

WHY VOMS SHOULD BE YOUR GO TO CONCUSSION TOOL



LEARNING OBJECTIVES

List the common impairments that occur to the ocular motor and vestibular system following a concussion.

Restate the clinical utility of the VOMS in the management and treatment of concussion.

Identify at least three neuro-correlates between the VOMS and an athlete's return to play progression.

Identify at least three neuro-correlates between the VOMS and an athlete's return to learn progression.



CONCUSSION= NETWORK DISRUPTION

- **Neurometabolic** (Giza & Hovda, 2014; Gardner, Iverson, & Stanwell, 2014)
- **Axonal** (Grossner, Mayer, & Hillary, 2019; Kontos & Collins, 2018)
- **Cerebrovascular** (Shenton et al., 2012)
- **Ocular motor** (Mucha et al., 2014)
- **Vestibular** (Mucha et al. 2014)



QUICK CHECK IN

Do you know what the VOMS is?

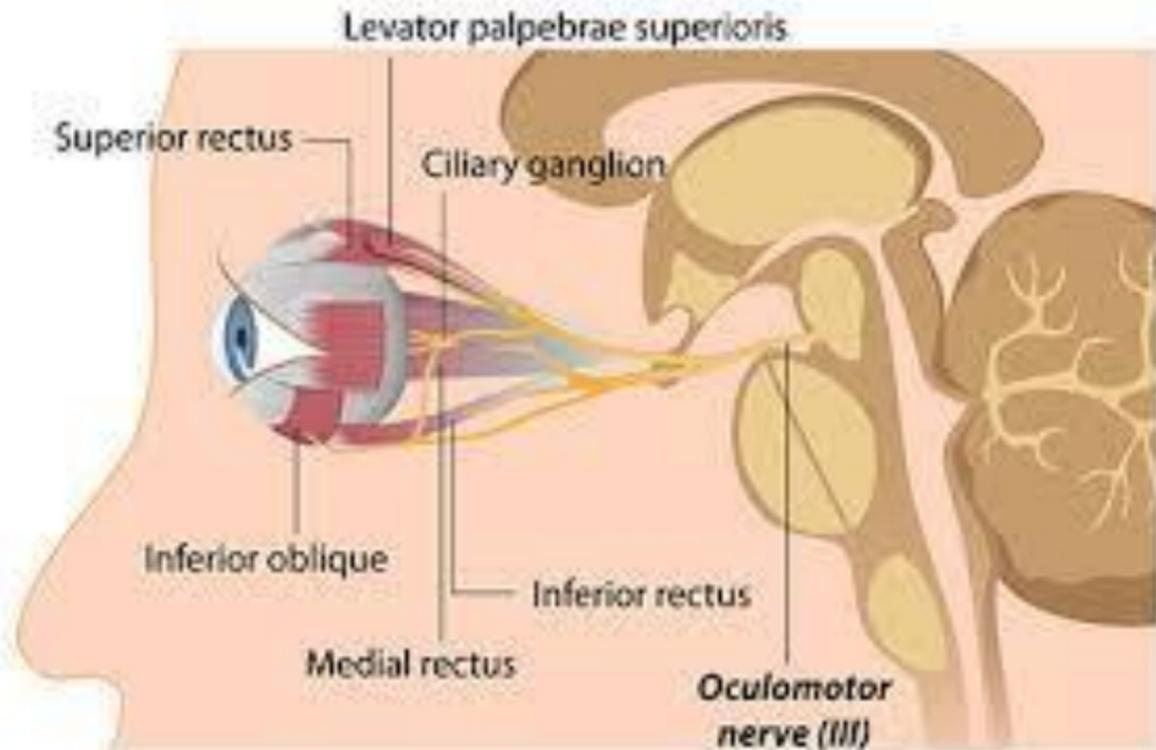
Have you been trained on how to administer the VOMS?

Do you use the VOMS when dx a concussion?

Do you use the VOMS in management and treatment of injury?

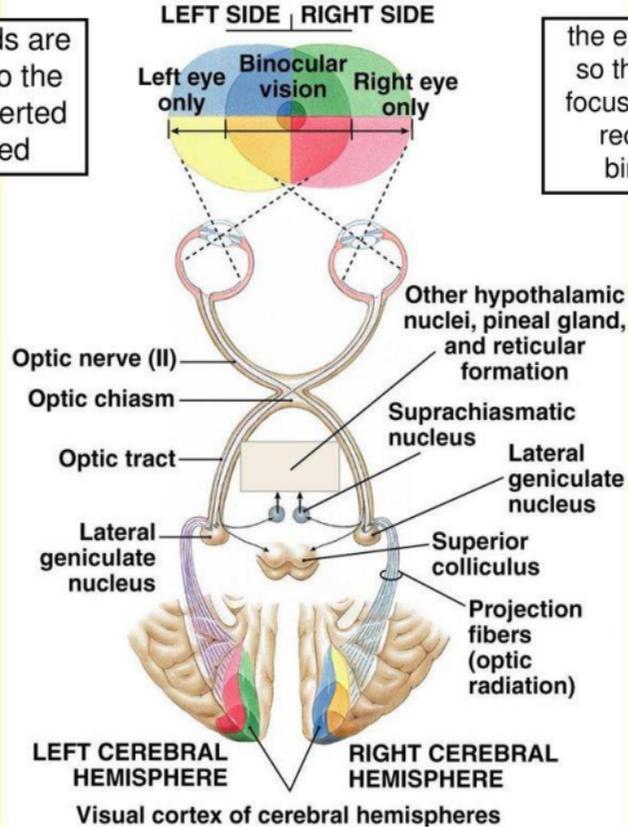


OCULAR MOTOR SYSTEM



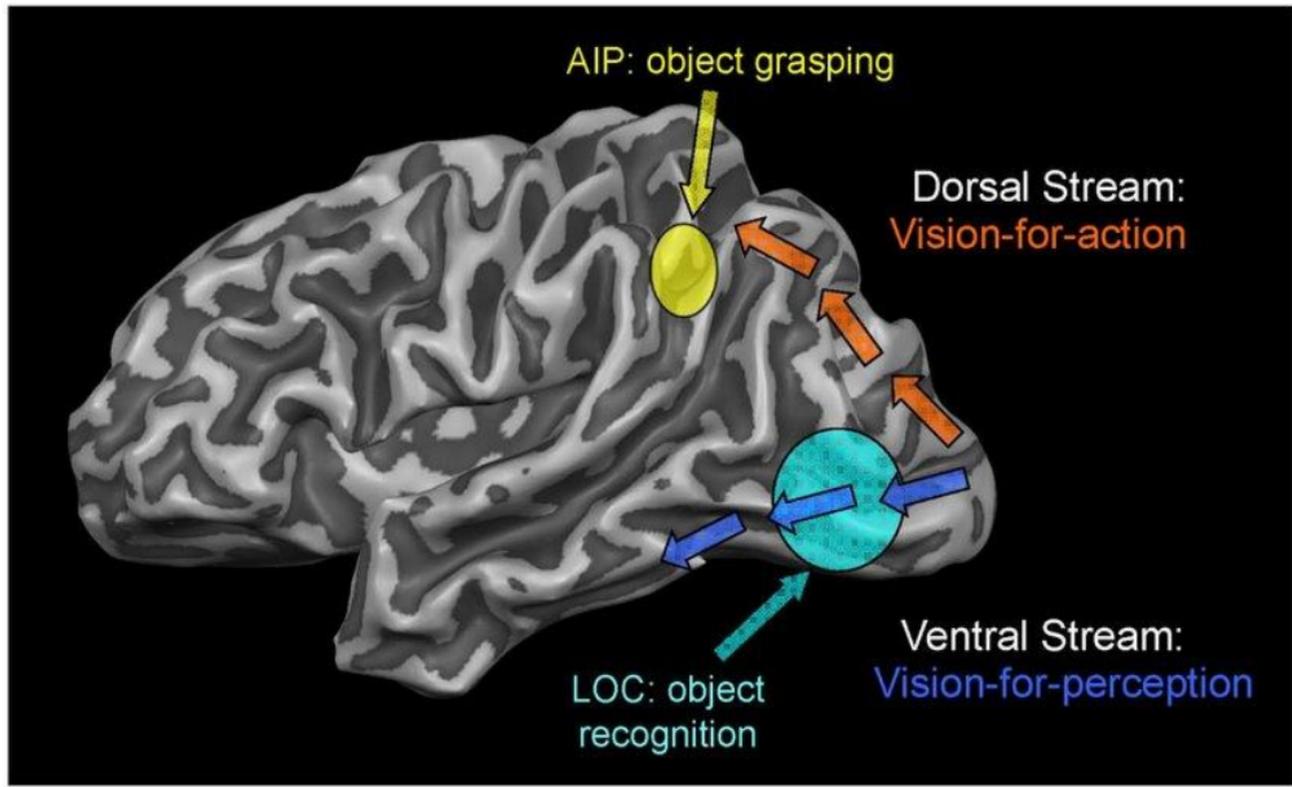
the visual fields are projected onto the retina both inverted and reversed

optic nerve fibers transmitting impulses from the right visual fields travel in left optic tract



the eyes must move so that the object is focused on the visual receptors in the binocular zone

optic nerve fibers transmitting impulses from the left visual fields travel in right optic tract





OCULAR MOTOR SYSTEM

Common Symptoms reported include:

Blurred vision

Headache “pressure”- usually behind eyes

Photophobia

Fogginess

VESTIBULAR



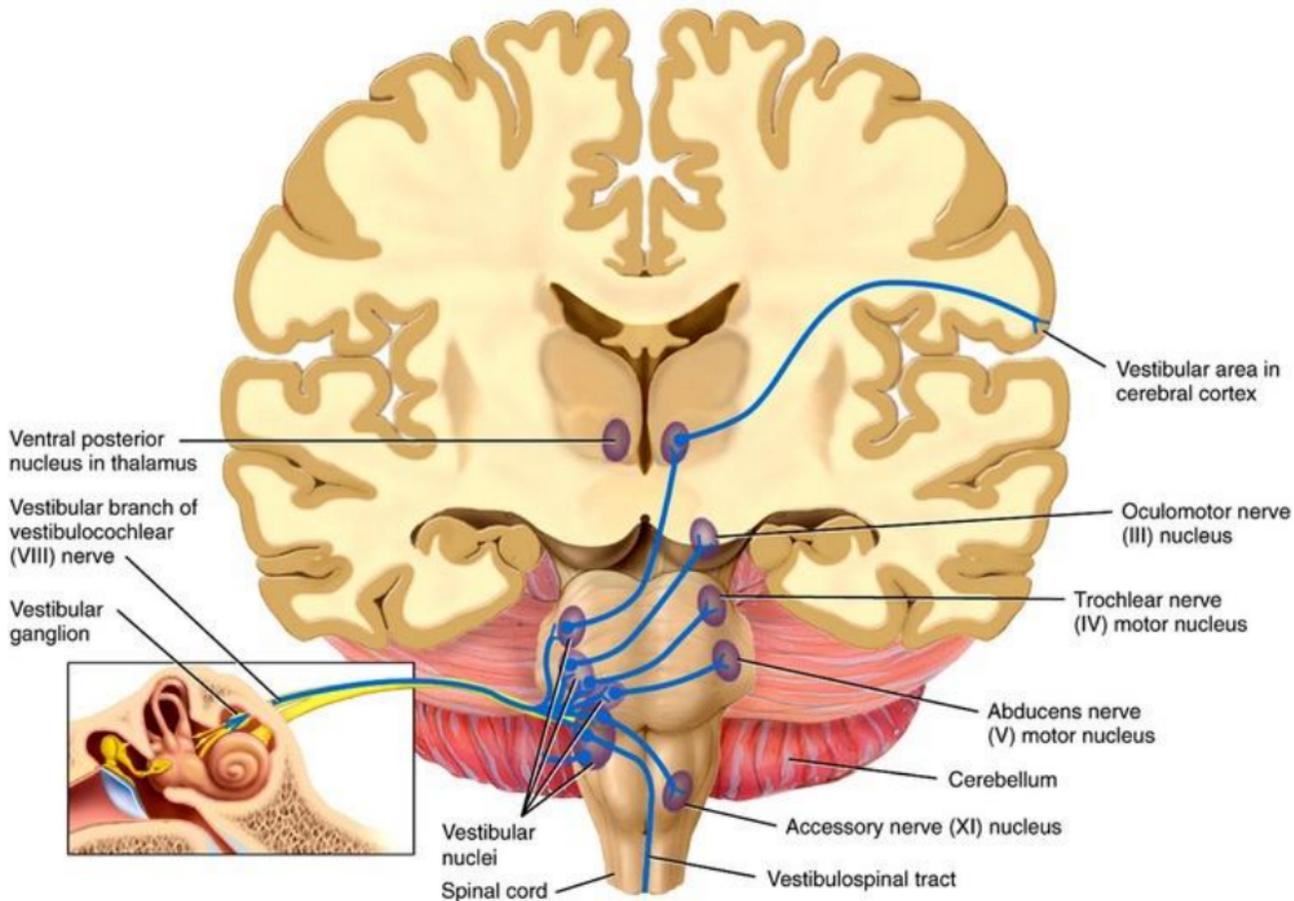
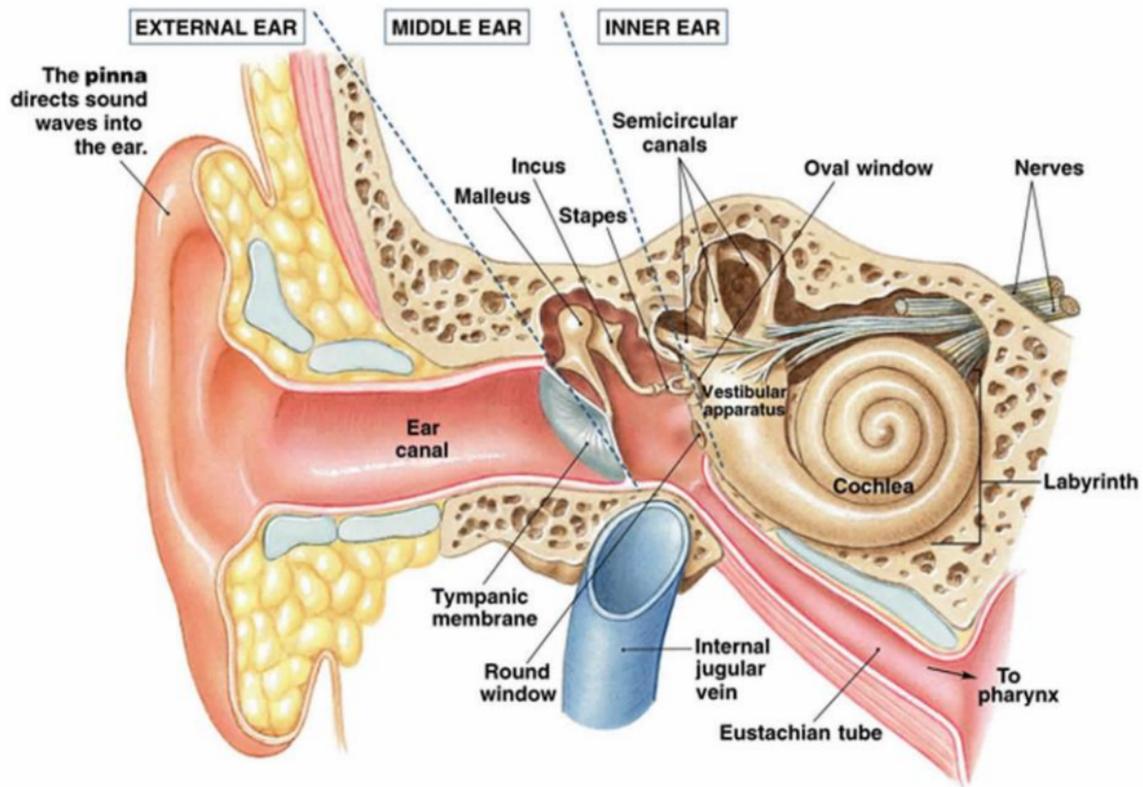
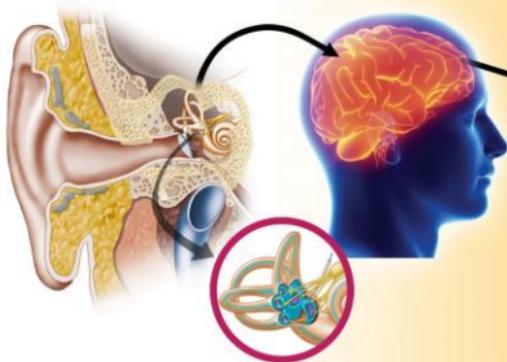


Figure 17.26 Tortora - PAP 12/e
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Your Balance System in Action

This is your vestibular (balance) system, which is part of your inner ear. It sends information about head motion and orientation to the brain for processing in order to send the right commands to the rest of your body.



Gaze Stability

Coordinates eye and head movements



Eye rotation



Gait Stability

Keeps you upright and stable



Spatial Orientation

Maintains your sense of equilibrium



**Massachusetts
Eye and Ear**



VESTIBULAR

Common Symptoms reported include:

Dizziness

Nausea

Blurred vision

Balance problems

Feeling “foggy”



BRING ON THE VOMS!



THE VESTIBULAR OCULAR MOTOR SCREENER

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A		
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

MEASUREMENT/DX

Article: Mucha, A., Collins, M., Elbin, R.J., Furman, J., Troutman-Enseki, C., DeWolf, R., Marchetti, G., & Kontos, A. (2014). A brief vestibular/ocular motor screening assessment to evaluate concussions. *The American Journal of Sports Medicine*. 42 (10), 2479- 2586

Aim: Provide initial data for the internal consistency and validity for VOMS

Participants: 64 age 11-17 1-10 days out from SRC injury (36 male, 28 female) and 78 controls

MEASUREMENT

Results:

The internal consistency of the VOMS total symptom score and the NPC distance was high, with Cronbach $\alpha = .92$.

61% reported symptom provocation after at least 1 VOMS item.

All VOMS items were positively correlated with PCSS total symptom score

The VOR (odds ratio [OR], 3.89; $P < .001$) and VMS (OR, 3.37; $P < .01$) components of the VOMS were most predictive of being in the concussed group

An NPC distance >5 cm and any VOMS item symptom score >2 resulted in an increase in the probability of correctly identifying concussed patients of 38% and 50%, respectively

Receiver operating characteristic curves supported a model including the VOR, VMS, NPC distance, and $\ln(\text{age})$ that resulted in a high predicted probability (area under the curve = 0.89) for identifying concussed patients

Reliable

In it's totality, really good at detecting concussion



MEASUREMENT

Article: Kontos, A., Surfrinko, A., Elbin, R.J., Puskar, A., & Collins, M. (2016). Reliability and associated risk factors for performance on the vestibular/ocular motor screening (VOMS) tool in healthy collegiate athletes. *The American Journal of Sports Medicine*. 44 (6), 1400-1406

Aim: 1. examine the internal consistency of the VOMS in a large sample of healthy, non-concussed collegiate athletes. 2. investigate the effects of patient sex and history of motion sickness, migraines, and concussions on baseline VOMS scores

Participants: 263 D1 collegiate athletes, age 18-21 (166 male, 97 female)

MEASUREMENT

Results:

Internal consistency of the VOMS was high (Cronbach $\alpha = .97$)

89% of athletes scored below cutoff levels (ie, 11% false-positive rate) of greater than or equal to 2 for any individual VOMS symptoms or NPC of greater than or equal to 5.

Again, Reliable

Very low false positive rate- few college students at baseline will have a positive VOMS

A stack of several sticky notes in various colors (pink, orange, purple, blue) is shown against a light green background. The top-most sticky note is light blue and features the text "KEY TAKEAWAYS" in bold, black, sans-serif capital letters.

**KEY
TAKEAWAYS**

MEASUREMENT

Article: Moran, R., Covassin, T., Elbin, R.J., Gould, D., & Nogle, S. (2018). Reliability and normative reference values for the vestibular/ocular motor screening (VOMS) in youth athletes. *The American Journal of Sports Medicine*. 46 (6), 1475-1980

Aim: establish normative data and document the internal consistency and false-positive rate of the VOMS in a sample of nonconcussed youth athletes

Participants: A total of 423 youth athletes (male = 278, female = 145) between the ages of 8 and 14 years completed baseline VOMS screening before the start of their respective sport seasons.

MEASUREMENT

Results:

internal consistency (Cronbach $\alpha = .97$) at baseline among youth athletes.

Approximately 60% of youth athletes reported no symptom provocation on baseline VOMS assessment

9% to 13% scoring over the cutoff levels (score of greater than or equal to 2 for any individual VOMS symptom, near point convergence distance of greater than or equal to 5 cm).

Again, Reliable

Very low false positive rate

Expanded findings to a younger population- few kids at baseline will have a positive VOMS



**KEY
TAKEAWAYS**

MEASUREMENT

Article: Moran, R., Covassin, T., & Elibin, R.J. (2019). Sex differences on vestibular and ocular motor assessment in youth athletes. *Journal of Athletic Training*, 54 (4), 445-448

Aim: To examine sex differences on baseline VOMS assessment among youth athletes.

Participants: 423 participants age 8 to 14 (278 males, 145 females).

Results:

No sex differences were demonstrated between male and female youth athletes on individual VOMS items (P range = .07–.98).

Female sex was not associated with increased odds for VOMS scores over clinical-cutoff levels (range: odds ratio =0.64; 95% confidence interval =0.35, 1.15; P=.13; odds ratio=0.91; 95% confidence interval=0.48, 1.71; P= .77).

Regarding Measurement:

Reliable (children thru college)

Low false-positives (no gender differences)



RECOVERY

Article: Anzalone, A., Blueitt, D., Case, T., McGuffin, T., Pollard, K., Garrison, C., Jones, M., Pavur, R., Turner, S., and Oliver, J. (2017). A positive vestibular/ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. *The American Journal of Sports Medicine*, 45 (2), 474-479

Aim: To examine whether symptom provocation or clinical abnormality in specific domains of the VOMS results in protracted recovery (time from SRC to commencement of RTP protocol)

Participants: 167 patients age 11-19 years old (69 girls, 89 boys) presenting with SRC in 2014

Method: During the initial visit (within 14 days of injury), VOMS was performed in which symptom provocation or clinical abnormality (eg, unsmooth eye movements) was documented by use of a dichotomous scale (0 = not present, 1 = present). The VOMS used in this clinic consisted of smooth pursuits (SMO_PUR), horizontal and vertical saccades (HOR_SAC and VER_SAC), horizontal and vertical vestibular ocular reflex (HOR_VOR and VER_VOR), near point of convergence (NPC), and accommodation (ACCOM). Domains were also categorized into ocular motor (SMO_PUR, HOR_SAC, VER_SAC, NPC, ACCOM) and vestibular (HOR_VOR, VER_VOR). Cox proportional hazard models were used to explore the relationship between the domains and recovery. Alpha was set at P less than or equal to .05. Recovery time was defined as cleared to start return to play.

RECOVERY

Results:

Symptom provocation and/or clinical abnormality in all domains except NPC ($P = .107$) and ACCOM ($P = .234$) delayed recovery (domain, hazard ratio [95% CI]: SMO_PUR, 0.65 [0.47-0.90], $P = .009$; HOR_SAC, 0.68 [0.50-0.94], $P = .018$; VER_SAC, 0.55 [0.40-0.75], $P \leq .001$; HOR_VOR, 0.68 [0.49-0.94], $P = .018$; VER_VOR, 0.60 [0.44-0.83], $P = .002$).

Effect for gender on recovery-boys, 16.9 \pm 9.0 days; girls, 24.1 \pm 15.9 days; $P = .001$

The lowest crude hazard ratio was for ocular motor category (0.45 [0.32-0.63], $P \leq .001$). when controlling for gender (109 were ocular motor vs 92 vestibular but gender break down for each group is not clear).

Positive VOMS related to delay in recovery



RECOVERY

Article: Knell G, Caze T, Burkhart SO. Evaluation of the vestibular and ocular motor screening (VOMS) as a prognostic tool for protracted recovery following pediatric sports-related concussion. *BMJ Open Sport & Exercise Medicine* 2021;7:e000970. doi:10.1136/bmjsem-2020-000970

Aim: To understand the relationship between initial vestibular and ocular motor screening (VOMS) and recovery time, and the utility of VOMS to screen for protracted recovery in youth/adolescent patients with sport-related concussion (SRC).

Participants: 549 patients age 8--18 years old (237 girls, 312 boys) presenting with SRC, presenting 0-7 days (67% were 13-18 years old)

Method: For aim 1A, to determine the association between recovery time and symptom provocation across the various VOMS domains, a symptom provocation was calculated by taking the sum of the differences in symptom provocation scores (scale of 0-10) from baseline for each VOMS test. The sum of differences in symptom provocation scores (from baseline to post-VOMS domain test) was modelled as discrete estimates.

RECOVERY

Results:

Any symptom provocation across all vestibular and ocular motor domains of the VOMS test is associated ($p < 0.05$) with recovery time in males.

Among females, in the fully adjusted models, only the convergence test in the ocular motor domain was not associated ($p = 0.08$) with recovery time, while all other tests were significantly associated ($p < 0.05$) with a recovery time.

Even when seen in more acute setting, positive VOMS related to delay in recovery

Interestingly, those in the protracted recovery were seen on average one day later (3 days vs 2 days). Possibly signaling even more why we should not be delaying care to a specialist

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**KEY
TAKEAWAYS**

RECOVERY

Article: Price, A., Knell G, Caze T, Abt, J, Loveland, D, & Burkhart SO. Evaluation of the vestibular and ocular motor screening (VOMS) as a prognostic tool for protracted recovery in Sports-Related Concussions Aged 8 to 12 years. Clin J Sport Med 2021:00:1-7

Aim: To explore the prognostic ability of the VOMS, K-D3, C3 logix trials to identify protracted recovery from SRC

Participants: 114 patients age 8-12 years old (41 girls, 73 boys) presenting with SRC, presenting 0-7 days

Outcome Measures: There were 2 main outcomes of interest related to SRC recovery time, based on the 2 distinct aims under study. The first was a discrete count of recovery time in days, which was estimated as the number of days from date of injury to date of medical clearance (aim 1). The second main outcome was protracted recovery, which was defined as greater than 30 days from the date of injury to the date of medical clearance (aim 2).

RECOVERY

Results:

- A positive VOMS screen was associated with 1.31 greater days to SRC recovery.
- K-D and C3 logix not associated with recovery times
- Positive screen on all measures combined related to protracted recovery

In acute setting, positive VOMS related to delay in recovery even in younger population

Stronger predictor in recovery than cognitive testing



**KEY
TAKEAWAYS**

LIMITS OF SELF-REPORT

Article: Caze, T., Vásquez, D., Moffatt, K., Waple, K., & Hope, D. (2021). A prospective pilot study of anxiety sensitivity and adolescent sports-related concussion. *Archives of clinical neuropsychology*, 36(6), 930-939.

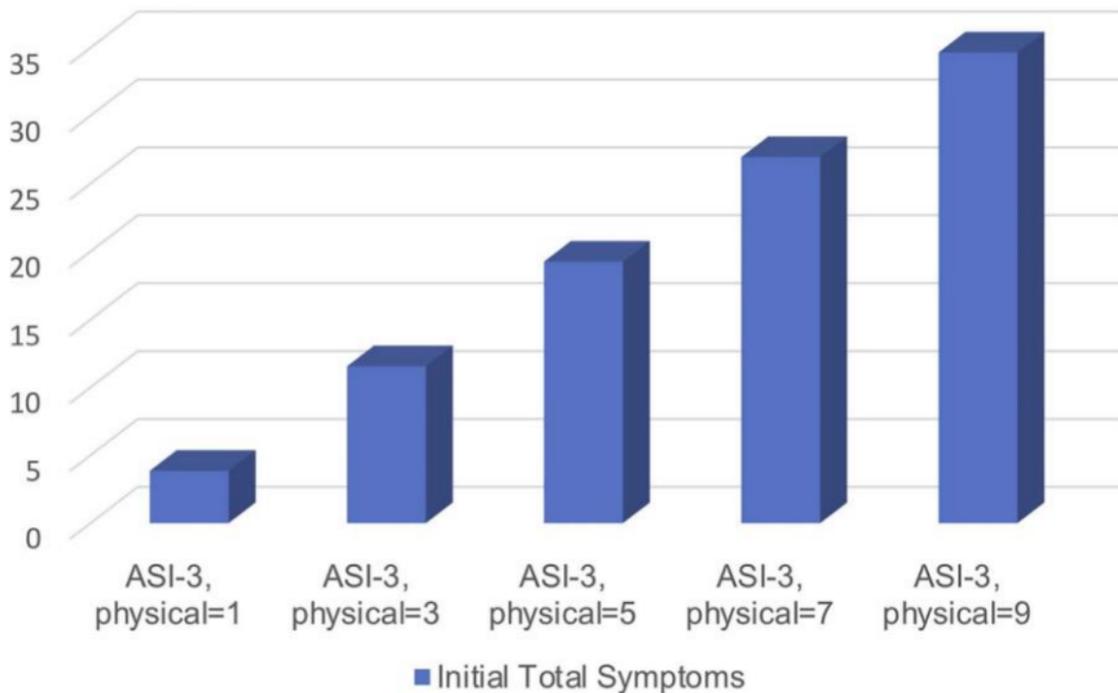
Aim: This study examined the relationship of that anxiety sensitivity (AS) with the initial and ongoing symptoms reported by adolescents after sustaining a sports-related concussion (SRC).

Participants: 40 participants, age 13-18, 20 concussed patients were matched by age, gender, and race with musculoskeletal controls

Outcome Measures: after the initial clinic intake, participants completed an online survey at three-time points. Survey measures included the self-report graded symptom checklist and the AS Index-3. Researchers used growth curve analysis to examine the relationship between AS Index-3 scores with initial and ongoing symptom reporting over time.

LIMITS OF SELF-REPORT

Concussed Groups Initial Total Symptoms



Personality/trait factors can influence self-reporting of symptoms, making it less reliable



LIMITATIONS OF SELF-REPORT

One of the challenges when working with individuals with mTBI is that management of concussion is often driven by the self-report of symptoms (Collins et al., 2016), which is highly subjective and may be driven by factors other than the concussion injury.



LIMITATIONS OF SELF-REPORT

A major limitation to the diagnosis of concussion being heavily reliant on self-report is that it can result in a high number of type I error (i.e. false positives). For example, in their study of 30,000 adolescent student athletes at baseline, Iverson et al., (2015) found that 20% of male participants and 28% of female participants at baseline reported enough symptoms to meet ICD-10 PCS symptom criteria.



LIMITATIONS OF SELF-REPORT

Additionally, baseline samples of adolescents found only 36% did not report symptoms (Asken et al., 2017) and only 40% of collegiate athletes at baseline were asymptomatic (Asken et al., 2017)



LIMITATIONS OF SELF-REPORT

This raises the question –After a few weeks, if minor symptoms persistent, what is related to the concussion and what is “normal degree of nonspecific symptomology” (McCrea et al., 2019, p.19).



Self-report symptom scales not specific, STOP
GIVING DAILY!

VOMS-Symptom Provocation more specific, DON'T
GIVE DAILY!

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**KEY
TAKEAWAYS**



Self-Reported Symptom Scale



Symptom Provocation Measure

VOMS-A MORE RELIABLE SNAPSHOT



VOMS NEURO-CORRELATES WITH CLASSROOM

Poor Smooth Pursuits- eyes will fatigue quickly, will either have increase in headache during highly visual classes or by end of the day.

Poor Saccades- screens will bother them, will often report lights in certain classes bothering them in addition to pressure headaches

Poor Convergence- classes with lots of note taking will provoke symptoms

Poor VOR/VMS- will struggle with band and passing periods



VOMS NEURO-CORRELATES WITH SPORT

Poor Smooth Pursuits- struggle with accuracy with sports that use ball/puck even in warm-ups

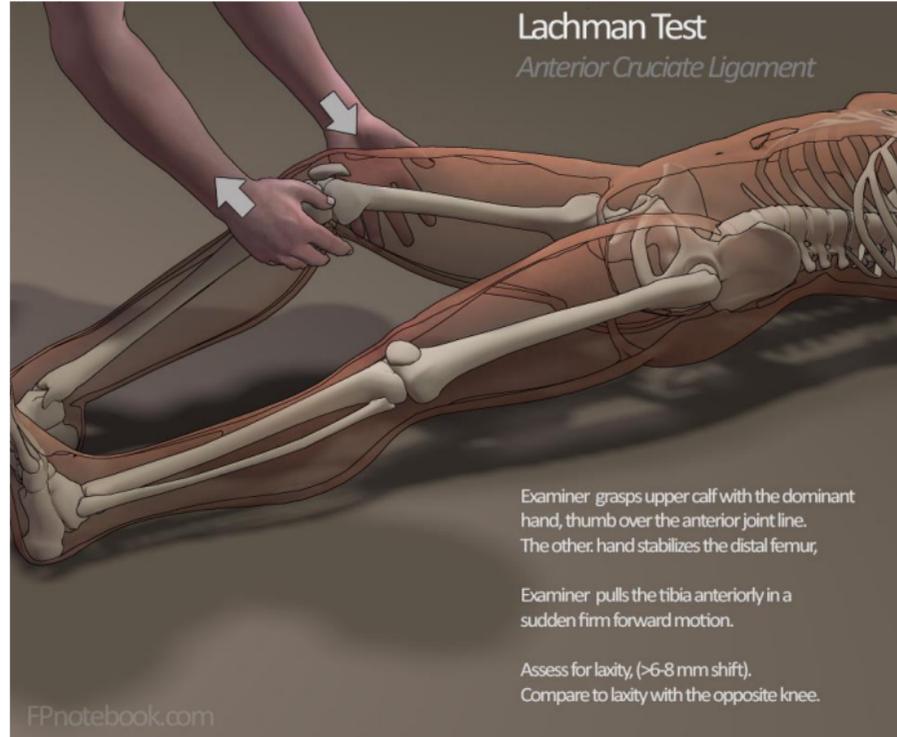
Poor Saccades- Miss more nuances during film session, eyes will fatigue quickly, often missing assignments and openings (point guard, line backer, etc.)

Poor Convergence- hitting or shooting slump will emerge

Poor VOR/VMS- may be fine with sports activity until introduce skills that require dynamic movements (lay-ups more problematic than static dribbling, star drill more problematic than lay-ups)



VOMS IS TO CONCUSSION WHAT LACHMAN IS TO ACL



LEARNING OBJECTIVES

List the common impairments that occur to the ocular motor and vestibular system following a concussion.

Restate the clinical utility of the VOMS in the management and treatment of concussion.

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