A Case Example

Safe Return to Play

A 14-year-old male athlete is referred to physical therapy for evaluation by his physician six days after hitting his head performing a vault stunt during a gymnastics exercise. He complains of imbalance and dizziness following the injury. No loss of consciousness, no neck trauma, and no prior history of head trauma are reported. The physician reports a normal neurological exam, with no tinnitus or visual problems.

The physical therapy evaluation indicates:

- Cervical range of motion: normal, without pain
- Oculomotor: normal smooth pursuit and saccade, near point convergence abnormal (15 cm)
- Dix-Hallpike: negative
- Head Thrust: negative, but provoked dizziness symptoms
- Clinical balance assessment: CTSIB shows mild sway on foam with eyes closed
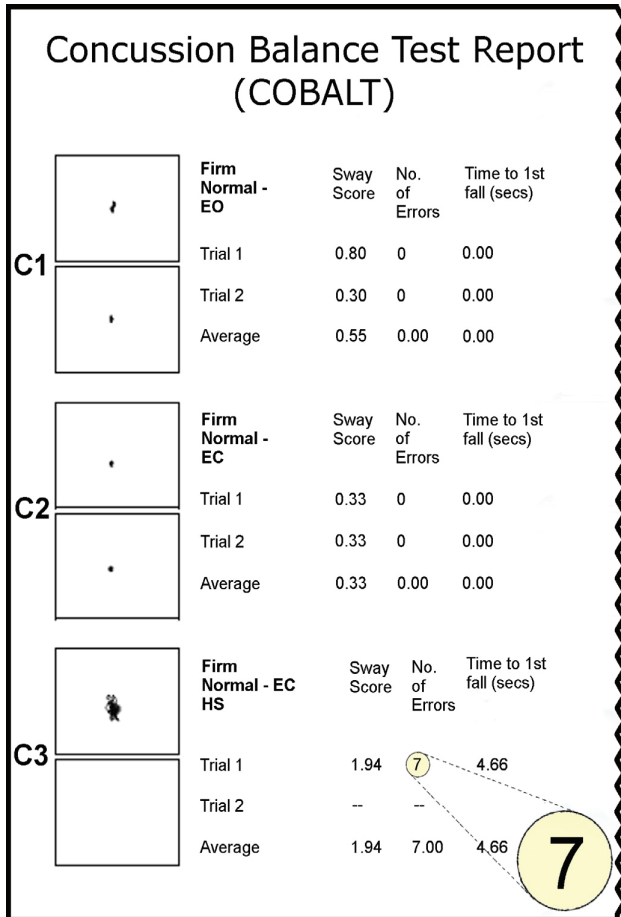- Gait: difficulty with ambulation with head turns due to onset of dizziness

Preliminary impression: Results to this point do not explain the dizziness and imbalance complaints. There is no indication of peripheral vestibular dysfunction or neck injury. The balance assessment used to this point was not sensitive enough to identify the balance impairment.

The case history suggests that the dizziness and balance symptoms may be the result of a possible concussion. The physical therapist chose to investigate the balance complaints with assessment tools that are more sensitive to subtle changes in sensory integration for balance, and changes in visual performance that are tied to vestibulo-ocular reflex (VOR). Three assessments were used:

- COBALT (Concussion Balance Test). This protocol is designed for an athletic population, using more challenging postural control conditions and incorporating head turns during the balance measurements.
- Computerized Dynamic Posturography (CDP). These protocols are considered the gold standard for balance assessment because it isolates and quantifies impairments that contribute to a balance problem.
- Dynamic Vision Testing. The Gaze Stabilization Test (GST) is used to investigate VOR impairment, particularly asymmetrical performance under high demand conditions.

COBALT

The COBALT protocols include a total of eight test conditions, with four completed with the patient standing on a firm surface and the same four tasks completed on a foam pad. The test conditions are progressively more challenging, with head turns included to stimulate dynamic vestibular inputs and visual motion sensitivity.

Concussion Balance Test Report (COBALT)

C1 — Firm Normal - EO

	Sway Score	No. of Errors	Time to 1st fall (secs)
Trial 1	0.80	0	0.00
Trial 2	0.30	0	0.00
Average	0.55	0.00	0.00

C2 — Firm Normal - EC

	Sway Score	No. of Errors	Time to 1st fall (secs)
Trial 1	0.33	0	0.00
Trial 2	0.33	0	0.00
Average	0.33	0.00	0.00

C3 — Firm Normal - EC HS

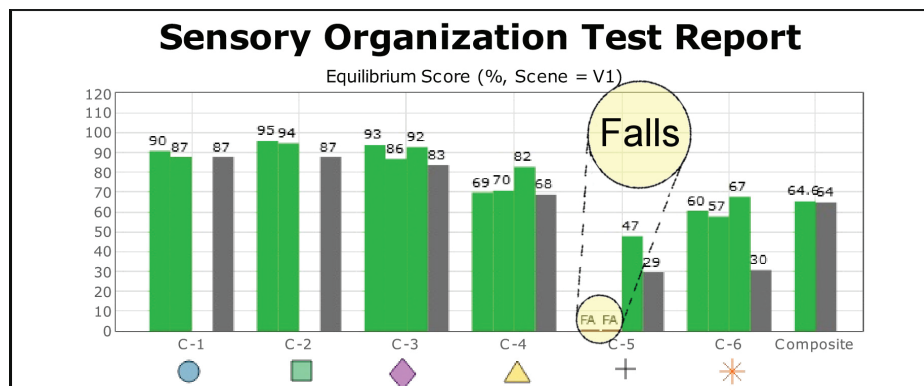|	Sway Score	No. of Errors	Time to 1st fall (secs)
Trial 1	1.94	7	4.66
Trial 2	--	--	
Average	1.94	7.00	4.66

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The COBALT was attempted, but discontinued after the third test condition due to provocation of dizziness symptoms. The results show seven errors on condition 3, with a sway velocity for that condition of 1.94 degrees per second. Normative data for this age group indicates that 100% of normal subjects can complete this condition with no scored errors. The high error count for this patient confirms abnormal balance performance with head turns (increased vestibular input). The measured sway velocity in this condition places the patient at the 5th percentile for his age, also confirming abnormal balance performance.

Computerized Dynamic Posturography (CDP)

The CDP protocols include a six condition Sensory Organization Test (SOT), a Motor Control Test (MCT), and an Adaptation Test (ADT). The SOT conditions systematically remove or distort visual or somatosensory information while measuring postural sway. The results are used to determine how well the patient is utilizing visual, somatosensory, and vestibular information to maintain their balance. The MCT measures automatic motor responses to surface perturbations, and the ADT measures the patient's ability to adapt to unexpected changes in the support surface.

This patient's MCT results are within normal limits, indicating good automatic motor function. The SOT results show borderline normal composite scores, poor equilibrium scores for condition 5, and variable scores for condition 6, indicating poor use of vestibular information. His equilibrium scores in other conditions were within normal limits. The ADT was not included in the evaluation.
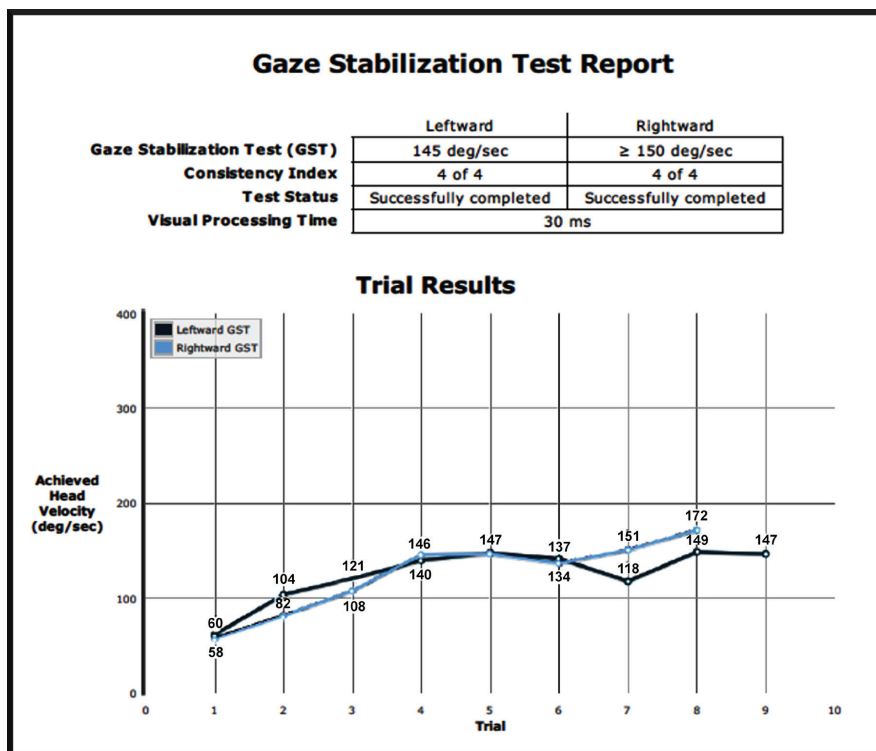
Sensory Organization Test Report

Equilibrium Score (%, Scene = V1)

Falls

	C-1	C-2	C-3	C-4	C-5	C-6	Composite
	90 87 87	95 94 87	93 86 83	69 70 82 68	FA FA 47 29	60 57 67 30	64.6 64

Gaze Stabilization Test

The GST protocol is designed to determine the head velocity and direction where visual accuracy breaks down. The results are used to estimate the point of retinal slip, where the patient's VOR response does not stabilize vision with head movement in a given direction.

This patient's GST data for the yaw plane shows stable vision up to 145 degrees/second for leftward movement, and ↗150 degrees/second for rightward movement. Although results for both directions are within normal limits, the possible asymmetry in performance suggests VOR function may not be adequate for this athlete's demand.

Impression. The SOT results and the possible asymmetry in GST results indicate impaired balance control under vestibular demand, with possible subtle impairments in VOR with head movements to the left. Although the GST results are within normal limits, the VOR performance may not be adequate for an athlete, and at least suggest that focused training should improve performance. Taken together with the history, the complaint of dizziness with head motion is better understood. The treatment plan can emphasize postural control in vestibular demand and VOR exercises.

Treatment Plan. The patient was seen for three visits over the course of two weeks. At the first visit, home exercises for habituation with head rotations progressing to trunk rotations while standing on a firm surface were assigned. At the second visit, symptoms were reduced but the patient reported "still not feeling 100%." He was able to complete all COBALT conditions, and provocation of dizziness symptoms was noted. His sway score for condition 7 (head rotation, eyes closed, foam surface) was at the 10th percentile and for condition 8 (visual motion sensitivity, en bloc rotation, foam surface) was at the 25th percentile. GST was completed at this visit with the results as noted above. High level balance exercises including unstable surfaces and gait with head turn, and VOR exercises with high head velocities were assigned.

Gaze Stabilization Test Report

	Leftward	Rightward
Gaze Stabilization Test (GST)	145 deg/sec	≥ 150 deg/sec
Consistency Index	4 of 4	4 of 4
Test Status	Successfully completed	Successfully completed
Visual Processing Time	30 ms	

Trial Results

At the third visit, repeat testing for COBALT, SOT and GST was completed to monitor progress.
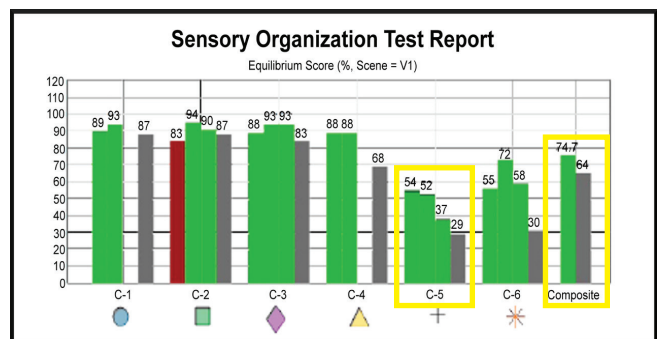
COBALT: The patient completed all conditions with no errors. Sway scores were at 95th percentile for condition 7 and 75th percentile for condition 8.

SOT: Composite score improved from 64 at second visit to 74.7 (normal range is 64 and above). The equilibrium score for Condition 5 improved from 18/100 to 53/100 (normal range is 29 and above).

GST: GST was measured at 200 degrees/sec-ond leftward and 220 degrees/second right-ward.

The test data confirmed improvement in balance function and VOR performance. The results were sent to the patient's physician, and the patient was cleared to return to play.
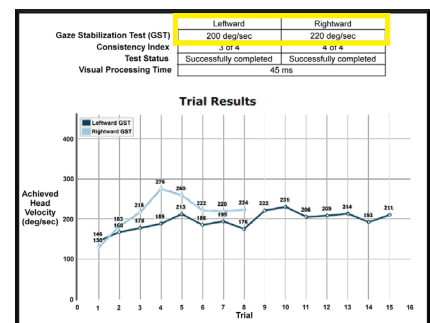

Discussion

Dizziness and balance problems are frequently reported after a suspected concussion. While dizziness is a symptom that is difficult to quantify objectively, it is possible to use objective measures for balance and VOR performance. Note that the objective measures used in this case were used to confirm the functional impression, to focus home exercises on measured impairments, and to document progress through treatment.

Recovery time from suspected concussion varies, and is very difficult to predict. To minimize the risk of more serious and potentially permanent injury from a second concussion before recovery is complete, it is important to monitor improvement in balance along with cognitive function and symptom reduction.

Once all of those indicators show results in normal range (or to baseline levels, if available), a return to play decision can be made safely. If that decision can be made using sensitive, objective measures, it provides better confidence to the healthcare providers.

The objective measures used in this case are sensitive to even subtle changes in balance and VOR performance that may be affected by concussion injuries. Comparison to normative data helps the provider interpret the data, and it helps pinpoint performance deficits that can be addressed in treatment. Repeat measures provide documentation of progress through therapy, and help determine optimal discharge timing.

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