Assessment of Risk of fall in Patients with Peripheral Vestibular Disorders

Protocol for thesis submitted in partial fulfillment of the Master Degree in Audiology

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List of Abbreviations

ADT	Adaptation test
CoG	Center of gravity
CoM	Center of mass
CCR	Cervico-colic Reflex
CDP	Computerized Dynamic Posturography
CHL	Conductive Hearing Loss
CNS	Central Nervous System
COR	Cervico-ocular Reflex
CTSIB	Clinical test for sensory integration and balance
DC	Decompensated
DGI	Dynamic Gait Index
DHI	Dizziness Handicap Inventory
FGA	Functional Gait Assessment
MCT	Motor Control Test
POMA	Performance Oriented Mobility Assessment
PREF	Preference
PSP	Progressive Supra-nuclear Palsy
PTA	Pure Tone Audiometry
PVL	Peripheral vestibular lesion
BBS	Berg Balance Scale
TUG	Timed Up & Go Test
CGS and FGS	Comfortable and Fast Gait Speeds
SOM	Somatosensory
SOT	Sensory Organization Test
SNHL	Sensory Neural Hearing Loss
TIA	Transient Ischemic Attacks
VEMPs	Vestibular Evoked Myogenic Potentials
VNG	Video-nystagmography
VOR	Vestibulo-ocular reflex
UC	Unilateral compensated
UU	Unilateral Uncompensated
VIS	Visual
VSR	Vestibulo-spinal Reflex

Aims of the work:

1- To develop the Arabic version of FGA test

2- To standardize the FGA test by applying test on a group of normal adults,

3- To apply FGA test on subjects with peripheral vestibular disorders,

4- To compare the results of FGA with CDP in patients with peripheral vestibular disorders.

Introduction and Rationale:

Balance is a mechanism that facilitates our orientation in the three dimensional space, thereby prevent falling down by regulating postural control. Information about our orientation in the space is transferred by proprioception, eyes, ocular muscles and vestibular system. This incoming information is evaluated and modified by the central nervous system. Then, extensor or flexor muscle groups of lower limbs are activated accordingly**. (Sherrington et al., 2001)**

As the maintenance of balance depends on the interaction of multiple sensory, motor, and integrative systems, if any one of them is affected, patient is at a risk of fall. **(Sherrington et al., 2001)**

If gait is solely executed in relation to sensory feedback, each step will include a great deal of balance adjustment and this will lead to an uneven gait pattern. Stable gait calls for motor planning in order to allow a feed-forward strategy that adjusts the next step in an appropriate way **(Woollacott & Tang, 1997)**. This means that stable gait requires a proactive dynamic postural control and orientation in space.

Balance deficits and/or dizziness often results in a decreased activity level and fear of falling, which in turn may lead to weakness and impaired ability to engage in community involvement **(Lois et al.,2003).** Patients with reduced or absent labyrinthine inputs may be unstable; as impairment in the function of vestibulospinal reflex (VSR) is believed to contribute to postural disturbances. These patients frequently experience gait instability in situations that require them to walk and move their head, turn, or stop quickly **(Herdman, 2000).**

It’s expected that the differences between people with and without balance or vestibular impairments would be greatest on difficult walking tasks. For prediction

of falls risk a technique is needed which provides a battery of tests that help to assess the functional capacity of the balance disordered patients.

Computerized Dynamic Posturography (CDP) has been used to assess balance in a variety of conditions **(Fife et al., Whitney et al., 2006)**. According to the manufacturer, computerized dynamic posturography (CDP) is an assessment technique used to objectively quantify and differentiate among the wide variety of possible sensory, motor and central adaptive impairments to balance control **(Neurocom.,2005)**.

Posturography test may provide good prediction of all the different classes of falls as the dynamic postural responses to destabilizing events are significantly altered to fallers compared to non fallers **(Lois et al., 2003).**

One specific CDP test is Sensory Organization Test (SOT), which provides an extremely sensitive objective assessment of the main sensory systems involved in balance and stability. The SOT is a well-recognized assessment tool that has been extensively used to evaluate dynamic standing balance both in research and clinical practice **(Vouriot et al., 2004& Ray et al., 2007).** However, it is expensive and not available in a wide scale.

Functional gait assessment (FGA) is a standardized test for assessing postural stability during various walking tasks for patients with balance disorders **(Wrisley et al., 2004).** That test is a modified version of the Dynamic Gait Index (DGI), which was developed to quantify gait dysfunction in older adults during the performance of level walking, as well as more complex functional gait tasks **(Whiteny et al., 2003)**. However, further research is needed to assess concurrent & predictive validity of data obtained with the FGA in patients of vestibular disorders **(Whiteny et al., 2004)**.

Therefore, the present study is designed to develop an Arabic version of FGA test; and to determine the clinical usefulness & predictive value of FGA scores as an office test can be applied at any office or clinic compared to CDP as a laboratory test. It's cost effective in patients with peripheral vestibular disorders.

Materials and Method

- **Materials:**

I) Subjects:

The present study comprised two groups:

Study group: consisted of **42** patients; selected according to the following criteria:

A) -Age range 20-60 years

- Diagnosed as patients with peripheral vestibular disorders
- Normal Otological examination
- No history of neurological disorders
- No history of orthopedic problems

B) Control group: consisted of **20** normal subjects. They were age matched with the study group & selected according to the following criteria:

- No history of ear symptoms
- Normal otological examination
- No History of any vestibular insult
- No history of neurological disorders
- No history of orthopedic problems

II) Equipment:

- Two channel audiometer Madsen, model Orbiter 922
- Sound treated room I.A.C model 1602
- Immittancemeter GSI, Model 33
- Computerized infra red 4 channel video nystagmography (VNG), model ICS, version 5.1.
- Computerized Dynamic Posturography system (Equitest), Software version 4.1.

III) Tools:

- Stop watch
- Stick Yard for marking borders of the walkway
- Tow boxes, the height of each is 11 cm

- **Method:**

Patients were evaluated in two sessions one for audiological evaluation and the other for vestibular evaluation.

All subjects were submitted to the following:

- Full history taking.
- Basic audiological evaluation
- Assessment of risk of fall by:
  - Functional gait assessment test. ***(Wrisley et al., 2004)***.

-For patients with peripheral vestibular disorders the following will be conducted:

- Arabic Dizziness handicap inventory (DHI). ***(EL Gohary et al., 2000)***
- Representative Falls Case History Form. ***(Tibbits, 1996)***.
- Laboratory Vestibular Tests:
  - Videonystagmography **(VNG)**
  - Computerized Dynamic Posturography **(SOT)**
  - Vestibular Evoked Myogenic Potentials Test (VEMPs) (just for 9 patients), ***Appendix VI***

A) History taking:

Full history was taken including detailed personal history, the main complaint of the patient and its duration. History of present illness was taken in details including analysis of the main complaint as well as onset, course, frequency, duration of the complaint, precipitating and relieving factors and if there's any associated aural or vegetative symptoms, ***Appendix I***

The history of falls were driven through asking patient to report number of any previous falls, medications, gait problems, dizziness, vertigo, or loss of consciousness, environmental problems such as lighting, flooring or others, history of major illness such as CNS, musculoskeletal, CVS or others. As conducted through questions of Office staff evaluation of patient Falls **(Tibbits, 1996)** which were translated into Arabic, ***Appendix II***.

B) Arabic Dizziness Handicap Inventory (DHI) (El Gohary et al; 2000):

-The questionnaire is formed of 25 questions, for evaluating patient's degree of handicap include emotional ***(E)***, functional ***(F)***, & physical ***(P)*** related questions, ***Appendix III***.

-Patient had to answer with yes, sometimes, or no according to the difficulties that may be experienced due to his complaint

-Questions answered with yes are given 4 points, questions answered with sometimes are given 2 points, and questions answered with no are given 0 point. There are seven questions that compromise the physical subscale (maximum score 28), eighteen questions for both emotional and functional subscales (nine questions for each) (maximum score 36). Scores up to 25 was considered mild degree of handicap, above 25 to 50 was moderate handicap, above 50 to75 was moderately sever and above 75 was severe handicap.

C) Otological Examination:

D) Basic Audiological Evaluation:

1- Pure tone & speech audiometry:

- Pure Tone Audiometry: Air conduction thresholds were tested at 0.25, 0.5, 1,2,4 & 8 KHz. Bone conduction thresholds were tested at 0.5, 1,2 & 4 KHz. Effective masking using narrow band noise was introduced to the contra-lateral ear whenever indicated.

- Speech Audiometry: including speech reception threshold testing (SRT) using Arabic spondee words **(Soliman et al., 1985)** , & word discrimination testing using Arabic phonetically balanced (PB) words **(Soliman, 1976)** at 40 dB sensation level (ref. SRT) or at most comfortable level.

2- Acoustic Immittance Testing: Including tympanometry & acoustic reflex thresholds measurement.

E) Laboratory Vestibular Evaluation:

1-Videonystagmography (VNG)

The test battery included tests for spontaneous nystagmus, gaze nystagmus & Occulomotor testing for random saccade, smooth pursuit & optokinetic testing. Positional and Positioning tests were also included.

Bithermal caloric testing was done using cold (at 30°C) and warm (at 44°C) irrigations. Each irrigation was 250 cc water per minute for 30 seconds. Proper mental task was given to the patient; nystagmus was recorded with fixation suppression test.

The percentage of caloric weakness was considered to be significant at the level of 20% and more while signs of uncompensation were included the presence of spontaneous nystagmus, positional nystagmus or significant directional preponderance more than 25%.

2-Computerized Dynamic Posturography (CDP)

Sensory Organization Test (SOT)

At the beginning preparation for testing was done first, by completing the demographic data (as name, age, date of birth, & height). Then the patient was properly fitted with safety harness, safety straps that were tight enough to prevent patient's fall, but loose enough to prevent patient from gaining support. Lastly, patient was standing on the platform with feet properly positioned according to patient height & facing a visual surround.

The test was done under six conditions. The first three conditions were done on fixed platform (C1) eyes opened, (C2) eyes closed, (C3) in a sway referenced visual enclosure. The other three conditions utilizes a sway referenced platform (C4) eyes opened, (C5) eyes closed, (C6) a sway referenced visual enclosure. Three trials were done for each condition; each lasting for 20 seconds to improve the reliability of the resulting measures. **(Nashner, 1993)**

During each trial the patient is instructed to ignore any surface or visual surround motion and remain upright and as steady as possible.

Sway referencing was done with a gain of +1 (one degree of platform or visual enclosure rotation for each degree of body sway).

Analysis of the results included equilibrium scores and sensory analysis composite scores; patient was compared to the default age specific norms of the equipment.

F) Evaluation of Risk of Fall (Office Testing):

Functional Gait Assessment

-The Functional gait assessment (FGA) is a standardized test for assessing postural stability during various walking tasks. The test is a modified version of Dynamic gait Index test (DGI) which was developed by ***Shumway-Cook & Woollacott;1995. Wrisley et al., 2004*** revised the DGI test to create the FGA test. ***Appendix IV***

The FGA is a 10-task gait test that comprises:

- Gait level surface.

- Change in gait speed.

- Gait with horizontal head turns.

- Gait with vertical head turns.

- Gait and pivot turn.

- Step over obstacle.

- Gait with narrow base of support.

- Gait with eyes closed.

- Ambulating backwards.

-Step.

The FGA test could be performed in all patients. The instructions of most of the items were understood by subjects of the study & control groups. However, repeating of instructions in the items of gait with horizontal & vertical head turns was needed. Time needed to complete testing was about 10 to 15 minutes. (For translated test items, instruction and scoring see ***Appendix V***.