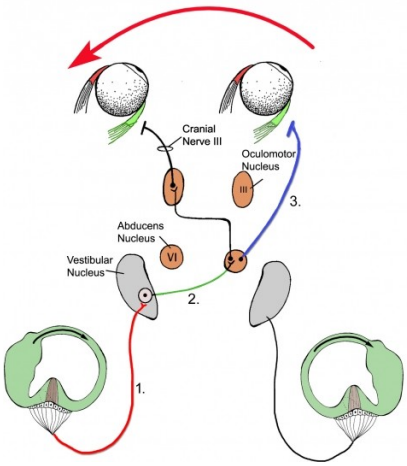
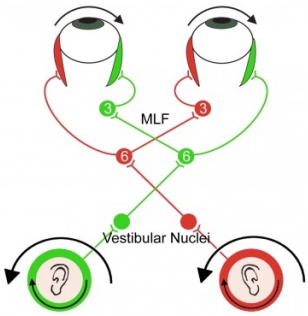
VOR Testing - Clinical Cheat Sheet

OVERVIEW & VESTIBULO-OCULAR REFLEX

VOR Definition: The vestibulo-ocular reflex is a monosynaptic 3-neuron arc generating compensatory eye movements opposite to head motion, stabilising retinal images during head movement. The fastest human reflex with <15 ms latency.

3-Neuron Arc: Vestibular afferent hair cells (CN VIII) → vestibular nucleus complex (medial/lateral) → oculomotor nuclei (CN III, IV, VI). Push-pull mechanism between paired canals ensures bilateral compensation.

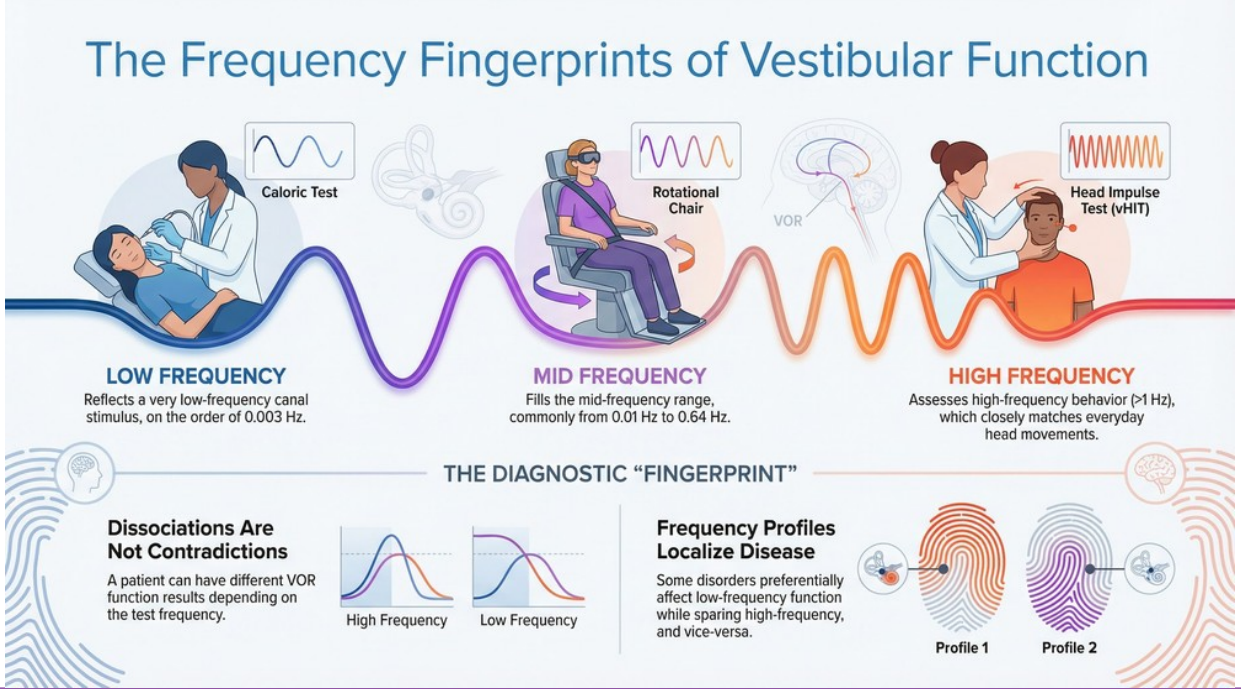




Gain Definition: VOR gain = eye velocity / head velocity. Normal gain ≥0.80 ensures retinal image stability. Gain <0.70 produces oscillopsia (visual blur during head movement).

Frequency Specificity: Different tests assess different frequency ranges: vHIT (2-6 Hz), rotational chair (0.01-1 Hz), caloric (0.002 Hz). Complete VOR assessment requires testing across frequency spectrum.

VOR TEST BATTERY



Test	Frequency	What It Measures	Key Advantage
vHIT (Video Head Impulse)	2-6 Hz (high freq)	Individual semicircular canal function	Captures acute vestibular loss, canal-specific
Caloric Testing	0.002 Hz (very low)	Horizontal canal function individually	Isolates each ear independently
Rotational Chair	0.01-1.0 Hz (mid freq)	VOR gain, phase, symmetry	Bilateral symmetric stimulus; compensation assessment
Head Shaking Nystagmus	Variable	Directional preponderance	Bedside test; reveals vestibular asymmetry
Dynamic Visual Acuity	Active head motion	Functional VOR during daily tasks	Correlates with patient symptoms

CLINICAL ASSESSMENT PROTOCOL

A. vHIT Protocol: Unpredictable head impulses (±20° amplitude, peak velocity 150-250°/sec). Patient fixates distant target. Measure gain for all 6 semicircular canals. Record covert and overt saccades.

B. Caloric Testing: Warm (44°C) and cool (30°C) irrigation for 30 seconds each. Measure peak slow-phase velocity. Calculate canal paresis (CP) and directional preponderance (DP).

C. Key Calculations: Canal Paresis = [(RW+RC) -(LW+LC)] / (RW+RC+LW+LC) × 100. Abnormal >25%. Directional Preponderance = [(RW+LC) -(LW+RC)] / total × 100.

D. Clinical Correlation: Normal vHIT gain >0.80; <0.70 abnormal; catch-up saccades (covert or overt) indicate vestibular loss with compensation attempt.

VOR INTERPRETATION MATRIX

Test	Normal Range	Mild Abnormality	Severe Abnormality
vHIT Gain (horizontal)	>0.80	0.65-0.80 (early loss)	<0.50 (chronic/severe vestibular loss)
vHIT Gain (vertical)	>0.70	0.50-0.70 (subtle loss)	<0.50 (significant canal dysfunction)
Caloric SPV	10-60°/sec	5-10°/sec (hypoactive)	<2°/sec or absent (dead labyrinth)
Canal Paresis	<25%	25-40% (moderate asymmetry)	>40% (significant unilateral loss)
Catch-up Saccades	Minimal/none	1-2 covert per trial	Multiple overt + covert (decompensated)

BILATERAL VS UNILATERAL DYSFUNCTION PATTERNS

Feature	Unilateral Loss	Bilateral Loss	Central VOR Dysfunction
vHIT Gain	Reduced ipsilesional only	Reduced bilaterally (<0.60)	Normal or mildly reduced
Caloric Response	Canal paresis >25%	Bilateral weakness (total <20°/sec)	Normal calorics, abnormal vHIT pattern
Catch-up Saccades	Ipsilesional only	Bilateral	Absent or inappropriate (central pattern)
Key Symptom	Vertigo, unsteadiness	Oscillopsia, severe imbalance	Vertigo with brainstem signs
Common Cause	Vestibular neuritis, Meniere	Ototoxicity (gentamicin), bilateral Meniere	Brainstem stroke, MS, cerebellar disease

ACUTE VESTIBULAR LOSS: TIMELINE & COMPENSATION

Day 0-3 (Acute): Spontaneous nystagmus (fast-phase away from lesion), severe vertigo, vomiting, positive vHIT with overt saccades. vHIT gain typically <0.40.

Week 1-4 (Subacute): Nystagmus diminishes, covert saccades develop, VOR gain improves via central compensation. Caloric still shows canal paresis.

Month 1-6 (Compensation): vHIT gain may normalise (0.70-0.80) despite permanent canal loss. Covert saccades become primary compensation strategy.

Chronic (>6 months): Well-compensated patients have near-normal vHIT but persistent caloric asymmetry. Decompensation possible with illness, fatigue, or medication.

Testing Pearls: vHIT may miss well-compensated loss — always combine with calorics. Caloric canal paresis >25% + normal vHIT = high-frequency compensation only.