT. This seminar deals with the slip and fall claim which is one of the most frequent claims plaguing "premises liability" and potential fraud. This seminar has been very beneficial to our restaurant and leisure industry clients.

To set up a seminar please contact Bob Dwyre at 727-409-5701. Both seminars are approved for adjuster continuing education credits in Florida, Georgia, North Carolina and Texas.

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