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# Neurologic Care in Concussion and Post-Concussive Encephalopathy

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Concussion has become a more recent “medical fad” with a lot of media coverage and hence an increasing incidence. According to the Center for Disease Control (CDC) and Prevention there are estimates of as many as 3.8 million sport-related traumatic brain injuries occurring annually (Centers for Disease Control and Prevention, 2007). Given these numbers, concussion care will require that both primary and specialist physicians feel comfortable in its management. This article will discuss the pathophysiology,

epidemiology, clinical evaluation, therapies and prognosis in patients with concussion. The complex and chronic symptoms after a concussion and their management will be highlighted. Appropriate concussion care is essential for improving both the long and short term outcomes in adolescent athletes. There is an important role for the neurologist in improving the outcome in these athletes.

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## Introduction

**A** concussion is defined as a mild traumatic brain injury (mTBI) induced by biomechanical forces that cause direct or indirect impact to the head. A concussion results in neuropathological changes with possible associated evolution of short- and long-term impairments. In children and adolescents, these changes occur during a critical time of brain development, rendering this population more vulnerable to long-term sequelae. Unlike the popular myth that children are more resilient, their brains are not.

In the past, concussion were graded as mild, moderate, or severe and were given the nomenclature of grade 1, 2, or 3, but this has since been done away with after the 2012 Zurich consensus guidelines and the 2013 American Academy of Neurology Revised Position Statement on Concussion in Sport. The newer evidence supports that a brief loss of consciousness has no predictive value on clinical course or long-term cognitive impairment.<sup>1,2</sup>

## Pathophysiology

Several human and non-human studies propose that a concussion results in a rotational acceleration of the brain with a resultant shear injury and an associated neuronal

depolarization, metabolic derangements at a cellular level, and decreased blood flow. These are all to varying degrees and hence no two concussions have an identical outcome.<sup>3-5</sup> The location of the impact has no defined prognosis or outcome although blows to the top of the head have an increased risk of loss of consciousness.<sup>6</sup>

## Epidemiology

About 13–15% of all sport-related injuries sustained by high school athletes are concussions.<sup>7</sup> The CDC estimates that as many as 3.8 million sport-related traumatic brain injuries occur annually. There is a dramatic increase in the number of adolescents diagnosed with concussion in outpatient and emergency room settings.<sup>8</sup> The incidence is highest among boys playing collision sports like football, ice hockey, and lacrosse.<sup>7-9</sup> In girls, the incidence is highest amongst those playing soccer, lacrosse, and field hockey.<sup>7-9</sup> It is important to note that in children, concussion are frequently seen in non-athletic activities such as biking, skateboarding, ice skating, and motor vehicle accidents.

The burden of care is spread among primary care and specialist providers, but most of this burden belongs to primary care providers who are estimated to manage about 60% of patients.<sup>8,10</sup>

## Clinical Manifestations

### Acute

The common clinical findings that are seen at the sideline or in the setting of an emergency room or

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medical provider's office include headache, confusion, disorientation, memory complaints, stunned appearance, inattentiveness, slow or incoherent speech, gait imbalances, dizziness, vomiting, and emotional or behavioral changes.

Urgent referral to an emergency room should be sought if there is a declining mental status, multiple trauma sites, neck pain, any focal neurological deficits, and concern for skull fracture, seizures, and prolonged loss of consciousness.

### *Subacute*

Most patients will present to the clinician a few hours or days after the incident, and at this time, a careful history and physical examination is again key to exclude any findings warranting urgent attention such as those listed earlier. The typical complaints at this time that would suggest a concussion include headache, dizziness, nausea, photosensitivity, fatigue, self-limited vomiting, feeling mental slowness, trouble with memory (both anterograde and retrograde memory), trouble concentrating, sleep disturbances, and emotional changes.

### *Chronic*

More than 80% of concussed adolescent athletes will have full recovery within 14–21 days of injury.<sup>11</sup> The most common lingering symptoms in the minority include headaches (5.3%), attentional disorders (3.4%), depression (1.4%), and anxiety. It is important to assess the premorbid contribution of these symptoms, as they are often exaggerated after a concussion. At this time, it is not known whether these lingering symptoms are a direct consequence of the trauma, a normal process of recovery, or the psychosocial outcome of the lifestyle changes that occur after being diagnosed with a concussion. Regardless, these chronic symptoms can be burdensome and significantly life altering, and therefore, great care needs to be taken to ensure these children are provided with the appropriate supports to ensure complete recovery. It is more common for the neurologist to be involved at this stage in the disorder.

### *Chronic Traumatic Encephalopathy*

Chronic traumatic encephalopathy (CTE) is a term used to refer to the neurodegeneration that is believed to be a result of the late effects of repeated head injuries. This

term was initially coined *dementia pugilistica* due to the association with boxing in retired players. These repeated injuries are associated with gross changes of cerebral atrophy, cavum septum pellucidum with fenestrations, and shrinkage of the mammillary bodies. There are pathological changes including dense tau immunoreactive inclusions (neurofibrillary tangles, glial tangles, and neurophil neurites), diffuse axonal injury, and TDP-43 proteinopathy. These changes are associated with disordered memory, executive functioning deficits, behavioral and personality disturbances including depression, apathy, impulsivity, irritability, aggression, and suicidality, as well as parkinsonism and motor neuron disease. There are no formal clinical criteria in order to make this diagnosis and in the adolescent population would not be an eminent consideration. The emphasis in adolescence is to prevent the future occurrence of this, if it were possible.

## **Clinical Assessment**

### *Sideline Assessment*

This can be performed by a coach or an athletic trainer if no medical personnel is present. A number of score-based assessments have been developed specifically to guide triage as to whether referral to an emergency room is required. Well-known, standardized assessments include Sport Concussion Assessment Tool version 3 (SCAT3), Standardized Assessment of Concussion (SAC), the Balance Error Scoring System (BESS), King–Devick (KD test), and the Tandem Walk. It is ideal when these assessments have been done in a pre-participation environment with baseline assessments, otherwise median parameters are the benchmark. With any one or combination of these tools, a reasonable diagnosis of a concussion can be made. This is as important as the immediate decision to remove the player from the field is crucial. As a general rule, any impact to the head that results in headache, disorientation, memory concerns, gait or emotional concerns requires immediate removal from the field.

### *Acute Assessments in Urgent Center or Emergency Room*

By a series of historical and clinical factors a diagnosis of a concussion can be made in the absence of any additional testing. The persistence of any neurological symptoms as listed earlier warrants that the adolescent has sustained a concussion. A number of the standardized assessments as listed earlier are

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