The 180-Degree Clinical Chair Rotation Test in Normal Subjects and Patients with Various Peripheral Vestibular Abnormalities.

Abstract

Background

Rotary chair testing (ROT) is the gold standard assessment for horizontal semicircular canal (SCC) function, particularly in cases of suspected bilateral vestibular hypofunction.[1,2] Despite sensitivity (0.747) and specificity (0.634) for peripheral vestibulopathy, its clinical adoption remains limited by cost and spatial requirements. A clinic-based 180-degree chair rotation test, coupled with video-oculography (VOG), offers an accessible alternative for assessing vestibulo-ocular reflex (VOR) function across the full spectrum of peripheral vestibular disorders.

Objective

To assess the utility of the 180-degree clinical chair rotation test in characterizing per-rotatory nystagmus, post-rotatory nystagmus, and VOR suppression in healthy normal subjects and in patients with diagnosed peripheral vestibular abnormalities, including vestibular migraine (VM), benign paroxysmal positional vertigo (BPPV), and Meniere's disease.

Methods

A total of 100 healthy volunteers and 100 patients with peripheral vestibular disorders were enrolled across all age groups at the Vertigo and Balance Disorders Clinic, Bengaluru, India. The chair was manually rotated 180 degrees by a single right-handed examiner, with a 10-second inter-rotation

gap, under three conditions: vision allowed (fixation), vision denied (fixation eliminated), and VOR suppression. Eye movements were recorded using the 'Balance Eye VOG' system.

Results

Normal subjects demonstrated absent post-rotatory nystagmus (PRN) and intact VOR suppression. Among patients with vestibular migraine, PRN was significantly more prevalent (59.5%) compared with normal subjects (14.3%; $p < 0.001$). Non-vestibular migraine patients also showed significantly elevated PRN positivity (43.1%; $p = 0.008$). Distinct VOG patterns were identified for right posterior semicircular canal BPPV, lateral semicircular canal BPPV and Meniere's disease, enabling lesion lateralization.

Conclusion

The 180-degree clinical chair rotation test,combined with VOG recording of per-rotatory nystagmus, post-rotatory nystagmus, and VOR suppression, constitutes a simple, intuitive, and clinically informative tool for assessing peripheral vestibular disorders. Further prospective studies with larger sample sizes are warranted to validate normative thresholds and disease-specific diagnostic criteria.

Keywords: *rotary chair test; video-oculography; vestibulo-ocular reflex; post-rotatory nystagmus; Bilateral vestibulopathy, LSCC*

1. Introduction

Vestibular function testing plays a key role in diagnosing disorders of the inner ear balance system. Rotary chair testing (ROT), also known as rotational chair testing, evaluates horizontal semicircular canal function and vestibulo-ocular reflex (VOR) pathways. Unlike caloric testing, which assesses each ear separately at low frequency, ROT evaluates bilateral vestibular responses across physiologically relevant frequencies.[1,2,8].

ROT has demonstrated good diagnostic utility in peripheral vestibulopathy and is included in the diagnostic criteria for bilateral vestibular dysfunction. [2,4]It also provides information regarding central vestibular compensation. However, its routine clinical use remains limited because of the high cost and space requirements of motorised rotary chair systems, particularly in resource-limited settings.[1,7]

The 180-degree clinical chair rotation test is a low-cost alternative using rapid manual chair rotation combined with video-oculography (VOG) to assess per-rotatory nystagmus, post-rotatory nystagmus (PRN), and VOR suppression. These parameters may provide clinically useful information regarding vestibular function and lesion localization.

The present study aimed to evaluate these VOG parameters in healthy controls and patients with peripheral vestibular disorders including vestibular migraine, benign paroxysmal positional vertigo (BPPV), and Ménière's disease. [1,2,8]

2. Materials and Methods

2.1 Study Design and Setting

This prospective, observational, single-center study was conducted at the Vertigo and Balance Disorders Clinic, Bengaluru, India. Informed consent was obtained from all participants. Ethical principles were followed in accordance with the Declaration of Helsinki.

2.2 Participants

Two groups were enrolled:

• **Group A (Normal Controls):** 100 healthy volunteers with no history of vertigo, hearing loss, neurological disease, or medications affecting vestibular function.

• **Group B (Patient Cohort):** 100 patients with peripheral vestibular disorders including vestibular migraine (VM), posterior SCC BPPV (right PSCC BPPV), lateral SCC BPPV (geotropic variety), and Meniere's disease across all age groups.

2.3 Equipment

Eye movements were recorded using the 'Balance Eye VOG' system (Figure 1), a binocular video-oculography device that captures horizontal and vertical slow-phase velocity (SPV), amplitude, and frequency of nystagmus in real time. The device provides simultaneous display of right eye (red trace) and left eye (blue trace) horizontal nystagmus waveforms.

Figure 1. Clinical setup demonstrating the Balance Eye VOG device and chair rotation technique at the Vertigo and Balance Disorders Clinic, Bengaluru, India.

2.4 Test Procedure

A single right-handed examiner performed all tests to ensure methodological consistency. The subject was seated upright on a standard rotating chair. The chair was manually rotated 180 degrees in either direction,with a minimum 10-second inter-rotation gap to allow nystagmus to decay.

Each subject underwent testing under three sequential conditions:

• Vision Allowed (Fixation): Subjects fixated on a stationary visual target during and after rotation, assessing per-rotatory nystagmus.

• Vision Denied (Fixation Eliminated): The VOG goggles were occluded to eliminate visual fixation, maximizing vestibular contribution to nystagmus and unmasking post-rotatory nystagmus.

• VOR Suppression: Subjects were instructed to fixate on their thumb, testing the ability of the smooth pursuit system to suppress the VOR.

2.5 Parameters Assessed

The following VOG parameters were systematically evaluated for each rotation direction and each vision condition:

- Per-rotatory nystagmus: Direction, slow-phase velocity (SPV), amplitude, and duration of nystagmus occurring during rotation.
- Post-rotatory nystagmus (PRN): Presence, direction, SPV, and duration of nystagmus persisting after cessation of rotation.
- VOR suppression: The ability to suppress per-rotatory nystagmus by optic fixation, expressed as the VOR suppression ratio.

2.6 Statistical Analysis

Categorical data were analyzed using the chi-square test or Fisher's exact test as appropriate. Statistical significance was defined as $p < 0.05$. All analyses were performed using standard statistical software.

3. Results

3.1 Normal Subjects

In 100 healthy volunteers, per-rotatory nystagmus was consistently elicited bilaterally following chair rotation in both directions. The nystagmus beat toward the direction of rotation during rotation and rapidly decayed with visual fixation. Post-rotatory nystagmus was absent or minimal in most normal subjects. VOR suppression was intact, with marked attenuation of nystagmus SPV when subjects fixated on a chair-fixed target.

Normative VOG waveforms under vision-allowed and vision-denied conditions are presented in Figures 2a and 2b, respectively. Figure 2c illustrates intact VOR suppression in a normal subject.

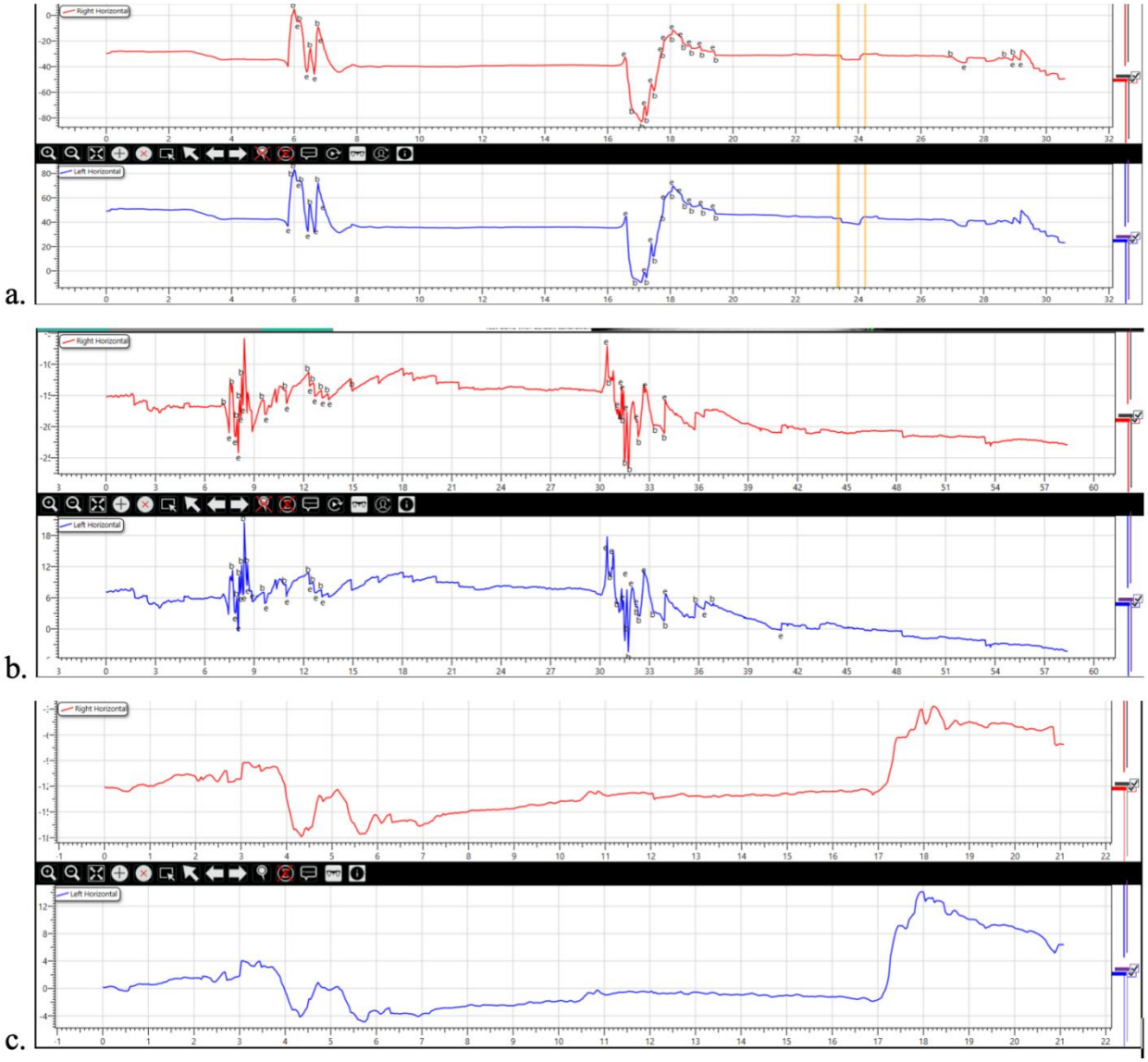

Figure 2a. Normative VOG waveform (vision allowed / fixation): Right eye (red) and left eye (blue) horizontal nystagmus traces showing per-rotatory nystagmus with rapid decay and absent post-rotatory nystagmus in a healthy normal subject.

Figure 2b. Normative VOG waveform (vision denied): Horizontal nystagmus traces with fixation eliminated. The absence of post-rotatory nystagmus confirms intact vestibular decay in the normal group.

Figure 2c. VOR suppression tracing in a normal subject: Near-complete suppression of per-rotatory nystagmus by chair-fixed fixation demonstrates intact cerebello-ocular VOR suppression pathways.

3.2 Post-Rotatory Nystagmus: Vestibular Migraine vs. Normal

Post-rotatory nystagmus was assessed as a binary outcome (positive/negative) and compared between patient subgroups and normal controls. Table 1 summarizes findings for vestibular migraine (VM) versus normal subjects.

Table 1. Post-Rotatory Nystagmus in Vestibular Migraine vs. Normal Subjects

Group	PRN Positive n (%)	PRN Negative n (%)	Total	P-value
Vestibular Migraine	22 (59.5%)	15 (40.5%)	37	< 0.001
Normal	4 (14.3%)	24 (85.7%)	28	–
Total	26	39	65	

Vestibular migraine patients showed a significantly higher rate of PRN positivity (59.5%, 22/37) compared with normal subjects (14.3%, 4/28; $p < 0.001$). This highly significant difference underscores the role of aberrant central vestibular processing in VM, manifesting as prolonged post-rotatory nystagmus beyond the physiological decay observed in normals.

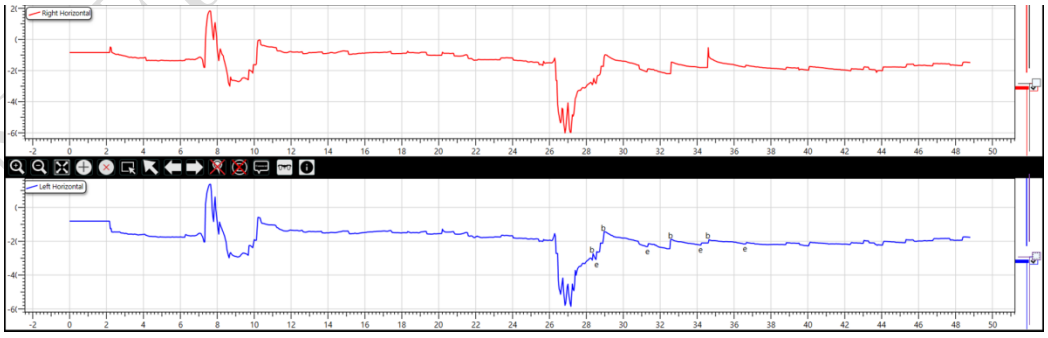

Figure 3. Representative VOG waveform in a patient with vestibular migraine demonstrating post-rotatory nystagmus (both directions) with prolonged slow-phase velocity decay, indicating vestibular hyper-reactivity characteristic of this condition.

3.3 Post-Rotatory Nystagmus: Non-Vestibular Migraine vs. Normal

Table 2 presents the comparison of PRN prevalence in non-vestibular migraine patients against normal subjects.

Table 2. Post-Rotatory Nystagmus in Non-Vestibular Migraine vs. Normal Subjects

Group	PRN Positive n (%)	PRN Negative n (%)	Total	P-value
Non-Vestibular Migraine	25 (43.1%)	33 (56.9%)	58	0.008
Normal	4 (14.3%)	24 (85.7%)	28	–
Total	29	57	86	

Non-vestibular migraine patients also demonstrated significantly elevated PRN positivity (43.1%, 25/58) compared with normal subjects (14.3%, 4/28; $p = 0.008$). This finding suggests a subclinical vestibular activation component even in migraine patients not fulfilling formal vestibular migraine diagnostic criteria, possibly reflecting shared central sensitization mechanisms.

3.4 BPPV – Right Posterior Semicircular Canal

In patients with right PSCC BPPV, the 180-degree rotation elicited characteristic per-rotatory nystagmus with a paroxysmal burst of mixed vertical-torsional nystagmus consistent with posterior canal activation. Post-rotatory nystagmus demonstrated an asymmetric pattern, with the direction and amplitude consistent with an ipsilesional (right-sided) posterior canal origin. VOR suppression was preserved, distinguishing this from central pathology.

3.5 BPPV – Lateral Semicircular Canal (Geotropic Variety)

In patients with LSCC BPPV (geotropic variety), chair rotation produced a characteristic direction-changing horizontal post-rotatory nystagmus that beat toward the ground (geotropic) on both clockwise and counterclockwise rotations, consistent with canalithiasis of the lateral SCC. The pattern was distinctly different from normal subjects and from PSCC BPPV, reflecting free-floating otolith debris within the lateral canal ampulla.

3.6 Meniere's Disease

In Meniere's disease patients, rotational testing revealed unidirectional post-rotatory nystagmus with asymmetric SPV, reflecting reduced peripheral vestibular drive from the hydropic labyrinth. Valsalva maneuvers performed during VOG recording unmasked Valsalva-induced nystagmus (SPV 10.36°/s, right horizontal), consistent with the pressure-sensitive endolymphatic hydrops mechanism. VOR suppression was impaired in proportion to vestibular paresis severity.

3.7 Summary of VOG Findings by Diagnosis

Table 3 provides a consolidated summary of VOG parameters across all diagnostic groups, highlighting the distinctive pattern for each condition.

Table 3. Summary of VOG Parameters by Diagnosis

Diagnosis	Per-Rotatory Nystagmus	Post-Rotatory Nystagmus	VOR Suppression	Key Feature
Normal Subjects	Present (bilateral)	Absent	Intact	No PRN; good VOR-S
Vestibular Migraine	Present	Positive (59.5%)	Mildly impaired	Post-rotatory nystagmus
Non-Vestibular Migraine	Present	Positive (43.1%)	Variable	Subclinical vestibular activation
Right PSCC BPPV	Present	Present	Intact	Paroxysmal

				vertical/torsional burst
LSCC BPPV (Geotropic)	Present	Geotropic horizontal	Intact	Direction-changing horizontal PRN
Meniere's Disease	Asymmetric	Unidirectional	Impaired	SPV asymmetry; Valsalva-triggered

4. Discussion

This study demonstrates that the 180-degree clinical chair rotation test, combined with portable VOG recording, provides diagnostically informative vestibular parameters across a spectrum of peripheral vestibular disorders. The three core parameters — per-rotatory nystagmus, post-rotatory nystagmus, and VOR suppression — contribute complementary diagnostic information.[2,7].

The physiological basis of this test rests on cupuloendolymph mechanics of the semicircular canal system. Rapid 180-degree rotation creates transient endolymph deflection of the cupula, generating a VOR that drives compensatory eye movements. The magnitude and duration of evoked nystagmus reflect the functional integrity of the peripheral vestibular end-organ and its central connections. Unlike sinusoidal harmonic acceleration (SHA) testing performed in motorised chairs, the 180-degree impulsive step rotation delivers a broadband stimulus that activates multiple frequency-tuned VOR pathways.

The significantly higher rate of PRN in vestibular migraine patients (59.5% versus 14.3% in controls; $p < 0.001$) aligns with evidence implicating central vestibular sensitization as a core mechanism in VM. [8,10].The trigeminovascular system modulates brainstem vestibular nuclei

activity, resulting in prolonged neural discharge following rotational stimulation — reflected as persistent post-rotatory nystagmus in VOG recordings. Even non-vestibular migraine patients showed elevated PRN rates (43.1%; $p = 0.008$), suggesting a continuum of vestibular involvement in migraine and raising the possibility that rotational testing may serve as an objective biomarker for vestibular sensitization.[8,10].

The distinctive nystagmus patterns elicited in PSCC BPPV and LSCC BPPV mirror established biomechanical models of canalith repositioning. In PSCC BPPV, the rotational stimulus produces mixed torsional-vertical nystagmus congruent with ipsilateral posterior canal activation. In contrast, LSCC BPPV demonstrates geotropic direction-changing horizontal nystagmus reflecting ampullofugal deflection of the lateral cupula by free-floating debris.In Meniere's disease, rotational VOG demonstrated SPV asymmetry, reflecting reduced vestibular gain of the hydropic labyrinth [9,11].An advantage of rotational testing in Meniere's disease lies in its ability to track central compensation — progressive normalization of VOR asymmetry as the central vestibular system adapts to unilateral peripheral hypofunction.

From a clinical utility perspective, the 180-degree test offers several advantages over conventional motorized ROT. It requires no specialized capital equipment beyond a portable VOG device and rotating chair, making it deployable in community clinics and resource-limited settings. The manoeuvre can be performed by a single trained examiner in under five minutes, with results immediately interpretable in office.The test complements clinical examination, head impulse test (HIT), and caloric testing by providing additional information about central vestibular compensation and bilateral function.

Limitations of the present study include the modest sample size in diagnostic subgroups, cross-sectional design, and absence of inter-rater reliability data. Manual delivery of the rotational stimulus introduces some variability in angular velocity compared with motorized systems. Future studies should establish normative age-stratified thresholds, assess test-retest reliability, and explore utility in central vestibular pathology and post-treatment monitoring.

5. Conclusions

The 180-degree clinical chair rotation test represents a simple, intuitive, and clinically practical tool for the assessment of peripheral vestibular function. When coupled with portable video-oculography, it enables reliable characterisation of per-rotatory nystagmus, post-rotatory nystagmus, and VOR suppression - parameters that collectively facilitate lesion lateralization and diagnosis across a broad spectrum of vestibular disorders.The significantly elevated post-rotatory nystagmus in both vestibular and non-vestibular migraine supports its role as a sensitive marker of central vestibular sensitization. Larger prospective multicenter studies are required to establish robust normative data, disease-specific diagnostic thresholds, and longitudinal validity.

Declarations

Conflicts of Interest: The author declares no financial relationships or conflicts of interest relevant to the subject of this article.

Ethical Approval: Informed consent was obtained from all participants. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Funding: No external funding was received for this study.

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