Effect of Eye Movement Training on Balance in Post Stroke Patients with Unilateral Spatial Neglect. First Preliminary report

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Abstract:

Background: Unilateral Spatial Neglect (USN) is a complex disorder associated with stroke and is more severe and persistent following right hemisphere damage. Stroke patients have mobility limitations, muscle weakness, and behaviors disorders. The problem with USN is lack of orientation and information from affected side that may cause balance problems specially in elderly survivors. Training eye movements are aimed at improving visual function by training patients to navigate the blind hemifield and increase their overall sensitivity. Accurate reliable knowledge of balance in stroke survivors is important for prognosis and to predict falls. **Aim of the study:** This study was designed to find out the effect of training eye movements on balance in elderly post stroke survivors with USN. **Subjects and Methods**: The study included 15 of both sexes with post stroke USN (11 males and 4 females) their mean age was 69.1 ± 1.9 years. Patients received sequentially in same session training for eye movement program and a traditional gait training program 4 days/week for 6 weeks. Balance assessment was measured by Berg Balance Scale (BBS), Time Up and go test (TUG), 10 meters Talking Test (10mWT), and 6 Minutes Walking Test (6MWT). **Results:** there were significant changes in between pre and post-study as the analysis of mean values of BBS, TUG, 10mW, and 6MWT. **Conclusion**: eye movement training had a significant effect on improving balance in post stroke survivors with USN. Eye movement training improved patients with USN ability to explorer the blind hemispace and to improve balance.

Keywords: Unilateral Spatial Neglect, Eye Movement Training, Balance

Background

In many countries stroke affects up to 0.3% of the population annually and is the second most common cause of death **[1].** A stroke occurs when there is an interruption to blood flow to the brain by either blood clot blocking the blood vessel or by a haemorrhage in the brain. Strokes can cause early signs, such as drooping of one side of their face, loss of speech, or weakness or paralysis of the upper limb and/or lower limb or one side of the body **[2].**

Stroke is the most leading cause of functional impairment. For elderly patients who are more than 65 years of age, 6 months after stroke, 26% are still dependent in most of their activities of daily living (ADLS), and 46% of them have cognitive problems. Stroke changes the lives not only of stroke survivors but also of their family their care givers **[3].**

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Populations in the Middle East and North Africa (MENA) countries have a similar life style, dietary habits, and also have similar vascular risk factors that may increase stroke risk, types, and disease burden. Egypt is one the most populated nation in the Middle East and Africa with an estimated 90.5 million people. According to recent estimates studies in Egypt, the overall prevalence rate of stroke is high with a crude prevalence rate of 963/100,000 inhabitants **[4].**

With an aging population, the incidence of stroke is expected to be rising, and consequently also the number of patients with stroke related visual impairment. This is often not reflected in the rehabilitation outcomes, where the main goals focus

Print ISSN 2636-3224
Online ISSN 2636-3232

traditionally is on restoring motor function and speech function. Lately, however, the importance of addressing also visual problems has been increasingly acknowledged and visual rehabilitation more widely offered **[5].**

Unilateral Spatial neglect (USN) is a behavioral disorder occurring usually in patients post stroke. USN is defined as pathologically asymmetric spatial behavior, caused by a brain lesion usually in right cerebral hemisphere and resulting in left hemiplegia and disability **[6].**
There are many causes of spatial neglect include stroke, traumatic brain injury, brain tumors, and aneurysm. Neurodegenerative diseases such as Multiple Sclerosis may cause neglect symptoms **[7].** Although patients with USN may recover spontaneously from neglect after stroke as assessed on paper and pencil tests such as cancellation test, but they still have persistent disability, decreased community mobility and high risk of falls **[8].**

Patient with Spatial neglect are also suffering from other cognitive symptoms affecting functional abilities and their caregiver interaction, such as delirium, abnormal awareness of deficits this will interfere with their quality of life specially in elderly **[9].**

Balance problems in post stroke patients can be assessed by simple questionnaires tests, includes the Time Up and Go test (TUG), the Berg Balance Scale (BBS), the Brunel Balance Assessment, the Postural Assessment Scale for Stroke patients, the 10-meter walking test (10mWT), and the 6-minute walking test (6MWT) **[10].**
The eye muscles act as 3 agonist/antagonist pairs. The 6 extra ocular muscles are located outside the eyeball and pull on the eyeball to turn it. When your eye points forward, 60% of the motor neurons are active in all these muscles. To look elsewhere, one of a muscle pair contracts and the other relaxes. We need 3 pairs of muscles to allow rotations in all possible directions: 1. Horizontal, the medial and lateral recti (MR and IR). 2. Vertical, the superior and inferior recti (R and IR). 3. Torsional, the superior and inferior oblique (SO and IO). Movement of Eye muscles includes: Saccadic Movements, Optokinetic Movements, Vestibular Movements, Vergence Movements, and Smooth Pursuit Movements **[11].**
There are many ways in which vision can be affected in patients post stroke. Visual problems include loss of visual field loss, central vision, visual perceptual abnormalities, and eye movement may be affected. These may occur in isolation but more frequently occur in combination **[12].**
It is estimated that more than 70% of stroke patients will have an eye movement disorder that can impact their rehabilitation outcome and their return to independent living. This implies that the diagnosis and treatment of visual problems may be a critical component for many stroke patients to return to independent activities of daily living (ADLs) **[13].**

Many studies have demonstrated that patients with post stroke visual disorders tend to altering their eye movements or concentrating more on the blind hemifield to overcome for their neglection problems. This may explains why there is still no generally accepted rehabilitating method or program for survivors with visual field disorders **[14].**

Hemiparesis is the most common neurological disorders in patients with a stroke. Stroke survivors with hemiparesis have balance problems, which increases the risk of falling, mortality, and high socio-economic costs. Various underlying complications give rise to balance impairment, such as joint range of motion, muscle weakness, altered muscular tone, sensory deficits, abnormal postural reactions, and cognitive deficits **[10].**

Materials and Methods
1-subjects:

The study included 15 of both sexes with post stroke USN (11 males and 4 females) their mean age was 69.1 ± 1.9 years. Body mass index (BMI) mean was 27.1± 0.95 kg/m² (Table 1). Patients received sequentially in same session training for eye movement program and traditional gait training. Balance assessment was measured by Berg Balnce Scale (BBS), Time Up and go test (TUG), 10 meters Talking Test (10mWT), and 6 Minutes Walking Test (6MWT) by program 4 days/week for 6 weeks.

Table 1: General characteristics of the patients.

Characteristics	Patients
Participants n	15
Age (mean ± SD (range))	69.1 ± 1.9
Sex (N (% Male))	11 (73%)
BMI	27.1±0.95kg/m²
Months post stroke	15.3 ± 2.06

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Inclusion criteria: These patients were chosen under the following criteria: Patients who had a stroke at least six months prior. Patients who could walk without caretaker assistance or no severe spastic or abnormal movement. Adequate hearing (hearing aid if required). Patients who had no problem with their state of consciousness and absence of dementia. Patients who had no orthopedic problems that may affect gait. Neglection was defined by one or more of the following tests: Line Bisection Test (LBT) **[15]**, Star Cancellation Test (SCT) **[16],** and/or Apples Test (APT) **[17].** Patients will be chosen in both sexes. Clinically and medically stable.

Exclusion criteria: Patients who met one of the following criteria were excluded from the study: Only one functional eye. Neurological problem or any severe co-morbidity likely to affect gait. Instability of patient's medical condition. Obese **(BMI ≥ 30 Kg⁄m2).** Association with another medical problem that can affect patient cooperation or study outcomes.

2-Materials:

Measurement tools: Weight and height scale was used to measure body weight and height (to calculate body mass index) using formula "weight (kg) / hight (m²)" **[18].** Stop watch to calculate time in the 6MWT.Training tools: Eye training tools including printed letters cards, pencil, fixed objects on wall and baton, for training the eye movement based on physiological eye movements.

3-Methods:

Eye training exercises were as follows: First: A picture card was shown to the patient, and then mixed with 20 other cards and spread face up on the desk. The patients were instructed to cover the right eye and then repeated with covering the left eye. The patients were instructed to find that one card. This task was repeated approximately 10 times. **Second:** The therapist moved a pencil slowly while drawing circles. Patient was instructed to keep his or her sight fixed on the tip of the pencil. In this exercise, the distance between the pencil and the patient was maintained at approximately 1 meter. **Third:** The patient was instructed to quickly shake the head laterally and a small card with letters written upside down was presented to the patient to read. This task was repeated approximately 10 times. **Fourth:** The therapist moved a pencil slowly from a point approximately 5 cm away from the patient's head to a point approximately 50 cm away from patient. Patient was instructed to keep his or her eyes on the pencil. Then patient was instructed to cover the right eye. This task was performed for approximately five minutes and then repeated for the left eye. **Fifth:** Patient was instructed to shift weight toward one limb with partial weight bearing on the other, focusing in a fixed target object and keeping the sight on the target object. The fixed object is on the wall 3 meters away from him, at patient sight level. Patient was instructed to cover the sound eye. This task was performed for approximately five minutes

Evaluative procedures:

Balance assessment: Berg balance scale (BBS) was used as the primary balance outcome measure for analysis. The TUG, 10mWT, and 6MWT were used as the clinical outcome measurements to evaluate the balance of patients.

BBS frequently in a clinical setting, BBS has shown excellent reliability in patients with acute stroke **[19],** and also showed a moderate to large responsiveness at detecting changes within 2–12 weeks **[20].**

TUG is a single-item test that requires the subject to stand up, walk 3 meters, turn back, and sit down again. The total

time during the sequential movements is recorded. A time of <10 seconds indicates normal mobility, 11–20 seconds is the normal limit for disabled patients, and >20 seconds is considered to be abnormal. Since it uses agreement in a stop-watch duration rather than rating scales, it is probably the most reliable functional balance test **[21].** Furthermore, the TUG has been shown to be valid and to identify the risk of falling in community-dwelling older adults as well as in patients with stroke **[22].**

An assessment tool of functional mobility measuring the time taken to walk a 10-meter distance without assistance is the 10mWT **[23].** It records the time a patient takes to walk 10 meters at a normal, comfortable speed.

The 6MWT is a one-time measure of the functional status of patients **[24].** The patients walk along a 30-meter hallway for 6 minutes, and the total distance covered is recorded. The 6MWT should be performed indoors, along long, flat, straight, enclosed corridor with a hard surface that is seldom travelled. The walking course must be 30 meters in length. The length of the corridor should be marked every 3 meters. The turnaround points should be marked with a cone. Starting line which marking the beginning and the end of each 60 meters lap should be marked on the floor using brightly colored tape. For every patient the distance achieved was measured in fixed time which is 6 minute **[25].**

RESULTS

This study was conducted to find out the effect of eye movement training on balance of elderly patients with post stroke USN. The measured variables included: measuring balance by BBS, TUG, 10mW, and 6MWT. As shown in **table (2)** there were significant changes in between pre and post-study as the analysis of mean values of BBS, TUG, 10mW, and 6MWT.

After the intervention, the patients showed a statistically significant increase in BBS from 42 ± 1.8 to 46 ± 3.9, TUG showed a statistically significant decrease from 17.8 ± 9.1 seconds to 15.9 ± 11.5 (s), 10mW(s) showed a statistically significant decrease from14.6 ± 5.9 to 12.7 ± 4.3 and 6MWT (m) showed a statistically significant increase in walked distance from 265 ± 67.8 (m) to 343 ± 44.9.

Table 2: Results pre and post eye movement training

Test	Pre training	Post Training
BBS	42 ± 1.8	46 ± 3.9
TUG (s)	17.8 ± 9.1	15.9±11.5
10mW(s)	14.6 ± 5.9	12.7 ± 4.3
6MWT (m)	265± 67.8	343± 44.9

Discussion

Training techniques for the eye movement are aimed at improving or even restoring visual function by training patients to response to a stimulus in the blind hemifield and improve their overall sensitivity to them. This is done by administering repeated stimuli to facilitate the brain reactivate visual **[13].**

This study was conducted to find out the effect of eye movement training on balance in elderly patients with post stroke USN. After 6 weeks of training there was a significant increase in BBS, a significant decrease in TUG, a significant decrease in time 10mW and a significant increase in distance walked in 6MWT.

Bisson et al., 2007 [26], supported our results they stated that, eye movement training, intended to improve balance and visual ability, is based on neuroplasticity, which is the foundation of the rehabilitation of patients with central nervous system diseases. In another study, when eye movement training program used as part of a fall prevention program, there was an improved agility and dynamic balance control in elderly people by influencing vision and improving proprioceptive sensory information that affects balance control.

An early study by **De Weerdt W et al. [27]** on weight distribution and gait in patients with stroke reported on the effects of visual feedback. Also, a study that added action observation training for patients with stroke using visual information reported that the training

brought about improvements in weight bearing, stability, and gait function **[28].**

Conclusion: eye movement training had a significant effect on improving balance in post stroke survivors with unilateral spatial neglect (USN). Eye movement training improves balance in patients with USN by improving their ability to explorer the blind hemispace.

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