MAYO CLINIC

CONCUSSION UPDATE

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MAYO CLINIC SPORTS MEDICINE CENTER

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Speaker(s)

DISCLOSURE OF RELEVANT FINANCIAL RELATIONSHIP(S) WITH INELIGIBLE COMPANIES

Name	Nature of relationship	Company
None		

NO DISCLOSURE OF RELEVANT FINANCIAL RELATIONSHIP(S) WITH INELIGIBLE COMPANIES

Name
Eric Crowley LAT, ATC

2

REFERENCES TO OFF-LABEL OR INVESTIGATIONAL USAGE(S) OF PHARMACEUTICALS OR INSTRUMENTS:

Name	Manufacturer/Provider	Product/Device
None		

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LEARNING OBJECTIVES

Upon conclusion of this activity, participants should be able to:

- Identify pre-concussion factors for the individual and the organization (Domain 1, Task: 0101 & 0102)
- Discuss concussion evaluation tools and protocols (Domain 2, Task: 0202)
- Summarize current concussion management strategies (Domain 2, Task: 0204 & 0205)

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CONCUSSION TOOLS, PROTOCOLS, & MANAGEMENT STRATEGIES

- Baseline Testing
- The pathophysiology of a concussion
- Evaluation
  - Concussion profiling
  - Concussion interview
    - Prolonged recovery
  - Symptoms
  - Clinical examination
  - Rehabilitation strategies
- Clinical Pearls

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BASELINE TESTING

- NATA position statement: Management of sport concussion(Broglio, et al. 2014)
  - Athletes at high risk of concussion should undergo baseline examination before the competitive season
  - Baseline should be performed annually
  - The baseline examination should consist of symptom intake, physical and neurologic evaluations, measures of motor control, and neuro cognitive function

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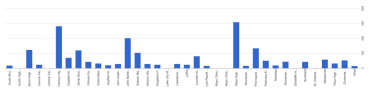
BASELINE TESTING

Which schools do we test?

- 25 high schools



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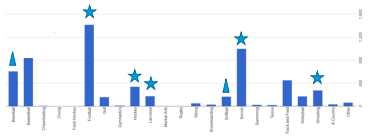
BASELINE TESTING

Which sports do we test?



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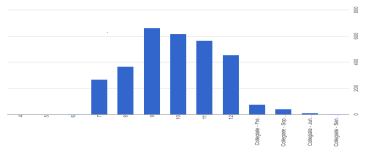
BASELINE TESTING

Which grades do we test?



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BASELINE TESTING

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BASELINE TESTING

Demographics **Athlete Information**

1) Today's Date
2) Last Name
3) First Name
4) Sex
5) Date of birth
6) Email

Today's Date	07-31-2022
Select the High School or organization you currently or will attend:	Rochester Community and Technical College
What grade are you in? For fall sport athletes what grade will you be in?	Collegiate - Freshman
How do you think you are as a student?	Average (What type of student are you?)
List the sport(s) you participate in	Soccer
List position(s) you play	Midfield

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BASELINE TESTING

Baseline Medical History **PCSS**

Have you ever been hospitalized or had advanced imaging for a head injury (MRI or CT scan)?	No
Have you ever been diagnosed with headaches or migraines?	No
Do you have a learning disability, dyslexia, or ADD/ADHD?	None
Have you ever been diagnosed with depression, anxiety, or psychiatric disorder?	None
Do you wear glasses or contacts with sport activity?	No
Have you ever had a concussion before?	No

	0 - None	1	2	3 - Moderate	4	5	6 - Severe
Please Rate the Severity of your Headache symptoms on a typical day.	⊗	○	○	○	○	○	○
Please rate your "pressure in the head" symptoms on a typical day.	⊗	○	○	○	○	○	○
Please rate your neck pain symptoms on a typical day.	⊗	○	○	○	○	○	○

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BASELINE TESTING

Objective Tests **Brief Physical Exam**

- Standardized assessment of concussion (SAC)
- King Devick (KD)
- SWAY

Physical Exam: Do you currently have neck pain?	⊗ No
PE: Do you have regular headaches?	⊗ No
PE: On average how many hours do you sleep a night?	8 (numeric value only)
PE: Eye Motion	⊗ Normal
PE: eye convergence	⊗ Normal
PE: Pupil shape at rest	⊗ Normal

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BASELINE TESTING

Sport (s)	Additional Sport	School	Grade
Football, Track and Field	____	Mayo High School	12

Type of Student	History of Head Injury	History of Migraine or Headache
Average	No	No

History of Learning Disability	Mental Health Background	Concussion History (yes or no)	Number of Concussion
None	None	Yes	2

Total Symptoms	Symptom Severity	Would Not Mention Concussion	Total SAC Score	King Devick Test
4	4	No	26	47.6 seconds

Baseline Physical Exam

Cervical Spine Pain	Cervical Spine Positive Findings	Eye Motion	Eye Motion Positive Findings	Eye Convergence	Pupil Shape At Rest	Pupil Shape Positive Findings
No	____	Normal	____	Normal	Normal	____

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CONCUSSION PATHOPHYSIOLOGY (GIZA, ET AL. 2014)

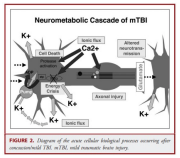

FIGURE 2. Diagram of the acute cellular biological process occurring after concussion/mild TBI, mTBI, mild traumatic brain injury.

- Acute Pathophysiology
  - Ionic flux causing a depolarization
    - Potassium out
    - Sodium and calcium in
  - Glutamate release
  - Trigger voltage-gated ion channels

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CONCUSSION PATHOPHYSIOLOGY (GIZA, ET AL. 2014)

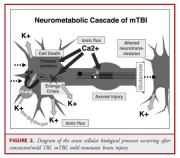

FIGURE 2. Diagram of the acute cellular biological process occurring after concussion/mild TBI, mTBI, mild traumatic brain injury.

- Energy Crisis
  - The body is trying to restore ionic and cellular homeostasis
  - ATP requiring membrane ionic pumps try to increase production
  - The result is Hyperglycolysis (increase in glucose utilization) and a depletion of intracellular energy reserves
  - Result is an increase in ADP
  - Due to the reduction in blood flow then there may be a mismatch between energy supply and demand.

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CONCUSSION PATHOPHYSIOLOGY (GIZA, ET AL. 2014)

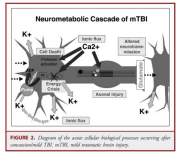

FIGURE 2. Diagram of the acute cellular biological process occurring after concussion/mild TBI, mTBI, mild traumatic brain injury.

- Calcium then goes into the mitochondria, but this causes mitochondrial dysfunction and continues to exacerbate the cellular energy crisis.
- Because of the continuation of the energy crisis the glucose metabolic rates are then impaired.
- The impaired metabolic rates can last 7 to 10 days in animal models.
- Energy Crisis and the risk for a second injury
  - It's thought that due to the drop in glucose during the "energy crisis" the individual may be at a higher risk for a repeat concussion within the 7 – 10 day window.

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CONCUSSION PATHOPHYSIOLOGY (GIZA, ET AL. 2014)

Pathophysiology and the associated acute symptoms/clinical correlations

- Ionic flux
  - Migraine headache, photophobia, phonophobia
- Energy crisis
  - Vulnerability to 2nd injury
- Axonal injury
  - Impaired cognition, slow processing, slowed reaction time
- Impaired neurotransmission
  - Impaired cognition, slow processing, slowed reaction time

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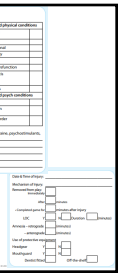
CLINICAL CONCUSSION EVALUATION

CLINICAL INTERVIEW



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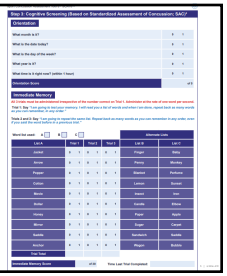
CLINICAL CONCUSSION EVALUATION

- Symptoms
- SAC
- Physical Exam:
  - Cervical Spine
  - Neurologic exam
  - VOMS
- KD
- SWAY



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CLINICAL CONCUSSION EVALUATION

- Cervical spine exam
- Neurologic exam
  - CN
  - Strength, sensation, tone, reflexes
  - Coordination
  - Balance
- Eye exam
  - Accommodation, convergence
  - King-Devick

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Clinical Concussion Evaluation: VOMS

Smooth Pursuits (Mucha et al, 2014)

- Test the ability to follow a slowly moving target.
  - Fingertip at a distance of 3 ft. from the patient.
  - Athlete is to maintain focus on the target as the examiner moves the target smoothly in the horizontal and vertical direction 1.5 ft. in each direction.
  - Record: Headache, Dizziness, Nausea & Fogginess ratings after the test.

Saccades (Mucha et al, 2014)

- Test the ability of the eyes to move quickly between targets. The patient and the examiner are seated.
  - **Horizontal Saccades**:
    - Holds two single points horizontally at a distance of 3 ft. from the patient
    - Gaze 30 degrees to left and 30 degrees to the right
    - Move eyes as quickly as possible from point to point.
    - 10 repetitions are performed.
    - Record: Headache, Dizziness, Nausea & Fogginess ratings after the test
  - **Vertical Saccades**:
    - Same as above, but vertical

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Clinical Concussion Evaluation: VOMS

Vestibular-Ocular Reflex (VOR) Test (Mucha et al, 2014)

- Assess the ability to stabilize vision as the head moves.
  - **Horizontal VOR Test**:
    - Rotate their head horizontally while maintaining focus on the target
    - 20 degrees to each side
    - 10 repetitions are performed.
    - Record: Headache, Dizziness, Nausea and Fogginess ratings 10 sec after the test is completed. (Figure 5)
  - **Vertical VOR Test**:
    - The test is repeated with the patient moving their head vertically

Visual Motion Sensitivity (VMS) Test (Mucha et al, 2014)

- Test visual motion sensitivity and the ability to inhibit vestibular-induced eye movements using vision.
  - The patient holds arm outstretched and focuses on their thumb. Maintaining focus on their thumb, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the
  - 5 repetitions are performed
  - Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 7)

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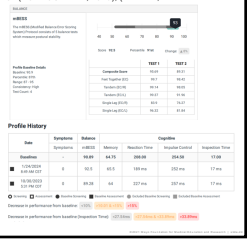
CLINICAL CONCUSSION EVALUATION: BALANCE (KONTOS ET AL, 2019), (HAIDER, ET AL. 2021), (SCHNEIDER, ET AL. 2019)

- **Clinical Examination**
  - Gait assessment with Technology
    - SWAY:
      - Comparable to the Biodex balance system(Patterson, et al. 2014)
      - Reliable when operating on multiple devices(VanRavenhorst-Bell,et al. 2021)
      - Comparable to the ImPACT test(VanRavenhorst-Bell et al. 2021)



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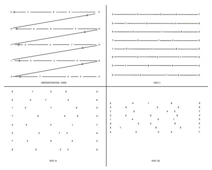
SIDELINE EVALUATION – KING DEVICK

- 2 min test
- Cards or iPad
- Compare to baseline
- 86% sensitivity*
- 90% specificity*
- Screens for:
  - Saccades
  - Attention
  - Concentration
  - Speech/Language



*Galetta KM, Liu M, Leong DF, et al. Concussion. 2015;1:1–15.

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MAYO CLINIC | Orthopedics and Sports Medicine

Mayo Clinic Orthopedics and Sports Medicine Low Risk Patient Concussion Management

The goal is to utilize knowledge and expertise of our athletic trainers to work to maximal licensure. This could minimize unnecessary in-clinic concussion visits for low-risk concussion patients and provide a resource to patients and staff for care and questions as needed.

Licensed Athletic Trainer - managed concussions.

If a patient has the following history and presentation:
- Baseline testing (SAC & KD).
- 1st diagnosed concussion.
  - Exception would be if diagnosed with a concussion (maximum of 1) prior to age 10.
- No loss of consciousness
- Symptoms score less than 25 within 24-*48 hours of injury, .
- No history or underlying risk factors for prolonged recovery.
  - Diagnosis of ADHD
  - Other Learning Disorder
  - Depression
  - Anxiety
  - History of Migraine Disorder

Athletic Trainer can manage if the above requirements are met and started return to play protocol by day 7.

If meeting clearance criteria/asymptomatic can be cleared by ATC. If athlete is **NOT,** then send to Mayo Clinic Orthopedics and Sports Medicine or another preferred local provider with concussion knowledge for further evaluation and treatment.

- If ATC manages the concussion, **documentation within EPIC must be completed** within 2 days from clearance for full participation. Documentation into Healthy Roster or EMR should be done as well. If athlete is not a Mayo patient, documentation in outreach EMR (Healthy Roster) should be completed.

If patient/family or ATC has concerns at any time patient can be sent to Mayo Clinic Orthopedics and Sports Medicine or another preferred local provider for further evaluation.

Person diagnosed with a concussion should not be cleared to full game before 7 days since the time of injury. (Exceptions may exist but discuss with physician).

Minimum requirement for full athletic clearance – Protocol on next page
- ✓ Return to baseline or asymptomatic state.
- ✓ Tolerating full school activities 100% without symptom recurrence.
  - If not attending school fully after 3 school days because of symptoms, then needs to be seen by physician instead.
- ✓ Has completed return to play progression.
  - Injured athlete should not progress beyond level 3 until attending full school and back to baseline symptoms.
- ✓ Has returned to baseline or improved time in KD and SAC score. It must be no worse than a 2-point difference compared to a baseline. If performed SCAT 6 then will review by physician but will not limit progression through return to play. (no research yet in this area)
- ✓ Neurocognitive test (Sway or Impact) is within normal limits. This needs to be done prior to attempting Level 5 but should not be completed prior to days 2-4.
  - If below normative level, need to contact physician. May be able to re-test or may be required to be seen in-clinic.
  - Scores in Bold Red (Impact) are considered below norms and would need physician review for next steps.
  - Any scores with concerns require physician review before clearance.

If athlete does not meet the above requirements, they will be required to be seen by a provider for clearance from their concussion. They can still go through the full process with their school's athletic trainer but will need to be seen by a provider prior to attempting a full-contact practice (Level 5).

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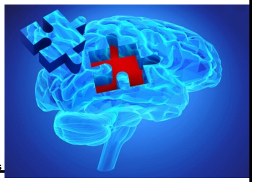
CEREBRAL CONCUSSION CLINICAL PROFILES
((KONTOS, ET AL. 2019)

- **Cerebral concussion clinical profiles**
  - Vestibular
  - Ocular
  - Cognitive-fatigue
  - Posttraumatic migraine
  - Anxiety/mood
- **Modifier concussion clinic profiles**
  - Cervical
  - Sleep
- **Retrospective study on clinical profiles**
  - Frequency the clinical profiles
  - Association among different clinical profile



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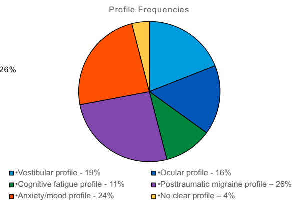
PROFILE FREQUENCIES (KONTOS, ET AL. 2019)

- Vestibular profile - 19%
- Ocular profile - 16%
- Cognitive fatigue profile - 11%
- Posttraumatic migraine profile – 26%
- Anxiety/mood profile - 24%
- No clear profile – 4%



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CLINICAL PROFILE SCREENING{KONTOS, ET AL. 2020}

- Purpose: "evaluate the reliability and validity of a newly developed, brief, clinical profile-based symptom inventory"
- Methods
  - Subjects: 12 – 19 YO
  - Controls
    - They participated in concussion baseline testing
    - Inclusion if no concussion within 3 months of baseline testing
  - Concussed subject
    - Recruitment from 3 different concussion clinic locations
  - N – 100 subjects/group based on the 80% power analysis
  - Measures
    - Concussion clinical profile screening tool (29 vs. 22 question survey)
    - PCSS
    - ImPACT
    - VOMS

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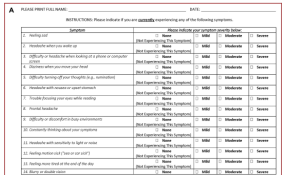
CLINICAL PROFILE SCREENING (KONTOS, ET AL. 2020)



A

PLEASE PRINT FULL NAME: _____ DATE: _____

INSTRUCTIONS: Please indicate if you are **currently** experiencing any of the following symptoms.

Symptom	Please indicate your symptom severity below:
1. Feeling sad	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
2. Headache when you wake up	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
3. Difficulty or headache when looking at a phone or computer screen	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
4. Dizziness when you move your head	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
5. Difficulty turning off your thoughts (e.g., ruminations)	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
6. Headache with nausea or upset stomach	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
7. Trouble focusing your eyes while reading	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
8. Frontal headache	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
9. Difficulty or discomfort in busy environments	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
10. Constantly thinking about your symptoms	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
11. Headache with sensitivity to light or noise	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
12. Feeling motion sick ("see or car sick")	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
13. Feeling more tired at the end of the day	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe
14. Blurry or double vision	☐ None (Not Experiencing This Symptom) ☐ Mild ☐ Moderate ☐ Severe

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VESTIBULAR (KONTOS, ET AL. 2020)

- 4. Dizziness when you move your head
- 9. Difficulty or discomfort in busy environments
- 12. Feeling motion sick("see or car sick")
- 15. Feeling or sensation of slow wavy dizziness(i.e. Lightheadedness)
- 21. Feeling or sensation of fast spinning dizziness (i.e., vertigo)

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW	AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5= ____
COGNITIVE/FATIGUE (Items 13, 24, 28)=	____	÷3= ____
MIGRAINE (Items 2, 6, 11, 20, 27)=	____	÷5= ____
OCULAR (Items 3, 7, 8, 14, 19)=	____	÷5= ____
VESTIBULAR (Items 4, 9, 12, 15, 21)=	____	÷5= ____

MODIFIER SCORES:

	RAW	AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4= ____
NECK (Items 16, 25)=	____	÷2= ____

CP SCREEN TOTAL RAW SCORE= ____

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OCULAR (KONTOS, ET AL. 2020)

- 3. Difficulty or headache when looking at a phone or computer screen
- 7. Trouble focusing your eyes while reading
- 8. Frontal headache
- 14. Blurry or double vision
- 19. Eye strain (eyes feel tired) during visual activities

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW	AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5= ____
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MODIFIER SCORES:

	RAW	AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4= ____
NECK (Items 16, 25)=	____	÷2= ____

CP SCREEN TOTAL RAW SCORE= ____

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COGNITIVE FATIGUE (KONTOS, ET AL. 2020)

- 13. Feeling more tired at the end of the day
- 24. Trouble remembering things (e.g., what you completed today or having to re-read information)
- 28. Increased headache following cognitive activity

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW	AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5= ____
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MODIFIER SCORES:

	RAW	AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4= ____
NECK (Items 16, 25)=	____	÷2= ____

CP SCREEN TOTAL RAW SCORE= ____

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POSTTRAUMATIC MIGRAINE (KONTOS, ET AL. 2020)

- 2. Headache when you wake up
- 6. Headache with nausea or upset stomach
- 11. Headache with sensitivity to light or noise
- 20. Visual aura (e.g. Flashes, stars, spots, flickering light) with or without headache
- 27. Increased headache following physical activity

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW	AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5= ____
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MODIFIER SCORES:

	RAW	AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4= ____
NECK (Items 16, 25)=	____	÷2= ____

CP SCREEN TOTAL RAW SCORE= ____

FIGURE 1. *Continued*

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ANXIETY/MOOD (KONTOS, ET AL. 2020)

- 1. Feeling sad
- 5. Difficulty turning off your thoughts (e.g., rumination)
- 10. Constantly thinking about your symptoms
- 26. Feeling nervous or anxious
- 29. Feeling more stress than usual

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW	AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5= ____
COGNITIVE/FATIGUE (Items 13, 24, 28)=	____	÷3= ____
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MODIFIER SCORES:

	RAW	AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4= ____
NECK (Items 16, 25)=	____	÷2= ____

CP SCREEN TOTAL RAW SCORE= ____

FIGURE 1. *Continued*

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SLEEP MODIFIER (KONTOS, ET AL. 2020)

- 17. Sleeping more than usual
- 18. Sleeping less than usual
- 22. Difficulty falling asleep
- 23. Difficulty staying asleep

C

CP SCREEN SCORING SHEET

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PROFILE SCORES:

	RAW		AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5=	____
COGNITIVE/FATIGUE (Items 13, 24, 28)=	____	÷3=	____
MIGRAINE (Items 2, 6, 11, 20, 27)=	____	÷5=	____
OCULAR (Items 3, 7, 8, 14, 19)=	____	÷5=	____
VESTIBULAR (Items 4, 9, 12, 15, 21)=	____	÷5=	____

MODIFIER SCORES:

	RAW		AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4=	____
NECK (Items 16, 25)=	____	÷2=	____

CP SCREEN TOTAL RAW SCORE= ____

FIGURE 1. *Continued*

43

CERVICAL MODIFIER (KONTOS, ET AL. 2020)

- 16. Neck pain or stiffness
- 25. Difficulty moving your neck

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW		AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	____	÷5=	____
COGNITIVE/FATIGUE (Items 13, 24, 28)=	____	÷3=	____
MIGRAINE (Items 2, 6, 11, 20, 27)=	____	÷5=	____
OCULAR (Items 3, 7, 8, 14, 19)=	____	÷5=	____
VESTIBULAR (Items 4, 9, 12, 15, 21)=	____	÷5=	____

MODIFIER SCORES:

	RAW		AVERAGE
SLEEP (Items 17, 18, 22, 23)=	____	÷4=	____
NECK (Items 16, 25)=	____	÷2=	____

CP SCREEN TOTAL RAW SCORE= ____

FIGURE 1. *Continued*

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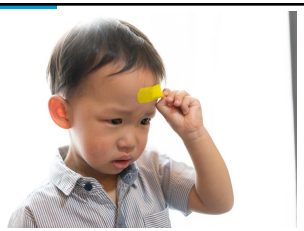
CLINIC

- **Results**
  - Reliab
    - C
    - C
  - The cli
  - The cli
  - The co



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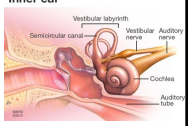
CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Common symptoms**
  - Dizziness with movement or change of position
  - Dizziness, nausea, mental fogginess and anxiety in busy environments
  - Balance problems
  - Motion sensitivity
  - Vertigo when lying down, looking up, or rolling over

Inner ear



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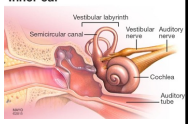
CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Risk factors**
  - Personal history of motion sickness/sensitivity
  - Personal history of vestibular disorder
  - Comorbid migraine
  - Comorbid anxiety disorder

Inner ear



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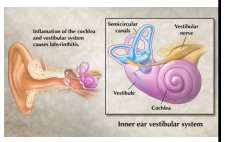
CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019), (HAIDER, ET AL. 2021), (SCHNEIDER, ET AL. 2019)

- **Clinical Examination**
  - Abnormal Vestibular screening
    - Symptom provocation with vestibular ocular reflex testing (VOR)
  - Dynamic Visual Acuity
    - The patient is asked to perform static visual acuity and note which is the lowest line on the chart
    - Perform horizontal head rotation
    - A positive test is an inability to read the line within two lines of the static test
  - Head Thrust Test / Head Impulse Test
    - Focus on nose
    - Quick rotation
      - Corrective saccade



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CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019), (HAIDER, ET AL. 2021), (SCHNEIDER, ET AL. 2019)

- **Clinical Examination**
  - Balance assessment
    - Static
      - Hands on hips in a tandem stance for 20 seconds with eyes closed
    - Dynamic
      - Tandem gait forward with five steps and eyes open then five steps with eyes closed. Repeat the test backwards with eyes open first then closed; each for 5 steps
    - BESS

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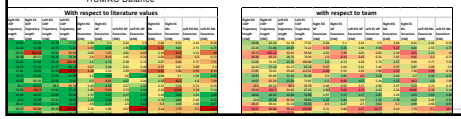
CLINICAL PROFILE: VESTIBULAR (KONTOS ET AL. 2019), (HAIDER, ET AL. 2021), (SCHNEIDER, ET AL. 2019)

- **Clinical Examination**
  - Gait assessment with Technology
    - SWAY:
      - Comparable to the Biodex balance system (Patterson, et al. 2014)
      - Reliable when operating on multiple devices (VanRavenhorst-Bell,et al. 2021)
      - Comparable to the ImPACT test(VanRavenhorst-Bell et al. 2021)
        - Wichita State
    - HUMAC Balance



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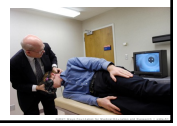
CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- Assessment of Benign Paroxysmal Position Vertigo (BPPV) (Schneider, et al. 2019)
  - PC
    - Fully Supported / Modified Hallpike
  - HC
    - Modified Roll / Lateral Body Position
  - AC
    - Straight / Deep Head Hanging Test



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CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
- **Vestibular Hypofunction**
  - Vestibular rehabilitation therapy
    - Adaption
    - Habituation
    - Substitution
    - Cognition
  - Dynamic exertion therapy
  - Sub-symptom threshold aerobic exercise (Haider, et al. 2021)

- **Targeted treatment strategies**
- **Benign Paroxysmal Position Vertigo (BPPV)**
  - PC
    - Modified Canalith Reposition Maneuver
  - HC
    - Horizontal Hybrid Maneuver
  - AC
    - Yacovino Maneuver

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CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
- **Vestibular Hypofunction**
  - Vestibular rehabilitation therapy
    - Adaptation
      - Trying to reduce gaze instability
      - Oscillopsia

1. Eye movement without head movement
2. Focusing while turning their head – VOR activities / gaze stabilization
3. Targets – coordination of eye and head movement
4. Dynamic total movement
   - Walking with targeting

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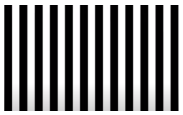
CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
- **Vestibular Hypofunction**
  - Vestibular rehabilitation therapy
    - Habituation
      - Find what brings on the symptoms (desensitization)
      - Head position, frequency, direction

- Optokinetic Stimulation



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CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
- **Vestibular Hypofunction**
  - Vestibular rehabilitation therapy
    - Substitution
      - Challenge eyes, ears, or touch

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CLINICAL PROFILE: VESTIBULAR (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
- **Vestibular Hypofunction**
  - Vestibular rehabilitation therapy
    - Cognition

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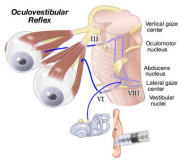
CLINICAL PROFILE: OCULAR (KONTOS, ET AL. 2019)

- **Common symptoms**
  - Blurred vision, diplopia, eye strain, difficulty focusing
  - Difficulty reading
    - Skipping lines or problems with comprehension



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CLINICAL PROFILE: OCULAR (KONTOS ET AL. 2019)

- **Risk factors**
  - Personal/family history of eye muscle surgery, strabismus, amblyopia, or other ocular diagnoses

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CLINICAL PROFILE: OCULAR (KONTOS, ET AL. 2019)

- **Clinical Examination**
  - Abnormal near point convergence measurements (Haider, et al. 2021;Kontos, et al. 2019)
    - The test is performed 3 times with the best distance recorded. A normal test in the general population is less than 10 cm and in children and adolescents it is less than 6 cm
  - Repetitive Saccades (Haider, et al. 2021)
    - Horizontal and vertical saccades - athlete should be able to perform 20 repetitions without eliciting symptoms
      - Abnormal response
        - Delayed initiation of eye movement
        - Slow velocity
        - Inaccurate movements such as over shooting or under shooting
        - Symptoms such as headache, dizziness, or nausea
  - Heterophoria testing

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CLINICAL PROFILE: OCULAR

Heterophoria

Exophoria
- Causes a heteronymous diplopia or crossed diplopia. When an image seen by the right eye is to the left of the image seen by the left eye. Essentially the eye may be positioned lateral.
- Eye or eyes pointing outward.

Esophoria
- A tendency for the visual axes to cross. When this occurs the patient will have homonymous diplopia. When an image observed by the right eye is located to the right of the image.
- Eye or eyes pointing inward.

Hyperphoria
- The visual axis of one eye is higher than the other.

Hypophoria
- The visual axis of one eye is lower than the other.

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CLINICAL PROFILE: OCULAR (KONTOS, ET AL. 2019)

- Testing Heterophoria Distance & Near
  - Tool:
    - Maddox Rods
    - Bernell cards; near and distance
  - Exam room setup
    - The exam room may be illuminated or dimed in order to see the red line image on the test cards.
  - Testing procedure
    - Near
      - Testing cards are placed 16 inches away from the patient's chin
    - Distance
      - Testing cards are held 10 feet away from the patient
    - The Maddox Rods occluder is placed over the right eye with rods going vertical. The patient is instructed they will see a horizontal line on the test card. The patient is asked if the red line is to their right or left of the y-axis. The patient will then state the exact number to the right or left of the y-axis. (Testing procedures are the same for near and distance)
    - The Maddox Rods occluder is placed over the right eye with rods going horizontal. The patient is instructed they will see a vertical line on the test card. The patient is asked if the red line is to their right or left of the y-axis. The patient will then state the exact number to the right or left of the y-axis. (Testing procedures are the same for near and distance)
  - Referral criterion
    - Esophoria: Any esophoria distance or near
    - Exophoria : Distance ≥ 4 / Near ≥ 6
    - Right hyperphoria / Right hypophoria: ≥ 2 Hyper/Hypo distance or near

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CLINICAL PROFILE: OCULAR (KONTOS ET AL. 2019)

- **Clinical Examination**
  - Eye Box (Samadani, et al. 2016)
    - Eye Box tracks the eyes while the patient is watching a music video, a cartoon, or short film clip.
    - The position of the pupil is mapped over time
    - The clip is 220 seconds
      - 88% Sensitivity; concussed vs. controls
      - 77% specificity; concussed vs. controls

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CLINICAL PROFILE: OCULAR (KONTOS ET AL. 2019)

- **Clinical Examination**
  - Eye Box (Samadani, et al. 2016)

Table 3: The p-values and the area under the receiver operating characteristic curve (area under the curve) for each candidate eye tracking measure as it correlates to age, male versus female or concussion versus control

Variable	p-value, correlated with age	p-value, male vs female	p-value, concussion vs control	AUC_value
conj_boxscore_value	0.996	0.285	<0.0001	0.74
conj_totVar_value	0.122	0.25	0.0009	0.734
conj_varAspect_value	0.128	0.974	0.0011	0.733
conj_varX_value	0.856	0.074	0.0062	0.701
conj_varXbot_value	0.821	0.735	0.0062	0.701
conj_varXlef_value	0.948	0.223	0.0015	0.725
conj_varXrit_value	0.258	0.011	0.0006	0.744
conj_varXtop_value	0.93	0.095	0.0002	0.76
conj_varY_value	0.082	0.33	0.0055	0.696
conj_varYbot_value	0.624	0.69	0.0149	0.672
conj_varYlef_value	0.315	0.565	0.0102	0.682
conj_varYrit_value	0.057	0.256	0.0170	0.669
left_areamean_value	0.724	0.18	0.0236	0.66
left_areamedian_value	0.933	0.43	0.0109	0.68
left_varYlef_value	0.62	0.338	0.0003	0.753
left_varYtop_value	0.945	0.873	0.0149	0.672
left_widthmean_value	0.352	0.368	0.0268	0.657
left_widthmedian_value	0.439	0.79	0.0045	0.701
right_areamedian_value	0.118	0.523	0.0436	0.643
right_distTop_value	0.090	0.018	<.0001	0.848
right_varXrit_value	0.133	0.654	0.0436	0.643
right_varYtop_value	0.246	0.634	0.0304	0.653
right_widthmean_value	0.358	0.676	0.0490	0.639
right_widthmedian_value	0.102	0.834	0.0170	0.669
right_aspectRationmean_value	0.854	0.453	0.0313	0.621

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CLINICAL PROFILE: OCULAR (KONTOS ET AL. 2019)

- **Clinical Examination**
  - Eye Box (Samadani, et al. 2018)
    - Purpose: evaluate objective eye tracking measures among child and adolescent athletes who sustained a concussion within 10 days of examination and a group of healthy control participants.
    - Hypothesis: eye movement variability would be higher for the concussion group compared to the control group.
    - Inclusion: consisted of enrolling in the study within the first 10 days of injury and being between the ages of 8 and 18.
    - Conclusion: the normalized amount of the eye trajectory while watching a video was greater among youth athletes who were tested within 10 days of a concussion than controls.

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CLINICAL PROFILE: OCULAR (KONTOS ET AL. 2019)(Haider, et al. 2021)

- **Targeted treatment strategies**
  - Vision therapy
    - Repetitive saccades
      - Post-it notes or fingers
      - Okay to have symptoms, not too high
    - Static Fixation
      - Brock string
        - 3 beads on a string: "1 on the end, 1 in the m… possible but still in focus. Patient started by looking at the far list, then the middle, then the closest. The goal is to keep each bead in focus clear, not blurry or double). As patient has improved with training they moved the closest bead closer to the nose while keeping it clear the goal of getting it within 6 cm from the no was without doubling
    - Dynamic Fixation
      - Pencil pushups
  - Exposure/recovery approach when engaging in visual demanding tasks
  - Prism lenses
  - Sub-symptom threshold aerobic exercise

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CLINICAL PROFILE: COGNITIVE-FATIGUE (KONTOS, ET AL. 2019)

- **Common symptoms**
  - Feeling "in a fog
  - Difficulty concentrating
  - Memory problems
  - Feeling slowed down
  - Fatigue or low energy
  - Symptoms worsen throughout the day especially headache

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CLINICAL PROFILE: COGNITIVE-FATIGUE (KONTOS ET AL. 2019)

- **Clinical Examination**
  - Neurocognitive deficits across domains (ImPACT Testing)
- **Risk factors**
  - Personal history of ADHD, or learning disability
- **Targeted treatment strategies**
  - Brief academic/work accommodations
  - Exercise in the form of a daily walk(Collins, et al. 2014)
  - Behavior regulation
  - Medication with stimulant properties
  - Have a normal day
  - Stop asking them their sysmtpoms

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CLINICAL PROFILE: POSTTRAUMATIC MIGRAINE (KONTOS ET AL. 2019)

- **Common symptoms**
  - Intermittent, moderate to intense headache
  - Headache often present upon wakening
  - Headache with nausea and or photosensitivity
- **Clinical Examination**
  - Neuro cognitive deficits across domains are common (ImPACT Testing)
- **Risk factors**
  - Personal/family history of migraine
  - Personal history of motion sickness
  - Comorbid anxiety disorder or sleep problems
  - Female athlete
- **Targeted treatment strategies**
  - Referral to headache specialist
  - Behavioral regulation
  - Cervical spine treatment
  - Locate what is causing the symptoms

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CLINICAL PROFILE: ANXIETY/MOOD (KONTOS ET AL, 2019)

- **Common symptoms**
  - Anxiety/depression, worry, difficulty turning off thoughts, rumination, excessive preoccupation or focus on symptoms
  - Sadness, limited social interaction or loss of interest
  - Panic attacks
- **Clinical Examination**
  - Elevated scores above cutoff on mood/anxiety questionnaires
- **Risk factors**
  - Personal and or family history of psychiatric issues
  - Psychiatric/mood medications taken in the past
  - Comorbid migraine and sleep problems
  - Presence of significant life stressor

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CLINICAL PROFILE: ANXIETY/MOOD (KONTOS ET AL, 2019)

- **Targeted treatment strategies**
  - Psychotherapy approaches, including cognitive behavioral therapy, behavioral activation, and exposure therapy
  - Psychotropic medication
  - A daily exercise plan and have the athlete track their progress (Collins, et al. 2014)
  - Diaphragmatic Breathing
  - Sub maximal aerobic exercise (Haider, et al. 2021)

70

MODIFIER PROFILE: SLEEP (KONTOS, ET AL. 2019;SCHNEIDER, ET AL. 2019)

- **Common symptoms**
  - Sleeping more than usual
  - Sleeping less than usual
  - Difficulty falling asleep
  - Difficulty staying asleep
- **Targeted treatment strategies**
  - Have a with consistent wake-up time
  - Monitor sleep time with a diary
  - Relax for an hour prior to going to bed
  - Only use the bed for sleeping
  - Limit naps
  - Limit screen time prior to sleeping

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MODIFIER PROFILE: CERVICAL (KONTOS, ET AL. 2019)

- **Cervical**
  - **Anatomy**
    - C1 innervates the atlanto-occipital joint
    - C2 innervates the atlanto-occipital joint and the C2-C3 zygapophyseal joint
    - C3 innervates the C2-C3 zygapophyseal joint and can refer pain to the frontotemporal region
  - **Common symptoms**
    - Neck pain or stiffness
    - Difficulty moving your neck
    - Tension headaches – dull pressure or pain on the side of the head

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MODIFIER PROFILE: CERVICAL (KONTOS, ET AL. 2019)

- **Clinical Examination**
  - Neurologic testing
  - Palpation
  - Assessment of posture
  - Range of motion
  - Spurling test
  - Vertebral artery test
  - Joint position sense
  - Craniocervical flexion test (chin tuck test; deep flexors)
  - Cervical flexor and extensor endurance (chin tuck lift/hold & extend)
  - Cervical flexion-rotation test

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MODIFIER PROFILE: CERVICAL (KONTOS, ET AL. 2019)

- **Targeted treatment strategies**
  - Cervical spine neuromuscular control exercises
  - Trigger point release or instrument assisted soft tissue mobilization
  - Flexibility
  - Joint mobilization techniques
  - Manipulation
  - Strengthening

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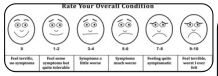
ADDITIONAL TOOL: LEDDY PROTOCOL/BCTT (LEDDY AND WILLER 2013)

Performing the test:
- 3.2-3.6 MPH
- Incline 0% for 2 minutes then increase by 1% point every minute to max height



What measurements are recorded:
- Heart rate
- Rating of overall condition
- Rate of perceived exertion
- King Devick©® Pre and post exercise

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CONCUSSION PEARLS

- Immediate disclosure of the concussion (education)
  - 5 days longer recovery if delayed reporting
- School & Symptoms
  - It is okay to have some symptoms and be at school
- Encouragement
  - Encourage the athlete that they will get better
- Prolonged recovery
  - Still a concussion?
- Utilize your resources
  - School nurse
  - PT/OT
  - Ophthalmology
  - Sport psychology
  - Accommodations

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FUTURE CONCUSSION RELATED TOPICS

- Vision screening with heterophoria and esophoria
- Delayed reporting of concussion
- Return to learn
- Return to school
- Musculoskeletal injury and concussion

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THANK YOU

- Questions & Discussion

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