

From Impact to Recovery: Optimizing Concussion Assessment and Treatment

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Concussions

- May have a combination of:
 - Central vestibular dysfunction
 - Posttraumatic BPPV
 - Neck injuries

Concussion Clinical Profile Descriptions

Cognitive	Ocular	Vestibular	Migraine	Mood / Anxiety
HA with cognitive and physical activity	Frontal HA with visual work	Dizziness	Variable, intermittently severe HA	Hypervigilance, rumination
Feels best in AM	Difficulties with visually based classes and activity	Nausea / motion sickness	Often waking with HA	Depression
Fatigue, reduced energy	Pressure behind the eyes	Feels “one step behind” especially when moving the head	Nausea, photophobia, phonophobia	Overwhelmed (poor tolerance of busy environments)
End of day symptoms	Visual focus issues	Symptomatic in busy environments	Stress, anxiety, lack of exercise	Difficulty initiating sleep (inability to turn thoughts off)
Possible sleep deficits	Blurry vision	Off-balance	Sleep dysregulation	Difficulty maintaining sleep
Cognitive impairment - generalized	Double vision		May also be present with vestibular migraines	Excessive focus on symptoms
				Limited socialization

Concussion Clinical Practice Guidelines: Recommendations for Examination

Selection of tools based
on patient age and
required functional level
relative to patient goal

Grades of Recommendation

• A (strong evidence)

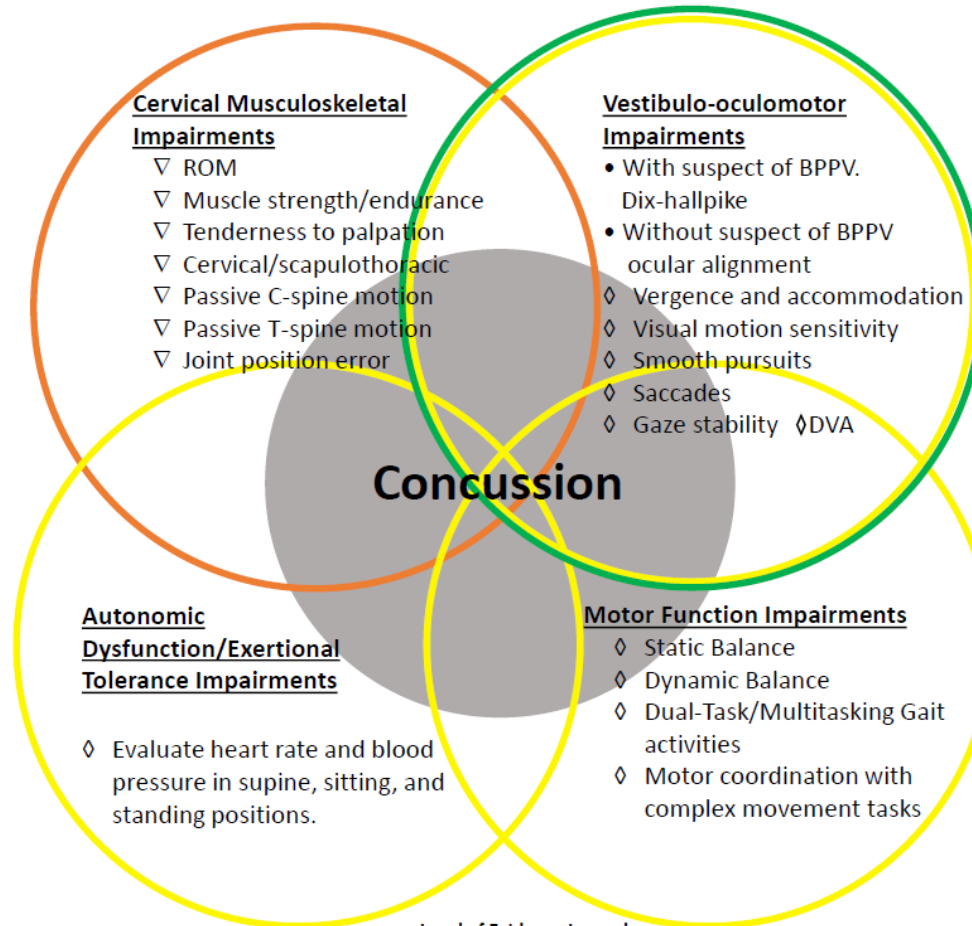
• B (moderate evidence)

◇ C (weak evidence)

◇ D (conflicting evidence)

▽ E (Theoretical/
Foundational)

▽ F (Expert Opinion)



Level of Evidence Legend

Green – circle

Yellow – Diamond

Orange - Triangle

For more detailed information, please refer to the original document: Journal of Orthopaedic & Sports Physical Therapy

Document produced by Academy of Neurologic Physical Therapy

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Vestibular Evaluation - Concussion

Subjective Exam



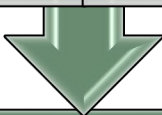
Symptom Assessment

Symptom report measures

Dizziness Handicap Inventory

Visual Vertigo Analogue Scale

Convergence Insufficiency
Symptom Scale (if indicated)



Balance Tests

BESS **OR** mCTSIB

FGA



Oculomotor and Vestibular Testing

Bucket Test (for Subjective
Visual Vertical (SVV))

VOMS

BPPV testing

Dynamic Visual Acuity

Assessment of Symptoms - Symptom Scales

SCAT6 (Sport Concussion Assessment Tool)

- SCOAT6 (Sports Concussion Office Assessment Tool)

DHI (Dizziness Handicap Inventory)

VVAS (Visual Vertigo Analog Scale)

CISS (Convergence Insufficiency Symptom Survey)

SCAT6

Baseline: ☐

Suspected/Post-injury: ☐

Time elapsed since suspected injury: mins/hours/days

The athlete will complete the symptom scale (below) after you provide instructions. Please note that the instructions are different for baseline versus suspected/post-injury evaluations.

Baseline: Say *"Please rate your symptoms below based on how you typically feel with "1" representing a very mild symptom and "6" representing a severe symptom."*

Suspected/Post-injury: Say *"Please rate your symptoms below based on how you feel now with "1" representing a very mild symptom and "6" representing a severe symptom."*

PLEASE HAND THE FORM TO THE ATHLETE

Symptom	Rating
Headaches	0 1 2 3 4 5 6
Pressure in head	0 1 2 3 4 5 6
Neck pain	0 1 2 3 4 5 6
Nausea or vomiting	0 1 2 3 4 5 6
Dizziness	0 1 2 3 4 5 6
Blurred vision	0 1 2 3 4 5 6
Balance problems	0 1 2 3 4 5 6
Sensitivity to light	0 1 2 3 4 5 6
Sensitivity to noise	0 1 2 3 4 5 6
Feeling slowed down	0 1 2 3 4 5 6
Feeling like "in a fog"	0 1 2 3 4 5 6
"Don't feel right"	0 1 2 3 4 5 6
Difficulty concentrating	0 1 2 3 4 5 6
Difficulty remembering	0 1 2 3 4 5 6
Fatigue or low energy	0 1 2 3 4 5 6
Confusion	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6
More emotional	0 1 2 3 4 5 6
Irritability	0 1 2 3 4 5 6
Sadness	0 1 2 3 4 5 6
Nervous or anxious	0 1 2 3 4 5 6
Trouble falling asleep (if applicable)	0 1 2 3 4 5 6

Do your symptoms get worse with physical activity?

Y N

Do your symptoms get worse with mental activity?

Y N

If 100% is feeling perfectly normal, what percent of normal do you feel?

If not 100%, why?

PLEASE HAND THE FORM BACK TO THE EXAMINER

Once the athlete has completed answering all symptom items, it may be useful for the clinician to revisit items that were endorsed positively to gather more detail about each symptom.

Total number of symptoms:

of 22

Symptom severity score:

of 132

SCOAT6

0
None

1
Mild

2

3
Moderate

4

5

6
Severe

Symptom	Date of Assessment			
	Pre-injury	Day injured (date)	Consult 1	Consult 2
	Rating	Rating	Rating	Rating
Headaches				
Pressure in head				
Neck pain				
Nausea or vomiting				
Dizziness				
Blurred vision				
Balance problems				
Sensitivity to light				
Sensitivity to noise				
Feeling slowed down				
Feeling like "in a fog"				
Difficulty concentrating				

Dizziness Handicap Inventory (DHI)



	Yes	No	Sometimes
E18. Because of your problem, is it difficult for you to concentrate?			
F19. Because of your problem, is it difficult for you to walk around the house in the dark?			
E20. Because of your problem, are you afraid to stay home alone?			
E21. Because of your problem, do you feel handicapped?			
E22. Has your problem placed stress on your relationships with members of your family or friends?			
E23. Because of your problem, are you depressed?			
F24. Does your problem interfere with your job or household responsibilities?			
P25. Does bending over increase your problem?			

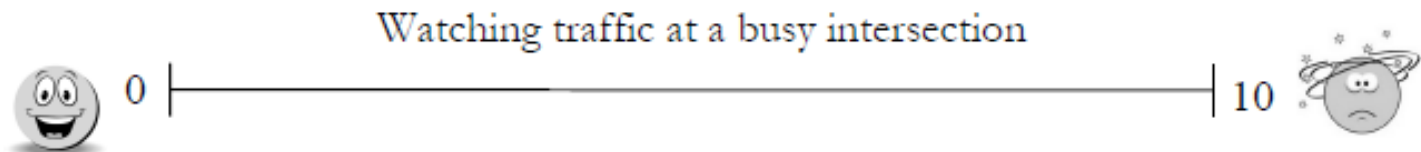
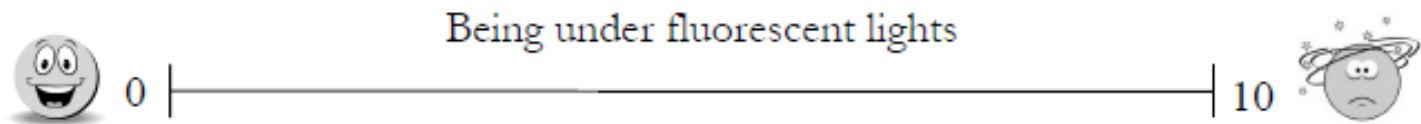
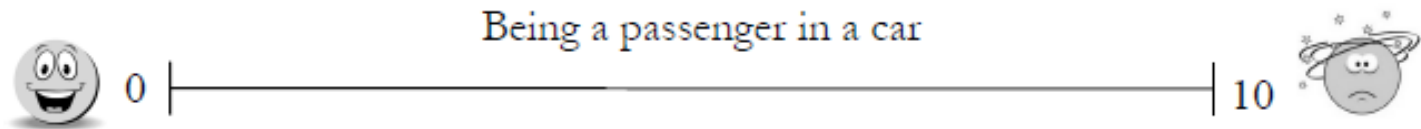
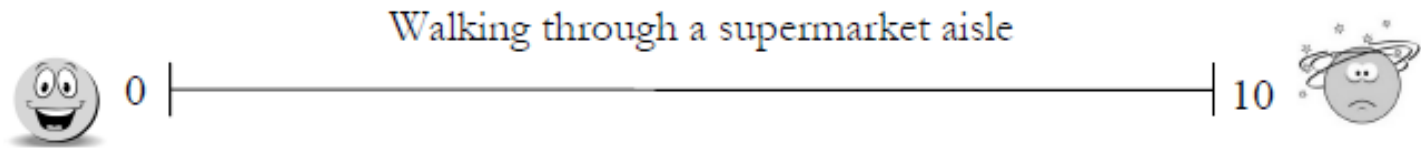
- Cut-off scores
 - 0 – 30 mild handicap
 - 31 – 60 moderate handicap
 - 61 – 100 severe handicap
- MCID = 18 points

Visual Vertigo Analogue Scale

(Adapted from Longridge et al., 2002)

Indicate the amount of dizziness you experience in the following situations by marking off the scales below.

0 represents no dizziness  and 10 represents the most dizziness 



CONVERGENCE INSUFFICIENCY SYMPTOM SURVEY (CISS)

	Never	(not very often) Infrequently	Sometimes	Fairly Often	Always
1. Do your eyes feel tired when reading or doing close work?					
2. Do your eyes feel uncomfortable when reading or doing close work?					
3. Do you have headaches when reading or doing close work?					
4. Do you feel sleepy when reading or doing close work?					
5. Do you lose concentration when reading or doing close work?					
6. Do you have trouble remembering what you have read?					
7. Do you have double vision when reading or doing close work?					
8. Do you see the words move, jump, swim or appear to float on the page when reading or doing close work?					
9. Do you feel like you read slowly?					
10. Do your eyes ever hurt when reading or doing close work?					
11. Do your eyes ever feel sore when reading or doing close work?					
12. Do you feel a "pulling" feeling around your eyes when reading or doing close work?					
13. Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
14. Do you lose your place while reading or doing close work?					
15. Do you have to re-read the same line of words when reading?					
	___ X 0	___ X 1	___ X 2	___ X 3	___ X 4

For adults, scores ≥ 21 are considered positive

For ages < 21 years old, scores of ≥ 16 are considered positive

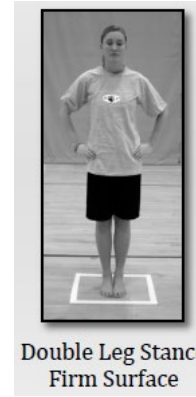
If positive screen here AND positive convergence insufficiency on the VOMS, consider referral to Optometry

For a score of 16 or greater, vision therapy may be indicated.^{1,2,3}

Balance Testing

Balance Error Scoring System (BESS)

- Shoes off & hands on iliac crests for all tests
- Use Airex Foam
- Establish leg dominance
 - The leg with which they kick a ball
- **Double leg stance: Feet together**
- **Single leg stance**
 - Stand on non-dominant leg
 - 20 deg hip flexion, 45 deg knee flexion, neutral frontal plane
- **Tandem stance**
 - Non-dominant leg in back
 - Back of anterior foot must touch front of posterior foot
- **Each trial is 20 seconds**



BESS Scoring / Instructions for Errors

Errors:

- Moving the hands off the hips
- Opening the eyes
- Step, stumble or fall
- Abduction or flexion of the hip beyond 30°
- Lifting the forefoot or heel off of the testing surface
- Remaining out of the proper testing position for greater than 5 seconds

The maximum total number of errors for any single condition is 10.

If a subject commits multiple errors simultaneously, only one error is recorded.

B.E.S.S. SCORECARD		
Count Number of Errors max of 10 each stance/surface	FIRM Surface	FOAM Surface
Double Leg Stance (feet together)		
Single Leg Stance (non-dominant foot)		
Tandem Stance (non-dominant foot in back)		
TOTAL SCORES: total each column		
B.E.S.S. TOTAL: (Firm+Foam total)		

MDC = 8-10 points
Worsening score is ~ 6-point decline

BESS – Age Related Norms (Men)

Age	Superior	Above Average	Broadly Normal	Below Average	Poor	Very Poor
20 – 29	0 – 4	5 – 6	7 – 14	15	16 – 21	22+
30 – 39	0 – 4	5 – 6	7 – 15	16 – 18	19 – 26	27+
40 – 49	0 – 5	6 – 7	8 – 16	17 – 20	21 – 27	28+
50 – 54	0 – 6	7	8 – 17	18 – 23	24 – 28	29+
55 – 59	0 – 7	8 – 10	11 – 20	21 – 28	29 – 34	35+
60 – 64	0 – 8	9 – 11	12 – 21	22 – 27	28 – 35	36+
65 – 69	0 - 12	13 - 14	15 - 23	24 - 33	34 – 39	40+

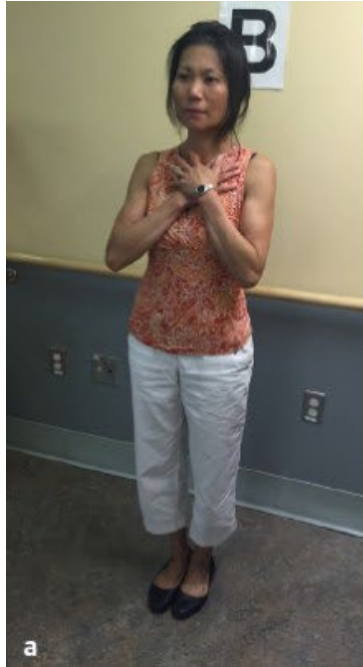
Iverson GL, Koehle MS. Normative data for the balance error scoring system in adults. *Rehabil Res Pract.* 2013;2013:846418.

BESS – Age Related Norms (Women)

Age	Superior	Above Average	Broadly Normal	Below Average	Poor	Very Poor
20 – 29	0 – 5	6 – 7	8 – 14	15 – 19	20 – 25	26+
30 – 39	0 – 4	5 – 6	7 – 15	16 – 19	20 – 27	28+
40 – 49	0 – 5	6 – 7	8 – 15	16 – 20	21 – 29	30+
50 – 54	0 – 7	8 – 9	10 – 20	21 – 24	25 – 35	36+
55 - 59	0 – 8	9 – 10	11 – 21	22 – 28	29 – 39	40+
60 – 64	0 - 9	10 – 12	13 – 22	23 – 31	32 – 43	44+
65 – 69	0 - 13	14	15 - 24	25 – 27	28 - 38	39+

Iverson GL, Koehle MS. Normative data for the balance error scoring system in adults. *Rehabil Res Pract.* 2013;2013:846418.

Modified Clinical Test of Sensory Integration in Balance (mCTSIB)



Eyes open



Eyes closed



Eyes open
On foam



Eyes closed
On foam

- 30 sec trials
- Up to 3 trials if needed per condition
- Time and document how long position is held up to 30 sec

<https://entokey.com/vestibular-rehabilitation-2/>

1. GAIT LEVEL SURFACE

Instructions: Walk at your normal speed from here to the next mark (6 m [20 ft]).

Grading: Mark the highest category that applies.

- (3) Normal—Walks 6 m (20 ft) in less than 5.5 seconds, no assistive devices, good speed, no evidence for imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside of the 30.48-cm (12-in) walkway width.
- (2) Mild impairment—Walks 6 m (20 ft) in less than 7 seconds but greater than 5.5 seconds, uses assistive device, slower speed, mild gait deviations, or deviates 15.24–25.4 cm (6–10 in) outside of the 30.48-cm (12-in) walkway width.
- (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, or deviates 25.4–38.1 cm (10–15 in) outside of the 30.48-cm (12-in) walkway width. Requires more than 7 seconds to ambulate 6 m (20 ft).
- (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside of the 30.48-cm (12-in) walkway width or reaches and touches the wall.

2. CHANGE IN GAIT SPEED

Instructions: Begin walking at your normal pace (for 1.5 m [5 ft]). When I tell you “go,” walk as fast as you can (for 1.5 m [5 ft]). When I tell you “slow,” walk as slowly as you can (for 1.5 m [5 ft]).

Grading: Mark the highest category that applies.

- (3) Normal—Able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speeds between normal, fast, and slow speeds. Deviates no more than 15.24 cm (6 in) outside of the 30.48-cm (12-in) walkway width.
- (2) Mild impairment—Is able to change speed but demonstrates mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside of the 30.48-cm (12-in) walkway width, or no gait deviations but unable to achieve a significant change in velocity, or uses an assistive device.
- (1) Moderate impairment—Makes only minor adjustments to walking speed, or accomplishes a change in speed with significant gait deviations, deviates 25.4–38.1 cm (10–15 in) outside the 30.48-cm (12-in) walkway width, or changes speed but loses balance but is able to recover and continue walking.
- (0) Severe impairment—Cannot change speeds, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width, or loses balance and has to reach for wall or be caught.

3. GAIT WITH HORIZONTAL HEAD TURNS

Instructions: Walk from here to the next mark 6 m (20 ft) away. Begin walking at your normal pace. Keep walking straight; after 3 steps, turn your head to the right and keep walking straight while looking to the right. After 3 more steps, turn your head to the left and keep walking straight while looking left. Continue alternating looking right and left every 3 steps until you have completed 2 repetitions in each direction.

Grading: Mark the highest category that applies.

- (3) Normal—Performs head turns smoothly with no change in gait. Deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width.
- (2) Mild impairment—Performs head turns smoothly with slight change in gait velocity [eg, minor disruption to smooth gait path], deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width, or uses an assistive device.

(1) Moderate impairment—Performs head turns with moderate change in gait velocity, slows down, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width but recovers, can continue to walk.

(0) Severe impairment—Performs task with severe disruption of gait [eg, staggers 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width, loses balance, stops, or reaches for wall].

4. GAIT WITH VERTICAL HEAD TURNS

Instructions: Walk from here to the next mark (6 m [20 ft]). Begin walking at your normal pace. Keep walking straight; after 3 steps, tip your head up and keep walking straight while looking up. After 3 more steps, tip your head down, keep walking straight while looking down. Continue alternating looking up and down every 3 steps until you have completed 2 repetitions in each direction.

Grading: Mark the highest category that applies.

- (3) Normal—Performs head turns with no change in gait. Deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width.
- (2) Mild impairment—Performs task with slight change in gait velocity [eg, minor disruption to smooth gait path], deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width or uses assistive device.
- (1) Moderate impairment—Performs task with moderate change in gait velocity, slows down, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width but recovers, can continue to walk.
- (0) Severe impairment—Performs task with severe disruption of gait [eg, staggers 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width, loses balance, stops, reaches for wall].

5. GAIT AND PIVOT TURN

Instructions: Begin with walking at your normal pace. When I tell you, “turn and stop,” turn as quickly as you can to face the opposite direction and stop.

Grading: Mark the highest category that applies.

- (3) Normal—Pivot turns safely within 3 seconds and stops quickly with no loss of balance.
- (2) Mild impairment—Pivot turns safely in >3 seconds and stops with no loss of balance, or pivot turns safely within 3 seconds and stops with mild imbalance, requires small steps to catch balance.
- (1) Moderate impairment—Turns slowly, requires verbal cueing, or requires several small steps to catch balance following turn and stop.
- (0) Severe impairment—Cannot turn safely, requires assistance to turn and stop.

6. STEP OVER OBSTACLE

Instructions: Begin walking at your normal speed. When you come to the shoe box, step over it, not around it, and keep walking.

Grading: Mark the highest category that applies.

- (3) Normal—Is able to step over 2 stacked shoe boxes taped together (22.86 cm [9 in] total height) without changing gait speed; no evidence of imbalance.
- (2) Mild impairment—Is able to step over one shoe box (11.43 cm [4.5 in] total height) without changing gait speed; no evidence of imbalance.
- (1) Moderate impairment—Is able to step over one shoe box (11.43 cm [4.5 in] total height) but must slow down and adjust steps to clear box safely. May require verbal cueing.
- (0) Severe impairment—Cannot perform without assistance.

Functional Gait Assessment

7. GAIT WITH NARROW BASE OF SUPPORT

Instructions: Walk on the floor with arms folded across the chest, feet aligned heel to toe in tandem for a distance of 3.6 m (12 ft). The number of steps taken in a straight line are counted for a maximum of 10 steps.

Grading: Mark the highest category that applies.

- (3) Normal—Is able to ambulate for 10 steps heel to toe with no staggering.
- (2) Mild impairment—Ambulates 7–9 steps.
- (1) Moderate impairment—Ambulates 4–7 steps.
- (0) Severe impairment—Ambulates less than 4 steps heel to toe or cannot perform without assistance.

8. GAIT WITH EYES CLOSED

Instructions: Walk at your normal speed from here to the next mark (6 m [20 ft]) with your eyes closed.

Grading: Mark the highest category that applies.

- (3) Normal—Walks 6 m (20 ft), no assistive devices, good speed, no evidence of imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width. Ambulates 6 m (20 ft) in less than 7 seconds.
- (2) Mild impairment—Walks 6 m (20 ft), uses assistive device, slower speed, mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width. Ambulates 6 m (20 ft) in less than 9 seconds but greater than 7 seconds.
- (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width. Requires more than 9 seconds to ambulate 6 m (20 ft).
- (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width or will not attempt task.

9. AMBULATING BACKWARDS

Instructions: Walk backwards until I tell you to stop.

Grading: Mark the highest category that applies.

- (3) Normal—Walks 6 m (20 ft), no assistive devices, good speed, no evidence for imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width.
- (2) Mild impairment—Walks 6 m (20 ft), uses assistive device, slower speed, mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width.
- (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width.
- (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width or will not attempt task.

10. STEPS

Instructions: Walk up these stairs as you would at home (ie, using the rail if necessary). At the top turn around and walk down.

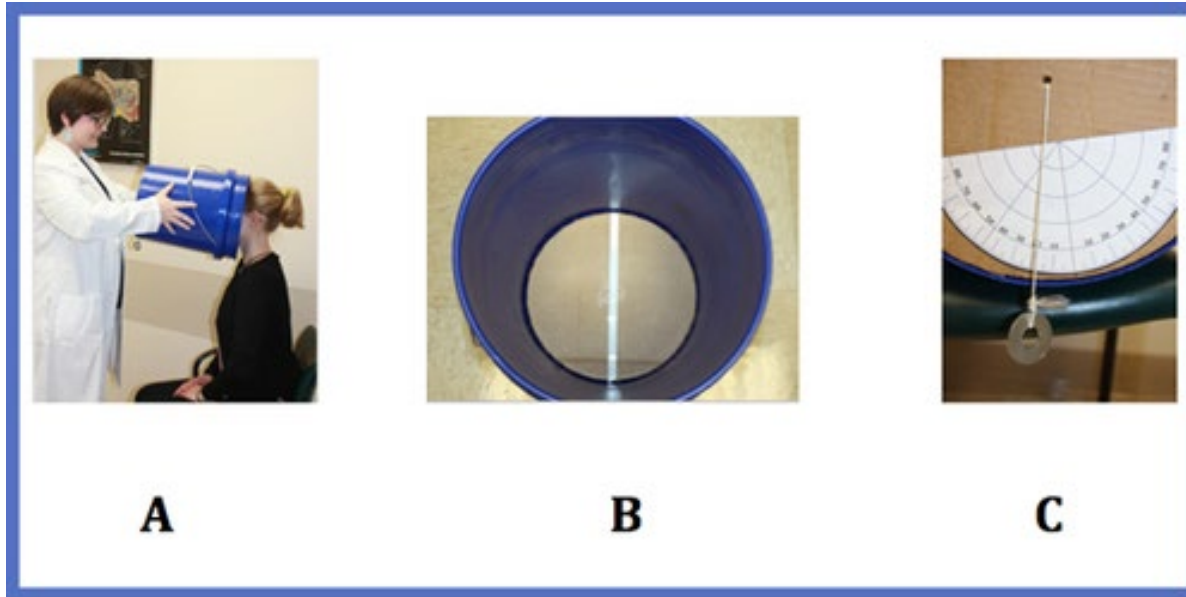
Grading: Mark the highest category that applies.

- (3) Normal—Alternating feet, no rail.
- (2) Mild impairment—Alternating feet, must use rail.
- (1) Moderate impairment—Two feet to a stair; must use rail.
- (0) Severe impairment—Cannot do safely.

TOTAL SCORE: _____ MAXIMUM SCORE 30

Oculomotor / Vestibular Testing

Subjective Visual Vertical - Bucket Test



- Measures perception of verticality
- Patient reports when line has returned to vertical position
- **Normal < 2-2.5 degrees from vertical**

In patients with concussion, there is higher variability noted between responses

Vestibular/Ocular Motor Screening (VOMS)

VOMS SCORING SHEET

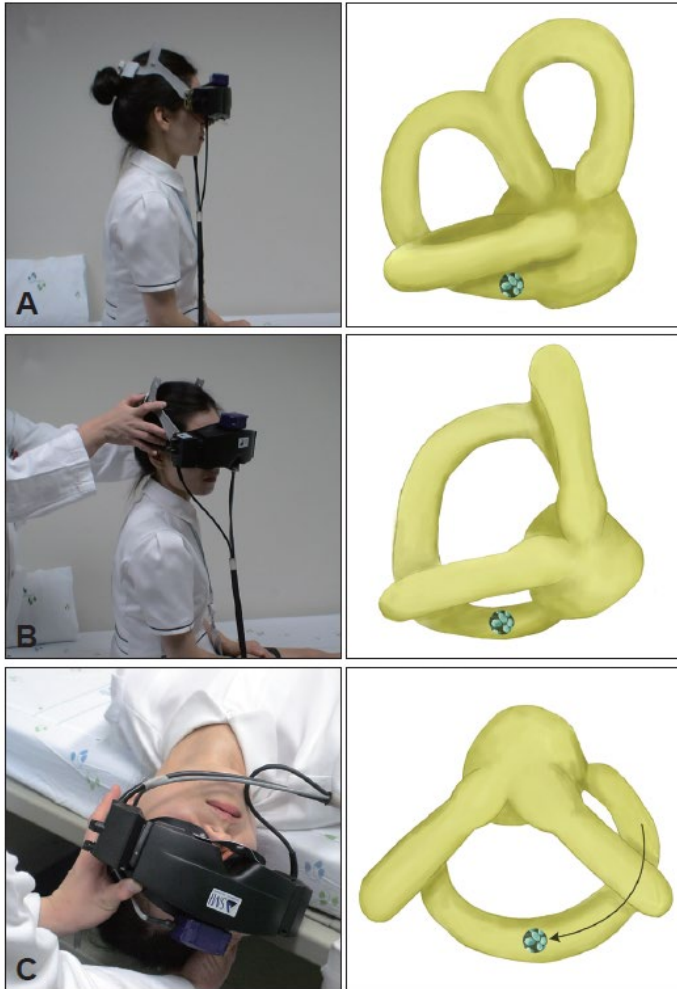
Symptoms on a 0-10 point scale

Vestibular/ Oculomotor	Type	Not Tested	Headache	Dizziness	Nausea	Fogginess	Comments
Baseline Symptoms							
Smooth Pursuit							
Saccades (Horizontal)							
Saccades (Vertical)							
Convergence (Near Point)							Score#1 _____ cm Score#2 _____ cm Score#3 _____ cm
VOR Horizontal							
VOR Vertical							
Visual Motion Sensitivity							

- A change from baseline of ≥ 2 is considered abnormal

- [Mucha, 2014](#)

Dix-Hallpike Test



Lee SH, Kim JS. 2010

- Tests for anterior or posterior canal BPPV
- 45 degrees cervical rotation
- Sit to supine w/ 20 – 30 deg cervical extension
 - Look for nystagmus & symptoms of vertigo



<https://www.youtube.com/watch?v=jrp8iPfvP4Y&t=19s>

Roll Test

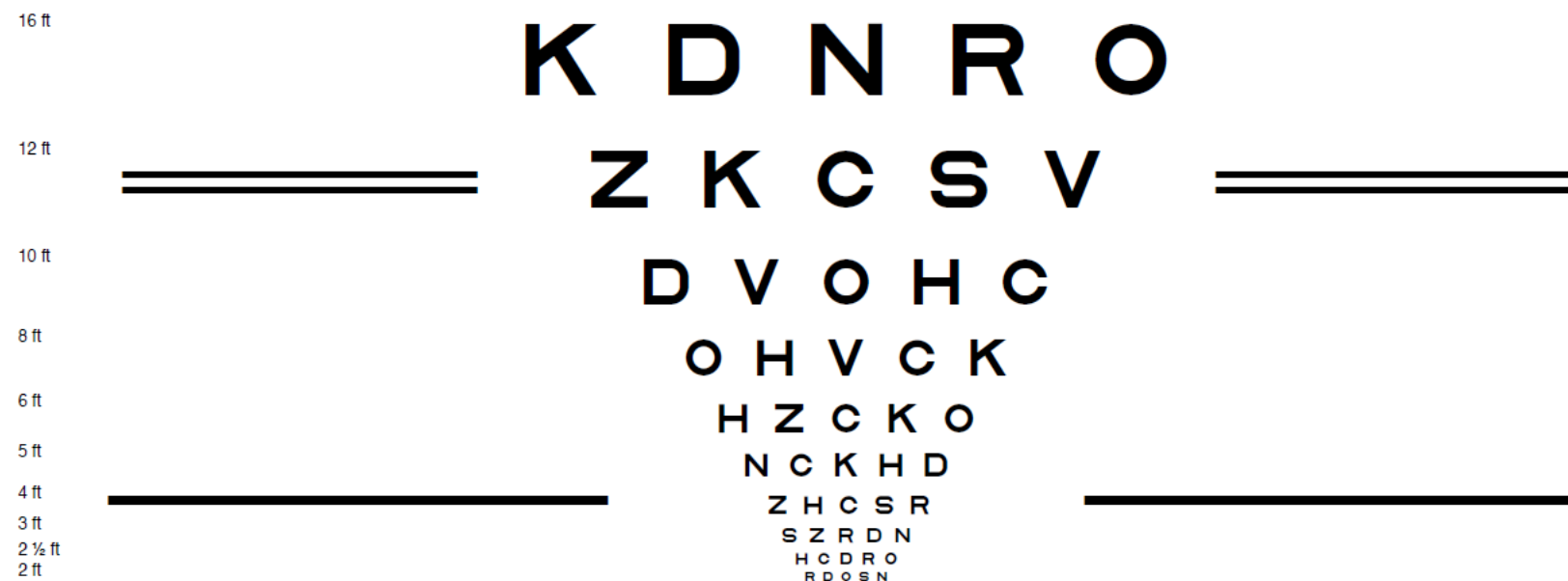
- **Tests for Horizontal SCC BPPV**
 - Pt in supine position, head flexed to 20-30 degrees
 - Roll head quickly to 1 side
 - Check for nystagmus and vertigo
 - Roll head slowly back to midline
 - Roll head quickly to opposite side
 - Check for nystagmus and vertigo



Dynamic Visual Acuity (DVA)

Use ETDRS
EyeChart

**3 lines or more
difference from
static visual
acuity is
abnormal**



<https://i-see.org/eyecharts.html>

Vestibular Evaluation - Concussion

Other Tests to consider

- Motion Sensitivity Quotient (MSQ)
- Modified Motion Sensitivity Test (mMST) or Screening Version (4-item)
- Buffalo Concussion Treadmill Test / Buffalo Concussion Bike Test

Motion Sensitivity Quotient (MSQ)

	Intensity	Duration	Score
Baseline Symptoms			
1. Sitting-to-supine			
2. Supine-to-left side			
3. Left-to-right side			
4. Supine-to-sit			
5. Left hallpike			
6. Return from hallpike			
7. Right hallpike			
8. Return from hallpike			
9. Sitting: nose □ left knee			
10. Return to sit			
11. Sitting: nose □ right knee			
12. Return to sit			
13. Sitting: head rotation 5x			
14. Sitting: head flex, and ext. 5x			
15. Standing: turn right			
16. Standing: turn left			
Intensity: rated from 0 to 5 (0 = no symptoms, 5 = severe symptoms)			
Duration: rated from 0 to 3 (5-10 sec = 1, 11-30 sec = 2, ≥ 30 sec = 3)			
Motion sensitivity quotient: $\frac{\# \text{ Provoking positions} \times \text{score}}{20.48} = \text{Total}$			

- Scoring
 - 0-10 = mild motion sensitivity
 - 11-30 = moderate motion sensitivity
 - 31-100 = severe motion sensitivity

Modified Motion Sensitivity Test (mMST)

modified Motion Sensitivity Test (mMST) Patient _____
Date _____

All movements are done in standing, eyes are open, in front of a plain wall
Symptoms must return to baseline before the next movement is performed
Tester is recording the change of intensity from baseline, then after the movement is completed

Intensity	0-10	Duration	<5 s	=0	Score = Intensity + Duration
	0 = none		5-10 s	=1	
	10 = severe		11-20s	=2	
			21-30s	=3	
			>30 s	=4	

Baseline Symptoms = _____

MOVEMENT	Intensity	Duration	Score
1. 5x Horizontal head turns			
2. 5x Vertical head turns			
3. 5x Right diagonal head turns (upper left quadrant down to right)			
4. 5x Left diagonal head turns (upper right quadrant down to left)			
5. 5x Trunk Bends (bending knees reaching to floor)			
6. 5x Right quarter body turns (Look over right shoulder with trunk rotation, feet planted)			
7. 5x Left quarter body turns (Look over left shoulder with trunk rotation, feet planted)			
8. 1x 360 degree turn to right			
9. 1x 360 degree turn to left			
10. 5x VOR cancellation (follow thumbs horizontally with head/trunk rotation X45 degrees each direction)			
Total score			

MSQ = Total score x (# of positions with change) / 14.00
_____ X _____ /14.00

MSQ = _____
0-10 mild range
11-30 moderate
31-100 severe

modified Motion Sensitivity Test

Date _____

- All movements are done in standing, eyes are open, in front of a plain wall (4-6' away)
- Symptoms must return to baseline before the next movement is performed
- Tester records the change of intensity from baseline, after the movement is completed

Intensity 0-10 Duration <5 s =0 Score = Intensity + Duration
 0 = none 5-10 s =1
 10 = severe 11-20s =2
 21-30s =3
 >30 s =4

Baseline Symptoms = 0

MOVEMENT	Intensity	Duration	Score
1. 5x Horizontal head turns	5	3	8
2. 5x Vertical head turns	2	1	3
3. 5x Right diagonal head turns (upper left down to right)	4	2	6
4. 5x Left diagonal head turns (upper right down to left)	5	2	7
5. 5x Trunk Bends (bending knees reaching to floor)	7	2	9
6. 5x Right quarter body turns (Look over right shoulder with trunk rotation, feet planted)	6	4	10
7. 5x Left quarter body turns (Look over left shoulder with trunk rotation, feet planted)	7	4	11
8. 1x 360 degree turn to right	8	3	11
9. 1x 360 degree turn to left	8	4	12
10. 5x VOR cancellation (follow thumbs horizontally with head/trunk rotation X45 degrees each way)	7	2	9
Total score			86

mMSQ = Total score x (# of positions) / 14.00
 86 x 10 /14.00

MSQ = 61.4
 0-10 mild range
 11-30 moderate
 31-100 severe

Modified Motion Sensitivity Test (mMST) Screen

modified Motion Sensitivity Test (mMST) Screen

Patient _____

Date _____

All movements are done in standing, eyes are open, in front of a plain wall

Symptoms must return to baseline before the next movement is performed

Tester is recording the change of intensity from baseline, then after the movement is completed

Intensity	0-10	Duration	<5 s	=0	Score = Intensity + Duration
	0 = none		5-10 s	=1	
	10 = severe		11-20s	=2	
			21-30s	=3	
			>30 s	=4	

Baseline Symptoms = _____

MOVEMENT	Intensity	Duration	Score
1. 5x Horizontal head turns			
2. 5x Vertical head turns			
5. 5x Trunk Bends (bending knees reaching to floor)			
10. 5x VOR cancellation (follow thumbs horizontally with head/trunk rotation X45 degrees each direction)			
Total score			

MSQ screen= Total score x (# of positions with change) / 2.24
_____ x _____ /2.24

MSQ = _____

0-10 mild range
11-30 moderate
31-100 severe

Buffalo Concussion Treadmill Test

Buffalo Concussion Treadmill Test (BCTT)

Minute	Incline	Speed	HR	RPE	Symptoms
Baseline	-----	-----			
0 - 1	0%				
1 - 2	1%				
2 - 3	2%				
3 - 4	3%				
4 - 5	4%				
5 - 6	5%				
6 - 7	6%				
7 - 8	7%				
8 - 9	8%				
9 - 10	9%				
10 - 11	10%				
11 - 12	11%				
12 - 13	12%				
13 - 14	13%				
14 - 15	14%				
15 - 16	15%				
16* - 17					
17 - 18					
18 - 19					
19 - 20					
20 - 21					
21 - 22					
22 - 23					
24 - 25					

* Maintain 15% incline; increase speed by 0.4 mph each minute

End of test parameters (prior to cool down):

Time: _____; Incline: _____; HR: _____; Max HR: _____

Symptoms: _____

Protocol:

- Defer testing if pretest resting symptoms ≥ 7 on VAS
- Speed selection:
 - 3.6 mph for patients over 5'5"
 - 3.2 mph for those under 5'5"
 - Adjust speed as needed for height or fitness level
- Adjust incline by 1% each minute
- Patient should rate RPE and symptom severity (use VAS); also record HR
- * If patient makes it to 16 minutes – increase speed by **0.4 mph** each additional minute
- TERMINATION Guidelines (any of the following):
 - Maximum exertion (RPE score of 17 or higher) is reported
 - Symptom exacerbation that causes significant increase in pain or symptom severity
 - An increase of ≥ 3 points on the VAS from resting score
 - 1 point given for each increase in a symptom or appearance of a new symptom
 - PT notes a **Rapid** progression of complaints (ex. Headache to searing focal pain) between symptom reports, patient appears faint or unsteady, or determines that continuing the test constitutes significant health risk for the participant
 - Patient reports an inability to continue the test safely

Once test is terminated, reduce speed to 2.5 mph and incline to 0% for a 2 minute cool down (if patient is safe to continue). Continue to report VAS ratings each minute

BCTT Results Interpretation

Submax symptom-limited threshold

- Acutely concussed or not recovered
- Threshold HR = HR @ symptom exacerbation (stopping criteria)

Maximal exertion (RPE to 17+) without symptom limit

- Physiologically recovered

TREATMENT

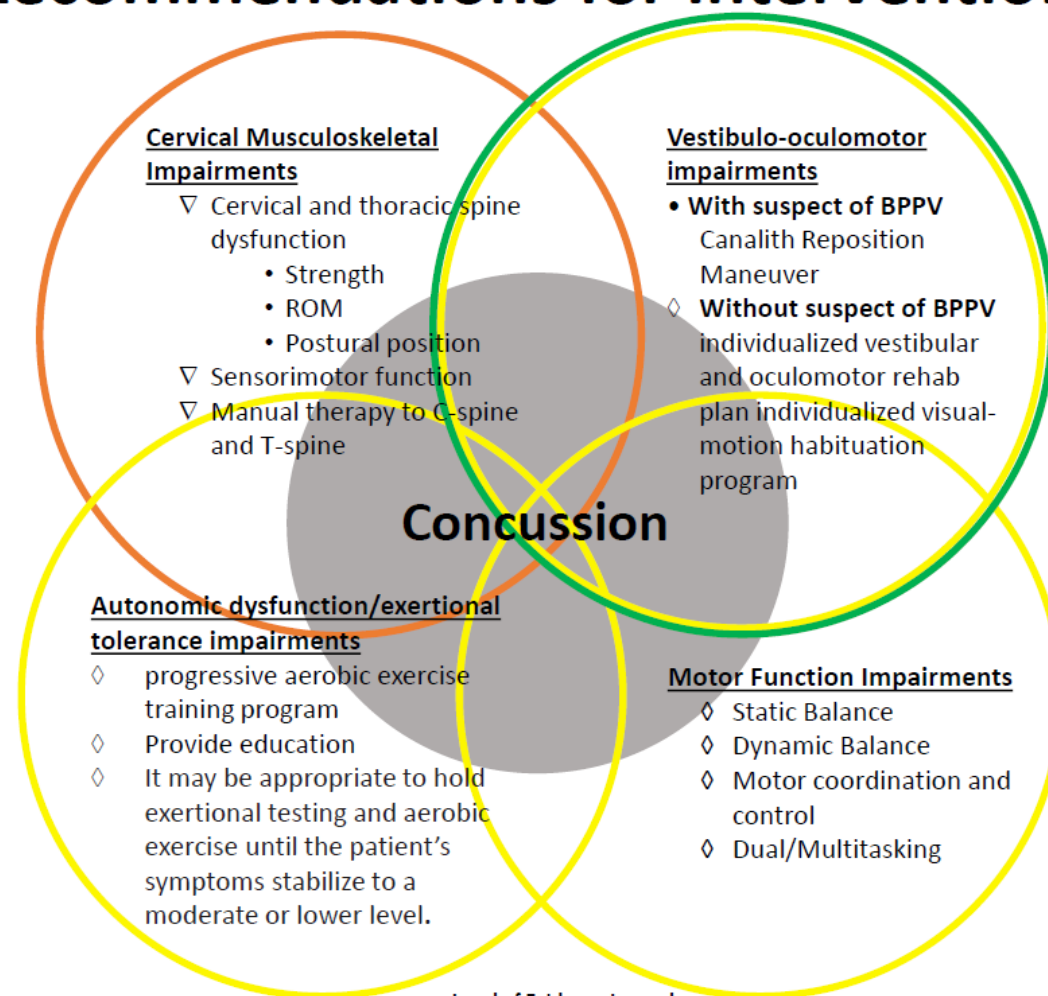


Concussion Clinical Practice Guidelines: Recommendations for Intervention

Selection of tools based on patient age and required functional level relative to patient goal

Grades of Recommendation

- A (strong evidence)
- B (moderate evidence)
- ◊ C (weak evidence)
- ◊ D (conflicting evidence)
- ▽ E (Theoretical/ Foundational)
- ▽ F (Expert Opinion)



Level of Evidence Legend

Green – circle Yellow – Diamond Orange - Triangle

For more detailed information, please refer to the original document: Journal of Orthopaedic & Sports Physical Therapy
Document produced by Academy of Neurologic Physical Therapy www.neuropt.org info@neuropt.org

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Treatment Ideas based on Symptoms/Dysfunction

Noted Deficits	Exercise
BPPV	Canalith Repositioning Maneuvers based on location of otoconia
Oculomotor dysfunction / sensitivity	Eye exercises (smooth pursuits, saccades, convergence)
Abnormal VOR / DVA	VOR exercises (gaze stability)
Motion sensitivity (head or body movements)	Habituation exercises using the VOMS, MSQ, or mMST VOR exercises (but now doing for habituation)
Symptoms with VOR cancellation	Habituation exercises with head and eyes moving together throughout
Visual motion sensitivity	Visual habituation exercises
Decreased balance / abnormal gait	Gait and balance exercises Use items from outcome measures to match exercises to deficits
Poor endurance or symptom exacerbation during aerobic exercise	Aerobic training within symptom tolerance / Interval training

Dix Hallpike or Sidelying Test

Right

Nystagmus: R upbeat and torsional

< 60 sec

R posterior canalolithiasis

Epley for R PC

Tend to report short lasting symptoms (seconds) worse with laying down or sitting up in bed, looking up/down, or bending over

> 60 sec

R posterior canal cupulolithiasis

Semont or Liberatory Maneuver for R PC

Tend to report relative short-lasting symptoms (seconds to minutes) worse with laying down or sitting up in bed, looking up/down, or bending over

Nystagmus: R downbeat and torsional

Very rare occurrence and treatment beyond scope of this course

Left

Nystagmus: L upbeat and torsional

< 60 sec

L posterior canalolithiasis

Epley for L PC

Tend to report short lasting symptoms (seconds) worse with laying down or sitting up in bed, looking up/down, or bending over

> 60 sec

L posterior canal cupulolithiasis

Semont or Liberatory Maneuver for L PC

Tend to report relative short-lasting symptoms (seconds to minutes) worse with laying down or sitting up in bed, looking up/down, or bending over

Nystagmus: L downbeat and torsional

Very rare occurrence and treatment beyond scope of this course

Roll Test

Right
and
Left

Nystagmus: geotropic

Typically < 60 sec

Horizontal canalolithiasis
(positive side= side w/strongest nystagmus/worse symptoms)

BBQ Roll – start towards affected side or
Gufoni – towards unaffected side; head turns downward for 2nd position

Tend to report relative short-lasting symptoms (seconds) worse with rolling over

Nystagmus: ageotropic

Typically > 60 sec

Horizontal canal cupulolithiasis
(positive side= side w/lesser nystagmus/least symptoms)

Gufoni – towards affected side; head turns upward for 2nd position

Tend to report relative short-lasting symptoms (seconds to minutes) worse with rolling over

Treatment of Convergence Insufficiency



Saccades & Smooth Pursuits

V	S	X	P	E	F	N	P	V	D
E	A	N	C	B	B	A	K	O	E
D	B	K	E	P	T	H	W	F	M
S	M	A	R	D	X	F	R	T	O
A	X	S	O	G	A	D	V	S	X

O	E	A	N	C	N	C	B	K	F
G	D	B	K	E	K	E	P	M	A
P	S	M	A	R	A	R	D	L	G
U	A	X	S	O	S	O	G	P	B
S	N	C	T	K	T	K	U	Z	L

- Link for 4-Square Saccade Exercise targets:
<https://www.med.umich.edu/1libr/PMR/VisionExercises/FOUR-SQUARE-SACCADES-Table>
- Website for eye exercises:
<https://sportsvisioninstitutepllc.com/resources-%26-downloads>
 - Scroll down to section for Saccades
 - This section has instructions for the 4-Square Saccades Exercise
 - Scroll down to section for Eye Movement Exercises

VOR Exercises (Gaze Stability)



- X1 Exercise
- X2 Exercise

VOR Exercises (Gaze Stability)

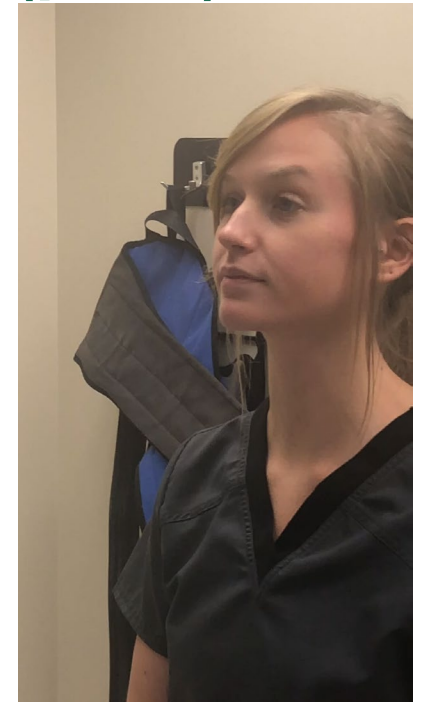
Gaze shifting exercise (set-up)



Gaze shifting exercise (yaw)



Gaze shifting exercise (pitch)



Gaze Stabilization Progressions

Levels	Background	Balance Challenges	Target Size	Speed of head movement	Time
Easy	Plain/White	Sitting Standing with feet apart	Large <ul style="list-style-type: none">• 72 pt (+) font• Arial; Calibri	Slow <ul style="list-style-type: none">• 60-85 bpm	1 minute
Medium	Busy (checkerboard or wallpaper)	Romberg or tandem position Standing on foam pad Single leg stand on firm ground	Medium <ul style="list-style-type: none">• 36-48 pt font	Medium <ul style="list-style-type: none">• 90 – 120 bpm	1.5 minutes
Difficult	Moving background (e.g. TV; window in front of traffic; crowded area; visually complex environment)	Walking forward/back; Jumping Single leg stand on foam Treadmill	Small <ul style="list-style-type: none">• 22 pt font or less	Fast <ul style="list-style-type: none">• > 120 bpm• Progress as tolerated	2 minutes

Habituation – Movement Based



Assess symptoms

Motion Sensitivity Quotient (MSQ)

Modified Motion Sensitivity Test (mMST)



Treatment

Choose 3-4 exercises

Prioritize movements causing moderate level of symptoms

Reps: 3-5

Frequency: 2-3 times per day

If nausea or headaches occur, decrease exercise intensity/exposure

<https://www.youtube.com/watch?v=T9bf3u9qd6o>

Habituation: VOR Cancellation

- Can set up exercise like the way we test it
 - Parameters
 - Size of target
 - Duration
 - Speed of movement
 - Background – plain versus complex or busy
 - Body position or moving
- Ball toss up/down tracking motion with eyes and head



Medbridge.com

Habituation – Visual Motion Sensitivity

- **Assessment**

- Visual Vertigo Analogue Scale (VVAS)

- **Treatment**

- Low tech option:
 - YouTube videos that relate to areas noted on VVAS
 - Prioritize visual motions that cause moderate level of symptoms
 - If nausea or headaches occur, decrease exercise intensity/exposure

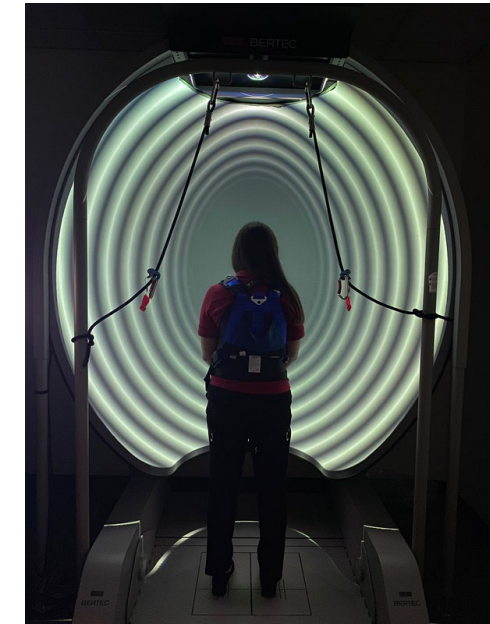
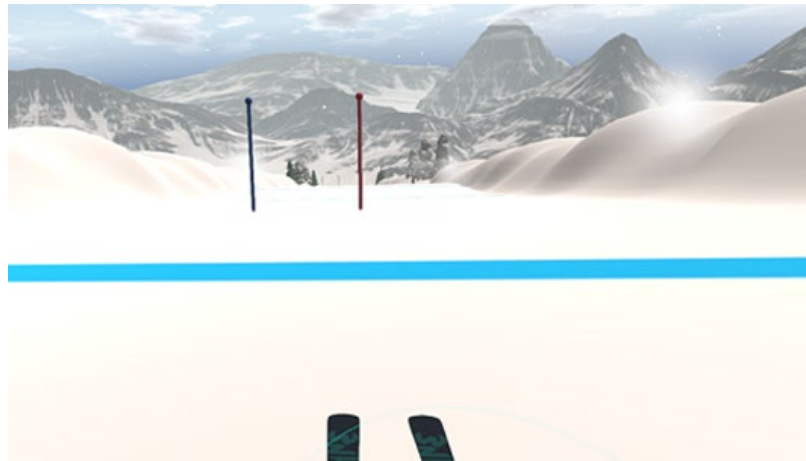


<https://www.youtube.com/watch?v=OPEL52sGhBM&t>

<https://www.youtube.com/watch?v=T9bf3u9qd6o>

Habituation – Visual Motion Sensitivity

- **Treatment**
 - High tech exercise options:
 - Virtual reality equipment
 - Use of posturography equipment
 - If nausea or headaches occur, decrease exercise intensity/exposure



<https://www.youtube.com/watch?v=T9bf3u9qd6o>

Balance Training

Condition	Predominate System Used for Balance	Potential Exercises
Standing with eyes closed on firm surface	Somatosensory	<ul style="list-style-type: none"> • Balance on firm ground with eyes closed or with vision challenge (dark glasses, busy visual environment, Vaseline or plastic wrap layers on goggles, in a darkened room) • Add in challenging stance positions (Romberg, semi-tandem, tandem, single leg stance) • Marching in place on firm ground with eyes closed
Standing or walking with eyes opened on a compliant surface	Vision	<ul style="list-style-type: none"> • On foam or dynamic surfaces (rocker board, wobble board, BOSU) • Add in balance task (multi-directional reaching, hitting balloon, ball toss, etc.) • Add in challenging stance positions (as above) • March in place on foam pad, walking on foam pad, or foam balance beam with eyes open
Standing on a compliant surface with eyes closed or with head moving Walking with eyes closed Walking with head turns	Vestibular	<ul style="list-style-type: none"> • On foam or dynamic surfaces with eyes closed, while moving head, OR with vision challenge (see above or in a busy visual environment) • Add in balance task (as above) • Add in challenging stance positions (as above) • Marching in place on foam with eyes closed, walking with eyes closed (or with vision challenge), stepping/mini-jumps on mini-trampoline, or walking with head turns

Aerobic Training - BCTT Exercise Prescription

- **Mild symptoms exacerbation exercise**

- Target HR = 90% of threshold HR
- Continue exercise bout at the target HR for as long as patient wants, OR
 - Until symptoms increase by MORE than 2 points from pre-exercise values
- Target duration at least 20 minutes
 - Can terminate earlier (for symptom increase beyond 2 points), OR
 - Continue longer than 20 minutes (if symptoms stay within range)



RTP Examples

IJSPT

CLINICAL COMMENTARY PEDIATRIC SPORTS SPECIFIC RETURN TO PLAY GUIDELINES FOLLOWING CONCUSSION

Keith H. May, PT, DPT, SCS, ATC, CSCS¹

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Thomas G. Burns, PsyD, ABPP/CN¹

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John A. Polikandriotis, PhD, MBA, MPH, FACHE¹

May KH, Marshall DL, Burns TG, Popoli DM, Polikandriotis JA. Pediatric sports specific return to play guidelines following concussion. *Int J Sports Phys Ther.* 2014;9(2):242-255.

Appendix 3			
Return to Physical Activity Following Concussion			
Football			
Stage	Activity	Football Specific Exercise	Objective of the Stage
1	No physical activity; Complete physical and cognitive rest	<ul style="list-style-type: none"> No activity 	<ul style="list-style-type: none"> Recovery and elimination of symptoms
2	Light aerobic activity	<ul style="list-style-type: none"> 10-15 min of walking at home or at field, or stationary bike 	<ul style="list-style-type: none"> Add light aerobic activity and monitor for symptom return
3	Moderate aerobic activity Light resistance training	<ul style="list-style-type: none"> 20-30 min jogging w/helmet Resistance training -body weight squats and push-ups 1 set of 10 reps each 	<ul style="list-style-type: none"> Increase aerobic activity and monitor for symptom return
4	Non-contact football-specific drills	<ul style="list-style-type: none"> Moving in/out 3 point stance, bear crawls through tunnel, tires, step over bags (vertical and lateral), QB/center exchange, QB drop backs, passing, break downs and plant, jump cuts, backpedaling, match the hips, up/downs <p>*Start w/o helmet; progress to helmet and shoulder pads if symptom free</p>	<ul style="list-style-type: none"> Maximize aerobic activity Accelerate to full speed with change of directions (cuts) Introduce rotational head movements Monitor for symptoms
5	Limited contact football drills	<ul style="list-style-type: none"> Stage 4 workout in full pads Hit/push pads then sled (focus on technique-head up, square up, stay low), step and hit, run and hit, leverage drill, punch drill 	<ul style="list-style-type: none"> Maximize aerobic activity Add deceleration/rotational forces in controlled setting Monitor for symptoms
6	Full contact practice (after medical clearance)	<ul style="list-style-type: none"> Normal training activities 	<ul style="list-style-type: none"> Reassess for symptoms every 30 minutes throughout the practice Monitor for symptoms
7	Return to play	<ul style="list-style-type: none"> Normal game play 	<ul style="list-style-type: none"> Assess frequently Monitor for symptoms Consider one side of the ball only, no special teams play
<ul style="list-style-type: none"> Progress to the next stage may occur every 24 hours as long as symptoms do not return. It is recommended that you seek further medical attention if you fail more than 3 attempts to pass a stage 			

References

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- Mucha A, Whitney S. Concussion assessment: an overview. Medbridge online education course.
- Quatman-Yates CC, Hunter-Giordano A, Shimamura KK, et al. Physical Therapy Evaluation and Treatment After Concussion/Mild Traumatic Brain Injury. *J Orthop Sports Phys Ther*. 2020;50(4):CPG1-CPG73. doi:10.2519/jospt.2020.0301
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- Mucha A, Collins MW, Elbin RJ, et al. A Brief Vestibular/Ocular Motor Screening (VOMS) assessment to evaluate concussions: preliminary findings. *Am J Sports Med*. 2014;42(10):2479-2486.
- Anzalone AJ, Blueitt D, Case T, et al. A Positive Vestibular/Ocular Motor Screening (VOMS) Is Associated With Increased Recovery Time After Sports-Related Concussion in Youth and Adolescent Athletes. *Am J Sports Med*. 2017;45(2):474-479. doi:10.1177/0363546516668624
- May KH, Marshall DL, Burns TG, Popoli DM, Polikandriotis JA. Pediatric sports specific return to play guidelines following concussion. *Int J Sports Phys Ther*. 2014;9(2):242-255.

Resources - Videos

- [YouTube Video – How to do the Famous Vision Therapy Exercise: Brock String](#)
- Habituation for clinicians (ANPT): <https://www.youtube.com/watch?v=T9bf3u9qd6o>
- Adaptation for clinicians (ANPT): https://www.youtube.com/watch?v=tTvG3JT_bL0
- Habituation for patients (ANPT): <https://www.youtube.com/watch?v=E2h12PTvjT4>
- Adaptation for patients (ANPT): <https://www.youtube.com/watch?v=KM0qBwedbp8>

Resources – Videos on BPPV

- Peter Johns videos on YouTube
 - Dix Hallpike Test and Epley Maneuver: <https://www.youtube.com/watch?v=kvVnEsGVLUY>
 - Positive Dix Hallpike Test: <https://www.youtube.com/watch?v=7ePecb9azS4>
 - Horizontal canal BPPV and the Gufoni Maneuvers: <https://youtu.be/VRjRTnIw9YE>
- Posterior canal BPPV nystagmus:
<https://www.youtube.com/shorts/nw126UDXyo8>
- Horizontal canal BPPV geotropic nystagmus:
https://www.youtube.com/watch?v=g_7gQF8XMCY

Resources

Concussion CPG Information - <https://www.neuropt.org/practice-resources/anpt-clinical-practice-guidelines/concussion-cpg>

Patient Education Fact Sheets - <http://www.neuropt.org/special-interest-groups/vestibular-rehabilitation/patient-education-fact-sheets>

DVA Charts (printable) (look for links for Chart R, Chart 1, and Chart 2) : <https://i-see.org/eyecharts.html>

Make your own bucket for the SVV Bucket Test: <https://www.scribd.com/document/376515745/svv-bucket-how-to-pdf>

Brock Strings (Amazon): <https://www.amazon.com/Brock-String-Convergence-Training-Shooters/dp/B075881G1K/>

Contact me for the following

- Any of the outcome measures presented
- Electronic versions of any of the articles referenced
- Visual vertigo habituation exercises – list of links for first person POV videos
- If you need the information to make a referral for UAB Eye Care (Optometry)



Ask

Important

Questions