MILD TRAUMATIC BRAIN INJURY FOLLOWING CERVICAL ACCELERATION/DECELERATION INJURY

Trauma sustained in motor vehicle collisions (MVCs) is the single most important cause of both fatal and mild brain injuries, causing 67% of all cases. The most common diagnosis given is concussion. The head and neck, being suspended at the end of a comparatively inflexible torso, are subject to high acceleration forces during a MVC that often result in injuries to these areas. In low-speed rear impact collisions (LOSRIC), head acceleration is frequently two and one-half times that of the vehicle, and brain injury is a common consequence. Many of these MVC-related injuries are the result of blunt head injury, which describes contact with some object, but without penetration of the skull. An example would be striking the steering wheel or doorpost. However, even without head contact, MVCs can produce very high accelerations of the brain with resulting brain injury.

The source of the brain trauma was previously thought to be a shearing of axons, which result from abrupt acceleration and deceleration of brain tissue. During a low speed whiplash injury in an approximate 7 mph collision the head may be accelerated to 9-18 g. Since the brain is a soft structure, shear strains are created as the outer part of the brain moves at a different rate than the inner part of the brain. Movement of the brain within the skull also results in high intracranial pressure gradients. At the time of injury, the brain is subjected to massive depolarization and tissues are damaged through transient shear forces that mechanically deform axons and microvessels.

Jane et al. (1) proved conclusively that non-centroidal accelerations of the head without contact could produce damage to axons. Animals were subjected to non-centroidal accelerations of 60° within a span of 5-25 msec, which is equivalent to 4190-21,000 rad/sec². These animals experienced a brief loss of consciousness (LOC).

Most brain injuries are minor, defined as producing a Glasgow Coma Scale of 13 or more, and the term mild traumatic brain injury (MTBI) is most useful. These injuries constitute a very extensive subgroup of patients. From within this subgroup, the spectrum of injury ranges from mild concussion without LOC, but with some amnesia or confusion, to the classical concussion with brief LOC, amnesia, and mental changes that can be permanent. The postconcussion syndrome (PCS) can develop from either, and posttraumatic headaches (PTHA), which are often an integral part of PCS, are very common residuals, lasting anywhere from six months to several years. MTBI presents a risk of PTHA of about 40-60% (2).

Radanov et al. (3) have studied the incidence of PTHA and cognitive deficits seen following whiplash some injuries. While they found that a history of headaches before the injury
significantly increased the likelihood of posttraumatic headache (by a factor of more than two), this occurred only with findings indicative of significant injury to the cervical spine. They studied a random sample of 98 "common whiplash" patients, and evaluated them for evidence of cognitive impairment. After six months, 67 patients had recovered fully, while 31 were still symptomatic. It was noted that the symptomatic group, who were older at baseline, provided a greater variety of symptoms, greater neck pain intensity, and greater cognitive impairment. Neuropsychological function had returned to normal after six months in all cases, but the symptomatic group displayed delayed recovery in complex attentional functioning.

Unfortunately, many of these head injuries are too subtle to be discovered by means of most of the diagnostic tests available today. However, researchers have demonstrated areas of hypoperfusion and hypometabolism (diminished blood supply) in the brains of CAD patients using SPECT and PET, respectively.

The concept of MTBI is somewhat controversial, dating back to 1961, when Miller (4), in a classic writing, suggested that most of these complaints were the result of "litigation neurosis." His theories have since been almost universally debunked, although they remain influential in medicolegal settings for obvious reasons! Furthermore, virtually every study ever published on the outcome of CAD injury in which litigation was an outcome variable, has failed to show a correlation.

In patients with MTBI in addition to whiplash injuries, psychological consequences can be very significant. Mayou and Bryant (5) reported that, "We conclude that the continuing report of neck symptoms at three months and one year is largely unrelated to the psychological and social variables assessed at, or soon after, injury or to compensation."

Based upon the data that is readily apparent in the literature pertinent to whiplash injuries, the forces involved in MVC associated cervical acceleration/deceleration can and do produce injury to the brain. The resulting symptom complex and consequent treatment is often overlooked and/or downplayed in the context of typical health care delivery.

Fortunately, most of these patients’ symptoms will resolve approximately three months post-injury, however, an important segment of them, especially patients who are older, have preexisting medical or psychiatric conditions, or substance abuse, will have longer recoveries. Some patients will have permanent deficits.

REFERENCES:


