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Effectiveness of Transcutaneous Electrical Nerve Stimulation in the management of patients with Hemiplegic Shoulder Pain

Submitted by:

Nirjona Rohman Srabonty

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

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Department of Physiotherapy

CRP, Savar, Dhaka-1343, Bangladesh

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We, the undersigned, certify that we have carefully read and recommend to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled, **“Effectiveness of Transcutaneous Electrical Nerve Stimulation in the management of patients with Hemiplegic Shoulder Pain.”** Submitted by, **Nirjona Rohman Srabonty**, for the partial fulfillment of the requirement for the degree of Bachelor of Science in Physiotherapy (B.Sc. PT).

………………………………………

Asma Islam
Associate Professor and MPT Coordinator
Department of Physiotherapy
BHPI, CRP.
(Supervisor)

………………………………………

Prof. Dr. Mohammad Sohrab Hossain, PhD
Professor of Physiotherapy, BHPI
Executive Director, CRP.

………………………………………

Mohammad Habibur Rahman
Assistant Professor of Physiotherapy
School of Science and Technology
Bangladesh Open University, Gazipur-1750.

………………………………………

Prof. Md. Obaidul Haque
Vice Principal
BHPI, CRP.

………………………………………

Dr. Shazal Kumar Das, PhD
Assistant Professor and Head
Department of Physiotherapy
BHPI, CRP.

Approved Date:

Declaration

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

Name: Nirjona Rohman Srabonty **Date:**

Nirjona Rohman Srabonty
Bachelor of Science in Physiotherapy (B.Sc. PT)
DU Roll No: 1524
Reg.no:6236 Session: 2019-2020
BHPI, CRP, Savar, Dhaka-1343

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Acronyms

TENS Transcutaneous Electrical Nerve Stimulation

HSP Hemiplegic Shoulder Pain

SPADI Shoulder Pain and Disability Index

MAS Modified Ashworth Scale

AROM Active Range of Motion

PROM Passive Range of Motion

TENS Transcutaneous Electrical Nerve Stimulation

HSP Hemiplegic Shoulder Pain

SPADI Shoulder Pain and Disability Index

MAS Modified Ashworth Scale

ICC Intraclass Correlation Coefficient

RCT Randomized Controlled Trial

CRP Centre for the Rehabilitation of the Paralyzed

BHPI Bangladesh Health Professions Institute

WHO World Health Organization

NMES Neuromuscular Electrical Stimulation

FES Functional Electrical Stimulation

IFC Interferential Current

BMRC Bangladesh Medical Research Council

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ABSTRACT

Background: Hemiplegic Shoulder Pain (HSP) is a common and disabling complication after stroke, hindering recovery and quality of life. While conventional physiotherapy is standard in rehabilitation, its effect on HSP is often limited. Transcutaneous Electrical Nerve Stimulation (TENS), a non-invasive electrotherapy, has shown promise for pain relief in neurological conditions, but its specific role in HSP, especially in low-resource settings like Bangladesh, is not well established. **Objective:** This study aimed to evaluate the effectiveness of TENS combined with conventional physiotherapy in reducing shoulder pain, improving range of motion (ROM), and minimizing spasticity in stroke patients with hemiplegic shoulder pain. **Methods:** A randomized controlled trial was conducted at CRP, Savar, with 30 stroke patients with HSP. Participants were randomly assigned to an experimental group (TENS + physiotherapy, n=15) or control group (physiotherapy only, n=15) over 16 sessions. Outcome measures included the Shoulder Pain and Disability Index (SPADI), Modified Ashworth Scale (MAS), and goniometric assessment of Active and Passive ROM. Data were analyzed using SPSS 25 with t-tests, Mann-Whitney U, and Wilcoxon Signed-Rank tests. **Results:** Both groups showed significant within-group improvements in pain, disability, and ROM ($p<0.05$). However, only the experimental group showed a statistically significant reduction in disability scores ($p=0.006$), while the control group did not ($p=0.120$). Between-group comparisons revealed no significant difference in MAS or ROM post-intervention ($p>0.05$), though the combined use of TENS yielded better overall improvements in functional outcomes. **Discussion:** TENS combined with physiotherapy offers added benefits in reducing pain and improving function in HSP patients. Although no significant differences were observed in spasticity and ROM between the groups, the experimental group showed greater improvement in disability, suggesting the potential value of integrating TENS in post-stroke rehabilitation protocols. Further large-scale studies are needed.

Keywords: *Hemiplegic Shoulder Pain, Transcutaneous Electrical Nerve Stimulation (TENS), Range of Motion.*

Chapter-i	Introduction

1.1 Background

In 1970, According to World Health Organization, Stroke is defined as rapidly developing clinical signs of focal disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin. (WHO, 1970).Stroke is the leading global cause of disability. It ranks as the second most typical cause of death. Stroke can occur from an artery supplying the brain becoming blocked or ruptured, and is often caused modifiable risk factors, such as smoking, unhealthy diet & insufficient exercise. (WHO, 2019)

Hemiplegic shoulder pain is a common complication following stroke, characterized by pain and discomfort in the shoulder of the affected side. It significantly impacts the quality of life and functional recovery of stroke patients, with prevalence rates reported as high as 84% (El Marbouh et al., 2023). Hemiplegic shoulder pain affects a substantial number of stroke survivors, with studies indicating rates exceeding 65% (Mahayati & Mahayati, 2024). The pain often leads to decreased upper extremity function and limitations in daily activities, as evidenced by a strong correlation between shoulder pain and activity limitations (Rashid et al., 2024).

For instance, a study conducted in Pakistan reported that 54.5% of stroke survivors experienced shoulder pain, with a notable correlation to limitations in daily activities (Rashid et al., 2024). In contrast, a systematic review highlighted that the prevalence of HSP can range from 22% to 47% across different populations (Anwer & Alghadir, 2020). Additionally, another study noted that up to 77% of stroke patients may suffer from HSP, emphasizing its commonality as a post-stroke complication (Mahayati & Mahayati, 2024).

Hemiplegic Shoulder Pain arises from various factors, including shoulder subluxation, rotator cuff injuries, and spasticity (Mahayati & Mahayati, 2024). It occurs in 55.6% to 77% of stroke patients, with rates persisting over time. Risk factors include female gender, large-area strokes, and limited shoulder mobility (Li et al., 2023). Hemiplegic shoulder pain is linked to increased pain and disability, leading to sleep disturbances and reduced overall well-being (Mahayati & Mahayati, 2024).

Hemiplegic shoulder pain complicates rehabilitation, often resulting in longer hospital stays and decreased functional recovery (Li et al., 2023). Integrated care pathways have shown promise in improving pain management and rehabilitation outcomes, with a 65% response rate in pain reduction (Walsh et al., 2021). The diagnosis of hemiplegic shoulder pain is difficult to make & is often used to describe a complexity of shoulder problems. It can be caused by multiple reasons, including neuropathic pain, shoulder impingement, subluxation, immobilization & spasticity etc. The quality of life may be negatively impacted by hemiplegic shoulder pain during the rehabilitation process. Several causes of hemiplegic shoulder pain divided into 2 groups: Neurological factors (Paralysis, spasticity, sensory disorders & neuropathic pain) & mechanical factors (glenohumeral subluxation, rotator cuff muscles injury, muscle imbalance & changes in the position of the scapula). Hemiplegic shoulder pain is closely related to decrease in muscle strength in the upper extremities, particularly in the shoulder muscles also decrease range of motion of shoulder (Mahayati & Ryanto, 2024).

The management of hemiplegic shoulder pain typically involves a multidisciplinary approach, combining pharmacological treatments, physical therapy, and other interventions. Many patients do not achieve adequate pain relief due to the variability in individual responses to medications (Li & Alexander, 2015). Common analgesics and anti-inflammatory drugs can have adverse effects, complicating the management of Hemiplegic shoulder pain (Griffin, 1986). Conventional physiotherapy plays a crucial role in the rehabilitation of patients with paralysis, focusing on restoring mobility, reducing pain, and improving functional independence. At the Centre for the Rehabilitation of the Paralyzed (CRP), a combination of evidence-based physiotherapeutic techniques is utilized to enhance motor recovery. These include soft tissue release, positioning, mobilization, scapular settings exercises, active facilitatory movement, active & passive range of motion exercise, stretching exercise, strengthening exercise, mirror therapy, postural training, task specific training etc.

Transcutaneous Electrical Nerve Stimulation (TENS) is a non-invasive electrotherapy technique widely recognized for its ability to alleviate pain by using electrical currents to stimulate the peripheral nervous system. This stimulation blocks pain signals from reaching the brain and promotes the release of endogenous opioids, offering an effective, non-pharmacological alternative for managing both acute and chronic pain (Lee H et al., 2024). TENS allows for customization of electrical impulses, with low-frequency (2-4 Hz) and high-frequency (70-100 Hz) settings tailored to specific pain conditions (Moyya et al., 2024). It is particularly beneficial in chronic conditions like lower back pain, arthritis, and neuropathic pain, providing a cost-effective substitute for traditional medications (Cai et al., 2023; Crelerot et al., 2024). In musculoskeletal conditions, TENS has shown significant efficacy. For instance, it substantially reduces chronic low back pain, as evidenced by studies showing marked improvement compared to control groups (Wahyono, Ramadhan and Alpiah, 2024). It also effectively decreases pain in myofascial pain syndrome when used alongside other treatments, although it is less effective as a standalone intervention (Toopchizadeh et al., 2024). In sports physiotherapy, TENS aids in pain relief and muscle recovery by improving blood circulation and reducing inflammation, making it invaluable during athlete rehabilitation (Astra et al., 2024). Similarly, in neurological conditions, TENS has shown promise in neuromuscular rehabilitation, helping patients with spinal cord injuries and post-stroke conditions regain function (Allen et al., 2023). However, its effectiveness in neurological pain relief remains mixed, with some studies showing limited improvement (Vance et al., 2022).

While TENS is generally considered safe, individual responses can vary, and its long-term efficacy remains debated. The quality of existing research is inconsistent, necessitating further high-quality studies to establish standardized protocols and better understand its role in managing pain across neurological and musculoskeletal conditions (Cai et al., 2023; Crelerot et al., 2024). Research has shown that TENS can significantly reduce pain in various shoulder conditions, including frozen shoulder, with studies reporting a p-value < 0.05 for pain reduction (Rismayanti et al., 2024). In stroke patients, TENS may also help improve the range of motion and functional abilities, leading to better rehabilitation outcomes (Rismayanti et al., 2024).

TENS has grown in popularity in the field of physical rehabilitation because to its low risk profile and affordability of usage. However, its usefulness in the management of HSP has not been adequately investigated.

The purpose of this study is to evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) along with conventional physiotherapy in alleviating hemiplegic shoulder pain (HSP) and improving patient outcomes. HSP is a common complication following stroke that significantly impacts rehabilitation and quality of life. This study seeks to determine whether TENS can provide effective pain relief and enhance functional recovery in affected patients.

1.2. Rational

Hemiplegic shoulder pain (HSP), a common and debilitating complication among stroke survivors. In Bangladesh, where rehabilitation resources are limited, traditional physiotherapy methods such as therapeutic exercises and manual therapy remain the primary treatment options for HSP. However, the efficacy of these conventional approaches in effectively alleviating HSP is not well-supported by robust evidence, highlighting a significant gap in clinical practice.

Transcutaneous Electrical Nerve Stimulation (TENS) has gained global recognition as a non-invasive, cost-effective, and promising modality for pain management. Its mechanism of action, which involves modulating nociceptive signals and stimulating sensory nerves, has shown potential in reducing pain and improving functional outcomes in patients with HSP. Despite its proven benefits in other countries, the integration of TENS with conventional physiotherapy for HSP management remains unexplored in Bangladesh.

This study aims to address this gap by rigorously evaluating the effectiveness of TENS in managing HSP among stroke patients through a randomized controlled trial. By investigating the combined use of TENS and traditional physiotherapy, the study seeks to generate critical evidence that could support the adoption of TENS as a standard intervention in local clinical settings. The findings have the potential to significantly improve rehabilitation outcomes for stroke survivors, enhance their quality of life, and advance the field of physiotherapy in Bangladesh.

Thus, the title is justified as it encapsulates the study's focus on evaluating an innovative, evidence-based intervention (TENS) to address a pressing clinical challenge (HSP) in a resource-constrained setting, with the ultimate goal of improving patient care and advancing rehabilitation practices.

1.3 Aim:

To evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation along with conventional physiotherapy to improve upper limb function with Hemiplegic Shoulder Pain patients.

1.4 Objectives:

General objective:

To evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation in the Management of patients with Hemiplegic Shoulder Pain

Specific Objectives:

- To determine the patients pain and disability level of the affected shoulder.
- To measure the effectiveness of TENS on ROM of the patients affected side.
- To measure the effectiveness of TENS on spasticity of the patients affected side.
- To compare the outcomes of TENS intervention with a control group
- To evaluate the patients baseline characteristics.

1.5 Hypothesis:

Null hypothesis:

There is no significant difference in effectiveness of TENS combined with conventional physiotherapy between conventional physiotherapy alone in stroke patients with hemiplegic shoulder pain.

$$Ho = \mu 1 - \mu 2 = 0$$

Alternative Hypothesis:

There is a significant difference in effectiveness of TENS combined with conventional physiotherapy between conventional physiotherapy alone in stroke patients with hemiplegic shoulder pain.

$$Ha = \mu 1 - \mu 2 \neq 0$$

1.6 Operational definition

Stroke: A stroke is a sudden disruption of blood flow to the brain, caused by either a blockage (ischemic stroke) or rupture (hemorrhagic stroke) of an artery, resulting in a loss of neurological function that persists for more than 24 hours or leads to death, with a vascular origin.

Hemiplegic Shoulder Pain (HSP): HSP refers to pain, discomfort, and limited function in the shoulder of the affected side in individuals who have experienced a stroke, typically resulting from factors such as shoulder subluxation, spasticity, rotator cuff injuries, and muscle imbalance. It significantly impacts daily activities and rehabilitation outcomes, often leading to decreased upper extremity mobility and prolonged recovery.

TENS: TENS is a non-invasive therapeutic technique that uses controlled electrical currents delivered through skin electrodes to stimulate peripheral nerves, aiming to alleviate pain by blocking pain signals to the brain and promoting the release of endogenous opioids. It is commonly used for managing acute and chronic pain in various musculoskeletal and neurological conditions.

Chapter- ii	Literature Review

Hemiplegic Shoulder Pain

Hemiplegic shoulder pain (HSP) is a common and debilitating complication following a stroke, significantly affecting patients' recovery and overall quality of life. Defined as pain occurring in the shoulder of the hemiplegic side, Hemiplegic shoulder pain results from various factors, including immobilization, spasticity, and shoulder impingement. The prevalence of HSP among stroke patients is notably high, ranging from 35.2% to 77%, with studies reporting persistence rates of 55.6% at hospital admission and 59.4% after two months (Mahayati & Mahayati, 2024; Li et al., 2023; El-Sonbaty et al., 2022). Several risk factors contribute to the development of HSP, including demographic variables such as female gender and the presence of larger strokes, as well as clinical factors like increased muscle tension, glenohumeral subluxation, and restricted shoulder range of motion (Li et al., 2023; El-Sonbaty et al., 2022). The impact of HSP extends beyond pain, as it is associated with significant functional limitations, decreased upper extremity function, and increased disability, ultimately leading to a reduced quality of life and higher hospitalization rates (Mahayati & Mahayati, 2024; Li et al., 2023). Despite these challenges, research indicates that early intervention and targeted rehabilitation strategies can effectively mitigate the effects of HSP, underscoring the necessity for prompt and individualized therapeutic approaches in stroke rehabilitation (Deleva et al., 2023).

Pathophysiology for Hemiplegic Shoulder Pain

The pathophysiology of hemiplegic shoulder pain (HSP) involves a complex interplay of mechanical and neurological factors, leading to various shoulder disorders. Understanding these mechanisms is essential for effective management and prevention strategies. One of the primary contributors to HSP is muscle imbalance, where weakness in the external rotators and deltoid muscles, combined with spasticity in the internal rotators, results in a forward and downward pull on the shoulder, compromising stability (Deleva et al., 2023). Neurological factors also play a crucial role, as stroke-induced changes in muscle tone and coordination can lead to abnormal shoulder mechanics, increasing the risk of pain (El Marbouh et al., 2023). Imaging studies frequently reveal conditions such as bicipital tendinitis, bursitis, and adhesive capsulitis, all of which correlate with pain severity (El-Sonbaty et al., 2022).

Several contributing factors further exacerbate HSP. Prolonged immobilization post-stroke can lead to muscle atrophy and joint stiffness, worsening pain and functional decline (Mahayati & Mahayati, 2024). Glenohumeral subluxation, commonly observed in stroke patients, is another major contributor to shoulder pain, as it disrupts joint alignment and stability (Li et al., 2023). Additionally, demographic factors such as female gender and larger stroke size have been linked to a higher risk of developing HSP (Li et al., 2023). Despite its high prevalence, research suggests that proactive rehabilitation, including early mobilization and proper positioning, can significantly mitigate the impact of HSP, emphasizing the importance of timely and targeted interventions in stroke rehabilitation (Deleva et al., 2023; Li et al., 2023).

Hemiplegic shoulder pain (HSP) significantly impacts functional recovery and quality of life in stroke patients, not only causing discomfort but also interfering with rehabilitation efforts and leading to poorer clinical outcomes. The presence of HSP is closely linked to reduced upper limb function, limiting the use of the affected arm in daily activities and rehabilitation exercises (Chuang et al., 2017). Additionally, patients with HSP frequently experience increased pain during passive movements, further hindering rehabilitation progress and delaying motor recovery (Hoo et al., 2013). However, studies suggest that effective pain management strategies, such as EMG-triggered neuromuscular electrical stimulation, can improve shoulder function and reduce pain intensity, facilitating a more effective rehabilitation process (Chuang et al., 2017).

Beyond its impact on physical recovery, HSP significantly diminishes health-related quality of life, restricting participation in daily activities and reducing overall well-being (Adey-Wakeling et al., 2016). The condition is highly prevalent among stroke survivors, with estimates ranging from 22% to 55%, highlighting its widespread burden and the need for effective management strategies (Hoo et al., 2013). Promising interventions, such as suprascapular nerve blocks, have demonstrated efficacy in alleviating pain and improving quality of life outcomes, offering a potential therapeutic option for affected individuals (Adey-Wakeling et al., 2013). Despite the availability of treatment options, the chronic nature of HSP can lead to persistent pain and disability, emphasizing the necessity for ongoing research and individualized therapeutic approaches to enhance recovery and optimize the quality of life for stroke patients.

Conventional management of hemiplegic shoulder pain

Pharmacological interventions for hemiplegic shoulder pain (HSP) in stroke patients encompass analgesics, muscle relaxants, and corticosteroid injections, each demonstrating varying degrees of efficacy. Recent studies suggest that combining these pharmacological approaches with rehabilitative techniques can significantly reduce pain and enhance shoulder function. Among the available treatments, botulinum toxin type A injections have shown notable effectiveness, particularly when administered in the subscapularis muscle, leading to a marked reduction in pain scores over time (Larrazet et al., 2016). Additionally, neuromuscular electrical stimulation (NMES), particularly EMG-triggered NMES, has been found to be more effective than transcutaneous electrical nerve stimulation (TENS) in alleviating pain intensity and improving shoulder mobility (Chuang et al., 2017).

Corticosteroid injections are another commonly used intervention, offering short-term relief from inflammation and pain associated with HSP. However, their long-term efficacy remains uncertain, necessitating further comparative studies to determine their sustained benefits over other therapeutic approaches. Research also indicates that integrating pharmacological treatments with rehabilitative techniques, such as bilateral arm training, yields superior outcomes for stroke patients experiencing Hemiplegic shoulder pain (Chuang et al., 2017). Despite the potential benefits of pharmacological interventions, concerns regarding adverse effects, particularly with prolonged use, highlight the need for careful patient selection and ongoing research to optimize treatment strategies (Allida et al., 2020).

Non-pharmacological approaches to managing hemiplegic shoulder pain (HSP) in stroke patients have demonstrated promising results, utilizing various rehabilitative techniques aimed at alleviating pain and improving functional outcomes. Physical therapy, e.g., exercise and positioning techniques form the cornerstone of these interventions, offering effective alternatives or complementary strategies to pharmacological treatments. Acupuncture has also emerged as a beneficial adjunct to rehabilitation, with studies indicating that its combination with rehabilitation training leads to greater pain reduction, showing a mean difference of -1.32 in shoulder pain scores (Zhan et al., 2022). Beyond pain relief, acupuncture has been associated with improvements in upper limb motor function and activities of daily living, suggesting broader rehabilitative benefits (Zhan et al., 2022). Innovative rehabilitation methods, including functional electrical stimulation (FES) , have demonstrated significant enhancements in shoulder range of motion and overall upper limb function, offering engaging and effective therapeutic options (Montoya et al., 2022). Moreover, strength training of the non-hemiplegic side has been linked to improved balance and mobility, further supporting the role of targeted rehabilitation in stroke recovery (Shao et al., 2022).

While these non-pharmacological approaches are effective, their applicability may vary among stroke patients, highlighting the necessity for personalized rehabilitation strategies. Further research is needed to optimize these interventions and tailor them to diverse patient needs, ensuring comprehensive and effective management of HSP in rehabilitation.

Conventional treatments for hemiplegic shoulder pain (HSP) in stroke patients often face notable limitations, primarily due to their insufficient effectiveness and the multifactorial nature of the condition. While traditional rehabilitation methods, such as physical therapy, remain widely utilized, they frequently fail to address the underlying causes of pain, leading to suboptimal outcomes. Studies indicate that conventional rehabilitation alone has limited success in significantly reducing pain intensity in HSP patients, emphasizing the need for more comprehensive treatment strategies (Sire et al., 2021). Furthermore, systematic reviews suggest that combining rehabilitative techniques with conventional therapy yields superior results, highlighting the inadequacy of standard methods when used in isolation (Sire et al., 2022).

Transcutaneous Electrical Nerve Stimulation (TENS)

Transcutaneous Electrical Nerve Stimulation (TENS) operates through key mechanisms, including the pain gate theory and the release of endogenous opioids, both of which contribute to its analgesic effects. According to the pain gate theory, the spinal cord functions as a gate that modulates pain signals based on the balance of input from large and small sensory fibers. TENS primarily stimulates large-diameter A-beta fibers, which inhibit the transmission of pain signals from smaller A-delta and C fibers, effectively "closing the gate" to pain perception (Mendell, 2014). This process reduces the intensity of pain experienced during TENS application, making it a widely used modality for pain management.

In addition to its role in spinal modulation, TENS also promotes the release of endogenous opioids, which are natural pain-relieving substances produced by the body. These opioids, such as beta-endorphins, bind to opioid receptors in the central nervous system, providing analgesic effects and modulating pain responses (Hill, 1981; Kapitzke et al., 2005). Furthermore, immune cells contribute to this process by releasing opioid peptides in inflamed tissues, enhancing the overall pain-relieving effect of TENS (Kapitzke et al., 2005).

While TENS is effective for many patients, individual responses to treatment may vary. Some individuals may experience limited pain relief, potentially due to chronic pain mechanisms or alterations in receptor expression that affect the efficacy of opioid-mediated analgesia (Tavares & Lima, 2007). This variability underscores the need for personalized treatment approaches and further research to optimize the effectiveness of TENS for different pain conditions. Transcutaneous Electrical Nerve Stimulation (TENS) includes various modalities, such as conventional, acupuncture-like, and burst modes, each with distinct mechanisms and applications. Understanding these types is essential for optimizing pain management strategies and tailoring treatments to individual patient needs.

Conventional TENS utilizes continuous low-frequency electrical pulses, primarily operating on the gate control theory to block pain signals at the spinal cord level. It is commonly used for both acute and chronic pain relief, with studies demonstrating significant pain reduction across various conditions (Kerai et al., 2014; Gibson et al., 2017). Acupuncture-like TENS, on the other hand, mimics traditional acupuncture by delivering higher-frequency pulses aimed at stimulating endogenous opioid release, thereby enhancing analgesic effects. This modality is often employed for chronic pain management, although the evidence regarding its efficacy remains mixed (Kerai et al., 2014).

Burst mode TENS involves delivering bursts of pulses, potentially enhancing neural activation differently from conventional TENS. Research indicates that burst stimulation can provide similar pain relief while minimizing paraesthesia, making it a favorable option for patients with neuropathic pain (Manning et al., 2019). Additionally, burst mode has shown promise in modulating pain pathways more effectively than continuous stimulation, suggesting its potential advantage in complex pain conditions (Gousset et al., 2020). While these TENS modalities offer valuable options for pain management, individual responses to treatment vary, underscoring the need for further research. Optimizing TENS therapy requires personalized approaches based on patient characteristics, pain mechanisms, and treatment goals to maximize therapeutic benefits.

Transcutaneous Electrical Nerve Stimulation (TENS) is widely recognized for its safety, cost-effectiveness, and ease of application in pain management. Research supports its efficacy in reducing pain intensity across various conditions, including both acute and chronic pain, with minimal adverse effects. The safety profile of TENS is well established, with studies indicating that adverse events are typically mild, such as skin irritation at electrode sites, and no serious complications have been reported, making it a low-risk option for pain relief (Gibson et al., 2017; Johnson et al., 2022). Additionally, TENS is a cost-effective alternative to pharmacological treatments, helping to reduce the need for more expensive interventions.

Clinical Evidence on TENS for Pain Management

Transcutaneous Electrical Nerve Stimulation (TENS) has been extensively studied for its effectiveness in managing both musculoskeletal and neuropathic pain, demonstrating significant pain reduction in various conditions. A systematic review of 381 studies found that TENS significantly lowers pain intensity compared to placebo, with a standardized mean difference (SMD) of -0.96, highlighting its potential as a non-invasive pain management strategy (Johnson et al., 2022). However, patient responses to TENS vary, underscoring the importance of personalized electrode placement and parameter adjustments to optimize therapeutic outcomes (Gladwell et al., 2016). In neuropathic pain management, evidence suggests that TENS provides a favorable post-intervention effect compared to sham treatments, though the quality of evidence remains low due to inconsistencies in study designs and high risk of bias (Gibson et al., 2017). While these findings indicate the promise of TENS in pain relief, its overall efficacy remains a subject of debate due to methodological limitations in existing research. To strengthen the clinical application of TENS, future studies should focus on standardizing treatment protocols and improving the quality of evidence to better understand its full therapeutic potential.

Transcutaneous Electrical Nerve Stimulation (TENS) has been explored as a potential treatment for stroke-related pain, particularly in conditions such as hemiplegic shoulder pain and central post-stroke pain. While some studies suggest that TENS may offer therapeutic benefits, the overall evidence remains inconclusive due to variability in study outcomes and methodological limitations. For post-stroke shoulder pain, a review of electrical stimulation techniques, including TENS, found no significant reduction in pain incidence or intensity, although there was an improvement in passive range of motion (Price & Pandyan, 2000). Similarly, another study reported no significant effect of TENS on pain-free range of motion in hemiplegic shoulder pain, emphasizing the variability in individual responses (Whitehair et al., 2019). In the context of central post-stroke pain, a systematic review found that TENS, among other treatments, demonstrated little to no effect on pain relief, further questioning its efficacy in this domain (Mulla et al., 2015). While basic science suggests that TENS may influence pain pathways through mechanisms such as neuromodulation, clinical trials underscore the importance of appropriate dosing and intensity for effectiveness (De Santana et al., 2008). However, many studies suffer from high risk of bias and small sample sizes, limiting confidence in their findings (Gibson et al., 2017). Despite these limitations, further research is warranted to clarify the role of TENS in stroke-related pain management and to optimize its application for improved patient outcomes.

Comparison of TENS with Other Pain Management Strategies

Comparative studies suggest that TENS may not be as effective as other modalities; for instance, research comparing TENS with neuromuscular electrical stimulation (NMES) demonstrated that EMG-triggered NMES provided greater pain relief and improved shoulder function (Chuang et al., 2017). Additionally, evidence indicates that combining TENS with physical therapy leads to better outcomes than TENS alone, underscoring the importance of multimodal rehabilitation strategies (Alanbay et al., 2020). While TENS is supported by moderate-certainty evidence for general pain management, its specific role in hemiplegic shoulder pain remains inconclusive, necessitating further research to determine its optimal integration into stroke rehabilitation programs.

The comparison of Transcutaneous Electrical Nerve Stimulation (TENS) with other electrotherapy modalities, such as Neuromuscular Electrical Stimulation (NMES), Functional Electrical Stimulation (FES), and Interferential Current (IFC), highlights their distinct applications in rehabilitation. TENS primarily targets pain relief by stimulating sensory nerves, with evidence suggesting its effectiveness in managing chronic pain and enhancing exercise performance, though its impact on range of motion in conditions like hemiplegic shoulder pain remains limited (Astokorki & Mauger, 2017; Whitehair et al., 2019). In contrast, NMES is designed to elicit muscle contractions, improving strength and endurance, particularly in frail individuals, with varying levels of muscle torque and fatigue depending on the stimulation protocol used (Paillard, 2022;Alahmari et al., 2022). FES, often employed in neurological rehabilitation, facilitates functional movements by activating paralyzed muscles, promoting motor recovery in post-stroke patients. IFC, similar to TENS in its analgesic effects, offers advantages in deeper tissue penetration and broader pain relief (Astokorki & Mauger, 2017). While TENS remains a preferred choice for pain management, NMES and FES are more effective for muscle strengthening and functional recovery, underscoring the need for individualized treatment approaches based on patient needs and rehabilitation goals.

While TENS remains a widely used modality, its clinical effectiveness requires further validation to optimize therapeutic approaches for HSP. The study aims to address existing gaps in the effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) for hemiplegic shoulder pain by comparing it with other electrotherapy modalities and examining its acute effects. While TENS is widely utilized in clinical practice, research on its immediate analgesic impact remains limited.

Limitations and Gaps in Existing Literature

The existing literature on transcutaneous electrical nerve stimulation (TENS) for hemiplegic shoulder pain reveals several limitations and gaps. Firstly, there is a notable inconsistency in the parameters and methodologies employed across studies, as highlighted by the scoping reviews which indicate that while electrical stimulation is frequently studied, the specific application methods remain unclear and varied (Ito et al., 2023). Additionally, the evidence regarding the effectiveness of TENS is often inconclusive, with factors such as dosing, timing of outcome measurement, and population characteristics inadequately addressed (Sluka et al., 2013).

Rationale for this study

Research indicates that TENS can effectively reduce pain levels and enhance passive range of motion (PROM) when combined with conventional rehabilitation(Ekim et al., 2008;Chuang et al., 2017). However, comparative studies suggest that while TENS is beneficial, it may not be as effective as other interventions like suprascapular nerve block or EMG-triggered neuromuscular electrical stimulation (NMES) in terms of immediate pain relief and functional outcomes (Ersoy et al., 2022;Chuang et al., 2017). Notably, high-intensity TENS has shown superior results in improving PROM compared to low-intensity TENS and placebo (Leandri et al., 1990). Thus, further investigation into optimizing TENS protocols could enhance therapeutic outcomes for HSP patients.

Outcome Measurement Tool:

Outcome measurement tool is a very important component of every research and has to be valid and reliable. The following research project used three outcome measurement tool Shoulder pain & disability index scale (SPADI), Modified Ashworth Scale (MAS) and Goniometer to measure the post intervention outcome of pain in affected side and function.

Shoulder pain & disability index scale (SPDAI)

The Shoulder Pain and Disability Index (SPADI) is a widely used, validated self-report questionnaire designed to assess the severity of pain and functional disability in individuals with shoulder disorders (Roach et al., 1991). It consists of 13 items, divided into two subscales: pain (5 items) and disability (8 items). Each item is scored using a visual analog scale (VAS) or a numerical rating scale (NRS), with higher scores indicating greater impairment. The total SPADI score is calculated as the weighted mean of the subscale scores, ranging from 0 (no impairment) to 10 (maximum disability). SPADI has demonstrated good reliability, validity, and responsiveness in various musculoskeletal conditions, including hemiplegic shoulder pain following stroke (Christie et al., 2010). SPADI was found to have reliability coefficients of Intraclass correlation coefficient (ICC) $\geq$ 0.89 in a variety of patient populations. Internal consistency is high with Cronbach α typically exceeding 0.90 (Roy et al., 2009). In this study, SPADI will be used to measure changes in shoulder pain and functional limitation before and after transcutaneous electrical nerve stimulation (TENS) intervention.

Goniometer

Goniometer is a tool to measure range of motion of the joints (Parati et al., 2023).

Modified Ashworth Scale

The Modified Ashworth Scale (MAS) is a widely used clinical tool for assessing spasticity in neurological conditions. It grades spasticity on a six-point scale based on resistance during passive movement. For instance, one study reported intraclass correlation coefficients (ICCs) exceeding 0.7 for intra-rater reliability, indicating good consistency, while inter-rater reliability was also found to be satisfactory with ICCs around 0.82 (Yoo et al., 2022; Ansari et al., 2022).

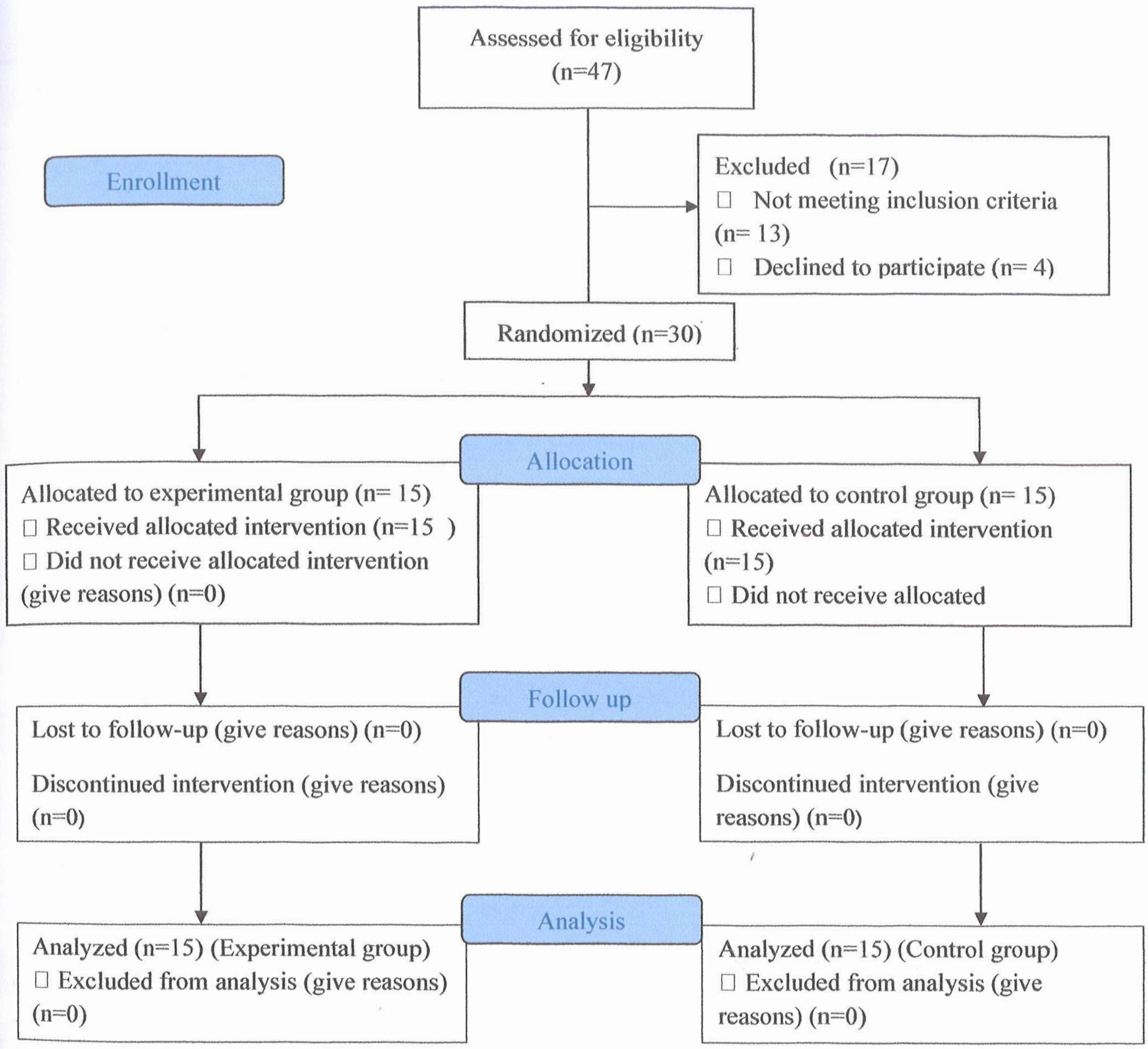
This study was a randomized control trial design to find out the effectiveness of Transcutaneous electrical nerve stimulation along with conventional physiotherapy in hemiplegic shoulder pain patients. To identify the effectiveness of treatment regimen, Shoulder pain & disability index, Modified Ashworth Scale, Goniometer were used as a measurement tool for measuring the upper limb function caused by stroke. All patients signed an informed consent form prior to their inclusion into the study.

3.1 Study Design:

Experimental quantitative research which was Randomized Controlled Trail (RCT) design was chosen because the experimental study is the best way to find out the effectiveness of this study. The study was an experimental between two subject designs. Conventional physiotherapy with TENS was applied to the experimental group and Conventional physiotherapy only was applied to the control group.

A pre-test (before intervention) and post-test (after intervention) was administered with each subject of both groups to compare the pain, tone, range of motion of upper limb, improvement of upper limb function after treatment.

Flowchart of the phases of Randomized controlled trial



CONSORT flowchart for a randomized controlled trial of a treatment program including TENS along with conventional physiotherapy for patients with hemiplegic shoulder pain.

3.2 Study area:

The study area was Neurology unit and SRU of Physiotherapy Department of Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka.

3.3 Study Population

The study population was the patients diagnosed as stroke with hemplegic shoulder pain in the Neurology Unit and SRU of Physiotherapy Department.

3.4 Study duration

The study was conducted from 1st June 2024 to 31st May 2025, and the duration of data collection 1st January 2025 to 31 March 2025 approximately 3 months, from initial recruitment through to the final dissemination of results.

3.5 Sampling technique

A total of 47 participants were assessed for eligibility using a simple random sampling technique. Of these, 17 individuals were excluded — 13 did not meet the inclusion criteria and 4 declined to participate. The remaining 30 eligible participants were then randomly allocated into two groups using a simple randomization method: 15 were assigned to the experimental group (TENS + conventional physiotherapy), and 15 to the control group (conventional physiotherapy only). This random allocation helped reduce selection bias and ensured comparability between the groups.

3.6 Sample Size:

Sample size was 30 participants. 15 participants were in experimental group and remaining 15 participants were in control group.

3.7 Sampling:

Simple Random Sample Technique are used in this study. Subjects, who met the inclusion criteria, were taken as sample in this study. 30 patients were selected from Neurology unit of Physiotherapy department of CRP, Savar and then 15 patients were assigned to Experimental group for the treatment approaches of TENS alone with conventional physiotherapy and other 15 patients were assigned to control group for the treatment approaches of conventional physiotherapy treatment by computer generated random number using Microsoft Office Excel 2019 because it improves internal validity of experimental research. The samples were given numerical number C1, C2, C3 etc. for the control group and E1, E2, E3 etc. for experimental group. The study was a single blinded technique.

3.8 Inclusion criteria

- Confirmation diagnosis of Hemiplegia due to stroke (both Ischemic or Haemorrhagic)
- Presence of shoulder pain on the hemiplegic side
- All ranges of age
- A stable condition and suitable for exercise
- Ability to understand and follow instructions

(Zhou et al., 2018)

3.9 Exclusion criteria

- Severe cognitive impairment
- Uncontrolled medical conditions
- Skin conditions or lesions at electrode placement sites
- Diagnosis of shoulder subluxation, pre stroke history of Frozen shoulder, trauma or brachial plexus injury.
- Recent shoulder surgery or significant shoulder trauma.

(Badaru, 2020)

3.10 Data Collection Procedure

The study procedure was conducted through assessing the patient, initial recording, treatment and final recording. After screening the patient at department, the patients were assessed by qualified physiotherapist. Sixteen sessions of treatment was provided for every subject. Forty subjects were chosen for data collection according to the inclusion criteria. The researcher divides all participants into two groups and coded C1 (20) for control group and E1 (20) for experimental group. The experimental group received the conventional physiotherapy with TENS and control group received only conventional physiotherapy. Data was gathered through a randomization, pre-test, and intervention and post-test procedure and by using a written questionnaire form which was formatted and prepared by the researcher under the supervision of the supervisor which also includes the Numerical pain rating scale, Modified Ashworth Scale, Action arm research test to measure function of upper limb, and goniometer tools to measure the range of motion. Pretest was performed before the intervention and the same procedure was performed to collect the post test data. The researcher collected the data both in experimental and control group in front of the qualified physiotherapist in order to reduce the biasness. At the end of the study, specific test was performed for statistical analysis.

3.11 Data Collection Tool

The data collection tools employed in this study consisted of a written questionnaire, pen, paper, Goniometer.

3.12 Questionnaire:

The questionnaire for this study was carefully developed under the constant observation, advice and permission of the supervisor following certain guidelines. There was shoulder pain & disability index scale to measure pain & functional disability level of the shoulder, Modified Ashworth Scale to measure the tone, Goniometer to measure the range of motion of shoulder. The question was formulated to find out effectiveness of TENS along with conventional physiotherapy in stroke patients with hemiplegic shoulder pain.

Primary outcome measurement

The primary outcome is the pain level of the stroke patients with hemiplegic shoulder pain. The Shoulder pain & disability index scale will measure the pain level of this patients.

Secondary outcome measurement

The secondary outcome includes disability level of the patients, Spasticity, Range of motion (ROM). The Shoulder pain & disability index scale will measure the disability level of the patients, the Modified Ashworth Scale will measure the spasticity of the patients, goniometer will measure the ROM of the patients.

3.13 Measurement tools:

3.13.1 Goniometer

Goniometer is a tool to measure range of motion of the joints.

3.13.2 Shoulder pain & disability index scale (SPDAI)

The Shoulder Pain and Disability Index (SPADI) is a widely used, validated self-report questionnaire designed to assess the severity of pain and functional disability in individuals with shoulder disorders (Roach et al., 1991). It consists of 13 items, divided into two subscales: pain (5 items) and disability (8 items). Each item is scored using a visual analog scale (VAS) or a numerical rating scale (NRS), with higher scores indicating greater impairment. The total SPADI score is calculated as the weighted mean of the subscale scores, ranging from 0 (no impairment) to 10 (maximum disability).

SPADI has demonstrated good reliability, validity, and responsiveness in various musculoskeletal conditions, including hemiplegic shoulder pain following stroke (Christie et al., 2010). SPADI was found to have reliability coefficients of Intraclass correlation coefficient (ICC) ≥ 0.89 in a variety of patient populations. Internal consistency is high with Cronbach α typically exceeding 0.90 (Roy et al., 2009). In this study, SPADI will be used to measure changes in shoulder pain and functional limitation before and after transcutaneous electrical nerve stimulation (TENS) intervention.

3.13.3 Modified Ashworth Scale

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

3.14 Intervention

In experimental group patients will take TENS with conventional physiotherapy & the control group patients will take only conventional physiotherapy.

In conventional therapy therapist has given:

- Soft tissue release
- Positioning
- Mobilization
- Scapular setting
- Passive & Active ROM

- Active facilitatory movement
- Stretching exercise
- Strengthening exercise
- Mirror therapy
- Postural training
- Task-specific training

Treatment protocol for experimental group:

(Conventional Physiotherapy along with TENS therapy for 10-15 minutes)

Electrode placement: Usually, two to four electrodes are placed around the affected shoulder area.

- Over the posterior deltoid muscle
- Around the supraspinatus muscle

Stimulation parameters:

Frequency: 80 Hz

Pulse width: 60 microseconds

Intensity: Adjust to comfortable for the patient

Session length: 10-15min per session, 4times weekly, 4weeks (16session).

Figure-1

(Partially taken from Badaru, 2020)

3.15 Data analysis

Data Analysis was done with SPSS 25 & Microsoft excel.

3.16 Ethical consideration

The research proposal was submitted for approval to the administrative bodies of the ethical committee of CRP and also had followed the Bangladesh Medical Research guideline (BMRC) and the World Health Organization (WHO) guideline. Again Before data collection, permission from the Ethical Committee of Bangladesh Health Professions Institute (BHPI) took and a requested letter hand over to the appropriate authority of the study area for taking permission and seeking assistance for smooth access to data collection with insurance of patient's safety. In order to eliminate ethical claims, the participants were set free to receive treatment for other purposes as usual. Each participant was informed about the study before beginning and given written consent. The researcher received verbal and signed an informed consent form to participate in this study from every subject. The participants were informed that they have the right to meet with an outdoor doctor if they think that the treatment is not enough to control the condition or if the condition becomes worse. The participants were also informed that they were completely free to decline to answer any question during the study and were free to withdraw their consent and terminate participation at any time. If the patients wanted to withdraw themself from the study, it would not affect their treatment in the physiotherapy department and they would still get the same facilities. Every subject had the opportunity to discuss their problem with the senior authority or administration of CRP and had any questioned answer to their satisfaction.

4.1 Table 1: Baseline characteristics of the participants:

Variable	Experimental group Mean (n=15) & Standard deviation (SD)	Control Group Mean (n=15) & Standard deviation (SD)
Age	48.07 & ±12.215	54.33 & ± 7.898
Pre Total pain score	30.6 & ± 8.862	22.2 & ±9.167
Pre Total disability score	65.13 & ± 21.38	61.73 & ±24.581
Pre Shoulder Flexion AROM	62.27& ±73.757	71.27 & ±80.247
Pre Shoulder Extension AROM	24.67 & ±24.746	24.67 & ±27.789
Pre Shoulder Abduction AROM	75.53 & ±74.244	61.27 & ±70.152
Pre Shoulder Adduction AROM	27.87 & ± 20.618	21 & ±23.238
Pre Shoulder Lateral Rotation AROM	30.8 & ±34.126	31& ±36.524
Pre Shoulder Medial Rotation AROM	32.33 & ±30.047	31.46 & ±34.94
Pre Shoulder Flexion PROM	146.87 & ±39.973	166.67 & ±31.717
Pre Shoulder Extension PROM	48.33 & ±15.546	52.67 & ±16.132
Pre Shoulder Abduction PROM	142.07 & ±46.841	164.8 & ±34.546
Pre Shoulder Lateral Rotation PROM	70.27 & ±26.51	73.07 & ±32.132
Pre Shoulder Medial Rotation PROM	65.27 & ±11.164	65.33 & ±10.076
Pre MAS	Median=1.000 (Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension)	

4.2 Age:

A total of 30 participants were selected for this study. The mean age of participants was 51.2 and standard deviation was 10.597, whereas experimental group Mean±SD were 48.07 & ±12.215 and control group Mean±SD were 54.33 & ± 7.898

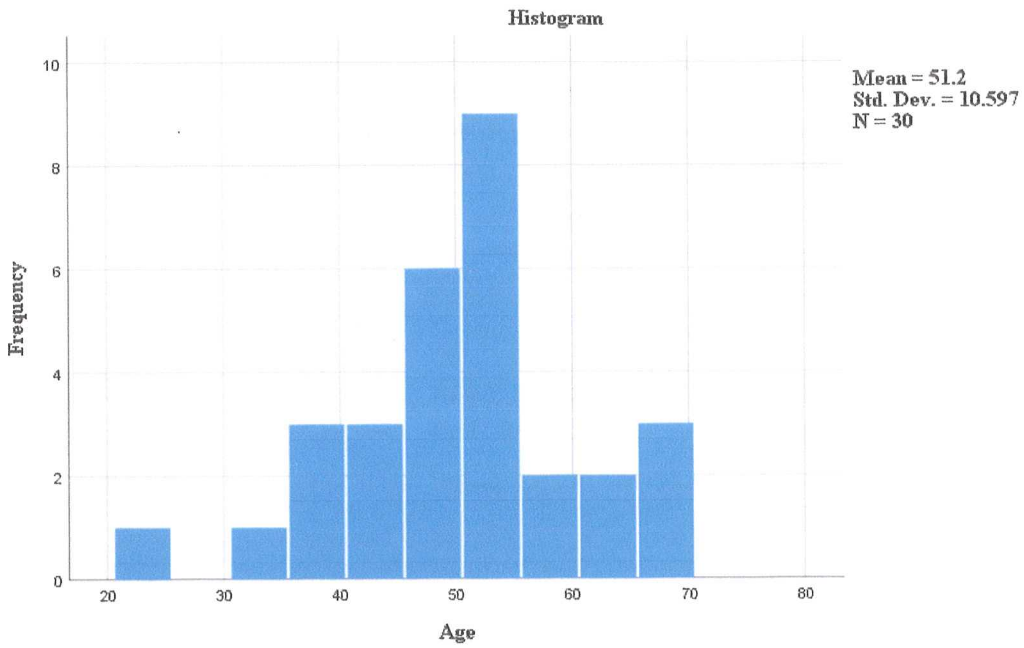


Figure-1: Age of the participants

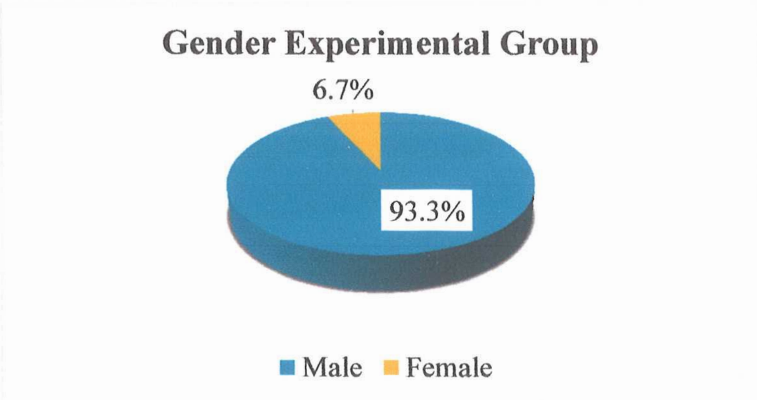
4.3 Table 2: Sociodemographic and stroke related information

Variable	Type of variable	Frequency/Percentage (Experimental)	Frequency/Percentage (Control)
Gender	Nominal	Male, n=14/93.3% Female, n=1/6.7%	Male, n=12/80% Female, n=3/20%
Occupation	Nominal	Service holder, n=2/13.3% Businessman ,n=7/46.7% Housewife ,n=1/6.7% Construction worker ,n=1/6.7% Abroad ,n=2/13.3% Driver ,n=2/13.3%	Service holder, n=3/20% Businessman, n=3/20% Housewife, n=2/13.3% Farmer, n=1/6.7% Teacher, n=1/6.7% Abroad, n=3/20% Garments worker, n=1/6.7% Village doctor, n=1/6.7%
Marrital status	Nominal	Married, n=14/93.3% Unmarried, n=1/6.7%	Married, n=15/100%
Affected side	Nominal	Right, n=6/40% Left, n=9/60%	Right, n=6/40% Left, n=9/60%
Type of stroke	Nominal	Ischemic, n=15/100%	Ischemic, n=15/100%
Living area	Nominal	Rural, n=1/6.7% Urban, n=6/40% Semi-urban, n=8/53.3%	Rural, n=3/20% Urban, n=10/66.67% Semi-urban, n=2/13.3%
Family type	Nominal	Nuclear, n=10/66.7% Extended, n=5/33.3%	Nuclear, n=11/73.3% Extended, n=4/26.7%
Education level	Nominal	Illiterate, n=2/13.3% Primary, n=2/13.3% Secondary, n=3/20% SSC, n=4/26.7% HSC, n= 1/6.7% Graduate, n=2/13.3% Masters or above, n=1/6.7%	Illiterate, n=2/13.3% Primary, n=3/20% Secondary, n=1/6.7% SSC, n=3/20% HSC, n=3/20% Graduate, n=3/20%
Past medical history	Nominal	Hypertension, n=2/13.3% Hypertension, heart disease, CKD, n=1/6.7% Hypertension, Diabetes, n= 6/40% Hypertension, diabetes,	Hypertension, n=4/26.7% Hypertension, diabetes, n=4/26.7% Hypertension, diabetes, heart disease, n=2/13.3%

	heart disease, n=4/26.7% No=1/6.7% Hypertension, diabetes, heart disease, arthritis, n=1/6.7%	No=1/6.7% Hypertension, heart disease, n=3/20% Hypertension, diabetes, arthritis, n=1/6.7%

4.3.1 Gender

Among 30 participants, male participants were 93.3% and female participants were 6.7% in experimental group. In control group male participants were 80 % and female participants were 20%.



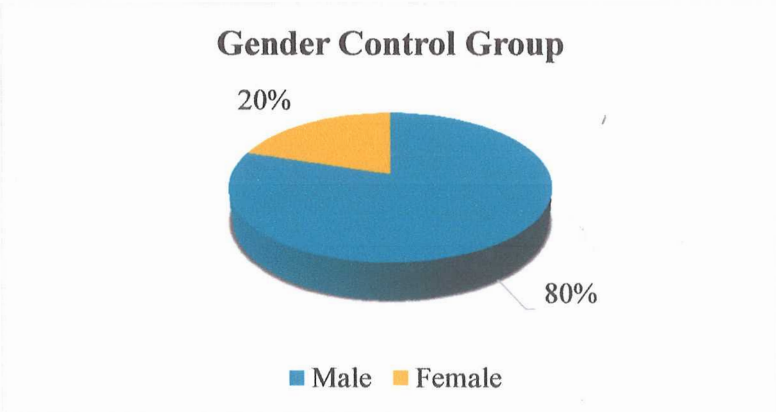
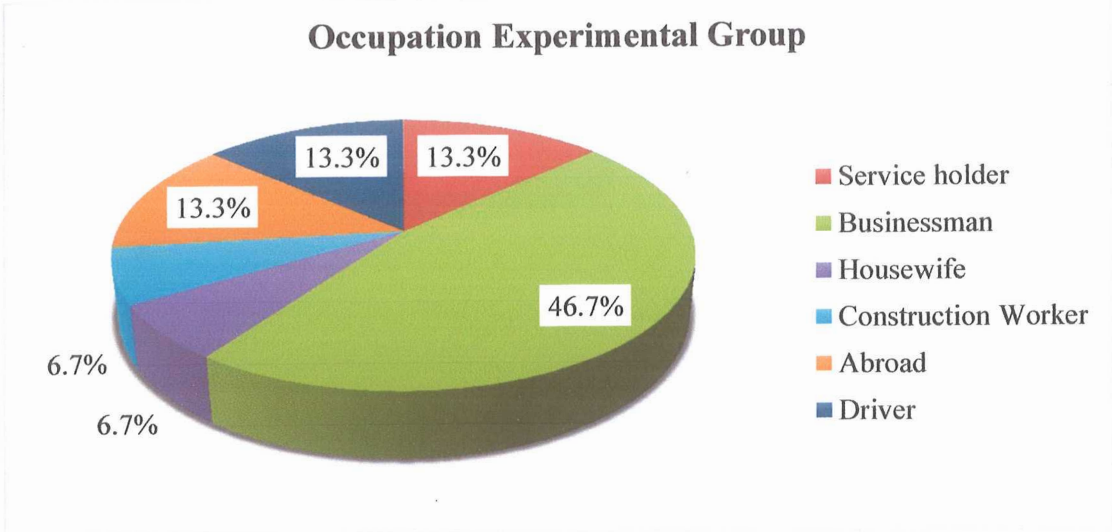


Figure-2: Gender of the participants

4.3.2 Occupation

Among 30 participants, in experimental group, service holder are 13.3%, businessman are 46.7%, housewife is 6.7%, construction worker is 6.7%, 13.3% is working in abroad, 13.3% are driver. In control group, service holder are 20%, businessman are

20%, housewife are 13.3%, farmer is 6.7%, teachers are 6.7%, 20% are working in abroad, garments worker are 6.7%, village doctor are 6.7%.



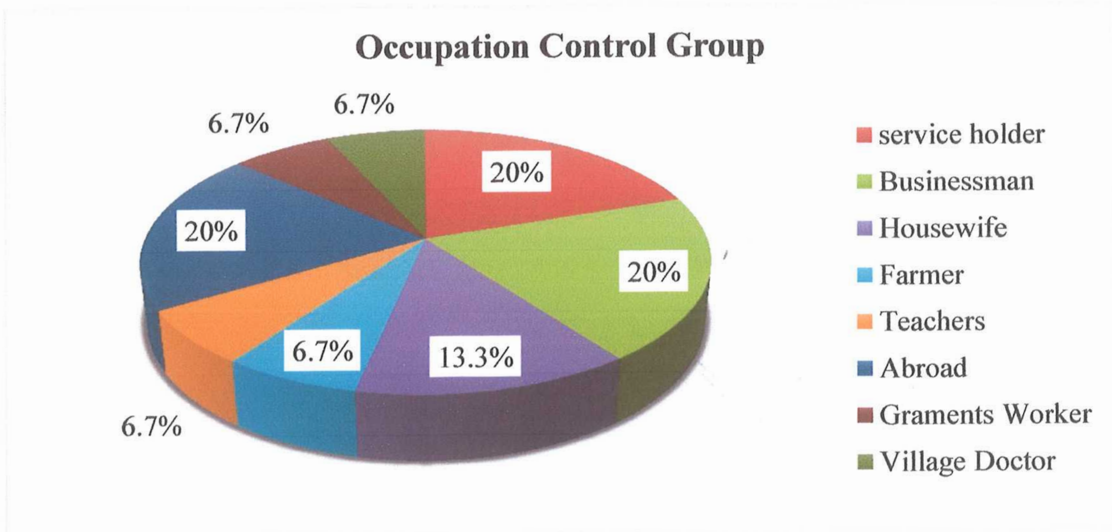
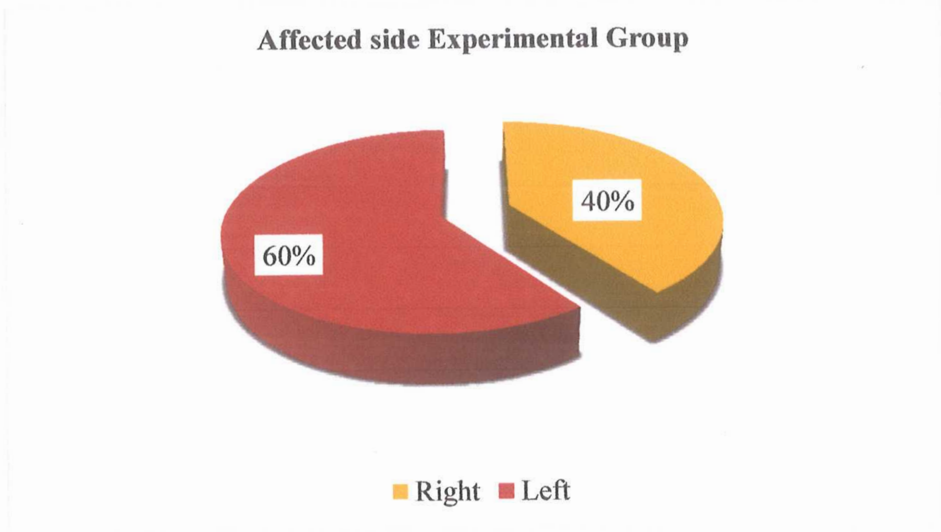


Figure-3: Occupation of the participants

4.3.3 Affected side

Among 30 stroke patients, In experimental group, 40% (n=6) were right side and 60% (n=9) were left side affected. In control group, 40% (n=6) were right side and 60% (n=9) were left side affected.



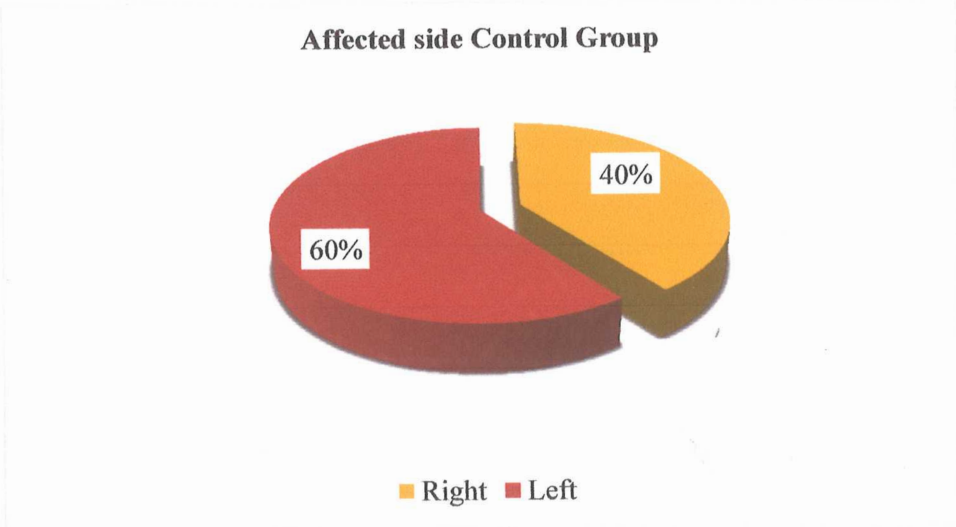
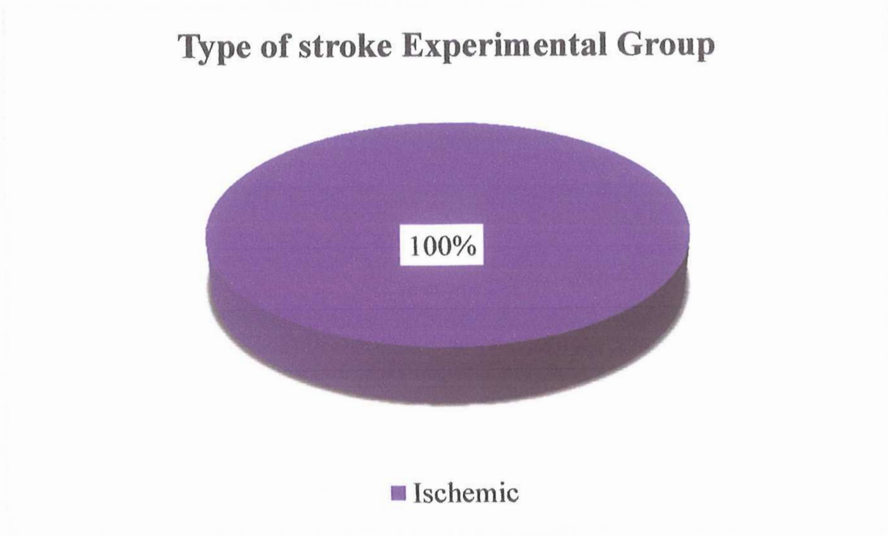


Figure-4: Affected side of the participants

4.3.4 Type of stroke

Among 30 stroke patients, in experimental group, 100% (n=15) had Ischemic type of stroke. In control group, 100% (n=15) had Ischemic type of stroke.



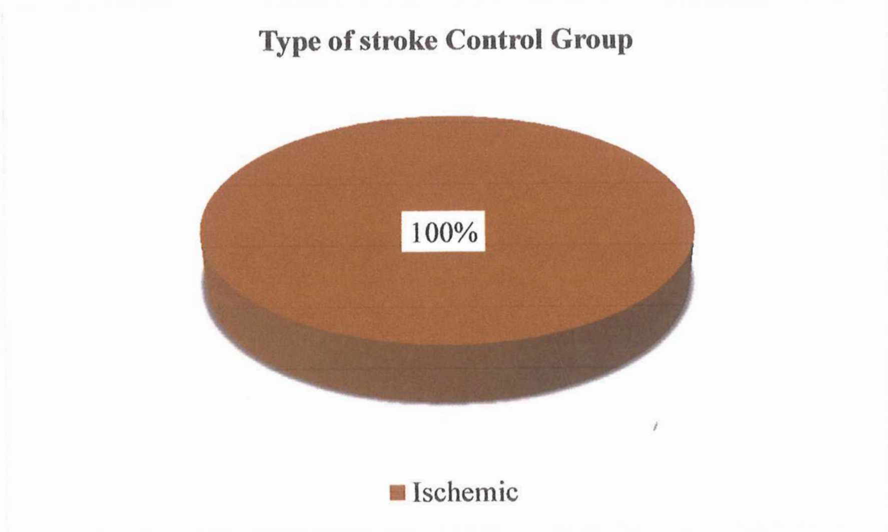
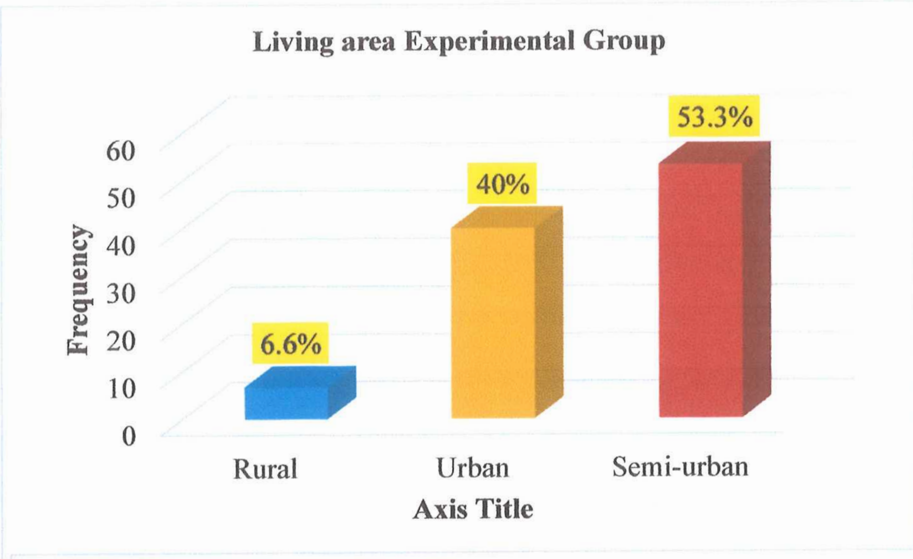


Figure-5: Type of stroke of the participants

4.3.5 Living area

The study was conducted on 30 stroke patients. Among them, in experimental group, 40% were lived in urban area, 53.3% were in semi-urban area and 6.7% were in rural area. In control group, 66.67% were lived in urban area, 13.3% were in semi-urban area and 20%% were in rural area.



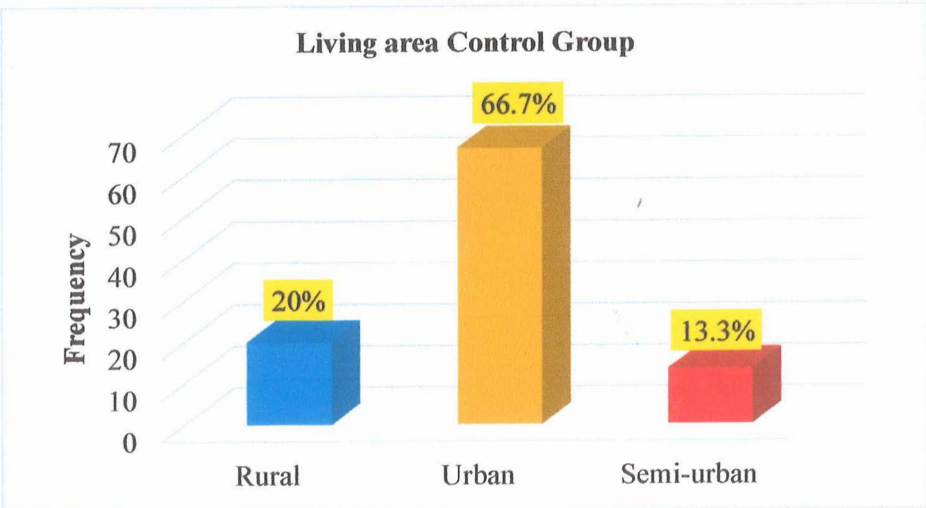
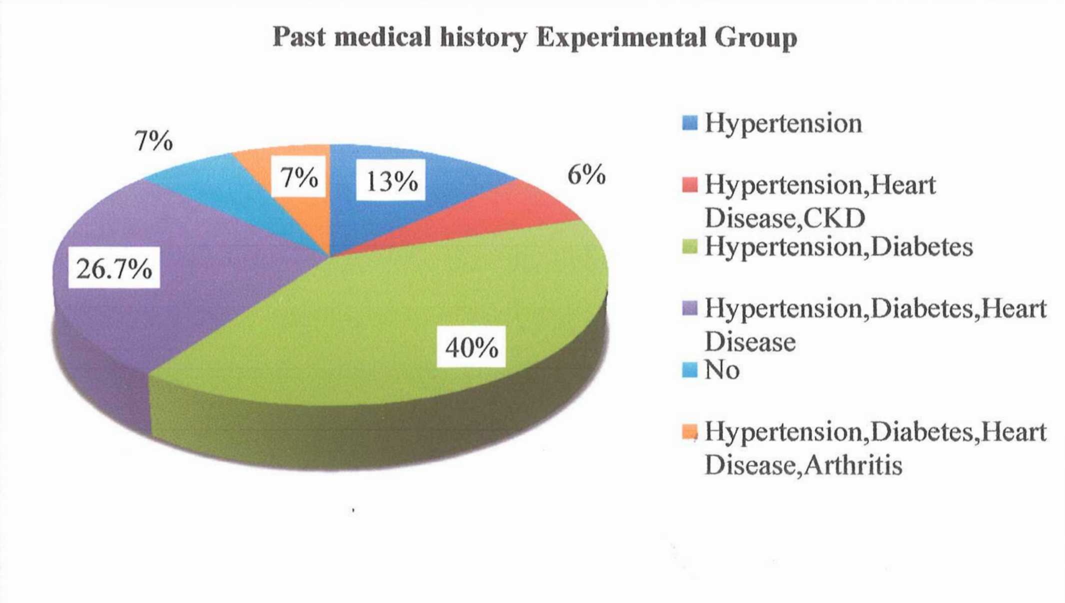


Figure-6: Living area of the participants

4.3.6 Past medical history

Among 30 participants , 13% (n=2) had been suffering from hypertension, 6% (n=1) had been suffering from hypertension with heart disease & CKD, 40% (n=6) had been suffering from hypertension with diabetes, 26.7% (n=4) had been suffering from hypertension with diabetes & heart disease, 7% (n=1) had no past medical history & 7% (n=1) had been suffering from hypertension with diabetes, heart disease & arthritis in experimental group . In control group, 26.7% (n=4) had been suffering from hypertension, 26.7% (n=4) had been suffering from hypertension with diabetes, 13.3% (n=2) had been suffering from hypertension with diabetes & heart disease, 6.7% (n=1) had no past medical history, 20% (n=3) had been suffering from hypertension with heart disease, 6.7% (n=1) had been suffering from hypertension with diabetes & heart disease. .



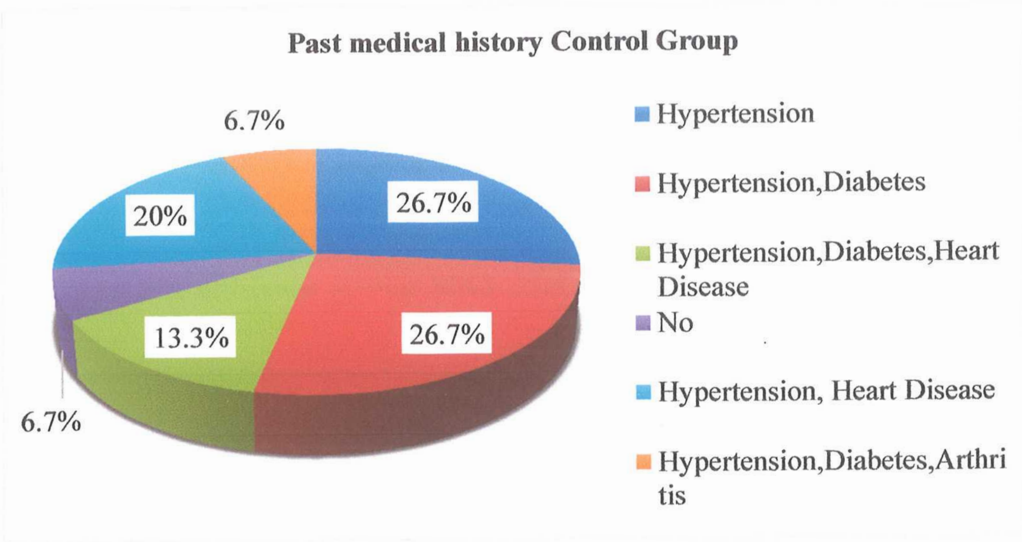


Figure-7: Past medical history of the participants

Inferential Analysis

Q. Is there any difference in Post Modified Ashworth Scale (MAS) scores between the experimental group and the control group?

1. Hypothesis

H_0 = There is no difference in Post MAS scores between the experimental and control groups

H_a = There is a difference in Post MAS scores between the experimental and control groups

2. α value α = 0.05

3. Assumption

-Data is ordinal (Non-parametric test required due to the nature of the MAS scale)

-Independent groups

- Sample size =30

4. Compute the statistics

- Mann-Whitney U test

Table 3: Mann–Whitney U test for Modified Ashworth scale control group

Variable	Category of participants	N	Mean rank	Sum of ranks	Mann-Whitney U score	P sig (2-tailed)	Comment
Post MAS	Experimental	15	15.50	232.50	112.500	1.000	Not significant
	Control	15	15.50	232.50			

The table shows that the mean ranks and sum of ranks are identical between the experimental and control groups. The Mann–Whitney U score is 112.500, with a p-value of 1.000. Since the p-value is greater than 0.05, the result is not statistically significant. Therefore, the null hypothesis is accepted and the alternative hypothesis is rejected. It can be concluded that there is no significant difference in spasticity, as measured by the Modified Ashworth Scale, between the experimental and control groups after the intervention.

Q. Is there any difference between Pre MAS and Post MAS scores using the Modified Ashworth Scale?

1. Hypothesis

H_0 = There is no difference between pre MAS and post MAS scores

H_a = There is a difference between pre MAS and post MAS scores

2. α value = 0.05

3. Assumption

-Data is ordinal and does not follow a normal distribution (non-parametric test required.

-Sample size = 30

4. Compute the statistics: -Wilcoxon Signed-Rank Test

Table-4: Wilcoxon Signed-Rank Test for Modified Ashworth Scale experimental group

Variable		**N**	**Mean rank**	**Sum of ranks**	**Test statistics (Wilcoxon signed-rank test) Based on negative ranks Z**	**Asymp. Sig (2-tailed)**	**Comment**
Pre & Post MAS	Negative rank	7	4.00	28.00	-2.428	0.015	Significant
	Positive rank	0	0.00	0.00			
	Tie	8					
	Total	15					

The Wilcoxon Signed-Rank Test was performed to evaluate differences between pre- and post-intervention Modified Ashworth Scale (MAS) scores in the experimental group. Given that the data was ordinal and non-normally distributed, a non-parametric approach was appropriate. Out of 15 participants, 7 showed negative ranks (mean rank = 4.00, sum of ranks = 28.00), indicating a decrease in scores, while no positive ranks were observed, and 8 cases were ties. The test yielded a Z value of -2.428 with a p-value of 0.015, which is below the 0.05 significance threshold. This result indicates a statistically significant reduction in spasticity following the intervention.

Table-5: Wilcoxon Signed-Rank Test for Modified Ashworth Scale Control group

Variable		**N**	**Mean rank**	**Sum of ranks**	**Test statistics (Wilcoxon signed-rank test) Based on negative ranks Z**	**Asymp. Sig (2-tailed)**	**Comment**
Pre & Post MAS	Negative rank	5	3.00	15.00	-2.070	0.038	Significant
	Positive rank	0	0.00	0.00			
	Tie	10					
	Total	15					

The Wilcoxon Signed-Rank Test for the control group showed a significant reduction in MAS scores (Z = -2.070, p = 0.038), with 5 negative ranks and 10 ties, indicating decreased spasticity.

Q. Is there any significant difference in SPADI (Shoulder Pain and Disability Index) scores among experimental and control groups before & after intervention?

1. Hypothesis

H_0 = There is no difference in SPADI (Shoulder Pain and Disability Index) scores among experimental and control groups before & after intervention

H_a = There is a difference in SPADI (Shoulder Pain and Disability Index) scores among experimental and control groups before & after intervention

2. α value = 0.05

3. Assumption

-The data is normally distributed (Normal curve on histogram), so parametric test is used.

-Sample size=30

-Parametric test applicable: Paired t-test used

4. Compute the statistics

-Paired t-test applied for both experimental and control groups

Table-6: Paired t-test for Shoulder pain & disability index (within group analysis):

Variables	**Experimental**			**Comment**	**Control**			**Comment**
	Observed t value	**df**	**Sig (P value)**	significant	**Observed t value**	**df**	**P value**	Significant
Total pain score	9.598	14	0.000		18.657	14	0.000	

Total disability score	3.237	14	0.006	Significant	2.875	14	0.12	Not significant

The total pain score shows statistically significant improvement in both the experimental group ($t = 9.598$, $p = 0.000$) and the control group ($t = 18.657$, $p = 0.000$). Since the p-values are less than 0.05, both results are significant and suggest reduced pain post-intervention. However, for the total disability score, while the experimental group shows a significant change ($t = 3.237$, $p = 0.006$), the control group does not show statistical significance ($t = 2.875$, $p = 0.120$). Since $p > 0.05$ in the control group, the null hypothesis is accepted here.

The intervention significantly reduced both pain and disability in the experimental group. In contrast, the control group showed improvement in pain only, not in disability. This indicates the experimental treatment was more effective in addressing both pain and functional disability.

Q. Is there any significant difference in post-intervention Shoulder Pain and Disability Index (SPADI) scores between the experimental & control group?

1. Hypothesis

H_0 = There is no significant difference in total pain score and total disability score between the experimental & control group

H_a = There is a significant difference in total pain score and/or total disability score between the experimental & control group

2. α value = 0.05

3. Assumption

-The data is continuous and normally distributed (Normal curve on histogram).

- Randomization of data

-Sample size=30

4. Compute the statistics

-Independent t-test

Table 7: Independent t-test for Shoulder pain & disability index scale

Variable	Experimental post test mean	Control Post test mean	Observed t value	df	Sig (P value)	Comment
Post Total pain score	11.40	5.47	1.578	28	0.127	Not significant
Post Total disability score	51.47	53.27	-0.158	28	0.876	Not significant

The independent t-test results showed no significant differences in post-intervention SPADI scores between the experimental and control groups. For total pain score, the difference was not significant ($t = 1.578$, $p = 0.127$), and for total disability score, the result was also not significant ($t = -0.158$, $p = 0.876$). This indicates that the intervention did not produce a statistically significant change in either pain or disability levels between the groups.

Q. Is there any significant improvement in shoulder range of motion (ROM) control group after intervention?

1. Hypothesis

H_0 = There is no significant difference in pre- and post-ROM scores control group

H_a = There is a significant difference in pre- and post-ROM scores control group

2. α value = 0.05

3. Assumption

-Data is not normally distributed (Normal curve on histogram).

-Sample size = 30

-Test used = Wilcoxon Signed-Rank Test

4. Computed Statistics

Table 8: Wilcoxon Signed-Rank Test for AROM & PROM for the control group

Variable		**N**	**Mean rank**	**Sum of ranks**	**Test statistics (Wilcoxon signed-rank test) Based on negative ranks Z**	**Asymp. Sig (2-tailed)**	**Comment**
Pre & Post Shoulder flexion AROM	Negative rank	0	0.00	0.00	-2.670	0.008	Significant
	Positive rank	9	5.00	45.00			
	Tie	6					
	Total	15					
Pre & Post Shoulder extension AROM	Negative rank	0	0.00	0.00	-2.023	0.043	Significant
	Positive rank	5	3.00	15.00			
	Tie	10					
	Total	15					
Pre & Post	Negative rank	0	0.00	0.00	-2.805	0.005	Significant

Shoulder abduction AROM	Positive rank	10	5.50	55.00			
	Tie	5					
	Total	15					
Pre & Post Shoulder lateral rotation AROM	Negative rank	0	0.00	0.00	-1.000	0.027	Significant
	Positive rank	6	5.50	21.00			
	Tie	9					
	Total	15					
Pre & Post Shoulder medial rotation AROM	Negative rank	0	0.00	0.00	-2.207	0.180	Not Significant
	Positive rank	2	5.00	3.00			
	Tie	13					
	Total	15					
Pre & Post Shoulder flexion PROM	Negative rank	1	5.00	5.00	-0.674	0.500	Not Significant
	Positive rank	4	2.50	10.00			
	Tie	10					
	Total	15					
Pre & Post Shoulder extension PROM	Negative rank	0	0.00	0.00	-1.814	0.066	Not Significant
	Positive rank	4	2.50	10.00			
	Tie	11					
	Total	15					
Pre & Post Shoulder abduction PROM	Negative rank	0	0.00	0.00	-1.826	0.068	Not Significant
	Positive rank	4	2.50	10.00			
	Tie	11					
	Total	15					
Pre & Post Shoulder lateral rotation PROM	Negative rank	0	0.00	0.00	-1.826	0.068	Not Significant
	Positive rank	4	2.50	10.00			
	Tie	11					
	Total	15					
Pre & Post	Negative rank	0	0.00	0.00	-1.604	0.109	Not Significant

Shoulder medial rotation PROM	Positive rank	3	2.00	6.00			
	Tie	12					
	Total	15					

The Wilcoxon Signed-Rank Test for the control group showed mixed results across different shoulder ROM measures. Significant improvements were observed in shoulder flexion AROM ($Z = -2.670$, $p = 0.008$), shoulder extension AROM ($Z = -2.023$, $p = 0.043$), shoulder abduction AROM ($Z = -2.805$, $p = 0.005$), and shoulder lateral rotation AROM ($Z = -1.000$, $p = 0.027$). Other ROM parameters, including shoulder extension PROM, abduction PROM, lateral rotation PROM, medial rotation AROM, flexion PROM, and medial rotation PROM, did not show significant changes ($p > 0.05$). This indicates selective improvements in certain active movements post-intervention.

Q. Is there any significant improvement in shoulder range of motion (ROM) experimental group after intervention?

1. Hypothesis

H_0 = There is no significant difference in pre- and post-ROM scores experimental group

H_a = There is a significant difference in pre- and post-ROM scores experimental group

2. α value = 0.05

3. Assumption

-Data is not normally distributed (Normal curve on histogram).

-Sample size = 30

-Test used = Wilcoxon Signed-Rank Test

4. Computed Statistics

Table 9: Wilcoxon Signed-Rank Test for AROM & PROM for the experimental group

Variable		N	Mean rank	Sum of ranks	Test statistics (Wilcoxon signed-rank test) Based on negative ranks Z	Asymp. Sig (2-tailed)	Comment
Pre & Post Shoulder flexion AROM	Negative rank	0	0.00	0.00	-2.809	0.000	Significant
	Positive rank	10	5.50	190.00			
	Tie	5					
	Total	15					
Pre & Post Shoulder extension AROM	Negative rank	0	0.00	0.00	-2.214	0.003	Significant
	Positive rank	6	3.50	66.00			
	Tie	9					
	Total	15					

Pre & Post Shoulder abduction AROM	Negative rank	0	0.00	0.00	-2.937	0.000	Significant
	Positive rank	11	6.00	231.00			
	Tie	4					
	Total	15					
Pre & Post Shoulder lateral rotation AROM	Negative rank	0	0.00	0.00	-2.366	0.001	Significant
	Positive rank	7	4.00	91.00			
	Tie	8					
	Total	15					
Pre & Post Shoulder medial rotation AROM	Negative rank	0	0.00	0.00	-2.366	0.008	Significant
	Positive rank	7	4.00	45.00			
	Tie	8					
	Total	15					
Pre & Post Shoulder flexion PROM	Negative rank	0	0.00	0.00	-2.533	0.011	Significant
	Positive rank	8	4.50	36.00			
	Tie	7					
	Total	15					
Pre & Post Shoulder extension PROM	Negative rank	0	0.00	0.00	-2.214	0.027	Significant
	Positive rank	6	3.50	21.00			
	Tie	9					
	Total	15					
Pre & Post Shoulder abduction PROM	Negative rank	0	0.00	0.00	-2.388	0.017	Significant
	Positive rank	7	4.00	28.00			
	Tie	8					
	Total	15					
Pre & Post Shoulder lateral rotation PROM	Negative rank	0	0.00	0.00	-2.366	0.018	Significant
	Positive rank	7	4.00	28.00			
	Tie	8					
	Total	15					
Pre & Post Shoulder	Negative rank	0	0.00	0.00	-1.342	0.180	Not Significant

medial rotation PROM	Positive rank	2	1.50	3.00			
	Tie	13					
	Total	15					

The Wilcoxon Signed-Rank Test for the experimental group revealed significant improvements in most shoulder ROM measures post-intervention. For AROM, all assessed movement demonstrated significant improvement: flexion ($Z = -2.809$, $p = 0.000$), extension ($Z = -2.214$, $p = 0.003$), abduction ($Z = -2.937$, $p = 0.000$), lateral rotation ($Z = -2.366$, $p = 0.001$), and medial rotation ($Z = -2.366$, $p = 0.008$). PROM measures showed significant gains in flexion ($Z = -2.533$, $p = 0.011$), extension ($Z = -2.214$, $p = 0.027$), abduction ($Z = -2.388$, $p = 0.017$), and lateral rotation ($Z = -2.366$, $p = 0.018$), while medial rotation PROM was not significant ($p = 0.180$).

This indicates that the intervention was effective in enhancing both active and passive ROM in most movements for the experimental group.

Q. Is there any difference in Post Shoulder ROM (AROM and PROM) between Experimental and Control group?

1. Hypothesis

H_0 = There is no difference in post shoulder ROM between experimental and control group.

H_a = There is a difference in post shoulder ROM between experimental and control group.

2. α value

α = 0.05

3. Assumption

-Data is not normally distributed (Normal curve on histogram), so a non-parametric test (Mann-Whitney U test) is used.

-Two independent groups (Experimental and Control)

-Sample size = 30

4. Compute the statistics

-Mann-Whitney U test

Table 8: Mann-whitney U test for ROM

Variable	Category of participants	N	Mean rank	Sum of ranks	Mann-Whitney U score	P sig (2-tailed)	Comment
Post Shoulder flexion AROM	Experimental	15	15.50	232.50	112.500	1.000	Not significant
	Control	15	15.50	232.50			
Post Shoulder extension AROM	Experimental	15	15.83	237.50	107.500	0.823	Not significant
	Control	15	15.17	227.50			
	Experimental	15	16.90	253.50	91.500	0.375	

Post Shoulder abduction AROM	Control	15	14.10	211.50			Not significant
Post shoulder lateral rotation AROM	Experimental	15	15.63	234.50	110.500	0.930	Not significant
	Control	15	15.37	230.50			
Post shoulder medial rotation AROM	Experimental	15	16.07	241.00	104.000	0.700	Not significant
	Control	15	14.93	224.00			
Post shoulder flexion PROM	Experimental	15	14.23	213.50	93.500	0.288	Not significant
	Control	15	16.43	251.50			
Post shoulder extension PROM	Experimental	15	14.57	218.50	98.500	0.326	Not significant
	Control	15	16.43	246.50			
Post shoulder abduction PROM	Experimental	15	13.87	208.00	88.000	0.170	Not significant
	Control	15	17.13	257.00			
Post shoulder	Experimental	15	13.73	206.00	86.000	0.158	Not significant

lateral rotation PROM	Control	15	17.27	259.00			
Post shoulder medial rotation PROM	Experimental	15	15.47	232.00	112.000	0.962	Not significant
	Control	15	15.53	233.00			

All the post-intervention AROM and PROM comparisons between experimental and control groups showed no statistically significant difference ($p > 0.05$). Therefore, the null hypothesis is accepted, indicating that the intervention did not produce a statistically significant difference in range of motion outcomes when compared to the control group.

Chapter-v	Discussion

5.1 Discussion

This study aimed to evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) in the management of hemiplegic shoulder pain among stroke patients. A total of 30 stroke patients with hemiplegic shoulder pain participated, randomized into an experimental group received TENS with conventional physiotherapy and a control group received only conventional physiotherapy. The findings indicate that TENS in combination with physiotherapy significantly reduces pain levels and improves functional ability, though some measures—particularly spasticity reduction and range of motion—did not show additional benefits over conventional physiotherapy alone. These results are consistent with prior research, but they also point to important areas for further investigation, particularly regarding long-term effects and comparison with other modalities.

Baseline characteristics, including age, gender distribution, type of stroke, and affected side, were comparable between groups. The mean age was 51.2 years (SD ±10.6), predominantly male participants (experimental group 93.3%, control group 80%). This is consistent with findings by Badaru (2020), who reported a mean age of 56 ± 9.26 years and a male predominance of 60% in their study on TENS efficacy in HSP management. In our study, the experimental group comprised 93.3% male participants, which is consistent with findings from Chuang et al. (2017), where 66% of the participants were male. This demographic similarity enhances the generalizability of our findings. The predominance of males in this study does not present a limitation, as it reflects the demographic profile of stroke patients in general, making the findings externally valid for this population.

In terms of the affected side, 60% of participants in this study had left-sided hemiplegia and 40% had right-sided hemiplegia. Waller and Whitall (2005) found that patients with left hemispheric strokes demonstrated better functional improvements, particularly in bilateral arm training, compared to right hemispheric stroke patients. This distribution is also comparable to the study by Chuang et al. (2017), which reported a similar prevalence of left-sided hemiplegia. The predominance of left-sided hemiplegia may be attributed to the higher incidence of right hemisphere strokes, which often result in left-sided motor deficits. The demographic distribution in this study strengthens the applicability of the findings to a wider population of stroke patients. The incidence of ischemic stroke (100% of the study sample) aligns with broader epidemiological data showing that ischemic strokes account for approximately 80% of all stroke cases globally (Hankey, 2013). Additionally, a significant portion of participants (53.3%) had comorbid hypertension, and 40% had diabetes. This is consistent with findings from Ergul et al., (2016), which demonstrated a high prevalence of hypertension and diabetes in stroke patients, highlighting the importance of addressing these comorbid conditions during stroke rehabilitation.

The study's primary outcome measures included the Shoulder Pain and Disability Index (SPADI) to assess pain and functional disability, the Modified Ashworth Scale (MAS) for spasticity, and goniometric measures for shoulder range of motion (ROM). The intervention period spanned 16 sessions, following which outcomes were reassessed and compared within and between groups.

The primary outcomes of the study were pain reduction and functional improvement, which were measured using the Shoulder Pain and Disability Index (SPADI). The results indicated that both the experimental and control groups showed significant reductions in pain scores ($p < 0.001$). However, the experimental group, which received TENS combined with conventional physiotherapy, demonstrated a significantly greater improvement in disability scores ($p = 0.006$), suggesting that TENS provides additional functional benefits compared to physiotherapy alone. This finding is consistent with studies by Chuang et al. (2017) and Lai et al. (2009), who noted that TENS can significantly reduce pain in stroke patients. TENS works by providing electrical impulses that interfere with pain signals, thereby reducing the perception of pain (Chuang et al., 2017). Additionally, the pain relief facilitated by TENS likely contributed to the improvement in functional outcomes. The SPADI score, which reflects both pain intensity and disability, showed more significant functional gains in the TENS group, reinforcing the idea that pain management plays a critical role in enhancing rehabilitation outcomes in stroke patients (Lai et al., 2009). The reduction in pain aligns indicating that TENS can modulate pain by blocking pain signals and enhancing the release of endogenous pain-relieving substances like endorphins (Chuang et al., 2017). TENS significantly reduces musculoskeletal pain in stroke patients. In their randomized controlled trial, TENS combined with conventional rehabilitation therapies provided greater pain relief than physiotherapy alone, similar to the results observed in this study. However, other studies, such as De Sire et al. (2022), have noted that while TENS effectively reduces pain in the short term, its long-term efficacy is still a subject of debate. They suggest that the effects of TENS may diminish over time, requiring further research into its sustained effectiveness. In contrast, a study by Zhou et al. (2018) on Neuromuscular Electrical Stimulation (NMES) found superior results in terms of pain reduction and functional improvement compared to TENS. NMES, which stimulates deeper muscle layers, can alleviate both pain and muscle spasticity more effectively. This highlights a potential area of improvement for future research, where TENS could be compared directly with NMES to assess which modality provides more sustained pain relief and improved functional outcomes in HSP patients. A meta-analysis by De Sire et al. (2022), which found that TENS combined with physical rehabilitation improves functional outcomes in stroke patients. They noted that TENS plays a crucial role in reducing pain and enhancing patient motivation to participate in therapy. The findings in this study's conclusions, suggesting that TENS may facilitate rehabilitation by alleviating pain, thus allowing stroke patients to engage more effectively in physical exercises that improve motor function. A study by Chung et al. (2021) compared TENS to robot-assisted rehabilitation in post-stroke patients and found that the robot-assisted approach led to more significant improvements in motor function. This suggests that although TENS is an effective adjunct for pain management, it might not be as effective as other advanced therapies in promoting functional recovery.

A significant finding was observed in the Modified Ashworth Scale (MAS) scores when comparing pre- and post-intervention scores within groups using the Wilcoxon Signed-Rank Test ($p = 0.002$), indicating a significant reduction in spasticity. However, between-group analysis using the Mann–Whitney U test revealed no significant difference post-intervention ($p = 1.000$), suggesting that while both groups improved, TENS did not offer a statistically superior effect on muscle tone compared to conventional therapy alone. The limited effect of TENS on spasticity is consistent with findings from Pan et al. (2022), who suggested that TENS is more effective for short-term pain relief than for addressing spasticity or muscle tone abnormalities. The lack of significant findings regarding spasticity reduction aligns with Pan et al. (2022), who found that while TENS can reduce spasticity in the short term, its effects are often transient. Their study concluded that NMES or more invasive treatments like suprascapular nerve block (SSNB) are more effective for managing spasticity in stroke patients. This contrasts with our findings, which suggest that TENS may not significantly impact muscle tone in the long term. A study by Zhou et al. (2018) explored the effects of NMES on spasticity and found that NMES reduced spasticity more significantly than TENS. This suggests that NMES might be a more appropriate intervention for patients with persistent spasticity, while TENS could be considered as an adjunct treatment for pain relief. Additionally, SSNB has shown greater long-term efficacy in controlling shoulder pain and spasticity in stroke patients compared to TENS (Ersoy et al., 2023).

Assessments of AROM and PROM revealed statistically significant improvements in all directions within both groups ($p < 0.05$). Shoulder active and passive ROM improved significantly within both groups across all measured movements (flexion, extension, abduction, lateral and medial rotation). However, between-group comparisons did not yield significant differences, indicating that while both interventions were effective in enhancing shoulder mobility, TENS did not offer additional benefits over conventional therapy alone. This finding aligns with research by Ada et al. (2006), who reported improvements in ROM due to physiotherapy interventions, particularly stretching and strengthening exercises. However, TENS did not significantly alter ROM beyond the benefits provided by physiotherapy alone. The absence of significant improvement with TENS may be attributed to the fact that ROM improvements are often more dependent on physical therapy techniques than on electrotherapy alone. Additionally, studies by Chuang et al. (2017) and Zhou et al. (2018) found that while TENS can provide short-term pain relief, it does not substantially influence joint mobility when compared to other rehabilitation techniques. This supports the conclusion that TENS may not be the most effective modality for improving ROM, and its benefits may be more evident in pain reduction and functional recovery rather than in improving joint mobility. The findings from this study suggest that TENS, when combined with conventional physiotherapy, significantly improves pain relief and functional recovery in stroke patients with hemiplegic shoulder pain (HSP). However, its effects on spasticity and range of motion (ROM) were not superior to conventional physiotherapy alone. These results underscore the need for a multifaceted approach to stroke rehabilitation, incorporating a combination of pain relief strategies, neuromuscular re-education, and functional training.

When comparing TENS with other modalities, such as neuromuscular electrical stimulation (NMES) and suprascapular nerve block (SSNB), studies have shown varying degrees of effectiveness. For instance, a randomized controlled trial by Zhou et al. (2018) indicated that NMES was more effective than TENS in maintaining long-term analgesia in HSP patients. Similarly, a study by Ersoy et al., (2023) found that SSNB led to a more rapid reduction in pain compared to TENS. These findings suggest that while TENS is beneficial, other modalities may offer superior outcomes in certain aspects of HSP management.

5.2 Limitations

The study has several limitations.30 stroke patients with hemiplegic shoulder pain participated in the study which had a limited sample size in both groups and did not provide enough data to generalize the findings to the larger population with this condition. Researcher only explored the effect of TENS with conventional physiotherapy after 16 sessions, so the long-term effect of treatment was not explored in this study. Data was collected one clinical setting CRP Savar, it can influence the result. Sometimes treatment sessions were interrupted due to public holiday mistaken in appointment schedule may interrupt the result. On the other hand, the clinical placement was on going, so there was a limited time duration about data collection which may also interrupt the result. The treatment period was only 16 sessions of intervention for the two groups that experimental group and control group. Other studies with longer intervention time are required for conclusive results. There was no available research done in this area in Bangladesh. So, relevant information about with TENS along with conventional physiotherapy for Bangladesh was very limited in this study. So, further research with larger samples, longer intervention periods, & follow up assessments is recommended to confirm & extend these results.

Chapter-vi Conclusion & Recommendation

6.1 Conclusion

Both the experimental and control groups demonstrated improvements across multiple outcome measures throughout the intervention. The post-intervention results of the Modified Ashworth Scale (MAS) indicated no significant difference between the groups, suggesting that both interventions produced comparable reductions in spasticity. However, within-group analysis revealed statistically significant improvements from pre to post-intervention MAS scores, underscoring the effectiveness of the treatments in reducing muscle tone. Regarding the Shoulder Pain and Disability Index (SPADI), both groups showed significant reductions in pain scores, while only the experimental group exhibited significant improvements in disability scores. This suggests that the additional treatment components applied in the experimental protocol were more effective in addressing functional limitations. Analysis of shoulder range of motion (AROM and PROM) indicated significant within-group improvements for both groups following the intervention. The experimental group demonstrated more consistent gains across both AROM and PROM measures, whereas improvements in the control group were largely restricted to AROM. Nonetheless, comparisons between the two groups post-intervention did not reveal statistically significant differences. This finding indicates that although both interventions were effective in enhancing shoulder mobility and reducing pain, neither demonstrated clear superiority in terms of overall ROM outcomes.

6.2 Recommendation

- The study period was so short, future studies will need more time to complete.
- Investigator use only 30 participants as the sample of this study, in future the sample size would be more.
- Extend the duration & frequency of the intervention to determine the cumulative impact of TENS on shoulder mobility & pain.
- Follow up must be included.
- Explore combination therapies, comparative studies between TENS, NMES, and other interventions like SSNB to assess the most effective strategies for managing HSP and improving spasticity and ROM.

- Sample should collect from different hospital, clinic, institute and organization in different district of Bangladesh to generalize the result.
- Focus on different stroke phases (acute, subacute & chronic) to understand the effectiveness of TENS across recovery stages.

Reference

Ada, L., Dorsch, S. and Canning, C.G. (2006), 'Strengthening interventions increase strength and improve activity after stroke: a systematic review', *Australian Journal of Physiotherapy,* vol.52, no.4, pp.241-248.

Adey-Wakeling, Z., Liu, E., Crotty, M., Leyden, J., Kleinig, T., Anderson, C.S. and Newbury, J. (2016), 'Hemiplegic shoulder pain reduces quality of life after acute stroke: a prospective population-based study', *American journal of physical medicine & rehabilitation*, vol.95, no.10, pp.758-763.

Alahmari, S.K., Shield, A.J. and Trajano, G.S. (2022), 'Effects of three neuromuscular electrical stimulation methods on muscle force production and neuromuscular fatigue', *Scandinavian Journal of Medicine & Science in Sports*, vol.32, no.10, pp.1456-1463.

Alanbay, E., Aras, B., Kesikburun, S., Kizilirmak, S., Yasar, E. and Tan, A.K. (2020), 'Effectiveness of suprascapular nerve pulsed radiofrequency treatment for hemiplegic shoulder pain: a randomized-controlled trial', *Pain physician*, vol.23, no.3, p.245.

Allen, C.B., Williamson, T.K., Norwood, S.M. and Gupta, A. (2023), 'Do electrical stimulation devices reduce pain and improve function? —a comparative review', *Pain and Therapy*, vol.12, no.6, pp.1339-1354.

Allida, S., Cox, K.L., Hsieh, C.F., Lang, H., House, A. and Hackett, M.L. (2020), 'Pharmacological, psychological, and non-invasive brain stimulation interventions for treating depression after stroke', *Cochrane Database of Systematic Reviews*, (1).

Ansari, N.N., Rahimi, M., Naghdi, S., Barzegar-Ganji, Z., Hasson, S. and Moghimi, E., (2022), 'Inter-and intra-rater reliability of the modified modified ashworth scale in the assessment of muscle spasticity in cerebral palsy: A preliminary study', *Journal of Pediatric Rehabilitation Medicine*, vol.15, no.1, pp.151-158.

Anwer, S. and Alghadir, A. (2020), 'Incidence, prevalence, and risk factors of hemiplegic shoulder pain: a systematic review', *International journal of environmental research and public health*, vol.17, no.14, p.4962.

Astokorki, A.H. and Mauger, A.R. (2017), 'Transcutaneous electrical nerve stimulation reduces exercise-induced perceived pain and improves endurance exercise performance', *European journal of applied physiology*, vol.117, pp.483-492.

Astra, J., Gusril, G., Bafirman, B., Syafrianto, D., Ockta, Y. and Cahyani, F.I. (2024), 'Analyzing the Role of Transcutaneous Electrical Nerve Stimulation in Sports: A Literature Perspective on Its Application and Benefits in Physiotherapy', *Jurnal Penelitian Pendidikan IPA*, vol.10(SpecialIssue), pp.76-82.

Badaru, U.M. (2020), 'Comparative Efficacy of Soft Tissue Massage and Transcutaneous Electric Nerve Stimulation in the Management of Hemiplegic Shoulder Pain', *Nigerian Journal of Physiological Sciences,* vol.35, no.2, pp.143-146.

Cai, B., Guo, H., Hu, Z. and Wang, Q. (2023), 'Transcutaneous Electrical Nerve Stimulation (TENS) In Chronic Low Back Pain Management: Principles, Applications, And Future Directions', *Highlights in Science, Engineering and Technology*, vol.74, pp.1607-1612.

Chuang, L.L., Chen, Y.L., Chen, C.C., Li, Y.C., Wong, A.M.K., Hsu, A.L. and Chang, Y.J. (2017), 'Effect of EMG-triggered neuromuscular electrical stimulation with bilateral arm training on hemiplegic shoulder pain and arm function after stroke: a randomized controlled trial', *Journal of neuroengineering and rehabilitation*, vol.14, pp.1-12.

De Sire, A., Moggio, L., Demeco, A., Fortunato, F., Spanò, R., Aiello, V., Marotta, N. and Ammendolia, A., (2022), 'Efficacy of rehabilitative techniques in reducing hemiplegic shoulder pain in stroke: Systematic review and meta-analysis', *Annals of Physical and Rehabilitation Medicine*, vol.65, no.5, p.101602.

Deleva, R., Parashkevova, P. and Seleva, S. (2023), 'Kinesitherapeutic Approaches To Overcome Hemiparetic Shoulder Pain', In *Varna Medical Forum*, Vol.12, pp. 79-85.

DeSantana, J.M., Walsh, D.M., Vance, C., Rakel, B.A. and Sluka, K.A. (2008), 'Effectiveness of transcutaneous electrical nerve stimulation for treatment of hyperalgesia and pain', *Current rheumatology reports*, vol.10, no.6, pp.492-499.

Ekim, A., Armağan, O. and Öner, C. (2008), 'Efficiency of TENS treatment in hemiplegic shoulder pain: a placebo controlled study'. *Agri*, vol.20, no.1, pp.41-46.

El Marbouh, A., Ammari, M., Hammani, T., Daimi, M., Tendart, V., Mounguengui, H. and Khalfaoui, S.E.L. (2023), 'Painful Hemiplegic Shoulder: Mechanical Factors', *SAS J Med*, vol.10, pp.1121-1124.

El-Sonbaty, H.A.E., Abou Elmaaty, A.A., Zarad, C.A. and El-Bahnasawy, A.S. (2022), 'Clinical and radiological assessment of hemiplegic shoulder pain in stroke patients', *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, vol.58, no.1, p.41.

Engebretsen, K., Grotle, M., Bautz-Holter, E., Ekeberg, O.M. and Brox, J.I. (2010), 'Determinants of the shoulder pain and disability index in patients with subacromial shoulder pain', *Journal of rehabilitation medicine*, vol.42, no.5, pp.499-505.

Ergul, A., Hafez, S., Fouda, A. and Fagan, S.C. (2016), 'Impact of comorbidities on acute injury and recovery in preclinical stroke research: focus on hypertension and diabetes', *Translational stroke research,* vol.7, pp.248-260.

Ersoy, S., Paker, N., Kesiktaş, F.N., Bugdayci, D.S., Karakaya, E. and Çetin, M. (2023), 'Comparison of transcutaneous electrical stimulation and suprascapular nerve blockage for the treatment of hemiplegic shoulder pain', *Journal of Back and Musculoskeletal Rehabilitation*, vol.36, no.3, pp.731-738.

Gibson, W., Wand, B.M. and O'Connell, N.E. (2017), 'Transcutaneous electrical nerve stimulation (TENS) for neuropathic pain in adults', *Cochrane Database of Systematic Reviews*, (9).

Gladwell, P.W., Badlan, K., Cramp, F. and Palmer, S. (2016), 'Problems, solutions, and strategies reported by users of transcutaneous electrical nerve stimulation for chronic musculoskeletal pain: qualitative exploration using patient interviews', *Physical therapy*, vol.96, no.7, pp.1039-1048.

Gousset, S., Mouraux, A. and Van Den Broeke, E.N. (2020), 'Burst-like conditioning electrical stimulation is more efficacious than continuous stimulation for inducing secondary hyperalgesia in humans'. *Journal of neurophysiology*, vol.123, no.1, pp.323-328.

Griffin, J.W. (1986), 'Hemiplegic shoulder pain', *Physical therapy*, vol.66, no.12, pp.1884-1893.

Haefeli, M. and Elfering, A. (2006), 'Pain assessment', *European spine journal,* vol.15, pp. S17-S24.

Hankey, G.J. (2013), 'The global and regional burden of stroke', *The lancet global health,* vol.1, no.5, pp. e239-e240.

Hill, R.G. (1981), 'Endogenous opioids and pain: A review', *Journal of the Royal Society of Medicine*, vol.74, no.6, pp.448-450.

Hoo, J.S., Paul, T., Chae, J. and Wilson, R.D. (2013), 'Central hypersensitivity in chronic hemiplegic shoulder pain', *American journal of physical medicine & rehabilitation*, vol.92, no.1, pp.1-13.

Ito, D., Kawakami, M., Kuwahara, W., Yamada, Y., Kondo, K. and Tsuji, T. (2023), 'Parameter mapping of hemiplegic shoulder electrical stimulation for motor function: A scoping review', *NeuroRehabilitation*, vol.53, no.1, pp.19-32.

Johnson, M.I., Paley, C.A., Jones, G., Mulvey, M.R. and Wittkopf, P.G. (2022), 'Efficacy and safety of transcutaneous electrical nerve stimulation (TENS) for acute and chronic pain in adults: a systematic review and meta-analysis of 381 studies (the meta-TENS study)', *BMJ open*, vol.12, no.2, p.e051073.

Kapitzke, D., Vetter, I. and Cabot, P.J. (2005), 'Endogenous opioid analgesia in peripheral tissues and the clinical implications for pain control', *Therapeutics and clinical risk management*, vol.1, no.4, pp.279-297.

Kerai, S., Saxena, K.N., Taneja, B. and Sehrawat, L. (2014), ‘Role of transcutaneous electrical nerve stimulation in post-operative analgesia’, *Indian journal of anaesthesia*, vol.58, no.4, pp.388-393.

Klotz, T., Borges, H.C., Monteiro, V.C., Chamlian, T.R. and Masiero, D. (2006), ‘Physiotherapy treatment in hemiplegic shoulder pain in stroke patients-Literature Review’, *Acta Fisiatrica*, vol.13, no.1, pp.12-16.

Lee, H., Kim, E., Zhu, X., Lee, J.M. and Suh, H.S. (2024), ‘Transcutaneous electrical nerve stimulation (TENS) for pain control in women with primary dysmenorrhoea’, *Cochrane Database of Systematic Reviews*, (7).

Lai, S.M., Studenski, S., Duncan, P.W. and Perera, S. (2002), ‘Persisting consequences of stroke measured by the Stroke Impact Scale’, *Stroke,* vol.33, no.7, pp.1840-1844.

Larrazet, S., Joste, R., Stefan, A., Delaubier, A., Gueyraud, A., Foucault, P., Guillou, C. and Dabbadie, T. (2016), ‘Hemiplegic shoulder pain: comparison of two sites of intramuscular injections of botulinum toxin type A,“epautox” study’, *Annals of Physical and Rehabilitation Medicine*, vol.59, p.e72.

Leandri, M., Parodi, C.I., Corrieri, N. and Rigardo, S. (1990), ‘Comparison of TENS treatments in hemiplegic shoulder pain’, *Scandinavian journal of rehabilitation medicine*, vol.22, no.2, pp.69-71.

Li, Y., Yang, S., Cui, L., Bao, Y., Gu, L., Pan, H., Wang, J. and Xie, Q. (2023), ‘Prevalence, risk factor and outcome in middle-aged and elderly population affected by hemiplegic shoulder pain: An observational study’, *Frontiers in Neurology*, vol.13, p.1041263.

Li, Z. and Alexander, S.A. (2015). ‘Current evidence in the management of poststroke hemiplegic shoulder pain: a review’. *Journal Of Neuroscience Nursing*, vol.47, no.1, pp.10-19.

Mahayati, D. and Ryanto, A. (2024), ‘The Hemiplegic Shoulder Pain: A Descriptive Study’, *FISIO MU: Physiotherapy Evidences*, vol.5, no.2, pp.169-174.

Mann, C.J. (2003), ‘Observational research methods. Research design II: cohort, cross sectional, and case-control studies’. *Emergency medicine journal,* 20(1), pp.54-60.

Manning, A., Ortega, R.G., Moir, L., Edwards, T., Aziz, T.Z., Bojanic, S., Green, A.L. and Fitzgerald, J.J. (2019), ‘Burst or conventional peripheral nerve field stimulation for treatment of neuropathic facial pain’, *Neuromodulation: Technology at the Neural Interface*, vol.22, no.5, pp.645-652.

Mendell, L.M. (2014), ‘Constructing and deconstructing the gate theory of pain’, *Pain®*, vol.155, no.2, pp.210-216.

Montoya, D., Barria, P., Cifuentes, C.A., Aycardi, L.F., Morís, A., Aguilar, R., Azorín, J.M. and Múnera, M. (2022), ‘Biomechanical assessment of post-stroke patients’ upper limb before and after rehabilitation therapy based on FES and VR’, *Sensors*, vol.22, no.7, p.2693.

Moyya, P.D., Bindu, K.H., Kumar, N.K., Reddy, S.V., Manikanta, G. and Rahul, S.G. (2024), ‘Design of Transcutaneous Electrical Nerve Stimulator Machine for Chronic Low Back Pain’. In *2024 5th International Conference on Circuits, Control, Communication and Computing (I4C)* (pp. 7-12). IEEE.

Mulla, S.M., Wang, L., Khokhar, R., Izhar, Z., Agarwal, A., Couban, R., Buckley, D.N., Moulin, D.E., Panju, A., Makosso-Kallyth, S. and Turan, A. (2015), ‘Management of central poststroke pain: systematic review of randomized controlled trials’, *Stroke*, vol.46, no.10, pp.2853-2860.

Paillard, T. (2022), ‘Neuromuscular or sensory electrical stimulation for reconditioning motor output and postural balance in older subjects?’, *Frontiers in Physiology*, vol.12, p.779249.

Pan, J.X., Diao, Y.X., Peng, H.Y., Wang, X.Z., Liao, L.R., Wang, M.Y., Wen, Y.L., Jia, Y.B. and Liu, H. (2022), ‘Effects of repetitive peripheral magnetic stimulation on spasticity evaluated with modified Ashworth scale/Ashworth scale in patients with spastic paralysis: A systematic review and meta-analysis’, *Frontiers in Neurology*, vol.13, p.997913.

Parati, M., Gallotta, M., De Maria, B., Pirola, A., Morini, M., Longoni, L., Ambrosini, E., Ferriero, G. and Ferrante, S. (2023), 'Video-based goniometer applications for measuring knee joint angles during walking in neurological patients: A validity, reliability and usability study', *Sensors*, vol.23, no.4, p.2232.

Price, C.I., Pandyan, A.D. and Cochrane Stroke Group. (1996), 'Electrical stimulation for preventing and treating post-stroke shoulder pain', *Cochrane Database of Systematic Reviews*, vol.2010, no.1.

Rashid, H., Javed, A., Jadoon, I.J., Masood, P., Javed, N., Sarwar, P., Babar, S. and Shafique, K. (2024), 'Tendency of Hemiplegic Shoulder Pain and Its Association with Activities of Daily Living Limitations in Stroke Population', *Journal of Health and Rehabilitation Research*, vol.4, no.2, pp.1342-1347.

Rismayanti, R., Hutabarat, H.A. and Alpiah, D.N. (2024), 'Effectiveness of Trancutaneus Electrical Nerce Stimulation on Frozen Shoulder (TENS): Literatur Review', *International Journal of Social Research*, vol.2, no.2, pp.87-92.

Roach, K.E., Budiman-Mak, E., Songsiridej, N. and Lertratanakul, Y. (1991), 'Development of a shoulder pain and disability index', *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*, vol.4, no.4, pp.143-149.

Roy, J.S., MacDermid, J.C. and Woodhouse, L.J. (2009), 'Measuring shoulder function: a systematic review of four questionnaires', *Arthritis Care & Research: Official Journal of the American College of Rheumatology*, vol.61, no.5, pp.623-632.

Shao, C., Wang, Y., Gou, H., Xiao, H. and Chen, T. (2023), 'Strength training of the nonhemiplegic side promotes motor function recovery in patients with stroke: a randomized controlled trial', *Archives of Physical Medicine and Rehabilitation*, vol.104, no.2, pp.188-194.

Sluka, K.A., Bjordal, J.M., Marchand, S. and Rakel, B.A. (2013), 'What makes transcutaneous electrical nerve stimulation work? Making sense of the mixed results in the clinical literature', *Physical therapy*, vol.93, no.10, pp.1397-1402.

Tavares, I. and Lima, D. (2007), 'From neuroanatomy to gene therapy: searching for new ways to manipulate the supraspinal endogenous pain modulatory system', *Journal of anatomy*, vol.211, no.2, pp.261-268.

Toopchizadeh, V., Izadseresht, B., Eftekharsadat, B., Salehi-Pourmehr, H. and Dolati, S. (2024), 'Effectiveness of transcutaneous electrical nerve stimulation (TENS) modality for treating myofascial pain syndrome: A systematic review and meta-analysis', *Journal of Research in Clinical Medicine*, vol.12, no.1, pp.14-14.

Vance, C.G., Dailey, D.L., Chimenti, R.L., Van Gorp, B.J., Crofford, L.J. and Sluka, K.A. (2022), 'Using TENS for pain control: update on the state of the evidence', *Medicina*, vol.58, no.10, p.1332.

Wahyono, E., Ramadhan, G.F. and Alpiah, D.N. (2024), 'Effectiveness of Use of Transcutaneous Electrical Nerve Stimulation (Tens) Modality To Reduce Pain In The Lower Back: Literature Review', *International Journal of Social Research*, vol.2, no.4, pp.169-177.

Waller, S.M. and Whitall, J. (2005), 'Hand dominance and side of stroke affect rehabilitation in chronic stroke', *Clinical rehabilitation*, vol.19, no.5, pp.544-551.

Walsh, M., Ashford, S., Rose, H., Alfonso, E., Steed, A. and Turner-Stokes, L. (2022), 'Stratified management of hemiplegic shoulder pain using an integrated care pathway: an 18-year clinical cohort analysis', *Disability and Rehabilitation*, vol.44, no.20, pp.5909-5918.

Whitehair, V.C., Chae, J., Hisel, T. and Wilson, R.D. (2019), 'The effect of electrical stimulation on impairment of the painful post-stroke shoulder', *Topics in stroke rehabilitation*, vol.26, no.7, pp.544-547.

Yoo, M., Ahn, J.H., Rha, D.W. and Park, E.S. (2022), 'Reliability of the modified Ashworth and modified Tardieu scales with standardized movement speeds in children with spastic cerebral palsy', *Children*, vol.9, no.6, p.827.

Zhan, J., Luo, Y., Mao, W., Zhu, L., Xu, F., Wang, Y., Chen, H. and Zhan, L. (2023), 'Efficacy of acupuncture versus rehabilitation therapy on post-stroke shoulder pain: A systematic review and meta-analysis of randomized controlled trials.', *Medicine,* vol.102, no.29, p. e34266.

Zhan, J., Wei, X., Tao, C., Yan, X., Zhang, P., Chen, R., Dong, Y., Chen, H., Liu, J. and Lu, L. (2022), 'Effectiveness of acupuncture combined with rehabilitation training vs. rehabilitation training alone for post-stroke shoulder pain: a systematic review and meta-analysis of randomized controlled trials', *Frontiers in Medicine*, vol.9, p.947285.

Zhou, M., Li, F., Lu, W., Wu, J. and Pei, S. (2018), 'Efficiency of neuromuscular electrical stimulation and transcutaneous nerve stimulation on hemiplegic shoulder pain: a randomized controlled trial', *Archives of physical medicine and rehabilitation*, vol.99, no.9,pp.1730-1739.

Appendix-1

বাংলাদেশ হেলথ্ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

Ref: CRP-BHPI/IRB/12/2024/1016 Date: 15 /11/2024

To
Nirjona Rohman Srabonty
4th Year B.Sc. in Physiotherapy
Session: 2019-2020, Student ID: 112190492
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal "Effectiveness of Transcutaneous Electrical Nerve Stimulation in the Management of patients with Hemiplegic Shoulder Pain" by ethics committee.

Dear Nirjona Rohman Srabonty,
Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above mentioned dissertation, with yourself, as the principal investigator and Asma Islam, Associate Professor, Department of Physiotherapy, BHPI as thesis supervisor. The Following documents have been reviewed and approved:

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

The purpose of the study is to evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation in the Management of patients with Hemiplegic Shoulder Pain. The study involves use of a Numerical pain rating scale, Modified Ashworth Scale, Goniometer, Action research arm test measurement tools to explore the effectiveness of TENS of hemiplegic shoulder pain patients that may take 20 to 30 minutes to participate in the test. Any instruction or precaution for collection of specimen and there is no likelihood of any harm to the participants. The members of the Ethics committee have approved the study to be conducted in the presented form at the meeting held at **9 AM on 15 July, 2024 at BHPI (44th IRB Meeting).**

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

Best regards,

Muhammad Millat Hossain,
Associate Professor & Course Coordinator, MRS
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

সিআরপি-চাপাইন, সাভার, ঢাকা-১৩৪৩, বাংলাদেশ। ফোন: +৮৮ ০২ ২২৪৪৪৫৪৬৪-৫, +৮৮ ০২ ২২৪৪৪১৪০৪, মোবাইল: +৮৮ ০১৭৩০ ০৫৯৬৪৭
CRP-Chapain, Savar, Dhaka-1343, Bangladesh. Tel: +88 02 224445464-5, +88 02 224441404, Mobile: +88 01730059647
E-mail : principal-bhpi@crp-bangladesh.org, Web: bhpi.edu.bd

Appendix-2

24th December, 2024

Head

Department of Physiotherapy

Centre for the Rehabilitation of the Paralysed (CRP)

Chapain,Savar,Dhaka-1343

Through: Head, Department of Physiotherapy, BHPI.

Subject: Prayer for seeking permission to collect data for conducting research project.

Sir,

With due to respect and humble submission to state that I am Nirjona Rohman Srabonty, a student of 4th year B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my research project entitled: **"Effectiveness of Transcutaneous Electrical Nerve Stimulation in the management of patients with Hemiplegic Shoulder Pain"** under the supervision of Asma Islam, Associate Professor, Department of Physiotherapy, BHPI.I want to collect data for my research project from the Department of Physiotherapy at CRP. So, I need permission for data collection from the NeurologyUnit of Physiotherapy Department at CRP- Savar, Dhaka-1343. I would like to assure that anything of the study will not be harmful for the participants and the Department itself.

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

Nirjona

Yours faithfully,

Nirjona Rohman Srabonty

4th Year B.Sc. in Physiotherapy

Class Roll: 09; Session: 2019-2020

Bangladesh Health Professions Institute (BHPI)

(An academic Institution of CRP)

CRP-Chapain, Savar, Dhaka-1343.

Forewarded to HOD(PT, BHPI)
Asma Islam
28/12/2024

Forwarded and Recommended for your kind approval
28.12.2024
Dr. Shazal Kumar Das, PhD
Assistant Professor and Head
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343.

Approved
31/12/24
Prof. Dr. Mohammad Anwar Hossain, PhD
Professor Physiotherapy Department BHPI
Senior Consultant & Head
Physiotherapy Department
CRP, Savar, Dhaka-1343

Appendix-3

অনুমতি পত্র

(অংশগ্রহণকারীকে পড়ার জন্য অনুরোধ করা হলো)

আসসালামু আলাইকুম,

আমি নির্জনা রহমান শ্রাবন্তী, ঢাকা বিশ্ববিদ্যালয় এর চিকিৎসা অনুষদের অন্তর্ভুক্ত বাংলাদেশ হেলথ প্রফেশন্স ইন্সটিটিউট এর বিএসসি ইন ফিজিওথেরাপি কোর্সের ২০১৯ -২০২০ সেশনের শিক্ষার্থী। বিএসসি ইন ফিজিওথেরাপি। ডিগ্রী অর্জনের জন্য আমাকে একটি গবেষণা সম্পূর্ণ করতে হবে। আমার গবেষণার শিরোনাম হল "হেমিপ্লেজিক কাঁধে ব্যথার রোগীদের উপর ট্রান্সকিউটেনিয়াস বৈদ্যুতিক স্নায়ু উদ্দীপনার কার্যকারিতা" । এই অধ্যয়নের উদ্দেশ্য হেমিপ্লেজিক কাঁধের ব্যথার জন্য ট্রান্সকিউটেনিয়াস ইলেকট্রিকাল নার্ভ স্টিমুলেশনের কার্যকারিতা মূল্যায়ন করা। এই থিসিস সম্পর্কে আপনাকে কিছু প্রশ্ন জিজ্ঞাসা করার জন্য, আমি আপনার সাথে দুবার দেখা করব: একবার চিকিৎসার আগে এবং চিকিৎসার পরে । আমি আপনাকে আশ্বস্ত করছি যে আপনার দেওয়া চিকিৎসার ফলে কোনো ক্ষতি হবে না। এছাড়া ফিজিওথেরাপিস্টরা চিকিৎসা দেবেন। এতে আনুমানিক ৩০ থেকে ৪০ মিনিট সময় লাগবে। আমি আপনাকে অনুগত করছি যে, এটা আমার অধ্যয়নের একটি অংশ যা অন্য কোন উদ্দেশ্যে ব্যবহৃত হবে না। তাই এই গবেষণায় অংশগ্রহণ আপনার বর্তমান ও ভবিষ্যতের চিকিৎসায় কোন প্রভাব ফেলবে না। আপনি যে তথ্য প্রদান করবেন তার গোপনীয়তা বজায় থাকবে। এই গবেষণায় আপনার অংশগ্রহণ স্বেচ্ছায় এবং কোন নেতিবাচক প্রভাব ছাড়াই আপনি যে কোন সময় এই অধ্যয়ন থেকে নিজেকে প্রত্যাহার করে নিতে পারবেন। এছাড়াও কোন প্রশ্ন আপনার পছন্দ না হলে উত্তর না দেওয়ার বা সাক্ষাৎকারের সময় কোন উত্তর না দিতে চাওয়ার অধিকার আপনার আছে। এই অধ্যয়নে অংশগ্রহণকারী হিসেবে আপনার কোন প্রশ্ন থাকলে আপনি আমার সাথে অথবা আমার সুপারভাইজার আসমা ইসলাম,সহযোগী অধ্যাপক, ফিজিওথেরাপি ডিপার্টমেন্ট, বিএইচপিআই, সি আর পি সাভার, ঢাকা এর সাথে যোগাযোগ করতে পারেন।আপনি যদি অনুগ্রহপূর্বক আপনার সম্মতি দেন, তবে আমরা শুরু করতে পারি?

হ্যাঁ ☐ না ☐

ধন্যবাদ আপনার অংশগ্রহণের পাশপাশি প্রশ্নগুলোর যথাযথ উত্তর দিয়ে সহযোগিতা করার জন্য।

অংশগ্রহণকারীর স্বাক্ষর এবং তারিখ ____________________

তথ্য সংগ্রহকারীর স্বাক্ষর এবং তারিখ __________________

রোগীর তথ্য

রোগীর আইডিঃ	
সাক্ষাৎকারের তারিখঃ	
অংশগ্রহণকারীর নামঃ	
ঠিকানাঃ	
ফোন নম্বরঃ	

পর্ব-১ঃ সামাজিক জনতাত্ত্বিক তথ্য

নং	প্রশ্ন	উত্তর
১	বয়স	........বছর
২	লিঙ্গ	১। পুরুষ ২। মহিলা ৩।উভয় লিঙ্গ
৩	পেশা	১। চাকুরিজীবী ২। ব্যবসায়ী ৩। গৃহিনী ৪। কৃষক ৫। ছাত্র/ছাত্রী ৬। শিক্ষক ৭। শ্রমিক ৮। অন্যান্য
৪	বৈবাহিক অবস্থা	১। বিবাহিত ২। অবিবাহিত
৫	স্ট্রোকের তারিখ	....
৬	আক্রান্ত দিক	১। ডান ২। বাম ৩। উভয়

৭	স্ট্রোকের ধরন	১। ইস্কেমিক ২। রক্তক্ষরণজনিত
৮	ধর্ম	১। মুসলিম ২। হিন্দু ৩। বুদ্ধ ৪। খ্রিস্টান
৯	বাসস্থান	১। গ্রামীণ ২। শহুরে ৩। আধা-শহুরে
১০	পরিবারের ধরন	১। ছোট পরিবার ২। বড় পরিবার
১১	শিক্ষাগত যোগ্যতা	১। নিরক্ষর ২। প্রাথমিক ৩। মাধ্যমিক ৪। এসএসসি ৫। এইচএসসি ৬। স্নাতক ৭। মাস্টার্স বা তার উপরে
১২	মাসিক আয়	....
১৩	অতীত রোগের ইতিহাস	১। উচ্চ রক্তচাপ ২। ডায়াবেটিস ৩। হৃদরোগ ৪। আর্থ্রাইটিস ৫। অন্যান্য

পর্ব-২: মডিফাইড এশওয়ার্থ গ্রেড স্কেলে টোন পরীক্ষা

চিকিৎসার পূর্বে

গ্রেড	বর্ণনা
০	মাংসপেশিতে টন নেই
১	মাংসপেশী টোনে সামান্য বৃদ্ধি, যা আঘাত এবং মুক্তিতে বা আক্রমণ স্থানের শেষে কম প্রতিরোধের সাথে প্রকাশ হয়, যখন আক্রান্ত অংশটি কে মোশনে ফ্লেক্সশন বা এক্সটেনশনে চালানো হয়
১+	মাংসপেশির টোনে সামান্য বৃদ্ধি, যা একটি আঘাতে প্রকাশিত হয়, এরপর সামান্য প্রতিরোধে অনুভূত হয় (অধিকাংশের চেয়ে কম হয়ে)
৩	অঙ্গের মুভমেন্টের অধিকাংশে মাংসপেশির টোনে আরও সোজা বৃদ্ধি, তবে আক্রান্ত অংশগুলি সহজে চলানো যায়
৪	মাংসপেশীর টোনে বৃদ্ধি, প্যাসিভ নড়াচড়া কঠিন
৫	(আক্রান্ত অংশগুলি) ফ্লেকশন বা এক্সটেনশন শক্ত হয়ে যাবে

চিকিৎসার পরে

গ্রেড	বর্ণনা
০	মাংসপেশিতে টন নেই
১	মাংসপেশী টোনে সামান্য বৃদ্ধি, যা আঘাত এবং মুক্তিতে বা আক্রমণ স্থানের শেষে কম প্রতিরোধের সাথে প্রকাশ হয়, যখন আক্রান্ত অংশটি কে মোশনে ফ্লেক্সশন বা এক্সটনশনে চালানো হয়
১+	মাংসপেশির টোনে সামান্য বৃদ্ধি, যা একটি আঘাতে প্রকাশিত হয়, এরপর সামান্য প্রতিরোধে অনুভূত হয় (অধিকাংশের চেয়ে কম হয়ে)
৩	অঙ্গের মুভমেন্টের অধিকাংশে মাংসপেশির টোনে আরও সোজা বৃদ্ধি, তবে আক্রান্ত অংশগুলি সহজে চলানো যায়
৪	মাংসপেশীর টোনে বৃদ্ধি, প্যাসিভ নড়াচড়া কঠিন
৫	(আক্রান্ত অংশগুলি) ফ্লেকশন বা এক্সটেনশন শক্ত হয়ে যাবে

পর্ব-৩: কাঁধের ব্যথা এবং অক্ষমতা সূচক

কাঁধের ব্যথা এবং অক্ষমতা সূচক

Source: Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res.* 1991 Dec;4(4):143-9)

কাঁধের ব্যথা এবং অক্ষমতা সূচক একটি স্ব-প্রশাসিত প্রশ্নাবলী, যা মূলত দুটি মাত্রা নিয়ে গঠিত। প্রথম মাত্রাটি রোগীর ব্যথার তীব্রতা পরিমাপ করে, যেখানে পাঁচটি প্রশ্ন থাকে। দ্বিতীয় মাত্রাটি কার্যকরী কার্যকলাপের উপর নির্ভর করে, যা রোগীর দৈনন্দিন জীবনে কাঁধের ব্যথার কারণে কতটা অসুবিধা হচ্ছে তা আটটি প্রশ্নের মাধ্যমে মূল্যায়ন করে। এই প্রশ্নাবলীটি বিশেষভাবে কাঁধের সমস্যার পরিমাপের জন্য তৈরি করা হয়েছে এবং এটি নির্ভরযোগ্য ও বৈধ অঞ্চল-নির্দিষ্ট পরিমাপ হিসেবে পরিচিত। SPADI সম্পূর্ণ করতে সাধারণত একজন রোগীর ৫ থেকে ১০ মিনিট সময় লাগে। এটি চিকিৎসক এবং থেরাপিস্টদের কাঁধের ব্যথা নির্ণয় এবং চিকিৎসার অগ্রগতি পর্যবেক্ষণের জন্য একটি গুরুত্বপূর্ণ হাতিয়ার, যা রোগীর কাঁধের ব্যথা এবং দৈনন্দিন জীবনে এর প্রভাব সম্পর্কে বিস্তারিত তথ্য প্রদান করে।

স্কোর করার নির্দেশাবলী

প্রশ্নগুলোর উত্তর দেওয়ার জন্য, রোগীদের প্রতিটি প্রশ্নের জন্য একটি ১০ সেন্টিমিটার ভিজ্যুয়াল অ্যানালগ স্কেলে একটি চিহ্ন দিতে হবে। ব্যথার মাত্রার জন্য মৌলিক নির্দেশক হলো 'কোনো ব্যথা নেই' এবং 'সবচেয়ে খারাপ ব্যথা যা হতে পারে', এবং কার্যকরী কাজগুলোর জন্য মৌলিক নির্দেশক হলো 'কোনো অসুবিধা নেই' এবং 'এতটা কঠিন যে সাহায্য প্রয়োজন'। উভয় মাত্রার স্কোরগুলোকে গড় করে একটি মোট স্কোর পাওয়া যায়।

স্কোরের ব্যাখ্যা

মোট ব্যথার স্কোর: / ৫০ X ১০০ = %

(দ্রষ্টব্য: যদি একজন ব্যক্তি সব প্রশ্নের উত্তর না দেন, তাহলে মোট সম্ভাব্য স্কোর দ্বারা ভাগ করুন। উদাহরণস্বরূপ, যদি ১টি প্রশ্নের উত্তর না দেওয়া হয়, তাহলে ৪০ দ্বারা ভাগ করুন।)

মোট অক্ষমতার স্কোর: _______________ / ৮০ X ১০০ = %

(দ্রষ্টব্য: যদি একজন ব্যক্তি সব প্রশ্নের উত্তর না দেন, তাহলে মোট সম্ভাব্য স্কোর দ্বারা ভাগ করুন। উদাহরণস্বরূপ, যদি ১টি প্রশ্নের উত্তর না দেওয়া হয়, তাহলে ৭০ দ্বারা ভাগ করুন।)

মোট কাঁধের ব্যথা এবং অক্ষমতা সূচকের স্কোর: _/ ১৩০ X ১০০ = %

(দ্রষ্টব্য: যদি একজন ব্যক্তি সব প্রশ্নের উত্তর না দেন, তাহলে মোট সম্ভাব্য স্কোর দ্বারা ভাগ করুন। উদাহরণস্বরূপ, যদি ১টি প্রশ্নের উত্তর না দেওয়া হয়, তাহলে ১২০ দ্বারা ভাগ করুন।)

দুটি উপ-স্কেলের গড় নিয়ে একটি মোট স্কোর তৈরি করা হয়, যা ০ (সবচেয়ে ভালো) থেকে ১০০ (সবচেয়ে খারাপ) পর্যন্ত হয়।ন্যূনতম তাৎপর্যপূর্ণ পরিবর্তন (৯০% আত্মবিশ্বাস) = ১৩ পয়েন্ট (এর চেয়ে কম পরিবর্তন পরিমাপের ত্রুটির কারণে হতে পারে)

কাঁধের ব্যথা এবং অক্ষমতা সূচক

দয়া করে সেই লাইনে একটি চিহ্ন দিন যা গত সপ্তাহে আপনার কাঁধের সমস্যার কারণে আপনি যে অসুবিধা অনুভব করেছেন তা সঠিকভাবে প্রতিফলিত করে।

ব্যথার স্কেলঃ

আপনার ব্যথা কতটা তীব্র?

আপনার ব্যথার বর্ণনা দেওয়ার জন্য যে সংখ্যাটি সবচেয়ে ভালোভাবে উপযুক্ত, তা বৃত্তাকার করুন। এখানে ০ মানে কোনো ব্যথা নেই এবং ১০ মানে কল্পনার সবচেয়ে খারাপ ব্যথা।

সবচেয়ে খারাপ অবস্থায়?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
যখন সংশ্লিষ্ট পাশে শুয়ে থাকেন ?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
উঁচু তাক থেকে কিছু নেওয়ার চেষ্টা করেছেন?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনাকে ঘাড়ের পেছনে স্পর্শ করেছেন?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
সংশ্লিষ্ট হাত দিয়ে চাপ দিচ্ছেন ?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০

অক্ষমতার স্কেলঃ

আপনার কতটা অসুবিধা হচ্ছে?

আপনার অভিজ্ঞতার বর্ণনা দেওয়ার জন্য যে সংখ্যাটি সবচেয়ে ভালোভাবে উপযুক্ত, তা বৃত্তাকার করুন। এখানে: ০ = কোনো অসুবিধা নেই এবং ১০ = এতটাই কঠিন যে সাহায্যের প্রয়োজন।

আপনার চুল ধোয়া?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার পিঠ ধোয়া?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
জামা পরা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
সামনে বোতামযুক্ত একটি জামা পরা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার প্যান্ট পরা?	0	১	২	৩	৪	৫	৬	৭	৮	৯	১০
উঁচু তাকের উপর একটি বস্তু রাখা?	0	১	২	৩	৪	৫	৬	৭	৮	৯	১০

১০ পাউন্ড (৪.৫ কিলোগ্রাম) ওজনের একটি ভারী বস্তু বহন করা?	0	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার পিছনের পকেট থেকে কিছু সরানো?	0	১	২	৩	৪	৫	৬	৭	৮	৯	১০

কাঁধের ব্যথা এবং অক্ষমতা সূচক

দয়া করে লাইনে এমন একটি চিহ্ন দিন যা আপনার কাঁধের সমস্যার কারণে গত সপ্তাহে আপনার অভিজ্ঞতাকে সর্বোত্তমভাবে উপস্থাপন করে

ব্যথার স্কেলঃ

আপনার ব্যথার তীব্রতা কত?

আপনার ব্যথার বর্ণনা দেওয়ার জন্য, বৃত্তাকার করুন সেই সংখ্যাটি যা সবচেয়ে ভালোভাবে আপনার ব্যথাকে প্রকাশ করে,

যেখানেঃ ০ = কোনো ব্যথা নেই এবং ১০ = কল্পনার সবচেয়ে খারাপ ব্যথা।

সবচেয়ে খারাপ অবস্থায়?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আক্রান্ত পাশে শুয়ে থাকলে?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
উঁচু তাক থেকে কিছু নাগালের মধ্যে আনা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
ঘাড়ের পিছন দিক স্পর্শ করা	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আক্রান্ত বাহু দিয়ে ধাক্কা দেওয়া	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০

অক্ষমতার স্কেলঃ

আপনার কতটা অসুবিধা হচ্ছে?

আপনার অভিজ্ঞতা বর্ণনাকারী সংখ্যাটিকে বৃত্তাকার করুন, যেখানে: ০ = কোনো অসুবিধা নেই এবং ১০ = এত কঠিন যে সাহায্যের প্রয়োজন।

আপনার চুল ধোয়া?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার পিঠ ধোয়া?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
জামা পরা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
সামনে বোতামযুক্ত একটি জামা পরা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার প্যান্ট পরা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
উচু তাকের উপর একটি বস্তু রাখতে পারা ?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
১০ পাউন্ড (৪.৫ কিলোগ্রাম) ওজনের একটি ভারী বস্তু বহন করা?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০
আপনার পিছনের পকেট থেকে কিছু সরানো?	০	১	২	৩	৪	৫	৬	৭	৮	৯	১০

পর্বঃ৪ গনিওমিটার দ্বারা পরিমাপকৃত আক্রান্ত অঙ্গসমূহের সঞ্চালন পরিসীমা

নড়াচড়া	সক্রিয় রেঞ্জ অফ মোশন (চিকিৎসার পূর্বে)	সক্রিয় রেঞ্জ অফ মোশন (চিকিৎসার পর)	নিষ্ক্রিয় রেঞ্জ অফ মোশন (চিকিৎসার পূর্বে)	নিষ্ক্রিয় রেঞ্জ অফ মোশন (চিকিৎসার পর)
কাঁধের ফ্লেকশন				
কাঁধের এক্সটেনশন				
কাঁধের এবডাকশন				
কাঁধের এডাকশন				
কাঁধের লেটারাল রোটেশন				
কাঁধের ইন্টারনাল রোটেশন				

Informed Consent

Assalmualaikum, I am Nirjona Rohman Srabonty, a student of the B.Sc. in Physiotherapy course, Session 2019-2020, at Bangladesh Health Profession Institute, under the Faculty of Medicine, University of Dhaka. I must complete a thesis to earn my B.Sc. in physiotherapy degree. My thesis title is **"Effectiveness of TENS in the management of patients with Hemiplegic shoulder pain"**. The purpose of this study is to evaluate the effectiveness of Transcutaneous Electrical Nerve Stimulation for Hemiplegic Shoulder Pain. In order to ask you some questions about this thesis, I will meet with you twice: once before the intervention and again after completion. I am assuring you that the treatment provided to you would not cause any damage. Besides, Physiotherapists will provide the treatments. The information you provide will be kept confidential and will only be used for thesis purposes. You have the right to terminate your participation at any time. Moreover, if you feel uncomfortable answering any question you can skip that question. The questionnaire will take 20 to 30 minutes to fill up. Please give me the correct answers to the questions and enable the data collector to evaluate your health. Contact my supervisor if you have any questions. Asma Islam, Associate Professor of BHPI, Department of Physiotherapy . If you would kindly give your consent, we can start. So may I have your consent to proceed with the interview?

Yes: ☐ No: ☐

Thank you for your participation as well as the information.

Signature of Participant..................

Date…………………

Signature of Data Collector……………….

Date……………………….

Signature of the Researcher..................

Date……………………

Questionnaire (English)

Title: "Effectiveness of TENS in the management of patients with Hemiplegic shoulder pain"

Patient's Information

Patient Id:	
Date of Interview:	
Name of Participant:	
Address:	
Phone number:	

Part-1: Socio-demographic Information

No.	Questions	Response
1	Age	…..years
2	Gender	o Male o Female
3	Occupation	o Service holder o Businessman o Housewife o Farmer o Student o Teachers o Others
4	Marital status	o Married o Unmarried

5	Date of stroke	……………..
6	Affected side	○ Right ○ Left ○ Both
7	Type of stroke	○ Ischemic ○ hemorrhagic
8	Religion	○ Muslim ○ Hindu ○ Buddho ○ Christian
9	Living area	○ Rural ○ Urban ○ Semi-urban
10	Family type	○ Nuclear family ○ Extended family
11	Education level	○ Illiterate ○ Primary ○ Secondary ○ SSC ○ HSC ○ Graduate ○ Masters or above
12	Monthly income	…………………………
13	Past medical history	○ Hypertension ○ Diabetes ○ Heart disease ○ Arthritis ○ Others…………..

Part-II: Tone in Modified Ashworth Scale

Pre test

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

Post test

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

Part-III:Shoulder pain & Disability index

Shoulder Pain and Disability Index (SPADI)

Source: Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res*. 1991 Dec;4(4):143-9.
The Shoulder Pain and Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for pain and the other for functional activities. The pain dimension consists of five questions regarding the severity of an individual's pain. Functional activities are assessed with eight questions designed to measure the degree of difficulty an individual has with various activities of daily living that require upper-extremity use. The SPADI takes 5 to 10 minutes for a patient to complete and is the only reliable and valid region-specific measure for the shoulder.

Scoring instructions

To answer the questions, patients place a mark on a 10cm visual analogue scale for each question. Verbal anchors for the pain dimension are 'no pain at all' and 'worst pain imaginable', and those for the functional activities are 'no difficulty' and 'so difficult it required help'. The scores from both dimensions are averaged to derive a total score.

Interpretation of scores

Total pain score: ________/ 50 x 100 = %

(Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 40)

Total disability score: _______/ 80 x 100 = %

(Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 70)

Total Spadi score: _______/ 130 x 100 = %

(Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 120)

The means of the two subscales are averaged to produce a total score ranging from 0 (best) to 100 (worst).

Minimum Detectable Change (90%

confidence) = 13 points (Change less than this

may be attributable to measurement error)

Pre test

Shoulder Pain and Disability Index (SPADI)

Please place a mark on the line that best represents your experience during the last week attributable to your shoulder problem.

Pain scale

How severe is your pain?

Circle the number that best describes your pain where: 0 = no pain and 10 = the worst pain imaginable.

At its worst?	0	1	2	3	4	5	6	7	8	9	10
When lying on the involved side?	0	1	2	3	4	5	6	7	8	9	10
Reaching for something on a high shelf?	0	1	2	3	4	5	6	7	8	9	10
Touching the back of your neck?	0	1	2	3	4	5	6	7	8	9	10
Pushing with the involved arm?	0	1	2	3	4	5	6	7	8	9	10

Disability scale

How much difficulty do you have?

Circle the number that best describes your experience where: 0 = no difficulty and 10 = so difficult it requires help.

Washing your hair?	0	1	2	3	4	5	6	7	8	9	10
Washing your back?	0	1	2	3	4	5	6	7	8	9	10
Putting on an undershirt or jumper?	0	1	2	3	4	5	6	7	8	9	10
Putting on a shirt that buttons down the front?	0	1	2	3	4	5	6	7	8	9	10
Putting on your pants?	0	1	2	3	4	5	6	7	8	9	10
Placing an object on a high shelf?	0	1	2	3	4	5	6	7	8	9	10

Carrying a heavy object of 10 pounds (4.5 kilograms)	0	1	2	3	4	5	6	7	8	9	10
Removing something from your back pocket?	0	1	2	3	4	5	6	7	8	9	10

Post test

Shoulder Pain and Disability Index (SPADI)

Please place a mark on the line that best represents your experience during the last week attributable to your shoulder problem.

Pain scale

How severe is your pain?

Circle the number that best describes your pain where: 0 = no pain and 10 = the worst pain imaginable.

At its worst?	0	1	2	3	4	5	6	7	8	9	10
When lying on the involved side?	0	1	2	3	4	5	6	7	8	9	10
Reaching for something on a high shelf?	0	1	2	3	4	5	6	7	8	9	10
Touching the back of your neck?	0	1	2	3	4	5	6	7	8	9	10
Pushing with the involved arm?	0	1	2	3	4	5	6	7	8	9	10

Disability scale

How much difficulty do you have?

Circle the number that best describes your experience where: 0 = no difficulty and 10 = so difficult it requires help.

Washing your hair?	0	1	2	3	4	5	6	7	8	9	10
Washing your back?	0	1	2	3	4	5	6	7	8	9	10
Putting on an undershirt or jumper?	0	1	2	3	4	5	6	7	8	9	10
Putting on a shirt that buttons down the front?	0	1	2	3	4	5	6	7	8	9	10
Putting on your pants?	0	1	2	3	4	5	6	7	8	9	10
Placing an object on a high shelf?	0	1	2	3	4	5	6	7	8	9	10
Carrying a heavy object of 10 pounds (4.5 kilograms)	0	1	2	3	4	5	6	7	8	9	10
Removing something from your back pocket?	0	1	2	3	4	5	6	7	8	9	10

Part-IV: Range of motion of affected limbs measured by Goniometer

Movement	Active ROM(Pre test)	Active ROM (Post test)	Passive ROM (Pre test)	Passive ROM (Post test)
Shoulder flexion				
Shoulder Extension				
Shoulder abduction				
Shoulder Adduction				
Shoulder lateral rotation				
Shoulder internal rotation				