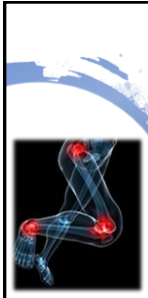


The Brain & Lower Extremity Connection:

Neuromuscular & Musculoskeletal Treatment of Athletes who Sustain Concussion & Lower Extremity Injury

S. Tyler Shultz, PT, DPT, OCS

Rebecca Bliss, PT, DPT, NCS

Objectives

- Apply recent research evidence regarding concussion management with concurrent LE injury to clinical decision making
- Identify and apply appropriate interventions to daily practice in management of this patient population to include: sensory reweighting, NM exercise, and sport specific training
- Discuss implications of identifying prior injury history to guide assessment and interventions with regards to this patient population
- Review and apply common functional outcome measures and functional tests used for return to sport for patients following concussion and LE injury
- Identify potential risk factors that increase susceptibility for re-injury in patients with history of concussion and lower extremity injuries

Patient Case

- Meghan is a 16 y/o female high school soccer player
- She is currently a junior and is competitive for a D-1 collegiate soccer scholarship
- In the off-season she participates in track and field
- In late March, she fell while running the 400m hurdles, and suffered a concussion
- Athlete was given a week of rest, graduated through return to play protocol for track and hurdles and then cleared to compete.

- L inversion ankle sprain 3 weeks ago
- Radiographs negative for fracture

- Referred from team MD for "eval and treat, lateral ankle sprain"
- Treated by team trainer, unable to return to running or practice

- Relevant history: of 2 low-grade L ankle sprains over the past 5 years, did not miss any time due to these injuries - treated with RICE and tape

Current Injury

What Would You Do Next?

What subjective information do you need?

What objective information do you need?

Current Evidence

High School Athletes

- High school athletes with history of previous concussion, odds for sustaining subsequent time-loss LE injury increased 34%
- Sports with LESRI's in High School Athletics:
  - Football for boys (2.01/1000) and soccer for girls (1.59/1000)
  - Girls had 1.5x the proportion of season-ending injuries

Leading diagnoses:
- Sprains (50%)
- Strains (17%)
- Contusions (12%)
- Fractures (5%)

Injury Location:
- Ankle (40%)
- Knee (25%)
- Thigh (14%)
- Other (21%)

(Lynall et al., 2017; Fernandez et al., 2007)

Current Evidence

Collegiate Athletes

- Collegiate athletes with history of concussion are **1.97x** more likely to experience an acute LE musculoskeletal injury after concussion than before
- **1.64x** more likely to experience acute MSK injury after concussion as compared to their matched controls
- History of concussion showed an association with:
  - Lateral ankle sprains
  - Knee injury
  - LE muscle strain

  *Overall odds ratios 1.6 to 2.9 elevated risk

(Lynall et al., 2017; Gilbert et al., 2016)

Current Evidence

Active Duty Soldiers

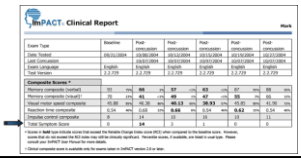
- Within 2 years of concussion:
  - Hazard of LE injury was 38% greater in concussed soldiers as compared to matched non-concussed controls
  - 15 month post injury hazard rate 45%

(Kardouni et al., 2018)

Current Evidence

General Athletics

- Recent studies show poor neurocognitive performance, either at baseline or after concussion, is associated with increased risk of musculoskeletal injury


ImPACT- Clinical Report

(Herman et al., 2015)

Risk for Ankle Sprain

Intrinsic Factors:

- ↓ Dorsiflexion
- ↓ Proprioception
- ↓ Single leg balance

Level 1

- ↓ LE Strength
- ↓ Coordination
- ↓ Cardio. endurance
- Female
- ↑Height

Level 3

Extrinsic Factors:

- Type of sport
- Position played
- Level of competition

Level 2
Level 3

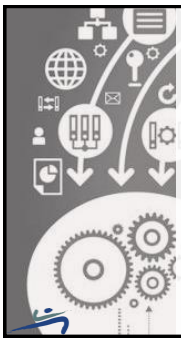
(Vuurberg et al., 2018)

Development of Chronic Ankle Instability (CAI)

- Increased talar curvature, lack of external support use, lack of comprehensive balance and proprioception exercise
- Deficiency in dynamic postural control & altered hip mechanics

"Due to the neuromuscular origin of some factors, physical therapy might be helpful to improve impairments after a LAS and prevent progression to CAI"

(Vuurberg et al., 2018; Martin et al., 2013)



Proposed Theories

- Brain unable to effectively coordinate movement
- Neurocognitive dimensions are likely higher integrated with NMR control and motor learning
- Poor ImPACT performance on all domains occurred in athletes who sustained ACL injury
- Continued dynamic postural control deficits with increased motor evoked potential latency and decreased amplitude
- Decreased dynamic balance and altered gait mechanics may cause increase risk for LE injury

(Herman, et al., 2015; Lynall et al., 2015; Lynall et al., 2017)

Neurocognition & Sports Performance

Dimensions of neurocognitive performance in the sport performance context.

Dimension	Working Definition
Visual attention	The ability to concentrate on visual input to the exclusion of other less essential stimuli
Self-monitoring	The ability to focus on proprioceptive/kinesthetic feedback
Agility/fine motor skill	The ability to make minor adjustments in motor activity
Processing speed/reaction time	The ability to engage in stimulus-response behavior within an intended time frame
Dual tasking	The ability to engage in two activities at the same time to maximize goal attainment

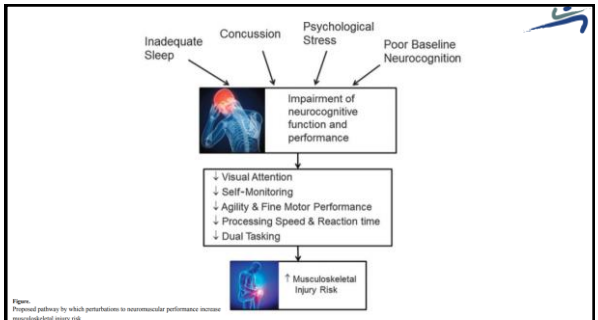


Figure.
Proposed pathway by which perturbations to neuromuscular performance increase musculoskeletal injury risk.

(Herman et al., 2015)

Proposed Theories

- Change in neuromuscular function, specifically altered LE stiffness
- Clinical implications of lingering dynamic balance deficits unclear- need for alterations to concussion-assessment batteries
- Small magnitude dynamic balance deficits may possibly be exacerbated in highly dynamic sport environments that have both significant motor and cognitive demands
- Postural control deficits in post concussion may persist long after injury resolution
  - Comparison of athlete vs. non-athlete

(Dubose et al., 2017; Lynall et al., 2017; Lynall et al., 2015; Schmidt et al., 2018)

Why Is This Important?

- Do typical msk interventions address risk factors to prevent CAI?
- Are we screening concussion history in msk settings effectively?
- Are we training to fullest prior to release from concussion rehab?
- Do specific LE injury prevention protocols need to be implemented in individuals with hx of concussion?
- Sport specific drills with added motor and cognitive tasks?
- Implications on athletes and non-athletes

What Would You Do Next?

What **other** subjective information do you need?

What **other** objective information do you need?

Evaluation Considerations - History

Neuro Considerations

- Hx of Concussion
- Recent Neurocognitive Assessment?
- What tools were used for return to play?

Ortho Considerations

- History of ankle sprains
- Balance and proprioceptive activities
- Brace use?

Evaluation Considerations - MSK

ROM:
- Right DF = 16°
- Left DF = 2°
- CC DF = 3cm L; 9cm R

Strength:
- B hip abd = 4/5
- Right eversion = 5/5
- Left eversion = 3/5

Joint Mobility:
- Hypomobile talocrural AP
- Hypermobile subtalar-medial

Single leg balance:
- EO: R = 30s, L = 6s
- EC: R = 30s, L = 0s

Evaluation Considerations - MSK

Function:
- Gait: antalgic w/ decreased DF at TSt after walking 30'; unable to run
- Squat: limited by ankle DF, notable hip IR + adduction
- Calf Raise: R single leg = 19 reps; L single leg = 3 reps; B = 25
- Hop: unable to perform on L LE

FAAM Sports = 25%
LEFS = 45/80

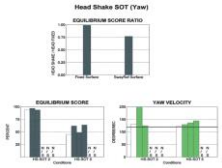
Evaluation Considerations - NEURO

Oculomotor
- L ptosis
- Hypometric saccades
- Convergence Insufficiency

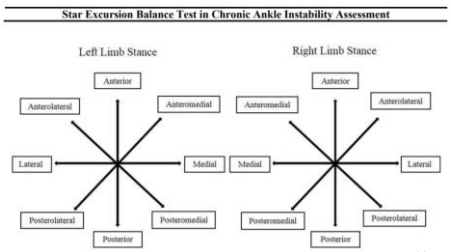
Vestibular
- R + Head Thrust
- DVAT 3 line difference

Cervical
- > 4.6 degrees Cervical JPE right rotation and extension

CISS = 18
FGA = 27/30
SOT = WNLs
HSSOT = Condition 2 84%
Condition 5 37%



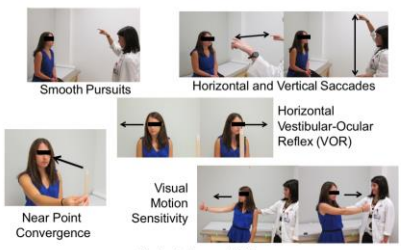
Evaluation Considerations



(Khuman et al., 2014)

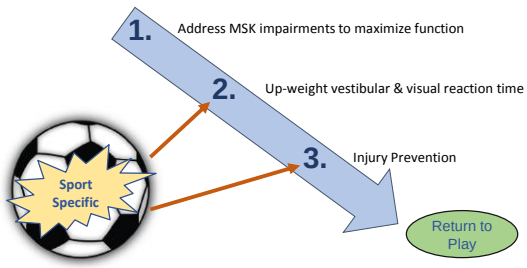
Evaluation Considerations

The Vestibular/Ocular Motor Screening-VOMS



Mucha et al., 2014; AJSM

Intervention Priority



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What Do We Know? - Recurrent LAS

B RISK FACTORS – ACUTE LATERAL ANKLE SPRAIN

- History of previous LAS
- Lack of external support**
- Lack of normal DF ROM**
- Balance + Proprioception exercise**
- Proper warm up:**
  - Dynamic movements
  - Static stretching
- Incomplete rehab**

Present in our case:

- ↓ Dorsiflexion**
- ↓ Balance**
- Incomplete rehab**

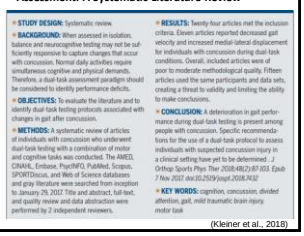
** = MODIFIABLE with Physical Therapy!

(Martin et al., 2013)

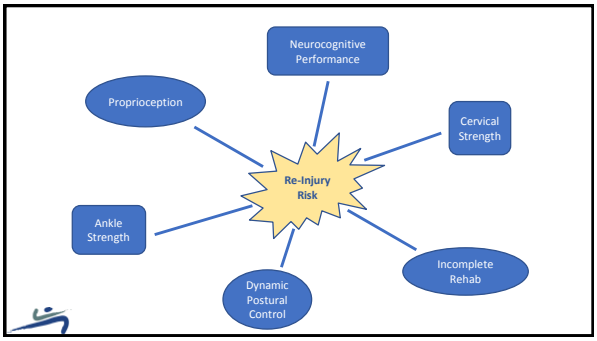
What Do We Know? - Recurrent Concussion

- Neurocognition
- Lack of rehab
- Cognitive Gait Assessments?
- Limited evidence suggests that decreased gait velocity, increased medial-lateral displacement, and increased cognitive errors with a dual-task (gaitcognitive) paradigm exist in concussed individuals suspected to have a concussion, despite normal neuropsychological tests and postconcussion symptom scales.

Dual-Task Assessment Protocols in Concussion Assessment: A Systematic Literature Review



(Kleiner et al., 2018)



Future Considerations

- Baseline & RTS neurocognitive performance
- Are we screening concussion history in msk settings effectively?
- Are we training to fullest prior to release from concussion rehab?
- Do specific LE injury prevention protocols need to be implemented in individuals with hx of concussion?
- Sport specific drills with added motor and cognitive tasks?
- Implications on athletes and non-athletes

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