International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effect of Fast Muscle Activation and Stepping Training (Fast) on Balance and Mobility in Individuals with Cerebellar Ataxia- An Experimental Study

Dr. Dhruti D Shah[1], Dr. Khyati Shah[2]

[1]PT MPT (Neurosciences) Gujarat University Shree Swaminarayan Physiotherapy College, Ranip Ahmedabad.
[2]PT MPT (Neurological and Psychosomatic Disorders), Professor, vice-principal and PG Guide, PhD scholar Shree Swaminarayan Physiotherapy College, Ranip, Ahmedabad.

ABSTRACT

INTRODUCTION: Cerebellar ataxia is a heterogeneous group of movement disorders caused by cerebellar damage. Balance impairment is a key issue in approximately 70% of individuals with cerebellar ataxia, yet targeted training of movement speed required to regain balance has been largely overlooked. The Fast Muscle Activation and Stepping Training (FAST) program incorporates rapid functional movements that produce bursts of muscle activation essential for effective stepping, balance, and postural recovery.

AIM OF THE STUDY: To evaluate the effectiveness of Fast Muscle Activation and Stepping Training on balance and mobility in individuals with cerebellar ataxia.

METHOD: A pre-post experimental design was used. Twenty-four individuals with cerebellar ataxia (aged 40–70 years, both male and female), diagnosed by a neurologist and willing to participate, were recruited through random sampling. Individuals with Berg Balance Scale (BBS) score 21–40 (moderate balance impairment), Timed Up and Go (TUG) >20 seconds (moderate fall risk), Scale for the Assessment and Rating of Ataxia (SARA) 6–23 (moderate ataxia), Mini-Mental State Examination (MMSE) >24, and independent ambulation with/without a cane were included. Individuals with sensory ataxia, prosthetic device use, congenital anomalies, spinal or lower limb injuries affecting weight bearing, psychological, neurological, or cardiorespiratory conditions, peripheral neuropathy, or seizures were excluded. Participants underwent intervention for 3 days per week for 8 weeks (45 minutes per session). Outcomes included BBS, SARA, and TUG. Data were analyzed using SPSS version 20.0. Normality was tested with the Shapiro–Wilk test; pre- and post-intervention comparisons were analyzed with a paired t-test.

RESULT: The Shapiro–Wilk test confirmed normal data distribution ($p > 0.05$). The paired t-test revealed statistically significant improvements in balance and mobility post-intervention ($p < 0.05$).

CONCLUSION: The FAST intervention demonstrated significant improvement in balance and mobility in individuals with cerebellar ataxia. It is considered feasible for clinical application.

KEYWORDS: Cerebellar ataxia, FAST training, Balance.

INTRODUCTION

Cerebellar ataxia (CA) is not a disease but instead describes a collection of symptoms associated with both genetic and acquired disease that affects the cerebellum or its connections. Cerebellar ataxia is characterized by postural and gait instability, lack of coordination of extremities and trunk with cognitive impairment. The overall prevalence of the disease associated with Cerebellar ataxia is 8.22 per 100,000 population.[1] An ataxic patient often struggle with their functional disability, they often experience progressive loss of functional independence due to frequent fall, requiring long term rehabilitation.[2] Several current approaches for Cerebellar ataxia including standard care physiotherapy methods, vestibular Rehabilitation, Intensive physiotherapy and other advance techniques like r-TMS have demonstrated varying degrees of effectiveness. However these methods often face challenges, such as limited accessibility, High resource demand for Cerebellar ataxia.[3] Ataxia frequently lack individualized intervention tailored to patient specific needs, which are critical for optimizing rehabilitation outcomes.

FAST intervention is an approach works on dynamic balance & mobility and they observed that session of FAST training in cerebellar ataxia survivor has found to improve muscle activation and postural response during an internal perturbation balance task.[1] Recent cases series reported that improvement were seen in dynamic balance that were retrained for 8 week following a fast-stepping session training. Their changes in balance were accompanied by an increase in participation in meaningful activates in community and improvements in movement kinematic of stepping Reactions.[5] Finding suggests that FAST training may be effective approach to improve dynamic balance and mobility following ataxia.

Its mechanism hypotheses is FAST retraining will result in 1) Increase fast and self-selected natural walking speed. 2) Reduced postural sway perturbation. 3) Improved timing and amplitude of muscle activation during FAST (squat). 4) Increased Balance self-efficacy. Therefore, this study aims to evaluate the effect of Fast muscle activation and stepping training on balance and mobility in individuals with cerebellar ataxia.[6]

METHODOLOGY

Type of Study: An Experimental Study

Sample Size: 24

Sample population: Cerebellar Ataxia

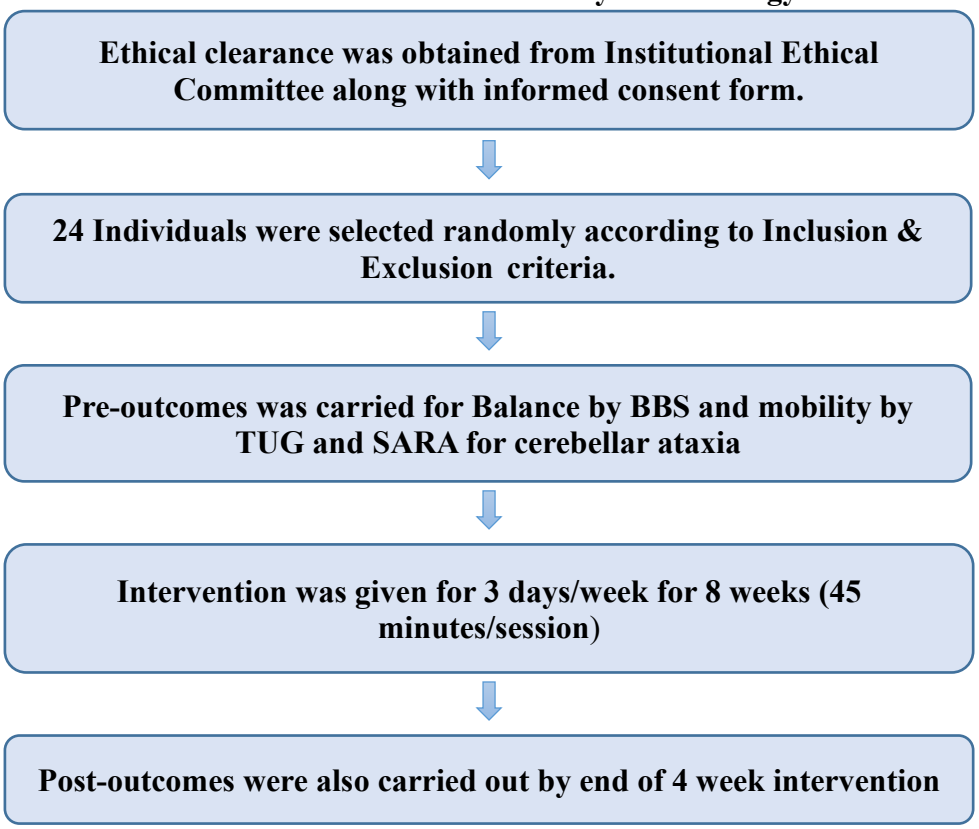
Sampling method: Purposive Sampling

An experimental study design was done to investigate the effect of the FAST program on balance and mobility in individuals with cerebellar ataxia. The study was approved by the Institutional Ethics Committee of Shree Swaminarayan Physiotherapy College, Bhuj, Gujarat (approval no. SPCP/IEC/150/2025). Written informed consent was obtained from all participants prior to their enrollment in the study. The study was conducted at S.M.H. Hospital and affiliated clinics in Bhuj, Gujarat, India. Participants were individuals who were clinically diagnosed with cerebellar ataxia by a neurologist. A total of 24 participants who met the eligibility criteria were recruited for the study. The intervention was conducted for three days a week over a period of eight weeks, with each session lasting approximately 45 minutes. Participants were recruited using purposive sampling and were randomly allocated into the study group. Since this was a single-group pre-post design, participant blinding was not possible. However, outcome assessments were conducted by an independent blinded assessor to minimize bias.

The inclusion criteria for participation were: individuals aged between 40 to 70 years, both males and females, diagnosed with cerebellar ataxia by a neurologist, willing to participate and provide informed

consent, and scoring within specific clinical limits — Berg Balance Scale (BBS) score between 21–40 (indicating moderate balance impairment), Timed Up and Go (TUG) score up to 20 seconds (indicating moderate fall risk), Scale for the Assessment and Rating of Ataxia (SARA) score between 6–23 (moderate ataxia), and Mini-Mental State Examination (MMSE) score above 24. Participants were required to be ambulatory, with or without the use of assistive devices. Exclusion criteria included individuals with sensory ataxia, congenital anomalies, prosthetic devices, epilepsy or conditions affecting weight-bearing, severe psychological, cardiac, or respiratory disorders, peripheral neuropathy, or other severe illnesses[7,1]

FIGURE 1. Flowchart of Study Methodology



OUTCOME MEASURES

1. **BERG BALANCE SCALE (BBS):** [7] Evaluates static and dynamic balance across 14 functional tasks. Demonstrates excellent inter-rater and intra-rater reliability (ICC = 0.95). Shows strong validity in neurological populations.[7]
2. **TIMED UP AND GO TEST (TUG)** [7] Measures functional mobility and fall risk by recording the time to rise from a chair, walk 3 meters, turn, and return to the chair. High test–retest reliability (ICC = 0.99). Demonstrates good concurrent validity with gait and balance measures.
3. **SCALE FOR THE ASSESSMENT AND RATING OF ATAXIA (SARA):** A clinical scale assessing gait, stance, coordination, and speech in ataxia. Demonstrates high inter-rater reliability (ICC = 0.98) and strong construct validity for ataxia severity.

PROCEDURE

After obtaining the informed consent from the patient the procedure was explained in detail to the subjects. All the patients underwent pre-test assessment for balance and mobility by BBS, SARA, TUG. Based on

the selection criteria 24 subjects were selected and they were assigned using Purposive sampling.

FAST MUSCLE ACTIVATION AND STEPPING TRAINING: [5]

1**) Squats**: (30 degrees of hip and knee flexion as fast as possible)

- 5 sets of repetitions|
- 5 sec of rest between each repetition
- 30 sec between each set

2 Steps:

Instructions: Lean forward/ backward/ to the side and let yourself fall like a tree until you feel like you are losing your balance. The goal is to take steps that are long enough and fast enough that you are able to regain y our balance.

Progression of step activities includes:

A. Simple blocked practice: (Stepping leading with each leg in each direction is practiced in blocks of 10 repetitions)

* 2 sets of 60 repetitions 10 rep/set

* Leading with right and left leg leaning forward, backward and lateral directions.

B. Semi-random practice:

1. Stepping leading with each leg in each direction is practiced in blocks of 5 repetition

5 sets of 5 reps with each leg in each direction (75 reps with each leg/each side in total)

II. Stepping using alternate leading legs/leaning side each time for total 10 reps (5 reps/side) forward, backward and laterally.

5 sets of 10 reps (75 reps with each leg/to each side)

C. Random practice:

Stepping leading with paretic leg in all 3 directions-forward, backwards and laterally to left side then leading with the right leg in all 3 directions.

D. Random nomination of lead leg with reduced movement planning time

Therapist randomly nominates the lead leg after leaning in the forward or backward direction has been initiated by the participant.

- 20 steps with any leg in the forward and backward directions (40 reps)

E. Concurrent task planning:

A simple concurrent cognitive task (example: counting backwards from 10) as they lean and step. Repeat with (2a) and progress to (2c)

Complementary activities to add to challenge and interest:

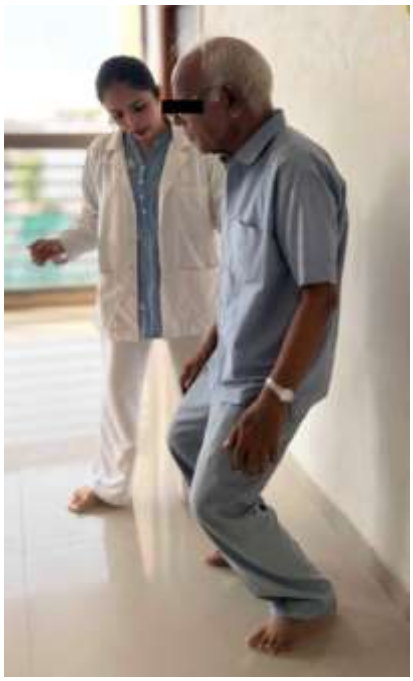
A. Step over 4 square exercise:

- With the use of masking tape, a 't' design creating 4 squares.
- Subjects will move forward in square in a counter clockwise direction until reaching the starting position.
- Subjects will then move in a clockwise direction to again return to the starting position.
- Sequence to be completed as fast as possible without touching the tapelines.

B. Additional stepping and bounding activities

1. Leaning and stepping off a sissel balance fit dome
2. Stepping onto/off of a stable low block/step, progressing to bounding on/off block/step

3. Bounding off one leg to land in a step-to position working toward a “flight phase” with both feet off the ground, progress to bounding and landing on the opposite foot.
4. 60 reps with each leg/side.



SQUATS

SIMPLE BLOCKED PRACTICE

SEMI-RANDOM PRACTICE

STEP OVER 4 SQUARE EXERCISE

STATISTICAL ANALYSIS

Data obtained from 24 subjects were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25, and Microsoft Excel 2010.The normality of the data was assessed using the Shapiro–Wilk test, which indicated that the data followed a normal distribution.Since the data were normally distributed, a paired t-test was applied to compare the pre- and post-intervention outcomes.Descriptive statistics including mean, median, and standard deviation (SD) were calculated to summarize the data. The analyzed

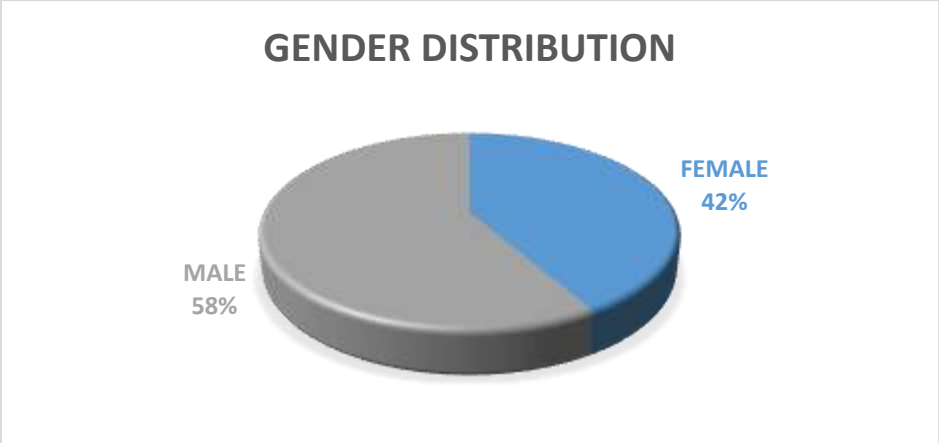
data were presented in the form of tables and graphical representations for better visualization and interpretation of results.

RESULT

This study was conducted to study the effect of Fast Muscle activation and stepping training on balance and mobility in individuals with cerebellar ataxia. Total 24 individuals were included in the study. Pre-post 4week data of BBS, SARA, TUG were taken for balance and mobility. Demographic data were taken age, gender, height, weight which descriptive data shows in below table.

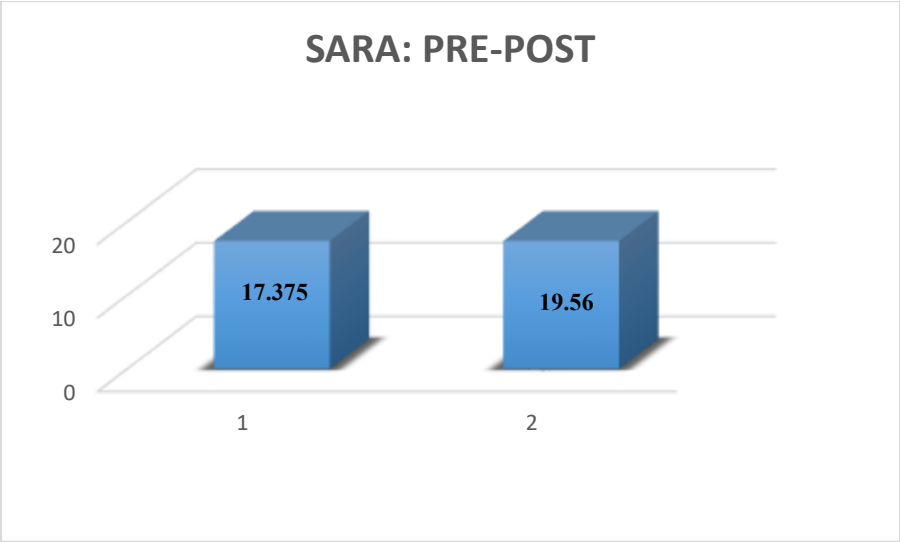
TABLE 1: GENDER DISTRIBUTION OF PARTICIPANTS INCLUDED IN STUDY

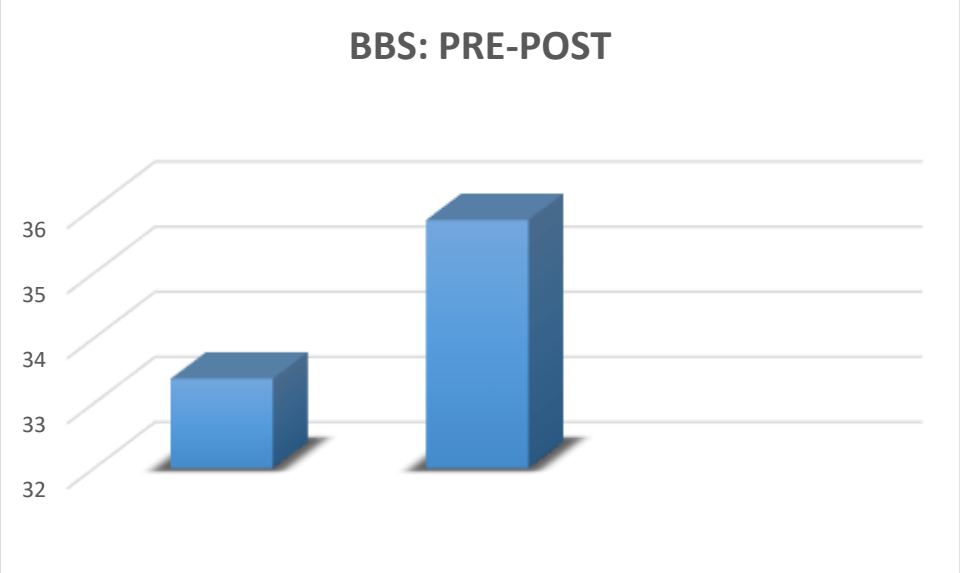
GENDER	FREQUENCY	PERCENT
MALE	14	58.3
FEMALE	10	41.7
TOTAL	24	100

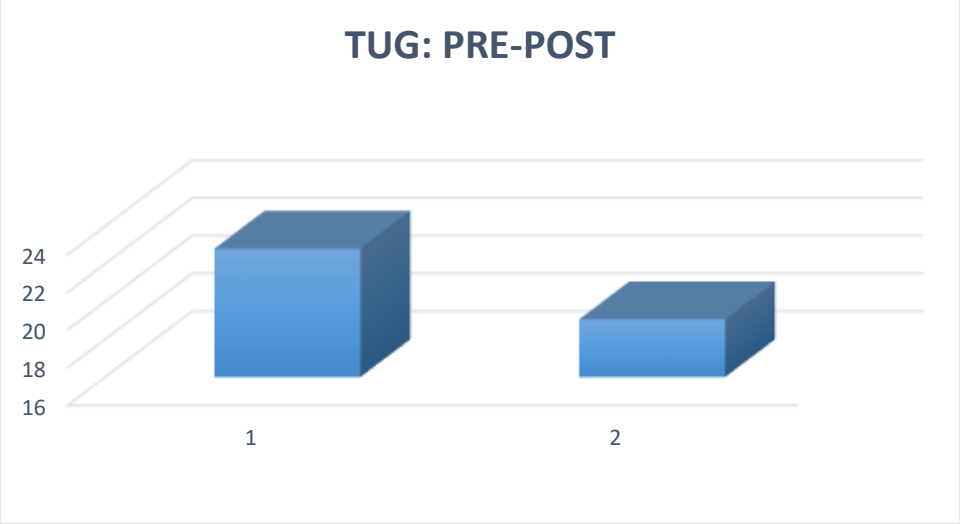


Analysis was done using SPSS 20.0 software. Results shows that the intervention significantly improved both balance and mobility among the individuals. The BBS scores increased was significant post intervention from 33.375 ± 4.80 to 35.8125 ± 4.277 ($p<0.05$), indicating improved balance. The TUG scores decreased was also significant because there was post intervention improvement in speed timing from 22.8124 ± 2.9033 to 19.0625 ± 2.9090 ($p< 0.05$). The SARA also showed post-intervention improvement from 17.375 ± 3.5939 to 19.5625 ± 3.36588 ($p< 0.05$) indicating statisically significant improvement in balance and mobility.

OUTCOME MEASURES	PRE (MEAN ± SD)	POST (MEAN +_ SD)	P-VALUE
SARA	17.37 ± 3.593	19.56 ± 3.365	0.020
BBS	33.37 ± 4.80	35.81 ± 4.27	0.000
TUG	17.37 ± 3.59	19.06 ± 2.90	0.000


SARA: PRE-POST
20
10
0
17.375
19.56
1
2


BBS: PRE-POST
36
35
34
33
32


TUG: PRE-POST
24
22
20
18
16
1
2

DISCUSSION

The present study focused on evaluating the effectiveness of FAST training on balance and mobility in individuals with cerebellar ataxia. A total of 24 participants were purposively selected, and pre- and post-intervention statistical analyses was conducted. The results demonstrated a statistically significant improvement in both balance and mobility following the intervention.

Individuals with cerebellar ataxia commonly experience functional disability due to frequent balance disturbances, which often lead to recurrent falls and necessitate long-term rehabilitation. These individuals typically exhibit delayed muscle activation, impaired timing, and poor anticipatory postural adjustments. FAST training enhances feedforward control, promotes faster recruitment of agonist and antagonist muscle synergies, and facilitates cerebellar adaptive mechanisms through repetitive, high-speed, task-oriented movements. Essentially, it retrains the central nervous system to respond more efficiently to perturbations, thereby improving stability and mobility. Traditional task-oriented training (TOT) focuses primarily on functional tasks but often does not emphasize movement speed or reactive stepping. Similarly, dual-task training integrates cognitive and motor components but does not consistently train rapid balance reactions.[4] FAST training, however, combines speed, variability (blocked-random practice), and perturbation-based stepping, making it a more comprehensive and intensive approach for improving reactive balance and dynamic stability. Therefore, regular performance of FAST exercises may enhance muscle activation and postural responses during internally generated perturbations. Several previous studies support the findings of the present research.[4] **Kimberly J. Miller et al.** (2014) conducted a study published in BMC Neurology on subacute stroke patients, reporting that FAST training significantly improved balance and mobility [5]. Similarly, **Ms. Shazia Neelam** (2020) compared the effects of FAST and task-oriented training with sensory input in subacute stroke and concluded that FAST was more effective in improving balance.[4] In the current study, all participants completed the full 8-week intervention program, demonstrating significant improvement in balance and mobility by the end of the training. The study employed pre- and post-test measurements using the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Scale for the Assessment and Rating of Ataxia (SARA). Data analysis was conducted using a paired t-test and represented through bar graphs, indicating consistent improvement among participants undergoing FAST training. Each intervention session followed standardized parameters for frequency, duration, and progression, ensuring reliability and reproducibility of outcomes.

CONCLUSION

The result demonstrated a significant improvement in Balance and Mobility. Hence, this study concludes that FAST (fast muscle activation and stepping training) can be considered as a feasible intervention for clinical application in individuals with cerebellar ataxia.

LIMITATIONS

This study had certain limitations. Firstly, the absence of a control group restricts direct comparison with other therapeutic approaches, which limits the strength of causal inferences. Secondly, the relatively small sample size (n=24) reduces the generalizability of findings. Thirdly, the study did not include long-term follow-up to assess retention of improvements, nor did it evaluate quality of life, functional independence, or other clinical symptoms such as Tremors and Dysmetria.

FUTURE RECOMMENDATION

Future studies should incorporate larger and more diverse sample sizes with randomized controlled trial (RCT) designs to validate the efficacy of FAST training. Long-term follow-up is recommended to determine the sustainability of balance and mobility improvements. Additionally, integrating patient-reported outcome measures such as quality of life, functional independence, and fall incidence could provide a more holistic view of the benefits. Comparative studies between FAST and other rehabilitation techniques (e.g., task-oriented training, dual-task training, or vestibular rehabilitation) may help identify the most effective interventions.

ACKNOWLWDGMENT

I express my sincere gratitude and deep appreciation to my guide, Dr. Khyati Shah, for her unwavering support, valuable guidance, and constant encouragement throughout this study. I would also like to extend my heartfelt thanks to all my patients for their kind cooperation and participation. Lastly, my sincere thanks to my parents and Dr. Rahul Sanghvi for their continuous support and motivation throughout this journey.

REFERENCES

1. Effectiveness and cost of integrated cognitive and balance training for balance and falls in cerebellar ataxia: a blinded two-arm parallel group RCT Stanley J. Winser1, Anne Y. Y. Chan2, Susan L. Whitney3,Cynthia H. Chen4 and Marco Y. C. Pang1.
2. Stanley WJ, Kelly CKL, Tung CC, Lok TW, Ringo TMK, Ho YK, et al. Cost of cerebellar ataxia in Hong Kong: a retrospective cost-of-illness analysis. Front Neurol.(2020) 11:711. Doi: 10.3389/fneur.2020.00711.
3. Efficacy of Wii Balance Board based Exergame Training among individuals with Cerebellar Ataxia: A Feasibility Study Sayan Pratihar1, Karthiga Rajasekaran1, Shanmuga Priya Raji Reddy Parasuraman SRM College of Physiotherapy, Faculty of Medicine & Health Sciences, SRM Institute of Science and Technology , Chennai, Tamil Nadu, India
4. Effectiveness of fast muscle activation with stepping training and task oriented exercises with sensory input to improve balance among sub-acute stroke patients- a comparative study ms. Shazia neelam1, dr. S. Jeyakumar2, dr. B. Senthil Kumar3, Ms. Gayathri4
5. Protocol for a randomized controlled clinical trial investigating the effectiveness of Fast muscle Activation and Stepping Training (FAST) for improving balance and mobility in sub-acute stroke Kimberly J Miller et al. BMC Neurol. 2014.
6. Effects of therapeutic exercise on disease severity,balance, and functional Independence among individuals with cerebellar ataxia: A systematic review with meta-analysis Stanley Winser, Kwan Chan, Wing Ki Chen, Chung Yau Hau, Siu hangleung, Yee Hang Leung & Umar Muhammad Bello.
7. Protocol for a randomized controlled clinical trial investigating the effectiveness of Fast muscle Activation and Stepping Training (FAST) for improving balance and mobility in sub-acute stroke Kimberly J Miller1, Michael A Hunt1, Courtney L Pollock1, Dianne Bryant2 and S Jayne Garland1.