EFFECT OF VISUAL MOTOR COORDINATION WITH BODY AWARENESS TRAINING ON BALANCE, COORDINATION AND INTENSITY OF TREMOR IN PATIENTS WITH CEREBELLAR ATAXIA

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A DISSERTATION SUBMITTED TO THE TAMILNADU

Dr. M.G.R. MEDICAL UNIVERSITY, CHENNAI,

AS PARTIAL FULFILLMENT OF THE

MASTER OF PHYSIOTHERAPY DEGREE

MAY 2018

CERTIFICATE

This is to certify that a bonafide work of **Mr. Ranjith.K.V** of K.G. College of Physiotherapy, Coimbatore submitted in partial fulfillment for the requirements of Master of Physiotherapy Degree course from the Tamil Nadu Dr. M. G. R Medical University under the **Registration No: 271620303** for the May 2018 Examination.

Date: Principal

Place: Coimbatore

Date:

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Internal examiner

External examiner

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I INTRODUCTION

Ataxia is a lack of muscle coordination which may affect speech,eye movement , the ability to swallow ,walking ,picking up objects ,and other voluntary movements. Cerebellar ataxia is caused by the dysfunction of the cerebellum due to lesion in the cerebellum, and / or the afferent and efferent connections of the cerebellum which is involved in the assimilation of sensory perception ,coordination ,and motor control it also plays a important role in motor learning and adaptation. Therefore, if the cerebellum is damaged it results in Dysmetria, Tremor, Dyssynergia, Dysdiadochokinesia, Hypotonia, Dysarthria, Nystagmus.

Intervention for rehabilitation includes medication, surgery,and physical therapy. The effect of medication and surgery depends on the cause of ataxia and extend of neuronal damage; however, there is no radical treatment for these disease yet (Akiyoshi Matsugi, 2017)

Patients with cerebellar damage have impaired motor learning (Boyd LA et. al., 2004), but their ataxia ,gait ,and ADL can be improved. In walking, ataxia is evident by a shortened stride length,high step pattern ,and decreased push-off and veering. These gait deviations have been closely linked to the severity of the individual's balance deficits (Morton SM et. al., 2010). These deficits lead to taxing and unsafe mobility. Since the disease –modifying pharmacological treatment for ataxia are much available, physical therapy intervention could be the primary treatment option.

Patients with ataxia suffer from disturbance of balance and coordination. This leads to exceedingly uncontrolled, swaying movements. Patient tends to avoid these uncontrolled movements and , in particular, stop to perform those movements that demand high coordinative efforts. Thus, their movements repertoire is increasingly restricted to movements with only poor variation as a consequence, the patients lose coordination skills , reaction ability and gait safety to a larger extent.

Cerebellar tremor , also known as kinetic, action, or intention tremor , is a dyskinetic disorder characterized by a board, coarse , and low frequency (<5 Hz) tremor. Tremor is a condition where goal-directed movements produce shaking in the moving body parts, most noticeably in the hand. It is more obvious when performing delicate fine movements than broad sweeping ones. The amplitude of cerebellar tremor increases as an extremity approaches the endpoint of deliberate and visually guided movement. A cerebellar tremor is usually perpendicular to the direction of movement. It is the result of dysfunction of the cerebellum,particularly on the same side in the lateral zone, which controls visually guided movements.(Seeberger L et.al.,2014)

The most common site for cerebellar lesions that leads to the intentional tremor is superior cerebellar peduncle and dentate nucleus, through which cerebellum is linked to the rest of the brain(Bhidayasiri R et.al.,2000) Intention tremors can also be caused as a result of damage to the brainstem or thalamus . Both of these structures are involved in the transmission of information between the cerebellum and the cerebral cortex, as well as between the cerebellum and the spinal cord, and then on to the motor neurons. When these become damaged, the relay system between the cerebellum and the muscle which it is trying to act upon is compromised, resulting in the development of a tremor(Dale P George JA et. al.,2008).

Despite these considerable challenges, recent evidence suggests that individual with cerebellar disease may benefit from long-term motor training following an intensive , high level 4week training program , cerebellar patients showed the ability to improve motor skills and functional performance(Synofzik M et.al.,2014).

Body awareness training (BAT) is a method for improvement of dynamic balance and postural control ability.BAT is comprised of simple repetitive movements that maintain ability using stability limits(Eriksson EM et.al.,2008). A main component of BAT is to enhance an individual's awareness of their movement. Multiple slow repetitive movements may enable the participant to experience the body and its limits .In other words, BAT generates awareness of one's body and enables focus on body awareness during movement. Movements are performed in various positions in order to identify the center line of the body.BAT results in improved postural control, balance, free breathing and coordination (Lindvall MA et.al.,2014).

Visual Motor Coordination (VMC) or visual motor integration is the coordination of visual perceptual abilities and fine motor control involves effective, efficient communication between the eye and the hand movements. It integrates " Both visual and motor abilities with the environmental context to accomplish a goal "(O'Sullivan SB.,2014).

Though tremor may be the most quantifiable of all movement disorders, there is currently no universally accepted method of rating or measuring tremor. There can be considerable variability in the manner in which clinicians assess the presence of tremor and its severity. In an attempt to standardize the evaluation of tremor a number of rating scales have been developed that optimize comparability between studies and patient population. One of the earlier tremor scales developed that is still in use today is the Fahn -Tolosa – Marin Tremor Rating Scale. This 5-point scale rates tremor severity based on tremor amplitude, from 0 (no tremor) to 4 (severe tremor) in each part of the body, and includes assessments of specific abilities and functional disabilities. The Finger-to-Nose Test (FNT) is a long-standing test used for the evaluation of upper-limb coordination. It is part of a standard neurologic examination. Patients are asked to touch their nose with the tip of their index finger and tremor intensity in rated according to the fahn's tremor rating scale.

The Nine Hole Peg Test is gold standard tool used to measure finger dexterity in patients with various neurological diseases. It has therefore been reasoned that these patients may get limited benefit from rehabilitation that relies on motor learning (Thach WT et.al.,2000).

The Berg balance scale is used to objectively determine a patient's ability (or inability) to safely balance during a series of predetermined tasks. It is a 14 item list with each item consisting of a five-point ordinal scale ranging from 0 to 4, with 0 indicating the lowest level of function and 4 the highest level of function and takes approximately 20 minutes to complete. Adequate upper-limb function requires the maintenance of motor coordination. In clinical practice, coordination is usually evaluated by observing the quality of accurate, fast, and alternating repeated movements.

Hence this study tends to find out whether a physiotherapeutic intervention using the principles of body awareness training and visual motor coordination has effect balance , coordination and intensity of tremor in patients with cerebellar ataxia.

1.1 NEED FOR THE STUDY

Individual with cerebellar ataxia exhibits a progressive worsening of motor coordination leading to balance deficit and intentional tremor. As these features may cause a devastating consequences in their daily activity. There is a need to identify and test innovative interventions to reduce these major progressive symptoms. Hence these features are difficult to treat with pharmacotherapy and drugs and Physiotherapy has not much focused on research in the management of ataxia hence, there is a need for a study to fill the research gap.

1.2 AIM OF THE STUDY

The purpose of the study is to find out the effect of visual motor co-ordination with body awareness training on balance, co-ordination and intensity of tremor in patients with cerebellar ataxia.

1.3 KEYWORDS

- Cerebellar ataxia
- Visual motor coordination
- Body awareness training
- Fahn's Tremor Rating Scale
- Nine Hole Peg Test
- Berg Balance Scale

1.4 OBJECTIVES OF THE STUDY

To find out the effectiveness of visual motor coordination with body awareness training on balance, co-ordination and intensity of tremor in patients with cerebellar ataxia.

1.5 HYPOTHESIS

(a) NULL HYPOTHESIS

There is no significant improvement in visual motor coordination with body awareness training on balance, co-ordination and intensity of tremor in patients with cerebellar ataxia.

(b) ALTERNATE HYPOTHESIS

There is a significant improvement in visual motor coordination with body awareness training on balance, co-ordination and intensity of tremor in patients with cerebellar ataxia.

II REVIEW OF LITERATURE

CEREBELLAR ATAXIA

KK.Sinha et.al., (2004)

Conducted a study to determine the prevalence of different SCA mutation in a relatively homogenous population from eastern india and identified 28 families with autosomal dominant cerebellar ataxia from eastern india and concluded that although slow ocular saccades are highly suggestive of SCA 2 , that they are not universal,nor are they exclusive to this disorder and SCA2 is likely to be the commonest dominant ataxia in eastern india.

Lara A. Boyd et.al.,(2004)

Conducted the study to determine the specific components (spatial or temporal) of an implicit motor-tracking task affected by cerebellar stroke in which individuals with unilateral cerebellar stroke (n=7) and a control group (n=10) were studied and concluded that during implicit motor learning, the cerebellum appears to participate in the formation of predictive strategies for the timing of the motor responses, rather than for the accuracy of motor execution.

Rangaraj.R et.al., (2005)

Conducted a study to know the prevalence, clinical and molecular genetic characteristics of cerebellar ataxia in an ethnic tamil community in india.The total population of the two villages was 378 and cerebellar ataxia was found in 25 individuals belonging only to former community (7.2%). The mean age of onset was 39.8 years with salient features of ataxia gait, dysarthria, pyramidal signs, slow saccades and bleeding diathesis. This study concluded that prevalence of SCAI is high in ethical tamil community.Which with appropriate counseling, prenatal evaluation and therapy will prevent the spread of disease to the next generation.

Shahriar Nafissi et.al., (2009)

Conducted a cross sectional study to determine the various etiologies and their relative prevalence's in the population suffering from cerebral ataxia, 136 patients in range of 6 to 75 years. From March 1993 to march 1999 were classified based on the etiological factors in which multiple sclerosis, CVA and hereditary cerebellar ataxia. Were the most common etiologic factors associated with cerebellar ataxia .

Wafaa MA Farghaly et.al.,(2011)

Conducted a study to determine the prevalence and etiology of acquired ataxia in a geographical region with total population of 62,583.A door –to –door survey was used to identify the cause of acquired cerebellar ataxia and concluded with a prevalence rate of about 27.16/100,000 with mean age of 31 years and with a male to female ratio of 2.1:1.

Miyai I et.al., (2012)

Conducted a study to investigate short and long–term effects of intensive rehabilitation on ataxia, gait, activities of daily living in patients with degenerative cerebellar disease in which a total of 42 patients with pure cerebellar degeneration were randomly assigned into groups and underwent 2 hours of physical and occupational therapy for 4 weeks .Control group received after 4 weeks delay and concluded that immediate group showed significant improvement in ataxia , gait speed and ADL than the control group.

NINE HOLE PEG TEST

V Mathiowetz et.al., (1985)

Conducted a study to establish standardized procedures for Nine Hole Peg Test of finger dexterity, for reliability and validity study , 26 female occupational therapy students were tested very high interrater reliability was found test re-test reliability was reported to be moderate to high and a significant practice effect was found between the test and re-test occasions

Kimatha Oxford Grice et.al., (2003)

Conducted a study to evaluate the interrater and test-retest reliability of the commercially available Smith and Nephew Rehabilitation Division version of the Nine Hole Peg Test, and to establish new adult norms for the Nine Hole Peg Test for the finger dexterity utilizing this particular version. 703 subjects, ranging in age from 21 to 71 + years, were tested and showed high interrater reliability and only moderate test-retest reliability.

Hui-xia niu et.al.,(2017)

Conducted a study to evaluate the 9-hole peg test (9-HPT) and 10-meter walk test (10-MWT) are commonly used to test finger motor function and walking ability. The aim of this present study was to investigate the efficacy of these tests for evaluating functional loss in Chinese Charcot-Marie-Tooth (CMT) disease. The 9-HPT and 10-MWT might be useful for functional assessment in Chinese patients with CMT.

Peter Feys et.al., (2017)

Conducted a study to determine the manual dexterity performance measure for multiple sclerosis were various tests and patient reported outcomes measures are available , the Nine Hole Peg Test (9HPT) is considered as a gold standard measure of manual dexterity and most frequently used in MS research and clinical practice , and found that 9HPT reliable within and between test sessions, and showed high convergent validity with other manual dexterity as well as more comprehensive upper limb measures

FAHN'S TREMOR RATING SCALE

Julie Hooper et.al., (1998)

Conducted a study to determine the reliability of Fahn's Tremor Rating Scale in assessing the movement disorders in patients with multiple sclerosis. Videos were made of 10 patients with MS showing their rest , postural, action / intension , and goal related movement disorders as well as their performance of spirometry , a volumetric task , and timed functional task and this study concludes that FTRS is a reliable a potentially useful tool to assess movement disorders in patients with MS.

Rodger J. Elble et.al., (2006)

Conducted a study to determine the relationship of a TRS to actual tremor amplitude , Data from five laboratories were analysed , and 928 patients with various types of hand tremor were studied, tremor in writing , drawing, horizontal posture, rest and finger-nose testing was graded using a variety of TRS. The relationship between TRS scores and tremor amplitude was computed for each task and concluded that knowledge of the relationship between TRS and precise measures of tremor is useful in interpreting the clinical significance of changes in TRS produced by disease (or) therapy .

Mark A. Stacy et.al.,(2007)

Conducted a study to evaluate interrater and intrarater reliability of the Fahn-Tolosa-Marin Tremor Rating Scale (TRS) in essential tremor (ET) video tape recordings of 17 subjects with ET were evaluated with the TRS. Interrater reliability were grater for part A items than for B items the average spearman correlation was 0.87 indicating very good consistency between the two video tapes, when judging tremor in handwriting and drawings.

Elble R et.al., (2018)

Conducted a study to review rating scales for the assessment of tremor, seven tremor severity scales, six activities of daily living / disability scales. Four quality of life scales and give screening instruments were identified by searching Pubmed. Gor, in which five tremor severity scales including Fahn-Tolosa – Marin Tremor Rating Scale , and concluded that all the scales need more comprehensive analysis of sensitivity to change in order to judge their utility in clinical trials and individual patient assessments.

BERG BALANCE SCALE

Korner- Bitensky N et.al., (2008)

In a recent study 655 physiotherapist working with stroke population, identified that BERG BALANCE Scale is most commonly used assessment tool across the continuum of stroke rehabilitation. The purpose of the study was to review the psychometric properties of the BBS specific to stroke and to identify strengths and weaknesses in its usefulness for stroke rehabilitation.21 studies examined the psychometric properties of BBS and 16 studies examined on validity of BBS with a stroke population were retrieved. Concluded that BBS is a psychometrically sound measure of balance impairment for use in post stroke assessment.

Tyson SF et.al., (2009)

Studied and identified the clinically feasible measurement tools of balance activity in people with neurological conditions to recommend for use in clinical practice. Nineteen measurement tools were selected .Of these Brunel balance assessment and Berg Balance scale in sitting and standing, weight shift, step/tap and step –up tests reached the required standard and are usable in clinical practice.

Down S et.al., (2013)

Studied that Berg Balance Scale has high intra and inter rater reliability in measuring the balance ability in patients suffering from balance impairment. Eleven studies involving 668 participants were included in the review. The intra reliability was with a pooled estimate of 0.98 and inter reliability of 0.97. They concluded that Berg Balance Scale has absolute reliability among people with moderately poor to normal balance.

Kuan-Lin Chen et.al., (2014)

Studied about the responsiveness of the original and the short form Berg Balance Scale in people with stroke at both the individual level and group level. Totals of 226, 202, and 168 patients with stroke were assessed with the BBS and SFBBS data were extracted from the patient's responses on the BBS. At the individual person level, the BBS detected significant balance improvement in about twice as many patients as the SFBBS detected.

BODY AWARENESS TRAINING

Eriksson EM et.al., (2007)

Conducted a study to compare irritable bowel syndrome patients with apparently healthy persons and to evaluate body awareness therapy on normalising tensions in the body, 21 IBS patients received BAT 2 hrs weekly for 24 weeks. IBS patients scored higher for gastrointestinal and psychological symptoms, and presented with altered biochemical stress markers. Hence BAT gave relief of both somatic complaints, psychological symptoms and normalized body tension.

Lars Hansson et.al., (2009)

Studied the outcome of basic body awareness therapy(BAT) added to treatment as (TAU) usual compared to TAU only, for patients with mood , somatoform or personality disorders in psychiatric out-patient service. 77

patients were randomized to basic BAT and TAU. The results indicate that basic BAT in addition to TAU, in a relatively short intervention period improves the body awareness and attitude towards the body as well as self – efficacy, sleep and physical coping resources compared to TAU only.

Hedlund L et.al., (2010)

Conducted a study to describe the experience of basic body awareness therapy in patients with schizophrenia were a qualitative study of 8 patients with schizophrenia were interviewed and this study concluded that patients with schizophrenia report positive treatment effects of physiotherapy with BAT.

Dae –hyouk bang et.al.,(2015)

Conducted a study to investigate the effects of body awareness training on mild visuospatial neglect in patients following acute stroke. 12 patients were randomly assigned to experimental and control group were the experimental group underwent went BAT for 15 mins followed by task oriented training for 30 mins and the following study suggested that the BAT with task-oriented training has feasibility and suitability in patients with mild visuospatial neglect in patients following acute stroke.

Hyun – Shin Cho et.al., (2016)

Conducted a study to investigate the effect of BAT on balance and walkingability in chronic stroke patients. Subjects were randomly assigned to experimental and control group . Which received BAT for 20 mins followed by walking training for 30 mins for 5 days for 4 weeks and the result suggested that BAT has a positive effect on balance in patients with chronic stroke.

PROXIMAL STABILITY TRAINING

Weiss et.al., (2000)

Conducted a study to evaluate the effect of progressive resistance strength training program on change in muscle strength , gait , and balance in stroke patients . subjects participated in a 12 week sessions, and concludes that strength training is an appropriate intervention to improve the quality of physical function in older community dwelling stroke survivours.

Karatas et.al., (2004)

Conducted a study to evaluate the trunk muscle strength in stroke patients and to assess how it relates to body balance and functional disability, investigated isometric and isokinetic reciprocal trunk flexion and extension strength at angular velocities in 38 stroke patients and 40 healthy volunteers. The findings indicate trunk flexion and extension muscle weakness in stroke patients, which can interfere with balance, stability, and functional disability.

FUNCTIONAL MOVEMENT TRAINING TRAINING

Iig.W et.al., (2007)

Conducted a study, to determine the effectiveness of a 4-week intensive coordinative training for 16 patients with progressive ataxia due to cerebellar degeneration (n = 10) or degeneration of afferent pathways (n = 6). Study concluded that patients with cerebellar ataxia, coordinative training improves motor performance and reduces ataxia symptoms, enabling them to achieve personally meaningful goals in everyday life. Training effects were more distinct for patients whose afferent pathways were not affected. For both groups, continuous training seems crucial for stabilizing improvements and should become standard of care.

Burkard S et.al., (2010)

Conducted a study to evaluate physiotherapeutic interventions for patients with degenerative cerebellar disease, evidence for long-term effects and transfer to activities of daily life is rare.They have recently shown that coordinative training leads to short-term improvements in motor performance. To evaluate long-term benefits and translation to real world function, They here assessed motor performance and achievements in activities of daily life 1 year after a 4 week intensive coordinative training, which was followed by a home training program. This study concludes that in patients with degenerative cerebellar disease, continuous coordinative training leads to long-term improvements, which translate to real world function.

Synofzik M et.al., (2014)

Conducted a study to demonstrate that high-intensity coordinative training might lead to a significant benefit in patients with degenerative ataxia. Cerebellum is essentially involved in movement control and plays a critical role in motor learning. It has remained controversial whether patients with degenerative cerebellar disease benefit from high-intensity coordinative training. This training might be based either on physiotherapy or on whole-body controlled videogames ("exergames"). The benefit shown in these studies is equal to regaining one or more years of natural disease progression. In addition, first case studies indicate that even subjects with advanced neurodegeneration might benefit from such training programs. For both types of training, the observed clinical improvements are paralleled by recoveries in ataxia-specific dysfunctions (e.g., multijoint coordination and dynamic stability). Importantly, for both types of training, the retention of the effects seems to depend on the frequency and continuity of training.

BALANCE TRAINING

Morton SM et.al., (2003)

Conducted a study to determine the relative contributions of balance versus leg-coordination deficits to cerebellar gait ataxia in humans. studied 20 subjects with cerebellar damage and 20 control subjects performing three tasks: a lateral weight-shifting task to measure balance, a visually guided stepping task to measure leg- coordination, and walking and recorded three-dimensional joint position data during all tasks and center of pressure coordinates during weight-shifting. Each cerebellar subject was categorized as having no detectable deficits, a balance deficit only, a leg-placement deficit only, or both deficits.then determined the walking abnormalities associated with each of these categories .this study concluded that balance deficits are more closely related to cerebellar gait ataxia than leg-placement deficits.

Jennifer L. Keller et.al.,(2014)

Conducted a study to determine if a home balance exercise program is feasible for improving locomotor and balance abilities in cerebellar ataxia subjects. Fourteen subjects with cerebellar ataxia participated in a six-week individualized home-based balance exercise program and attended five testing sessions (2 pre-training, 1mid-training, 1 post-training, and 1 one month follow-up visit). Pre-training, post-training, and follow-up testing included a neurological assessment, clinical gait and balance tests, and laboratory assessments of balance and walking and concluded Improvement in locomotor performance in people with cerebellar ataxia after a six-week home balance exercise program.

Bultmann U et.al., (2014)

Conducted a study to assess motor deficits in the acute phase after isolated cerebellar stroke focusing on postural impairment and gait ataxia and outlines the role of lesion site on motor outcome, the course of recovery and the effect of treadmill training. 23 patients with acute and isolated cerebellar infarction participated. Deficits were quantified by ataxia scores and dynamic posturography in the acute phase and in a follow up after 2 weeks and 3 months. MRI data were obtained to correlate lesion site with motor After 3 months a mild ataxia in lower limbs and gait, especially in gait speed persisted. Because postural impairment had fully recovered, remaining gait ataxia was likely related to incoordination of lower limbs. Treadmill training did not show significant effects. Future studies are needed to investigate whether intensive coordinative training is of benefit in patients with cerebellar stroke.

VISUAL MOTOR CO-ORDINATION

R. C. Miall et.al., (2001)

Conducted a test using functional magnetic resonance imaging (fMRI) of the human brain during visually guided tracking tasks requiring varying degrees of eye–hand coordination. The cerebellum was more active during independent rather than coordinated eye and hand tracking. Motor coordination depends on predictive information about movement. Synchronous movement of two effectors cannot be achieved simply by reaction to reafferent proprioceptive or visual inputs. In the factorial experiment, coordinated tracking was more accurate than tracking with hand movement alone. Hence, a predictive 'forward model' estimate of the movement outcome based on motor commands being sent to one effector is probably used to program or modify the movement of the other effectors. In conclusion, previous imaging studies using parametric variations of movement parameters have shown responses distributed throughout the motor system. study has exposed activity constrained to the cerebellum and is thus powerful support for its role, suggested from physiology and theory, in the coordination of eye and hand movements.

Jeff Pelz et.al.,(2001)

Conducted a study to explore the temporal coordination of eye, head, and hand movements while subjects performed a simple block-copying task. The task involved fixations to gather information about the pattern, as well as visually guided hand movements to pick up and place blocks. Subjects used rhythmic patterns of eye, head, and hand movements in a fixed temporal sequence or coordinative structure. Coordination was maintained by delaying the hand movements until the eye was available for guiding the movement. This suggests that observers maintain coordination by setting up a temporary, task specific synergy between the eye and hand. Head movements displayed considerable flexibility and frequently diverged from the gaze change, appearing instead to be linked to the hand trajectories. This indicates that the coordination of eye and head in gaze changes is usually the consequence of a synergistic linkage rather than an obligatory one.

Sumit Ranjan et.al.,(2011)

The purpose of this study was to investigate the influence of eye movement on the characteristics of the hand movement during a reach to grasp task. In this experiment, 9 college-age individuals performed the task of reaching and grasping a vertical dowel in two conditions: (1) with eye movement and (2) without eye movement (by fixating eye on central dowel). compared the performance in three sub-conditions: (1) full vision, (2) vision block before eye movement, and (3) vision block after eye movement. found that presence or absence of either eye movement or continuous vision of target and hand does not modify the accuracy of grasp. Reach duration was shorter with full vision and reach trajectory was shorter when eye movement was coordinated with hand movement. We concluded that continuous vision of the hand and target is not necessary for the online control of these complex movements, but vision is necessary for optimizing the speed of the movement.

P.S.Archambault et.al., (2015)

Conducted a study to review the kinematics, reaction times and muscle activity observed during the online correction of hand movements as well as the underlying neurophysiological processes studied through single-cell neural recordings in monkeys. Brain stimulation, lesion and imaging studies in humans are also discussed. demonstrated that while online correction mechanisms strongly depend on the activity of a parieto-frontal network of which the posterior parietal cortex is a crucial node, these mechanisms proceed smoothly and are similar to what is observed during simple point-to-point movements. Online correction of hand movements would rely on feedforward and feedback mechanisms in the parietal cortex, as part of the activity within the fronto-parietal network for the planning and execution of visuo-motor tasks.

III MATERIALS AND METHODOLOGY

3.1 STUDY DESIGN

Single group pre test and post test experimental study design.

3.2 STUDY SETTING

Study was conducted in Department of physiotherapy K.G Hospital and physiotherapy Outpatient Department, KG College of Physiotherapy, Coimbatore.

3.3 STUDY SAMPLING

Based on selection criteria, 15 cerebellar ataxia subjects were selected and they were allotted into a single group .

3.4 STUDY DURATION

The study duration was for about 8 months and individual patient receives a treatment for duration of eight weeks.

3.5 CRITERIA FOR SELECTION

3.5.1 INCLUSION CRITERIA

- ❖ Both sexes were included in the study.
- ❖ Age group between 40-60 years.
- ❖ Patients diagnosed as cerebellar ataxia by neurologist.
- ❖ Cerebellar damage confirmed by MRI or CT scan.

- ❖ Tremor rating score of 1-4 according to FNT.
- ❖ Upper and lower limb muscle power >4.
- ❖ Berg balance scale score atleast 40/56.
- ❖ Patient able to stand and take steps.
- ❖ Patient with ability to understand therapist direction and communication.
- ❖ Patient with no medical contraindication against exercise.

3.5.2 EXCLUSION CRITERIA

- ❖ Patients with fredrick's ataxia.
- ❖ Cognitive impairment patients (MMSE score < 22).
- ❖ Medically unstable (uncontrolled hypertension, unstable angina).
- ❖ Disoriented patients.
- ❖ Tabes dorsalis.
- ❖ Wilson's disease.
- ❖ Spasticity and rigidity.
- ❖ Visual impairments and hearing deficits.

3.6 VARIABLES

3.6.1 INDEPENDENT VARIABLES

- ❖ Visual Motor Coordination (VMC)
- ❖ Body Awareness Therapy (BAT)

- ❖ Proximal stability training
- ❖ Balance training
- ❖ Functional movement training

3.6.2 DEPENDENT VARIABLE

- ❖ Balance
- ❖ Co-ordination
- ❖ Intensity of tremor

3.7 OUTCOME MEASURES

- ❖ Berg Balance scale (BBS)
- ❖ Nine Hole Peg Test (9HPT)
- ❖ Fahn's Tremor Rating Scale

3.8 PARAMETERS

- ❖ Balance
- ❖ Co-ordination
- ❖ Intensity of tremor

3.9 MATERIALS REQUIRED

- ❖ Weight cuffs
- ❖ Weighted jacket
- ❖ 9 hole-peg test apparatus

- ❖ Table ,chair
- ❖ Grading scale assessment sheets

3.10 ORIENTATION OF THE SUBJECTS

Before treatment all subjects were explained about the study and procedure to be applied and were asked to inform if they felt any discomfort during the course of the treatment. All the subjects who were interested to participate in the study were asked to sign the consent form before the treatment.

3.11 PROCEDURE

Based on the selection criteria 15 subjects were selected. They were assigned into a single group. All 15 subjects were involved for pre-test assessment for balance, coordination and intensity of tremor using the outcome measures.

The 8 weeks treatment program was given 5 days per week, 60 minutes per session.

❖ **GROUP (EXPERIMENTAL GROUP) :**

- Warm up exercise for 5 minutes.
- Primary components of the physiotherapy interventions include proximal stability training, balance training, and coordination exercise for the upper limbs.

- Furthermore, principles of Body Awareness Training (BAT) and Visual Motor Coordination (VMC) were applied to the Physiotherapy interventions.
- Cool down exercises for 5 minutes.

After 8 weeks of treatment sessions, all subjects were involved for the post test assessment.

3.12 STATISTICAL TOOLS

Paired‘t’ test:

Formula of paired‘t’ test:

$$S = \sqrt{\frac{\sum d^2 - \frac{(\sum d)^2}{n}}{n-1}}$$

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

d = difference between the pre test versus post test

$\bar{d}$ = mean difference

n = total number of subjects

S = standard deviation

$\sum d^2$ = sum of the squared deviation

IV DATA ANALYSIS AND INTERPRETATION

TABLE I

BERG BALANCE SCALE

PAIRED 't' TEST - PRE TEST AND POST TEST VALUES

<table>
<tr><th>S. No</th><th>Test</th><th>Mean</th><th>Mean Difference</th><th>Standard deviation</th><th>Paired 't' Value</th></tr>
<tr><td>1.</td><td>PRE TEST</td><td>43.40</td><td rowspan="2">9.6</td><td>1.64</td><td rowspan="2">13.9396</td></tr>
<tr><td>2.</td><td>POST TEST</td><td>53.00</td><td>1.93</td></tr>
</table>

The table I shows the analysis of Berg Balance Scale. Using paired 't' test with 14 degrees of freedom and 0.05% as a level of significance, the table 't' value is 1.761 which was lesser than the calculated 't' value 13.94. The result shows that there was marked difference between pre-test and post-test values.

GRAPH I

BERG BALANCE SCALE

PAIRED ‘t’ TEST - PRE TEST AND POST TEST VALUES

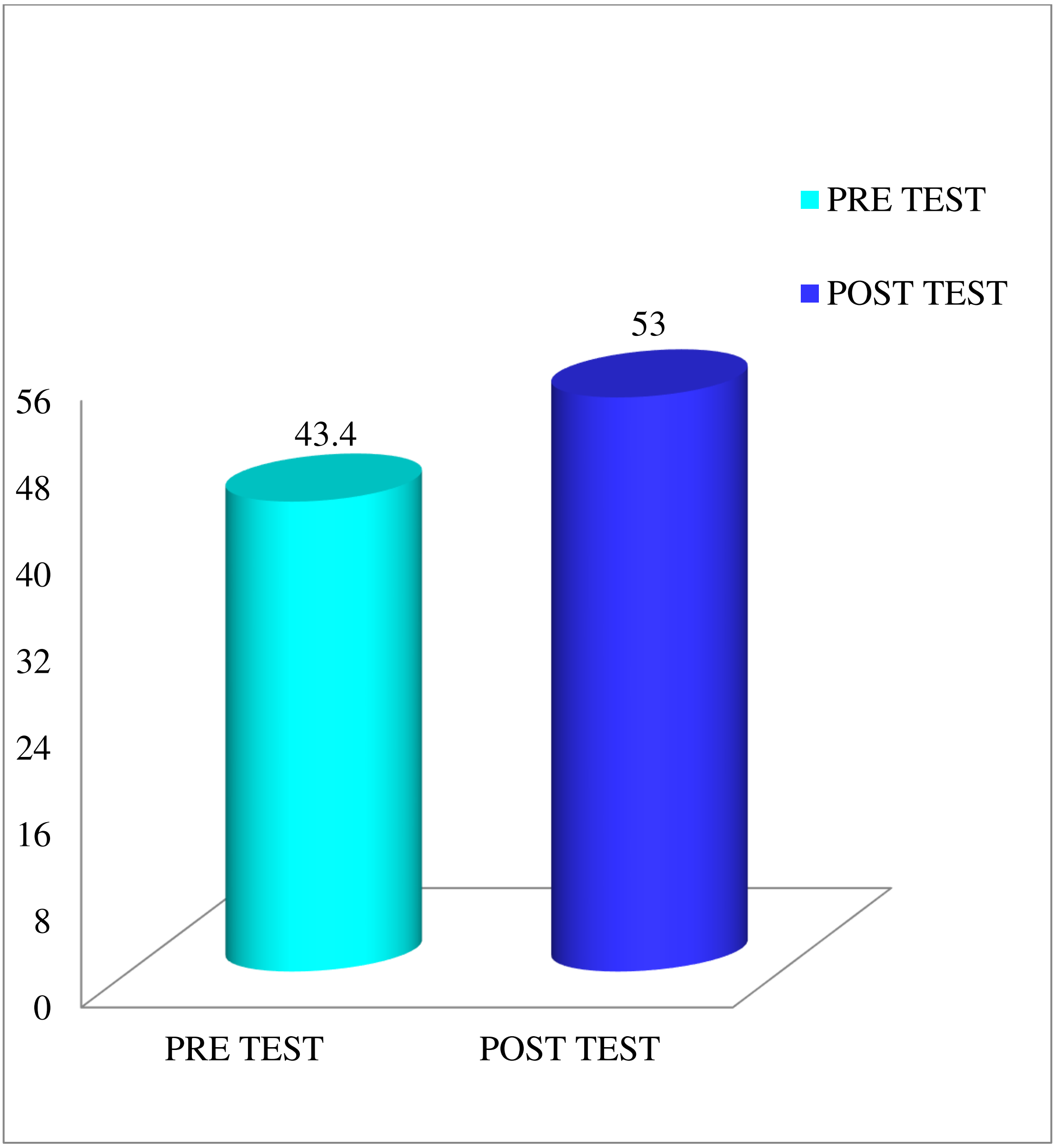


TABLE II

NINE HOLE PEG TEST

PAIRED ‘t’ TEST - PRE TEST AND POST TEST VALUES

S. No	Test	Mean	Mean Difference	Standard deviation	Paired ‘t’ Value
1.	PRE TEST	2.80	3.2	0.77	11.4508
2.	POST TEST	6.00		1.31	

The table II shows the analysis of Nine Hole Peg Test. Using paired ‘t’ test with 14 degrees of freedom and 0.05% as a level of significance, the table ‘t’ value is 1.761 which was lesser than the calculated ‘t’ value 11.45. The result shows that there was marked difference between pre-test and post-test values.

GRAPH II

NINE HOLE PEG TEST

PAIRED ‘t’ TEST - PRE TEST AND POST TEST VALUES

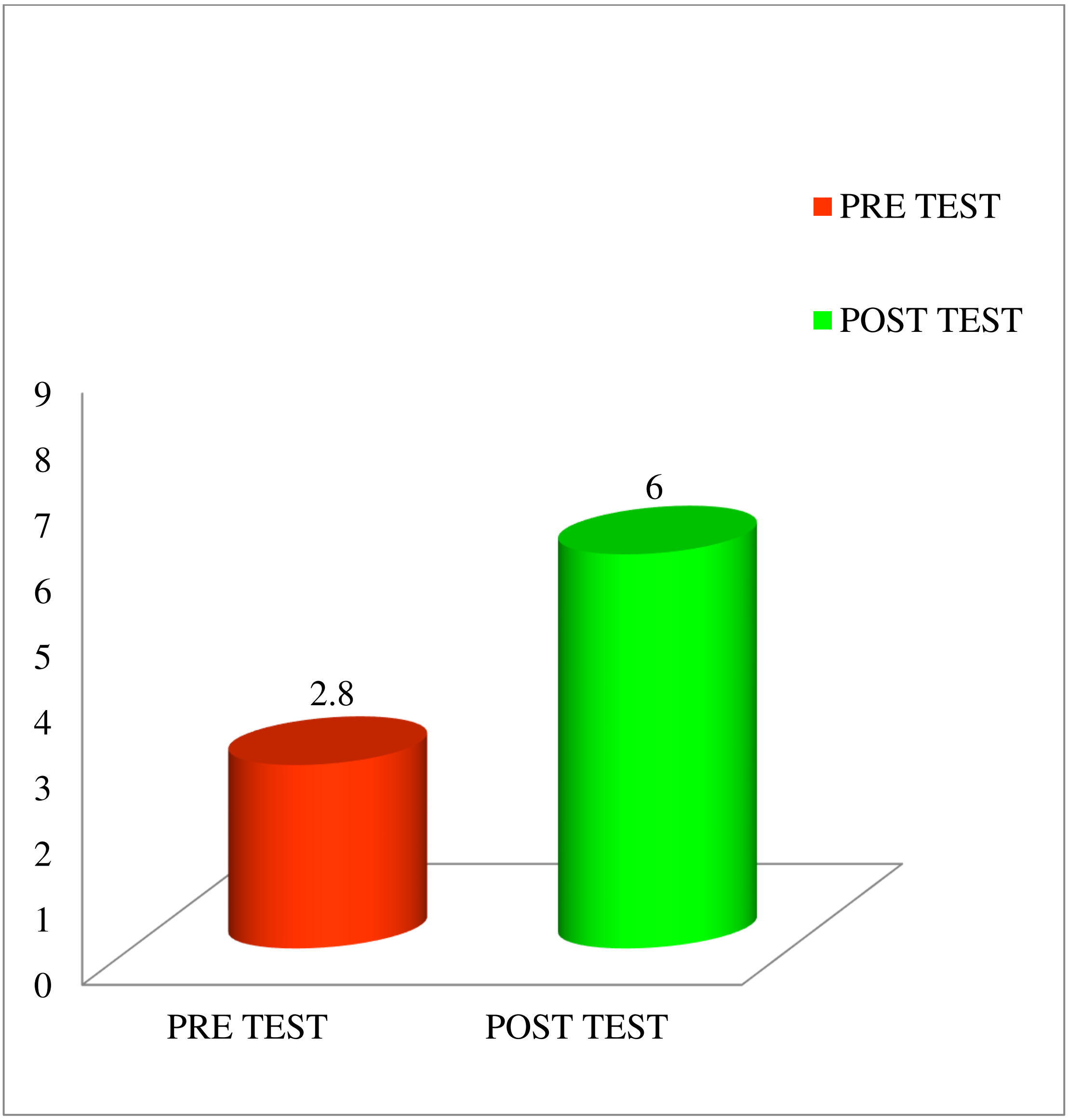


TABLE III

FAHN'S TREMOR RATING SCALE

PAIRED 't' TEST - PRE TEST AND POST TEST VALUES

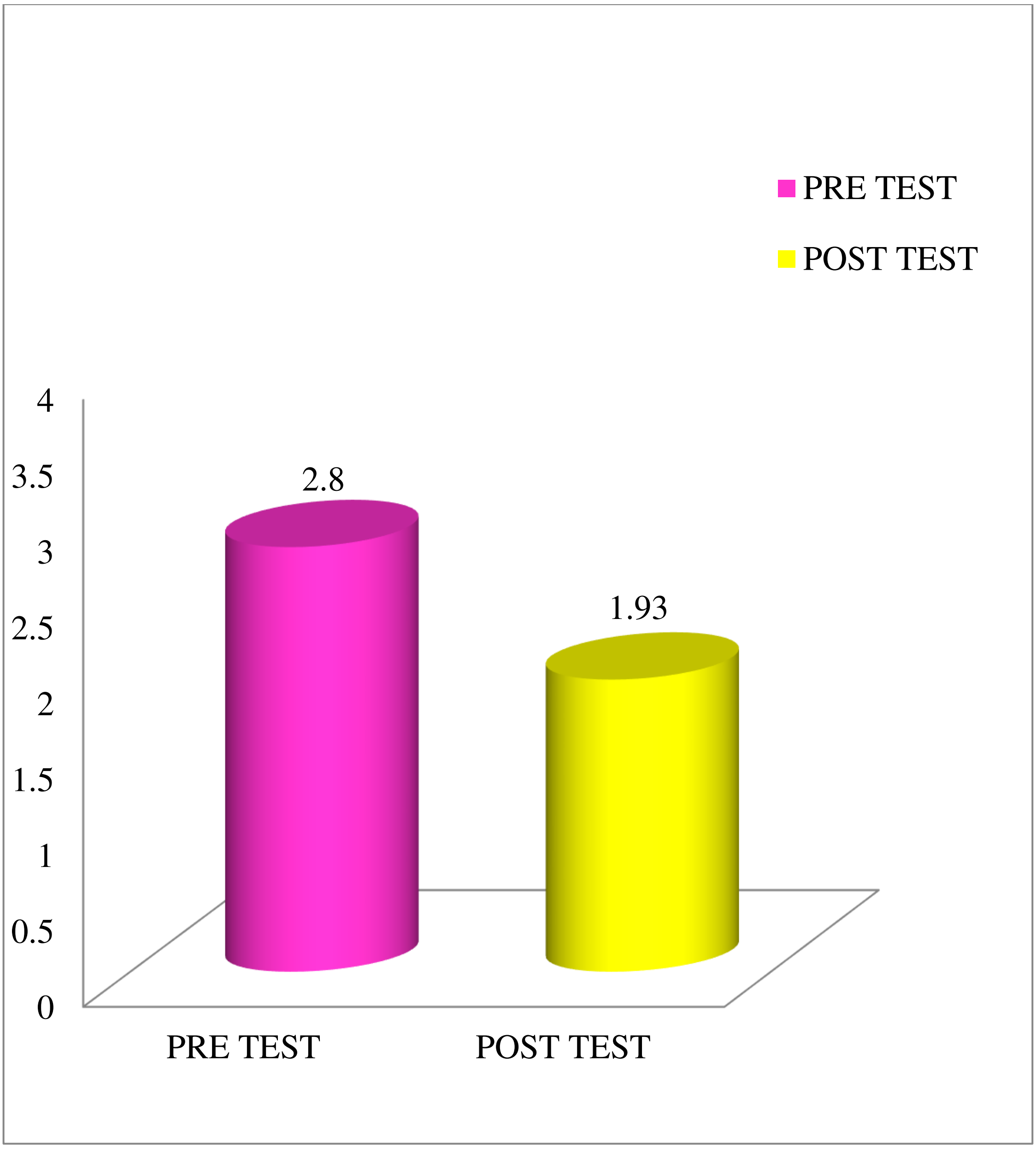
S. No	Test	Mean	Mean Difference	Standard deviation	Paired 't' Value
1.	PRE TEST	2.80	0.87	0.77	3.1663
2.	POST TEST	1.93		0.80	

The table III shows the analysis of Fahn's Tremor Rating Scale . Using paired 't' test with 14 degrees of freedom and 0.05% as a level of significance, the table 't' value is 1.761 which was lesser than the calculated 't' value 3.17. The result shows that there was marked difference between pre-test and post-test values.

GRAPH III

FAHN'S TREMOR RATING SCALE

PAIRED 't' TEST - PRE TEST AND POST TEST VALUES



V DISCUSSION

This study is to analyze the effect of visual motor coordination with body awareness training on balance, coordination and intensity of tremor in patients with cerebellar ataxia.

There is a paucity of research describing the effectiveness of rehabilitation interventions for individual's cerebellar ataxia. This study describes a novel Physiotherapy approach that emphasized balance, functional movement, and proximal stability training with an integration of principles of BAT and VMC in patients with cerebellar ataxia.

Body Awareness Training generates awareness of one's body and enables focus on body awareness during movement. Movements are performed in various positions in order to identify the center line of the body, Balance depends on multiple sensory inputs and neuromuscular system interactions, BAT consisted of sensory stimulation and awareness of shifting body weight, as a result, balance ability is improved. However, walking speed is related more to strength than to sensation (Dae-Hyouk Bang, et.al., 2016). Body awareness training (BAT) is a method for improvement of dynamic balance and postural control ability. BAT is comprised of simple repetitive movements that maintain ability using stability limits (Eriksson EM et.al., 2007). The participants receiving the intervention had improved body awareness, body acceptance, and self-efficacy (Gyllensten et.al., 2003).

Visual feedback influence the coordinate frame in which the CNS stores and recalls the memories of learned skills in a reaching-generalization task (Parmar PN et.al., 2011). Visual Motor Coordination was incorporated into balance and proximal stability training. Integrating visual input into motor abilities was a key component to enhance the overall treatment. VMC was used to heighten the information about body movements. Altered functional movement patterns, hypothesized because of poor visual integration, were noted in the examination and during subsequent therapy sessions. Given the patient's presentation and the known cerebellar influence on saccade generation, (Quinet J et.al., 2015)

Postural stability is defined as the ability to maintain or control the center of mass in relation to the base of support to prevent falls and complete desired movements .The ability to maintain a posture, such as balancing in a standing or sitting position, is operationally defined as static balance (Horak FB et.al., 1987). The significant effect of core stability training may be attributed to that core stability training improves neuromuscular system performance that causes the optimal lumbar-pelvic -hip chain mobility and good acceleration and deceleration, appropriate muscular balance, proximal stability and good function (Norris CM et.al., 2001). These will result in strengthening the lower extremity muscles which can control the movement (Gribble P et.al., 2003).

Numerous studies confirmed the significant effect of core stability in adult populations with different pathological conditions (Ko et.al., 2004) concluded that core stability exercises have a positive effect on the improvement of physical and psychological performances of older women who are vulnerable to falls. (Ozmen et.al., 2015) concluded that core stability exercises resulted in significant gains in balance and core endurances in adolescent badminton players. (Sandrey and Mitzel et.al., 2013) found that a 6-week core stabilization training resulted in significant improvement in balance test score in high school track and field athletes.(YU and Park et.al., 2013) concluded that the core stability enhancing exercise is effective in improving muscle activity of the lower trunk in stroke patients.

Physical therapy intervention is the primary treatment for gait ataxia and imbalance in individuals with cerebellar damage. Evidence suggests that individuals with cerebellar disease may benefit from long-term motor training. Following an intensive, high-level four-week training program, cerebellar patients showed the ability to improve motor skills and functional performance Intensive coordinative training improves motor performance in degenerative cerebellar disease. (Ilg W et.al., 2009).

Dynamic and static balance exercises, affected dynamic balance more than static balance, and we did not test dynamic balance. Improving dynamic balance during gait may be reflected in the trend towards reduced variability in stride length across visits. In the future a dynamic balance test, such as shift of center of gravity, should be assessed(Morton SM et al 2010)

In patients with cerebellar ataxia, coordinative training improves motor performance and reduces ataxia symptoms, enabling them to achieve personally meaningful goals in everyday life. Training effects were more distinct for patients whose afferent pathways were not affected (Synofzik M et.al., 2009). Patients with degenerative cerebellar disease, continuous coordinative training leads to long-term improvements, which translate to real world function. (Burkard S et.al., 2010).

Hence this study was conducted to find out the effectiveness of visual motor coordination and body awareness training in cerebellar ataxia patients. Primary outcome measures used were Berg Balance Scale, Nine Hole Peg Test , Fahn's Tremor Rating Scale to assess the Balance, Coordination and Intensity Of Tremor.

Analysis of pre-test and post-test values of the experimental group at 5% level of significance showed significant improvement in Berg Balance Scale , Nine Hole Peg Test , Fahn's Tremor Rating Scale following Visual Motor Coordination and Body Awareness Training. This permits the rejection of null hypothesis.

It can be concluded that visual motor coordination and body awareness training in a low cost and low risk motor rehabilitation intervention for individuals with cerebellar ataxia.

VI SUMMARY AND CONCLUSION

This study is to find out the effectiveness of visual motor coordination and body awareness training on balance, coordination and intensity of tremor in patients with cerebellar ataxia.

Based on the selection criteria 15 subjects were selected. They were assigned into a single group, All 15 subjects were involved for pre-test assessment for balance, coordination and intensity of tremor using the Berg balance scale, Nine hole peg test and Fahn's tremor rating scale.

The 8 weeks treatment program was given for 5 days per week, 60 minutes per session. where each session consists of 5 mins of warm-up , followed by physiotherapy intervention including Proximal stability training, Balance training ,Functional movement training using the principles of Visual Motor Coordination and Body Awareness Training , after the 8 weeks of the treatment program the post-test assessment for the Balance, Coordination and Intensity of Tremor was done using the outcome measures.

The results were analyzed using student't' test, that showed a significant improvement .Hence it can be concluded that the visual motor coordination with body awareness training is effective in patients with cerebellar ataxia.

VII LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS

1. The period allotted for the study was found to be insufficient for the inclusion of greater number of subjects.
2. Study was done only in a single group.
3. Without a control group this finding is limited.
4. Influence of drug, nutritional, psychological state and climate cannot be controlled.
5. Though Berg Balance scale (BBS),Fahn’s Tremor Rating Scale ,Nine Hole Peg Test (9HPT) were administered, bias is possible.
6. The difference in individual interest shown towards to the treatment sessions and further practice.
7. Small study 15 subjects were only included in the study.

RECOMMENDATIONS

1. Comparative study has to be done to prove the effectiveness.
2. Study with more patients is recommended.
3. Study can be done in subjects with different age groups.
4. The study can be extended to all other types of genetic cerebellar degeneration.
5. Follow up study can be done to know the long term effects.

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X APPENDIX

APPENDIX-I

BODY AWARENESS TRAINING

Body awareness training (BAT) is a method for improvement of dynamic balance and postural control ability. BAT is comprised of simple repetitive movements that maintain ability using stability limits. A main component of BAT is to enhance an individual's awareness of their movement. BAT results in improved postural control, balance, free breathing, and coordination.

The physiotherapist encourage the patients to move in more optimal ways by using both body gestures and words for guiding. Turning the attention both to the patient's own performance and to what is experienced during the exercises is central elements of the therapy and stimulates mental presence and awareness.

- The participants were informed to wear comfortable clothes and be barefoot to be able to be in contact with the floor during the movements.

- The sessions started and ended sitting on a chair. Together with the physiotherapist, the participants reflected upon the exercises; experiences, bodily and mental aspects, and expectations before the up-coming session.
- The intention was that participants would experience how the movement felt in their bodies, and how they could integrate the movements in their everyday life.
- Up and down from the floor was part of the movements. Participants who expressed fear of falling were given the option of having a chair behind when doing exercises in standing. Adapted to the participants' capacity, the

intensity in the sessions and the degree of difficulty was increased by the physiotherapists during the eight-week period.

- The participants were urged to incorporate the movements in their daily life, however, no specific home movements were given.
- Movements were performed in sitting, standing, and supine. In sitting, to find a good alignment a pillow wedge was used and the participants were not allowed to use the backrest.
- The participants were urged to be aware of tensions in the body, soften in the lower back and the hip joints, and feeling that the legs and feet carried some of your weight.
- Participants were asked to reflect upon their breathing and the contact with the chair and the floor. By pressing one foot at a time to the floor the centre line (core stability) was stimulated.
- To incorporate their breathing, the participants were encouraged to sound on the letter ‘m’ when breathing out. With the sound, the participant could both feel the vibrations in the body and hear if their breaths were regular and calm

- In standing, the participants were told to stand with the feet hip abroad marching in place, noticing their feet against the floor. The stability limits were explored by shifting the weight forward, backward, left, and right until feeling that you are in balance. In standing, the centre line was stimulated through rotation around the centre line and the arms softly moving.

- In supine, participants were lying with straight legs, focusing on contact with the floor and their breathing.

APPENDIX-II

VISUAL MOTOR COORDINATION

Visual Motor Integration (VMI) is the ability of the eyes & hands to work together in smooth, efficient patterns. It involves visual perception and eye-hand co-ordination. Visual-Motor skills require the ability to translate visual perception into motor functioning and involve motor control, motor accuracy, motor co-ordination and psychomotor speed.

The patient is adviced to see the actions and exercise they perform throughout rehabilitation program.

APPENDIX-III

PROXIMAL STABILITY TRAINING

Proximal stability training involved core strengthening exercises with the inclusion of cues that guided the patient's attention to increasing awareness of his body in space during activities such as weighted trunk rotation.

- Scapular stabilization exercises in supine
- Four-way bilateral hip strengthening with resistance
- Weighted trunk rotation
- Squat training with upper extremity proprioceptive neuromuscular facilitation patterns (D1/D2) including visual tracking of the hand

- Upper extremity proprioceptive neuromuscular facilitation patterns (D1/D2) including visual tracking of the hand while in quadruped and tall kneeling

APPENDIX-IV

BALANCE TRAINING

Balance training involved progressively reaching his limits of stability during activities in a standing position such as reactive stepping.

- Multidirectional stepping
- Multidirectional stepping with verbal cues: for direction change and to colored dots on floor
- Single limb stance with VMC (eyes open and eyes closed; on foam)
- Single limb stance on foam with trunk rotation
- Single limb stance with VMC (eyes open and eyes closed; on foam; trunk rotation)

- Single limb stance on foam with addition of head turns to integrate visual exercises
- Single limb stance on foam with addition of head turns and vestibulo-ocular reflex exercises

- Gait and balance training through obstacle course training incorporating single limb stance, cross stepping, reactive stepping, changing speeds, and adding complex motor and cognitive tasks
- Static balance training that included visual complexity (background changes, head turns, eyes open and eyes closed)
- Gait and balance training through obstacle course training incorporating single limb stance, cross stepping, reactive stepping, changing speeds, and adding complex motor and cognitive tasks

APPENDIX-V

FUNCTIONAL MOVEMENT TRAINING

Functional movement training involved increasing body awareness during functional movement patterns.

All the upper limb activities performed with weight cuff (1kg) over the wrist.

- Sitting with arm supported on a table and placing hand at specific mark
- Try to reach an object
- Picking up objects
- Put the hand in a ring or hole
- Flex the shoulder to 90 degree with elbow and wrist extended , then take the finger to the tip of the nose
- Touch the therapist finger and then to the tip of the patient nose
- Tap bilateral hand on bilateral thighs and alternating palmer and dorsal surfaces as fast as possible.

APPENDIX-VI

BERG BALANCE SCALE

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. A recent study of the BBS, which was completed in Finland, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities.

Description:

14-item scale designed to measure balance of the older adult in a clinical setting.

Equipment needed:

Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Completion:

Time: 15-20 minutes

Scoring: A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56

Interpretation: 41-56 = low fall risk

21-40 = medium fall risk

0 –20 = high fall risk

A change of 8 points is required to reveal a genuine change in function between 2 assessments.

Berg Balance Scale

Name: ____________________________________ Date: ____________________

Location: __________________________________ Rater: ____________________

ITEM DESCRIPTION SCORE (0-4)

Sitting to standing ________

Standing unsupported ________

Sitting unsupported ________

Standing to sitting ________

Transfers ________

Standing with eyes closed ________

Standing with feet together ________

Reaching forward with outstretched arm ________

Retrieving object from floor ________

Turning to look behind ________

Turning 360 degrees ________

Placing alternate foot on stool ________

Standing with one foot in front ________

Standing on one foot ________ Total ________

GENERAL INSTRUCTIONS:

Document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item. In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

• The time or distance requirements are not met

• The subject's performance warrants supervision

• The subject touches an external support or receives assistance from the examiner.

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring. Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and

10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

Berg Balance Scale

SITTING TO STANDING : Please stand up. Try not to use your hand for support.

- 4- able to stand without using hands and stabilize independently
- 3- able to stand independently using hands
- 2- able to stand using hands after several tries
- 1- needs minimal aid to stand or stabilize
- 0- needs moderate or maximal assist to stand

STANDING UNSUPPORTED: Please stand for two minutes without holding on.

- 4- able to stand safely for 2 minutes
- 3 - able to stand 2 minutes with supervision
- 2 - able to stand 30 seconds unsupported
- 1 - needs several tries to stand 30 seconds unsupported
- 0- unable to stand 30 seconds unsupported If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL: Please sit with arms folded for 2 minutes.

- 4- able to sit safely and securely for 2 minutes
- 3 - able to sit 2 minutes under supervision

- 2 - able to able to sit 30 seconds
- 1 -able to sit 10 seconds
- 0 - unable to sit without support 10 seconds

STANDING TO SITTING : Please sit down.

- 4- sits safely with minimal use of hands
- 3 - controls descent by using hands
- 2 - uses back of legs against chair to control descent
- 1 - sits independently but has uncontrolled descent
- 0 - needs assist to sit

TRANSFERS INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

- 4- able to transfer safely with minor use of hands
- 3- able to transfer safely definite need of hands
- 2- able to transfer with verbal cuing and/or supervision
- 1- needs one person to assist
- 0- needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED INSTRUCTIONS:

Please close your eyes and stand still for 10 seconds.

- 4- able to stand 10 seconds safely

- 3- able to stand 10 seconds with supervision
- 2- able to stand 3 seconds
- 1- unable to keep eyes closed 3 seconds but stays safely
- 0- needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER INSTRUCTIONS: Place your feet together and stand without holding on

- 4- able to place feet together independently and stand 1 minute safely
- 3- able to place feet together independently and stand 1 minute with supervision
- 2- able to place feet together independently but unable to hold for 30 seconds
- 1- needs help to attain position but able to stand 15 seconds feet together
- 0- needs help to attain position and unable to hold for 15 seconds

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

- 4 - can reach forward confidently 25 cm (10 inches)
- 3- can reach forward 12 cm (5 inches)
- 2- can reach forward 5 cm (2 inches)

- 1- reaches forward but needs supervision
- 0- loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.

- 4- able to pick up slipper safely and easily
- 3- able to pick up slipper but needs supervision
- 2- unable to pick up but reaches 2-5 cm (1-2 inches) from slipper and keeps balance independently
- 1- unable to pick up and needs supervision while trying
- 0- unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)

- 4- looks behind from both sides and weight shifts well
- 3 -looks behind one side only other side shows less weight shift
- 2 -turns sideways only but maintains balance
- 1 -needs supervision when turning
- 0 -needs assist to keep from losing balance or falling

TURN 360 DEGREES INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

- 4- able to turn 360 degrees safely in 4 seconds or less
- 3 - able to turn 360 degrees safely one side only 4 seconds or less
- 2- able to turn 360 degrees safely but slowly
- 1- needs close supervision or verbal cuing
- 0- needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

- 4- able to stand independently and safely and complete 8 steps in 20 seconds
- 3 -able to stand independently and complete 8 steps in > 20 seconds
- 2- able to complete 4 steps without aid with supervision
- 1 -able to complete > 2 steps needs minimal assist
- 0- needs assistance to keep from falling /unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot.

- 4- able to place foot tandem independently and hold 30 seconds

- 3- able to place foot ahead independently and hold 30 seconds
- 2- able to take small step independently and hold 30 seconds
- 1- needs help to step but can hold 15 seconds
- 0- loses balance while stepping or standing

STANDING ON ONE LEG INSTRUCTIONS: Stand on one leg as long as you can without holding on.

- 4- able to lift leg independently and hold > 10 seconds
- 3- able to lift leg independently and hold 5-10 seconds
- 2- able to lift leg independently and hold ≥ 3 seconds
- 1- tries to lift leg unable to hold 3 seconds but remains standing independently.
- 0- unable to try of needs assist to prevent fall

TOTAL SCORE (Maximum = 56)

APPENDIX-VII

NINE HOLE PEG TEST INSTRUCTIONS

General Information:

- The Nine Hole Peg Test should be conducted with the dominant arm first.
- One practice trial (per arm) should be provided prior to timing the test.
- Timing should be performed with a stopwatch and recorded in seconds.
- The stop watch is started when the patient touches the first peg.
- The stop watch is stopped when the patient places the last peg in the container.

Set-up (Mathiowetz et al, 1985):

- A square board with 9 holes,
  - i. holes are spaced 3.2 cm (1.25 inches)
  - ii. apart each hole is 1.3 cm (.5 inches) deep
- 9 wooden pegs should be .64 cm (.25 inches) in diameter and 3.2 cm (1.25 inches) long
- A container that is constructed from .7 cm (.25 inches) of plywood, sides are attached (13 cm x 13 cm) using nails and glue
- The peg board should have a mechanism to decrease slippage.
- The pegboard should be placed in front of the patient, with the container holding the pegs on the side of the dominant hand.

Patient Instructions (Mathiowetz et al, 1985):

- The instructions should be provided while the activity is demonstrated.
- The patient's dominant arm is tested first.
- Instruct the patient to:
    i. "Pick up the pegs one at a time, using your right (or left) hand only and put them into the holes in any order until the holes are all filled. Then remove the pegs one at a time and return them to the container. Stabilize the peg board with your left (or right) hand. This is a practice test. See how fast you can put all the pegs in and take them out again. Are you ready? Go!"
- After the patient performs the practice trial, instruct the patient:
    i. "This will be the actual test. The instructions are the same. Work as quickly as you can. Are you ready? Go!" (Start the stop watch when the patient touches the first peg.)
    ii. While the patient is performing the test say "Faster"
    iii. When the patient places the last peg on the board, instruct the patient "Out again…faster."
    iv. Stop the stop watch when the last peg hits the container.
- Place the container on the opposite side of the pegboard and repeat the instructions with the non-dominant hand.

Nine Hole Peg Test

Name:____

______

Dominant Hand (circle one): Right Left

Time to complete the test in seconds:

Date: ________

Dominant Hand: ___________ Non-Dominant Hand: _______

Date: ________

Dominant Hand: ___________ Non-Dominant Hand: _______

Date: ________

Dominant Hand: ___________ Non-Dominant Hand: _______

Date: ________

Dominant Hand: ___________ Non-Dominant Hand: _______

APPENDIX-VIII

FAHN'S TREMOR RATING SCORE ACCORDING TO FNT

Patient sits comfortably. If necessary, support of feet and trunk is allowed. Patient is asked to point repeatedly with his index finger from his nose to examiner's finger which is in front of the patient at about 90 % of patient reach. Movements are performed at moderate speed. Average performance of movements is rated according to the amplitude of the intentional tremor.

0 -No tremor

1- Tremor with an amplitude < 2 cm

2 - Tremor with an amplitude < 5 cm

3 -Tremor with an amplitude > 5 cm

4 -Unable to perform 5 pointing movements

APPENDIX-IX

CONSENT FORM

This is to certify that I --- freely and voluntarily agree to participate in the study **"EFFECT OF VISUAL MOTOR COORDINATION WITH BODY AWARENESS TRAINING ON BALANCE, CO-ORDINATION AND INTENSITY OF TREMOR IN PATIENTS WITH CEREBELLAR ATAXIA"**

I have explained about the procedure and the risks that would occur during the study.

Participant:

Witness:

Date:

I have explained and defined the procedure to which the subject has consented to participate.

Researcher:

Date: