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ORIGINAL ARTICLE

Reliability, Validity and Sensitivity to Change of Turkish Dizziness Handicap Inventory (DHI) in Patients with Unilateral Peripheral Vestibular Disease

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Objective: The Dizziness Handicap Inventory (DHI) is a condition specific health status measure for patients with vestibular disease. The purpose of this study is to evaluate the internal consistency, test-retest reliability, construct validity and sensitivity to change of the DHI in people with peripheral vestibular disorder.

Materials and Methods: Thirty-three patients with unilateral peripheral vestibular disease were included in the study. For analysis of test-retest reliability, Turkish version of DHI inventory developed by "translation-back translation" method was performed to patients on the day of admission and one week after admission. To assess validity, patients were also evaluated with the visual Analog Scale (VAS), Romberg/tandem Romberg test (eyes open/closed), standing on foam (eyes open/closed), static posturography, five times sit to stand test (FTSTS), timed up to go test (TUG), gait speed, dynamic Gait Index (DGI), functional gait assessment (FGA) and Activities-specific Balance Confidence Scale (ABC). To assess sensitivity to change, 27 patients were involved in a 4 week customized vestibular rehabilitation program.

Results: Crohnbach alpha for DHI total was 0.92, Crohnbach alpha for emotional subscore was 0.83, Crohnbach alpha for functional subscore was 0.88 and Crohnbach alpha for physical subscore was 0.67. Although ABC showed significant correlation with DHI ($r=0.62$-0.53, $p<0.05$) no such a correlation was determined between DHI and other parameters ($p>0.05$). Significant improvement was achieved in DHI and other parameters by customized exercise program ($p<0.05$).

Conclusions: Although Turkish DHI scale showed high internal consistency and sensitivity change, its test-retest reliability and validity was relatively poor.

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Dizziness is one of the most prevalent complaints that cause people to seek medical care and responsible for 8 million primary care office visits annually.[1] Although observed in various diseases, it is a symptom most commonly observed in peripheral vestibular disease (up to 40%). [2,3]

Patients with peripheral vestibular disease frequently experience dizziness, gaze disturbances and balance disorders. These impairments disturb the patients' quality of life and restrict their daily activities. [4,5] Thus, it is imperative to detect the patients with dizziness and initiate the appropriate therapy. Conventional vestibulometric techniques (caloric testing, rotatory chair, posturagraphic testing) are inadequate for quantifying the impact of dizziness on everyday life.[6] Subjective assessment scales such as Visüal Analog Scale (VAS), Vertigo symptom scale is also used to evaluate dizziness.[7] Dizziness Handicap Inventory (DHI) is the most common scale used for patients with dizziness which was developed to evaluate the self-perceived handicapping effects imposed by vestibular system disease6 Dutch and Chinese translations of this scale have been prepared. [8,9] Despite its popular use, an equivalent Turkish version of the DHI for Turkish

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populations is not available yet. Therefore, the purpose of our study was to assess the validity, reliability and sensitivity to change of Turkish version of DHI.

Materials and Methods

All patients were reviewed by the board of consultant physicians from Ear-Nose and Throat, Neurology and Physical Medicine and Rehabilitation departments (The Dizziness Council) that assembled once a week to evaluate every patient with vertigo, dizziness and balance problems and patients that were eligible for the study and also appropriate for vestibular rehabilitation were recruited for the study. Among these, patients that were diagnosed to have peripheral vestibular dysfunction by neurological and otological examinations and vestibular function tests (electronystagmography, bithermal caloric test, ocular motor testing and positional testing) performed by a neuro-otologist or neurologist between January 2007 and July 2008 were included in the study.

Patients having any problem that could interfere with rehabilitation (ambulatory problems, restricted cervical movement [flexion, extension, lateral flexion and rotation less than 30°], a disorder affecting visual and somatosensorial system, cognitive, orthopedic or neurological disorders), those having fluctuating and intermittent vertigo, benign paroxysmal positional vertigo or having symptoms for less than two months were excluded. All vestibular suppressing medications used by the patients were stopped one week before the start of the study.

The DHI was translated into Turkish by three Turkish doctors (1 physical therapy and rehabilitation, 1 ENT, and 1 neurology specialist) who were proficient in English. They gathered to determine the translation that best reflected the meaning of English items. English back-translations from Turkish were done separately by two official linguists (1 native English speaker that can speak Turkish and 1 teacher of English literature who has lived in England for 15 years) that were uninformed about the original version. Finally, they gathered to discuss and decide for the translations. This final version was compared with the original English version, which appeared to be identical. This version was presented to 10 patients with central [3], bilateral [4], unknown etiology [3]. They were asked whether they could understand all items of the Turkish DHI. None of the patients in this initial group reported any problem about any item of the DHI.

Forty-five patients completed DHI at their first examination. Duration of the disease, concomitant diseases, migraine, social status, educational level, hearing capacity, use of spectacles and fall (within last 6 months) were recorded in the first visit either by face to face interview or from patient charts. These patients were also evaluated by visual analog scale (VAS) for imbalance, Romberg (eyes open and closed), tandem Romberg (eyes open and closed), standing on foam (eyes open and closed), Five Times Sit to Stand Test, Timed up to Go test, gait speed, Dynamic Gait Index (DGI), Functional Gait Assessment (FGA), Dizziness Handicap Questionnaire (DHI) and static posturography (Tetrax Interactive Balance System, Tetrax, Ramat Gan, and Sunlight Medical, Tel-Aviv, Israel).

Twelve of the 45 patients were lost to follow-up due to transportation problems or loss of interest. Therefore, one week after the first assessment, DHI could be performed to 33 patients for the second time to check for test-retest reliability. One-week time interval was chosen to minimize the effect of time on memory and due the possibility of substantial changes in the vestibular condition which could interfere with the results of the study.

Four weeks customized vestibular rehabilitation program was administered to evaluate the responsiveness (sensitivity to change). Six of the 33 patients were excluded as they could not complete the rehabilitation program. DHI questionnaire was performed to 27 patients that have completed the rehabilitation program and tests performed at the first visit [visual analog scale (VAS) for imbalance, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on a foam (eyes open, closed), 5 times squat-stand up test, timed up to go test, gait

speed, dynamic gait index (DGI), functional gait assessment (FGA) test, Activities-specific Balance Confidence Scale (ABC) and static posturography (Tetrax Interactive Balance System, Tetrax, Ramat Gan, and Sunlight Medical, Tel-Aviv, Israel)] were repeated.

Methods used for patient evaluation are described below.

Dizziness Handicap inventory (DHI): It is a multidimensional self-assessment scale that quantifies the level of disability and handicap in three subscales: physical, emotional and functional. It is possible to use both the total score and the scores of the three subscales separately. Scores range from 0 to 100, where 100 means high level of disability and handicap from symptoms of dizziness. A total score >60 in DHI signifies serious dizziness and greater risk of falling. A score between 0-30 and 31-60 shows mild and moderate dizziness, respectively. [6,10] The DHI has high internal consistency reliability (Crohnbach's alpha 0.89) and test-retest reliability (Pearson product-moment correlation 0.97). [6] Discriminant validity was demonstrated by the good association between number of dizziness episodes and DHI scores. Convergent validity was demonstrated by the high correlation coefficients between the total DHI score and eight dimensions of the generic questionnaire Short Form 36. [11,12]

Visual Analog Scale (VAS): A 10-cm visual analog scale (VAS) was used to assess the severity of imbalance. A vertically oriented 10 cm line was used for VAS, where "no imbalance" corresponds to the bottom of the line and "the worst imbalance that they could imagine" corresponds to the top of the line. Patients were instructed to place a mark on the 10-cm vertical line according to severity of their imbalance.

The Romberg test: Patients stood feet close to each other for 30 seconds, first with eyes open and then closed. Time in seconds was noted. [13]

Tandem Romberg test: The participants stood with one foot just in front of the other (heel to toe) for 30 second, first with eyes open and then closed. The time in seconds was noted.

Standing on foam: Subjects were asked to stand on a 12 cm thick, medium density foam pad measuring 45x45 cm (Neurocom International Inc., Clackamas,USA) first with eyes open, and then closed. The distance between two feet was approximately 5 cm. The time in seconds was noted.

Static posturography: Postural control was measured using the Tetrax Interactive Balance System (Tetrax, Ramat Gan, and Sunlight Medical, Tel-Aviv, Israel). This method of posturography is based on the assessment of the vertical pressure fluctuations on four independent force plates, each placed beneath the two heels and toe parts of the subject while standing in an upright position. The software of the system elaborates four basic parameters, obtained by standing in eight positions. Intensity of sway is measured by Fourier transformation across a spectrum of sway frequencies ranging from 0.01 to 3.00 Hz. The standard examination protocol includes standing for 32 seconds in each of the eight positions as follows: (i) head straight, eyes open, support solid; (ii) head straight, eyes closed, support solid; (iii) head straight, eyes open, support soft (foam rubber); (iv) head straight, eyes closed, support soft; (v) head turned to the right, eyes closed support solid; (vi) head turned to the left, eyes closed support solid; (vii) head up, eyes closed, support solid; and (viii) head down, eyes closed, support solid. Tetrax evaluates 8 positions and calculates a value called falling index. Falling index is expressed as a numeric value between 0 and 100, determined by stability of patient, Fourier conversion and synchronization results. "0" denotes no risk of fall while "100" denotes high risk of fall. Patients are classified into three groups as low risk (0-35), moderate risk (36-57) and high risk (58-100). Falling index was used for the evaluation. [14,15]

Five Times Sit to Stand Test (FTSTS) test: This test was performed by moving 5 times from sit to stand position from a 43 cm height chair as quickly as possible (floor to seat) with their arms folded. The time

in seconds was noted. The FTSTS is a valid measure of balance and lower extremity strength in older persons. [16] FTSTS has been previously used for people with vestibular dysfunction. [17]

Timed up to go test (TUG): Patients were asked to stand from a chair with armrest, walk for 3 meters and return to sitting position at their comfortable pace. The time in seconds was noted. Scores on the TUG test of 11.2 seconds or greater showed the highest sensitivity and specificity for identifying a fall history among people with vestibular dysfunction. [18]

Gait speed: Patients were asked to walk at their normal speed on a 6 meter-long pathway. The time in seconds was noted.

Dynamic gait index (DGI): Patients completed the 8 walking items of the DGI including walking on level surfaces, with a quick pivot turn, at different speeds, with head movements (pitch and yaw), over and around objects, and up and down steps. [19] Each item was scored on an ordinal scale (range 0-3) based on established descriptors with a maximum total score of 24. Scores less than 19 have been related to falls in people with vestibular disorders [20] and scores of less than 19 have been related falls in community-dwelling older people. [21] The DGI has good interrater reliability (K=0.64) in people with peripheral vestibular dysfunction. [22] The DGI was used to describe each patient's dynamic gait performance.

Functional gait assessment (FGA): The FGA is a 10-item gait test that comprises 7 of the 8 items from the original DGI and 3 new items, including "gait with narrow base of support", "ambulating back-wards" and "gait with eyes closed". Each item was scored on an ordinal scale (range 0-3) based on established descriptors with a maximum total score of 30. Intraclass correlation coefficients for interrater and intrarater reliability of the total FGA scores was 0.86 and 0.74 respectively; internal consistency of the FGA scores was 0.79 in patients with peripheral vestibular disorders. [23]

Activities-specific Balance Confidence (ABC) Scale: The ABC is comprised of 16 questions that ask people to rate how confident they are in maintaining their balance while performing specific tasks. [24] Scores range from 0 to 100, with 100 as the best score. People that have low levels of physical activity and higher risk of falling usually show lower scores (under 50). [25,26]

Exercise Program: An exercise program developed by physical medicine and rehabilitation specialist considering the history, physical examination and diagnostic tests were prescribed for the patients. This program consisted of training and exercise components. Functions of the balance system, causes of dizziness and rationale and contraindications for performing of exercise were explained during the training component. Patients were actively involved in adapting the exercise program to their symptoms, capabilities and lifestyle. The exercises were personalized by the physical medicine and rehabilitation specialist according to their symptoms and functional disability of the patient. The exercises were designed to be challenging during the training period, and different aspects of balance training were emphasized for different patients in order to individualize the exercises. Exercises given to the patients are summarized below:

Adaptation Exercises: To improve gaze stability, subjects were initially asked to move their heads in yaw rotation while focusing on a stationary hand-held target, "X1 viewing" and progressed to "X2 viewing" in which the target and the head rotated in equal and opposite yaw directions. Exercises were performed in horizontal and vertical planes 3 times a day for 1 minute each.

Substitution Exercises: Patients with little or no vestibular function were taught to substitute vision and somatosensation for their loss of vestibular function. For example, a patient might be instructed to fixate their gaze during ambulation to stabilize their walking and to decrease veering to the side, or to stand on the foam with eyes closed to keep balance. Substitution exercises could be modified to become increasingly more difficult as the patient improved.

Visual desensitization: Disturbances that the patients experienced during performance of their daily activities were determined. In patients reporting enhanced sensitivity or poor tolerance to self or visual motion, additional desensitization exercises were added.

Balance Exercises: Patients tried to restore balance while switching between static (eg. standing) and dynamic movements (e.g. walking) by altering visual, somatosensorial and vestibular impulses.

The exercise program consisted of 1 session per week for a period of 4 weeks, and each session lasted for approximately 30-45 minutes in the rehabilitation unit. All patients were followed-up once a week by the physical medicine and rehabilitation specialist.

In addition to the exercises performed in the hospital, all patients were given instructions with diagrams of exercises to be performed as home exercise program twice a day. Each home program was designed to take approximately 30 to 40 minutes. Home program comprised 4-5 substitution, habituation and balance exercises that the patients performed with difficulty at the rehabilitation unit.

During training period in the hospital, compliance was monitored by a physician. Home exercises were monitored with a chart that was filled every day by the patient.

Study was approved by the local ethics committee of our institution and informed consent forms were obtained from all of the patients that participated.

Statistical Analysis: Data were entered in the SPSS package, version 16.0. Descriptive statistics were used to characterize the sample. Cohen Kappa analysis was performed to assess item-specific test-retest reliability of DHI. For the consistency of whole scale, reliability analysis was performed, Crohnbach alpha coefficients were calculated and item total correlation was assessed. Correlation between subdivisions of scales and other parameters determined were assessed by Pearson correlation analysis. Paired T test was used to determine the effectiveness of the treatment. A p-value below 0.05 was considered as statistically significant.

Results

Study included 33 patients with unilateral peripheral vestibular disease. Demographical and clinical data of patients are presented in Table 1.

Table 1. Demographic and clinical data of patients

	n:33
Age (year, mean±SD)	50.09± 14.06
Gender (n, male, female)	11/22
Marital status (married, %)	81.8
Education (primary school, %)	60.6
Concomitant disease (%)	
Hypertension	57.6
Psychiatric disorder	12.1
History of migraine (present, %)	15.2
Hearing problem (present, %)	93.9
Use of spectacles (present, %)	81.8
History of fall within last 6 months (present,%)	48.5
Duration of disease (month, mean±SD)	40.21±42.93

The weighted kappa for individual item ranged from 0.160 to 0.917 (Table 2). Crohnbach alpha for DHI total was 0.92. Crohnbach alpha for emotional subscore of DHI scale was 0.83, Crohnbach alpha for functional subscore was 0.88 and Crohnbach alpha for physical subscore was 0.67.

DHI was compared with VAS imbalance, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on foam (eyes open, closed), static posturography (Tetrax Interactive Balance System, falling index), FTSTS, TUG, gait speed, DGI, FGA and ABC to assess its validity. Although DHI showed significant correlation with ABC ($r=0.62$-0.53, $p<0.05$) no such a correlation was observed between DHI and other parameters assessed ($p>0.05$, Table 3). Twenty-seven patients completed vestibular rehabilitation program. Turkish DHI total and emotional, physical and functional subscores and other parameters assessed showed significant improvement at the end of the 4 week customized exercise program ($p<0.05$, Table 4).

Table 2. Test-retest reliability of the Turkish DHI

	Weighted kappa
Question 1	0.421
Question 2	0.491
Question 3	0.160
Question 4	0.479
Question 5	0.460
Question 6	0.679
Question 7	0.418
Question 8	0.453
Question 9	0.555
Question 10	0.298
Question 11	0.512
Question 12	0.736
Question 13	0.714
Question 14	0.415
Question 15	0.646
Question 16	0.654
Question 17	0.568
Question 18	0.348
Question 19	0.613
Question 20	0.917
Question 21	0.669
Question 22	0.310
Question 23	0.699
Question 24	0.682
Question 25	0.449

DHI: Dizziness Handicap Inventory

Discussion

Our study showed that Turkish DHI scale provided high internal consistency and sensitivity to change in unilateral peripheral vestibular disease, but its test-retest reliability and validity was relatively poor.

In the original study [6], internal consistency reliability value for total score of DHI scale (Crohnbach alpha) was 0.89 and Crohnbach alpha for subscores ranged from 0.72 to 0.85, Crohnbach alpha for the total score of the Chinese translation of the scale 9 was 0.75, and subscores ranged from 0.64 to 0.87. Similar to other studies Crohnbach alpha for total score of Turkish DHI in our study was 0.92 and subscores ranged from 0.67 to 0.88. These results suggested that Turkish DHI provided high internal consistency.

Test-retest reliability for total score (r=0.97) and subscores (r= 0.92-0.97) were high in the original study. [6] Chinese version of DHI scale [9] showed test-retest reliability coefficient of 0.64- 0.85, most weighted kappa values (kappa W) exceeded 0.80 in Dutch version. [8] In our study test-retest reliability was lower compared to other versions. In our version, most weighted kappa values (kappa W) were determined as

Table 3. Construct validity: Correlation of Turkish DHI inventory with VAS imbalance, FTSTS, TUG, gait speed, DGI, FGA, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on a foam (eyes open, closed) and static posturography (Tetrax, fall index)

	DHI total (r)	DHI emotional (r)	DHI functional (r)	DHI physical (r)
VAS	0.35	0.37	0.32	0.21
FTSTST	0.04	-0.06	0.09	0.06
TUG	0.16	0.17	0.21	-0.01
Gait speed	0.02	0.004	0.04	0.006
DGI	-0.31	-0.24	-0.32	-0.23
FGA	-0.26	-0.23	-0.29	-0.14
Romberg (eyes open)	-0.26	-0.22	-0.21	-0.26
Romberg (eyes closed)	-0.35	-0.31	-0.32	-0.29
Tandem Romberg (eyes open)	-0.34	-0.37	-0.29	-0.26
Tandem Romberg (eyes closed)	-0.22	-0.16	-0.27	-0.12
Foam (eyes open)	-0.32	-0.37	-0.33	-0.12
Foam (eyes closed)	-0.11	-0.08	-0.07	-0.02
Fall index	0.31	0.26	0.36	0.18
ABC scale	-0.618**	-0.553**	-0.553**	-0.525**

DHI: Dizziness Handicap Inventory, VAS: Visual Analog Scale, TUG: Timed Up To Go Test, FTSTST: Five Times Sit To Stand Test, DGI: Dynamic Gait Index, FGA: Functional Gait Assessment, ABC: Activies-specific Balance Confidence Scale

Table 4. The DHI total and subscores and VAS, FTSTST, gait speed, DGI, FGA, Romberg (eyes open, eyes closed), Tandem Romberg (eyes open, eyes closed), Foam (eyes open, eyes closed) tetrax total before and after customized exercise program

n:27	Baseline	Follow up	p
DHI total	49.33±23.91	35.14±25.05	0.00
DHI emotional	12.38±8.50	8.38±9.07	0.01
DHI functional	19.14±10.98	13.90±11.07	0.02
DHI physical	17.65±7.93	14.20±8.97	0.03
VAS (dizziness)	50.00±18.64	26.00±16.35	0.00
TUG (second)	9.81±2.97	8.60±2.25	0.00
FTSTST (second)	9.92±1.95	8.88±1.74	0.003
Gait speed (m/s)	0.97±2.97	8.88±1.73	0.001
DGI	19.19±4.38	22.14±2.61	0.001
FGA	22.00±2.61	27.38±3.50	0.000
Romberg (eyes open, second)	28.82±5.39	30.00±0.00	0.329
Romberg (eyes closed, second)	28.18±6.41	30.00±0.00	0.208
Tandem Romberg (eyes open, second)	21.59±11.90	27.14±7.76	0.026
Tandem Romberg (eyes closed, second)	6.88±10.18	14.44±13.12	0.004
Foam (eyes open, second)	28.44±4.96	30.00±0.00	0.166
Foam (eyes closed, second)	17.91±11.42	27.53±7.84	0.001
Fall Index	54.00±33.96	30.21±26.77	0.001
ABC	59.81±23.06	80.62±27.02	0.04

DHI: Dizziness Handicap Inventory, VAS: Visual Analog Scale, TUG: Timed Up To Go Test, FTSTST: Five Times Sit To Stand Test, DGI: Dynamic Gait Index, FGA: Functional Gait Assessment, ABC: Activities Specific Balance Confidence Scale

moderate. In our study, patients were asked to answer to questions and one week following the first assessment, DHI was re-applied to determine test-retest reliability. In the original study, patients answered the questions through face to face interview and DHI was re-applied on the same day to determine test-retest reliability. In addition, despite of our concerns about low educational level of our patients to affect the answers, no such information was presented in the original study. These may be the reasons for lower test-retest reliability of the scale in our study. Additionally, there is no word in Turkish that exactly corresponds to "dizziness", thus patients usually describe this as "confusion, feeling in space, feeling of movement". Patients could have difficulty in answering the questions, because they were probably unable to define their diseases. We think further studies using face to face interview method and re-applied within a shorter period (on the same day or within 2 days) are required to determine the test-retest reliability of the scale.

Vestibular rehabilitation and medical treatment has provided significant improvement of DHI scale in the original study, Chinese version of the scale 9 and also in the study of Enloe et al.[27] Similar to these studies, DHI scale (total and subscore) showed improvement together with other parameters after customized vestibular rehabilitation program and it was found to be sensitive to change.

One of the strong sides of our study is administration of customized vestibular rehabilitation program in the hospital by the physicians. We believe that our rehabilitation program will be of use and serve as a model for other studies.

Small number of patients may be considered as a limitation for our study. Since study group included only patients with unilateral vestibular disease that have completed rehabilitation program, defining this number of patients as small may not be appropriate. However, a control group could provide additional benefit to assess correlation and sensitivity to change.

Addressing these limitations is anticipated in future studies.

Although Turkish DHI scale showed high internal consistency and sensitivity change in our study, its test-retest reliability and validity was relatively poor. We think that further studies investigating dizziness with face to face interview are required to determine the test-retest reliability and validity of the scale.

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