

Vestibular and Vision Integration in Concussion Management for Athletic Trainers

Lisa Brekke, PT, DPT

Kinetic Edge Physical Therapy



About Me

- Bachelors in Psychology from Iowa State University
- Masters in Exercise Science from Concordia University – St Paul
- Doctor of Physical Therapy from Sacred Heart University
- Mentorship at Access Balance and Vestibular Center in Connecticut
- Vestibular training: Emory Competency Certificate
- Currently growing a vestibular/concussion program at Kinetic Edge Physical Therapy in Des Moines

Objectives

01

Identify vestibular and visual deficits for treatment

02

Improve treatment for vestibular and visual dysfunction

03


Appropriate referral to Physical Therapy or Physician

04

Improve ATC and family identification of good concussion programs

Current Research for Baseline Testing

- VOMS, SCAT₃, and ImPACT at baseline has poor reliability and does not significantly increase diagnostic yield (Ferris, 2022)
- The order of baseline testing to yield the best results: ImPACT, SAC, BESS, SCAT (Lempke, 2021)
- Insufficient sleep can affect baseline and post concussion testing and should be considered when interpreting results (Terry, 2022)
- Racial and SES differences in NPC and K-D testing at baseline (Wallace, 2020)
- ImPACT has shown ceiling effects (Gaudet, 2021)
- mBESS has poor internal consistency and poor to mod test –retest (Kontos, 2021)
- King-Devick may require 30 trials for an accurate baseline (Fraser, 2021)



What Do You Utilize for
Sideline Testing?

ImPACT

VOMS

King-Devick

mBESS

SCAT5

Current
Sideline
Testing
Best
Practice

ImPACT Test

Computerized testing

Assesses visual and verbal memory, processing speed, and reaction time

20-25 minutes to complete

Used at baseline, immediately after concussion, and during recovery

King- Devick

Computerized or paper

Baseline and sideline test

2 minutes

Saccadic eye movement

Cost

VOMS

Baseline Symptoms

Smooth Pursuits – 2 reps horizontal and vertical

Saccades – 10 reps horizontal and vertical

Convergence – 3 reps

VOR – 10 reps horizontal and vertical

VMS – 5 reps

Assess symptoms after every test

Key numbers: 3ft, 14-point font



Break Out

SCAT 5

10 minutes

On field assessment

Off field assessment

Addition of C-spine assessment in on field portion compared to SCAT₃ in off field assessment

Both utilize mBESS

Vestibular Screen/Examination

VOMS

VOR

VMS

Abnormal: unable to keep eyes on target, unable to keep pace, LOB on VMS, symptoms

mBESS

mBESS

Varies by age and gender

mCOBALT

- Abnormal: > 1 error

BPPV

Dix Hallpike

Supine Roll

Abnormal: nystagmus.
Patient report of spinning or falling

Benign Paroxysmal Positional Vertigo Examination

- Anywhere from 10-57% of individuals with concussions have BPPV (Gianoli, 2022)
- Assessment should include multiple canals
 - Dix Hallpike
 - Supine roll
 - Side lying – modification for cervical restrictions

BPPV Treatment

- Treat based on the (+) canal
- Epley Maneuver for a (+) Dix Hallpike
- Gufoni Maneuver for a (+) Supine roll



Break Out

Vestibular Treatment

BPPV (Must be addressed first)

Head movements

Gaze stabilization

- Turns
- Nods
- Diagonals
- Sitting → Standing → with movement

- Solid background → complex background
- Sitting → Standing → with movement
- Surface type
- VOR x 1, VOR x 2

Visual Screen/Examination

VOMS

Smooth pursuits

Saccades

Convergence

VMS

Abnormal: interrupted, slow, abnormal distance, LOB, symptoms

Alternate Cover Test

Abnormal: vertical skew, disconjugate



Break Out



Vision Treatment

- Vision specific exercises should only be utilized if visual symptoms do not recover on their own by:
 - 2 weeks for adults
 - 4 weeks in adolescents
- Submaximal exercise leads to quicker recovery
- Exercises to include after this time frame
 - Repetitive saccades
 - Brock string or pencil pushups
 - Sport specific
- Referral out to vision therapy may be indicated

Aerobic Assessment and Treatment

Buffalo
Concussion
Treadmill Test

Buffalo
Concussion
Bike Test

Subthreshold
Activity

When to Refer

Red flags

BPPV

Multiple systems

Not progressing

Out of your comfort zone

Identification of Good Concussion Programs

Communication with physician and ATC if able

A steady progression of activities

Heavy on the education

Home program

Addressing immediate and delayed symptoms

Return to learn before return to play

Comfortable referring as needed



Case Study 1

- 23-year-old male
- Injured during hockey game
- Returned to game for a brief period, reporting only back pain
- SCAT5 performed
- CN intact
- No neck pain or tenderness
- Initial Symptom Score 20/22, 62/132
- Previous history of concussion 5 years ago

First 4 weeks

- ATC treated
- Low back pain and some neck stiffness reported
- Symptoms scores progressively improved to 0/22, 0/132
- Started reporting fatigue and fogginess
- Neuropsych testing to return to play and failed

Referral to Physical Therapy

- At 1 month:
 - Foggy, fatigued, headaches , concentration, blurred vision, and lightheaded
 - Above symptoms reported primarily during and after skating
 - Neck stiffness, challenged with visual on VOMS, symptoms while ambulating with head turns
 - BCTT: 60% age predicted max heart rate

Discharge

- Total of 4 visits
- Progressed aerobic daily
- Day of discharge: no symptoms x 72 hours, BCTT passed, no change in symptoms through full examination, passed his neuropsych testing the previous week



Case Study 2

- 15-year-old male
- Injured in football
- Returned to play after injury
- Car accident with in 2 weeks following
- PT x 2-3 months with no progress

Referral to Physical Therapy

- 5 months after the initial injury
- Symptom score of 71 /132
- Severe shoulder pain 7/10
- Examination: c/s AROM limited with severe symptoms, unable to perform gaze holding, increased symptoms and challenged with ocular tests, poor balance with feet together eyes closed
- Immediate onset of feeling like he was falling in supine: positive R DH

Discharge

- 5 weeks of PT – 14 visits
- PCSS: 25/132 – mental health symptoms primarily
- All testing normal, passed BCTT, full return to learn



Case Study 3

- 14-year-old female
- Injured in softball game
- Removed immediately
- Seen by PT on day 10

Referral to Physical Therapy

- 25/64 on Rivermead Scale
- In school with no accommodations
- Examination: increased symptoms and imbalance with conditions 3,4,7,8 on mCOBALT, increased symptoms with vestibular portion of VOMS, passed BCTT, neck pain/tenderness, bending increased dizziness

Discharge

- 3 visits
- HEP
- Started return to play protocol at 2nd visit, progressed over the weekend with assist from parents, and returned to full return to play at 3rd visit.

References

- Brown, Lisa, and James Camarinos. “The Role of Physical Therapy in Concussion Rehabilitation.” *Seminars in Pediatric Neurology*, vol. 30, July 2019, pp. 68–78.
- Cameron, Ben, et al. “One-Year Stability of Preseason Sport Concussion Assessment Tool 5 (SCAT5) Values in University Level Collision and Combative Sport Athletes.” *The Physician and Sportsmedicine*, 20 July 2021, pp. 1–8.
- Czerniak, Lauren L., et al. “Sensitivity and Specificity of Computer-Based Neurocognitive Tests in Sport-Related Concussion: Findings from the NCAA-DoD CARE Consortium.” *Sports Medicine*, vol. 51, no. 2, 14 Dec. 2020.
- Daly, Ed, et al. An Assessment of Current Concussion Identification and Diagnosis Methods in Sports Settings. A Systematic Review. 21 Feb. 2022.
- Ferris, Lyndsey M., et al. “Utility of VOMS, SCAT3, and Impact Baseline Evaluations for Acute Concussion Identification in Collegiate Athletes: Findings from the NCAA-DOD Concussion Assessment, Research and Education (CARE) Consortium.” *The American Journal of Sports Medicine*, vol. 50, no. 4, 2022, pp. 1106–1119.
- Fraser, Clare L., and Rowena Mobbs. “Visual Effects of Concussion: A Review.” *Clinical & Experimental Ophthalmology*, vol. 50, 30 Aug. 2021, 10.1111/ceo.13987. Accessed 25 Dec. 2021.
- Fraser, Melissa A., et al. “Concussion Baseline Retesting Is Necessary When Initial Scores Are Low.” *Clinical Journal of Sport Medicine*, vol. 32, no. 1, 24 Nov. 2020.
- Fuller, Gordon Ward, et al. “Expansion of Cognitive Testing for Off-Field Concussion Screening in Elite Rugby Players: A Cohort Study.” *Journal of Science and Medicine in Sport*, vol. 24, no. 12, Dec. 2021, pp. 1204–1210.
- Gaudet, Charles E, et al. “Immediate Post-Concussion and Cognitive Testing: Ceiling Effects, Reliability, and Implications for Interpretation.” *Archives of Clinical Neuropsychology*, vol. 36, no. 4, 26 Sept. 2020.
- Gianoli, Gerald, J. Post-concussive Dizziness: A Review and Clinical Approach to the Patient. *Frontiers in Neurology*, 12. 2022.
- Harmon, Kimberly G, et al. “Diagnostic Accuracy and Reliability of Sideline Concussion Evaluation: A Prospective, Case-Controlled Study in College Athletes Comparing Newer Tools and Established Tests.” *British Journal of Sports Medicine*, 21 Apr. 2021.
- Kontos, Anthony P., et al. “Review of Vestibular and Oculomotor Screening and Concussion Rehabilitation.” *Journal of Athletic Training*, vol. 52, no. 3, Mar. 2017, pp. 256–261.
- Kontos, Anthony P., et al. “Test-Retest Reliability of the Vestibular Ocular Motor Screening (VOMS) Tool and Modified Balance Error Scoring System (MBESS) in US Military Personnel.” *Journal of Science and Medicine in Sport*, vol. 24, no. 3, Sept. 2020.

References

- Lempke, Landon B., et al. “Optimizing Order of Administration for Concussion Baseline Assessment among NCAA Student-Athletes and Military Cadets.” *Sports Medicine*, 15 June 2021.
- Lempke, Landon B., et al. “Athletic Trainers’ Concussion-Assessment and Concussion-Management Practices: An Update.” *Journal of Athletic Training*, vol. 55, no. 1, Jan. 2020, pp. 17–26, 10.4085/1062-6050-322-18. Accessed 6 Feb. 2020.
- Manderino, Lisa M., and John Gunstad. “Improved Post-Injury Cognitive Test Results: Examining Invalid Baseline ImPACT Testing.” *Brain Injury*, 2 Feb. 2022, pp. 1–7.
- Mohler, Samantha, et al. “How Long after Maximal Physical Exertion Should Baseline Computerized Neurocognitive Testing and Symptom Assessment Be Administered?” *Brain Injury*, vol. 35, no. 2, 17 Jan. 2021, pp. 241–247.
- Nicholson, Caitlin A., et al. “Sideline Assessment of Concussion.” *Operative Techniques in Sports Medicine*, 16 Jan. 2022.
- Oldham, Jessie R., et al. “The Association between Baseline Eye Tracking Performance and Concussion Assessments in High School Football Players.” *Optometry and Vision Science*, vol. 98, no. 7, July 2021, pp. 826–832.
- Quatman-Yates, C.C., et al. “Concussion: Physical Therapy Treatment after Mild Traumatic Brain Injury.” *Journal of Orthopaedic & Sports Physical Therapy*, vol. 50, no. 4, Apr. 2020, pp. 178–178.
- Roberts, Mark Thomas William, and Jonathan Daniel Lichtenstein. “The Effect of Test Setting upon Test-Retest Reliability of ImPACT Baseline Tests in High School Athletes.” *Neurology*, vol. 98, no. 1 Supplement 1, 4 Jan. 2022, pp. S23–S23, n.neurology.org/content/98/1_Supplement_1/S23.2.
- Terry, Douglas P., et al. “Sleep Insufficiency and Baseline Preseason Concussion-like Symptom Reporting in Youth Athletes.” *Clinical Journal of Sport Medicine*, vol. Publish Ahead of Print, 23 Apr. 2021.
- Wallace, J, et al. “Socioeconomic Status and Race as Social Determinants of Health to Be Considered in Clinical Use of Pre-Season Vestibular and Oculomotor Tests for Concussion.” *Journal of Clinical and Translational Research*, vol. 6, no. 4, 7 Oct. 2020.
- Wong, Christopher Kevin, et al. “Sequencing and Integration of Cervical Manual Therapy and Vestibulo-Oculomotor Therapy for Concussion Symptoms: Retrospective Analysis.” *International Journal of Sports Physical Therapy*, vol. 16, no. 1, 1 Feb. 2021, pp. 12–20.