NORMATIVE DATA AND TEST-RETEST RELIABILITY OF THE SINUSOIDAL HARMONIC ACCELERATION TEST AND VELOCITY STEP TEST

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INTRODUCTION

Rotatory chair testing is a component of the vestibular test battery. It has primarily been used for analyzing the vestibulo-ocular reflex (VOR) during angular stimulation of the horizontal semicircular canals.

Standard rotational testing involves Sinusoidal Harmonic Acceleration test (SHAT) and Velocity-step test (VST) for evaluation of the horizontal semicircular canal function. SHAT presents stimuli at several sinusoidal frequencies where gain, phase and symmetry of eye movements are analyzed, while VST provides constant velocity stimulation after rapid-onset acceleration followed by rapid deceleration and time constant is recorded.

Rotatory chair has many clinical applications. It is considered the "gold standard" in the evaluation of bilateral vestibular lesions and can be used to assess vestibular central compensation following acute vestibular dysfunction.

The VOR changes as a function of age is a controversial topic and studies of rotatory chair SHAT and VST are limited in literature with variable normal ranges for the test parameters from lab to lab.

AIM OF THE WORK

The aim of the work was to establish normative data on the SHAT and VST. Additionally, the test-retest reliability of the different response parameters characterizing those two rotational paradigms was discussed.

SUBJECTS AND METHODS

One hundred healthy subjects were enrolled in this study ranging in age from 20 to 67 years with normal peripheral hearing or mild presbycusis, normal bedside tests and normal videonystagmography (VNG) test battery. Exclusion criteria included history of ear disease, otologic surgery, hearing impairment, vestibular complaints and migraine headache.

Subjects were divided into two groups; group A included 50 subjects below 50 years of age and group B included 50 subjects 50 years of age or above. A group of thirty subjects (30%) were tested twice, with a two or three week interval between the two test sessions, to evaluate the test-retest reliability. Reliability was assessed using intraclass correlation coefficient (ICC).

Subjects underwent SHAT and VST. SHAT was presented at frequencies 0.02, 0.04, 0.08, 0.16, 0.32 and 0.64 Hz with a peak velocity of 60°/s. VST used maximum velocity of 100°/s with acceleration and deceleration of 200°/s2.

RESULTS

Table 1: Normative data of rotatory SHAT gain (%), phase (deg/sec) and symmetry (%) for the total sample.

	Gain	Phase	Symmetry
0.02 Hz			
Min. – Max.	20.0 – 68.50	189.4 – 223.1	0.0 – 29.0
Mean ± SD.	37.74 ± 10.13	201.8 ± 6.82	7.71 ± 5.85
95% C.I for mean	35.73 – 39.74	200.5 – 203.2	6.55 – 8.87
0.04 Hz			
Min. – Max.	25.0 – 73.0	173.7 – 201.0	0.0 – 30.0
Mean ± SD.	44.65 ± 10.44	186.9 ± 5.29	7.36 ± 5.67
95% C.I for mean	42.58 – 46.72	185.8 – 187.9	6.24 – 8.48
0.08 Hz			
Min. – Max.	27.0 – 76.0	160.3 – 189.4	0.0 – 26.0
Mean ± SD.	46.39 ± 11.65	175.0 ± 5.07	6.56 ± 5.77
95% C.I for mean	44.07 – 48.70	174.0 – 176.0	5.41 – 7.71
0.16 Hz			
Min. – Max.	26.50 – 69.0	149.1 – 175.0	0.0 – 26.0
Mean ± SD.	47.34 ± 10.86	163.3 ± 4.83	7.69 ± 5.67
95% C.I for mean	45.18 – 49.50	162.4 – 164.3	6.56 – 8.82
0.32 Hz			
Min. – Max.	29.50 – 77.50	123.8 – 157.7	0.0 – 20.0
Mean ± SD.	51.62 ± 12.09	139.6 ± 6.15	7.17 ± 4.89
95% C.I for mean	49.22 – 54.01	138.4 – 140.9	6.20 – 8.14
0.64 Hz			
Min. – Max.	40.50 – 99.50	47.70 – 111.1	0.0 – 27.0
Mean ± SD.	71.15 ± 13.49	82.24 ± 12.65	7.02 ± 6.08
95% C.I for mean	68.47 – 73.82	79.73 – 84.75	5.81 – 8.23

SD: Standard deviation   **CI:** Confidence interval

Table 2: Normative data and Comparison between the two studied groups according to VST time constant (TC)

VST	Total	Group A	Group B	P
Per CW TC				
Min. – Max.	9.0 – 26.60	9.0 – 26.60	9.60 – 23.80	
Mean ± SD.	15.38 ± 3.73	15.0 ± 4.04	15.76 ± 3.38	0.308
95% C.I for mean	14.64– 16.12	13.85– 16.15	14.80– 16.72	
Post CW TC				
Min. – Max.	9.90 – 30.0	9.90 – 30.0	13.50 – 26.60	
Mean ± SD.	18.11 ± 4.54	16.77 ± 4.87	19.46 ± 3.77	0.003*
95% C.I for mean	17.21– 19.01	15.39– 18.15	18.39– 20.53	
Per CCW TC				
Min. – Max.	8.0 – 27.0	8.10 – 23.60	8.0 – 27.0	
Mean ± SD.	13.61 ± 3.49	13.14 ± 3.70	14.08 ± 3.23	0.178
95% C.I for mean	12.92– 14.30	12.09– 14.19	13.16– 15.0	
Post CCW TC				
Min. – Max.	8.30 – 27.80	8.30 – 23.80	8.90 – 27.80	
Mean ± SD.	17.75 ± 4.60	16.18 ± 3.84	19.31 ± 4.80	0.001*
95% C.I for mean	16.83– 18.66	15.09– 17.27	17.94– 20.67	

CW: clockwise   **CCW:** counter clockwise   **TC:** time constant   *: $p \leq 0.05$

CONCLUSION

- Normative data for SHAT and VST were constructed in our laboratory as a baseline to interpret VOR function with no significant age related differences in VOR gain, phase and symmetry for SHAT.
- Additionally, there was no significant age related difference in per rotatory time constant, however post rotatory time constant for both CW and CCW directions was significantly longer for the older group.
- ICC values indicated better reliability for SHAT parameters for the lower frequencies (0.02 to 0.16 Hz) than the higher frequencies and moderate reliability for VST time constant.