



SPORTS Med

CSMS Committee on the Medical Aspects of Sports

A Service of the CSMS Physicians' Health & Education Fund

June • 2004

Michael A. Lee, MD, Editor

Concussion: Diagnosis, Immediate, and Follow-up Care

The value of neuropsychological testing

Carl W. Nissen, MD

This article discusses concussion and the new neuropsychiatric tests that can be used to mass screen athletes participating in contact sports. This test can help standardize the treatment of concussions and more accurately assess when an athlete may return to competitive sports.

Concussions have always been understood to be a risk of athletic participation. Recently sports medicine providers have become more aware of their occurrences and the immediate as well as long term sequelae that are associated with them. A concussion is defined as an immediate, transient alteration of mental function. While they occur commonly in

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Treatment of ACL Injuries in the Pediatric Population

Kirsten A. Pierz, M.D.

Today, children are starting competitive sports at increasingly younger ages. This correlates with the increasing number of ACL injuries to the knee in younger patients. In the past, most experts have recommended non-surgical conservative treatment. There is now a trend toward surgical repair in younger athletes. This is discussed in the following article.

With increasing numbers of children involved in organized sports, it is not surprising that physicians see an increasing number of injuries to the anterior cruciate ligament (ACL) in their pediatric population. These injuries that were typically seen in adolescents and young adults are now being seen in younger children as well. Many of them have open

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Paintball: Perils and Pitfalls

Patricia Ecker, M.D.

Paintball is becoming one of the fastest growing outdoor sports. Participants and parents need to be aware of the importance of protective gear and safe equipment.

Paintball is a battle game in which players shoot at each other using pressurized gas guns filled with marble-sized paint capsules. The capsules burst upon impact and cover the target in paint. Sounds like fun? Paintball players think so. There can be injuries, however, if the protective gear and equipment are not used properly.

One problem is the size of the paintball. The gelatin, paint-filled ball measures about 0.68 inches in diameter. When fired through a gun at 300 feet per second, it turns into a small missile. Injuries in this sport can be serious because the paintball fits perfectly in the eye socket, increasing the risk of eye injuries.

Researchers from St. Barnabas Hospital in New York looked at unpublished data to describe the increasing incidence of eye injuries during paintball. Study authors say they found the number of paintball eye injuries treated in emergency departments has risen from about 545 in 1998 to more than 1200 in 2000. More than 40% of the injuries were in children. The injuries were seen most often in boys with the most common being bleeding and retinal detachment. In these cases, researchers found many of the children had permanent vision loss.

Severe paintball eye injuries were first

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Improving Sports Care for the Children in Connecticut

Girls Field Hockey and Lacrosse

I am very pleased to report that as a result of the Connecticut State Medical Society's Committee on the Medical Aspects of Sports' recommendation that girls Field Hockey and Lacrosse players wear full masks when playing their sport, the Connecticut Interscholastic Athletic Conference (CIAC) has mandated that girls Field Hockey players will wear eye shields that also cover the nose starting in the Fall of 2004 (Girls Lacrosse players already use a partial face protection). While our committee will continue to recommend full face masks in both of these girl's sports, this is an excellent first step making Connecticut one of the first states to try and reduce the injuries girls suffer in Field Hockey and Lacrosse.

Concussions

Physicians, trainers, and coaches have always had difficulty assessing and treating concussions. Similar but slightly different recommendations have come from different organizations and physicians may treat the same type of injury differently. Adolescents seem to be at greater risk from a concussion than adults, especially as regards the "second impact syndrome" (see Dr. Nissan's article). Until recently, there has been no objective test, done on a large scale, able to measure the effect on the brain from a head injury. CAT scans, MRIs and neurological examinations fail to show what is going on inside a concussed head. With the advent of neuropsychological tests we now have a tool to help us assess the post-concussion athlete. This test does not have to be modified and is also reliable for children with ADD or Learning Disabilities.

It is important to remember, however, that this test by itself is only part of the picture when evaluating a concussion. It needs to be used in conjunction with the CAT scan and neurological/physical exam of the patient. These tests have been used for professional athletes during the past few years.

Our Sports Medicine Committee is working with the CIAC on a program involving a small group of high schools to see if this testing can be adopted state-wide. Prior to the season, athletes will take a computer test at their local school to assess base-line functioning. Should a concussion occur they will have a follow-up test done at the school in addition to their evaluation by their physician. Hopefully this will lead to better care of concussed athletes and allow us to better determine when athletes are ready to return to play.

Baseball Pitching in High School

Our committee is also working on a project with the CIAC attempting to correlate the number of pitches thrown with shoulder and elbow injuries seen in baseball and softball pitchers. Hopefully we may be able to make some recommendations in order to decrease the growing number of shoulder and elbow injuries we are currently seeing in pitchers.



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Connecticut SportsMed

*A publication of the Connecticut State
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contact sports (football, hockey, lacrosse) they also occur in other sports with regularity.¹ The increased understanding of concussions has brought with it many studies and evaluation tools that allow athletic concussion care to improve. Unfortunately, it has also become apparent that while we better understand their incidence there are significant variations in the approach and management of these injuries among trainers, coaches, and physicians.² The concussed athlete's care is not being driven by data and often by individuals without any experience in sports concussions. Improving the diagnosis and care of these athletes is a goal we all share.

Currently the diagnosis of a concussion is based upon the recognition of one or more symptoms following a blow to the head. Table 1 lists some of the more common symptoms and signs of concussions. Once the diagnosis is made, the safety of the athlete is

the focus of care. Standard trauma care is then initiated followed by the determination of the concussion severity and grade as seen in Table 2.³ Once classified, the on-field care of adolescent and high school athletes is well defined by the position statement of the American Academy of Neurologists (AAN) established in 1997.³ In this statement an initial evaluation of the athlete is followed by a repeat examination in 15 minutes. If an athlete has been diagnosed as having a Grade 1 concussion or Bell-Ringer he/she can be allowed back to play that day if all symptoms clear.⁴ However, if symptoms persist then a player is held out from a return that day. These more seriously injured athletes and those rendered unconscious are classified as having Grades 2 and 3 concussions, respectively. They are commonly evaluated in a hospital ER with or without a head CT. It is at this point in the management of sports concussions that extreme variability exists. This variability is

unfortunately the result of a lack of objective information and/or evaluative tools to make further decisions.

Office management of the concussed athlete (e.g. follow-up care) has been guided by experience and a medical provider's 'sense' of when it was appropriate to return an athlete to competition. This non-objective criterion has resulted in varying return to play after Grade 3 concussions from one week to a full-season. The advent of neuropsychological testing has helped in the office setting in the follow-up care of concussed athletes but until recently has been unavailable and cumbersome for the non-professional athlete. This issue is now less problematic as three programs have recently been developed to assist in these situations. These programs known collectively as neuropsychological or neurocognitive assessment tools can be used in conjunction with clinical examinations to help determine when an athlete can safely be returned to play. These tests provide objective documentation of an athlete's mental function and can assist in the determination of when safe return-to-play can occur.² It is important to understand that these tests (i.e. ImPact and Headminder) are only additional pieces of information and not answers in-and-of-themselves. Clinical examinations, basic neurological examinations, and exertional tests are still paramount to making return-to-play decisions. (An exertional test requires that in the presence of a medical caregiver, a concussed athlete perform some simple tasks and thereby raising their blood-pressure. The increased cerebral pressure will reproduce symptoms in an athlete not ready to return to play and demonstrates that further restrictions are necessary.)

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Table 1.—Signs and Symptoms of Concussions

<i>Signs</i>	<i>Symptoms</i>
Confusion	Headache
Vacant stare	Nausea
Disorientation	Vomiting
Amnesia –	Double vision
Retrograde	Photosensitivity
Antegrade	Sleep disturbances
Personality changes	Cognitive changes

Table 2.—Concussion classification

Grade 1
No loss of consciousness
No amnesia
Transient confusion
Grade 2
No loss of consciousness
Amnesia – temporary
Mental status changes lasting more than 15 minutes
Grade 3
Loss of consciousness
Greater than 1 minute

Concussion: Diagnosis, Immediate, and Follow-up Care

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In addition to their utility in return-to-play decisions, these neuropsychological tests have led us to a better understanding of these injuries. One important difference is that it appears that concussions are different in adults than adolescents. Often concussions in the adolescent brain, especially in the repeat concussion situation, have enduring symptoms and/or more significant mental deficits. When followed over time, these injuries appear to leave the adolescent brain more susceptible to repeat, and at times more serious concussions.⁵ This suggests, that in an adolescent brain, the risk of a phenomenon known as Second Impact Syndrome is greater and needs to be guarded against by being sure that an athlete does not return to the field or court before he or she is ready. Second Impact Syndrome is a phenomenon where a susceptible brain is exposed to a second injury, sometimes trivial, causing serious and even fatal problems. Some studies have noted as high

as a 50% mortality rate in these situations demonstrating the severity of this issue.⁶

Recently, the neuropsychological tests have also shown that what has been felt to be a rather trivial, innocuous problem (Grade 1 or 'Bell-Ringer') may not be that at all. Many adolescents suffering from a Grade 1 concussions are allowed back into athletic events though they may have lingering effects for several days.⁷ This suggests that better monitoring and more information is necessary to determine who and when post-concussion adolescent athletes can return to play.

Our increased awareness of concussions is valuable in that it will lead us to better diagnosis and evaluate these athletes. As better tools and understanding of them comes about we will be better equipped to assure the health and safety of athletes with sports concussions.

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Paintball: Perils and Pitfalls

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documented in 1985 and goggles were soon recommended as protection. In recent years, more sophisticated facemasks with protective lenses have become the new standard at organized paintball facilities.

Most supervised paintball sites require players to wear protective equipment including facemasks. However, more and more people, including children, are playing unsupervised in backyards and basements. Children often don't wear the headgear regularly or they take off the mask if they become hot and the mask fogs. This unsupervised situation often leads to injury.

Paintball has moved from an

extreme sport to the mainstream; participation in the sport now numbers more than eight million. With the increasing number of children playing the sport, ophthalmologists urge parents to pay special attention to ensure their children have and wear the proper safety headgear when playing paintball. The headgear should be a specially designed paintball mask made to withstand the impact of a paintball. Most come with face shields, eye armor, and offers further protection by covering the forehead, ears and jaw.

Parts of the paintball gun can be dangerous too. Based on its investigation of two deaths caused by carbon dioxide (CO₂) canisters

flying off paintball guns, the United States Consumer Product Safety Commission (CPSC) recently issued a new warning.

In both of the deaths investigated by the CPSC, the brass valve unscrewed from the canister, turning the pressurized canister into a deadly projectile. In June 2003 a boy died after being struck in the head by a paintball CO₂ canister as he was removing the canister from the gun. In February 2004 a mother, who was watching a paintball party, was killed by a CO₂ canister that was expelled when someone else was removing a canister from a paintball gun.

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Paintball: Perils and Pitfalls

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Parents also need to know that they can be held liable for injuries that their children inflict while playing paintball. In June 2003, a 13 year old boy, perched on his roof, fired at a 12 year old girl who stood in her driveway. He fired twice without hitting her, then hit her in the eye with the third shot. The girl suffered retinal damage and lost partial sight in the eye. The parents and the boy were held liable for the injury.

Parents should remember to:

- Ensure children know that masks aren't an option; they are a

must

- Purchase eye protectors that conform to ASTM F1771 (1997) or carry the Protective Eyewear Certification Council's "PEEC" seal
- Make certain all persons in the vicinity of the paintball players are wearing protective eyewear because of the potential for injury
- Make sure that children know proper handling of the CO₂ canisters

This fast-action battle game of paintball is establishing itself as one of the fastest growing outdoor participation sports. If parents are

going to allow their children to participate in this sport, they must supervise them to make sure that they wear the proper safety equipment at all times.

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Treatment of ACL Injuries in the Pediatric Population

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physes (growth plates) with significant growth remaining. Although the mechanism of injury may be similar across all age groups, the treatment options may vary and must take into account the skeletal maturity of the patient.

It is widely accepted that an ACL-deficient knee is at risk for recurrent episodes of instability. Such instability can result in repetitive injury to the articular cartilage and menisci within the knee, thus increasing the risk of premature arthritis and disability. Although total knee replacements can improve the quality of life of older adults with arthritis, they are not able to withstand the forces of competitive athletics. Therefore, young adults who tear their ACL and wish to resume an active lifestyle are usually offered surgical reconstruction of their knee. Children, however, have typically been treated quite differently.

One of the characteristics that make the pediatric patient unique is the presence of open physes that allow for longitudinal growth of the long bones. Damage to such physes can result in premature

growth arrest, limb length discrepancy, and angular deformity. These risks decrease with increasing skeletal maturity, which can be estimated by chronological age, secondary sex characteristics (such as menarche and pubic hair), and radiographic age-based norms. Older children, whose physal closure is imminent, can be treated as adults. Those with significant growth potential present the greatest treatment challenge.

In the past, ACL tears in children were typically treated nonoperatively until the patients reached skeletal maturity. The children were either asked to refrain from sports altogether, or they were given a brace and allowed to return to sports. The reason for this approach is that standard surgical techniques for ACL reconstruction involve drilling bone tunnels in the proximal tibia and distal femur, thus risking injury to the growing physes about the knee. Unfortunately, nonoperative treatment, although successful in avoiding physal injury, cannot restore stability to the knee. Compliance with activity restrictions is poor amongst children, and bracing

and rehabilitation alone have not been shown to be effective in preventing intra-articular damage. Because of this, if a patient continues to exhibit knee instability, surgery should be considered.

The goal of surgery should be to re-establish anatomic stability to the knee and prevent repetitive cartilage injury and early degenerative arthritis. The ACL can be reconstructed with autogenous (from the patient) or allograft (donated from a cadaver) tissue grafts. Technical points that can decrease the risk of physal arrest during ACL reconstruction in the skeletally immature include keeping bone tunnels small and centrally located and using all soft tissue grafts. It is then important to follow patients until skeletal maturity in case a growth disturbance is encountered. If a growth arrest occurs, various treatments exist to restore symmetric limb lengths and alignment; thus allowing the patient years of unrestricted activity. The same cannot be said for the unstable knee that becomes prematurely arthritic.

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Treatment of ACL Injuries in the Pediatric Population

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With an increasing exposure to competitive sports at such young ages, today's pediatric population is at risk for ACL injuries. Because of the importance of growth about the knee, treatment of such injuries requires special consideration. In order to avoid recurrent instability and further intra-articular damage, athletes should not be allowed to return to sports until their knees have been stabilized. Ideally, this can be done without damage to their growth and bony alignment.

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