SYMPOSIUM ON HEAD INJURIES*

MECHANISM OF SCALP AND SKULL INJURIES, CONCUSSION, CONTUSION AND LACERATION*

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Head injury occurs as a result of the absorption of energy and may be classified as being either direct or indirect. A direct injury occurs when the head comes in contact with another object because of a difference in their velocities. Thus a moving object striking a stationary head or a moving head striking a stationary object will produce a direct injury. An indirect injury to the head is produced when the body is suddenly set in motion or brought to rest and forces are applied to the head indirectly, as in whiplash injuries or a fall in which the subject lands on his feet or buttocks. Regardless of whether the injury is direct or indirect, certain physical conditions are imposed on the head as energy is absorbed. These include deformation (change in shape of the skull), and acceleration or deceleration of the head caused by a blow. In the usual head injury in civilian life, deformation and acceleration or deformation and deceleration exist simultaneously or develop in rapid succession. With a direct injury it is possible that the head alone may be involved whereas with an indirect injury there is likelihood of damage not only to the head but to other parts of the body as well. In indirect injuries it is not essential for the head to come in contact with a non-moving or slower moving object. The sudden acceleration of the head may produce sufficient physical force to result in intracranial damage. The so-called “whiplash” injuries of the head and neck and injuries of the head in a fall with the lower parts of the body first striking a nonmoving object are examples of indirect forces acting upon the head.

Injuries of the craniospinal junction are frequent in head injury. Setting the freely movable head into motion results in stresses on the structures of the neck that fix the head to the body. These stresses are occasionally so severe as to result in ligamentous and muscular injury, fractures of the cervical spine and spinal cord and brain injury. A discussion of head injury must recognize the occurrence of cranio cervical damage. It is quite possible that a patient suffering from a minor head injury may have sustained a major injury to the cervical spine.

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MECHANISM OF INJURY TO THE SCALP

The scalp, which is so commonly involved in direct injury, presents pathologic changes related to physical properties of the injuring object. A blunt object may bruise the scalp or it may cause cranial and intracranial damage without any apparent injury to the scalp. A sharp object may puncture the scalp or lacerate it. A rapidly moving object, such as in hammer blows, brick injuries, etc., may contuse and lacerate the scalp. At times an injury to the scalp may not be apparent for several hours or days since the discoloration of the scalp from an underlying hemorrhage may be delayed. The presence of hair obscures a complete examination. The old custom of examination by completely shaving the head was of merit in this respect.

In the low-velocity injuries to the scalp, the edges of the wound are less damaged, although ragged and contaminated, than in high-velocity wounds. The latter may result in devitalized tissue, several millimeters to 2 to 3 centimeters in width, about the borders of the wound. In management of high-velocity wounds a more extensive debridement of the edges of the scalp may be required.

MECHANISM OF SKULL FRACTURE

The type of fracture of the skull, whether depressed, perforated, linear or comminuted, depends upon the velocity and shape of the injuring object and the energy absorbed by the head. The faster the blow, the greater the likelihood of depression or perforation. The slower the blow, provided the energy is adequate, the greater the likelihood of generalized deformation of the skull resulting in linear fractures. In the dry skull it has been found that a blow by a steel pellet \( \frac{3}{8} \) inch in circumference traveling at 50 ft./sec. results in a linear fracture while the same steel pellet traveling at 90 ft./sec. causes a perforation of the skull.

The deformation of the skull following the low-velocity impact has been studied by the use of a lacquer termed "stresscoat." It has been shown that with a low-velocity impact an area of inbending occurs around the point of the blow. This area of inbending rebounds if the force of the blow is not severe enough to cause comminution or depression at the point of impact. Simultaneously with the area of inbending, outbending occurs in regions of the skull in close proximity to the site of impact. A linear fracture is initiated in this area of outbending away from the point of impact and not in the inbended area. The fracture then extends toward the point of impact and in the opposite direction towards the base. The point of impact of the blow attracts the fracture line since, as it rebounds, it becomes an area of stress concentration. Consequently, the fracture line usually extends towards the point of the blow rather than to one side of this area. With the "stresscoat technic" vulnerable distant areas of deformation have been identified. For instance, in the forward portions of the vault and at the interparietal regions, blows result in deformations in the roof of the orbit on one or both sides. Occipital blows may result in transverse basal fractures in about 5 per cent.