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EFFECT OF BALANCE TRAINING WITH MIRROR FEEDBACK ON BALANCE AND AMBULATION IN INCOMPLETE SPINAL CORD LESION PATIENTS. A PILOT QUASI EXPERIMENTAL STUDY.

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Bachelor of Science in Physiotherapy (B.Sc. in PT)

DU Roll no- 827

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We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled

EFFECT OF BALANCE TRAINING WITH MIRROR FEEDBACK ON BALANCE AND AMBULATION IN INCOMPLETE SPINAL CORD LESION PATIENTS: A PILOT QUASI EXPERIMENTAL STUDY.

Submitted by **Luthfor Rahman,** for the partial fulfillment of the requirement for the degree of the Bachelor of Science in Physiotherapy (B.Sc. in PT)

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DECLARATION

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also declare that for any publication, presentation or dissemination of the study. I would be bound to take written consent from the Department of Physiotherapy of Bangladesh Health Profession Institute (BHPI).

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First of all, I would like to pay my gratitude to the Almighty who has given me the ability to complete this research project in time with great success. When I started the study, I didn't know whether I could complete it or not but I believed "Fortune favors the brave". So, I was determined to try my best to succeed and I am most grateful to almighty Allah because now I complete my study successfully. I would like to pay my gratitude towards my parents who constantly encouraged me to carry out this study. I would like to express my deepest gratitude to my honorable supervisor **Kazi Md. Amran Hossain**, Lecturer, Department of Physiotherapy and Rehabilitation, Jashore University of Science & Technology-7408, for his excellent guidance from the very beginning to the end of this study. Without his powerful supervision and excellent guidance, I would not be able to complete this project. I gratefully acknowledge my respect for Professor **Md. Obaidul Haque**, Vice- Principal, BHPI, CRP, Savar, Dhaka, **Mohammad Anwar Hossain**, Associate Professor, Department of Physiotherapy, BHPI and Senior Consultant & Head of Physiotherapy Department, BHPI, CRP, Savar, Dhaka, **Md. Shofiqul Islam**, Associate Professor, Head of the Department of Physiotherapy, BHPI, CRP, Savar, Dhaka. I am also thankful to my honorable teachers **Ehsanur Rahman**, Associate Professor & Head Department of Physiotherapy, BHPI, CRP, Savar, Dhaka, **Muhammad Millat Hossain**, Assistant Professor, Department of Rehabilitation Science, Member Secretary, Institutional Review Board, (IRB), BHPI, CRP, Savar, Dhaka, and **Fabiha Alam**, Assistant Professor, for supporting us during the project. I would also like to give special thanks to the BHPI librarian and other supporting staff for their positive help during the project study. Above all, I would like to give thanks to the participants of this study. Lastly, thanks to all who always are my well-wisher and besides me as a friend without any expectation.

Acronyms

ASIA	American Spinal Injury Association
BHPI	Bangladesh Health Professions Institute
BMRC	Bangladesh Medical Research Council
CRP	Centre for the Rehabilitation of the Paralysed
IRB	Institutional Review Board
PT	Physiotherapist
SCL	Spinal Cord lesion
TSCI	Traumatic Spinal Cord Injury
WHO	World Health Organization

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ABSTRACT

Background: By giving feedback on generated movements via a reflection of the body in the mirror, visual feedback training using a mirror can improve balance and postural control for the patient with incomplete spinal cord lesion patients. **Purpose:** The purpose of the study was to elicit to investigate the therapeutic effectiveness of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients. **Methodology:** The dissertation was a pilot experimental study with a Quasi-experimental study design. From, March 2022 to May 2022, 04 people with Incomplete SCL participated in this study from the inpatient treatment service of Spinal Cord Injury Unit, Physiotherapy Department, Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka. A structured questionnaire had used for socio-demographic information, neurological information, and Mini-BEST scale. A statistical test has been conducted as per the distribution of data. Descriptive statistics have been performed by mean, SD, frequency, percentage. Inferential statistics has been performed through Wilcoxon tests and Mann-Whitney U test. **Results:** After performing the conventional physiotherapy treatment along with designed balance exercise among and between groups the two groups have showed some changes in the sensory motor and Mini-BEST score. As the number of the participant was very lower the statistical test did not show significant changes. **Conclusion:** For better understanding of the effectiveness of balance training with mirror feedback the study should be conducted on a larger group of population.

Key Word: Spinal Cord Lesion, Tetraplegia, Mirror feedback, Balance, Ambulation.

CHAPTER I	INTRODUCTION

1.1 Background

The spinal cord is the principal passageway between the brain and the rest of the body for movement and sensory information. The spinal cord has longitudinally oriented white matter spinal pathways that surround core gray matter parts that contain the bulk of spinal neuronal cell bodies. The gray matter is divided into parts containing sensory and motor neurons (Kirshblum et al., 2011). Segmental nerves or roots carry axons from spinal sensory neurons into the spinal cord, and motor neurons' axons leave through segmental nerves or roots (Marino et al., 2003).

Everyone is susceptible to experiencing a spinal cord injury, and the patient with a spinal cord injury faces numerous difficulties in coping with the damage process and recovery. Although some people recover partial ability to do daily life tasks through rehabilitation, many activities are irreparably impaired (Kumar and Gupta, 2016).

Approximately 10000 Americans are hospitalized yearly due to spinal cord injuries (Saulino, 2014). Per year, 90 million people worldwide experience from spinal cord injuries of varying severity. In many nations, the prevalence of spinal cord injuries is poorly understood. It is approximated that the annual incidence of spinal cord injuries (SCI), excluding those who die at the scene of the event, is roughly 40 instances per million people in the United States. Since there have been no comprehensive incidence studies of SCI in the United States since the 1970s, it is unknown if the incidence has changed. The number of Americans with SCI projected to be alive in 2008 ranges between 229,000 and 306,000 (Spinal Cord Injury Statistics, 2009).

In a developing nation like Bangladesh, the life expectancy of spinal cord injury patients is significantly shorter than in a developed nation (Razzak et al., 2011). In Asia, including Bangladesh, SCI continues to be a leading cause of disability (Islam et al., 2011).

According to the Noonan et al., (2012) there are around 270,000 SCI patients in the United States. An estimated 11,000 SCIs occur annually in the United States (American Association of Neurological Surgeons, 2017) while the frequency in Europe ranges from 10.4 per million to 29.7 per million (Moghimian et al., 2015). The worldwide incidence of SCI ranges from 12.1 to 57.8 cases per million per year (Munce et al., 2013). the highest prevalence of SCI is 906 per million in the United States (Lim et al., 2017).

In Asia, SCI incidence rates range from 12.06 to 61.6 per million, with an average age range of 26.8 to 56.6 years (Ning et al., 2012). In the United States, the incidence of traumatic SCI is 40 cases per million or 12,000 new cases annually (Rabadi et al., 2013). Owing to variation in age, gender, race, and socio-cultural activities, the causes of SCI may vary from person to person (Hoque et al., 2012). Automobile accidents are the leading cause of severe spinal cord injuries. (Chen et al.,; Mothe and Tator,; Nwankwo and Uche, 2013).

In Bangladesh, almost 80 percent of the population resides in villages, while 65 percent of the labor force is involved in agriculture (Hossain, 2001). The World Health Organization (WHO) reports that ten percent of the country's population is impaired. According to Hoque et al., (2002) around 4.6% of the population is incapacitated owing to spinal cord injury or spinal cord damage.

Traumatic SCI is more prevalent in those younger than 40, whereas non-traumatic SCI is more prevalent in those older than 40. There is a higher mortality rate among elderly SCI patients (Chin, 2014). 40 percent of SCI patients come with total injury, 40 percent with incomplete injury, and 20 percent with either no cord or only root lesions (Rizollo et al., 2000).

Balance is the capacity to keep the body's center of gravity over its base of support. Balance impairment is the most prevalent following a stroke. Some stroke patients are unable to stand, while others have increased postural sway, asymmetric weight distribution, reduced weight-shifting capacity, and delayed or interrupted equilibrium reactions (Bonan et al., 2005).

Balance can be impacted by a range of factors, including joint movement restriction, weakness, changes in muscular tone, sensory deficits, abnormal postural reactions (Hammer et al., 2008), cognitive impairments, neurological disorders, vestibular deficiencies, (Tyson & Connell, 2009), loss of feeling, visual deformities, mechanoreceptors defects, co-ordination deficit, and debt, and absence of attention (Bayouk et al., 2006). Balance is a dynamic motor ability that necessitates the brain processing of auditory, optical, and somatosensory data in order to trigger the musculoskeletal system and produce synchronous visual stimuli, posture, stance, and movement. It has been proposed that the idea of balance contains four subcategories of motor skills: (i)stationary postural stability; (ii) voluntary postural control; (iii) automatic postural control; or (iv) postural control during environmental disruption (Ragnarsdóttir, 1996).

Visual feedback training utilizing a mirror can enhance postural control by providing feedback on generated movements via a reflection of the body in the mirror (Ramachandran and Rogers-Ramachandran, 2000). The concept of mirror therapy (MT) is the use of a mirror to produce a reflecting illusion of an injured limb in order to mislead the brain into believing movement has happened without pain, or to create positive visual feedback of a limb movement. It includes placing the damaged limb behind a mirror so that the reflection of the opposite limb appears in place of the affected limb (Moseley et al., 2007).

1.2 Rationale

Therefore, one of the most important and major goals of rehabilitation programs for patients with incomplete SCI is to restore their ability to maintain their balance when they are standing. Compensatory techniques for maintaining balance are required for these patients, and they must be learned and practiced repeatedly. These compensatory strategies include the activation of appropriate trunk, neck, and upper limb muscles in response to internal and external postural disturbances. When treating this population, conventional therapy focuses on muscle strengthening and the improvement of task-specific balance reactions. It has also been stressed the need of learning to use visual cues and sensory inputs from neurologically intact portions of the body in order to aid keep one's equilibrium while on the move.

Providing extra sensory information to people with balance impairment has been shown in numerous trials to improve their postural control. Using a computer screen to provide visual feedback on the displacement of COP is one of the techniques. Due to its high price, however, this approach is impractical for domestic use.

Visual feedback training utilizing a mirror can enhance postural control by providing feedback on generated movements via a reflection of the body in the mirror.

1.3. Aim and Objectives:

1.3.1. Aim of the study: The study aimed to investigate the therapeutic effectiveness of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients.

1.3.2. Objectives:

- To explore the socio-demographic (age, gender, educational status, occupation) characteristics of the patients.
- To find out the balance and ambulation-related information of patients with incomplete spinal cord lesions.
- To ascertain the efficacy of mirror feedback on improving balance in patients with incomplete spinal cord lesions.
- To determine which treatment is more effective than the other.
- To formulate a recommendation on treatment guidelines for Incomplete Spinal Cord Lesion Patients by evaluating the result of the study.

1.4 Hypothesis

1.4.1 Null Hypothesis

Ho:1-μ2 = 0 or μ1 ≥μ2, where the experimental group and control group mean difference is not same or control group is higher than experimental group.

The null hypothesis is – balance training with mirror feedback is not effective to improve balance and ambulation for incomplete spinal cord lesion patient.

1.4.2 Alternative Hypothesis

Ha: μ1-μ2 ≠ 0 or μ1 ≠μ2 where the experimental group and control group mean difference is not same.

Where,

Ho= Null hypothesis

Ha = Alternative hypothesis

μ1 = Mean difference in initial assessment

μ2 = Mean difference in final assessment

The alternative hypothesis is - balance training with mirror feedback is effective to improve balance and ambulation for incomplete spinal cord lesion patient.

1.5 Operational Definition

Paralysis

A nervous system injury or disease can impair the capacity to move a certain area of the body. This loss of motor capacity is referred to as paralysis.

Balance

The capacity to distribute your weight in such a way that you can stand or move without falling, or recover if you trip, is referred to as balance. Balance necessitates the coordination of various body parts, including the central nervous system, inner ear, eyes, muscles, bones, and joints. Any of these issues can have an impact on equilibrium.

Ambulation

The capacity to walk without help is referred to as ambulation. It is most commonly used to describe a patient's goals following surgery or physical therapy.

According to Wyndaele & Wyndaele., (2007) SCI prevalence has been reported to range from 223 to 755 per million persons worldwide. As survival rates have improved, the number of people with SCI has increased. People with spinal cord injuries in the United States can expect to live longer thanks to a nationwide database of 30,822 SCI sufferers, with mortality rates decreasing by around 40% in the first two years after the injury (Saadat et al., 2010). About 12,000 people are diagnosed with spinal cord injuries each year in the United States without taking into account those who die at or near the scene of the accident (NSCISC 2013). Traumatic SCI occurs at 40 cases per million people per year in the United States, which translates to 1200 new cases per year (Rabadi et al., 2013). When it comes to spinal cord injuries, Nwankwo and Uche., (2013) found that those between the ages of 31 and 45 are more likely to be injured, with 53 percent of injuries occurring in the cervical spine, 22 percent of injuries occurring in the thoracic spine, and 25 percent of injuries occurring in the lumbar spine.

People with spinal cord injuries in Bangladesh should expect a median lifespan of 5.36 years, according to a recent study. Of those admitted with SCI, 56.4 percent died within the first five years, while 43.6 percent survived for at least five years after their injury. According to a study, the most vulnerable age groups in Bangladesh at CRP were those aged 20 to 40, which accounted for 55.6% of the population. SCI was less common in people under the age of 20 and over the age of 50. Only 20.25 percent of the 158 patients had tetraplegia, compared to 86.1% who had traumatic injuries and 13.9% who had non-traumatic ones, resulting in 79.75% paraplegia (Razzak et al., 2011). Sixty-three percent of SCI in Bangladesh is caused by falling from high altitudes (Hoque et al., 2012). Another primary reason for tetraplegia in Bangladesh (around 18 percent) is falling while carrying a big load on one's head (Razzak et al., 2011).

An epidemiological study by Chen et al., (2013) indicated that the prevalence of spinal cord injury ranges from 236 to 1009 per million people worldwide. It's possible that the total incidence in this densely populated region is overestimated in existing Asian figures, with China and India, in particular, being underreported. Only for the Indian state of Jammu and Kashmir do we have prevalence statistics, which range from 236-to 464 per million for traumatic SCI. The proportion of tetraplegic patients in the Geriatric Population (47.5 per million) was higher than in the general population. SCI connected to land transportation is substantially lower in Asia, South than in Europe; it is most prevalent in southern Asia (Geyh et al., 2010). The incidence and frequency of spinal cord injury (SCI) are steadily increasing over the world.

There are a variety of motor, sensory, and autonomic problems that can arise after a spinal cord injury (SCI). As a result, individuals are more likely to suffer from a variety of secondary problems (Tonack et al., 2008), which are medical implications that might impede a person's functional capabilities. Pressure ulcers, urinary tract infections, intestinal issues, fractures, persistent pain, and depression are all common side effects of spinal cord injury (New et al., 2013). Some secondary consequences can be treated or prevented, but they nonetheless have an enormous impact on both the health care system and individual patients (Dorsett and Geraghty et al., 2008). Those who suffer a spinal cord injury are more likely to be hospitalized than the general population, and they are also more likely to be hospitalized numerous times in their lifetime. Patients with a spinal cord injury (SCI) needed 30 more hours of home-care services, were 2.7 times more likely to have physician contact, spent 3.3 more days in the hospital and were re-hospitalized 2.6 times more frequently than those without SCI, according to a study published in 2008.

Standing balance is retained through tiny postural rotations around the ankle joint, the amount of which depends on the amount of ankle stiffness present within the joint during normal undisturbed standing conditions. Neuronal activity in the plantar-flexor muscles is modulated by a variety of sensory inputs, including visual, somatosensory, and vestibular. The proper integration of somatosensory, visual, and vestibular inputs is required to maintain a silent stance (Baudry, 2016). Somatosensory deficiencies after a spinal cord injury (SCI) limit an individual's capacity to adapt their motions to the demands of the task at hand (Amatachaya et al., 2015; Jorgensen et al., 2017). Visual stimuli have been shown to influence quasi-static postural stability in people with SCI by previous work. In a study

Lemay et al., (2013) found that people with SCI are less stable instance and rely more on visual inputs to stay upright. SCI patients have poor postural stability because of an inability to control their center of pressure (COP).

People with motor iSCI are more prone to falling because they can walk but can't balance. Up to 75% of people with a motor iSCI (AIS C or D) regain walking abilities within a year (Burns et al., 2012). Falls are a major concern for people with iSCI since they can cause harm or hospitalization (Krause, 2004). Every year, 78 percent of ambulatory adults with iSCI fall (Khan et al., 2019), often when standing or walking, and most occur at home (Brotherton et al., 2007; Amatachaya et al., 2011). Loss of balance is a common cause of iSCI falls. Deficits in balance and sensory function have been noted in standardized clinical tests of gait, balance, and sensory function (Wannapakhe et al., 2014; Amatachaya et al., 2015).

Only a few researches have looked into interventions aimed at improving COP control as a means of improving standing balance in individuals with traumatic brain injury. A perturbation-based intensive balance training program, as well as a traditional intensive balance training program, is now being researched in the iSCI population (Unger et al., 2019). Research in the past has focused on enhancing the effectiveness of task-specific balance workouts by using video games (Wall et al., 2015), virtual reality (Villiger and colleagues, 2013), and visual feedback (Sayenko et al., 2010; Tamburella et al., 2013) when standing for long periods of time.

When it comes to improving gait and balance in people with chronic motor iSCI, visual biofeedback balance (vBFB) training may be more effective than conventional over-ground rehabilitation, according to a study published by Tamburella et al in 2013. (Control group). Visual feedback balance training (VFBT) has been shown to enhance postural control in people with iSCI. Studying the effects of balance training and visual feedback on upright stability was done by Sayenko et al., (2010). Over the course of four weeks, six people with SCI took part in a total of twelve one-hour training sessions (Sayenko et al., 2010). No correlation was found between gains in stability shown after a balance training intervention and clinically meaningful changes in standardized balance assessment measures in this investigation.

People with neurological problems, such as Parkinson's disease, stroke, and cerebellar ataxia are now able to relearn their balance through visual input (Ioffe et al., 2005). A possible link between positive laboratory force plate measurements and clinical and functional outcomes requires more research (Barclay-Goddard et al., 2004); however, the task specificity of the training has shown that the main positive effect on postural control can be attributed to improvements in sensorimotor integration and coordination (Walker et al., 2000). In a study, by Sayenko et al., (2010) at the National Rehabilitation Center for Persons with disabilities, Tokorozawa, Japan Six SCI patients with chronic motor and sensory impairments who could stand for 5 minutes without assistance underwent the VBT 3 times per week for 12 sessions. Participants stood on a force platform and were asked to change their center of pressure in the directions shown on a monitor. Throughout the course, performance and learning rate were assessed. The program's static and dynamic stability were evaluated. Across all activities, participants improved their scores by between 236±94 and 130±14%. The area inside the stability zone after the training reached 221±86% of the pre-training values.

In a study of amputees that tested the influence of visual feedback through a mirror, the postural sway decreased significantly (Hlavackova et al., 2009). This improvement was attributed to the visual information reflected in the mirror, which served as a sensory substitute for the wounded limb's reduced proprioception. In addition, visual feedback from a mirror facilitates the acquisition of correct motions through the correction of faults noticed during task performance. A study involving the use of visual feedback in balance training for stroke patients found that such training improved weight distribution and balance abilities (Cheng et al., 2004)

When it comes to successful therapies, exercises that test the center of gravity while the feet remain stationary (e.g., reaching while standing) and exercises that practice a narrow base of support (e.g., tandem series, single-leg stance) have been found to be beneficial to patients (Suzuki et al., 2004; Lin et al., 2007). Using dance steps, circles, figure eights, directional changes on command, obstacle courses, and dual-task training, dynamic gait training can be introduced into the development of the intervention (Liu-Ambrose et al., 2008). Maintaining postural control or walking pace is one part of dual-task training, and the other part may be a mental challenge such as counting backward or a manual job like carrying a weight (Woollacott et al., 2002)

Walking while talking, walking and counting, or walking while carrying a full cup of drink, various objects, or simulating laundry are all examples of dual jobs for balance training. In dual-task training, adjusting attentional emphasis between trials (e.g., trial one focuses on maintaining walking speed; trial two focuses on counting task) tends to have a stronger impact on outcomes. It was found that single-task training had no influence on balance performance in older persons (Shubert et al., 2010). Silsupadol et al., (2009) discovered that shifting the emphasis of dual-task priority instructions from cognitive to physical led to significant performance enhancements.

Tai-Chi, which is characterized by a series of soft, low-impact, and coordinated motions, is a suitable type of exercise for senior citizens (Penn et al., 2019). Tai-Chi promotes lower extremity muscle strength, improves balance control, proprioception, and postural adaptation, and decreases the risk of falling in older persons (Jain et al., 2017;Tsang et al., 2004). A recent work by Pen et al., (2019) showed that the iTC group improved in all 16 groups of lower-limb muscle strength (p 0.001–0.007). To date, only the tTC group's BBS score ($p = 0.005$) and bilateral hip flexor ($p = 0.010–0.033$) muscular strength have increased. The control group had enhanced right hip extensor muscle strength ($p = 0.033$). The control group got health information about workouts and fall prevention and had the same functional balancing tests as the other groups, with the same findings. A self-training program may have raised their awareness of exercise.

As technology improves, it can be put to good use in the rehabilitation area. VR, for example, creates a virtual environment that is nearly identical to the real one, allowing for a variety of sensory inputs and task-specific methods (Adamovich et al., 2009). Virtual reality has been shown to improve cognitive abilities and alleviate neuropathic pain (Chi et al., 2019). Patients with stroke, Parkinson's disease, and Multiple Sclerosis all benefit from virtual reality in terms of enhancing their ability to maintain balance (Casuso-Holgado et al., 2018). A systemic review by Alashram et al., (2020) demonstrated Findings were found in English-language studies investigating the effects of VR training on balance in patients with partial SCI (Scopus, PEDro, PUBMED, REHABDATA, EMBASE). The methodological quality of chosen research was assessed using the PEDro scale. Five pilot trials were included. There was a 2 to 3 range in the PEDro scores. The study sample size was under 20 patients. VR improved balance in people with partial SCI. The preliminary data suggested that VR training improved balance in people with partial SCI. 12-20 sessions of 30-60 minutes VR training may be effective.

CHAPTER III	METHODOLOGY

3.1 Study design

Pilot Quasi-experimental pre-test and post-test design types of quantitative research were selected to conduct this study. The study was conducted with two different subjects. The clinical trial design is a method of testing hypothesis by which cause and effect can be established. Both groups received a common treatment regimen. In this study, Group A received specific balance exercises along with conventional physiotherapy and Group B received specific balance exercises along with a mirror and conventional physiotherapy. A pre-test (before intervention) and post-test (after intervention) were administered to each subject of both groups to compare the effects on balance and ambulation before and after the treatment.

3.2 Study Site

Data was collected from the Spinal Cord Injury Unit of the Centre for the Rehabilitation of the Paralysed (CRP), Savar. Since these people with the disease came to CRP from all corners of Bangladesh from various economic backgrounds for receiving rehabilitation service they represent the entire population.

3.3 Study Duration

From, March 2022 to May 2022.

3.4 Study Population

A population is the whole group of items or individuals that meet the researcher's criteria. The study population was the patients diagnosed with incomplete Spinal cord lesions attended in the Spinal Cord Injury Unit of the Physiotherapy Department at CRP, Savar. For this study, about 4 people were selected.

3.5. Study sample:

In this study, the People with incomplete Spinal Cord lesions attended CRP and full fill inclusion criteria.

3.6 Sampling technique:

Hospital based sampling technique was used in this study.

3.7 Inclusion criteria

- Patients with incomplete spinal cord lesions who are attending at CRP.
- Patients who are able to stand for at least 5 minutes without support as per "Sayenko et al., 2010".
- Age group: 12-60 years. (According to physiotherapists opinion less than 12 years and more than 60 years old people can't understand the therapist's instructions)
- Both males and females were included (Krishblum et al., 2011)
- Those who were motivated and given consent to include in the study.

3.8 Exclusion Criteria

- Patients with complete spinal cord injury.
- SCI patient with a severe head injury.
- Patients with clinical disorders where balance exercise is contraindicated.
- Participants who were unwilling to participate.

3.9 Data collection procedure

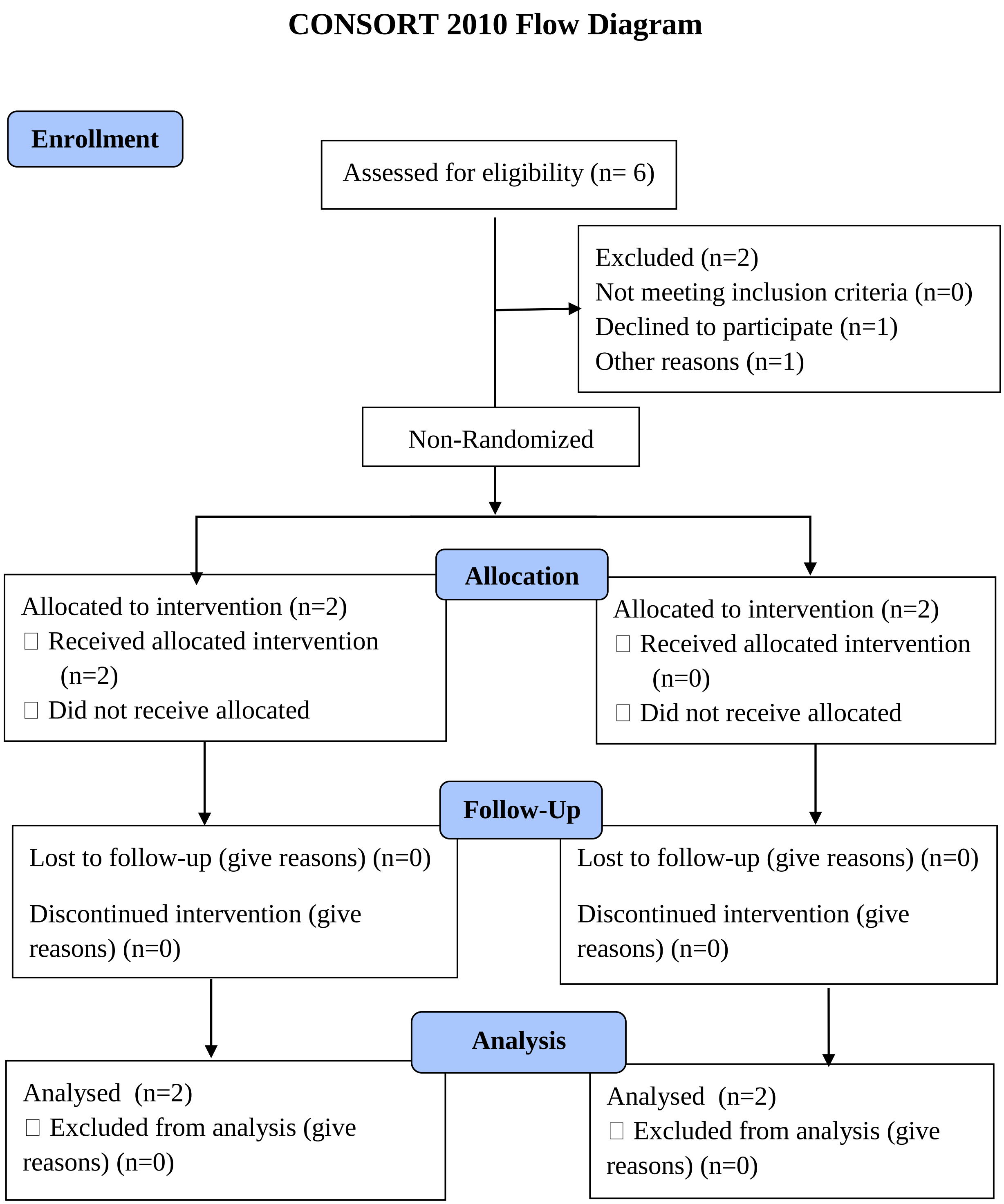
For data collection face to face, the interview method was used. To conduct the study firstly an informed consent form and a questionnaire were established. After that two people were trained over the questionnaire for completing the interview session successfully and also to compose the valuable data from the patients. And then a treatment protocol was developed. After developing the treatment protocol a presentation was delivered to staffs of the Spinal Cord Injury unit of the Physiotherapy Department and they accepted the intervention protocol.

Through evaluating the patient, initial recording, intervention, and final recording, data collection had been conducted. A qualified physiotherapist assessed the patients at CRP in the SCI unit after the outdoor department screening. For every subject intervention was provided for 3 weeks.

According to inclusion criteria, the number of subjects was chosen for this data collection. Data were collected by the researcher's formatted written questionnaire and it was gathered through a pre-test, intervention, and post-test. For taking post-test at the end of 3 weeks of intervention, the same procedure will be performed.

To reduce the biasness, in front of the qualified physiotherapist the researcher collected data from the group. The data collector took a face-to-face interview after the quantitative investigation in a setting that was far from the treatment room by preset close-ended questionnaire and recorded the interview. For completing each question, it took approximately 30 minutes.

3.10. Consort Flow Chart



3.11. Intervention:

Total Duration: 30minutes

Control Group:

- **Name of the exercise: Tandem Series**

Purpose: Improve Balance.

Instruction: Tandem walking forward with and without support for 3 min.

Fig-1

- **Name of the exercise: Slow Controlled Movement**.

Purpose: Improve balance and ambulation.

Instruction: Perform slow controlled movement while walking straight. Practice the exercise for two minutes.

Fig-2

- **Name of the exercise: Walking on Heel.**

Purpose: Improve balance.

Instruction: Walking on heel for 2 min with support and without support.

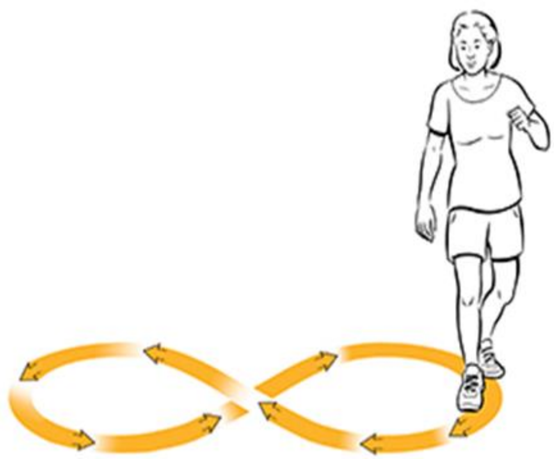
Fig-3

- **Name of the exercise: Figure Eight**

Purpose: Improve gait and balance.

Instruction: Starting from the midpoint of figure eight manner and ending also in the midpoint. Practice for 3 min.

Fig-4



- **Name of the exercise: Tai Chi Movements.**

Purpose: Improve balance and body control.

Instruction: Perform different Tai Chi movements for 10 minutes**.**

Fig-5

- **Name of the exercise: Walking while counting backward.**

Purpose: Improve gait and balance.

Instruction: The patient will walk in the normal manner. And at the same time the patient will count backward from 100 to 0.

It's a dual tasking exercise. Practice this exercise for 3 minutes.

- **Name of the exercise: Walking while carrying a full cup of liquid.**

Purpose: Improve gait and balance.

Instruction: The patient will walk straight in the normal manner and at the same time the patient will carry a full cup of liquid.

Perform the exercise for 3 minutes.

Fig-6

Experimental group:

- **Name of the exercise: Tandem Series**

Purpose: Improve Balance.

Instruction: Tandem walking forward with and without support for 3 min.

Fig-7

- **Name of the exercise: Slow Controlled Movement**.

Purpose: Improve balance and ambulation.

Instruction: Perform slow controlled movement while walking straight. Practice the exercise for two minutes.

- **Name of the exercise: Walking on Heel.**

Purpose: Improve balance.

Instruction: Walking on heel for 2 min with support and without support.

Fig-8

- **Name of the exercise: Figure Eight**

Purpose: Improve gait and balance.

Instruction: Starting from the midpoint of figure eight manner and ending also in the midpoint. Practice for 3 min.

- **Name of the exercise: Tai Chi Movements.**

Purpose: Improve balance and body control.

Instruction: Perform different Tai Chi movements for 10 minutes**.**

Fig-9

- **Name of the exercise: Walking while counting backward.**

Purpose: Improve gait and balance.

Instruction: The patient will walk in the normal manner. And at the same time the patient will count backward from 100 to 0.

It's a dual tasking exercise. Practice this exercise for 3 minutes.

- **Name of the exercise: Walking while carrying a full cup of liquid.**

Purpose: Improve gait and balance.

Instruction: The patient will walk straight in the normal manner and at the same time the patient will carry a full cup of liquid.

Perform the exercise for 3 minutes.

Fig-10

Balance exercise followed by FITT protocol: (Table-1)

Exercise	Frequency	Intensity	Type	Time
Tandeem series forward	6 m	2 set	Dynamic	3 min
Slow controlled motions	6 m	2 set	Dynamic	2 min
Figure eights	3 m	2 set	Dynamic	3 min
Tai chi movements		2 set	Dynamic	10 min
Walking on heel	6 m		Dynamic	2 min
Walking while counting backward	6 m	3 set	Dual-task	3 min
Walking while carrying a full cup of liquid	6 m	3 set	Dual-task	3 min

3.12. Outcome measurement tools:

To measure the outcome of the study, a total of two scales were used.

1. Mini-BESTest
2. ASIA impairment scale

Mini-BESTest : This clinical balance assessment tool is a shortened version of the Balance Evaluation Systems Test (BESTest). It aims to target and identify 6 different balance control systems so that specific rehabilitation approaches can be designed for different balance deficits. The BESTest was shortened based on factor analysis to include dynamic balance only and to improve clinical utilization.

ASIA: It involves both a Motor and Sensory examination to determine the Sensory Level and Motor Level for each side of the body (Right and Left), the single Neurological Level of Injury (NLI) and whether the injury is Complete or Incomplete.

The following ASIA Impairment Scale (AIS) designation is used in grading the degree of impairment: **(Table-2)**

Grade	**Type of injury**	**Description**
A	Complete	No sensory or motor function is preserved in the sacral segments S4-5.
B	Sensory incomplete	Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body
C	Motor incomplete	Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments S4-5 by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body. (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.
D	Motor incomplete	Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3.
E	Normal	. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade

3.13. Statistical Test

3.13.1. Determination of the nature of data

The variables were determined as nominal, ordinal, interval, and ratio data and considered their parametric or non-parametric properties based on data type, normality test, and standard procedure. (Hicks, Research method for Clinical therapists)

Table – 3: Data category and normality test of data

Variable	Description	Data type	Normality Test	Data distribution
Age Overall-		Ratio		Parametric
Age in category-	20-30 31-40 41-50 51-60	Ordinal		Non-parametric
Gender	Male Female	Nominal		Non-parametric
Marital Status-	Married Unmarried	Nominal		Non-parametric
Residential Area-	Rural Semi Urban Urban	Nominal		Non-parametric
Education-	Non-Education Primary Secondary Higher Secondary Graduate Post graduate	Ordinal		Non-parametric
Occupation-	Farmer Rickshaw Puller Garment Worker Driver	Nominal		Non-parametric

	Businessmen Day Laborer Teacher Student Unemployed Others			
Family Member		Ratio		Parametric
Earning Member		Ratio		Parametric
Monthly income overall-		Ratio		Parametric
Monthly income in category-	5000-10000 11000-20000 21000-30000 31000-40000	Ordinal		Non-parametric
Duration since injury/incidence		Ratio		Parametric
Duration of Rehab		Ratio		Parametric
Causes of injury-	Road Traffic Accident Fall from high Fall while carrying weight Scarf injury Shallow diving Others	Nominal		Non-parametric
History of surgery-	Yes No	Nominal		Non-parametric
Assistive device used-	Yes No	Nominal		Non-parametric

Any major disease/co-morbidities-	Diabetes mellitus Hypertension Lung disease Cardiovascular disease Epilepsy Others	Nominal		Non-parametric

3.13.2 Determination of statistical test (Table-4)

Purpose	Variable	Test
Relationship	In within group	Willcoxon test
	In between group	Mann-Whitney U

Also descriptive information is given in the result part as the number of data was quite small.

3.14. Ethical consideration:

The research proposal was submitted for approval to the institution of Review Board (IRB) of Bangladesh Health Professions Institute (BHPI) and after the defense, the research proposal approval was taken from the IRB. A written/ verbal consent was taken from the participant before collecting data. Afterwards, before commencing data collection, the researcher given approval from the appropriate authorities to ensure the respondents' safeness. To avoid morally acceptable assertions, the respondents were allowed to continue receiving intervention for several other reasons of course as usual. Before the study began, each participant was informed about it and provided written consent.

A pilot Quasi Experimental study results were analyzed by content analysis. By using this analysis process, the researcher organized collected data according to categories, coding. The study aims to evaluate the effectiveness of balance training with mirror feedback to improve balance and ambulation in incomplete spinal cord lesion patients.

A total of 6 potential participants were approached to take part in the study and two refused and they did not want to undertake an interview. A final total of participants took part, three male and one female, and the average age was years.

4.1. Socio-demographic information of the patient's

Table-5: Socio-demographic Information

P No	Age	Gender	Marital Status	Residential Area	Education	Occupation	Family Member	Earning Member	Monthly Income
1	27	Male	Unmarried	Rural	Higher Secondary	Other	5	2	30000 Taka
2	60	Male	Married	Rural	Primary	Day Laborer	5	1	1800 Taka
3	25	Male	Unmarried	Rural	Graduate	Student	4	1	8000 Taka
4	36	Female	Married	Urban	Non education	Garment Worker	5	2	30000 Taka

Table-6: Sociodemographic information (Mean ± SD, Frequency %)

Variable	Category	Mean ± SD, Frequency (%)
Age Overall-	Ratio	36.50±16.340 Years
Age in category- (20-30) (31-40) (41-50) (51-60)	Ordinal	 2(50%) 1(25%) 0 1(25%)
Gender Male Female	Nominal	 3(75%) 1(25%)
Marital Status- Married Unmarried	Nominal	 2(50%) 2(50%)
Residential Area- Rural Urban	Nominal	 3(75%) 1(25%)
Education- Primary Higher Secondary Graduate	Ordinal	 2(50%) 1(25%) 1(25%)
Occupation- Garment Worker Day Laborer Student Others	Nominal	 1(25%) 1(25%) 1(25%) 1(25%)
Family Member	Ratio	4.75 ± .500
Earning Member	Ratio	1.50 ± .577
Monthly income overall-	Ratio	21500 ± 10630.146

Monthly income in category- (5000-10000) (11000-20000) (21000-30000)	Ordinal	 1(25%) 1(25%) 2(50%)

Participant- 1

P1 was 27 years old male. He had bike accident on January 26, 2022. His spinal cord was injured in that accident. Then he was taken to Khulna Medical College Hospital. He was unable to move his limbs when he was admitted to Khulna Medical College Hospital and suffered a lot of mental anguish. His family had supported him very much, and his relatives used to come to see him. He was very worried about his family. He had been in Khulna Medical Hospital for 2 days, and then he had shifted to a clinic named Health Care. He stayed in this clinic for 4 days and received his general treatment, and then a neurosurgeon from Khulna Medical College Hospital referred him to CRP. At that point, his health condition was getting very worse, and his family members thought he would never be able to walk again. He felt so depressed thinking about his future. At that time, his brother and father supported him emotionally and financially. They were always there beside him at CRP.

Participant-2:

P2 was a 60-years old male. In Feb 2021, while doing his daily activities, he had to lift a heavy load on his back and suddenly fall down and immediately took him into Upazila Sadar Hospital Pabna. After some general measure doctor sent him to Pabna Medical College and Hospital. He took general treatment in that hospital for 7 days. At that time, he could not move his limbs and had no sensation. So he felt very depressed and also his family members thought he will not recover ever. And from Pabna Medical College and Hospital he diagnosed with a Spinal cord injury. The doctor from Pabna Medical College and Hospital sent him to CRP. As he was the only earning member of the family and he was totally disabled his family suffered very much. But his wife always stayed by his side and supported him mentally.

Participant-3:

P3 was 25 years old male. He had an accident on December 2021, and his spinal cord was injured in that accident. Then immediately he was taken to Manikjang Sadar Hospital. From there the patient was referred to the CRP.

Participant-4:

P4 was a 36-year-old female. In March 2021, she came to CRP due to severe illness. For general management, she was treated in the wards of CRP. After some medical investigations, she was diagnosed with a spinal tumor. For her further treatment, she was referred to a neurosurgeon at IBN Sina Medical Hospital. Here she has undergone spinal tumor surgery. After successful surgery, she was discharged from the hospital after 7 days. After discharge, she stayed in her house for six months, and when the symptoms came back suddenly, she again came to CRP with some disability. At that time, she was unable to walk and unable to do her daily activities by herself. Here in CRP, she was again diagnosed with a spinal cord injury. She was very depressed and anxious about her condition. She was very worried about her family. But her family members supported her very much at that time.

Table-7: Clinical Information

P No	Date since injury / Incidence	Duration of rehab	Causes of injury	History of surgery	Assistive device used	Any major disease/Co-morbidity
1	60 days	91 days	RTA	Yes	Yes (Wheel-Chair)	No
2	93 days	112 days	Fall while carrying heavy load	No	Yes (Wheel-Chair)	Hypertension
3	199 days	208 days	RTA	Yes	Yes (AFO)	No
4	387 days	123 days	Bone Tumor	Yes	Yes (Wheel-Chair)	Others (Asthma)

Table-8: Clinical information (Mean ± SD, Frequency %)

Variables	**Category**	**Mean ± SD, Frequency (%)**
Duration since injury/incidence	Interval	185.25 ± 146.734
Duration of Rehab	Interval	133.50 ± 51.410
Causes of injury-	Nominal	
Road Traffic Accident		2(50%)
Fall while carrying weight		1(25%)
Others		1(25%)
History of surgery-		
Yes		3(75%)
No		1(25%)
Assistive device used-		
Yes		4(100%)
No		0

Any major disease/co-morbidities- Hypertension Others	Nominal	 1(25%) 3(75%)

Participant-01

The patient had the accident 60 days before starting experimental physiotherapy and the duration of his rehabilitation was 91 days. The time of rehabilitation was counted from the time of admission to the last day of experimental treatment. The reason behind his spinal cord injury was a road traffic accident. Due to the spinal cord injury, he had to undergo spinal surgery. At the time of experimental treatment, he was able to walk by himself and also used a wheelchair for assistance. The patient has no other major diseases.

Participant-02

The patient who was participant No 2 had experienced a spinal cord injury 93 days before starting experimental physiotherapy, and the duration of his rehabilitation was 112 days. The time of rehabilitation was counted from the time of admission to the last day of experimental treatment. The cause of his spinal cord injury was a fall while carrying a heavy weight on his back. Due to the spinal cord injury, he had to undergo spinal surgery. At the time of experimental treatment, he was able to walk by himself and also used a wheelchair for assistance. Along with the spinal cord injury, the patient had hypertension.

Participant-03

Participant number 03 was diagnosed with a spinal cord injury due to a road traffic accident 199 days earlier. And after admitting to CRP, the whole rehabilitation time of the participant was 208 days. The time of the rehabilitation was considered the last day of experimental treatment. He has undergone surgery at the Centre for the Rehabilitation of the Paralysed. After surgery, he started physiotherapy as his main treatment. At the time of the study, he was able to walk, but he needed an assistive device. He used AFO for assistance in mobility. No major disease was found.

Participant-04

Participant 04 had a spinal tumor and progressively felt unwell and then was confirmed to have a spinal cord injury. She was diagnosed with SCI 387 days after starting the experimental treatment. Her total time of rehabilitation was 123 days. The main cause of her spinal cord injury was the spinal tumor. She needed surgery after being admitted to the Centre for the Rehabilitation of the Paralysed. And she gradually started walking with someone's assistance. Besides this, she used a wheelchair to get around easily.

Table-9: Neurological Information

Variable	Participant 01			Participant 02			Participant 03			Participant 04		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Sensory (Light touch) B/L Right side	32	46	14	31	40	9	34	48	14	32	42	10
Sensory (Light touch) B/L left side	36	48	12	32	40	8	35	50	15	32	42	10
Sensory (Pin prick) B/L Right side	38	50	12	34	44	10	40	50	10	35	46	11
Sensory (Pin prick) B/L left side	40	53	13	36	45	9	40	51	11	36	46	10
Total bilateral lower limb motor right side	14	20	6	14	16	2	12	16	4	9	15	6
Total bilateral lower limb motor left side	16	22	6	14	16	2	12	16	4	10	16	6
S4/5 sensory light touch	1	2	1	1	2	1	`1	2	1	1	2	1
S4/5 sensory pin prick	1	2	1	1	2	1	1	2	1	1	2	1
Sensation to deep pressure (Anal)	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Voluntary anal muscle contraction	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	

Participant 01

The pre-test score of sensory light touch bilateral right side was 32 out of 56, and after treatment, the post-test score was 46 out of 56. So, the total change in score was (14).

The pre-test score of sensory light touch bilateral left side was 36 out of 56, and after treatment, the post-test score was 48 out of 56. So, the total change in score was (12).

The pre-test score of the sensory pin prick bilateral right side was 38 out of 56, and after treatment, the post-test score was 50 out of 56. So, the total change in score was (12).

The pre-test score of the sensory pin prick bilateral right side was 40 out of 56 and after treatment, the post- test score was 53 out of 56. So, the total change in score was (13).

The pre-test score of the lower limb bilateral right side was 14 out of 24, and the post-test score was 20 out of 24. So, the total change in the score was (6).

The pre-test score of the lower limb bilaterally on the left side was 16 out of 24, and the post-test score was 22 out of 24. So, the total change in the score was (6).

The pre-test score of S4/5 sensory light touch was 1, and the post-test score was 2.

The pre-test score of s4/5 sensory pin prick was 1, and the post-test score was 2.

The pre-test and post-test of sensation to anal deep pressure were preserved.

The pre-test and post-test of voluntary anal contraction were preserved.

The ASIA impairment classification was AIS C.

Participant 02

The pre-test score of sensory light touch bilateral right side was 31 out of 56, and after treatment, the post-test score was 40 out of 56. So, the total change in score was (9).

The pre-test score of sensory light touch bilateral left side was 32 out of 56 and after treatment, the post-test score was 40 out of 56. So, the total change in score was (8).

The pre-test score of the sensory pin prick bilateral right side was 34 out of 56, and after treatment, the post-test score was 44 out of 56. So, the total change in score was (10).

The pre-test score of the sensory pin prick bilateral right side was 36 out of 56 and after treatment, the post- test score was 45 out of 56. So, the total change in score was (9).

The pre-test score of the lower limb bilateral right side was 14 out of 24, and the post-test score was 16 out of 24. So, the total change in the score was (2).

The pre-test score of the lower limb bilateral left side was 14 out of 24, and the post-test score was 16 out of 24. So, the total change in the score was (2).

The pre-test score of S4/5 sensory light touch was 1, and the post-test score was 2.

The pre-test score of s4/5 sensory pin prick was 1, and the post-test score was 2.

The pre-test and post-test of sensation to anal deep pressure were preserved.

The pre-test and post-test of voluntary anal contraction were preserved.

The ASIA impairment classification was AIS C.

<u>Participant 03</u>

The pre-test score of sensory light touch bilateral right side was 34 out of 56, and after treatment, the post-test score was 38 out of 56. So, the total change in score was (14).

The pre-test score of sensory light touch bilateral left side was 35 out of 56 and after treatment, the post-test score was 50 out of 56. So, the total change in score was (15).

The pre-test score of the sensory pin prick bilateral right side was 40 out of 56, and after treatment, the post-test score was 50 out of 56. So, the total change in score was (10).

The pre-test score of the sensory pin prick bilateral right side was 40 out of 56 and after treatment, the post- test score was 51 out of 56. So, the total change in score was (11).

The pre-test score of the lower limb bilateral right side was 12 out of 24, and the post-test score was 16 out of 24. So, the total change in the score was (4).

The pre-test score of the lower limb bilateral left side was 12 out of 24, and the post-test score was 16 out of 24. So, the total change in the score was (4).

The pre-test score of S4/5 sensory light touch was 1, and the post-test score was 2.

The pre-test score of s4/5 sensory pin prick was 1, and the post-test score was 2.

The pre-test and post-test of sensation to anal deep pressure were preserved.

The pre-test and post-test of voluntary anal contraction were preserved.

The ASIA impairment classification was AIS C.

Participant 04

The pre-test score of sensory light touch bilateral right side was 32 out of 56, and after treatment, the post-test score was 42 out of 56. So, the total change in score was (10).

The pre-test score of sensory light touch bilateral left side was 32 out of 56 and after treatment, the post-test score was 42 out of 56. So, the total change in score was (10).

The pre-test score of the sensory pin prick bilateral right side was 35 out of 56, and after treatment, the post-test score was 46 out of 56. So, the total change in score was (11).

The pre-test score of the sensory pin prick bilateral right side was 36 out of 56 and after treatment, the post- test score was 46 out of 56. So, the total change in score was (10).

The pre-test score of the lower limb bilateral right side was 9 out of 24, and the post-test score was 15 out of 24. So, the total change in the score was (6).

The pre-test score of the lower limb bilateral left side was 10 out of 24, and the post-test score was 16 out of 24. So, the total change in the score was (6).

The pre-test score of S4/5 sensory light touch was 1, and the post-test score was 2.

The pre-test score of s4/5 sensory pin prick was 1, and the post-test score was 2.

The pre-test and post-test of sensation to anal deep pressure were preserved.

The pre-test and post-test of voluntary anal contraction were preserved.

The ASIA impairment classification was AIS C.

Table-10: Relation of within group (For Experimental)

Variable	Test	Test Value	P Value
Sensory light touch right side	Willcoxon	-1.342	.180
Sensory light touch left side	Willcoxon	-1.342	.180
Sensory pin prick right side	Willcoxon	-1.342	.180
Sensory pin prick left side	Willcoxon	-1.342	.180
Bilateral lower limb motor right side	Willcoxon	-1.342	.180
Bilateral lower limb motor left side	Willcoxon	-1.342	.180
S 4/5 sensory light touch	Willcoxon	-.447	.655
S 4/5 sensory pin prick	Willcoxon	-.447	.655

Table-11: Relation of within group (For Control)

Variable	Test	Test Value	P Value
Sensory light touch right side	Willcoxon	-1.342	.180
Sensory light touch left side	Willcoxon	-1.342	.180
Sensory pin prick right side	Willcoxon	-1.342	.180
Sensory pin prick left side	Willcoxon	-1.342	.180
Bilateral lower limb motor right side	Willcoxon	-1.342	.180
Bilateral lower limb motor left side	Willcoxon	-1.342	.180
S 4/5 sensory light touch	Willcoxon	-1.414	.157
S 4/5 sensory pin prick	Willcoxon	-1.414	.157

Table-12: Relation of between group (post-test)

Variable	Test	Test Value	P Value
Sensory light touch right side	Mann-Whitney U	1.000	.439
Sensory light touch left side	Mann-Whitney U	1.000	.439
Sensory pin prick right side	Mann-Whitney U	1.500	.683
Sensory pin prick left side	Mann-Whitney U	2.000	1.000
Bilateral lower limb motor right side	Mann-Whitney U	1.000	.317
Bilateral lower limb motor left side	Mann-Whitney U	.500	.221
S 4/5 sensory light touch	Mann-Whitney U	2.000	1.000
S 4/5 sensory pin prick	Mann-Whitney U	2.000	1.000

Table-13: Balance and Ambulation related information

Participant	Mini-Best score (Balance & Ambulation)		
	Pre	Post	Change
Participant 01	11	24	13
Participant 02	5	16	11
Participant 03	5	17	12
Participant 04	0	9	9

<u>Participant 01</u>

For participant 1, the pre-test score of the Mini-Best scale was 11, and the post-test score was 24.

The total number of changes was 13.

<u>Participant 02</u>

For participant 2, the pre-test score of the Mini-Best scale was 5, and the post-test score was 16.

The total number of changes was 11.

<u>Participant 03</u>

For participant 3, the pre-test score of the Mini-Best scale was 5, and the post-test score was 17.

The total number of changes was 12.

<u>Participant 04</u>

For participant 4, the pre-test score of the Mini-Best scale was 0, and the post-test score was 9.

The total number of changes was 9.

Table-14: Relation of within group (Experimental)

Variable	Test	Test Value	P Value
Mini-Best scale score	Willcoxon	-1.342	.180

Table-15: Relation of within group (Control)

Variable	Test	Test Value	P Value
Mini-Best scale score	Willcoxon	-1.342	.180

Table-16: Relation of between groups

Variable	Test	Test Value	P Value
Mini-Best scale score	Mann-Whitney U	1.000	.439

CHAPTER-V DISCUSSION

The purpose of the study was to investigate the Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients and the objectives were to identify the socio-demographic information of the patient (Age, Sex, Occupation, Marital status, etc.) to elicit the effectiveness of balance training with mirror to improve balance and ambulation score in incomplete spinal cord lesion patients. To demonstrate improvement, 6incomplete spinal cord lesion patients were randomly assigned into two groups in this experimental investigation. Every person with a traumatic or non-traumatic history who visited the Centre for the Rehabilitation of the Paralyzed was examined for eligibility criteria, and 6 people met the criterion for participation. Two patients out of six did not complete the scheduled session. The pretest, balance intervention, and posttest were completed by 4 responders for quantitative analysis. A systematic questionnaire was used to assess the outcome. The researcher found no significant improvement in balance and ambulation, total motor score, and total sensory score. Age, gender, marital status, educational status, and occupation were taken to consideration as demographic variables. In this study age range of the participants were 12-60 years and there were4 groups of age range among them the age range between 20-30 years, which showed a maximum number of 2 participants (50%). In my study, participants' mean age was 36.50 years with a standard deviation ±16.340 which is partially similar to the study of Islam et al., (2011).

Male and female participants were in this study. Male was predominantly higher than female. Among 4 participants 75% (n=3) were male and only 25%(n=1) was female patient. In the study of Nwankwo & Uche., (2013) male-female ratio was 4.3:1 which means there were also higher male participants than females and this was the similarity between the two studies. In this study, I also found that married 2(50%) patients and unmarried 2(50%)differed from the previously published study in that it was a quasi-experimental study, whereas the previously published study was a cross-sectional study (Islam et al., 2011). In the study total duration since injuries mean was 185.25 days and SD was ± 146.734 days; total duration of rehab was mean 133.50 and SD was ± 51.410.

In this study the patient using assistive device as wheelchair is 3(75%) and KFO is 1(25%). In the study of Sayenko et al., (2010) wheelchair-walker ratio was 6:2 which means there were also high rate of using wheelchair as assistive device.

Before starting the treatment protocol, In experimental group by Wilcoxon test Sensory light touch right side p value was .180; Sensory light touch left side p value was .180; Sensory pin prick right side p value was .180; Sensory pin prick left side p value was .180; Bilateral lower limb motor right side p value was .180; Bilateral lower limb motor left side p value was .180; S 4/5 sensory light touch p value was .655 and S 4/5 sensory light touch p value was also .655. In control group by Wilcoxon test Sensory light touch right side p value was .180; Sensory light touch left side p value was .180; Sensory pin prick right side p value was .180; Sensory pin prick left side p value was .180; Bilateral lower limb motor right side p value was .180; Bilateral lower limb motor left side p value was .180; S 4/5 sensory light touch p value was .157 and S 4/5 sensory light touch p value was also .157.

In Mann-Whitney U test the changes in Sensory light touch right side p value was .439; Sensory light touch left side p value was .439; Sensory pin prick right side p value was -683; Sensory pin prick left side p value was 1.000; Bilateral lower limb motor right side p value was .317; Bilateral lower limb motor left side p value was .221; S 4/5 sensory light touch p value was 1.000 and S 4/5 sensory light touch p value was also 1.000. That means there were no significant changes between those two groups. But a study demonstrated that there is a significant change in motor functions due to balance exercise. In my study the number of the participant was very low and that could be a possible reason to not found any significance between these control and experimental group.

For balance ambulation in my study there also no significant changes founded. In the control group by Wilcoxon test the significant value of Mini-BEST score was .180 and in experimental group the significant value was .180 also.

In Mann-Whitney U test the changes in Mini-Best score the significant value was .439. A study by Houston et al., 2020 stated that in non-traumatic iSCI patient average baseline mini- BESTest scores ranged from 5.3 to 15.3/28 by visual feedback in balance training. That was a very significant change in the treatment. Improvements >2 SD were observed on the mini-BESTest4 weeks post-training (Participant 1 and 5), and 8 weeks post-training

(Participant 5). The time of the training session was quite long. And the training session for my participants was 3 weeks. This period of time is quite less for improvement in balance and ambulation.

A study by Chow et al., (2017) found that Rehabilitation combining VFT and FES is projected to improve static and dynamic balance stability more effectively than isolated therapy modalities. Because this study demonstrated the validity of our VFT games, we would like to merge the VFT and FES systems and conduct clinical studies on patients with iSCI in the future, with the goal of enhancing their balancing skills. The brain develops spatial awareness through visual feedback training by visualizing bodily displacement and orientation. Stimulation of the muscles retrains the central nervous system, allowing individuals with iSCI to regain some motor control over time. As a result, the suggested method will assist individuals with iSCI in improving their balance ability and overall quality of life.

According to Liu and Fielding., (2011) stated that shorter interventions (8 weeks or less) with lower frequency (twice a week or less) do not always result in meaningful changes in outcome measures. As my treatments time period was short and the time period was 3 weeks there any possible improvement could not be able to shown.

5.1 Limitation of the study

As it was the first study in Bangladesh, there were various limitations and obstacles to overcome when performing the research. Because there were only 4 participants in this study, the external validity of the investigation was reduced, and there may have been disagreement about the distribution of confounding characteristics such as economic status, age, duration since incidence, and balance and ambulation score. In this study, the participants get only 3 weeks of treatment sessions due to lack of time limitation. However, while the treatment was beneficial, it was unable to determine the long-term effects. Though the study was intended to be a Randomized Control Trial, however, it was not carried out due to a lack of patients and lack of time. In Bangladesh, this type of relevant study is not available, therefore research-related information is limited. An undergraduate student completed the research study, which was her first research project. As a result, the researcher had little practical experience with research procedures and strategies.

CHAPTER-VI CONCLUSION AND RECOMMENDATION

6.1 Conclusion

A spinal cord lesion is one of the most devastating injuries in human history. Millions of people suffer from spinal cord injuries each year. In Bangladesh, there is a scarcity of evidence and a reliable database on spinal cord lesions. There is no estimate of the number of people with spinal cord injuries in Bangladesh. Bangladesh is a country that is changing. The majority of them come from low-income families with limited educational opportunities. In this country, there is also a lack of understanding about injuries, particularly those caused by spinal cord lesions. A high proportion of SCI in Bangladesh was caused by traumatic factors that could have been avoided. The total number of respondents in this survey was 4, with 3 (75%) males and 1 (25%)female. As a result, males are more vulnerable than females. The study concluded that the most vulnerable age group was 20-30 years old, as well as people with lower levels of education. The study used a quasi-experimental pilot two group pre-test and post-test design to look at how balance and ambulation is improved following mirror feedback, and the results showed that the difference was not significant. Because of the short period of intervention time. Physiotherapy plays a significant role in their recovery as well. The purpose of this study is to investigate the effectiveness of balance training with mirror feedback on balance and ambulation in Incomplete Spinal Cord Lesion Patients, which will aid in their rehabilitation, functional activities, and overall quality of life. The researcher concluded the specific variables and comparison of their improvement as a result of this research. This will help professionals decide on a specific and effective treatment protocol for patients with incomplete SCI.

6.2. Recommendation

For people with SCI, physiotherapists should take on a broader role and use holistic treatment strategies. This is an area where physiotherapists need to polish up their knowledge. Patients should be involved in treatment by physiotherapists to reduce their balance and ambulation related problems. Physiotherapists should focus on this issue more during the treatment period. It would be insignificant if the physiotherapists did not involve the patients in their treatment. For this reason, it is necessary to involve the patients in various kinds of balance training programs. Despite the study's limitations, the investigators suggested some further steps that maybe taken to improve the success of future research. This is an area where we need to perform additional investigation. A true experimental study would provide a definite outcome regarding their balance and ambulation. Because the study was brief, it will be conducted over a longer period in the future. The male and female participant ratios were not equal also; therefore, for the correctness of the results, the male and female respondent ratios should be maintained in the future. The study time and the intervention period should also increase in future studies to determine the actual result.

REFERENCES

Adamovich, S.V., Fluet, G.G., Tunik, E. and Merians, A.S., (2009). Sensorimotor training in virtual reality: a review. NeuroRehabilitation, 25(1):29-44.

Alashram, A.R., Padua, E., Hammash, A.K., Lombardo, M. and Annino, G., (2020). Effectiveness of virtual reality on balance ability in individuals with incomplete spinal cord injury: A systematic review. Journal of Clinical Neuroscience, 72:322-327.

Amatachaya, S., Pramodhyakul, W., Wattanapan, P. and Eungpinichpong, W., (2015). Ability of obstacle crossing is not associated with falls in independent ambulatory patients with spinal cord injury. *Spinal Cord*, 53(8):598-603.

Barclay-Goddard, R., Stevenson, T., Poluha, W., Moffatt, M. and Taback, S., (2004). Force platform feedback for standing balance training after stroke. Cochrane Database of Systematic Reviews.

Baudry S., (2016) Aging changes the contribution of spinal and corticospinal pathways to control balance. *Exercise and Sport Sciences Reviews*; 44(3):104–109.

Bayouk, J.F., Boucher, J.P., and Leroux, A., (2006). Balance training following stroke: effects of task-oriented exercises with and without altered sensory input. International Journal of Rehabilitation Research, 29(1):51-59.

Bonan, I.V., Colle, F.M., Guichard, J.P., Viacut, E., Eisenfisz, M., and Yelnik, A.P., (2005). Reliance on visual information after stroke. Part I: Balance on dynamic posturography. Archives of Physical Medicine and Rehabilitation, 85:268–273.

Brotherton, S.S., Krause, J.S. and Nietert, P.J., (2007). Falls in individuals with incomplete spinal cord injury. *Spinal cord*, *45*(1):37-40.

Burns, A.S., Marino, R.J., Flanders, A.E. and Flett, H., (2012). Clinical diagnosis and prognosis following spinal cord injury. Handbook of clinical neurology, 109:47-62.

Casuso-Holgado, M.J., Martín-Valero, R., Carazo, A.F., Medrano-Sánchez, E.M., Cortés-Vega, M.D. and Montero-Bancalero, F.J., (2018). Effectiveness of virtual reality training for balance and gait rehabilitation in people with multiple sclerosis: a systematic review and meta-analysis. Clinical rehabilitation, 32(9):1220-1234.

Chen Y, Tang Y, Vogel LC, Devivo MJ., (2013). Causes of spinal cord injury. Topics in Spinal Cord Injury Rehabilitation; 19(1):1-8.

Cheng, P.T., Wang, C.M., Chung, C.Y. and Chen, C.L., (2004). Effects of visual feedback rhythmic weight-shift training on hemiplegic stroke patients. Clinical rehabilitation, 18(7):747-753.

Chi, B., Chau, B., Yeo, E. and Ta, P., (2019). Virtual reality for spinal cord injury-associated neuropathic pain: systematic review. Annals of physical and rehabilitation medicine, 62(1):49-57.

Chin, L.S., (2015). Spinal Cord Injuries Clinical Presentation [Online]. Available: http://emedicine.medscape.com/article/793582-clinical [Accessed on 20 November, 2015].

Dorsett, P., & Geraghty, T., (2008). Health-related outcomes of people with spinal cord injury—a 10 year longitudinal study. Spinal Cord, 46(5):386-391.

Geyh S, Fellinghauer BAG, Kirchberger I, Post MWM., (2010). Cross-cultural validity of four quality of life scales in persons with spinal cord injury. Health and Quality of Life Outcomes; 8(94): 2-16.

Hammer, A., Nilsagardy, Y., and Wallquist, M., (2008). Balance training in stroke patients-A systematic review of randomized controlled trials. Advances in Physical Therapy, 10:163-172.

Hlavackova, P., Fristios, J., Cuisinier, R., Pinsault, N., Janura, M. and Vuillerme, N., (2009). Effects of Mirror Feedback on Upright Stance Control in Elderly Transfemoral Amputees. Archives of Physical Medicine and Rehabilitation, 90(11):1960-1963.

Hoque MF, Hasan Z, Razzak ATMA, Helal SU., (2012). Cervical spinal cord injury due to fall while carrying heavy load on head: a problem in Bangladesh. Spinal Cord; 50(4): 275–77.

Hossain, M., (2001). Statement On the Rationale & Grounds for Introducing the Bill, Bangladesh Person With Disability Welfare Act 2001, National Forum Of Organization Working With The Disable (NFOWD), Dhaka.

Ioffe, M., Ustinova, K., Chernikova, L. and Kulikov, M., (2005). Supervised learning of postural tasks in patients with poststroke hemiparesis, Parkinson's disease or cerebellar ataxia. Experimental Brain Research, 168(3):384-394.

Islam, M. S., Hafez, M. A., & Akter, M., (2011). Characterization of spinal cord lesion in patients attending a specialized rehabilitation center in Bangladesh. Spinal cord, 49(7):783-786.

Jain, A., Taylor, J., Sanzo, P. and Zerpa, C., (2017). The effect of Tai Chi on functional lower extremity mobility and strength, ankle proprioception, and postural adaptation in older adults. Am J Med Med Sci, 7:229-237.

Jørgensen, V., Opheim, A., Halvarsson, A., Franzén, E. and Roaldsen, K., (2017). Comparison of the Berg Balance Scale and the Mini-BESTest for Assessing Balance in Ambulatory People with Spinal Cord Injury: Validation Study. *Physical Therapy*, 97(6):677-687.

Kirshblum, S.C., Burns, S.P., Biering-Sorensen, F., Donovan, W., Graves, D.E., Jha, A., Johansen, M., Jones, L., Krassioukov, A., Mulcahey, M.J., and Schmidt-Read, M., (2011). International standards for neurological classification of spinal cord injury (revised 2011). *The journal of spinal cord medicine*, *34*(6):535-546.

Krause, J.S., (2004). Factors associated with risk for subsequent injuries after traumatic spinal cord injury. Archives of physical medicine and rehabilitation, 85(9):1503-1508.

Kumar, N., & Gupta, B. (2016). Effect of Spinal Cord Injury on Quality of Life of Affected Soldiers in India: A Cross-Sectional Study. Asian spine journal, 10(2):267-275.

Lemay JF, Gagnon D, Duclos C, Grangeon M, Gauthier C, Nadeau S., (2013). Influence of visual inputs on quasi-static standing postural steadiness in individuals with spinal cord injury. *Gait & Posture* 2013; 38:357-60.

Lim, S. W., Shiue, Y. L., Ho, C. H., Yu, S. C., Kao, P. H., Wang, J. J., & Kuo, J. R., (2017). Anxiety and Depression in Patients with Traumatic Spinal Cord Injury: A Nationwide Population-Based Cohort Study. PLOS ONE, 12(1), e0169623.

Lin, M.R., Wolf, S.L., Hwang, H.F., Gong, S.Y. and Chen, C.Y., (2007). A randomized, controlled trial of fall prevention programs and quality of life in older fallers. Journal of the American Geriatrics Society, 55(4):499-506.

Liu-Ambrose, T., Donaldson, M.G., Ahamed, Y., Graf, P., Cook, W.L., Close, J., Lord, S.R. and Khan, K.M., (2008). Otago home-based strength and balance retraining improves executive functioning in older fallers: a randomized controlled trial. Journal of the american geriatrics society, 56(10):1821-1830.

Moghimian, M., Kashani, F., Cheraghi, M. A., & Mohammadnejad, E., (2015). Quality of life and related factors among people with spinal cord injuries in Tehran, Iran. Archives of trauma research, 4(3).

Moseley, L.G., Gallace, A. and Spence, C., (2008). Is mirror therapy all it is cracked up to be? Current evidence and future directions. *Pain*, *138*(1):7-10.

Mothe AJ, Tator CH., (2013). Review of transplantation of neural stem progenitor cells for spinal cord injury. International Journal of Developmental Neuroscience;31(7):701–713.

Munce SEP, Perrier L, Tricco AC, Straus SE, Fehlings MG, Kastner M., Jang E, Webster F, Jaglal SB., (2013). Impact of quality improvement strategies on the quality of life and well-being of individuals with spinal cord injury: a systematic review protocol. Systematic Reviews Journal; 2(14):2-5.

New PW, Farry A, Baxter D, Noonan VK., (2013). Prevalence of non-traumatic spinal cord injury in Victoria, Australia. Spinal Cord; 51:99–102.

Ning GZ, Wu Q, Li YL, Feng SQ., (2012). Epidemiology of traumatic spinal cord injury in Asia: a systematic review. Journal of Spinal Cord Medicine; 35(4):229–239.

Noonan, V. K., Fingas, M., Farry, A., Baxter, D., Singh, A., Fehlings, M. G., & Dvorak, M. F., (2012). Incidence and prevalence of spinal cord injury in Canada: a national perspective. Neuroepidemiology, 38(4):219-226.

Nwankwo OE, Uche EO., (2013). Epidemiological and treatment profiles of spinal cord injury in southeast Nigeria. Spinal Cord; 51:448–52.

Oliveira, C.B., Medeiros, I.R.T., Frota, N.A.F., Greters, M.E., and Adriana, B., (2008). Balance control in hemiparetic stroke patients: Main tools for evaluation. Journal of Rehabilitation Research & Development, 45(8):1215- 1226.

Penn, I.W., Sung, W.H., Lin, C.H., Chuang, E., Chuang, T.Y. and Lin, P.H., (2019). Effects of individualized Tai-Chi on balance and lower-limb strength in older adults. BMC geriatrics, 19(1):1-8.

Rabadi MH, Mayanna SK, Vincent AS., (2013). Predictors of mortality in veterans with traumatic spinal cord injury. Spinal Cord; 51(10):784–88.

Ragnarsdóttir, M., 1996. The Concept of Balance. *Physiotherapy*, 82(6), pp.368-375.Ragnarsdóttir, M., (1996). The Concept of Balance. *Physiotherapy*, 82(6):368-375.

Ramachandran, V. and Rogers-Ramachandran, D., (2000). Phantom Limbs and Neural Plasticity. *Archives of Neurology*, 57(3):317.

Razzak A, Helal SU, Nuri RP., (2011). Life expectancy after spinal cord injury in a developing country-a retrospective study at CRP, Bangladesh. Asia Pacific Disability Rehabilitation Journal; 22(2):114-23.

Rizzolo, S.J., Vaccaro, A.R., and Cotler, J.M., (2000). Cervical Spine Trauma [Online]. Available: Http://Www.Anzca.Edu.Au/Jficm/Resources/Ccr/2006/ March/Surgical Review Tdf.Html [Accessed on 3 July, 2015].

Saadat S, Javadi M, Divshali BS, Tavakoli AH, Ghodsi SM, Montazeri A, Rahimi-Movaghar V., (2010). Health-related quality of life among individuals with long-standing spinal cord injury: a comparative study of veterans and non-veterans. BMC Public Health; 10(6):1-7.

Saulino, M.F., (2014). Rehabilitation of persons with spinal cord injuries. Archives physical medicine and rehabilitation, 80 (11):1411–19.

Sayenko, D.G., Alekhina, M.I., Masani, K., Vette, A.H., Obata, H., Popovic, M.R. and Nakazawa, K., (2010). Positive effect of balance training with visual feedback on standing balance abilities in people with incomplete spinal cord injury. *Spinal cord*, *48*(12):886-893.

Shubert, T.E., McCulloch, K., Hartman, M. and Giuliani, C.A., (2010). The effect of an exercise-based balance intervention on physical and cognitive performance for older adults: a pilot study. Journal of geriatric physical therapy, 33(4):157-164.

Silsupadol, P., Shumway-Cook, A., Lugade, V., van Donkelaar, P., Chou, L.S., Mayr, U. and Woollacott, M.H., (2009). Effects of single-task versus dual-task training on balance performance in older adults: a double-blind, randomized controlled trial. Archives of physical medicine and rehabilitation, 90(3):381-387.

Spinal Cord Injury Statistics., (2009). Foundation for Spinal Cord Injury Prevention Care & Cure [Online].

Tamburella, F., Scivoletto, G. and Molinari, M., (2013). Balance training improves static stability and gait in chronic incomplete spinal cord injury subjects: a pilot study. *Eur J Phys Rehabil Med*, *49*(3):353-364.

Tonack, M., Hitzig, S. L., Craven, B. C., Campbell, K. A., Boschen, K. A., & McGillivray, C. F., (2008). Predicting life satisfaction after spinal cord injury in a Canadian sample. Spinal Cord, 46(5):380-385.

Tsang, W.W. and Hui-Chan, C.W., (2004). Effect of 4-and 8-wk intensive Tai Chi Training on balance control in the elderly. Medicine and science in sports and exercise, 36(4):648-657.

Tyson, S.F., Hanley, M., Chillala, J., Selley, A., and Tallis, R.C., (2006). Balance disability after stroke. Physical Therapy, 86(1):30-38.

Unger, J., Chan, K., Scovil, C.Y., Craven, B.C., Mansfield, A., Masani, K. and Musselman, K.E., (2019). Intensive balance training for adults with incomplete spinal cord injuries: protocol for an assessor-blinded randomized clinical trial. Physical Therapy, 99(4):420-427.

Villiger, M., Bohli, D., Kiper, D., Pyk, P., Spillmann, J., Meilick, B., Curt, A., Hepp-Reymond, M.C., Hotz-Boendermaker, S. and Eng, K., (2013). Virtual reality–augmented neuro rehabilitation improves motor function and reduces neuropathic pain in patients with incomplete spinal cord injury. Neuro rehabilitation and neural repair, 27(8), pp.675-683.

Walker, C., Brouwer, B. and Culham, E., (2000). Use of Visual Feedback in Retraining Balance Following Acute Stroke. Physical Therapy, 80(9):886-895.

Wall, T., Feinn, R., Chui, K. and Cheng, M.S., (2015). The effects of the Nintendo™ Wii Fit on gait, balance, and quality of life in individuals with incomplete spinal cord injury. The journal of spinal cord medicine, 38(6):777-783.

Wannapakhe, J., Arayawichanon, P., Saengsuwan, J. and Amatachaya, S., (2014). Changes of functional ability in patients with spinal cord injury with and without falls during 6 months after discharge. Physical Therapy, 94(5):675-681.

Woollacott, M. and Shumway-Cook, A., (2002). Attention and the control of posture and gait: a review of an emerging area of research. Gait & posture, 16(1):1-14.

Wyndaele M, Wyndaele JJ., (2007). Review incidence, prevalence and epidemiology of spinal cord injury: What learns a worldwide literature survey. Spinal Cord; 44:523–52.

APPENDIX

INFORMED CONSENT

Assalamu-alaikum

My name is Luthfor Rahman, student of B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI), CRP. I am conducting a study for partial fulfillment of Bachelor of Science in Physiotherapy degree, titled, "**Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients. A Quasi-Experimental Study".** Through this research, I will find out the Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients. For this purpose, I would need to collect data from the patient who are suffering from Spinal Cord lesion attending at CRR. Considering the area of research, you have met the inclusion criteria and I would like to invite you as a participant of this study. If you participate in this study, I will give you particular intervention & evaluate the Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients. The interventions that will be given are safe and will not cause any harm. Your participation will be voluntary. You may have the right to withdraw consent and discontinue participation during data collection or up to 1 month of data collection. If you have any query about the study or your right as a participant, you may contact with, researcher Luthfor Rahman (mobile No: 01798591668) or my supervisor, Kazi Md. Amran Hossain (mobile No: 01735661492), Lecturer, BHPI, CRP, Savar, Dhaka. In case of any issues, you also have the liberty to contact with IRB, Muhammad Millat Hossain, Ass Professor, Dept. of Rehabilitation Science, Member Secretary, Institutional Review Board (IRB) BHPI, CRP, Savar, Dhaka-1343, Bangladesh. (Email: millatcbr@yahoo.com; mscrehabscience@crp-bangladesh.org)

So, may I have your consent to proceed with the interview? Yes..........

I……………………………………………. have read and understand the contents of the form. I agree to participant in the research without any force.

Signature of the Interviewer…………………………………………….

Questionnaire

TITLE: Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients.

Interview schedule **Part I: patient's Identification & Socio-demographic questions.**		
1.1	Identification number	
1.2	Date of interview	
1.3	Address	
1.4	Mobile number	

Please select your correct answer and marked the answer through the circle ◯

QN	Questions	Response/Answer	Code
1.6	Age		
1.7	Gender	Male Female	00 01
1.8	Marital status	Married Unmarried Divorced Separated Widow	00 01 02 03 04
1.9	Residential area	Rural Semi-urban Urban	00 01 02
1.10	Education	Non-education Primary Secondary Higher Secondary Graduate Postgraduate	00 01 02 03 04 05

1.11	Occupation	Farmer Rickshaw puller Garment worker Driver Businessmen Day laborer Teacher Student Unemployed Others (specify)………….	00 01 02 03 04 05 06 07 08 09
1.12	Family member		
1.13	Earning member		
1.14	Monthly income		

Part II: Clinical Information

QN	Questions	Response/Answer	Code
2.1	Date since injury/incidence		
2.2	Duration of rehab		
2.3	Causes of injury	Road Traffic Accident Fall from high Fall while carrying heavy load Scarf injury Shallow diving Others (Specify)	00 01 02 03 04 05
2.4	History of surgery	Yes No	00 01
2.5	Assistive device used	Yes No	00 01

2.6	Any major disease/ Co-morbidities	Diabetes mellitus Hypertension Lung disease Cardiovascular disease Epilepsy Others	00 01 02 03 04 05

Part III: Pretest Questionnaire - Neurological Information

QN	Questions	Response	
		Right	Left
ASIA Impairment Scale			
3.1	**Sensory sub-score (light touch) B/L (0-56 score)**		
3.2	**Sensory sub-score (Pin prick) B/L (0-56 score)**		
3.3	**Total bilateral lower limb motor Sub-score (0-25 score)**		
3.4	**S4/5Sensoery light touch (0=absent, 1=altered/impaired, 2=normal)**		
3.5	**S4/5Sensoery pin prick (0=absent, 1=altered/impaired, 2=normal)**		
3.6	**Sensation to deep pressure (anal) Y=Yes present, N=Not present**		
3.7	**Voluntary anal muscle contraction Y=Yes present, N=Not present**		
3.8	**ASIA Impairment Scale Classification**		

Part IV: Pretest Questionnaire – Balance and Ambulation Information

ANTICIPATORY SUB SCORE: / 6

1. **SIT TO STAND**

Instruction: "Cross your arms across your chest. Try not to use your hands unless you must. Do not let your legs lean against the back of the chair when you stand. Please stand up now."

(2) Normal: Comes to stand without use of hands and stabilizes independently.

(1) Moderate: Comes to stand WITH use of hands on first attempt.

(0) Severe: Unable to stand up from chair without assistance, OR needs several attempts with use of hands.

2. **RISE TO TOES**

Instruction: "Place your feet shoulder width apart. Place your hands on your hips. Try to rise as high as you can onto your toes. I will count out loud to 3 seconds. Try to hold this pose for at least 3 seconds. Look straight ahead. Rise now."

(2) Normal: Stable for 3 s with maximum height.

(1) Moderate: Heels up, but not full range (smaller than when holding hands), OR noticeable instability for 3 s.

(0) Severe: < 3 s.

3. **STAND ON ONE LEG**

Instruction: "Look straight ahead. Keep your hands on your hips. Lift your leg off of the ground behind you without touching or resting your raised leg upon your other standing leg. Stay standing on one leg as long as you can. Look straight ahead. Lift now."

Left: Time in Seconds

(2) Normal: 20 s.

(1) Moderate: < 20 s.

(0) Severe: Unable.

Right: Time in Seconds

(2) Normal: 20 s.

(1) Moderate: < 20 s.

(0) Severe: Unable

To score each side separately use the trial with the longest time.To calculate the sub-score and total score use the side [left or right] with the lowest numerical score [i.e., the worse side].

REACTIVE POSTURAL CONTROL SUB SCORE: / 6

4. COMPENSATORY STEPPING CORRECTION- FORWARD

Instruction: "Stand with your feet shoulder width apart, arms at your sides. Lean forward against my hands beyond your forward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

(2) Normal: Recovers independently with a single, large step (second realignment step is allowed).

(1) Moderate: More than one step used to recover equilibrium.

(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

5. COMPENSATORY STEPPING CORRECTION- BACKWARD

Instruction: "Stand with your feet shoulder width apart, arms at your sides. Lean backward against my hands beyond your backward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

(2) Normal: Recovers independently with a single, large step.

(1) Moderate: More than one step used to recover equilibrium.

(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

6. COMPENSATORY STEPPING CORRECTION- LATERAL

Instruction: "Stand with your feet together, arms down at your sides. Lean into my hand beyond your sideways limit. When I let go, do whatever is necessary, including taking a step, to avoid a fall."

Left

(2) Normal: Recovers independently with 1 step

(1) Moderate: Several steps to recover equilibrium.

(0) Severe: Falls, or cannot step.

Right

(2) Normal: Recovers independently with 1 step

(1) Moderate: Several steps to recover equilibrium.

(0) Severe: Falls, or cannot step.

Use the side with the lowest score to calculate sub-score and total score.

SENSORY ORIENTATION SUB SCORE: / 6

7. **STANCE (FEET TOGETHER); EYES OPEN, FIRM SURFACE**

Instruction: "Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Be as stable and still as possible, until I say stop."

Time in seconds:

(2) Normal: 30 s.

(1) Moderate: < 30 s.

(0) Severe: Unable.

8. **STANCE (FEET TOGETHER); EYES CLOSED, FOAM SURFACE**

Instruction: "Step onto the foam. Place your hands on your hips. Place your feet together until almost touching. Be as stable and still as possible, until I say stop. I will start timing when you close your eyes."

Time in seconds:

(2) Normal: 30 s.

(1) Moderate: < 30 s.

(0) Severe: Unable.

9. **INCLINE- EYES CLOSED**

Instruction: "Step onto the incline ramp. Please stand on the incline ramp with your toes toward the top. Place your feet shoulder width apart and have your arms down at your sides. I will start timing when you close your eyes."

Time in seconds:

(2) Normal: Stands independently 30 s and aligns with gravity.

(1) Moderate: Stands independently <30 s OR aligns with surface.

(0) Severe: Unable.

DYNAMIC GAIT SUB SCORE: / 10

10. CHANGE IN GAIT SPEED

Instruction: “Begin walking at your normal speed, when I tell you „Fast‟, walk as fast as you can. When I say „slow‟, walk very slowly.”

(2) Normal: Significantly changes walking speed without imbalance.

(1) Moderate: Unable to change walking speed or signs of imbalance.

(0) Severe: Unable to achieve significant change in walking speed AND signs of imbalance.

11. WALK WITH HEAD TURNS – HORIZONTAL

Instruction: “Begin walking at your normal speed, when I say “right”, turn your head and look to the right. When I say “left” turn your head and look to the left. Try to keep yourself walking in a straight line.”

(2) Normal: performs head turns with no change in gait speed and good balance.

(1) Moderate: performs head turns with reduction in gait speed.

(0) Severe: performs head turns with imbalance.

12. WALK WITH PIVOT TURNS

Instruction: “Begin walking at your normal speed. When I tell you to „turn and stop‟, turn as quickly as you can, face the opposite direction, and stop. After the turn, your feet should be close together.”

(2) Normal: Turns with feet close FAST (< 3 steps) with good balance.

(1) Moderate: Turns with feet close SLOW (>4 steps) with good balance.

(0) Severe: Cannot turn with feet close at any speed without imbalance.

13. STEP OVER OBSTACLES

Instruction: “Begin walking at your normal speed. When you get to the box, step over it, not around it and keep walking.”

(2) Normal: Able to step over box with minimal change of gait speed and with good balance.

(1) Moderate: Steps over box but touches box OR displays cautious behavior by slowing gait.

(0) Severe: Unable to step over box OR steps around box.

14. TIMED UP & GO WITH DUAL TASK [3 METER WALK]

Instruction TUG: "When I say „Go", stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair."

Instruction TUG with Dual Task: "Count backwards by threes starting at …. When I say „Go, stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair. Continue counting backwards the entire time."

TUG:_seconds; Dual Task TUG:___seconds

(2) Normal: No noticeable change in sitting, standing or walking while backward counting when compared to TUG without Dual Task.

(1) Moderate: Dual Task affects either counting OR walking (>10%) when compared to the TUG without Dual Task.

(0) Severe: Stops counting while walking OR stops walking while counting.

When scoring item 14, if subject's gait speed slows more than 10% between the TUG without and with a Dual Task the score should be decreased by a point.

TOTAL SCORE:________/ 28

Part V: Posttest Questionnaire - Neurological Information

<table>
<tr><th rowspan="2">QN</th><th rowspan="2">Questions</th><th colspan="2">Response</th></tr>
<tr><th>Right</th><th>Left</th></tr>
<tr><td colspan="4">ASIA Impairment Scale</td></tr>
<tr><td>5.1</td><td>Sensory sub-score (light touch) B/L
(0-56 score)</td><td></td><td></td></tr>
<tr><td>5.2</td><td>Sensory sub-score (Pin prick) B/L
(0-56 score)</td><td></td><td></td></tr>
<tr><td>5.3</td><td>Total bilateral lower limb motor
Sub-score (0-25 score)</td><td></td><td></td></tr>
<tr><td>5.4</td><td>S4/5Sensoery light touch
(0=absent, 1=altered/impaired, 2=normal)</td><td colspan="2"></td></tr>
<tr><td>5.5</td><td>S4/5Sensoery pin prick
(0=absent, 1=altered/impaired, 2=normal)</td><td colspan="2"></td></tr>
<tr><td>5.6</td><td>Sensation to deep pressure (anal)
Y=Yes present, N=Not present</td><td colspan="2"></td></tr>
<tr><td>5.7</td><td>Voluntary anal muscle contraction
Y=Yes present, N=Not present</td><td colspan="2"></td></tr>
<tr><td>5.8</td><td>ASIA Impairment Scale Classification</td><td colspan="2"></td></tr>
</table>

Part VI: Posttest Questionnaire – Balance and Ambulation Information

ANTICIPATORY SUB SCORE: / 6

1. **SIT TO STAND**

Instruction: “Cross your arms across your chest. Try not to use your hands unless you must. Do not let your legs lean against the back of the chair when you stand. Please stand up now.”

(2) Normal: Comes to stand without use of hands and stabilizes independently.

(1) Moderate: Comes to stand WITH use of hands on first attempt.

(0) Severe: Unable to stand up from chair without assistance, OR needs several attempts with use of hands.

2. **RISE TO TOES**

Instruction: “Place your feet shoulder width apart. Place your hands on your hips. Try to rise as high as you can onto your toes. I will count out loud to 3 seconds. Try to hold this pose for at least 3 seconds. Look straight ahead. Rise now.”

(2) Normal: Stable for 3 s with maximum height.

(1) Moderate: Heels up, but not full range (smaller than when holding hands), OR noticeable instability for 3 s.

(0) Severe: < 3 s.

3. **STAND ON ONE LEG**

Instruction: “Look straight ahead. Keep your hands on your hips. Lift your leg off of the ground behind you without touching or resting your raised leg upon your other standing leg. Stay standing on one leg as long as you can. Look straight ahead. Lift now.”

Left: Time in Seconds

(2) Normal: 20 s.

(1) Moderate: < 20 s.

(0) Severe: Unable.

Right: Time in Seconds

(2) Normal: 20 s.

(1) Moderate: < 20 s.

(0) Severe: Unable

To score each side separately use the trial with the longest time.To calculate the sub-score and total score use the side [left or right] with the lowest numerical score [i.e., the worse side].

REACTIVE POSTURAL CONTROL SUB SCORE: / 6

4. **COMPENSATORY STEPPING CORRECTION- FORWARD**

Instruction: “Stand with your feet shoulder width apart, arms at your sides. Lean forward against my hands beyond your forward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall.”

(2) Normal: Recovers independently with a single, large step (second realignment step is allowed).

(1) Moderate: More than one step used to recover equilibrium.

(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

5. **COMPENSATORY STEPPING CORRECTION- BACKWARD**

Instruction: “Stand with your feet shoulder width apart, arms at your sides. Lean backward against my hands beyond your backward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall.”

(2) Normal: Recovers independently with a single, large step.

(1) Moderate: More than one step used to recover equilibrium.

(0) Severe: No step, OR would fall if not caught, OR falls spontaneously.

6. **COMPENSATORY STEPPING CORRECTION- LATERAL**

Instruction: “Stand with your feet together, arms down at your sides. Lean into my hand beyond your sideways limit. When I let go, do whatever is necessary, including taking a step, to avoid a fall.”

Left

(2) Normal: Recovers independently with 1 step

(1) Moderate: Several steps to recover equilibrium.

(0) Severe: Falls, or cannot step.

Right

(2) Normal: Recovers independently with 1 step

(1) Moderate: Several steps to recover equilibrium.

(0) Severe: Falls, or cannot step.

Use the side with the lowest score to calculate sub-score and total score.

SENSORY ORIENTATION SUB SCORE: / 6

7. **STANCE (FEET TOGETHER); EYES OPEN, FIRM SURFACE**

Instruction: "Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Be as stable and still as possible, until I say stop."

Time in seconds:

(2) Normal: 30 s.

(1) Moderate: < 30 s.

(0) Severe: Unable.

8. **STANCE (FEET TOGETHER); EYES CLOSED, FOAM SURFACE**

Instruction: "Step onto the foam. Place your hands on your hips. Place your feet together until almost touching. Be as stable and still as possible, until I say stop. I will start timing when you close your eyes."

Time in seconds:

(2) Normal: 30 s.

(1) Moderate: < 30 s.

(0) Severe: Unable.

9. **INCLINE- EYES CLOSED**

Instruction: "Step onto the incline ramp. Please stand on the incline ramp with your toes toward the top. Place your feet shoulder width apart and have your arms down at your sides. I will start timing when you close your eyes."

Time in seconds:

(2) Normal: Stands independently 30 s and aligns with gravity.

(1) Moderate: Stands independently <30 s OR aligns with surface.

(0) Severe: Unable.

DYNAMIC GAIT SUB SCORE: / 10

10. CHANGE IN GAIT SPEED

Instruction: "Begin walking at your normal speed, when I tell you „Fast‟, walk as fast as you can. When I say „slow‟, walk very slowly."

(2) Normal: Significantly changes walking speed without imbalance.

(1) Moderate: Unable to change walking speed or signs of imbalance.

(0) Severe: Unable to achieve significant change in walking speed AND signs of imbalance.

11. WALK WITH HEAD TURNS – HORIZONTAL

Instruction: "Begin walking at your normal speed, when I say "right", turn your head and look to the right. When I say "left" turn your head and look to the left. Try to keep yourself walking in a straight line."

(2) Normal: performs head turns with no change in gait speed and good balance.

(1) Moderate: performs head turns with reduction in gait speed.

(0) Severe: performs head turns with imbalance.

12. WALK WITH PIVOT TURNS

Instruction: "Begin walking at your normal speed. When I tell you to „turn and stop‟, turn as quickly as you can, face the opposite direction, and stop. After the turn, your feet should be close together."

(2) Normal: Turns with feet close FAST (< 3 steps) with good balance.

(1) Moderate: Turns with feet close SLOW (>4 steps) with good balance.

(0) Severe: Cannot turn with feet close at any speed without imbalance.

13. STEP OVER OBSTACLES

Instruction: "Begin walking at your normal speed. When you get to the box, step over it, not around it and keep walking."

(2) Normal: Able to step over box with minimal change of gait speed and with good balance.

(1) Moderate: Steps over box but touches box OR displays cautious behavior by slowing gait.

(0) Severe: Unable to step over box OR steps around box.

14. TIMED UP & GO WITH DUAL TASK [3 METER WALK]

Instruction TUG: "When I say „Go", stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair."

Instruction TUG with Dual Task: "Count backwards by threes starting at …. When I say „Go, stand up from chair, walk at your normal speed across the tape on the floor, turn around, and come back to sit in the chair. Continue counting backwards the entire time."

TUG:_seconds; Dual Task TUG:___seconds

(2) Normal: No noticeable change in sitting, standing or walking while backward counting when compared to TUG without Dual Task.

(1) Moderate: Dual Task affects either counting OR walking (>10%) when compared to the TUG without Dual Task.

(0) Severe: Stops counting while walking OR stops walking while counting.

When scoring item 14, if subject's gait speed slows more than 10% between the TUG without and with a Dual Task the score should be decreased by a point.

TOTAL SCORE:________/ 28

Ref: CRP/BHPI/IRB/03/2022/563

Date: 02/03/2022

Luthfor Rahman
4th Year B.Sc. in Physiotherapy
Session: 2016 - 2017
BHPI, CRP, Savar, Dhaka- 1343, Bangladesh

Subject: Approval of the research project proposal **"Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients"** by the ethics committee.

Dear Luthfor Rahman,

Congratulations.

The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the principal investigator and Kazi Md. Amran Hossain as thesis supervisor. The Following documents have been reviewed and approved:

Sr. No.	Name of the Documents
1	Dissertation Proposal
2	Questionnaire (English version)
3	Information sheet & consent form.

The purpose of the study is to find out the effect of balance training with mirror feedback on balance and ambulation in incomplete spinal cord lesion patients. Since the study involves questionnaire that takes maximum 30 minutes and have no likelihood of any harm to the participants, the members of the ethics committee approved the study to be conducted in the presented form at the meeting held at 09:00 AM on 12th October, 2021 at BHPI (30th IRB Meeting).

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring in the course of the study, any revision in the protocol and patient information or informed consent and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,

Muhammad Millat Hossain
Assistant Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Permission letter

Date: 07/03/2022

The Head of Department

Department of Physiotherapy

Centre for the Rehabilitation of the Paralysed (CRP),

Chapain, Savar, Dhaka-1343.

Through: Head, Department of Physiotherapy, BHPI

Subject: Seeking permission for data collection of 4th year physiotherapy research project.

Respected Sir,

With due respect and humble submission to state that I am Luthfor Rahman, student of 4th Professional B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI). The ethical committee has approved my research project entitled on **"Effect of Balance Training with Mirror Feedback on Balance and Ambulation in Incomplete Spinal Cord Lesion Patients"** Under the supervision of Kazi Md. Amran Hossain, Lecturer, Department of Physiotherapy, BHPI, CRP, Savar, Dhaka-1343, Bangladesh. My IRB No (CRP/BHPI/IRB/03/2022/563). I want to collect data for my research project from the patients of Spinal Cord Injury department, Department of Physiotherapy, CRP-Savar. So, I need permission for data collection from the Spinal Cord Injury department, Physiotherapy department of CRP-Savar. I would like to assure that anything of my study will not be harmful for the participants.

May I, therefore pray and hope that you would be kind enough to grant my application & give me permission for data collection and oblige thereby.

Yours obediently,

Luthfor Rahman

....

Luthfor Rahman

4th professional B.Sc. in Physiotherapy

Roll: 37, Session: 2016-17

Bangladesh Health Professions Institute (BHPI)

CRP, Chapain, Savar, Dhaka-1343.

Recommended

Shofiq

14.03.22

Md. Shofiqul Islam

Associate Professor & Head

Department of Physiotherapy

Bangladesh Health Professions Institute (BHPI)

CRP, Chapain, Savar, Dhaka-1343

Forwarded.

Kazi Md. Amran Hossain

Lecturer

Dept. of Physiotherapy

BHPI, CRP, Savar, Dhaka-1343

Approved

16/03/22