Cerebral Concussion in Sport
Management and Prevention

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Summary

This article explains the various stresses (tensile, compressive, and shearing) that can affect the brain, and how they may produce the different types of brain injury. The biomechanical forces and dynamics that produce coup versus contra coup injury are covered, as are the common intracranial athletic head injuries, i.e. concussion and the various intracranial haematomas (epidural, subdural, subarachnoid and intracerebral). Though less common in occurrence, because their outcome is so catastrophic, space is also devoted to the recognition, the treatment and (especially in the latter case) the prevention of the malignant brain oedema syndrome of the adolescent and the second impact syndrome of the adult. A major emphasis of this paper is the recognition of the 3 grades of cerebral concussion and the delineation of clear guidelines as to when it is safe to return to collision sports after sustaining such injuries, for the first, second or third time during a given season. Clear guidelines are also presented as to when to discontinue collision sport competition for the remainder of the season after multiple concussions. Because of the concern for the second impact syndrome, the requirement to never allow an athlete with postconcussion syndrome symptoms to return to competition is emphasised. Also covered is the prevention of head injuries, which sports are at greatest risk, and the need for additional research on the cumulative effects of concussion.

The central nervous system, brain and spinal cord are incapable of regeneration. Although many parts of the body now can be replaced by organ transplantation or artificial hardware, this is not possible for the brain. Brain injuries are one of the most common catastrophic athletic injuries and a leading cause of athletic death (Mueller & Cantu 1990).

According to statistics compiled by the US National Center for Catastrophic Sports Injury Research, those sports that have the greatest risk of causing catastrophic head or neck injury per 100 000 participants include football, gymnastics, ice hockey and wrestling (Mueller & Cantu 1990). In football, the use of the head in making a tackle is the most common cause of head injury; in gymnastics, it is the dismount in which one accidentally lands on the head; in wrestling, it is landing on the head in the process of the take-down; and in ice hockey, it is striking the boards head first. Other sports that entail a significant chance for head injury include the pole- vault in the track and the head-first slide in baseball. Also included in this category are equestrian sports, especially horse racing (Barber 1973; Barclay 1978), as well as motorcycle, automobile and boat racing (Bodnar 1977; Clarke & Braslow 1979), sky diving (Krel 1965; Petras & Hoffman 1983), boxing (Putnam 1983, the martial arts (McLatchie et al. 1980) and rugby (McCoy et al. 1984).

Sports that carry a risk for catastrophic head injury pose an even greater risk for minor head injuries. In the US, American football, because it is played by more than 1.5 million high school and college athletes, causes more minor head injuries than any other single sport. The incidence is estimated to be 250 000 per year, or approximately 20% (Gerberich et al. 1983).

1. Mechanisms of Head Injury
1.1 Biomechanical Forces that Affect the Brain

An understanding of 3 principles is necessary in order to comprehend how biomechanical forces produce skull and brain injury. A forceful blow to the resting movable head usually produces maximal brain injury beneath the point of cranial impact (coup injury). This is the situation when the head in a resting state is forcibly struck by another object such as a left hook or an opponent's football helmet (Albright et al. 1985). A moving head colliding with a nonmoving object usually produces maximal brain injury opposite the site of cranial impact (contra-coup injury). An example is an individual falling over backward, striking the head on the ground at the instant of impact. If a skull fracture is present, the first 2 dicta do not pertain, because the bone itself, either transiently (linear skull fracture) or permanently (depressed skull...