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Stoppage of Play

Concussions can have serious short- and long-term consequences. So why do athletes risk brain damage by returning to play too early?

By Chris Cooper **October 2013**

Richard Lautens/ZUMA Press/Corbis

Members of a hockey team wear special concussion-monitoring helmets as part of a University of Toronto study.

A little knock on the head can lead to big trouble, though the exact nature of the trouble has yet to be determined. Regardless, it's clear that there are significant problems associated with slamming the brain into the skull.

At present, former athletes are coming clean about depression, memory loss, anxiety and a host of other cognitive impairments related to head trauma. There have been suicides, and family trauma goes unmeasured. Concussion stats are questionable due to under-reporting. Doctors and scientists try to determine how to diagnose and treat concussions before allowing a return to activity, but they can be foiled by athletes and coaches who say everything's fine when it's not.

The latest generation of athletes is more wary to be sure, but many regularly return to play too soon and risk long-term health issues from repeated concussions.

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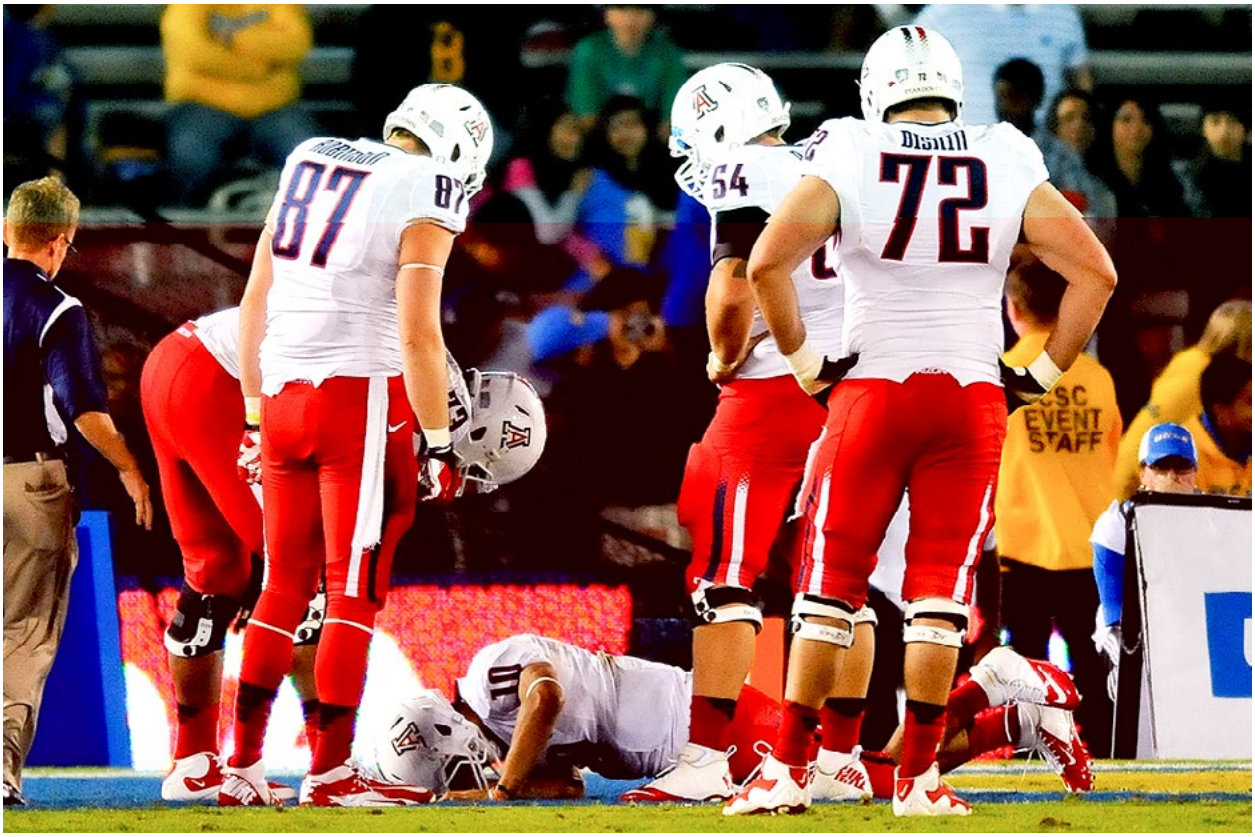
In the most prominent response to concussions in sports, the NFL received its first concussion-related lawsuit in 2011; by Jan. 31, 2012, there had been over 4,000 filings, and a judicial panel consolidated them into a class-action suit. Former players allege that the NFL deliberately concealed knowledge of links between football-related concussions and long-term neurological injuries such as dementia, depression, amyotrophic lateral sclerosis (ALS or Lou Gehrig's disease) and chronic traumatic encephalopathy (CTE).

> Many athletes regularly return to play too soon and risk long-term health issues from repeated concussions.

Critics of the suit argue that the risk is inherent to the sport and should be considered "part of the game." The NFL contends that a direct connection between concussion and traumatic brain injury hasn't been made. Public-health officials say that because epidemiological evidence is always uncertain, courts should follow the precautionary principle used in cases against Big Tobacco to decide settlements.

On Aug. 29, the NFL agreed to settle the suits by paying US$765 million, with most of the money marked as compensation for retirees. A total of $75 million was set aside for medical examinations, and $10 million was put up for research. At press time, the settlement still had to be approved by a federal judge.

Despite the emerging evidence of serious risk, football remains the most popular sport in the United States, with participation growing at every level. USA Football reports over 1.1 million players at the high-school level last year, almost double the number in second-ranked track and



Josh Thompson/ZUMA Press/Corbis

Arizona Wildcats quarterback Matt Scott suffered an apparent concussion during the third quarter of a Nov. 3, 2012, game.

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triple the number in basketball. News stories and lawsuits aren't dampening enthusiasm for a sport where head-on collisions are part of the game.

While the exact cause-and-effect relationship of concussions is being determined by science, it's abundantly clear that head injuries have serious effects in the short and long term. Mystery still surrounds the diagnosis and recommended recovery from concussion, but researchers now believe the responsibility for athlete safety must rest with the player and the parents first.

Anatomy of a Brain Injury

Suspended in spinal fluid and blood, your brain doesn't touch your skull. However, when your skull changes direction rapidly—a sudden stop, start or twist—your brain crashes into bone at speed.

Upon impact, the membranes of affected brain cells become compromised, and potassium rushes out, causing depolarization of the cells. If the affected area is involved with sight, the concussed person may see "stars." If the affected area is involved with hearing, the concussed may experience ringing in the ears. Depolarization continues for five to six minutes, and during that time the neurons affected are unable to fire again. Connected cells shut down to protect the injured neurons, and confusion, amnesia and unconsciousness will result, depending on how widespread the damage is.

The brain needs glucose for repair, but in a protective move the body decreases blood flow to the brain by up to 50 percent to prevent stroke-like damage. Normal blood flow to the brain takes up to 10 days, on average, to resume.

Without potassium in the cell, calcium rushes in, which inhibits neuron firing. It will take a few days to clear out the calcium, which means that affected neurons won't work for the better part of the week. If a cell can't get rid of the excess calcium in that time, it dies.

None of these effects will show up in a CT scan or MRI.

Tony Quinn/ISI/Corbis

Major League Soccer player Logan Pause of the Chicago Fire has at times worn protective headgear after a header gave him a concussion in 2011.

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James Borchuck/ZUMA Press/Corbis

The Riddell Speed Revolution helmet contains a series of internal air bladders, but even the best helmet can't prevent a concussion if the impact is severe.

Even without apparent skull damage, your brain could have taken a beating. Only in postmortem studies are scientists finding "holes" in the brains—large areas of cell death caused by calcium poisoning—of athletes who suffered multiple concussions. These dead zones are responsible for the dementia-like symptoms of punch-drunk boxers, rattled football players and whiplashed accident victims. ALS, early-onset Alzheimer's, depression, anxiety—research has linked a wide spectrum of traumatic brain injuries to sport-induced concussion.

In August 2013, scientists from Boston University published a link between concussion and CTE in the *Brain* article The Spectrum of Disease in Chronic Traumatic Encephalopathy.

Recovery from concussion, including rewiring affected areas of the brain, can take months. Reinjury during this recovery time can make the initial injury far worse: damaged cells lose more potassium, larger areas of the brain shut down and more cells die.

As stated earlier, the long- and short-term effects of concussions are not completely understood, but it's obvious that head trauma requires careful treatment.

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And yet many athletes return to activity before they should. In some cases, they hide their symptoms or lie about them due to a desire to play. In other cases, team doctors might rush players back before they're ready due to pressure from an owner or coach who needs his or her best players on the field. But in other cases, both doctors and patients follow all the correct protocols and still make mistakes.

Problem No. 1: Diagnosis

"So, how smart was your kid yesterday?"

This is an impossible question for parents to answer, but it's part of the typical diagnostic procedure for child athletes with a suspected concussion. Athletes of all ages are typically asked subjective questions—"Do you feel OK?"—and sometimes given cognitive tests to determine whether a brain injury has occurred.

Without a pre-concussion baseline, doctors, coaches and parents have trouble adequately assessing the severity of an injury.

CrossFit uses established baselines, such as Girl workouts, to objectively measure fitness. If you're faster, you're fitter. If you're slower or move less weight, you're less fit. The same standard doesn't apply when it comes to diagnosing brain injuries.

If a child falls on her head, a good ER doctor will give her a post-concussion test and then try to determine the severity of the injury based on her test score. A score below a certain threshold may lead the doctor to prescribe a week away from play. The missing link: what would the child have scored before the brain injury?

Efforts to diagnose concussions faster and better are widespread and well funded. The International Olympic Committee, Federation International de Football Association and other partners adopted the Sports Concussion Assessment Tool 3 (SCAT3) as a diagnostic test in May 2013.

The SCAT3 is a combination of other tests: the Glasgow Coma Scale, the Maddocks score for sideline testing, the Standardized Assessment of Concussion immediate memory recall test, and some examinations for balance and hand-eye coordination.

While some parts of the test are objective—recalling digits in reverse order can't be faked—others can be interpreted depending on the assessor. Some of the answers in the How Do You Feel? section of the SCAT3 include, "In a fog," "More emotional" and "Trouble falling asleep." What teenager doesn't feel those things? The test-retest validity of some sections is also suspect. For instance, every time you try to recall the months of the year in reverse order, you get better at doing so.

Lacy Atkins/San Francisco Chronicle/Corbis

Johnny Damon (right) and Damian Jackson collided in a 2003 playoff game, and Damon was knocked unconscious for several minutes.

Even on the best tests, scores aren't useful without a baseline for comparison. In one test for short-term memory, athletes are asked to recall words read aloud by the examiner. "Elbow, apple, carpet, saddle, bubble"—the athlete is asked to repeat the words in any order. Then the examiner moves on to a balance coordination test; afterward, the athlete is required to repeat the words again.

Without looking in the preceding paragraph, repeat the five words in any order. How many could you remember?

If an athlete can recall four out of five words, the score is four points. But what would that athlete have scored one day earlier without a concussion? What did you score? And what does a four out of five mean anyway? Is it a good number? For whom? The SCAT3 provides no cutoff score for return to play.

Dr. Christina L. Master is a pediatric-sports-medicine specialist at The Children's Hospital of Philadelphia (CHOP). Her research and clinical interests are in the area of pediatric and adolescent concussion. She is also the mother of three children, two of whom play ice hockey.

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Courtesy of Scott Thornton

Concussions are far from rare at hockey rinks, where athletes travel at very high speed and collisions are part of the game.

"We've come a long way in recognizing that there are physical-exam findings that we can use to diagnose concussion," Master said. "That's what we're getting at with the SCAT3. At CHOP, we use the SCAT tests but also an oculomotor, vestibular and balance test. There are very specific eye movements that are observed when you have a concussion. Between that and the symptoms tests, you can make a diagnosis with confidence."

Coaches aren't doctors, and even some doctors find themselves in unfamiliar territory when it comes to determining whether an athlete is fit to play.

The SCAT3 test was designed to be used on the sidelines, and its purpose is to help coaches decide when to remove an athlete from play. But coaches aren't doctors, and even some doctors find themselves in unfamiliar territory when it comes to determining whether an athlete is fit to play.

Courtesy of Scott Thornton

Scott Thornton, now a CrossFit affiliate owner, had several concussions in his NHL career.

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Dr. Master and her colleagues have published clinical reviews on their methods, but delivering the information to physicians, coaches and parents is another matter.

"Most physicians don't know the exam or haven't performed the exam," Master said.

In June 2012, the American Academy of Neurology published a research summary to help primary-care physicians and emergency-room staff diagnose concussions. The summary listed research published before June; Master and her team published their data days later, missing the research summary.

This means many doctors—as well as athletic trainers and coaches—don't have access to the best concussion tests available.

"Most schools don't have athletic trainers. Those few who do only cover football and lacrosse. In middle school, there are none. It all comes down to volunteer coaches," Master said. "So it comes down to the athletes themselves: they have to recognize it."

Problem No. 2: Underestimating Severity

Because a brain injury isn't visible, many athletes, parents, coaches and doctors underestimate how serious it can be.

Worse, kids are unlikely to report concussion-like symptoms, Master said, because they don't know what they are and "playing through" is a sign of toughness.

"I worked with the Philadelphia Flyers, where there's pressure for pay. No one is going to say, 'I have a mild symptom and should be pulled out.' But that's a bad set of role models for kids. A kid's job is school, not sports," Master said.

"Most parents I see kind of chuckle at it," said Scott Thornton, a former NHL player (1990-2008) and owner of CrossFit Indestri in Collingwood, Ont. "If it's my kid, though, he's not playing for a couple of weeks. It is serious. You're talking about peewee hockey in the middle of January. You're in a small town; is it really so important that your son or daughter has to play?"

Mike Warkentin

With concussion awareness increasing, many recreational players are now wearing helmets even in no-contact casual hockey games using sponge pucks.

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Andy Hendel owns CrossFit Charlotte. After years of playing pro football, including a term with the Miami Dolphins, he's familiar with the symptoms of concussion and the rush to return to play.

"I fell in love with the sport because I love to hit and get hit," Hendel said. "I'm not that big—six foot, 225. There's a guy like me coming around the corner all the time. I'm playing a guy who's six-four, 245, doesn't touch a weight. But I was the guy who would run through the wall anyway. That got me in trouble."

Though undiagnosed, Hendel is sure that he suffered concussions multiple times but didn't know the danger. He's not alone: Concussions Among University Football and Soccer Players, a 2001 study by McGill University, found that only 23 percent of concussed football players in their survey realized they had suffered a concussion.

"I remember having a headache for a week after one game against Clemson in college. You just think it's part of the game, because if you're in the training room, you're not playing," Hendel continued. "I remember another game where I got hit on the side of my head and don't remember anything after that, until the rest of the defense was out on the field and I was sitting on the bench by myself. I was supposed to call the huddle. They were looking for me."

Hendel's experience is not an anomaly. According to NFLconcussionlitigation.com, a study of 1,094 former NFL players aged 27 to 86 revealed 61 percent had been concussed once, while 30 percent of them had been concussed three times or more. Incredibly, 73 percent said that they were not held on the sidelines after the injury.

Problem No. 3: Pressure

"If you're not Sid, you're scared someone else will take your job," Thornton said, referring to NHL superstar Sidney Crosby, who suffered a concussion in January 2011. On Jan. 1, he was hit in the head by David Steckel of the Washington Capitals and left the game before returning. On Jan. 5, he was hit by Victor Hedman of the Tampa Bay Lightning and was clearly affected by the contact, though he finished the game. He played just 63 games in the 2010-2011 and 2011-2012 seasons. In late 2011, after developing a headache after a Dec. 5 game, he took and passed a concussion screen (the ImPACT Test) but held himself out of additional games nonetheless.

"The ImPACT (test) isn't everything. You've got to listen to your body on these things too," he told media at the time.

As one of the top players in the NHL, Crosby perhaps has more job security and financial stability than others and can afford to be very cautious. For others with less talent, worse contracts, marginal job security and smaller bank accounts, the pressure to play on can be extreme.

"You don't want to show weakness. You're worried it will be a red flag for the rest of your career, that maybe you won't get another long-term contract. That stuff comes into play at the high levels," Thornton said.

> "Because I wasn't knocked out, I didn't leave the game. I couldn't even drive home."
>
> —Scott Thornton

The NHL requires that players pass a baseline test before being allowed to return to play after a concussion, but Crosby's decision to keep himself off the ice highlights a problem Thornton confirms.

"I have to be honest: you can pass those tests," Thornton said. "I've had three minor concussions all within about 10 days. My trainer knew, but because I wasn't knocked out, I didn't leave the game. I couldn't even drive home."

Though the tests may diagnose a concussion while the player is in the acute stages, the risk for long-term brain injury is still heightened for weeks afterward.

"When you're in the acute stage, there's no way you can cheat (the tests)," Thornton said. "Simple tasks like memory words and doing dot-to-dot are very difficult when you're concussed. But there comes a point when you can pass those tests and still shouldn't be playing."

Thornton continued: "I'm not going to say that I wouldn't do it again."

Kids aren't immune to this type of pressure either, even if they're far from the NHL.

"The first lesson they told us in the CrossFit Kids course is that we need to be the one to tell the kid not to add weight," Thornton said. "If you ask a kid, it's a loaded question: 'Do

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you think you can play?' They're going to say, 'Yes.' We have to be the conscience for them and say, 'It's great that you're OK. I'm going to give you another week.'"

Athletes, even children, are often asked to self-diagnose. "Are you feeling OK? Dizzy? Sick?" The questions might come from parents, coaches or doctors, and even young athletes know that certain answers will earn a seat on the bench.

In a clinical setting, victims of more severe brain injuries are never asked to self-diagnose because the frontal lobe of the brain will disguise the brain's cognitive gaps. Those suffering from brain injury will frequently report that they have no symptoms, even if the cognitive gaps are obvious to everyone around them. With a concussion, the same may be true in a smaller sense: an athlete may attribute the fogginess to a lack of sleep or a headache to chance.

Playing injured or sick is often seen as a badge of honor, even in non-contact sports, and players who are frequently injured are sometimes saddled with derogatory terms while being abused by teammates and hardnosed coaches. Thornton believes the decision to return to play should be taken from the athlete's hands—and the hands of those with a stake in the game.

"Think about how much pressure the trainer is under to keep a guy on the ice. There's a shitload of pressure on those guys. They don't want to go tell their bosses that Sidney Crosby needs another month of rest for an injury that no one can see," Thornton said.

Master says that her own son, who knows the risks well, wouldn't likely report concussion symptoms to his own coach for fear of being branded a wimp. That means it's up to the parents to remove the decision from the child.

Courtesy of Tania Thomas

Decisions involving head injuries should be made by parents, and it's good policy to err on the side of caution. Children should not be asked to self-diagnose or decide whether or not they should continue playing.

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"A concussion may be one of the first injuries a kid has," she said. "It's one of those things where a parent has to pull a kid out of school and sports."

Parents need to be observant, and they need to act, according to Master.

"If a parent suspects concussion, they should pull the kid out of the setting where they're at risk. It's like not letting someone drive drunk," Master said. "If you're one second slow in a youth ice-hockey game, that's a big second. The most important thing is to take your kid from harm."

> "If a parent suspects concussion, they should pull the kid out of the setting where they're at risk."
>
> —Dr. Christina Master

Next, Master recommends a break from all activity, with a gradual return to cognitive tasks, light play and then full play.

"If you pulled a muscle, you wouldn't use it for a while," she said. "Then you'd test it a little and ramp up to full speed again. When you use your brain after a concussion, it hurts. So you don't ask it to do extra stuff like reading, texting or schoolwork. If your kid is bothered by their cell or television screen or smart board, keep them away from those things. After a few days, you start adding them back slowly."

What's the Answer?

Because concussions aren't completely understood, dealing with them can be very challenging. Head injuries cost the NFL three-quarters of a billion dollars. Crosby, perhaps the best player of his generation, has lost a chunk of his prime to concussions. In rinks and on fields all over the world, coaches, doctors, trainers, athletes and parents are forced to make decisions any time a head injury occurs.

How serious was the injury? Is the athlete OK or severely injured though few outward signs are present? Is the athlete lying about symptoms or is a doctor or coach ignoring them because it's a championship game?

The questions persist after the injury as well. How soon is too soon to return to activity? Are the symptoms really gone or is the brain still healing? Will another injury cause irreparable long-term damage? Is a season or even a career over?

Solutions are not easy to find in a sports world where injuries are very much a part of the game but long-term health is critically important. The best answer might be an emphasis on safety in the games and strict protocols for evaluation, diagnosis, treatment and return to activity when an injury has occurred.

Preseason baseline tests are also available in some areas. Athletes can be tested before the start of the season and can then be retested on the same criteria if a concussion is suspected. The difference between scores might make diagnosis easier for the child's physician. But even that plan isn't without flaws.

"We use ImPACT, we use Axon (baseline tests for concussion management)," Master said, "but you can't use them alone. If you do the pretest on the kid while they're with their friends, that's going to affect their score. If you're tired, hungry, have to pee or just broke up with your girlfriend, that's going to affect how you perform."

While the testing and retesting aren't perfect and won't help the athlete recover faster, they might provide clues to the child's progress.

> In the case of an adult or adolescent, the best judge may be the athlete, provided he or she is willing to be honest about symptoms.

"One snapshot in time is all the ER doc gets. You're in an ER, it's quiet … and you don't feel so bad. The doctor may not be the most up to date on all these tests. That's how diagnoses are missed," she said.

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Courtesy of Tania Thomas

Helmets are a start, but cautious, informed parents and coaches are needed to ensure the safety of young athletes.

Anything that will give a doctor a better picture of a change in the athlete's brain function can help, but baseline testing simply isn't the whole answer.

In the case of an adult or adolescent, the best judge may be the athlete, provided he or she is willing to be honest about symptoms. Like Crosby, smart athletes would honestly tell doctors and coaches that they just aren't OK, giving their brains a chance to heal. For child athletes, parents should be watching them very closely after an injury.

"If you go back to texting, watching TV, studying, and you can't do those things, you're not right. If it's a kid, the parent has to watch them. When they feel better doing those things, they're starting to recover," Master said.

At each step, athletes should make small tests: if watching television or reading provokes a headache or dizziness, more rest is required. When those don't trigger discomfort, trying a half day at work or school may be appropriate. Then a full day. Then a jog. When light exercise doesn't affect a player, he or she may return to a modified version of the sport without contact, ramping up to full practices.

Though the time required is different for each athlete, coaches must keep pressure to return in check. Players must also be willing to take a step backward rather than attempting to "push through" a brain injury as they might with a musculoskeletal problem.

"You have to be very aware as a parent, and give your kids a heads-up, too. Don't try to get back to playing too soon; it's not that kind of an injury. Don't push it," Master repeats.

As the NFL addresses head trauma by settling a landmark lawsuit, perhaps the best advice is the simplest: exercise extreme caution with any head injury. If you feel something isn't right with your child, your athlete or yourself, rest the brain until it's healed.

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About the Author

Chris Cooper is a writer for CrossFit. His gym, CrossFit Catalyst, is one of the first to receive insurance funding for treatment of traumatic brain injury.

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