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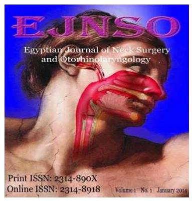

Vestibular Rehabilitation Therapy Outcome In Patients with Unilateral Peripheral Vestibular Disorders

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ABSTRACT

Objective: To study the efficacy of the rotational chair (RC) testing versus the self-assessment questionnaire (Dizziness Handicap Inventory = DHI)) in monitoring the vestibular rehabilitation therapy in patients with unilateral peripheral vestibular disorders. **Study Design:** Prospective Study. **Setting:** Clinical tertiary care vestibular function test centre. **Patients:** 20 patients (9 male and 11 females with documented unilateral peripheral vestibular lesion evaluated with history taking, bedside examination, Electronystagmography (ENG) and rotational chair testing tests. **Intervention:** Clinical, DHI, Caloric and RC tests, vestibular rehabilitation therapy (VORX1 and VORX2) **Materials and Methods:** Two groups: control and study groups; Study group was selected according to the following criteria: Recent onset of vertigo spells (2-10 months prior to the enrolment in this study), documented unilateral caloric weakness. Patients suffering from Diabetes Mellitus, hypertension and neurological deficits were excluded. DHI which designed to evaluate the patient's functional, physical and emotional status was conducted by the entire study group. Caloric testing was performed with standard bithermal irrigations of 30°C and 44°C for 45 seconds. The rotational chair testing paradigms used in this study were: A): The Rotational Sinusoidal Harmonic Acceleration (SHA) Test and; B): The Rotational Velocity Step (RVS) Test. Customized vestibular rehabilitation therapy program in the form of VORX1 and VORX2 was given to 15 patients out of 20 patients.

Results: In terms of demographic characteristics of the study group (20 patients), the age range was 23 - 54 years, and the gender distribution was 9 males and 11 females, the most common cause of dizziness was Vestibular Neuritis (30 %), followed by Ménière's Disease (25 %). DHI demonstrated that most of patients showed moderate to moderatlysevere degree of handicap; furthermore, most of patients showed moderate handicap as regard functional, physical and emotional status. Caloric test results revealed that all patients had abnormal caloric test. There was insignificant correlation between the rotational chair test findings and the self-assessment questionnaire (DHI) findings, but the DHI showed a significant improvement in patients received vestibular rehabilitation therapy as regard physical, functional and emotional scores

Conclusion: In summary, Rotational Chair testing is sensitive measure to quantify the presence of dysequilibrium; moreover, vestibular rehabilitation therapy is an effective line of treatment in patients with peripheral vestibular disorders.

Introduction

Dizziness and vertigo are among the most common symptoms causing patients to visit a physician. Falling can be a direct consequence of dizziness, and the risk is compounded in elderly persons with other neurologic deficits and chronic medical problems. The incidence of falling is 25% in subjects older than 65 years. The overall incidence of dizziness, vertigo, and imbalance is 5-10%, and it reaches 40% in patients older than 40 years (1).

Hain et al. (2000) reported that the human vestibular system is made up of three components: a peripheral sensory apparatus, a central processor, and a mechanism for motor output. The peripheral apparatus consists of a set of motion sensors, which send information to the central nervous system, specifically the vestibular nucleus complex and the cerebellum. This information includes head angular velocity, linear acceleration, and orientation of the head with respect to the gravitational axis. The central nervous system processes these signals and combines them with other sensory information to estimate head orientation (2).The output of the central vestibular system goes to the ocular muscles and spinal cord to serve two important reflexes, the vestibulo-ocular reflex (VOR) and the vestibulo-spinal reflex (VSR). The VOR generates eye movements, which enable clear vision while the head is in motion. The VSR generates compensatory body movement in order to maintain head and postural stability, thereby preventing falls (2).

The peripheral vestibular deficit is defined as any disease process that results in damage, either partial or complete, to only one side or both sides of the peripheral vestibular system involving the vestibular end organs and/ or the vestibular nerve (3). Zee (1998) found that peripheral vestibular disorders represent the most common cause of vertigo (4). The clinical presentation of vertigo and dizziness of vestibular origin are so complex and confusing for both the patient and clinician. The present lines of treatment for the peripheral vestibular disorders include medical, surgical or through vestibular rehabilitation therapy (5).

Vestibular rehabilitation exercises are specific form of physical therapy designed to promote habituation and compensation for a wide variety of balance disorders. The goal of Vestibular rehabilitation exercises is to improve balance minimize falls, and decrease dizziness by restoring normal vestibular functions and promoting mechanisms of central adaptation and compensations (6).

The rotational chair testing is a test in which sequences of sinusoidal angular velocity signals at several test frequencies are applied for evaluation of the VOR function (7). Shepard (2001) reported that rotational tests can be classified into two types: passive rotational tests and active rotational tests. Rotatory chair testing has been used to expand the evaluation of the peripheral vestibular system as it can stimulate frequencies in the 0.01 to 1.28 Hz which are considered more physiologic frequencies. It provides an adjunct to caloric test which stimulates frequencies in the 0.002 - 0.004 Hz (8).

This prospective study was designed to discuss the Vestibular Rehabilitation Therapy Outcome In patients with unilateral peripheral vestibular disorders as monitored subjectively by the Dizziness Handicap Inventory (DHI) and objectively by the rotatory chair testing.

Materials & Methodology:

This study was carried out in the audiology unit, El-Demerdash Hospital, ENT department, Ain-Shams University, Egypt. There were two groups, control and study groups, the control group consisted of 20 normal healthy volunteers (10 males and 10 females), their ages ranged from 22-56 years with mean age of 38 years, they were selected from nurses, medical students and relatives accompanying patients …etc. They were selected according to the following criteria: No history of vertigo, ear disease or intake of ototoxic medications, no history of systemic diseases/ visual loss or neurological disorders, with normal hearing sensitivity.

The study group consisted of 20 patients, 9 males and 11 females. Their ages ranged from 23-54 years with a mean age of 40.9 years. They suffered from peripheral vestibular disorders suggested by history and bedside neuro-otologic examination and documented by abnormal caloric test. They were selected according to the following criteria: recent onset of vertigo spells (2-10 months prior to the enrolment in this study), documented unilateral caloric weakness. Patients suffering from Diabetes Mellitus, hypertension and neurological deficits were excluded.

The final diagnosis was made based on the combination of detailed history taking, bedside neuro-otologic examination, audiologic evaluation, vestibular assessment and radiologic studies as clinically indicated. All the study group were submitted to the following:

l-History Taking: Full history was taken from all patients with the emphasis on the vertigo as regards its onset, course, duration and severity of the attacks, history of medical conditions or medical treatment and its effect on the control of the condition.

2-Dizziness Handicap Inventory (DHI): Jacobson and Newman (1991) developed the dizziness handicap inventory (DHI) at 1989. It was translated in Arabic language by El-Gohary et al. (2000) (13). All the patients were asked to answer this questionnaire, which consisted of 25 questions. These questions were designed to evaluate the patient functionally, physically and emotionally. The scoring involved the following: a (yes) response was given 4 points; (sometimes) response was given 2 points and 0 point for (no). Total maximum possible score was 100% for a significant self-perceived Handicap, 0 % suggested no handicap. In attempt to evaluate the degree of handicap, a score up to 25 % considered mild handicap, 25 - 50 % was moderate handicap, 50 - 75 % was moderately severe and > 75 % was severe handicap.

3-Otological examination and basic audiological evaluation,

4-Electronystagmography (ENG): It was performed using a computerized 4-channel ENG Micromedical system and an aquamatic caloric stimulator unit. ENG test battery was: Oculomotor tests, positional/ positioning tests, and caloric test. Caloric test done with standard bithermal irrigations of 30° and 44° for 45 seconds each in the following order: L30 degrees, R30 degrees, R44 degrees, and L44 degrees. Caloric test variables used in this study were the percentage of CW as calculated using the Jongkees Index formula and TES of all 4 irrigations.

5-The Rotational Chair Testing: It was performed using a Micromedical Technologies System 2000 with the standard commercially available software (4 Channel Spectrum S1.0.3) for test analysis. The patient was positioned and secured to the RC housed in a darkened booth with the patient's head restrained and adjusted so that both lateral semi-circular canals were close to the plane of stimulus. During rotation, the patient was instructed to keep his/ her eyes open and was given appropriate mental alerting tasks. First, the Sinusoidal Harmonic Acceleration (SHA) test of the VOR was performed; the VOR gain (ratio of the amplitude of peak slow-component eye velocity versus head velocity), phase (timing relationship between eye and head velocity), and symmetry (comparison of eye velocity during rightward vs. leftward rotation) were measured at 0.01, 0.02, 0.04, 0.08, 0.16, 0.32, and 0.64 Hz, with a peak angular velocity of 60 degrees/s.

After SHA testing, the rotational velocity step (RVS) test was performed using 100-degrees/s velocity steps to the right (clockwise) and left (counter-clockwise). The entire procedure was performed with both clockwise and counter-clockwise initial rotation with 2 bursts of nystagmus for each rotation: 1) per-rotary nystagmus, which starts with the initial acceleration of the chair, and 2) post-rotary nystagmus, which starts with the complete stop of the chair. The derived parameter is the time constant (Tc), which represents the time in seconds for the nystagmus slow-component velocity to decay to 37% of its peak value. Overall, 4 time constants were identified for each patient.

6-Customized vestibular rehabilitation therapy program: It was done for only 15 patients out of 20 patients as the patients with Meniere's disease were excluded. The program was conducted in self-directed program in which the patients perform customized therapy activities in their homes. Patients who were selected for the self-directed program had instruction session at the beginning to instruct, teach and make sure that the patient understood the appropriate way to do the exercises. The program was done for 6 weeks through which some patients were followed up by telephone and other by infrequent follow up visits to the vestibular clinic.

The vestibular rehabilitation program used in this study was a customized program to correct or adjust VOR deficiency in the form of VOR stimulation exercises (VORXI and VORX2). VORX1 means a head movement exercise through which the head moves in phase with the target (Figure 1A), while the VORX2 means a head exercise through which the head moves out of phase with the target (Figure 1B). The program began directly after testing as following: VORXl applied for 3 weeks and VORX2 applied for another 3 weeks.

7-After six weeks of rehabilitation, the group of patients who were received vestibular rehabilitation program were re-examined using the following:

-The DHI questionnaire which was used before treatment to evaluate the efficacy of the program subjectively.

-Rotational chair testing for evaluation the efficacy of the program objectively.

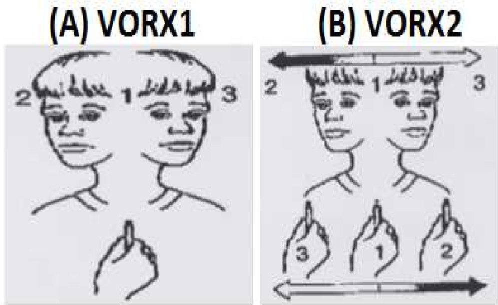


Figure (1): [A] VORXl in which the visual target is stationary, and the subject moves his head back and forth while trying to maintain visual fixation on the target. [B] VORX2 in which the visual target and the head move in the opposite directions while the subject keeps the target in focus {Quoted from Tusa et al.(1993)} (9).

Statistical analysis:

The SPSS® version 13.0 for Windows (SPSS Inc., Chicago, IL) was used. Results are presented as percentage, mean and standard deviation (SD). Paired *t*-test was used to compare results between the study group and the control group. Level of significance was set at $p \leq 0.05$.

Results:

Demographic Criteria:

Table (1) demonstrates the demographic characteristics of the study group (20 patients), the age range was 23 - 54 years, and the gender distribution was 9 males and 11 females. In terms of distribution of patients according to the final clinical diagnosis; this study demonstrated that the most common cause of dizziness was Vestibular Neuritis (30 %), followed by Ménière's Disease (25 %).

Table (1): Demographic Criteria.

Features	Study Group
Age (years): Range: Mean + SD:	 23 - 54 40.95 ± 10
Gender: Men: Women:	 9 11
Final Clinical Diagnosis: N. (%)	Ménière's Disease, 5 (25 %) Vestibular Neuritis, 6 (30 %) Labyrinthitis, 3 (15 %) Acoustic Neuroma, 2 (10 %) Unidentified, 4 (20 %)
Total Number:	20

Self-assessment Questionnaire (DHl) findings:

All the study group were asked to answer the Dizziness Handicap Inventory (DHI) questionnaire, which consisted of 25 questions, these questions were designed to evaluate the patients functionally, physically and emotionally.

Table (2): Distribution of patients according to the degree of handicap:

Degree of handicap (DHI Scores)	Number of Patients	Percentage of Patients
Mild (< 25%)	4	20 %
Moderate (25 – 50 %)	8	40 %
Moderatlysevere (50 – 75 %)	6	30 %
Severe (> 75%)	2	10 %

Table (2) demonstrates that most of patients showed moderate to moderatlysevere degree of handicap.

Table (3): Distribution of patients according to the percentage of functional, physical and emotional scores.

DHI Scores	Physical		Functional		Emotional	
	Number	%	Number	%	Number	%
Mild	3	15 %	4	20 %	6	30 %
Moderate	9	45 %	10	50 %	7	35 %
Mod-Severe	6	30 %	5	25 %	4	20 %
Severe	2	10 %	1	5 %	2	10 %

Table (3) demonstrates that most of patients showed moderate handicap as regard functional, physical and emotional status.

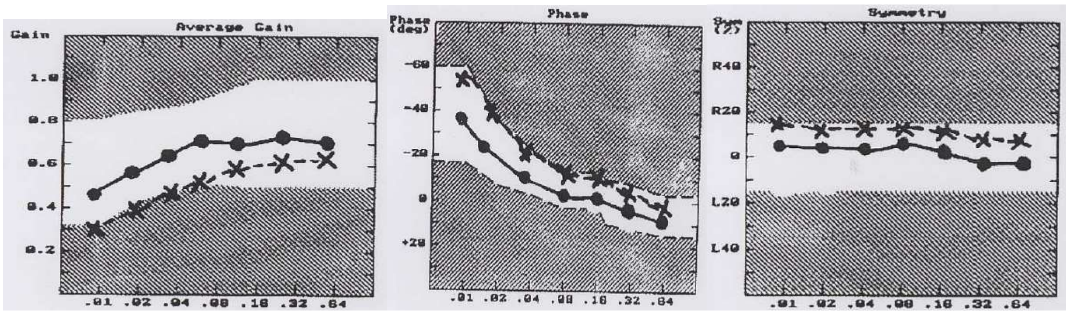
Electronystagmography Test:

Table (4): Distribution of the study group according to the ENG findings:

Study Group	Oculomotor Test		Positional/ Positioning Tests		Caloric Test	
	Normal	**Abnormal**	**Normal**	**Abnormal**	**Normal**	**Abnormal**
20	20	0	20	0	0	20

Table (4) demonstrated that all patients had normal results in oculomotor testing, positional and positioning tests. Caloric test results revealed that all patients had abnormal caloric test.

Rotational Chair Test:



Gain **Phase** **Symmetry**

●—●: Control group
X—X: Study group

Figure (2): Gain, phase and symmetry of the Sinusoidal Harmonic Acceleration (SHA) test in the study group as compared to the control group.

Table (5): Mean (X), Standard Deviation (S.D), t- and P- values of the Rotational Velocity Step (RVS) test parameters (Gain, Time constant) for the study group as compared to the control group:

Rotatory Velocity Step Test			Study gp.		Control gp.		t-Value	P-Value
			X	**S.D**	**X**	**S.D**		
Clock-Wise	**Per-Rotatory**	**Gain**	0.44	0.09	0.64	0.12	6.01	< 0.05
		T.C	11.8	2.94	16.6	2.39	5.73	< 0.05
	Post-Rotatory	**Gain**	0.44	0.08	0.56	0.09	4.98	< 0.05
		T.C	13.5	2.74	16.4	2.94	2.89	< 0.05
Counter Clock-Wise	**Per-Rotatory**	**Gain**	0.49	0.09	0.63	0.13	3.67	< 0.05
		T.C	13.3	3.85	16.9	2.68	3.77	< 0.05
	Post-Rotatory	**Gain**	0.42	0.09	0.56	0.09	4.35	< 0.05
		T.C	13.3	2.51	16.8	2.37	6.05	< 0.05

Table (5) showed statistically significant difference between the study group and the control group in terms of gain and time constant of the Pre- and Post-rotatory clockwise and counter clockwise rotation.

Correlation between Rotational Chair Test and DHI:

Table (6): Correlation between the Sinusoidal Harmonic Acceleration (SHA) Test findings and self-assessment questionnaire (DHI) findings:

SHA Test		DHI	
		r	**P**
Gain	**0.01**	- 0.063	> 0.05
	0.02	0.224	> 0.05
	0.04	0. 193	> 0.05
	0.08	- 0.156	> 0.05
	0.16	0.506	> 0.05
	0.32	0.597	> 0.05
	0.64	-0.259	> 0.05
Phase	**0.01**	- 0.119	> 0.05
	0.02	- 0.119	> 0.05
	0.04	0. 145	> 0.05
	0.08	- 0.33	> 0.05
	0.16	0.067	> 0.05
	0.32	0.125	> 0.05
	0.64	0.198	> 0.05
Symmetry	**0.01**	- 0.305	> 0.05
	0.02	0.093	> 0.05
	0.04	-0.140	> 0.05
	0.08	- 0.430	> 0.05
	0.16	0.104	> 0.05
	0.32	-0.139	> 0.05
	0.64	0.300	> 0.05

Table (6) showed insignificant Correlation between the Sinusoidal Harmonic Acceleration (SHA) test findings and self-assessment questionnaire (DHI) findings.

Table (7): Correlation between the Rotatory Velocity Step (RVS) test findings and the self-assessment questionnaire (DHI) findings:

Rotatory Velocity Step Test			DHI	
			r	P
Clock-Wise	Per-Rotatory	Gain	0.024	> 0.05
		T.C	-0.207	> 0.05
	Post-Rotatory	Gain	-0.646	> 0.05
		T.C	0.057	> 0.05
Counter Clock-Wise	Per-Rotatory	Gain	0.390	> 0.05
		T.C	0.629	> 0.05
	Post-Rotatory	Gain	0.390	> 0.05
		T.C	-0.151	> 0.05

Table (7) showed insignificant Correlation between the Rotatory Velocity Step (RVS) test findings and the self-assessment questionnaire (DHI) findings.

Pre- and Post-Vestibular Rehabilitation Therapy:

Table (8): Self-assessment questionnaire (DHI) in pre and post vestibular rehabilitation:

	Pre-Vestibular Rehabilitation		Post-Vestibular Rehabilitation		t-Value	p- Value
	X	S.D	X	S.D		
Physical	19.27	4.31	6.72	3.82	11.59	< 0.05
Functional	21.27	6.21	7.72	4.12	8.01	< 0.05
Emotional	15.63	5.78	3.45	4.82	11.49	< 0.05
Total	56.18	14.5	17.30	10.60	13.70	< 0.05

Table (8) showed a significant improvement in patients received vestibular rehabilitation therapy as regard physical, functional and emotional scores.

<u>Table (9):</u> Mean (X), Standard Deviation (SD), t – and P – values of VOR Gain, phase and symmetry in the study group (pre- and post-vestibular rehabilitation):

SHA Test		**Pre-Vestibular Rehabilitation**		**Post-Vestibular Rehabilitation**		**t-Value**	**P-Value**
		X	**S.D**	**X**	**S.D**		
Gain	**0.01**	0.30	0.04	0.36	0.05	6.29	<0.05
	0.02	0.41	0.05	0.47	0.06	4.31	<0.05
	0.04	0.48	0.05	0.54	0.07	6.94	<0.05
	0.08	0.56	0.11	0.58	0.06	0.86	> 0.05
	0.16	0.59	0.09	0.61	0.05	0.38	>0.05
	0.32	0.66	0.12	0.64	0.06	0.61	>0.05
	0.64	0.67	0.11	0.67	0.10	0.00	>0.05
Phase	**0.01**	-55.18	15.61	-52.45	14.27	2.75	>0.05
	0.02	-32.81	8.38	-32.27	8.27	0.62	>0.05
	0.04	-18.81	6.11	-19.63	5.02	1.09	>0.05
	0.08	-8.09	3.17	-8.36	3.04	1.00	>0.05
	0.16	-7.72	3.95	-7.90	4.43	0.21	>0.05
	0.32	-4.27	4.56	-3.63	2.41	0.67	>0.05
	0.64	2.36	2.33	1.81	1.72	1.32	>0.05
Symmetry	**0.01**	11.63	12.33	4.18	3.94	2.66	<0.05
	0.02	9.72	9.90	5.72	5.33	2.39	>0.05
	0.04	9.45	9.03	6.54	5.20	1.23	>0.05
	0.08	9.45	10.20	5.27	4.77	2.01	>0.05
	0.16	10.72	7.43	6.81	5.23	2.57	<0.05
	0.32	9.36	8.17	5.45	5.87	1.55	>0.05
	0.64	8.09	3.38	4.18	4.37	4.30	<0.05

Table (9) showed a significant improvement of gain at low frequencies (0.01, 0.02 and 0.04) with insignificant improvement in phase and variable significant in symmetry between the pre- and post-vestibular rehabilitation.

Table (10): Mean (X), Standard Deviation (SD), t- and P- values of rotatory velocity step test in the study group for pre- and post-vestibular rehabilitation:

Rotatory Velocity Step Test			Before		After		t-Value	P-Value
			X	**S.D**	**X**	**S.D**		
Clock-Wise	**Per-Rotatory**	Gain	0.43	0.11	0.56	0.06	4.48	< 0.05
		T.C	11.6	3.2	12.2	2.42	3.31	> 0.05
	Post-Rotatory	Gain	0.43	0.07	0.56	0.06	3.34	< 0.05
		T.C	14.1	2.5	14.7	2.49	3.13	> 0.05
Counter Clock-Wise	**Per-Rotatory**	Gain	0.48	0.09	0.54	0.06	4.84	< 0.05
		T.C	14	3.8	14.2	3.5	0.82	> 0.05
	Post-Rotatory	Gain	0.4	0.07	0.51	0.06	4.99	< 0.05
		T.C	12.6	2.6	13.2	1.94	1.32	> 0.05

Table (10) showed a significant improvement of gain with insignificant improvement in time constant between pre- and post-vestibular rehabilitation.

Discussion:

The present study was conducted on 20 patients with definite unilateral peripheral vestibular lesion diagnosed and documented by classic history, bedside examination and unilateral caloric weakness. Table (1) demonstrated the demographic criteria of the study group, the mean age of the study group was 40.95 ± 10, and the gender was tilted towards females than males (55 % females and 45 % males). Tokumaso et al. (1995) reported that the peripheral vestibular disorders are more common in females than males (10). However, Kamal et al. (1995 and 1996) found slight increase of peripheral vestibular disorders among males (11, 12).

The present study showed that the most common cause of peripheral vestibular disorders is vestibular neuritis (30 %), followed by Ménière's disease (25%) (Table 1). El-Gohary et al. (2000) reported another observation in a similar study on patients with peripheral vestibular disorders in which the most common cause was BPPV (36 %) followed by Vestibular neuritis (30 %) (13), this observation could be attributed to the selection criteria of the study.

Electronystagmography (ENG) test showed abnormal caloric test in all patients (100%) (Table 4); Unilateral caloric weakness was considered when the difference in the mean maximum slow phase velocity exceeds 20 %. Haid et al. (1995) reported abnormal caloric test results in 54 % of patients with peripheral vestibular lesions (14); the same was reported also by Stahle (1991) (15). The difference between the current study and the other studies could be attributed to the selection criteria of the study group.

Rotational chair testing demonstrated abnormalities at the sinusoidal harmonic acceleration (SHA) test which done at frequencies of (0.01 - 0.64 Hz), it revealed reduced gain limited to low frequencies (0.01-0.08) (Figure 1), which agreed with findings reported by El-

Gohary et al. (2000) (13). There was also phase lead at all frequencies and asymmetry limited mainly to the low frequencies (0.01-0.04). This reduction in the VOR gain in peripheral vestibular disorders could be attributed to the loss of velocity storage mechanism which normally functions to maintain the vestibular response (16). The rotational velocity step (RVS) test (Table 5) demonstrated statistically significant difference between the control group and the study group in the gain and time constant of the Pre- and Post-rotatory clockwise and counter clockwise rotation.

In terms of the Dizziness Handicap Inventory (DHI), the self-assessment questionnaire, arabic version DHI (Designed by El-Gohary et al. 2000) was conducted to all subjects in the study group, the majority of patients (80%) showed moderate to moderatlysevere degree of handicap (Table 2). Also, most of patient's functional, physical and emotional scores were between moderate and moderatlysevere degree (Table 3). These results agreed with the results of El-Gohary et al. (2000) (13) and with Asai et al. (1993) (17). This finding suggested that unilateral peripheral vestibular disorders affect the daily life activities of the patients.

In this study, there was no correlation between the DHI and RVS test, also between the DHI and SHA test, Tables (6, 7). This could be attributed to that RVS and SHA tests are objective measures while the DHI is a subjective measure. These observations agreed with the study conducted by Shepard and Telian (1996) that showed a very poor correlation between DHI and results of tests that determine the site or degree of lesion (18).

In the context of the vestibular rehabilitation program for the study group, only 11 patients out of 15 patients whom received vestibular rehabilitation therapy were completed the re-evaluation visit which revealed that:

Only 9 patients (81. 9 %) were demonstrated statistically significant improvements in the SHA test as regard gain; this improvement in the form of significant difference in gain especially at low frequencies, without statistical significant difference in phase and variable significance difference in symmetry before and after vestibular rehabilitation therapy (Table 9). As regard the RVS test, there was statistically significant improvement in gain without significant difference in time constant (Table 10). This observation could be attributed to two reasons: (l) the saturation of inhibitory responses of the intact labyrinth persists; (2) Only partial recovery of velocity storage occurs.

All the study group showed statistically significant difference in the DHI questionnaire between pre and post vestibular rehabilitation therapy as regard physical, functional and emotional scores (Table 8). These results are in agreement with the results of El-Gohary et al. (1997) which reported that 100 % of patients showed improvement (19). Shepard et al. (1993) found that 85 % of patients had at least some reduction of symptoms after therapy compared with what was experienced before therapy (20).

In summary, the DHI questionnaire showed a significant improvement in the group of patients who received vestibular rehabilitation therapy as regard physical, functional and emotional scores. Accordingly we can conclude that Rotational Velocity Step (RVS) in conjunction with Sinusoidal Harmonic Acceleration (SHA) tests are sensitive measures to quantify the presence of dysequilibrium; moreover, vestibular rehabilitation therapy is an effective line of treatment in patients with peripheral vestibular disorders.

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