Adolescent Concussions:
Improper Treatment Can Result in Dire Consequences

By Michael A. Lee, MD

This article discusses the latest recommendations for concussion evaluation and treatment. A summary of the article is below. The full article can be found starting on page 3.

In the past few years the use of neuro-psych testing has changed the way we view and treat concussions. There has been a paradigm shift from a guideline approach to a more individualized data driven approach. Dr. Cantu has revised his guidelines for classifying concussion based on neuro-psych testing. Amnesia is now more important than loss of consciousness in predicting a poor outcome. Adolescents are more vulnerable than adults. No adolescent should be allowed to return to a game if concussion symptoms are present. It is important not to increase the blood supply to the brain during recovery. No activity that causes an increase in headache should be undertaken during the recovery phase (exercise, school tests, stress). Before an adolescent is allowed to return to a sport, all symptoms must be resolved. The adolescent should have no symptoms when stressed with exercise in order to avoid “Second Impact Syndrome.” Neuro-psych testing will help in the management of concussions and return to play with objective data. The CIAC recommends baseline testing of high school athletes in contact sports.

Yoga: A Great Adjunct for Training

By Nanette Tummers

This article discusses some of the benefits of Yoga for athletes.

“There is no way I could have played as long as I did without yoga”

Kareem Abdul-Jabbar

Kareem knows what a lot of professional and recreational athletes who are starting to include yoga in their training: that yoga works! The pain that some of your patients may feel may not be from the physical activity itself, e.g., running, but from imbalances that running causes and exacerbates. Patients tend to spend more time improving their strengths but their weaknesses are often ignored or only paid attention to when an injury rears its ugly head. Yoga can provide the perfect balance for your patients by helping to them to train in functional strength and flexibility as well as many other benefits. Yoga brings the aspects of integration, balance, breathing, and movement as well as focus, mindfulness, and pa-

An Update on Football Helmet Design Changes

By Paul Manwaring

In this article some of the recent changes in football helmets are described.

Football helmets and football helmet technology have come a long way since the old leather helmets. However, for the past two decades, football helmet technology has been at a stand still with regards to concussion prevention. Finally, football helmet design has moved forward thanks to an in-depth six-year study of concussions and head impacts in the National Football League.

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Editor's Column

In this issue concussions in adolescents are discussed. Concussions are not as benign as they once were thought to be. With the availability of low cost neuro-psych testing as a screening tool it is now easy to obtain more objective data about when an adolescent is ready to return to play. It is important to remember that return to play can not be based solely on this test, but that the test should be used in conjunction with the history, physical exam, imaging studies and symptom free strenuous exercise. Hopefully, this will help to prevent “Second Impact Syndrome” or residual brain damage in our vulnerable adolescent athletes. In addition to the concussion article some recent changes in football helmet design are discussed.

Should the concussion article cause any anxiety, hopefully the yoga article will help you feel more relaxed.

Letter to the Editor

Dr. Spencer Erman from Hartford sent the following in response to the article about paintball:

I feel that a very important point was missed in Paintball: Perils and Pitfalls in the most recent issue, June 2004. Any “game” in which the purpose is shooting a projectile at an opponent, is inherently wrong.

Saying that wearing protective gear makes it safer, is like saying that wearing a bullet-proof kevlar vest makes it ok to shoot bullets at one another. I am not anti-gun. Hunting, target shooting, etc, is fine, in the appropriate place and at the appropriate time. Shooting other people is not a game—it is not a sport. I realize that the purpose of the article was to make this activity safer, but instead of encouraging it by discussing safety, it should have been discouraged.

Spencer G. Erman, MD
Medical Director
Hartford Medical Group
Avon Wellness Center

Editor's Response:

Many people are involved in risk-taking activities other than paintball. Our committee is not advocating paintball. We simply want to make it safer for those who participate. However, it is troubling that participants are now freezing the paintball and this causes considerably more pain and damage when the victim is hit. A hit to the ear may damage the eardrum and a hit to the temple area also may cause serious problems. Until the AAP and other organizations take a more definitive stand against paintballing, we offer this information to make this “sport” safer.

Spencer G. Erman, MD
Medical Director
Hartford Medical Group
Avon Wellness Center

Michael A. Lee, M.D.
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Facts and Statistics

Concussion is derived from the Latin word *concussus* which means to shake or be shaken violently.

- There are 1.5 million head injuries annually in the United States.
- 300,000 are sports related, the majority occurring in the pediatric age group.
- 20% of football players per season will sustain a concussion (this number may be low, see below).
- An athlete who sustains a concussion is 4–6 times more likely to sustain a second one.
- “Bell ringers” account for 75% of all concussive injuries and new research shows they may not be as benign as was once thought.
- Effects of concussions are cumulative in athletes returning to play prior to recovery.
- The *pediatric brain is more vulnerable* than an adult’s brain to damage from an injury, since brain maturation occurs to age 21.
- The best way to prevent problems with concussion is to manage them effectively when they occur.
- **After a concussion, no athlete should return to play while experiencing symptoms of concussion or having concussion symptoms with exertion.**

High school players tend to underrate and underreport concussions.

In a study by McCrea, 30% of football players had a concussion prior to the current season. 15.3% had a concussion during the season, only 43.7% reported the injury, and most of them were reported to the athletic trainer or coach. Concussions were reported only 11% of the time to physicians. The reasons given were: 1) not wanting to leave the game or practice, 2) not knowing the injury was a concussion, 3) the athlete thinking it was not serious enough to report, and 4) not wanting to let their teammates down. (McCrea, et al) (Comment)

We are all aware of coaches wanting to win and playing an injured athlete, but overzealous parents pushing their children also can cause them to participate in sports with concussion symptoms (i.e., the parent’s belief that if a child misses a game at six, he/she might not qualify for the Olympics or earn a college scholarship). If an athlete has a cast or crutches, it is clear that he/she should not play. Unfortunately there are no visible physical signs with a concussion. The macho mentality of showing how tough you are, that you can take a hit and come back right away needs to be replaced with a new philosophy. It is that the athlete understands that continuing to play with symptoms will certainly worsen the brain injury.

Repeat Concussions

More robust symptoms occur with next concussion.

Symptoms last longer with new blow.

Make one more susceptible to a new concussion.

Question remains if there is greater vulnerability with more than three concussions.

A study done at McCloud

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<tr>
<th><strong>Signs</strong></th>
<th><strong>Symptoms</strong></th>
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<tr>
<td>Appears dazed</td>
<td>Headache</td>
</tr>
<tr>
<td>Confused about play</td>
<td>Nausea (vomiting)</td>
</tr>
<tr>
<td>Answers question slowly</td>
<td>Balance problems</td>
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<tr>
<td>Personality/behavior change</td>
<td>Double vision</td>
</tr>
<tr>
<td>Forgets plays prior to hit</td>
<td>Photosensitivity</td>
</tr>
<tr>
<td>(Retrograde amnesia)</td>
<td>Feeling sluggish</td>
</tr>
<tr>
<td>Forgets plays after hit</td>
<td>Feeling foggy</td>
</tr>
<tr>
<td>(Anterograde amnesia)</td>
<td>Change in sleep pattern</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>Cognitive changes</td>
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*Loss of consciousness only occurs in 10% of concussions. If you have retrograde amnesia, you are 10 times more likely to have a poor outcome. If you have post-traumatic amnesia (anterograde amnesia) you are 4.2 times more likely to have a poor outcome. Amnesia is a more important predictor of poor outcome than loss of consciousness.*

All the above signs and symptoms are important in evaluating concussions.

**Later Signs of Concussion (Post-Concussion Syndrome)**

| **Decreased processing speed** |
| **Short term memory impairment** |
| **Concentration deficit** |
| **Irritability or Depression** (not because athlete can’t play) |
| **Fatigue/Sleep disturbances** (2nd most common post-concussion symptom after headache) |
| **General feeling of “fogginess”** |
| **Academic difficulties** |
University showed that concussed students had more symptoms and neurological problems as compared to non-concussed students. They scored lower on neurocognitive tests. Lower GPA scores suggest long term cognitive changes can lower grade performance in college classes.

Everyone is aware of Troy Aikman and Steve Young retiring early because of repeated concussions. Muhammed Ali (Cassius Clay) also demonstrates residual problems from repeated head injuries. More and more data is implicating concussions as a cause of learning and school problems as well as psychiatric problems.

The question of whether one is more vulnerable to a concussion after having three concussions remains to be answered. Once an athlete has an initial concussion there is a 4–6 times greater chance of having a second one than an athlete who never sustained a concussion. There is concern that the concussion damages may be cumulative.

**Pathophysiology of Concussions**

- During the acute phase, there are ionic fluxes (increased Na+ and K+), increased ATP needs, hyperglycolysis, increased lactate accumulation and axonal injury in some cells.
- Later changes include increased intracellular calcium, mitochondrial dysfunction, impaired oxidative metabolism, decreased blood flow (possibly due to increased calcium) and neurotransmitter disturbances.

There seems to be a metabolic mismatch. The increased energy demand and the decreased blood flow may cause cellular vulnerability that may be particularly susceptible to even minor changes in blood flow (which is why it is important not to increase the flow of blood to the brain during recovery). In the minutes to days after a head injury, the brain cells that are not irreversibly destroyed remain alive but in a vulnerable state. Increased blood flow seems to cause more destruction of brain cells. In animal models (rats) this dysfunction can last as long as two weeks.

**Concussion Grading Scales**

One of the problems in evaluating concussions is that CT scans and MRIs are insensitive to the subtleties of concussion and are mostly useful to rule out a bleed, etc. They measure anatomical abnormalities and a concussion is a metabolic abnormality.

There is also considerable variability in physician recommendations as well as the fact that athlete self-reporting determines management directives. This has led to the creation of concussion guideline scales in an attempt to guide physicians as to when athletes can return to competition. At least 20 different grading scales have been created to assess concussion, most placing emphasis on loss of consciousness. They have not been data driven and are primarily based on subjective data. There is no universal agreement on the grading of concussions.

One needs to monitor all post-concussion symptoms for severity and duration in order to determine the severity of the concussion. Therefore, on the first day of the concussion, you can’t know the duration of the symptoms and you can’t do a final grading until all the symptoms have cleared. In an NCAA study, most concussions graded as severe had concussion symptoms that lasted greater than seven days or post-traumatic amnesia that lasted over 24 hours.

This has led to Dr. Cantu’s revised guidelines as shown below:

### Second Impact Syndrome

Second Impact Syndrome was first described in 1973 by Schneider. The National Center for Catastrophic Sports Injury from 1980 to 1991 described 29 cases from football alone. The mortality was 50% and the morbidity was 50%. All cases were in high school or below.

Second Impact Syndrome occurs in athletes less than 21 years old with a prior concussion following a relatively minor impact. It has been shown to occur up to 14 days post-injury when the athlete returns to

### Cantu’s Concussion Guidelines

(Evidence-based Grading System)

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<th>GRADE</th>
<th>LOC</th>
<th>PTA</th>
<th>PCSS</th>
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<tr>
<td>1 (MILD)</td>
<td>NONE</td>
<td>or 30 minutes</td>
<td>or &lt; 24 hours</td>
</tr>
<tr>
<td>2 (MODERATE)</td>
<td>&lt; 1 minute</td>
<td>or 0 min but &lt; 24 hrs</td>
<td>or &gt;24 hrs but &lt; 7 days</td>
</tr>
<tr>
<td>3 (SEVERE)</td>
<td>&gt; 1 minute</td>
<td>or &gt; 24 hours</td>
<td>or &gt; 7 days</td>
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LOC = Loss of consciousness
PTA = Post-traumatic amnesia (includes retrograde and anterograde amnesia)
PCSS = Post-concussion signs and symptoms (other than amnesia)

Cantu, R.C. Post-traumatic (retrograde and anterograde) amnesia. J of Athletic Training 36(3)244-48,2001
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play prior to the resolution of symptoms from the initial concussion. There seems to be a catastrophic increase in intracranial pressure resulting in vasomotor paralysis, paralysis, edema, massive swelling, herniation, and death.

Tools To Evaluate Concussions
Most of the tools used to evaluate concussions are usually normal. The neurological exam may show balance problems or occasional lateral nystagmus but for the most part is normal. CT Scans and MRIs of the head are usually normal. fMRIs, SPECT scans and PET scans in the future may help in showing the location of the head injury. At this time, however, neuropsychological testing offers the most objective evidence as to what is happening inside the athlete’s brain and when used in conjunction with the history, physical exam, and imaging studies allows one to better determine when an athlete is able to return to play.

There are several different tests available (Headminder, Cogstate and ImPACT, etc.). The one in widest use is ImPACT. It is presently being used by the NFL, NHL, professional baseball, auto-racing, international rugby, and many colleges and high schools throughout the United States.

Neuro-psychological testing with ImPACT
ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing) provides objective data to help determine an athlete’s injury status. It is a computerized test developed by researchers at the University of Pittsburgh Medical Center. It accounts for individual differences in cognitive ability and symptom reporting through baseline testing. It can also be used without baseline testing because of the large data base that has been accumulated on nonconcussed and concussed individuals, broken down by age and sex. At this point, it can only be used on athletes over 12 years of age but work is being done to create a similar test for younger patients. It is most helpful when you have individual baseline data to compare to should an athlete have a concussion.

Why Should Schools do Neuro-Psych Testing (ImPACT)?
Concussions are one of the most serious problems at the High School level.

Proper management of concussion is the best form of prevention of serious injury.

An increasing number of schools are being sued each year for concussion management.

Parents appreciate the information provided by ImPACT about their injured child.

The computerized test includes:
Demographic/Concussion History Questionnaire.
Concussion Symptom Scale (21 item Likert Scale (e.g. dizziness, headache, fatigue, nausea, etc.). Athletes score the symptoms 0-6 with six being the worst.
Eight Neurocognitive Measures—The domains of Memory, Working Memory, Attention, Reaction Time, Mental Speed, Verbal Memory, Visual Memory, and Processing Speed are measured. Scores for each category are then calculated.

The test is automatically computer scored and gives percentiles compared to normative data.

ImPACT is easy to implement and can be coordinated by the athletic trainer in the preseason. ImPACT can be networked into a computer laboratory. ImPACT is cost effective and the annual fee is less than $400.00 per year. Full support and software are included in the price.

Evaluation with ImPACT can be done shortly after the concussion. Follow-up evaluations can occur approximately every five days. Once the ImPACT test returns to baseline (or estimated pre-injury status) with regard to symptoms as well as cognitive data and the athlete has a normal history/physical exam, the athlete may return to exertion or practice.

Return to Play
• Same Game Return to Play
Any adolescent athlete diagnosed with a concussion should not return to play in the same contest.
(Adolescent athletes with a “Bell Ringer” that might have been sent back into the contest in the past have neuro-cognitive abnormalities when tested with neuropsych testing.)

• Return to Play Following Concussion
During the recovery phase, athletes should not do any activity that causes increased blood flow to the brain. Consider no school for the first few days if symptoms are severe. No gym or sports. A note to excuse the athlete from tests may be indicated and the school should be made aware of any cognitive issues. An elevator pass may be necessary.

When recovering, reintroduce exercise slowly. If a headache or other symptoms occur, discontinue the activity. No carnival (spinning) rides for a while. Once the ImPACT test returns to baseline, and there are no concussion symptoms with exercise, the athlete may return to play.

Final Comments
• New research about concussions and its management are changing the standards for clinical practice.

• Concussions in adolescents seem to be different and need to be treated more cautiously or dire consequences can occur.

• An easy to use neuropsych-

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An Update on Football Helmet Design Changes

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During a six-year period (1996–2001), videotape of head impacts causing concussions was gathered from NFL games. The videos allowed researchers to recreate the direction, location, and velocity of impact in a laboratory setting. The results showed that concussions were resulting primarily from impacts on the facemask or side of the helmet as well as falls onto the back of the helmet. These results were contradictory to current thinking in helmet design. “Current National Operating Committee on Standards for Athletic Equipment standards primarily address impacts to the periphery and crown of the helmet, whereas players are experiencing injuries in impacts to the facemask, side, and back of the helmet.”

Due to these research findings, football helmet manufacturers have made design changes to help prevent concussions. Riddell has introduced the Revolution™ and Schutt has introduced the DNA helmet. The Riddell Revolution™ has introduced a new shell, which extends to the jaw area, as well as new padding to help decrease impact on the side of the head during impact. The Revolution™ shell has also been designed to increase the distance between the shell and the athlete’s head, which theoretically allows for greater room to deal with concussion causing impacts. A change in facemask design has also been made to protect the athlete from facemask impacts.

The major change in the Schutt DNA helmet is a change in the padding. Schutt has begun using Skydex™ material to pad their helmets. Skydex™ material, which was originally developed for running shoes, exhibits superior shock absorbing capability and durability. Similar to the Revolution™, the DNA has an extended jaw area to protect the athlete from side impacts.

Currently, data is being collected to evaluate the effectiveness of the redesigned helmets. These studies should be complete by the Fall of 2004. While no helmet on the market can eliminate the chance of concussion, the sports medicine community is hopeful that current helmet changes will help to decrease the number and severity of concussions associated with football.

Paul Manwaring is the President of the Connecticut Athletic Trainers Association and Assistant Athletic Trainer at Central Connecticut State University

References

2. www.riddell.com
3. www.schuttsports.com

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logical test is now available to allow us to evaluate what is really happening inside a concussed athlete’s head. This test can help us to objectively determine when an athlete may be ready to return to play.

• The CIAC has approved the recommendation of the Connecticut State Medical Society Committee on the Medical Aspects of Sports to do baseline testing on high school athletes involved in contact sports to be used as an adjunct along with the history, physical exam and imaging studies to help in deciding when athletes can return to play.

• There is a need to educate physicians, coaches, athletic trainers and most importantly the athletes as to the consequences of concussions if they aren’t handled properly (Second Impact Syndrome and residual brain damage).

Dr. Lee is a pediatrician with Pediatric Healthcare Associates in Southport, Connecticut specializing in adolescent and sports medicine. He is a charter member of AMSSM and Medical Director of the Student Health Center at Fairfield University

References:


Yoga: A Great Adjunct for Training

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tience into play. If an individual can bring the body into balance through the practice of yoga, they can hopefully enjoy their physical activity for longer periods of time and for years to come.

Let’s take a look at the research to substantiate recommending yoga. There is limited research conducted in the U.S., but a considerable body of scientific articles are available in Indian Medical journals such as Indian Journal of Physiological Pharmacology and the Journal of the Association of Physicians of India. The benefits of yoga have proven efficacious as evaluated through research sponsored by the National Center for Complementary and Alternative Medicine within the National Institute of Health for tunnel carpal syndrome and asthmatics. (http://nccam.nih.gov/research/). Currently clinical trials are evaluating the efficacy of yoga for chronic lower back pain, insomnia, attention in aging and multiple sclerosis, and treating shortness of breath in COPD (http://nccam.nih.gov/clinicaltrials/yoga.htm).

One of the first research studies conducted in the U.S. on yoga and fitness was at the University of California, Davis. Ten healthy untrained college students were tested for health related aspects of fitness: muscular strength, muscular endurance, cardiovascular fitness, body composition, lung function, and flexibility. Participants were required to attend a minimum of two classes per week for eight weeks. Yoga sessions consisted of breathing exercises, sun salutations (a dynamic form of cardiovascular warm up), yoga poses and meditation for a total of 75 minutes. Subjects were evaluated before and after the eight-week program. After the eight weeks of practicing yoga, there were significant increases in muscular strength (p<0.05); muscular endurance (p<0.01), flexibility (p<.01), and aerobic capacity (p<0.01).

As yoga is becoming increasingly popular in the U.S. and classes are readily available, the significant benefits of yoga might appeal to patients who might not be interested or drawn to traditional physical activity, e.g., walking or swimming. Flexibility is an integral part of total fitness and a yoga practice will provide the opportunity for more substantial flexibility than the standard 8 or 10 stretches included in most flexibility programs. Yoga also addresses a more whole body approach to flexibility. What this means is that instead of just stretching the hamstring for example, correct alignment of the entire body comes into play. Yoga teaches the participant to be more mindful of the stretching process and therefore reducing the chance for more injury.

What then are the variables from yoga that might lend it to reap all these benefits? Yoga emphasizes controlled breathing thereby increasing lung capacity and cardio respiratory fitness. The continued movement in yoga can allow for a sufficient heart rate training effect that is considered being low to moderate in intensity. In addition, the poses in yoga, particularly the standing and balancing poses, require sustained isometric contraction. Yoga is considered to be mind body exercise. With mind body exercise there is an emphasis on a shift from external stimuli to internal awareness thus allowing for improved concentration, decreased stress, and overall feelings of groundedness and being centered. This may then allow for a more positive attitude to deal with an injury or anxiety towards rehabilitation. Yoga classes include a relaxation component that can encourage patients to utilize these relaxation exercises as effective stress management tools.

Yoga can provide an incredible array of benefits for your patients. It is important to emphasize that it is not about getting your foot behind your head but consistency and patience is the success with yoga. The key is to let go of competition, which can be difficult for some patients. It is recommended that you encourage your patients to start in a beginner class. Yoga can be a perfect adjunct to rehabilitation and also encourage lifestyle changes that will hopefully encourage lifelong participation for your patients.

Dr. Nanette Tummers is an Assistant Professor of Physical Education and Health at Eastern Connecticut State University. Dr. Tummers specializes in wellness programming including research on older adults and children’s yoga. She teaches yoga to a wide variety of populations including obese adolescents, sedentary adults, college students, mentally challenged adults, athletes, and older adults.

References


Readers are encouraged to submit questions regarding sports medicine issues and concerns which will be answered by an expert.
To submit a question, simply type the question you would like answered along with your name, address, telephone number and email address (if applicable) and forward to:

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