EFFECTIVENESS OF PASSIVE STRETCHING ON UNAFFECTED CALF MUSCLE FOR IMPROVING STANDING BALANCE FOR THE PATIENT WITH CHRONIC HEMIPLEGIA.

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Declaration

- This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

- This dissertation is being submitted in partial fulfillment of the requirements for the degree of M.Sc. in Rehabilitation Science.

- This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. A Bibliography is appended.

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List of Abbreviations

BBS	Berg Balance Scale
BHPI	Bangladesh Health Professions Institute
BMRC	Bangladesh Medical Research Council
CP	Conventional Physiotherapy
CRP	Centre for the Rehabilitation of the Paralysed
CVA	Cerebro Vascular Accident
DU	University of Dhaka
IRB	Institution Review Board
SRU	Stroke Rehabilitation Unit

Abstract

Background: Stroke severity strongly impacts functional results, making it the largest cause of lifelong disability. Chronic stroke survivors' population in Bangladesh is increasing day by day and they often develop standing and walking balance problems.

Method: A randomized controlled trial (RCT) was conducted in the seating of CRP Neurology & SRU unit. A total of 64 sample were included in the research. Randomization table was developed through XL software. Initially look all new patient of stroke than compare with inclusive criteria and select for a participant. The participant enters into groups according to randomization table. Initial data was collected at the start of the trial and again 6 sessions later. The Berg Balance Scale (BBS) was used to evaluate the static balance of individuals who had experienced a stroke for an extended period. The control group was given conventional therapy, whereas the experimental group underwent passive stretching on the unaffected calf muscle. The BBS score is ordinal and from the normality test, the data was not normally distributed that's why non parametric test require. The Mann-Whitney U test was used to evaluate the efficacy between groups. The Wilcoxon Signed Rank test was conducted to assess the improvements within the groups.

Results: The analysis was conducted through SPSS and from Man Whitney U test use for the between group analysis and found that p value is ($p = 0.001$) where slandered significant level, p is ($p \leq 0.05$). It suggests that result is significant. The other test Wilcoxon test use for within both groups, the result of Experiment group p value is $p=0.001$but significant level is $p \leq 0.05$ that suggests result is significant. The other hand for control group p is found $p= 0.001$ but significant is $p \leq 0.05$ so this is also significant. Overall result proves the significant level of between experimental and control group and within individual group that has been scientifically proved that the null hypothesis had been rejected and accept the hypothesis. It means passive stretching on unaffected calf muscle improves the static balance.

Conclusion: Passive stretching is an innovative method that has been shown to enhance static balance and improve the active balance of individuals who have had a stroke for an extended period of time. Patients often exhibit a greater dependence on the unaffected limb while doing their regular activities. This often leads to difficulties in

the unaffected lower extremity. Passive stretching enhances static equilibrium, facilitating the smooth execution of regular activities.

Keywords: *Stroke, Unaffected limb, Static balance, passive Stretching.*

CHAPTER- I INTRODUCTION

1.1 Background

According to Zoghbi et al. (2014) and Mendis & Norrving (2014), Stroke is the primary cause of disability in the Asian population, making a significant morbidity in the context of a Sustainable Development Goal (SDGs). Stroke is the fourth most frequent cause of mortality in industrialized nations and main cause of disability in adults globally, affecting individuals of all ages (Ferreira et al., 2019).

Low- and middle-income nations have higher stroke mortality and burden, which is increasing over time (Kim & Johnston, 2011; Krishnamurthi et al., 2014; Norwich & Kissela, 2013). In the US, stroke incidence has increased by over 25% since 2010. An additional 4 million people are predicted to have a stroke by 2030, which would raise healthcare costs overall in the country (Han et al., 2017).

In Bangladesh, stroke ranks among the leading causes of preventable deaths (Islam et al., 2012). The World Health Organisation (WHO) projects that less developed countries accounted for 85.5% of stroke fatalities globally in 2001. Abiodun (2018) notes that these nations also had about seven times as many disability-adjusted life years (DALYs), or years of life lost and years lived with a disability, as industrialized (high-income) countries.

Severity of stroke significantly affects functional outcomes, making it the main cause of permanent disability in Western countries. Of those who survive a stroke, one-third will be able to do at least one ADL, and 460 out of 100,000 will not fully recover. After three months, 50% of stroke victims will be functionally independent, and 20% will need hospital care. Of stroke sufferers, 85% become unable of using their upper limbs (Cumming, Brodtmann, Darby & Bernhardt, 2014).

A stroke is a disease that results in some brain cells dying off. According to Page and Palma (2020), there are two primary forms of stroke: ischemic strokes, which are brought on by blockages, and hemorrhagic strokes, which are brought on by blood vessel ruptures. According to Hossain et al. (2011) and Siddique et al. (2009), risk factors for stroke in Bangladesh include hyperlipidemia, diabetes mellitus, heart disease, cigarette smoking, oral contraception, and a prior history of TIA.

It is well acknowledged that ischemic stroke may be caused by a variety of illnesses. Large-artery atherosclerosis (macroangiopathy), cardiac embolism, and cerebral small-

vessel disease (microangiopathy) are more frequent causes of ischemic stroke. Cervical artery dissection, cerebral vasculitis, coagulopathies, hematologic diseases, and other conditions are less prevalent causes of stroke. As opposed to hemorrhagic stroke, which has a worse prognosis, most stroke patients have ischemic stroke (Miah et al., 2008) & (Badiuzzaman et al., 2009).

Since young people who suffer from ischemic strokes are often in their prime earning years, the effects on the patients, their families, and society at large may be profound. People in poor nations bear over two thirds of the world's stroke burden (Truelsen et al., 2001).

The degree of injury to the target sites of brain affects the range of features reported after a stroke. More than 8% of people who have had a stroke have motor impairment that affects both their upper and lower extremities (Divya & Narkeesh, 2022). Only a few of the challenges that stroke survivors may experience include hemiparesis, motor Deficits, Cognitive Deficits, Aphasia, Proprioceptive deficits, and depressive symptoms (Gresham, Stason& Duncan, 2004; Semrau, Herter, Scott & Dukelow, 2013). The most typical after-stroke signs and symptoms are hemiparesis (Gracies et al., 2019) and muscle weakness (Schinwelski, Sitek & Sawek, 2019).

Both illnesses are characterized by a loss of function on one side of the body. According to Faria-Fortini, Michaelsen, Cassiano, and Teixeira-Salmela (2011), dystonia, active ROM deficits, and impairments in movement speed, precision, and bimanual coordination are all important contributors to functional disability and ADLs. For stroke victims, spasticity-induced paralysis is a significant problem (Chuang, Wu, & Lin, 2012). In the clinic, resistance to passive ROM is a sign of spasticity, which is defined by abnormally high muscle tone (Bhakta, 2000). Spasticity, a velocity-dependent motor disturbance, is defined by augmented tonic stretch reflex due to hyperexcitability of the stretch reflex. Ineffective management of spasticity can lead to muscle and tendon shortening as well as joint stiffness. This could seriously impair one's ability to carry out daily chores (Seim, Wolf & Starner, 2021). Participants also reported significant muscle weakening in the trunk's main muscles (Van Criekinge et al., 2017), which affects balance and coordination while sitting.

Prognosis in stroke patients is heavily influenced by the severity of neurological abnormalities and complications they experience after the initial event (Kuzu, Adiguzel,

Kesikburun, Yaşar & Ylmaz, 2021). The effectiveness of the patient's upper and lower extremities, as well as their trunk, typically decreases during the acute phase of stroke (French et al., 2010).

Rehabilitation after a stroke is an iterative, goal-oriented process that helps the patient regain as much physical, mental, emotional, linguistic, social, and functional ability as possible. The inability to open one's hand is a common symptom of permanent loss of hand function following a stroke. After a stroke, the goal of rehabilitation is to improve motor skills and function in the affected upper limb (Dimyan & Cohen, 2011). Improving range of motion, static and dynamic control, and muscular strength and stability are the cornerstones of contemporary post-stroke rehabilitation. Even though studies found the necessity of trunk control in the field of physiotherapy for Stroke survivors, the link between activity impairment and trunk muscles has not been totally understood by clinical investigations (Klnc et al., 2016).

About 60-70% of patients can walk after receiving rehabilitation. The rest of the population often suffers from muscular disorders such as muscle weakness, impaired proprioception of lower limb as well as loss of balance. Interventions that mainly focus on muscle normalization use the neuroplasticity of the brain to improve desired outcome (Criekinge et al., 2019).

Resistance to stretching may make routine activities harder. The amount of collagenous perimysium tissue and the number of cross-bridge attachments between myofilaments that are strongly bound (during active muscle contraction) and possibly weakly bound (during muscle lengthening) may affect passive and active stretch resistance. Quick stretches are resistant due to reflex muscle activation and viscosity. To improve movement efficiency for chronic stroke survivors, reducing stretch resistance may reduce resistance to desired actions. Movement, musculoskeletal, and general health are affected. Passive stretching to the target location normalizes stretch resistance (Behm et al., 2021).

It is common knowledge that stretching may enhance range of motion in both passive and active ways. Stretching is a common training technique that is used to improve functionality in athletic activities. In addition, the preparation of the muscles is an essential component to carry out everyday life activities. Stroke, Arthritis, Muscular

Dystrophy, Cerebral Palsy, and remaining illnesses may all cause a reduction in range of motion, which is one of the most impaired aspects of these disorders (Behm, 2018)

Balane and postural control are one of the most valuable components of human body and these are most impaired functions following stroke. Impaired balance and inability to maintain postural control is the most important underlying cause of fall among stroke patients. These impaired functions also hamper the daily life activities of the patients (Yoon et al., 2014).

Impairment in active control of balance is a common problem after stroke. Lack of balance increases the risk of fall in elderly and chronic stroke patients (Bower et al., 2019). As stroke causes unilateral paralysis and patients usually rely on the sound limb for weight bearing and coping changing center of gravity during daily activities. So it is crucial to enhance balance and to find out the methods that could actually improve balance.

A common technique for enhancing muscular function and preparing it for dynamic activity is stretching. The neuromuscular system is significantly impacted by stretching as well. For example, after one session of stretching, significantly enhances the optimum active strength, muscular energy, or visible contractile features has been seen. It is also believed that stretching improves proprioception and prepares the body to cope up with changing needs to maintain balance (Opplert and Babault, 2018)

Restriction of ROM in ankle is one of the most common features of chronic stroke. As a result of spasticity, calf muscle inactivation, overuse of muscles of the less affected leg contributes to the limitation. This hampers the overall function of the foot. It has been shown that ankle muscle energy helps to move the body forward and initiates gait (Lee et al., 2016).

Muscle shortening is the of the most prevalent problems after stroke. Muscle spasm can occur on both affected and less affected arm. Various authors have tried to improve more affected calf muscle activation as well as stretching. But there is scarcity when it comes to improving the functions of the less affected arm. As hemiparesis arises over the affected side, patients tend to use the more affected leg less and carries most of the body weight on the less affected arm. This increases fatigue and over pressure on less affected legs and causes muscle spasm. So, interventions targeting the unaffected calf

muscle can help to improve the overall balance of stroke survivors and may benefit their functionality (Ghasemi et al., 2017).

1.2 Rationale

Researcher have worked in the Neurology department for almost twenty four years, and during that time researcher have treated many patients who have suffered from chronic stroke. One of the most prevalent issues that stroke patients experienced was tightening in the calf muscle of their sound leg. As a result of the fact that they prefer to use the limb that was not impaired more often than the limb that is impaired, the overall muscular health of the muscle that is less impacted is very important to enable patients to have general mobility.

One thing that was already known were that stroke patients usually suffer from unilateral paralysis and have changes in their COG. Therefore, the integrity of the leg that has not been compromised is essential to deal with the additional demand placed on one side of the body.

In addition to evaluating a novel approach of enhancing the balance of stroke participants, this study may also pave the way for a new method of improving the functionality of stroke patients. Passive stretching of the calf muscle that has not been affected by the stroke may reduce the likelihood of falling, which is a frequent complication that occurs after a stroke.

In conclusion, passive stretching is a kind of stretching that does not involve any financial investment and only requires the efforts of a specialist. It is thus possible that the testing of this procedure will result in the incorporation of this intervention, which may be beneficial to a significant number of people who have been the survivors of chronic strokes.

1.3 Operational Definitions

Stroke

When blood flows to portion of the brain is stopped or diminished, brain tissue cannot get enough oxygen and nutrients, causing a stroke. A blood clot in an artery causes ischemic stroke, whereas a burst blood vessel causes hemorrhagic stroke, which causes brain hemorrhage. Lack of blood flow or bleeding kills brain cells, causing abrupt weakness or numbness, disorientation, difficulties speaking, visual issues, dizziness, and loss of coordination. Brain injury may be reduced, and results improved with prompt medical intervention.

Balance

It is the capacity to keep the body against gravitational force over its support while fixed and moving. It requires coordination between sensory systems (vision, vestibular, and proprioceptive inputs), the central nervous system (which processes them), and the musculoskeletal system. Balance helps people avoid falls, complete everyday tasks, and adjust to environmental changes. Balance needs regular changes and includes static and dynamic balance.

Stretching

Flexible muscles, joint range of motion, and reduced muscular tension are achieved by stretching muscles and tendons. Static stretching, dynamic stretching, and ballistic stretching may be done. Stretching is used in exercise to prepare the body for physical activity, increase performance, and help recuperation, as well as to relieve pain and improve mobility in those with musculoskeletal disorders.

Conventional treatment

Conventional stroke physiotherapy helps patients walk, balance, and relearn everyday tasks. It usually includes therapeutic activities (stretching, strengthening), gait training (practicing walking), balancing exercises, and posture to avoid difficulties. Physiotherapists may utilize ultrasound or electrical stimulation to treat pain and recover. The aim is to optimize patient function and independence.

1.4 Aim of the study

Evaluation of the impact of passive stretching on unaffected calf muscle for improving standing balance of chronic stroke survivors.

1.5 Objectives

1.4.1 General Objective

- To evaluate the efficacy of passive stretching for unaffected calf muscle for improving standing balance of chronic stroke survivors.

1.4.2 Specific objectives

- To find out socio demographic characteristics of patients.
- To evaluate effectiveness of passive stretching compared to conventional treatment in terms of balance.

CHAPTER - II LITERATURE REVIEW

Stroke is the leading cause of long-term disability in Western countries, and the degree of stroke severity greatly affects the resulting functional impairments. Stroke survivors often have significant limitations in their ability to perform activities of daily life. (Carod-Artal & Egido, 2009). About 460 people out of every 100,000 will have a recovery that is not complete. Twenty percent of stroke survivors will need institutional care after three months, while fifty percent will restore their ability to operate independently. People who have had Stroke are prominent to first experience a loss of function in their upper limbs than any other part of their body. (Cumming, Brodtmann, Darby & Bernhardt, 2014).

According to data provided by World Health Organization (WHO) in 2001, stroke was the third most common cause of death across all socioeconomic levels. Worldwide around five percent of total death is caused by all strokes. According to statistics collected from developed countries, around one in twenty people over the age of fourteen are thought to suffer from a stroke. Although there is a broad variety of stroke mortality and burden figures in poor countries (Feigin, Lawes, Bennett, Barker-Collo, and Parag, 2009). This indicates to a wide range of age group can have a risk of stroke in their life time. Even though stroke is a chronic disorder, studies have been conducted to examine short-term results, mainly in the field of impairments and disability (Sinden, Hicks, Stroemer, Vishnubhatla & Corteling, 2017). In 1980, World Health Organization (WHO) established an worldwide taxonomy related to impairments, disabilities as well as handicaps.

According to estimates, the rates of stroke among Bangladeshis aged 40-49, 50-59, 60-69, 70-79, and 80 and older are as follows: 20%, 30%, 0%, and 1%, respectively. A number of ratio of 3.14 male patients to 2.41 female patients is seen in this study (Sadat, Podder, & Biswas, 2023).

Burdea, Cioi, Martin, Fensterheim, and Holenski (2010) anticipated that stroke will be the main cause of disability across the globe. The elderly are more likely to be afflicted than people of any age or gender, although it may impact everyone. It is possible for a

stroke to affect motor, sensory, and cognitive abilities, as well as the capacity to maintain movement when it occurs.

One of the most severe outcomes of a stroke is lower extremity hemiplegia, which is also the most significant underlying impairment that individuals experience following a stroke. A good recovery after a stroke is connected with the ability to do daily tasks such as moving the paretic side that is paralyzed and encouraging an individual to perform his or her task independently (Maredza, Bertram & Tollman, 2015).

It has been counted that the number of Strokes that takes place in India ranges from 44 to 843 incidents per 100,000 persons. A bulk of the data that Pakistan has originated from case series that are gathered in hospitals and have been evaluated. The number of strokes that occur annually in Pakistan is believed to be about 350,000. (Elshaikh, 2021), with a prevalence of 250 per 100,000 people in the country. Stroke and transient ischemic attack are estimated to affect 21.8% of adults aged 35 and up in a recent study of an urban slum in Karachi (Syed, Khatri, Alamgir and Sayay, 2022).

The average age of stroke victims was 45 in another population-based study conducted in the northwest of Pakistan and Afghanistan (Badiuzzaman et al., 2009). The stroke rate among women in Pakistan is greater than that of male, and age difference between two groups is even less than was previously thought. Case-by-case issues have the potential to impair the results of these two demographic studies, which have very high estimates of the stroke incidence (Pandian et al., 2020). Sri Lanka has about 20 million people, and 9% of every 1000 of them suffer from a stroke each year (Ranawaka & Venketasubramanian, 2021). One research suggests that there are three instances of stroke for every one thousand people in Bangladesh, despite the fact that there is insufficient information about incidence of Stroke in Bangladesh. There are also little variations that may be seen in the projected stroke rate across all of the South Asian nations. The countries of Afghanistan, Nepal, Bhutan, and the Maldives all suffer from an inadequate amount of data (Isuru et al., 2021).

Ischemic stroke (IS) is ten times more common than hemorrhagic stroke (HS) in Western countries. Compared to IS, HS is thought to have a greater fatality rate. Previous research has shown that people with HS had a higher risk of dying from a stroke (Lee et al., 2011).

According to the findings of Elepola et al. (2022), many risk characteristics are shared by both HS and IS environments. It is generally agreed upon that there is a connection between diabetes and ischemic heart disease; however, the relative significance of causative traits such as high blood pressure, tobacco consumption, and alcohol intake is still a matter of controversy. In March of 2001 the Danish government established a countrywide Stroke Registry to keep track of all hospitalized stroke victims. There were 39,484 patients in the register as of February 2007 and 3,993 of them had HS (Syed, Khatri, Alamgir and Sayay, 2022).

The World Health Organization reports that developing nations account for an estimated 86% of all stroke-related fatalities worldwide. The incidence of deaths from stroke in South Asia has been estimated to be greater than 40% of all stroke deaths worldwide. It has been observed that this South Asia region has a higher incidence of stroke and heart disease than the rest of the globe does, which suggests that heart disease is a significant major causative factor for stroke in this region. South Asian nations there is a limited supply of both human resources (including neuroscientists and stroke specialists) and financial resources, even though the area has a high stroke prevalence (Wasay, Khatri, & Kaul, 2014).

The ranking of from the death of stroke, the male are third and female causes fourth among all the death in the United States. While men have a slightly higher risk of having a stroke, women have a higher risk of dying from a stroke (68 vs. 44 per 100,000 in 2002) due to their higher average age. Stroke survivorship is lower for women compared to men, according to several studies. Women are disproportionately affected by physical impairments and restrictions in ADL, or fundamental aspects of self-care. Stroke has a larger impact on men but greater in women in terms of cognitive impairment, depression, and fatigue, and overall quality of life (QOL) (Gargano, Wehner, & Reeves, 2011)

Another major contributor to disease and mortality in the United Kingdom is the stroke. A research that was conducted not too long ago discovered that during the years 2002 and 2004, the United Kingdom experienced between 1.36 and 1.62 strokes for every 1,000 people in the population (Maredza, Bertram & Tollman, 2015). There is a huge number of elderly citizens in Scotland, according to research, and prevalence of this phenomenon is growing at a rate of 2.8 per 1,000 people each year (Han et al., 2017).

Stroke has been responsible for the deaths of more than 46,000 persons in England and Wales. Stroke prevention is now a high goal in the public health policy of the United Kingdom. Diabetes Mellitus, Hypertension, High cholesterol, Atrial fibrillation, and hypertension are all significant risk factors that need to be managed more effectively with improved management. (Lee et al., 2011).

In Germany, some 200,000 people per year experience their first stroke, with another 60,000 experiencing a stroke after having one or more pre-stroke symptoms. Ischemic stroke results in around 80% of all cerebrovascular incidents, while other type, that is haemorrhagic variant accounts for about 20%. More than a quarter of stroke patients are younger than 65 (Behm et al., 2021). Risk factors (high blood pressure, tobacco use, insufficient physical activity, excess body fat, and others) are crucial in the development of vascular illnesses, which lead to stroke. Adjustments can be made easier with the help of medications and a change in lifestyle (Knecht, Borlongan, & dela Peña, 2018)

According to regular mortality data, the fatality rates associated with stroke are much lower in western European nations compared to those in eastern European countries (Burdea, Cioi, Martin, Fensterheim, and Holenski, 2010). In Singapore, stroke injuries affect 4.03% of the population and occur at an average rate of 1.8 per 1000 individuals over the age of 50. It is anticipated that this share will climb to 35% in the European area by the year 2050, up from 20% in the year 2000. Additionally, it is anticipated that the mean age group was found to increase from 37.7 years in the year 2000 to 47.7 years in the year 2050 (Truelsen et al., 2006).

Stroke is third leading cause of death in Thailand. Many of effects of stroke have worsened over time, despite survivors' initial resistance to change after 12 months, about half of the stroke survivors need assistance with functions of daily activities and self-care. Hospital readmissions, social service requirements, and rehabilitation facilities all remain high because of it. Stroke survivors face a multiplicity of challenges, including the disease itself, physical limitations, and isolation (Agyemang et al., 2014)

There are about 75,000 strokes annually, counted for South Africa, making it one of the leading causes of death and disability there. In 2011, there were 33,500 stroke patients out of total population of 13,100,000 (Maredza, Bertram & Tollman, 2015). This was a disproportionately high burden in rural South Africa. Stroke is very common, and study

of 7740 stroke patients found that over half of the survivors were younger than 65 and about a third were younger than fifty-five (Gargano, Wehner, & Reeves, 2011).

Young stroke survivors experience more severe consequences than their older counterparts because of the greater number of years they have spent contributing to society and the economy. Young stroke survivors may need extensive rehabilitation to return to normal life and the workforce (Maredza, Bertram & Tollman, 2015).

Different methods of muscle stretching are a popular method of improving Range of Motion (ROM). The aims of using muscle stretch could be either to improve flexibility or to improve the activity of muscle during activity of daily living. On the other hand, ROM is a common impairment in different Musculoskeletal and Neurological conditions such as Cerebral palsy, cystic fibrosis, CVA, muscular dystrophy. Stretching is known to decrease rate of injury incidence and improve muscle activity (Behm et al., 2021).

According to Iruthayarajah et al. (2017), persons who have had a stroke often have challenges with their balance and coordination. When we talk about balance, we are referring to the ability of achieving and maintaining a state of body equilibrium, both inside and outside the base of support. Once a stroke has occurred, decreased balance control is a key obstacle to recovering autonomy in doing day-to-day activities. Accidents that result in significant injuries are often the result of an imbalance that leads to a fall. In people who have had a stroke, balance problems are rather prevalent (Li et al., 2015). People who have survived a stroke often exhibit asymmetry in their weight bearing and increased postural sway. Additionally, they have a diminished capacity to adjust their body weight or deal with interruptions from the outside world. Maximum stroke survivors (75%) can restore the capacity to stand independently and keep their balance (van Duijnhoven et al., 2016). However, these challenges tend to continue even after they have been resolved.

The researchers Li et al. (2015) discovered that balance is affected by three different sensory systems: the visual, vestibular, and somatosensory (mechanoreceptors and proprioceptors) areas of the brain. According to Iruthayarajah et al. (2017), neurological disease, such as a stroke, may produce abnormalities in these systems, which can result in alterations in equilibrium and movements that depend on balance, such as walking or maintaining posture.

A study was done to investigate the effects of dynamic stretching training, which was done between static stretching (SS), contract-relax proprioceptive neuromuscular facilitation (PNF) taking into account the duration of static balance and the excitability of motor neurons. The training was performed four times per week for a period of six weeks. Prior to and after training, the static balancing time, Hmax/Mmax ratios, and H-reflex recovery curves (HRRC) were assessed in a total of 28 healthy volunteers (n=10 for the SS group, n=9 for the PNF group, and n=9 for the control group). At the same time as a trend was noted for PNF, SS improved the static balance time. Post training, at 150-200-250 msec interstimulus intervals, we noticed a decrease in facilitation, however during 500-700-900 milli second interstimulus period; there was an increase in H2/H1 ratio in the PNF group alone. Enhanced static balance was achieved with both stretching approaches (Kaya, Biçer, Yuktasir, Willems, & Yildiz, 2018).

For the purpose of determining whether or not stretching positively affects the neural and mechanical characteristics of calf muscle, a research that was randomized, controlled, and single-blinded was carried out. In all, there were 45 patients that participated in the research project. In the two months that followed their assignment to either the stretching group or the traditional therapy group, the results of their treatment were evaluated. Stretching was performed three times per week for a period of two months for patients in the experimental group, whereas patients in the control group got standard physical therapy. Both electrophysiological and ultrasonographic examinations were used in order to interpret the results. The length of the fascicle did not alter significantly during the different stages of the evaluation, as was indicated by the findings of the investigation. Both groups spent the same amount of time communicating with one another, and there was no statistically significant difference between the two groups. In a similar vein, there was not a clearly distinguishable difference between the groups that were observed. The pinnation angle varied significantly from one step of evaluation to the next, since there were several stages. Furthermore, it was shown that the interplay between time and groups was a key factor (Ghasemi, Khademi-Kalantari, Khalkhali-Zavieh, Rezasoltani, Ghasemi, Baghban, & Ghasemi, 2018).

Vittala et al. (2021) conducted a randomized controlled study (RCT) to assess the effectiveness of stretching exercises as a home-based treatment for enhancing balance in stroke patients. After using certain criteria to determine who would be included and

excluded, a total of thirty-six older people were chosen to participate as respondents. Subsequently, these people were segregated into three discrete groups for further examination. Furthermore, members in Group 1 engaged in physically stretching activities, in addition to exercises that included the balancing method. Group 2 participants were instructed to do active stretching activities along with exercises that improve balance. Group 3, acting as the control group, just performed balancing strategy exercises. Each group engaged in a distinct set of activities on a triweekly basis for a continuous period of six weeks. The Berg balance scale (BBS) is used to assess an individual's capacity to maintain their equilibrium.

Stretching has always been considered a major component of warm-up in sports activity. To evaluate the various components and methods of stretching application a study was conducted. The study has evaluated different approaches of stretching that has been adapted by many authors time to time. it has been shown that the extent of static stretch-induced effects can be affected by the degree of stretching, which may be connected to range of motion that is present. However, there was no research that investigated how the amplitude of dynamic stretching affected later muscle function. When compared to the slower velocity of stretching (50 beats per minute), the authors demonstrated that the quicker velocity of stretching (100 beats per minute) resulted in a greater vertical leap in height (Opplert & Babault, 2018).

A prospective cohort research was conducted in Australian and Singaporean inpatient rehabilitation centers. A group of 81 people were evaluated just one week before discharge. A depth-sensing camera (Kinect) was utilized to measure gait speed, stride length, cadence, step width, step length asymmetry, variability, and pelvic displacement across six meters (6mWT). Balance variables included step test, TUG, dual-task TUG, and Wii Balance Board-derived center of pressure velocity while static standing. Falls occurred in 28% of people over a year. Fallers had longer TUG duration, shorter strides, lower gait speed variability, and lower pelvic displacement and step test scores ($P < 0.001$). After controlling for country, past falls, and assistance usage, stride length, step length asymmetry, mediolateral pelvic displacement, step test, and TUG scores were significant predictors ($P < 0.040$). Adding comfortable gait speed as a covariate, only mediolateral pelvic displacement, TUG, and step test scores showed substantial benefits above conventional clinical evaluation ($P = 0.001$) (Bower et al., 2019).

Research examined the impact of Heel-Raise-Lower Exercise (HRLE) on plantarflexion, balance, and gait in stroke patients.

This research explored the effectiveness of heels raise-lower with forefoot on a block (HRB) vs heels raise-lower on a level floor (HRL) in enhancing strength and functional capabilities in stroke patients. Each group of 10 stroke patients received HRB or HRL training. The participants exercised 100 times each day, 5 days per week, for 6 weeks. Measurements of plantarflexor strength, static/dynamic balance, and gait characteristics were conducted utilizing MMT, BBS SD, and GAITRite systems. Both groups noted substantial improvements in plantar flexor strength after 6 weeks of treatment. Both groups showed considerable improvements in static and dynamic balance, as well as gait speed. Only the HRB group showed significant increases in cadence, SLSP, step length, and stride length on the paretic side. The HRB dramatically enhanced paretic plantar flexor strength, gait speed, and cadence compared to the HRL (Lee, Cynn, Yoon, & Lee, 2017).

Research was conducted to examine the efficacy of pelvic proprioceptive neuromuscular facilitation (PNF) and task-oriented activities on balance, gait metrics, and pelvic imbalance. The study included 64 individuals and were separated into two groups. The duration of the the protocol was four weeks, with a daily time engagement of 30 minutes. Patients underwent evaluation both at the starting point and conclusion of the session. Outcome measurements were collected and assessed for both groups before and after the treatment that was administered (Kovela et al, 2022).

After undergoing four weeks of therapy, the patients exhibited significant improvement in their balance, gait metrics, and pelvic inclination in both groups. Although both therapy regimens were effective for the patient, the combination of pelvic proprioceptive neuromuscular facilitation (PNF) and task-oriented exercises shows a statistically significant distinction compared to task-oriented exercises alone (Boob, Kovela, Boob Jr., & Kovela Sr., 2022).

Yoon, Hwang, An, and Oh (2014) performed a research to explore the changes that occur while walking in terms of the passive ankle dorsiflexion range of motion (ROM), maximal plantar force, force-time integral, and the amount of time it takes to heel off. Participants in the study had restricted ankle dorsiflexion, and the researchers investigated the effects of modified mobilization with movement (MWM) utilizing

talus glide taping before and after the administration of the technique. Following 5-minute strolling with modified MWM employing talus slide wrapping, passive ankle dorsiflexion ROM and latency when landing off considerably increased in comparison to before and directly following the wrapping. The enhanced MWM plus talus slide taping resulted in greater hindfoot pressure and pressure-time fundamental, and reduced forefoot pressure-time integral following 5 minutes of walking. No significant change was seen in any aspect prior to or following placing the adhesive.

CHAPTER - III METHODOLOGY

3.1 Study design

Randomized controlled trail (RCT) was the research design. The experimental design of this work qualifies it as a quantitative research approach. The reason the researcher selected the experimental study design is because it is the most effective method of determining the success of a research. The purpose of the study was to ascertain the effectiveness of passive stretching by comparing the experimental group with the control group.

3.2 Study site

Data were gathered from Neurology department & Stroke Rehabilitation Unit (SRU) of the Centre for the Rehabilitation of the Paralysed (CRP), which is the largest and model rehabilitation center for the Stroke patients in Bangladesh. It was a nonprofitable organization, which is providing comprehensive full rehabilitation of people with spinal cord injury (SCI) in Bangladesh we can say specialization rehabilitation center in Asia. Along here has very good academic seating and outdoor rehabilitation facilities for neuro, Musculo-skeletal, conditions and hah full multidisciplinary seatings. CRP emphasizes a comprehensive approach to rehabilitation as it understands that the success of the program depends on all factor's rehabilitation on the physical, psychological, and economical levels as well as scheduled release. Support was be extended once the person goes back to a live in the community. In outpatient department conducted 400 above patient per day. CRP has eight divisional center and head office in Savar and another in Mirpur, name Dhaka City Center, it indicates that covering whole Bangladesh as CRP capabilities. All of the patients try to come to the head office, Saver center for full rehabilitation or complete the end stage of rehabilitation. That is why huge gathering or demanding place is Neuro unit and SRU where above 200 patients receive physiotherapy treatment per day. For that, reason CRP was considered as a study site.

3.3 Study population

Chronic Stroke survivors with balance deficit of standing who attended Neurology and SRU unit of CRP to take physiotherapy treatment were selected as study population.

3.4 Study participants:

Participants with hemiplegia due to previous stroke and ability to walk independently who are receiving treatment from neuro unit and SRU under Physiotherapy department of CRP. Both genders are included, and age limitation was not followed but the age range of the study was 35years-85 years.

3.5 Inclusion criteria:

- Patients with at least 3 months after stroke has been diagnosed.
- Ability to stand or walk.
- Current treatment receiving.

3.6 Exclusion criteria

- Patients who are diagnosed with any kind of orthopedic condition (e.g. dislocation, fracture etc.)
- Patients who have any kind of cognitive impairment.

3.7 Problem identification

Researcher is an own self an practitioner of neurology field since 24 years both clinical and academic. Within practice identify the problem of tightness of unaffected calf muscle for chronic stroke survivors and it affect balance of standing. After some stretching it was resolved and improved balance.

To begin, researcher carried out pilot research on individuals who have suffered from chronic stroke. The patient's own self-reported issues were carefully documented. In addition, the views of practicing physiotherapists who were employed in the particular unit were documented. After then, the Neurology and SRU unit was the location where the general evaluation of stroke patients was eventually assessed. Muscle spasms, increased tone, motor and sensory deficits, and cognitive impairment were the characteristics that were most often seen. Surprisingly, the muscular spasm was shown to be prevalent in the sound limb, and pilot research discovered that the resolution of the muscle spasm resulted in an improvement in balance. This grabbed our attention, and as a result, we devised a method for extending the sound limb with the intention of enhancing the participants' sense of static stability.

3.8 Sampling technique

The Neurology and SRU section of the physiotherapy department at CRP, Savar, Dhaka, easily chose 64 individuals who were diagnosed with chronic stroke and met the inclusion criteria for the trial, numbered 1 through 64 according to the randomization table. Every participant to this research was equally likely to be placed in one of two groups. The experimental group included of thirty-two patients in all, who were treated with calf stretching in addition to standard physiotherapy procedures. Thirty-two patients were also included in the control group, which had standard physiotherapy treatment. Assessors were blinded throughout the trial. The participant assignment into the experimental and control groups was done at random by the researcher once the sampling procedure was over. This strategy was used since it raised the research's internal validity. Participants were assigned a computer-generated random number between 1 and 64 to either the trial or control group. Participants were divided into experimental or control groups using a computer-based randomization procedure. First participants were put in control group C1. Numbers were given to the control group, like C1, C2, C3, etc., and to the trial group, such E1, E2, E3, etc.

3.9 Sample size calculation

The equation for sample size is,

$$n = \left(\frac{Z_{\alpha/2} + Z_{\beta}}{d} \right)^2$$

Where,

- $Z_{\alpha/2}$ is the critical value for the significant level (1.96 for $\alpha = 0.05$).
- Z_{β} is the critical value for the desired power (0.253 for 60% power).
- Effect size (*d)*= 0.35.

Calculation from above values,

$$n = \left(\frac{1.96 + 0.25}{0.35} \right)^2 = (6.314)^2 \approx 39.85$$

N = 40*2= 80

So, a of total 80 samples are needed for this trial.

Due to time limitation and data scarcity, 32 participants were allocated to each group, including 64 participants.

3.10 Randomization

During the research, hospital-based randomization will be used to choose participants who are willing to provide their assent to the study. Randomization table was formed before selecting the participants.

Table: 1. Random Table from Microsoft XL

C1	0.606765	56
C10	0.85626	4
C11	0.6768876	34
C12	0.699193	64
C13	0.381863	11
C14	0.082937	17
C15	0.468145	60
C16	0.371551	13
C17	0.052734	51
C18	0.725532	37
C19	0.478975	44
C2	0.816158	59
C20	0.094998	50
C21	0.179177	41
C22	0.59072	62
C23	0.318526	36
C24	0.486726	20
C25	0.202782	32
C26	0.514106	26
C27	0.33372	45
C28	0.006261	47
C29	0.22275	49
C3	0.659422	29
C30	0.387401	38
C31	0.334844	10
C32	0.948464	25
C4	0.830135	53
C5	0.774065	58
C6	0.423632	42
C7	0.956208	12
C8	0.196389	61
C9	0.799773	57
E1+B4:D47	0.16781	31
E10	0.53245	40
E11	0.339671	6
E12	0.444873	16
E13	0.353454	33
E14	0.84397	35
E15	0.398849	21
E16	0.654231	23
E17	0.93892	30
E18	0.753821	24
E19	0.200602	48
E2	0.302509	22
E20	0.642238	43
E21	0.187629	7
E22	0.91277	5
E23	0.312415	15
E24	0.079238	1
E25	0.827352	55
E26	0.742609	18
E27	0.741975	9
E28	0.756164	27
E29	0.841301	46
E3	0.85889	63
E30	0.839106	8
E31	0.886742	2
E32	0.316934	28
E4	0.934926	3
E5	0.293668	14
E6	0.901098	54
E7	0.733075	19
E8	0.14265	39
E9	0.030158	52

Table: 2. Data gathering Table.

According to the random table serially one by one included as participants and enter the group. Participants will be assigned to parallel treatment arms in a ratio of one to one using a random selection process. A computer-generated sequence will be sent to each of the research sites, and it will randomly assign patients to either get calf stretching or conventional physiotherapy. The randomization will be carried out by a person who is not participating in this research himself or herself. Once the information about the participants has been gathered, the 'rand' function in Microsoft Excel 2021 will assign them to groups in a way that is not immediately obvious. The confidentiality of the group allocation shall be maintained in a consistent manner between the participants and the individuals evaluating the outcomes. The providers of treatment will have detailed information on the distribution of the groups. Following the completion of the randomization procedure, the specifics of the group allocation will be concealed in an envelope and will continue to be disguised until the therapy starts

being administered. Participants and outcome assessors will be blinded to group allocation throughout the trial to reduce bias. The participant's consent form will include this information. Participants in the control and experimental group were selected from PDMS software of CRP which maintain the appointment of patients. Control group were finished first than experimental were start with brief training of stretching to therapist.

3.11 CONSORT Flow Chart

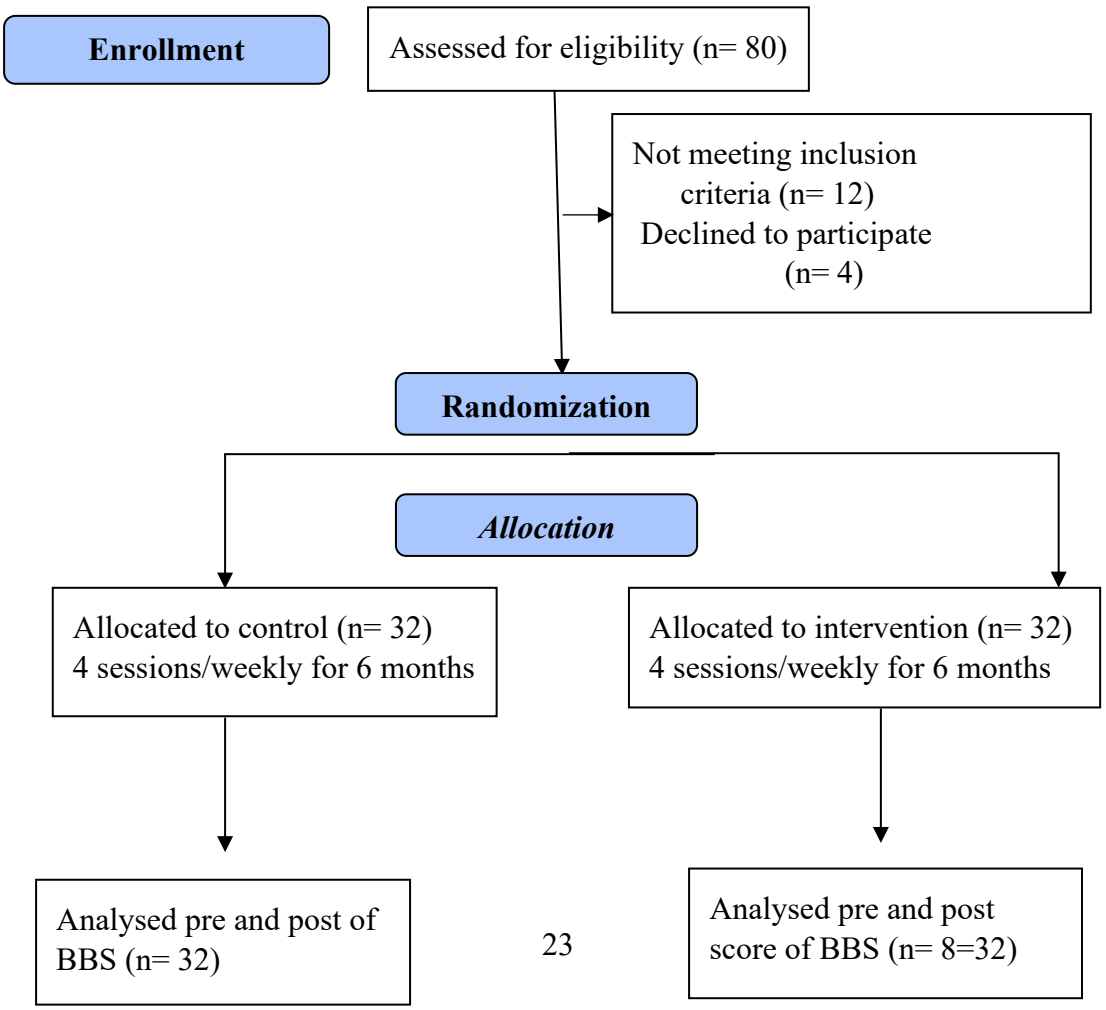

Figure: Flow chart of the phases of randomized control trail

3.12 Measurement tool

3.12.1 Berg Balance Scale (BBS)

The Berg Balance Scale (BBS) is known to be a clinical instrument that is used to evaluate balance and anticipate the likelihood of falling, especially in elderly patients and those with neurological disorders like stroke. The assessment comprises 14 activities, including transitioning from sitting to standing, standing without assistance, and performing a full 360-degree rotation. Each test is given a rating on a range of 0 to 4, with a maximum score of 56 signifying optimal balance. The administration of the BBS is straightforward and efficient, necessitating around 15-20 minutes and minimum equipment such as a chair, timer, and tiny item. Fall risk is classified into three categories: low, moderate, or high, which assists clinicians in developing and overseeing rehabilitation programs. Assessing static equilibrium is a widely used research technique**.** The reliability (ICC2,1= 0.99) for BBS was determined to be extremely reliable (Alghadir, Al-Eisa, Anwer, & Sarkar, 2018).

3.13 Data collection duration

6 months after collecting baseline data.

3.14 Treatment protocol

3.14.1 Experimental group:

Sound calf stretching 30 sec hold X 4 reps X 2 set

3-minute rest between sets

4 sessions/weekly for 6 weeks

3.14.2 Control group

Control group participants received conventional therapy for improving the functions.

3.15 Data collection tools

a. Basic data collection form.

b. Informed consent form.
c. Berg Balance Scale (BBS)
d. Pen.
e. Tool
f. Chair
g. Stopwatch

3.16 Data collection procedure

The study procedure was accompanied through identification of population from the PDMS software of CRP (appointment of patient). After this screening according to inclusion and exclusion criteria and select as participant. A certified physical therapist evaluated the patients after their departmental examination. Right after randomization, interventions were applied. Before beginning the traditional six-session therapy, the assessor calculates the BBS score. Assess the BBS post score once again after six therapy sessions. This approach keeps the control group running longer than the experimental group (researchers trained on passive stretching of unaffected calf muscle before the experimental group began). Using the approach, the assessor scores each participant both before and after. It was noted that four individuals withdrew from the research and fourteen were released from it; the gaps were filled in sequentially from top to bottom. Parents of the participants were not told about group allocation. The control group got only standard physiotherapy; the experimental group got stretching on the sound limb as well. It was requested of every patient to provide their written agreement to be included in the research. The chosen physiotherapist scored the BBS before the test, conducted standard treatment, and then scored the BBS once again after the test for the control group. For the experiment group, BBS was scored before to the experimental intervention and again after the test. The researcher adapted a Bangali version of the BBS form to gather the data. All the information collected in some other table. Before starting the therapy, the BBS was recorded on a questionnaire form and a pretest was administered. Three treatment sessions later, the same process was followed to administer the post-test. To minimize bias, the outcome assessor will gather data from both experimental and control groups while the physiotherapist is certified. Specific tests were run for statistical analysis of inference at the conclusion of the investigation.

3.17 Statistical test

Based on the type of data the researcher utilized four statistical tests. Data is ordinal and not normally distributed for hat region non-parametric test require for the analysis of inference. For between group analysis researcher had done Mann- Whitney U test because the data were not normally distributed, independent sample t-test and for within group analysis used Wilcoxon Signed-rank test and paired sample t-test.

Mann Whitney U test

The Mann Whitney U test is one of the non-parametric tests. This is used to compare two sample means that come from the same population and used to test whether two sample means are equal or not. Usually, the Mann-Whitney U test is used when the data when the assumptions of the t-test are not met. In this study, researchers applied this test for analyzing the mean of between two groups BBS total score.

Wilcoxon Signed-rank test

Two related samples are compared using the non-parametric statistical hypothesis test Wilcoxon signed-rank test. In this work, the BBS total score was analyzed within each group using this test.

3.18 Level of Significance

Calculated were the "p" values to determine the study's significance level. The likelihood of the results in experimental study is shown by the p-values. A probability is the degree of correctness of the produced outcomes. In rehabilitation service research, the "p value" represents the degree of significance in an experiment. A p value of 0.05 is regarded to be a noteworthy result. If the p value ($p < 0.05$) is equal to or less than the preset significance threshold, the results are deemed significant.

3.19 Ethical considerations

This study was carried out entirely in accordance with World Health Organization (WHO) recommendations. The Institutional Review Board (IBR) was presented the study proposal along with the methodology. After that, the Bangladesh Health

Professions Institute's (BHPI) ethics committee granted approval to the study proposal with methodology 2024. For participant safety, the researchers in this study obtained formal authorization from the relevant authorities before beginning the data collecting process. Regarding the illnesses and therapies of the patients, the researcher rigorously upheld. Every participant has to provide their written permission for the researcher to begin collecting data. Furthermore, participants were told that they might leave the research at any time and could visit with additional senior physiotherapists if necessary or if their health condition became worse. Every patient had the opportunity to talk about their issues with the department's top authority and the CRP administration, and they could ask whatever questions they wanted answered.

3.20 Safety measures and adverse reaction management

Although it is likely that the therapy will not result in any significant negative effects, the monitoring team will carefully observe for any unexpected occurrences during and after the intervention as well as quickly informing appropriate specialists. If any major adverse reactions arise, the chief investigator will inform the Ethical Review Board and will be mentioned in the final publication of the study.

3.21 Informed Consent

The most important step in every research project is informed consent. Legally and morally, research involving human subjects must do this. "The process of agreeing to take part in a study based on access to all relevant and easily digestible information about what participation means in terms of harms and benefits," states Hardicre (2014). Respect for all people should be the fundamental ethical tenet guiding informed consent in research. When getting informed permission, researchers must respect variety and take into account things like gender, race, religious views, culture, language, comprehension ability, etc. The ethical control and conduct of human research depend critically on informed permission (Islam, 2014). It is the procedure via which a participant learns about every facet of the trial. The permission form was followed by researchers prior to data collection. The subjects must provide their agreement (Bell & Waters, 2018). The researcher guaranteed that he maintained secrecy and underlined that participants are totally free to leave the study at any moment. In cases where

research includes minors (those under the age of eighteen), parental approval is required (Nijhawan, et al., 2013).

CHAPTER - IV RESULTS

4.1. Baseline characteristics

Table 4.1: Baseline characteristics

A total of 64 individuals were included in the study, and the researcher planned to distribute them in a ratio of one to one. The participants' ages ranged from 35 to 75 years old, with the youngest person being 35 years old and the oldest participant being 75 years old. This study recruited participants from a broad variety of age groups so that the researcher could more accurately generalize the findings of the study for a wider audience. When it came to the experimental group, the average age of the participants was 50.69 years old. 52.91 was the average age of the people in the control group. At the beginning of the study, the BBS scale was also assessed. 20 was the lowest possible range for each of the groups. The highest possible result for the overall BBS score was 51, whereas the experimental group and the control group both scored 50. In the experimental group, the mean value for the BBS total score was 29.31, and the standard

deviation (SD) was around 11.14. The standard deviation (SD) for the control group was 0.80, while the mean value for the group was 29.56.

	Experimental n= 32		Control n= 32	
	Mean ± SD	Min. - Max.	Mean ± SD	Min.-Max.
Age	50.69 ± 14.15	35 - 75	52.91 ± 12.06	35 - 75
Berg-Balance Scale (BBS)	29.31 ± 11.14	20 - 50	29.56 ± 0.80	20 - 51

Table 4.1: Baseline characteristics

4.2 Age of the participants

Figure-1: Age of the participants (correction of age 25-85 was before explanation)

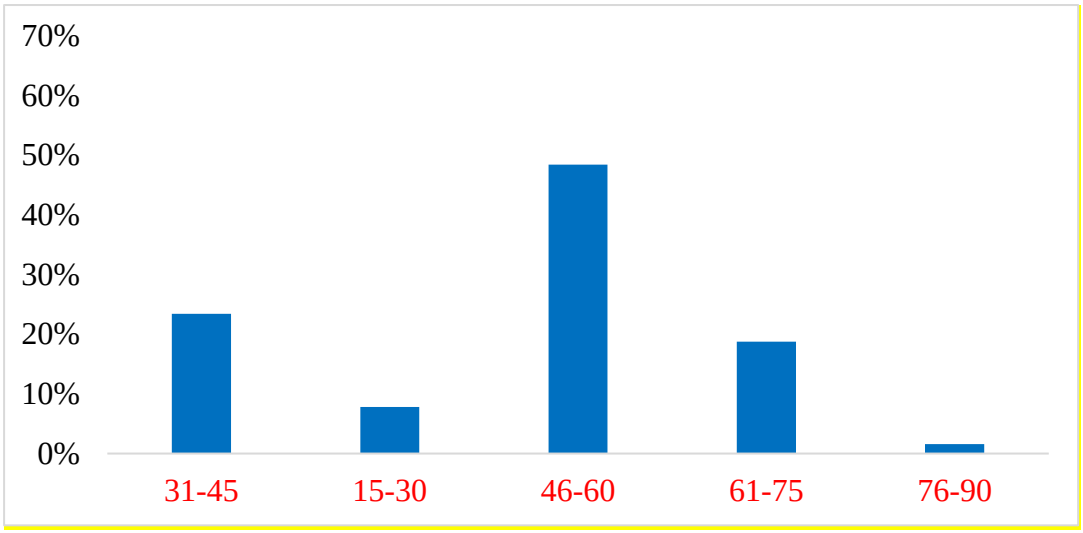

Figure-1: Age of the participants

The age category 46-60 has the highest number of participants, with a total of 31 individuals, or 48.4% of the total. The remaining groups are as follows: 15-30, which accounts for 7.8% (n=5); 31-45, which accounts for 23.4% (n=15); 61-75, which accounts for 18.8% (n=12); and 76-90, which accounts for 1.6% (n=1).

4.3 Gender of participants

Figure-2: Gender of the participants

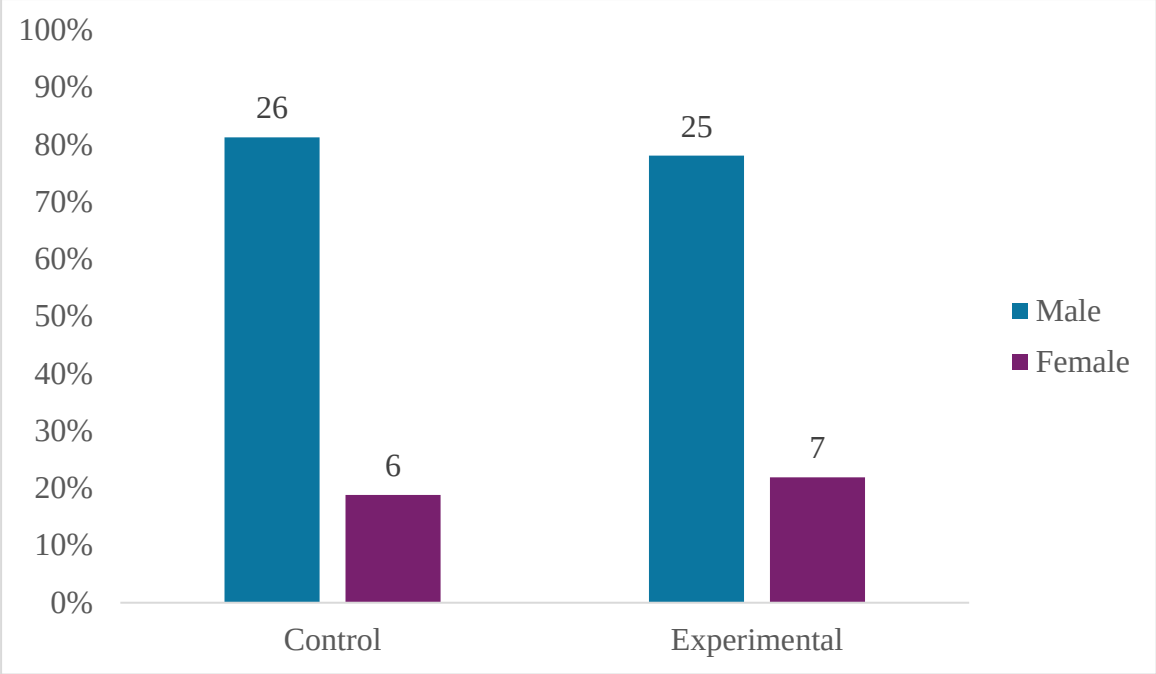

Figure-2: Gender of the participants

The study included both male and female participants. The control group included 81.3% (n= 26) male and 18.8% (n= 6) female. The experimental group included 78.1% (n= 25) male and 21.9% (n= 7) female.

4.4. Analysis of Berg Balance Scale (BBS)

4.4.1. Between group analyses of balance by Berg Balance Scale (BBS)

Table 4.2: Rank and test statistics of balance measured by Berg Balance Scale (BBS)

Table 4.1 displays the computed value of U. The Z value for balance is 2.562. The mean rank for the control group is 31.89, while for the experimental group it is 33.11. The P value is P= 0.01. From the probability table the $P \leq 0.05$ is significant but the result found P = 0.01 that mean result is significant. Therefore, the outcome rejects the null hypothesis and suggest a significantly difference between usual therapy and experimental intervention.

Between group analysis				
Category of patient	**N**	**Test Statistics (Mann-Whitney U Score)**		
		Mean Rank	**Z value**	**p-value**
Control	32	31.89	2.562	0.01*
Experimental	32	33.11		
Total	64			

*, significant value

Table 4.2: Rank and test statistics of balance measured by Berg Balance Scale (BBS)

4.4.2. Within group analyses of balance by Berg Balance Scale (BBS)

Table 4.3: Rank and test statistics of balance measured by Berg Balance Scale (BBS) for control group

Table 4.2 presents a comparison of the balance scores of participants in the control group before (pre) and after (post) the study. The legend of the table indicated that there was no observed decrease in balance among subjects following the use of standard care. The P value is P= 0.001. From the probability table the $P \leq 0.05$ is significant but the result found P = 0.001 that mean result is significant. Therefore receiving conventional therapy, 32 patients had a significant improvement in balance. Furthermore, none of the participants in the control group experienced an equivalent level of balance before and after the treatment. The estimated probability value indicates a highly significant difference.

Pre-test and Post-test of Control group			
	N	**Test Statistics (Wilcoxon Signed Rank Test)**	
Berg Balance Scale (BBS)		**Z value**	**p-value**
Positive ranks	32	5.480	0.001*
Negative ranks	0		
Ties	0		
Total	25		

*, significant value

Table 4.3: Rank and test statistics of balance measured by Berg Balance Scale (BBS) for control group

4.4.3. Within group analyses of balance by Berg Balance Scale (BBS)

Table 4.4: Rank and test statistics of balance measured by Berg Balance Scale (BBS) for experimental group

Table 4.3 presents a comparison of the balance scores of participants in the experimental group before (pre) and after (post) the study. The legend of the table indicated that there was no observed decrease in balance among subjects following the use of passive stretching. After receiving experimental therapy, 32 patients got positive rank 0 participants got negative rank and the P vale is P= 0.001. had a significant improvement in balance. Furthermore, none of the participants in the control group experienced an equivalent level of balance before and after the treatment. The estimated probability value indicates a highly significant difference.

After collecting baseline data, the participants received either control or experimental treatment. After evaluating the results, the researcher has concluded that passive Stretching to unaffected calf muscles improves static balance when measured with BBS scale.

Pre-test and Post-test of Experimental group			
	N	**Test Statistics (Wilcoxon Signed Rank Test)**	
Berg Balance Scale (BBS)		**Z value**	**p-value**
Positive ranks	32		
Negative ranks	0		
		5.480	0.001*
Ties	0		
Total	25		

*, significant value

Table 4.4: Rank and test statistics of balance measured by Berg Balance Scale (BBS) for experimental group

CHAPTER - V DISCUSSION AND CONCLUSION

5.1. Discussion

The research major purpose in this study was to discover whether or not stretching on the leg that is not affected by the stroke is beneficial for improving the static and dynamic balance of patients who have had prolonged period after diagnosed with stroke. Researcher himself had experience of working in the neurology field above 24 years in the clinical as well academic area. Problem found during experience of working and get effective result after applying passive stretching on unaffected calf muscle. Also gain better result to mobilize of unaffected side and changing the environment by the table and pillow that theory learned from basic and one advance Bobath course by the International Bobath Instructor Training Associations (IBITA) at 2023. Formulation the problem found though experience and Bobath training. Researcher had got convenient time to find out the solutions scientifically.

For the purpose of this findings, the data was collected systematically during the study, the data was collected following the intervention, and the conclusions obtained at the end of the study were all documented and taken into consideration. An average age of 50.69 years was found among the samples at the commencement of the research project, with a standard deviation of 14.15 years also present. Within both groups, the sample with the lowest age was 35 years old, while the participant with the oldest age was 75 years old. Twenty was the lowest possible total score on the BBS for both groups, whereas fifty was the greatest possible score for the experimental group and fifty-one was the highest possible score for the control group. The researchers were able to draw the conclusion that the experimental group and the control group are constituted of measures that are almost equal to one another. This conclusion was reached based on the baseline characteristics.

The researcher has planned to use Mann Whitney U and Wilcoxon test for the analysis of between group and within group effectiveness. A normality test was carried out for the understanding of data distribution. The Shapiro Wilk test was carried out for the normality test. The test revealed that the data is not normally distributed. So, the

researcher carried out similar tests for non-parametric data. Mann Whitney U and Wilcoxon test, both are the similar tests as independent samples T test and paired sample T test.

After doing an analysis of the total score of BBS between the control group and the experimental group, the researcher discovered that there were significant differences ($p = 0.01$). The disparities that were discovered to exist within both groups were also determined to be important.

The researchers Kaya, Bicer, Yuktasir, Willems, and Yildiz (2018) conducted a study to investigate the effects of dynamic training of stretching. The study was conducted between static stretching (SS), contract-relax proprioceptive neuromuscular facilitation (PNF), and static balance, taking into consideration the duration of static balance and the excitability of motor neurons. For a period of six weeks, the training was carried out on a weekly basis, to a total of four times. One of the limitations of this research was that the recharger did not determine whether or not our stretching regimen was superior to other types of therapy. On the other hand, researchers have analyzed several stretching strategies, comparable to the following study. An additional distinction lies in the fact that our study has focused on evaluating stretching strategies for healthy limbs, while the subsequent research has focused on stretching techniques for damaged limbs. There were a total of 28 healthy individuals who participated in the research. The static balancing time, Hmax/Mmax ratios, and H-Reflex Recovery Curves (HRRC) were evaluated. The SS group consisted of ten participants, the PNF group had nine participants, and the control group had nine participants. Concurrently with the observation of a pattern for PNF, SS demonstrated an improvement in the static balance time. Nevertheless, we have only analyzed the equilibrium using the BBS scale.

In 2017, Hwang and colleagues conducted a study to investigate the impact of unstable surface training and visual feedback training on the static and dynamic balance of stroke patients. The experiment comprised twenty stroke patients who were randomly assigned to either the unstable surface training group or the visual feedback training group. The researcher's sample size was insufficient. One benefit of our research is that we have used a total of sixty-four volunteers for our experiment. Each group participated in a 30-minute typical exercise program twice a week for a duration of four weeks. Furthermore, for a duration of four weeks, the participants in the unstable

surface training group engaged in training sessions on an unstable surface for thirty minutes, three times each week. Meanwhile, the people in the visual feedback training group followed a training regimen that included visual feedback.The analysis included the use of postural sway measurements of the center of pressure and trace length. The used scale is more sensitive than the BBS scale, since it employs scale data to analyze the motor function of stroke patients. The static and dynamic balancing parameters were recorded both before and after the four-week training period. The two groups were compared in data analysis using both the paired t-test and the independent t-test.

The impact of stretching the calf muscle was investigated by Ghasemi et al., 2018, who conducted a study that was quite similar to the one described above. There was a common interest among the researchers, which we also had. With that being said, a distinction was brought to light when the results were evaluated. A combination of neurophysiological and electrophysiological experiments were used in the subsequent study in order to assess the alterations in muscle activity. When compared to the ordinal scale that we used, these strategies are much more sensitive and valid. When it comes to the research that is self-funded like ours, these tests are not only difficult to do but also expensive. This results in a gap in the research that has to be filled.

When it comes to sports, stretching is a method that is often employed as a type of warm up technique. The purpose of the research carried out by Opplert et al. (2018) was to determine whether or not stretching is useful for athletes. Despite the fact that the research was carried out on a totally different population, the purpose of the study was to establish stretching as a kind of technique that has the potential to improve balance and minimize the risk of falling. Therefore, the therapy that was investigated in this research may be further included into the treatment of muscular dysfunction in the community of stroke patients.

Australia and Singapore both participated in a prospective cohort research that was conducted in inpatient rehabilitation facilities. An evaluation was carried out on a group of eighty-one specific persons right before they were released from custody. The velocity of gait, the length of the stride leg, the cadence, the width of the step, the length asymmetry of the step, the variability, and the displacement of the pelvic region were all recorded across a distance of six meters. This was accomplished with the help of a depth-sensing camera known as Kinect. The step test, the TUG (Timed Up and Go) test,

the dual-task TUG test, and the measurement of center of pressure velocity using the Wii Balance Board while standing still were the variables that were used in the assessment of balance (Bower et al., 2019). Measurements in many dimensions were used in the research project to investigate the effects of stretching. These methods have the potential to be included into our research in order to get a deeper comprehension of stretching.

Through the reduction of passive stiffness in the muscle-tendon unit (MTU), it has been shown that passive stretching may promote improvements in static balance, notably in populations of older individuals. The effects of static stretching on passive stiffness and postural balance in older men were explored in a research that was conducted by Palmer et al. (2017). They discovered that an acute session of static stretching considerably reduced passive stiffness and enhanced postural balance. This was shown by lower overall stability index (OSI) values after stretching as compared to those before stretching. The findings of the research demonstrated that static stretching was effective in reducing stiffness by focusing on the posterior muscles of the hip and thigh. This, in turn, brought to an improvement in the participants' capacity to maintain a stable stance. This is in contrast to previous studies that have indicated that static stretching had either no impact or a negative effect on balance. This might be due to variances in the protocols used for stretching, such as stretching for longer periods or stretching that is unique to the plantar flexors. According to the results, a shorter and more practical bout of static stretching may be advantageous for senior adults. This brief and practical bout of static stretching provides a straightforward intervention to improve static balance and perhaps lower the chance of falling (Palmer et al., 2017).

In order to enhance static equilibrium, both passive stretching (PS) and mobilization with movement (MWM) are used. This is especially true for groups who have compromised motor abilities, such as stroke patients. PS is a technique that includes maintaining a muscle in a stretched posture for a prolonged length of time. This technique has the potential to improve joint range of motion and muscle flexibility via the reduction of musculotendinous stiffness. It has been shown that this technique may enhance static balance by increasing the amount of dorsiflexion of the ankle and overall stability. MWM, on the other hand, is a technique that combines active patient movement with manual force that is administered by a therapist. The goal of this technique is to promote joint mobility and proprioceptive input, which therefore may

further improve balance and functional movement. Although both PS and MWM are shown to greatly improve static balance, studies have shown that MWM tends to result in bigger improvements in balance measures such as the Berg Balance Scale (BBS) and static balance ability (SBA) scores. This is the case even though both PS and MWM are shown to significantly improve static balance. The efficacy of MWM may be due to its dynamic character, which more closely simulates functional activities and provides greater carryover to tasks that are performed in real life. MWM may thus give better results in terms of increasing static equilibrium in clinical populations, despite the fact that PS is potentially advantageous (Park et al., 2018).

Both neural mobilization and passive stretching are aimed at improving static equilibrium, but they do so via rather distinct processes and in quite different settings. The primary mechanism by which passive stretching works is by lowering the amount of passive muscular stiffness. This is accomplished by elongating muscles to their maximum range of motion and maintaining the posture. Desensitizing the stretch-reflex response, which is useful in keeping a stable stance, particularly in older individuals, may lead to improvements in postural stability. This decrease in stiffness can lead to gains in postural stability. Neural mobilization, on the other hand, is a technique that directly addresses the neurological system by using oscillatory motions, either passive or active, with the goal of reducing neural stress, alleviating pain, and improving muscular flexibility and endurance. This approach has been found to have beneficial benefits on balance, flexibility, and muscular strength in neurological patients, such as those recuperating from strokes. These favorable effects are achieved by increasing axoplasmic flow and intraneural blood circulation for the patient. Passive stretching emphasis more on the musculoskeletal element, while neural mobilization addresses neuromuscular connections, making it especially beneficial for individuals with neurological deficits. Both procedures enhance balance, but passive stretching is more focused on the musculoskeletal side (Palmer et al., 2017).

A research was discovered that was carried out by Lee et al. in 2017 with the purpose of evaluating the effectiveness of heel raise-lower with forefoot on a block (HRB) vs heel raise-lower on a level floor (HRL) in improving muscular strength and functional abilities associated with stroke. Training in either HRB or HRL was provided to each of the ten groups of stroke participants. Participants worked out a total of one hundred times every single day, five times every week, and continued for a period of six weeks.

The MMT, BBS SD, and GAITRite systems were used in order to carry out the measurements of plantar flexor strength, static/dynamic balance, and gait characteristics. Both of the writers have attempted to examine a fresh technique for increasing the motor function of the lower limbs, despite the fact that the therapy is radically different from what we have offered. The following therapy was determined to be successful in comparison to the treatment that is considered to be standard. A further investigation into heel raise therapy is possible via the use of our research stretching technique. It is common knowledge that stretching not only enhances the functioning of muscles but also serves as an excellent strategy for warming up before doing activities that focus on strengthening.

The use of stretching exercises as a home-based treatment for improving balance in stroke patients was investigated by Vittala et al., 2021, who conducted a Randomized Controlled Trial (RCT) to determine whether or not the stretching exercises were effective. Following the application of certain criteria for inclusion and exclusion, a total of thirty-six older adults were chosen to take part in the study for the purpose of responding. After that, these people were separated into three independent groups for the purpose of conducting more research. The participants who were a member of Group 1 took part in activities that included physically extending themselves in addition to exercises that included the balancing techniques. The individuals who were assigned to Group 2 were instructed to engage in active stretching activities in combination with exercises that focused on developing balance. Balancing strategy exercises were the sole activities that Group 3, which acted as the control group, participated in over the duration of the study. Over the course of a period of six weeks in a row, every one of the groups took part in a distinct collection of activities on a triweekly basis. In order to ascertain whether or not a person is capable of maintaining their equilibrium, the Berg Balance Scale (BBS) is used. There are a number of factors that are similar, one of which is the fact that we have also assessed the results using the same method. As one of the distinguishing characteristics, the author has conducted research on the benefits of stretching as a kind of treatment that can be performed in the comfort of one's own home. On the other hand, according to the findings of our research, participants are needed to go to a rehabilitation facility in order to get treatment.

Within the context of walking, Yoon et al. (2014) conducted study to investigate the changes that take place in terms of the passive ankle dorsiflexion Range of Motion

(ROM), maximum plantar forces, force-time integral, and the number of times it takes to heel off. The researchers evaluated the effects of modified Mobilization with Movement (MWM) using Talus gliding taping before and after the administration of the method. The participants in the study had limited ankle dorsiflexion, and the researchers were interested in the effects of the technique. Despite the fact that there are some discrepancies between the two research, the authors of both studies have made an effort to improve the balance of the lower half of the body. It is possible that the MWM approach will be introduced to our research in order to improve the lives of chronic stroke survivors.

An examination of the variations between passive stretching and core stability training with the purpose of improving static balance in stroke survivors reveals a number of distinguishing characteristics. When doing passive stretching, the objective is often to improve the length and flexibility of the muscles by providing external force to the muscles without the active participation of the muscles themselves. Alternately, according to the findings of the study conducted by Haruyama and colleagues, core stability training consists of dynamic and static balance-improving physical exercises that develop trunk muscular strength and coordination. According to Haruyama et al. (2017) core stability training significantly improves static balance, dynamic balance, and mobility. This is accomplished by enhancing trunk function and lateral trunk control, which are two abilities that are crucial for maintaining balance. At the other end of the spectrum, Vahlberg et al. (2016) found that dynamic components in progressive resistance and balancing exercises helped chronic stroke patients walk quicker and with greater balance. Furthermore, these benefits sustained for up to six months. In conclusion, progressive resistance exercises and core stability training give broader gains in static and dynamic balance as well as general mobility, which makes them more effective for stroke patients' entire balance rehabilitation even if passive stretching is excellent for flexibility.

The aim of Chan et al. (2016) was to find out whether water-based exercises help stroke patients improve their balance. The researchers all had the same objective in mind even if they approached the problem in different ways. The following researcher assessed the lower limb function using the Berg Balance Score, the Community Balance and

Mobility Score, the Timed Up and Go Test, and the Two Minute Walk Test. Water-based exercise might be added after passive stretching of the unaffected leg to improve the outcomes of the participants' recovery. The training in the water, the researchers found, greatly enhanced lower limb function. One of the many limitations of our study is that we have only used the BBS scale and assessed static balance. Using multidimensional scales to assess the effectiveness of our therapy in a range of factors may help to increase the generalizability of the treatment.

Training of static stretching (SS) or contract-relax Proprioceptive Neuromuscular Facilitation (PNF) for 4 days per week for 6 weeks was evaluated for its impact on static balancing time and motor neuron excitability by Kaya et al 2018; they assessed static balancing times, Hmax/Mmax ratios, and H-reflex Recovery Curves (HRRC) in 28 volunteers who were physically healthy (SS: n = 10, PNF: n = 9, control: n = 9) previous and after training. SS was shown to improve static balancing time, according to a PNF trend. During the intervals of 500-700-900 msec between stimuli, the PNF group demonstrated an increase in the H2/H1 ratio; however, during the intervals of 150-200-250 msec after training, facilitation reduced. Enhanced static balance was achieved using both stretching processes. In the aftermath of SS and PNF training, the afferent inhibitions that were present during acute workouts were not present. Research indicates that training in contract-relax Proprioceptive Neuromuscular Facilitation may enhance the amount of inhibition on motoneuron pools that occurs at the supraspinal and postsynaptic levels. Analysis of the BBS score was utilized to evaluate the results of our research, which was only concerned with the enhancement of static balance. Funding and the participation of professionals from other disciplines are required for the development of more sensitive outcome measuring instruments. Therefore, more research might be carried out by using the following study methodology on limbs that are not impacted by the condition.

Workouts that focus on progressive resistance and balance (PRB) and passive stretching both have the same goal of increasing physical function; however, they accomplish this goal in different ways and provide distinct results. The reduction of stiffness and the promotion of flexibility are often the goals of passive muscle lengthening, which means that the person does not actively participate in the process. On the other hand, PRB exercises are exactly what Vahlberg et al. (2016) have characterized these exercises to be. They have found that exercising the balance system in conjunction with dynamic

muscle activation is the most effective way to develop both stability and strength. The findings of the study demonstrated that PRB exercises greatly improved the walking speed and balance of individuals who had suffered from chronic stroke, and these improvements persisted over an extended period of time. In addition, PRB exercises include motivating talks, which have the potential to boost adherence and long-term effects even more than passive stretching does. In comparison to passive stretching, PRB exercises provide a broader range of benefits for flexibility. This is due to the fact that PRB exercises actively improve strength, balance, and overall functional mobility.

Systematically linguistic Validation was conducted of Berg Balance Scale (BBS) and develop bangla version for conducting balance assessment of Hemiplegic patient who is suffering from Cerebro Vascular Accident(CVA). The process of development were original version of BBS collect and translated into bangle and again backward translation was conducted by experienced microbiologist and Physiotherapist, translation process was conducted with confidentiality maintenance within individual professionals. Corelate with other language translations, results and recommendations. Submitted all documents to relevant authority to acceptance and after acceptance following procedure maintain for develop versions after. Sub final versions developed of bangle after reliability and validity measurement through conducted pilot study for content validation by psychometric properties test and found the results of average is 44.5 that means they are able to walk and they are fully understand of content. Adopted all of findings and finally develop bangle versions of BBS for utilization it targets populations. Final bangle version is developed for use.

5.2. Conclusion

Balance reduction is the common problem after stroke. Due to loss of balance participants were unable to perform walking smoothly. The different factors cause of loss of static standing balance; poor Gravio-receptor and reduce muscle strength of hemiplegic side developed gradually muscle tightness of un affected side for chronic stroke. During standing and static standing require bilateral equal functions both right and left side of the body with Gravio-receptor. The stroke cholesterics is hemi functional so ultimately performing against gravity functions require more activation of against gravity muscles of sound side. This the region tightness develops of unaffected calf muscle of chronic stroke. Stretching is the unique technique for reduction of tightness.

Researchers made an effort to examine a therapy strategy that is both cost-effective and effective in improving the static balance of patients who have had chronic stroke. The application of stretching is simple, and the dose does not take a significant amount of time. In order for the therapists to be able to perform this treatment procedure, they need just a little amount of training. It is possible to include strengthening activities into the therapy regimen once stretching has been completed. In conclusion, the unaffected limb is often overlooked by rehabilitation specialists. However, contrary to popular belief, our research has significantly shown that stretching the unaffected calf muscle may also improve balance in those who have suffered from chronic stroke.

Stroke is an illness that is very debilitating and requires therapy at an early stage. even though given the socioeconomic context of Bangladesh, a significant number of stroke survivors do not get treatment, and they continue to tax the community in which they reside. And when they arrive to the rehabilitation facility after a significant amount of time has passed since the stroke, they often acquire the complication of muscular spasm in the calf that was not affected by the stroke. This is because they have continued to use the leg that was not affected in their everyday activities. Patients often experience excruciating pain as a result of this consequence, which is sufficient to limit their range of motion. An innovative strategy that would enable therapists to fix the issue and validate patients' ability to walk is stretching the muscle that is not impacted by the condition.

CHAPTER - VI LIMITTATIONS AND RECOMMENDATIONS

6. 1. Limitations

Despite of the effectiveness of passive stretching of unaffected calf muscle combined with usual care on dependent variable in this study, there were some limitations. The main limitations were unable to develop sampling frames within country or region which the lack external validity. This study was conducted center based and collected all data from one center who came to receive rehabilitation service in the department of Physiotherapy of the Center for the Rehabilitation of the Paralysed (CRP), it does not cover who receive rehabilitation service from other center or hospital.

No evidence of relevant research in Bangladesh and in the world so that in this study recharger face difficulty to get available information's and literature reviews.

The research only focuses on enhancing balance in individuals who have had a stroke and are dealing with long-term effects. The results were unable to generalized due to deducts of acute or sub-acute stroke.

In order to be included in the research, each participant must have a score of twenty on the BBS. The involvement of twelve patients with BBS scores who are at an increased risk of falling is expressly eliminated as a result of this. It is believed that the end of the year, which made it impossible to carry out procedures such as hole procedures, was the reason of the self-discharge of a large number of participants from the hospital owing to an unknown region. Following the continuation of two or three sessions prior to the patient's exit from the center, it became very difficult to do assessments, maintain permission forms, and carry out interventions.

The treatment was solely given to the calf muscle that was not affected by the condition. In the process of rehabilitation for stroke sufferers, the paretic calf muscle presents a substantial challenge and represents a constraint. However, our research does not involve any therapy for the lower leg that is impacted by the hole.

Because it is academic research, there are time constraints, and it is impossible to perform a study with a high number of samples due to the limited amount of time being allocated. They were discharged because the office had certain conditions for discharge. The selection of patients was challenging due to the fact that they obtained the

appointment from reception and distributed it using the standard procedures that were in place.

According to the PDMS program, it is difficult to locate new patients. A total of eight therapists were recruited for the purpose of gathering information on a new patient. Based on the criteria for exclusion, the remaining therapists were eliminated. There were a variety of bed structures, some of which could be hydraulically operated, while others could not. A shortage of financial resources was there. Patient living conditions varied; some patients were required to remain within the CRP, while others were permitted to remain outside of the CRP. While some participants were staying in air-conditioned facilities, some were staying in tin shed buildings, others were utilizing elevator services, and other participants' roads had an uneven surface. The living environments of the participants were not comparable. Treatment may be administered differently depending on the level of career.

It was a limited amount of time to carry out the investigation. A total of 64 people were included in the study, and the researcher believed that an adequate sample size would be 80. In addition, there were not enough patients who were qualified to participate in the trial.

6.2. Recommendations:

Further study should be conducted including other rehabilitation center and hospitals so that stretching could be generalized for both acute and sub-acute stroke survivors. A comprehensive stretching program should be ruled out with the aim to improve the overall functioning of lower limb irrespective of stroke stage a more generalizable treatment should be tested for both limbs. For instance, muscle activation techniques and stretching for paretic and sound limb could improve the overall balance of stroke patients. Similar living facilities with educated/untestable career are require conducting further better research. Equal treatment environment requires for further study for more validation of RCT. Further study requires in different clinical seating with strategic project plan where properly human, material and financial resources allocation. Rehabilitation specialists can follow the findings and can more concentration to unaffected calf stretching for the chronic stroke patients and can advise to career to continue passive stretching of unaffected calf muscle.

Strengthening after stretching has already been proved to effectively improve a muscle function. So, combining passive stretching and strengthening has some possibilities to improve the static and dynamic balance of stroke patients. This can be evaluated by using balance and strength scores.

In the case of chronic stroke patients, rehabilitation doctors might take the results into consideration and place a greater emphasis on extending the calf that is not affected. They might provide caretakers with the recommendation to maintain passive stretching of the calf muscle that is not impacted. It has previously been shown that strengthening that comes after stretching is an excellent way to increase muscular function. In light of this, the combination of passive stretching and strengthening has the potential to enhance both the static and dynamic balance of stroke patients simultaneously. Balance and strength scores are two methods that may be used to assess this.

When a patient has had a stroke, they may be given several assistive gadgets. Increasing the efficiency of devices on gait and the general functioning of the lower limbs may be accomplished by stretching. Additionally, to test this idea, the orthotic and neurology departments had to collaborate closely with one another.

In addition, several strategies for self-stretching have the potential to enhance the balance of stroke patients. There is a possibility that stroke patients may undertake these kinds of exercises in their own homes, and it is conceivable that they might be effective

in reducing the chronicity of the illness. However, it is likely that this sort of exercise may not be suited for some people.

In addition, more study might investigate the possibility of incorporating technology into stretching programs. For instance, the use of wearable devices to monitor and offer feedback on stretching methods could be one example of this. The accuracy and efficiency of stretching exercises might be improved as a result of this discovery, which would ultimately result in improved results for patients. In addition, research should be conducted to determine the long-term effects of stretching on the quality of life and functional independence of stroke survivors. This would provide a more comprehensive understanding of the intervention's effects.

It is necessary to evaluate a therapy that can be applied to both limbs in a more broad manner. For example, using muscular activation methods and stretching exercises for both the affected and unaffected limbs might enhance the overall balance of individuals who have had a stroke. Furthermore, it is necessary to have comparable residential facilities staffed by knowledgeable and impartial caretakers in order to carry out more thorough study. A conducive setting that ensures equitable treatment is crucial for conducting future investigations in order to enhance the credibility of randomized controlled trials (RCTs). Additional investigation is required in various clinical environments, using well-designed project strategies that include appropriate distribution of human, material, and financial resources.

The efficacy of stretching in various neurological illnesses should be evaluated by physiotherapists working in their separate rehabilitation departments. This evaluation might eventually lead to the development of a guideline for the use of stretching in neurological conditions in addition to stroke.

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