

Pediatric Sports Physical and Pre- and Post- Concussion Physical

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Disclosures

- I have no significant financial interest or any other relationship with the manufacturer(s) of any commercial product/service that is discussed as part of this presentation

Overuse Injuries and Burnout in Youth Sports: A Position Statement from the American Medical Society for Sports Medicine

- 27 million US youth 6 to 18 years of age participate in team sports.
- 60 million children aged 6 to 18 years participate in some form of organized athletics, with 44 million participating in more than 1 sport.
- Overuse injuries account for 45.9% to 54% of all injuries (large variation among sports).
- Incidence of overuse injury estimates range from 3.5 million to more than 3.7 million in high school alone

Concussions - Epidemiology

- 1.6-3.8 million sports/recreation related concussion/yr. (Brain Injury Assoc. of America)
 - 9% of all HS sports injuries (Gessel 2007)
 - Boys: Football
 - 60% of all HS concussions
 - Girls: Soccer



'Don't let kids play football': a killer idea

James MacDonald,^{1,2} Gregory D Myer^{3,4,5,6}

- “Recent calls to ban or curb youth tackle football, rugby and other contact sports markedly underplay an essential point: it is generally more dangerous for youth to be sedentary than to risk injury playing a contact sport.”

'Don't let kids play football': a killer idea

James MacDonald,^{1,2} Gregory D Myer^{3,4,5,6}

- World Health Organization: the fourth leading cause of death worldwide is physical inactivity.
- Sports Participation
 - Improved self-esteem
 - Higher academic and career achievement
 - Decreased risk of obesity, heart disease, certain cancers, social problems, teen pregnancy, mental health problems, suicide and all-cause mortality

Sports Physical

- So how can we prevent injuries in our youth athletes?
- How do we minimize the risk upon returning from an injury?
- *A good history and physical are paramount*

TABLE 2. Categorization of Risk Factors for Overuse Injury

Intrinsic Risk Factors**Growth-Related Factors**

Susceptibility of growth cartilage to repetitive stress

Adolescent growth spurt

Previous injury

Previous level of conditioning

Anatomic factors

Menstrual dysfunction

Psychological and developmental factors—athlete specific

Extrinsic Risk Factors

Training workload (rate, intensity, and progression)

Training and competition schedules

Equipment/footwear

Environment

Sport technique

Psychological factors—adult and peer influences

(Adapted from DiFiori JP. Evaluation of overuse injuries in children and adolescents. *Curr Sports Rep.* 2010;9:372–378.).

What is the Greatest Predictor of Injury????

- Prior Injury
 - Stress Fractures
 - Knee Injuries
 - Ankle Sprains
 - Low Back Injuries
 - Shoulder Disorders
 - Heat Illness
 - Dehydration

What is the Second Greatest Predictor of Injury

- Exposure
 - Practice Time
 - Games Played
 - Duration of Season
 - Lack of Off Season
 - Years Participated
 - Age of the Athlete

Brief Word on Training

- Epidemic of Overuse Injuries at Younger and Younger Ages, Why?
 - Athletes love their sports
 - Sports becoming specialized younger and younger age
 - Loss of childhood “free play”
 - Loss of multi-sport athlete
- What to Do??
 - Athletes need to incorporate more functional training
 - Cross Training needs to be encouraged
 - Min 2-4 months off of sport per year
 - Training needs to be cycled

What Types of Injuries Are Preventable?????

■ Acute Injuries

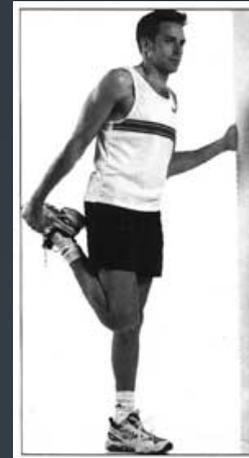
- Contusions
- Sprains
- Strains
- Fractures
- Dislocations
- Trauma
- Concussions

■ Overuse Injuries

- Tendonitis
- Bursitis
- Stress Fractures
- Overuse Joint Pain

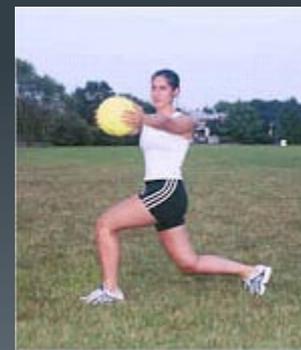
Old School Injury Prevention

- Emphasis on warm-up, stretching, and cool down
- Emphasis on bracing
- Emphasis on proper fitting equipment



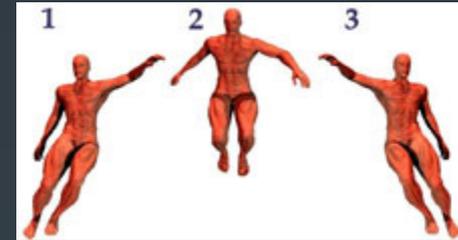
Current Injury Prevention Strategies

- Pre/In Season Conditioning
 - Strength, Balance, Plyometric
 - Flexibility
- Equipment
 - Braces/Taping
 - Protective Equipment
- Proper Technique
- Proper Training Regimen
- Following Rules/Rule Enforcement
- Safe Playing Environment



Pre-Season Conditioning for Prevention

- Key Components
 - Functional Strength
 - Agility
 - Balance
 - Plyometrics (jumping)
 - Core Strength
 - Hip, Back, Abd
 - Kinetic Chain



In Season Warm-Up/Conditioning

- Incorporate into warm-up
 - Easy for athletes to adhere
 - Standardization of Protocol
 - Administer to large numbers
-
- Ideal Program combines pre and in-season conditioning that is simple and efficient

Bracing Recommendations

- Braces are of marginal benefit
- Ankle Braces??
 - Benefit shown for wearing functional ankle brace or taping if history of sprain
- Knee Braces??
 - May reduce risk if history of MCL sprain or collegiate lineman in football
 - All other research to date has not shown benefit of knee braces for prevention of injury!!!

PPE Recommendations

- Preparticipation exams may identify prior injury patterns and provide an opportunity to assess sport readiness. (C)
- A history of prior injury is an established risk factor for overuse injuries and should be noted as part of each injury assessment. (A)
- Adolescent female athletes should be assessed for menstrual dysfunction as a potential predisposing factor to overuse injury. (B)

TABLE 8. Strength-of-Recommendation Taxonomy (SORT)¹⁹³

Strength of Recommendation	Basis for Recommendation
A	Consistent, good-quality, patient-oriented evidence
B	Inconsistent or limited-quality patient-oriented evidence
C	Consensus, disease-oriented evidence, usual practice, expert opinion, or case series for studies of diagnosis, treatment, prevention, or screening

PPE Recommendations

- Parents and coaches should be educated regarding the concept of sport readiness. (C) Variations in cognitive development, as well as motor skills, should be considered when setting goals and expectations.
- Early sport specialization may not lead to long-term success in sports and may increase risk for overuse injury and burnout. With the exception of early entry sports such as gymnastics, figure skating, and swimming/diving, sport diversification should be encouraged at younger ages. (C)

What about the injured athlete?



The image shows a screenshot of an ESPN W article. At the top, there are navigation links for ESPN W, SPORTS, VOICES, LIFE/STYLE, and CULTURE. The article is under the VOICES category. The title is "Helping your athlete kids recover from injury the right way". Below the title are social media sharing buttons for Facebook (Share 393), Pinterest (Pin it), and Twitter (Tweet). The byline reads "By Sharon Van Epps | Oct 5, 2016" and "Special to espnW.com".

"Dealing with youth sports' injuries is complicated, and an otherwise excellent pediatrician likely will have no training in sports medicine at all."

-Sharon Van Epps

"People ask me why I don't pull my kids out of sports after all they've been through, but the answer is simple: They are athletes. *To ask them not to compete would be like asking them to change who they are.* So, I'm trying my best to be the mother they need, and I'm learning that a big part of that is *teaching them how to heal.*"

Decision-Based RTP Model

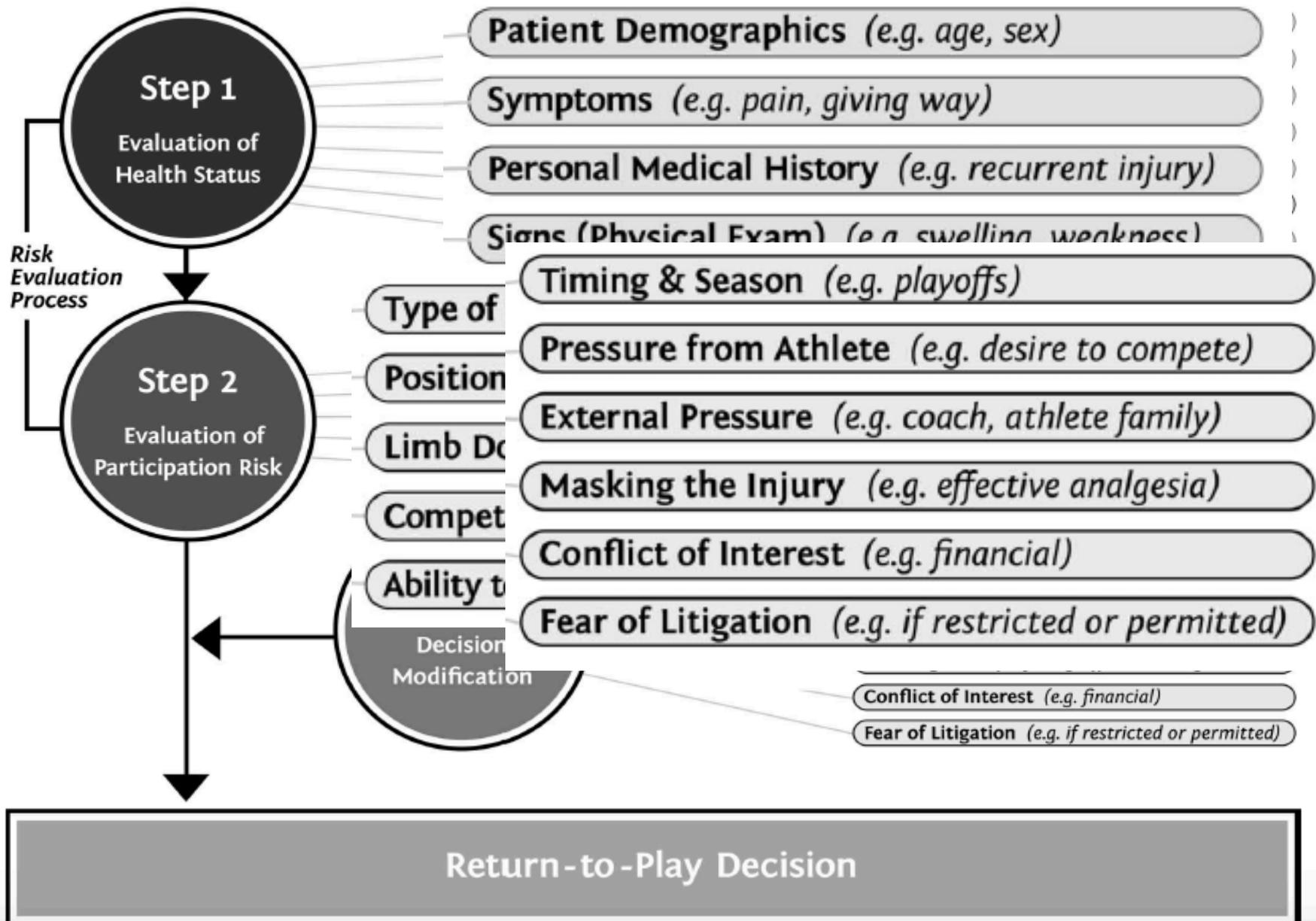




TABLE 1. General Recommendations for Each of the Physical Signs Used by Clinicians to Evaluate Whether an Athlete Should Be Allowed to Return to Play

Sign	General Recommendation	References
Strength	At or near pre-injury levels or symmetrical with unaffected side	14,30,51–53,56–61,65,67,68,71,73–79
Range of motion	At or near pre-injury levels or symmetrical with unaffected side	13,14,17,30,51–53,56–61,64,65,67,68,72,73,75–80
Joint stability	No instability	13,15,28,52,53,61,62,71,72,81
Tenderness	Injury site should be nontender	51,66,69,82
Inflammation or swelling	No swelling or inflammation	30,61,80
Effusion	No effusion	30,60
Girth	No specific recommendation provided	30

Creighton et Al. Clin J Sport Med 2010;20:379–385

Always ask why and what:

Why did the injury occur?

What is the risk of returning to play now?

What is the athletes functional ability?

The Why?!

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(Adapted from DiFiori JP. Evaluation of overuse injuries in children and adolescents. *Curr Sports Rep.* 2010;9:372–378.).

- Don't assume that a previous injury means that a bone/muscle/tendon is weak and therefore susceptible to repeat injury
- Repeat injury or multiple injuries to the lower/upper extremity may warrant a biomechanical evaluation by an experienced PT or Sports Medicine Physician

The What?!

TABLE 3. High-Risk versus Low-Risk Overuse Injuries

Location	High Risk	Low Risk
Hip/Pelvis	Femoral neck (tension-sided)	Femoral shaft stress fracture
Back (lumbar spine)	Pars interarticularis stress fracture	Congenital spondylolysis, pedicle stress fracture
Leg	Anterior cortical tibial stress fracture	Medial tibial stress fracture, fibular shaft stress fracture
Ankle	Medial malleolar stress fracture, talar dome osteochondral defect, talar neck stress fracture	Distal fibular stress fracture
Foot	Tarsal navicular stress fracture, fifth metatarsal proximal diaphyseal stress fracture, sesamoid stress fracture	Second, third, fourth metatarsal stress fractures, cuboid
Knee	Patellar stress fracture, osteochondritis dissecans of femoral condyle or patella	Tibial tubercle and inferior patellar pole apophysitis
Shoulder/arm	Effort thrombosis	Proximal humeral physeal stress fracture
Elbow	Osteochondral dissecans capitellum, apophyseal non-union of medial epicondyle	Medial epicondyle apophysitis
Wrist	Distal radial physeal stress injury	

- Familiarize yourself with high risk injuries.
- Shin splints are not always shin splints!
- High risk injuries are best managed by a sports medicine physician/orthopaedist

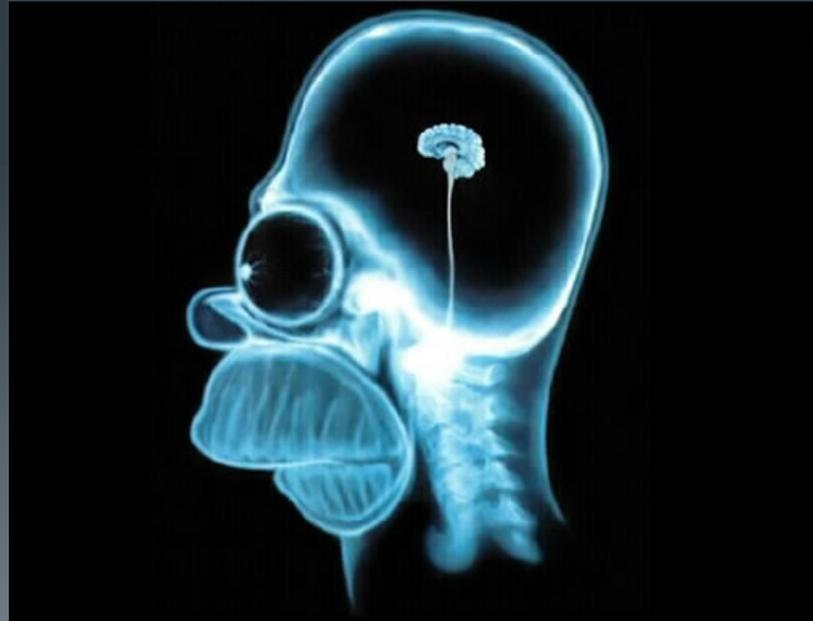
Injury evaluation recommendations

- When an overuse injury is diagnosed, it is essential to address the underlying cause(s). (C)
The athlete, parents, and coaches should be involved in reviewing all risk factors and developing a strategy to attempt to avoid recurrent injury.
- All overuse injuries are not inherently benign. (A)
Clinicians should be familiar with specific high-risk injuries, including stress fractures of the femoral neck, tarsal navicular, anterior tibial cortex and physis, and effort thrombosis.

What is a concussion?



- A functional disturbance rather than structural injury – standard structural neuroimaging studies are normal.



What is a concussion?

1. A complex pathophysiologic process affecting the brain, induced by mechanical forces. A direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head resulting in one or more of the following:

- Acute signs or symptoms
 - LOC, cognitive or memory dysfunction, amnesia
 - Blurred vision, photophobia, nausea, vomiting
 - Lightheadedness, vertigo, headache, tinnitus
 - Balance disturbance, difficulty concentrating
- Delayed signs or symptoms
 - Sleep irregularities, fatigue, depression, lethargy
 - Personality changes, inability to perform usual daily activities

What is a Concussion?

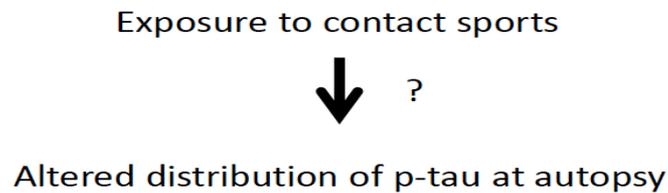
2. Concussion typically results in the *rapid onset of short-lived impairment of neurologic function that resolves spontaneously.*
3. Concussion *may result in neuropathological changes* but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4. Concussion results in a graded set of clinical symptoms that *may or may not involve 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 however, post-concussive symptoms may be prolonged.*
5. *No abnormality on standard structural neuroimaging studies is seen in concussion.*

Pathophysiology

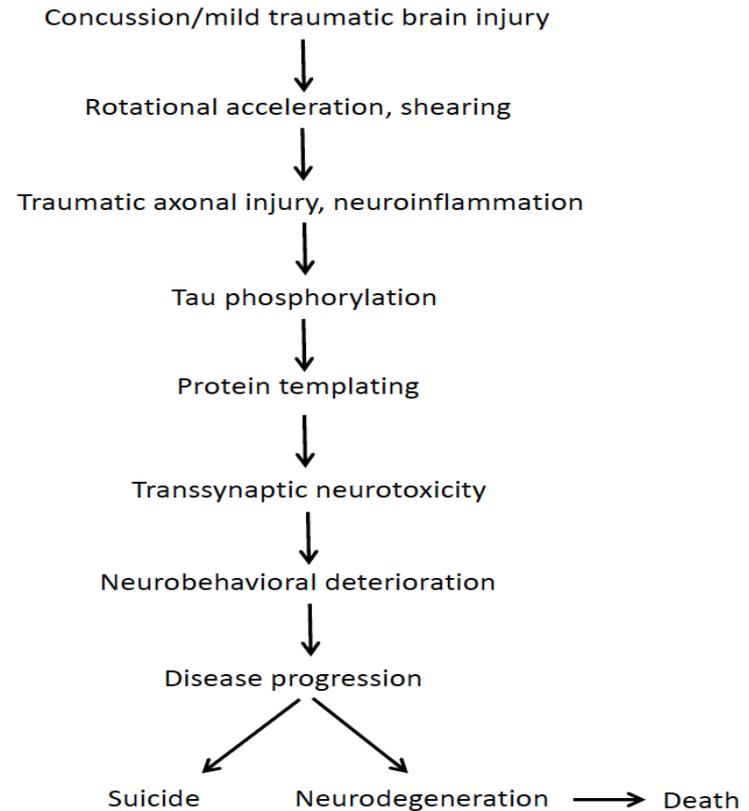
- Two main factors:
 - Increased fuel demand, tremendous metabolic stress due to increased activity
 - Massive ion flux → increased extracellular K^+ → ATP-dependent Na- K^+ pumps → increased intracellular Ca^{2+}
 - Massive neurotransmitter release followed by “spreading depression”
 - PET scans show local increased cerebral rate of glucose metabolism (up to 1 week post injury)
 - Decreased cerebral bloodflow
 - Seen in animal models up to 3 days after concussion

Pathophysiology

Conclusions



Empirical data



Accepted paradigm

Time to Re-think the Zurich Guidelines?

A Critique on the Consensus Statement on Concussion in Sport: The 4th International Conference on Concussion in Sport, Held in Zurich, November 2012

Neil Craton, MD, MHK† and Oliver Leslie, MD**

- Lack of diagnostic specificity
 - Guidelines suggest that any impulsive force followed by any 1 of 22 possible symptoms is a concussion
 - ? Whiplash, affective disorders, or inner ear pathology
 - Average score in uninjured patients is 3-10
- Mngt strategies not evidence based
 - Cornerstone of concussion management is physical and cognitive rest but there is NO citation for this recommendation
 - Rest and absence from work/sport has consequences
- Rehab goals that are not attainable
 - Athletes must be asymptomatic to return to sport
 - There is evidence that exercise itself in uninjured people can evoke symptoms seen in concussion
- Allegations of conflict of interest against prominent concussion researchers

Mechanical Etiology

- Two Types of Forces
 - **Contact-** direct force or impact
 - Head strikes or is struck by object
 - **Inertial-** acceleration (impulsive head motions)
 - Evidence suggests this is primary cause of concussion
 - *Linear*
 - Cause peak pressures within the brain
 - Studies identified relative threshold for skull fx but not concussion
 - *Rotational-* shearing forces across the brain
 - Increases likelihood of LOC
 - Typically causes greater tissue damage

Diagnosis

- Concussion vs. Structural Pathology
 - Important to assess for skull fx, intracranial bleed
- Initial History and Exam
 - Assessment of acute symptoms
 - Cranial nerves assessment
 - Sensation/strength/reflexes
 - Balance
 - Coordination
 - Cognition
 - Vision

Diagnosis

- Assessment tools
 - Sideline:
 - SAC
 - SCAT2
 - BESS
 - King Devick
 - Symptom score sheet
 - Physical Exam
 - Office: above plus:
 - Neurocognitive testing



Normal....or is it????

Physical Exam

Physical Exam

Normal...or is it????

Table 2. Common acute physical signs of cerebral concussion

Impaired conscious state or brief loss of consciousness

Confusion

Vacant stare/glassy eyed

Amnesia: retrograde or anterograde

Slow to answer questions or follow directions; easily distracted/poor concentration

Poor coordination or balance; unsteady gait

Personality change; inappropriate emotion (laughing or crying)

Slurred speech

In athletes during competition, one may also observe:

Unaware of period, opposition, or game score

Inappropriate playing behavior, eg, running in the wrong direction

Significantly reduced playing ability

Physical Exam

Normal....or is it????

- Balance (Proprioception)
- Cognition (Memory/processing)
- Coordination (diadochokinesia)
- Vision (saccades, nystagmus, convergence, smooth pursuit, VOR)

Balance Assessment



- Low Tech
 - BESS (Balance Error Scoring System)
 - Requires baseline
 - 3 stances (rhombberg, tandem, trendellenberg)
 - 2 surfaces (firm, foam)
 - Inexpensive and easy to administer
 - Showed similar recovery curve compared to SOT
 - Influencing Factors
 - Type of sport
 - Hx of ankle injury or instability
 - Exertion and fatigue
 - Baseline needed
 - Romberg's

Balance Assessment

- High Tech
 - CTSIB (Clinical Test of Sensory Interaction and Balance)
 - Sophisticated force plate system
 - Uses combo of 3 visual and 2 surface conditions
 - SOT (Sensory Organization Test)
 - Technical force plate system
 - 3 - 20 second trials
 - 3 different visual conditions
 - 2 different surface conditions
 - *Is this clinically cost effective?*

Cognition

❖ Low tech:

- ❖ From the sideline: What's the score of the game?, Who's winning? Who's your opponent?
- ❖ Months in reverse
- ❖ Numbers in reverse
- ❖ World spelled backwards
- ❖ 3 word recall at 1 & 5 minutes
- ❖ Serial 7's

Cognition

- ❖ High tech: Computerized Neurocognitive Testing
- ❖ (ImPACT) Immediate Post-Concussion Assessment and Cognitive Testing
 - ❖ First field tested in 1997
- ❖ One of several commercially available computerized neurocognitive tests
 - ❖ ANAM, Cogsport, Mindstreams, etc
- ❖ *Is this clinically cost effective?*

ImPACT

Exam Type	Baseline	Post-Injury 1	Post-Injury 2	Post-Injury 3	
Date Tested	10/26/2010	09/19/2011	10/06/2011	10/19/2011	
Last Concussion					
Exam Language	English	English	English	English	
Test Version	2.0	2.1	2.1	2.1	

Composite Scores	Percentile scores if available are listed in small type.								
Memory composite (verbal)	95	81%	77	17%	85	44%	94	78%	
Memory composite (visual)	76	58%	61	19%	54	5%	86	81%	
Visual motor speed composite	41.25	72%	32.88	19%	32.9	19%	45.78	90%	
Reaction time composite	0.57	58%	0.65	22%	0.61	38%	0.54	75%	
Impulse control composite	6		12		2		4		
Total Symptom Score	6		54		9		2		
Cognitive Efficiency Index:	0.52		0.35		0.37		0.56		

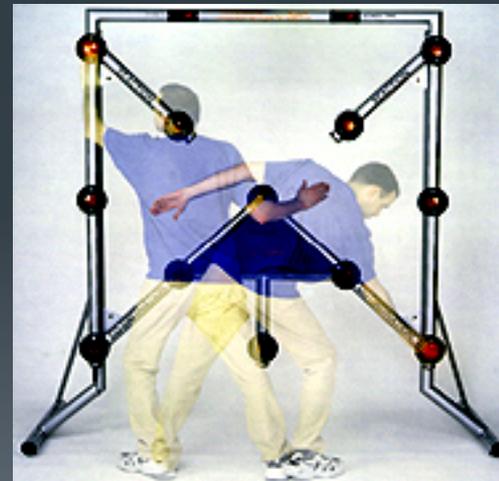
Neurocognitive Testing

- Criticized for its poor ability to indicate the presence of dysfunction
- Influenced by premorbid intelligence and other factors such as age, education, state of employment, socioeconomic status, depression, malingering, testing environment, motivation, and litigation.
- Many studies performed by test companies and those associated with them

Coordination

The ability to execute smooth, accurate, controlled movements

- Low tech:
 - Finger-to-nose test
 - Heel-to-shin test
- High tech:
 - Light board test(eg: BATAK)



Vision

- Visual system affected in concussion leading to eye movement and visual processing abnormalities
- Deficits are most prevalent in the first week post-injury and then recover over the next 6 months (usually less than this)
- King-Devick test – 2 minute test that requires an athlete to read single digit numbers on an ipad or piece of paper. Baseline test is needed.

Vision

- Heitger et Al. Brain 2009
 - Compared post-concussion syndrome(PCS) patients to those who had concussion but recovered completely
 - Evaluated reflexive, anti- and self-paced saccades, memory-guided sequences, and smooth pursuit
 - Oculomotor differences *largely unaffected by group disparities in depression and estimated intellectual ability*
- Ellis et Al. J Neursurg Pediatr 2015
 - Evaluated the prevalence of vestibul-ocular dysfunction in children and adolescents
 - VOD defined as more than one vestibular and oculomotor complaint and more than one objective PE finding(abnormal smooth-pursuits, saccades, VOR, etc)
 - 76.2% with acute sports-related concussion
 - 23.8% with postconcussion syndrome



The future??

- Graded aerobic treadmill testing
- MRI - Diffusion tensor imaging, Diffusion weighted imaging, functional MRI, magnetic resonance spectroscopy, PET scans?



Patient videos

Concussion recommendations



- Concussion can have multiple symptoms and signs that evolve over time
- Evaluation of cognition, balance, ocular movement, and coordination a must in patients with concussion
- It is unsafe to return to play when athlete has not returned to 100% (not necessarily asymptomatic)
- Return to play should follow a stepwise progression and should be tailored to each individual case

Take Home Points



- Evaluate for risk factors for injury at PPE and any injury evaluation
- Always ask “why did the injury occur?”
- Always ask “what is the risk of returning to sports and have they returned to their normal level of function”
- Many questions remain about pathophysiology, diagnosis, management, long term outcomes, and prevention of concussion
- We still need a lot of research!

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