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Case Report

The Stunned Brain: Neuroanatomical Correlates of an Acute Concussion in Boxing

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Abstract

The 2012 Zurich Consensus Statement defined concussion as a complex pathophysiological process affecting the brain induced by biomechanical forces. Concussive and post-concussion symptoms are currently thought to reflect a functional rather than structural disturbance typically resolving spontaneously with no imaging abnormality. The majority of patients with concussion recover within a 7-10 days period, in some symptoms persist beyond the 1 month generally accepted time frame for recovery. Some patients recover within the above generally accepted time frame but show reemergence of concussion symptoms after minor head bumps. Two such cases in amateur athletes are reported here.

Case Report

A 32-year old right handed professional male boxer with a record of 20 wins, no losses with 10 of the wins coming by way of knockout suffered a brutal KO during a high profile televised bout. The boxer went down with the head striking and then bouncing off the ring canvas. Immediately on impact with the ring canvas the boxer exhibited decerebrate posturing followed by a 20 seconds convulsion characterized by stiffening of the arms and low amplitude clonic jerks of the legs. The referee immediately signaled an end to the fight and motioned the ringside physician to enter the ring to tend to the downed fighter. Examination inside the ring revealed a conscious boxer (eyes open) with unresponsiveness (no response to commands). This conscious unresponsiveness state lasted for about one minute. Pupils were midsize, equal in size with sluggish response to light. The emergency medical service (EMS) personnel stationed ringside were summoned into the ring by the ringside physician. While maintaining spinal fixation, the boxer was placed in a hard cervical collar and lifted on to and strapped on a hard backboard. As this was accomplished, the boxer suddenly became responsive and started punching the air with his gloved hands as if he was back in the midst of the bout. He was combative and attempting to get up from the board. He was restrained by the medical staff. After about 1 minute, he calmed down and became fully alert and oriented. He realized that the fight had been stopped because of a KO and requested the medical staff to allow him to get up. At the post-fight medical evaluation he was determined to have suffered an acute concussion and administered a 90 days medical suspension. A neurology clearance was also requested prior to return to competitive boxing.

Discussion

The 5th international conference on concussion in sport held in Berlin, October 2016 defined a sport related concussion (SRC) as a traumatic brain injury induced by biomechanical forces resulting in the rapid onset of short-lived impairment of neurological function that resolves spontaneously [1]. However, in some cases, signs and symptoms may evolve over a number of minutes to hours. While SRC may result in neuro pathological changes, the acute clinical signs and symptoms largely reflect a functional brain disturbance rather than a structural injury with no abnormality seen on standard structural neuroimaging studies such as CT or MRI.

The centripetal theory of cerebral concussion postulates that in a concussion there is a centripetal progression of strains from the outer surfaces to the core (midbrain and basal diencephalon) of the brain [2-4]. The anatomical localization of memory is in the temporal lobes or orbitotemporal regions. As per the centripetal theory, less degree of force does not penetrate deep into the cortex and so while cognitive and memory dysfunction may result, consciousness is retained. Forces strong enough to penetrate through to the mesencephalic brainstem result in loss of consciousness. It is important to remember that the above theory and biomechanical concepts are largely based on primate research and not on humans. The observation that brainstem signs can occur in the absence of significant "cortical" symptomatology and that cortical signs can occur in the absence of significant "brainstem" symptomatology means that the centripetal theory explains some but not all of the varied clinical semiology of concussion. It is generally accepted that traumatic decerebration, short duration traumatic coma (loss of consciousness) and impact seizure are brainstem release phenomena in which cortical inhibition of normally suppressed brainstem activity is lost due to diffuse cerebral injury. It may also be that the above phenomena are primarily due to failure of activity in the mesencephalic reticular formation and with loss of brainstem reflex response without widespread cortical involvement. The amnesic symptoms noted during a concussion have been postulated to be due to a transient interruption or disturbance in the ascending cortical projections at the level of the mesencephalon. It is hence intriguing to think of a "brainstem concussion" distinct from a "cortical concussion" each with different clinical semiology and symptom complex [4].

The above described clinical semiology of an acute concussion in boxing has not been described thus far in the medical literature. While this "stunned brain syndrome" is unnerving to witness as a physician neurologist because of its dramatic presentation and rapid evolution; the syndrome is self-limited with the boxer returning to baseline neurological function usually in the ring itself. It likely has the bulk of its anatomical focus in the brainstem with some cortical and subcortical contribution.



Understanding the neuroanatomical correlates of an acute SRC as in boxing has important implications for our conceptual understanding of concussion and acute management of these injuries in the ring.

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