Sports Concussions in Children and Adolescents

Nationwide Children's

Concussion in Children and Adolescents

What is a Concussion?
A concussion may be caused by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head. Typically, this results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. Concussions result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.

Concussions result in a graded set of clinical symptoms that may or may not involve loss of consciousness – 10 percent or less have a loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that in a small percentage of cases, post-concussive symptoms may be prolonged. Standard structural neuroimaging studies are usually normal.

Epidemiology of Concussions: More than 30 million children and adolescents participate in sports in the United States each year. There are 1.6 to 3.8 million sports-related traumatic brain injuries each year, and over half go unreported (only 47 percent of high school athletes reported their concussions). The reasons for not reporting include: they didn't want to be held out of play; it wasn't serious enough to warrant medical attention; and, lack of awareness of probable concussion.

Second Impact Syndrome: Second impact syndrome (SIS) occurs when an athlete sustains a second head trauma before the original head injury or concussion has healed. This can lead to acute loss of auto regulation of cerebral blood flow, which leads to diffuse brain swelling, brain herniation, and subsequently paralysis or death. It only takes about two to five minutes for herniation to occur. This is almost exclusively seen in children and adolescents, not in adults.

Scope of the problem

- Mortality rate 50%; morbidity rate 100%
- According to a national registry:
  - 1980-1993: 35 cases
  - 2008: 5 cases

Signs and symptoms include loss of extraoccular movements, dilated/fixed pupils, and respiratory distress.

Signs and symptoms of concussions may be progressive and evolving. The best treatment is prevention.

Symptoms of Concussion

- Headache
- Generalized weakness
- Poor concentration
- Phonophobia
- Insomnia/hypersomnia
- Tinnitus
- Difficulty with memory
- Numbness/tingling
- "Seeing stars or lights"
- Depressed mood
- Emotional lability
- Fatigue
- Dizziness/vertigo
- Vision changes
- "Foggy" or "dazed"
- Nervousness/anxiety
- Nausea/vomiting

Signs of Concussion

- Vacant stare
- Confused
- Unusual emotions
- Disoriented
- Poor coordination or balance
- "Glassy-eyed"
- Loss of consciousness
- Slow to answer or follow instructions
- Unusually quiet
- Inappropriate behavior
- Motor phenomena:
  - Short-lived seizure
  - Tonic posturing
- Personality change

Management of Concussions

The current mainstay of treatment is physical and cognitive rest – rest from TV, video games, computer, athletic events and loud places. The patient may need rest from school, homework and tests if symptoms are present with school activity. Athletes must be asymptomatic before they are permitted to progress.

Return-to-Play Guidelines

- There's no return to play on the same day of incident for young athletes.
- Athletes must be asymptomatic without the use of medicines before they are allowed to progress to sports.
- Athletes must be asymptomatic before they're permitted to progress through the return-to-play protocol.
- A minimum of 24 hours should be spent at each stage. Younger athletes, or those who have a complicated concussion history, will often spend more than 24 hours at each stage.

Return-to-Play Staged Protocol

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective of Each Stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% MHR; no resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer; no head impact activities	Add movement
4. Non-contact training	Progression to more complex training drills, drills e.g., passing drills in football and ice hockey; may start progressive resistance training	Exercise, coordination and cognitive load
5. Full-contact practice	Following medical clearance, participation in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

Diagnostic Technologies on the Horizon

- Structural Imaging
  - CT, MRI, diffusion tensor imaging
- Functional Imaging – used more for research
  - fMRI, PET, brain SPECT
- Spectroscopy: MR spectroscopy (MRS), near-infrared spectroscopy (NIRS)
- Balance testing
  - BESS, Sensory Organizational Test (SOT), gait testing, virtual reality
- Electrophysiological tests
  - EEG, evoked potentials (EK), event-related potentials (ERPs), magneticoencephalography (MEG), HR variability
  - Genetics: APoE4, channelopathies
- Blood Markers: S100, neuron-specific enolase, cleaved
  - Tau protein, glutamate

Sports Medicine Concussion Clinic

The Sports Medicine Concussion Clinic at Nationwide Children's Hospital has a multidisciplinary team of pediatric specialists to best manage concussions in youth and adolescent athletes. Our experts offer something adult care providers can't – a complete understanding of children and adolescents.

The Sports Medicine Concussion Clinic uses sophisticated tools to assess postural stability and neurocognitive functioning as a sensitive way to evaluate young patients with a concussion. Some of these tools include the Balance Error Scoring System (BESS), the Sport Concussion Assessment Tool (SCAT) and a computer-based neurocognitive testing system (Axon Sports).

Neurocognitive (Concussion) Testing

Returning to play too soon after a brain injury, or concussion, may lead to serious, life-threatening complications. A computerized neurocognitive test is just one of the tools, when accompanied by a thorough medical history and exam, that may assist a qualified physician with the return-to-play decision.

Baseline neurocognitive tests evaluate the healthy athlete's decision-making ability, reaction time, attention and memory. In the event of an injury, a post-injury test would give the physician additional information to safely return that athlete to competition.

Although a neurocognitive test will never replace a thorough clinical exam by an experienced clinician, it can be a valuable tool in safely returning an athlete to participation. Furthermore, a more extensive neurocognitive testing program through the Department of Psychology at Nationwide Children's is used for those select athletes who need a more comprehensive evaluation.

When to Refer to Sports Medicine

If an athlete has any of the following conditions, please refer them to the Sports Medicine Concussion Clinic:

- A complicated concussion
- A history of multiple concussions
- A concussion that needs close follow-up
- Post-concussion syndrome that needs more complex management (e.g., pharmacological therapy)

A patient suffering from an acute concussion that rapidly deteriorates should be sent to the Emergency Department for further work-up, including imaging.

Sports Medicine Locations

- Canal Winchester *Close To Home*℠ Center
- Downtown Orthopedic Center
- Dublin Sports Medicine and Orthopedic Center
- East Columbus *Close To Home*℠ Center
- Hilliard *Close To Home*℠ Center
- Marysville *Close To Home*℠ Center
- New Albany Philip Heit Center for Healthy New Albany
- Westerville Sports Medicine and Orthopedic Center

For urgent consultation, call the Physician Direct Connect Line at (614) 355-0221 or (877) 355-0221. To make a referral or for more information, call (614) 722-6200 or (877) 722-6220, fax (614) 722-4000, or visit **NationwideChildrens.org/SportsMedicine.**

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