# EFFECTS OF NEUROMUSCULAR JOINT FACILITATION (NJF) THERAPY ON SCAPULAR DYSKINESIA INMATES WITH SUB-ACUTE STROKE

*Dissertation submitted to*

*The Tamil Nadu Dr. M.G.R. Medical University*

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*In partial fulfillment of the requirements for the degree of*

**MASTER OF PHYSIOTHERAPY**

**(Advanced Physiotherapy in Neurology)**


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**COLLEGE OF PHYSIOTHERAPY**

**SRI RAMAKRISHNA INSTITUTE OF PARAMEDICAL SCIENCES**

**COIMBATORE – 641044**

# CERTIFICATE

This is to certify that the dissertation work entitled **"EFFECTS OF NEUROMUSCULAR JOINT FACILITATION (NJF) THERAPY ON SCAPULAR DYSKINESIA INMATES WITH SUB-ACUTE STROKE"** was carried out by the candidate bearing the **Register No. 271720001 (May 2019)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Neurology).**

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**Place: Coimbatore**

**Date:**

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**Guide**
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**Place: Coimbatore**

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**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

**Place:**

**Date**:

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With great privilege I express my deep sense of gratitude to the **God Almighty** for his blessings, love and care for me and who have always been my source of inner strength and courage throughout my life.

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# ABSTRACT

**Background of the study:** About 60% - 80% of stroke, is an important cause of upper extremities dysfunction in hemiplegia, causing the severe disability in hand functions because of complex modes of upper limb dyskinesia. The term 'scapular dyskinesia' is a term used to describe any alterations in the normal state or dynamic position of the scapula during coupled scapulohumeral movements, these alterations in shoulder kinematics could lead to problems secondary to neuromuscular problems, such as shoulder subluxation and pain, suppress functioning of the upper extremity. So neuromuscular joint facilitation (NJF) therapy is applied on scapular dyskinesia by tactics of improving scapula position in patients with sub-acute stroke.

**Aim:** To study the effects of Neuromuscular Joint Facilitation (NJF) therapy on scapular dyskinesia in patients with sub-acute stroke.

**Methods:** The study was designed as a experimental design. The 15 subjects with sub-acute stroke who fullfilled the selection criteria were selected and was given Neuromuscular Joint Facilitation (NJF) therapy, scapula distance was measured from the spine with lateral scapular slide test. The treatment was carried out for a period of 4 weeks, for 30 minutes per session, 5 days per week.

**Results:** Significant improvement in scapula distance was seen in the patients at three varying positions in the coronal plane. At position 1 dependent 't' test calculated is **7.3551.** At position 2 dependent 't' test calculated is **3.826** and at position 3 dependent 't' test calculated is **5.0371** which is significant at the level **0.05%** at **14** degrees of freedom for all the three positions.

**Conclusion:** The study concluded that there is significant improvement in scapular dyskinesis in sub-acute stroke patients who received scapular NJF for a duration of 4 weeks.



***Key words:*** *stroke, Neuromuscular Joint Facilitation (NJF) therapy , scapular dyskinesis, lateral scapular slide test.*

# *Introduction*

# 1. INTRODUCTION

*"Think wellness, not illness",* when things go wrong, we often become focused - a little too focused - on the thing that went wrong. But instead of focusing on the bad, try focusing on the good. If you think that you'll never make a full recovery, that thinking might be the one thing standing in your way. When you become wellness-minded instead of illness-minded, you'll start to create space for that wellness to manifest in your life.

The first recorded use of the word '**stroke**' in English literature is in 1599[10]. The word conveys the sudden and seemingly random nature of the acute event, and as such describes some of the subjective experience of the person who has been 'struck'. Although there was some overlap between medical and lay terms, stroke seems to have been predominantly a lay term, while physicians from the time of Hippocrates up till the first half of the twentieth century favoured the word '**apoplexy**' [10].

Stroke is a clinical syndrome characterized by the sudden development of a persistent focal neurological deficit secondary to a vascular event [1]. In India the prevalence of stroke is estimated to be 203 per 1,00,000 people and it is projected to rank as the fourth leading cause of disability by the year 2020[9]. The deficits resulting have significant impact on independence, quality of life and the productivity of the survivors. The reduced ability to move leads to prolonged periods of time spent immobile [9].

There are various reasons why early implementation of upper limb rehabilitation is an important factor in the probability of recovery of upper limb function. After a stroke, the unaffected hemisphere inhibits the affected one. This inter-hemispheric inhibition can be influenced by an early start of rehabilitation of the involved upper limb. In order to keep the upper limb in the body scheme, early implementation of upper limb treatment is important[12].

A major concern for rehabilitation clinicians is the time spent with the upper extremity in the lap [9]. Although proximal muscles and joints may be least affected, purposeful movement requiring precise control of the proximal segments is slow,

inaccurate, and poorly coordinated. The distal region of the upper extremity is also capable of comfortable, coordinated movement, despite immobility of the proximal region of the upper extremity. Stroke survivors commonly have an impaired shoulder joint complex, because paretic muscles do not overcome the weight of the arm[11].

About 60% - 80% of stroke is an important cause of upper extremities dysfunction in hemiplegia, causing the severe disability in hand functions because of complex modes of upper limb dyskinesia [6]. The term 'scapular dyskinesia' is a term used to describe any alterations in the normal state or dynamic position of the scapula during coupled scapulohumeral movements, these alterations in shoulder kinematics could lead to problems secondary to neuromuscular problems, such as shoulder subluxation and pain, suppress functioning of the upper extremity.[5]. Furthermore, joint contracture and discomfort exerting by the upper limb dyskinesia results in limb disuse and hinders the long-term functional recovery [6].

The prerequisites for recovery of voluntary selective movements of the upper limb in patients post stroke include good core stability, correct scapula setting, efficient scapular humeral rhythm and good somatosensory function[12].

**Ideal scapular resting position is defined in following way** :

The superior angle of scapula and the lateral border of the acromion are located approximately on the same level as T2 and, thus, without excessive elevation or depression and 30 degree internally rotated with respect to the frontal plane. The orientation of the glenoid fossa should point downward (10 degree below to horizontal plane). In addition, the entire medial border of the scapula should be parallel to the thoracic midline; the scapula of the dominant side should be lower and farther away from the spine compared with the non-dominant side; the medial border and inferior angle should be flat against the chest wall; the superior angle should be level with the spinous processes of T3 or T4; and the inferior angle should be level with T7, T8, T9, or even T10.

**Motions Available**

The scapula also has available translatory motions of;

- Elevation and Depression.
- Protraction and Retraction.
- Upward and Downward Rotation.
- Internal and External Rotation.
- Anterior and Posterior Tipping.

Scapular dyskinesis can lead to limited functional activity of the upper extremity. In turn, upper extremity paresis in stroke patients often limits daily activities, and social roles. Scapular winging can be caused by weakness of the serratus anterior and rhomboid muscles. The serratus anterior plays an important role in scapular stability, causing upward rotation and protraction of the scapula. Rhomboids provide scapular stability, causing retraction and adduction of the scapula

Existing clinical practice for gaining hemiplegic upper limb motor control, Neuromuscular stimulation technique, Motor re-learning program (MRP), BOBATH technique, Proprioceptive Neuromuscular Facilitation (PNF), motor imagery technique, Constraint Induced Movement Therapy (CIMT), robotic therapy and for pain, modalities such as Transcutaneous electrical nerve stimulation (TENS) and ultrasound(US) [(1)].are used.

Proprioceptive Neuromuscular Facilitation (PNF) is a dynamic approach to the evaluation and treatment of neuromusculoskeletal dysfunction. PNF applies neurophysiological principles of sensory and motor system to manual evaluation and treatment of neuromuscular skeletal dysfunction. PNF provides the therapist with an efficient means for evaluating and treating neuromuscular and structural dysfunction. Structural dysfunction affect the body's capacity to assume and perform optimal postures and motions and often are associated with symptoms. Neuromuscular dysfunction cause repetitive, abnormal and stressful usage of the articular and myofascial system, often precipitating structural dysfunction and symptoms. The goal of the PNF is to facilitate an optimal structural and

neuromuscular state. This helps to reduce symptoms, to improve the distribution of forces through the symptomatic region, and to reduce the inherent functional stresses caused by poor neuromuscular control[13].

Neuromuscular Joint Facilitation (NJF) is a therapeutic exercise based on kinesiology that integrates the facilitation element of PNF and the joint composition movement aiming to improve the movement of the joint through passive exercise, active exercise and resistance exercise [3]. The main effects of NJF are facilitate the normal joint movement and the normal joint capsule and relieving pain [3].

The **basic procedures** for facilitation are:

**Resistance**: To aid muscle contraction and motor control, to increase strength, aid motor learning.

**Irradiation and reinforcement**: Use of the spread of the response to stimulation.

**Manual contact**: To increase power and guide motion with grip and pressure.

**Body position and body mechanics**: Guidance and control of motion or stability.

**Verbal** (commands): Use of words and the appropriate vocal volume to direct the patient.

**Vision**: Use of vision to guide motion and increase force.

**Traction or approximation**: The elongation or compression of the limbs and trunk to facilitate motion and stability.

**Stretch**: The use of muscle elongation and the stretch reflex to facilitate contraction and de- crease muscle fatigue.

**Timing**: Promote normal timing and increase muscle contraction through "timing for emphasis".

**Patterns**: Synergistic mass movements, components of functional normal motion[14].

## 1.1 NEED FOR THE STUDY

Though there are many therapies and techniques available for treating the upper limb dysfunction in stroke, there is a limited concentration on correcting the scapular orientation which is very much essential for upper limb function[11].

Neuromuscular Joint Facilitation (NJF) therapy is one of the effective technique based upon Proprioceptive Neuromuscular Facilitation (PNF) useful in musculoskeletal conditions like rotator cuff tendinitis, anterior cruciate ligament injury and more. There is a paucity of literature relating to the effect of Neuromuscular Joint Facilitation (NJF) therapy in neurological conditions.

Hence, the need arises to study the influence of neuromuscular joint facilitation (NJF) therapy on scapular dyskinesia in subacute stroke patients.

## 1.2 STATEMENT OF PROBLEM

The most of therapeutic approaches mainly focus on fine motor skills in distal extremities, not gross motor skills in proximal extremities, even they have been reported to provide benefits for chronic stroke patients, the necessary elements for correct scapular movement, which is often linked to proper initiation and recruitment, are impaired in stroke patients. A paretic arm can change scapular orientation, because scapular stabilizers are often so impaired by muscle weakness that they cannot overcome arm weight and maintain anatomical characteristics. Weakness of scapular stabilizers has been shown to increase motor impairment of upper extremities and consequently many stroke survivors of independent daily livings[11].

In general proximal stability is important for distal mobility, In stroke loss of proximal scapular orientation in upper extremity affects normal scapulohumeral joint position and pattern of movement that leads to shoulder impingement syndrome, pain, abnormal synergic upper limb pattern, further it leads to loss of functional activity over the affected upper extremity.

## 1.3 AIM OF THE STUDY

To study the effects of Neuromuscular Joint Facilitation (NJF) therapy on scapular dyskinesia in patients with sub-acute stroke.

## 1.4 OBJECTIVES OF THE STUDY

The objectives of the studies are ;

- To find out the effect of Neuromuscular Joint Facilitation (NJF) therapy on improving scapular dyskinesia in patients with sub-acute stroke.
- To compare the pre and post effects of Neuromuscular Joint Facilitation (NJF) therapy on improving scapular dyskinesia in patients with sub-acute stroke.

## 1.5 HYPOTHESIS

**Null Hypothesis ($H_0$):**

There is no effect of Neuromuscular Joint Facilitation (NJF) therapy on scapular dyskinesia by tactics of improving upper limb scapular pattern in patients with sub-acute stroke.

**Alternate Hypothesis ($H_1$):**

There is a effect of Neuromuscular Joint Facilitation (NJF) therapy on scapular dyskinesia by tactics of improving upper limb scapular pattern in patients with sub-acute stroke.

# *Review of Literature*

# 2. REVIEW OF LITERATURE

- **Hongdan Wang, Ming Huo et al., (2013):** conducted the study on Immediate effect of neuromuscular joint facilitation (NJF) on hip muscle strength, with included 45 healthy individuals and they were divided into two groups (group A: n=21 and group B: n=24) and evaluated the maximal flexor strength and maximum extensor strength of isokinetic movement of the hip joint using the Biodex system 3 isokinetic dynamometer. They concluded that NJF group showed significant increases in the maximum flexor and maximum extensor strengths after the intervention.

***Journal of physical therapy science (2013), vol.25, pp1455-1457***

- **Dustin D. Hardwick, Catherine E. Lang et al. 2011:** evaluated the study on scapular and humeral movement patterns of people with stroke during range of motion exercises which included 25 subjects and were divided into 2 groups (group A: stroke individuals n=13 and group B: healthy individuals n=12) and evaluated the scapular and humeral movement patterns during the exercise in participant with stroke and with those of a group of neurologically intact healthy control objects. They concluded that reduced humeral external rotation was the most common abnormality observed during the performance of 3 commonly prescribed shoulder ROM exercise by people with hemiparesis post stroke.

***Journal of neurologic physical therapy (2011), vol.35, pp18-25***

- **Peng Wu, Ming Huo et al. 2013:**conducted the study on the effects of neuromuscular joint facilitation on baseball pitching velocity and electromechanical reaction time of the teres major of young amateur baseball players which included 18 subjects who were divided into 2 groups ( group A: NJF n=10 and group B: control n=8) and evaluated the EMG-RT, premotor time and motor time of the teres major muscle during shoulder imternal rotation before and after 8 weeks of exercise using digital storage oscilloscope. They concluded that there were significant differences in baseball pitching velocity, before and after the NJF training.

***Journal of physical therapy science (2013), vol.25, pp1459-1461***

- **Joong-San Wang et al. 2016:** valuated the study on the immediate effect of proprioceptive neuromuscular facilitation (PNF) on muscle tone and muscle stiffness in stroke patients, which consisted of 15 patients with chronic stroke (stroke group) and 15 healthy persons (healthy group). They concluded that continuous application of the PNF intervention could decrease abnormally increased muscle tone and stiffness while increasing the muscle activity of the LE muscles.

***Journal of physical therapy science (2016), vol.28, pp967-970***

- **HongzHao Wang, Ming Huo et al. 2015** conducted the study on the change in dynamic balance performance of junior soccer players after progressive resistance treatment with neuromuscular joint facilitation (NJF), which consisted of 14 healthy males who were divided into two groups, namely the NJF and control groups. The NJF group consisted of 8 subjects, and the control group consisted of 6 subjects. The participants in the NJF group received NJF progressive resistance treatment. Dynamic balance performance was measured before and after 3 weeks of exercise. Significant improvement in dynamic balance performance was observed both in the NJF and control groups. In the NJF group, dynamic balance performance was significantly increased compared with that in the control group. The study concluded that NJF intervention shortened movement time, which implies that NJF is effective for dynamic balance performance.

***Journal of physical therapy science (2015), vol.27, pp3433-3435***

- **Deepak Joshi, Jeba Chitra et al. 2017** conducted the study on effect of scapular proprioceptive neuromuscular facilitation (PNF) on shoulder pain, range of motion (ROM), and upper extremity (UE) function in hemiplegic patients which included thirty hemiplegic patients which were recruited and randomly allocated to Group A ($n$ = 15) and Group B ($n$ = 15). Experimental group received conventional treatment plus scapular PNF-hold relax technique while control group received only conventional treatment comprised passive shoulder ROM and stretching exercises and transcutaneous electrical nerve stimulation for 12 sessions (4 sessions/week). The outcome measures used were visual analog scale, shoulder ROM, lateral

scapular slide test. The study concluded that scapular PNF has positive impact on post stroke shoulder pain and ROM, helps in strengthening of proximal muscles of UE, thereby correcting scapular alignment and improving the UE function in stroke patients.

***Indian Journal of Health Sciences and Biomedical Research (2017), vol.27, pp 276-282***

- **Chang Soon Song et al ;(2012)** conducted a study on "Effects of Scapular Stabilization Exercise on Function of Paretic Upper Extremity of Chronic Stroke Patients" with 11 participants for 30 minute session, 5 days per week, for 4 week in Korea, using assessment tool of Manual Function Test as a assessment tool and found that scapular stabilization exercises can improve the function of the paretic upper extremities of individuals with chronic stroke.

***Journal of Physical Therapy Science (2013); Volume 25; 403-405***

- **Odom CJ et al** conducted a study on "Measurement of scapular asymmetry and assessment of shoulder dysfunction using the Lateral Scapular Slide Test: a reliability and validity study" with 46 subjects were assessed with Lateral Scapular Slide Test (LSST), to determine scapular position with the arm abducted 0, 45, and 90 degrees in the coronal plane and their results suggest that measurements of scapular positioning based on the difference in side-to-side scapular distance measures are not reliable and sensitivity and specificity of the LSST measurements are poor and that the LSST should not be used to identify people with and without shoulder dysfunction.

***Physical Therapy (2001); Volume 8; 799-809***

- **Bin Zhou, QiuChen huang, Tao Zheng, Ming huo et al. (2015)** evaluated the study on the effects of neuromuscular joint facilitation on bridging exercises by assessing the cross-sectional area of the multifidus muscle and thickness of the musculus transversus abdominis study involved twelve healthy men and four exercises were evaluated: (a) supine resting, (b) bridging resistance exercise involving posterior pelvic tilting, (c) bridging resistance exercise involving anterior pelvic tilting, and (d) bridging resistance exercise involving neuromuscular joint

facilitation. The study concluded that Neuromuscular joint facilitation intervention improves the function of deep muscles such as the multifidus muscle and musculus transversus abdominis.

***Journal of Physical Therapy Science (2015); Volume 27; 1417-1419***

- **Ajit Dabholkar, Devanshi Mehta et al. (2015**) conducted the study on Assessment of scapular behaviour in stroke patients thereby by assessing the scapular stability, type of scapular dyskinesia and assessing the disability in stroke patients with scapular dyskinesia and the study concluded that the scapular stability is affected as evaluated by scapular dyskinesia test and scapular balance angle. Various types of scapular dyskinesia were observed. It was observed that patients with disability have scapular dyskinesia.

***International Journal of Health and Rehabilitation Sciences (2015); volume 4; 95-102***

- **Ko onoda, Ming Huo et al. (2015)** evaluated the study on changes in standing balance of younger persons after neuromuscular joint facilitation (NJF) treatment. The study included 57 healthy young people, who were divided into three groups: The NJF group, and the Proprioceptive Neuromuscular Facilitation (PNF) group and the control group and the study concluded that caput femoris rotation function can be improved by NJF treatment, and that improvement of caput femoris rotation contributes to improve dynamic balance by four hip patterns of NJF or PNF.

***Journal of Physical Therapy Science (2015); Volume 27; 1481-1483***

- **Lei Wang et al. (2016)** studied the immediate effects of neuromuscular joint facilitation (NJF) on the functional activity level after rehabilitation of anterior cruciate ligament (ACL) reconstruction. Ten young subjects (8 males and 2 females) who underwent ACL reconstruction were included in the study. The subjects were divided into two groups, namely, knee joint extension muscle strength training (MST) group and knee joint extension outside rotation pattern of NJF group. Extension strength was measured in both groups before and after the

experiment. Surface electromyography (sEMG) of the vastus medialis and vastus lateralis muscles and joint position error (JPE) test of the knee joint were also conducted. The study concluded that NJF training in patients with ACL reconstruction can improve knee proprioception ability and muscle strength.

***Journal of Physical Therapy Science (2016); Volume 28; 2084-2087***

- **Michael L.Voight, Brian C. Thomas** studied "The Role of Scapula in the Rehabilitation of Shoulder Injuries" and evaluated the strength of scapular muscles using Kibler's Lateral Scapular Slide test and presented a clinical understanding of the influence of scapular musculature in the mechanics of shoulder function.

***Journal of Athletic Training (2000); Volume 35;364-372***

- **Susan O' Sullivan, Thomas J.Schmitz** in "Physical Rehabilitation" stated that during spastic stage of stroke abnormal muscle tone may contribute to poor scapular position and contributes to subluxation and restricted movement and also the scapula should be mobilized on the thoracic wall with an emphasis on upward rotation and protraction to prevent soft tissue impingement syndrome in the subacromial space during overhead movements of the arms.

***Jayapee Brothers Medical Publishers(P)Ltd;4$^{th}$ edition;753,741***

- **Thomas Curtis and James R. Roush** conducted a study on "The Lateral Scapular Slide Test: A Reliability Study of Males with and without Shoulder Pathology" to test the reliability of the LSST using a scoliometer in 33 subjects and concluded that the LSST can be reliable in screening scapular position, although a large range of error exists in measurements as indicated by the standard error of the measurement, the LSST provides more objective measures than pure observation.

***North American Journal of Sports Physical Therapy (2006); Volume 3; 140–146***

# *Methodology*

# 3. METHODOLOGY

## 3.1 SOURCE OF DATA:

The source of data was gathered from Sri Ramakrishna Hospital, Coimbatore.

## 3.2 STUDY DESIGN:

The study design is an Experimental study.

## 3.3 STUDY SETTING:

The study was conducted at the department of physiotherapy and Neurology ward, Sri Ramakrishna Hospital, under the supervision of the guide, College of Physiotherapy, SRIPMS, Coimbatore.

## 3.4 CRITERIA FOR SAMPLING

**Inclusion criteria:**

- Stroke with sub acute phase
- Age between 50 to 60 years [1,6]
- Modified Ashworth scale of 2 to 3
- Upper extremity voluntary control of 3 or more than 3 [5]
- Co-operative and willing to participate [1]

**Exclusion criteria:**

- Unstable vital signs [6]
- If had a history of shoulder pain and pathology prior to stroke [2]
- Shoulder subluxation [1]
- Inability to follow the commands [1]
- Cognitive deficits

## 3.5 POPULATION:

The target population of the study was selected as per the inclusion criteria.

## 3.6 SAMPLE SIZE:

15 stroke patients was selected for the study and they were given Neuromuscular Joint Facilitation (NJF) therapy.

## 3.7 TOOL FOR DATA COLLECTION:

The assessment tool used to analyze the outcome is;

- Kibler's Lateral Scapular Slide Test

## 3.8 STUDY DURATION:

The study duration was 6 months.

## 3.9 TREATMENT DURATION

The treatment was carried out for a period of 4 weeks. The patients were treated for 30 minutes per session, 5 days per week.

## 3.10 PROCEDURE AND TREATMENT TECHNIQUE

The therapy was beginning only when the vital parameters proved stable and post therapy, the same parameters were checked for any abnormality. The pre test and post test outcomes were measured.

**Anterior Elevation**

**Therapist position:** stands behind the patient, facing up toward the patient's head.

**Grip:** Place one hand on the anterior aspect of the glenohumeral joint and the acromion with your fingers cupped. The other hand covers and supports the first. Contact is with the fingers and not the palm of the hand.

**Elongated Position:** Pull the entire scapula down and back toward the lower thoracic spine (posterior depression) with the angulus inferior rotated toward the spine. Be sure that the glenohumeral complex is positioned posterior to the central

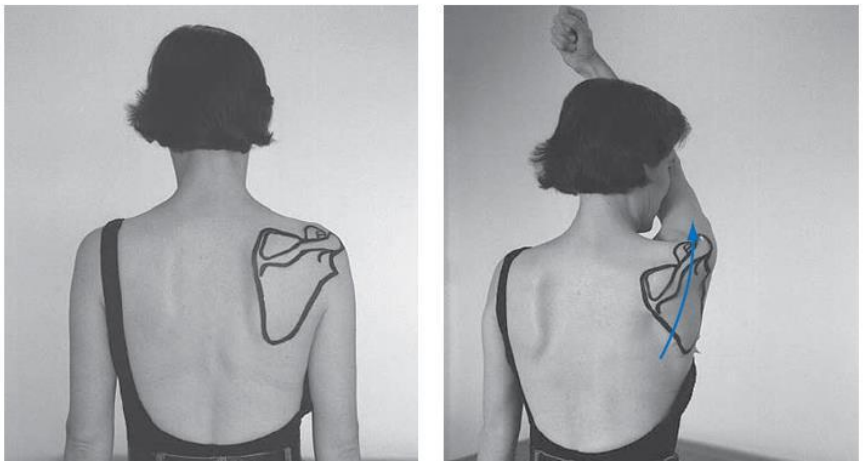
anteroposterior line of the body (midfrontal plane). Do not pull so far that you lift the patient's head up. Continued pressure on the scapula should not cause the patient to roll back or rotate the spine around one segment. **Command:** "Shrug your shoulder up toward your nose." "Pull".

**Movement:** The scapula moves up and forward in a line aimed approximately at the patient's nose. The inferior angle moves away from the spine.

**Body Mechanics:** Keep your arms relaxed and let your body give the resistance by shifting your weight from the back to the front leg.

**Resistance:** The line of resistance is an arc following the curve of the patient's body. To resist the rotation component, resistance is given at the angulus inferior in the direction of the spine. Start with your elbows low and your forearms parallel to the patient's back. At the end of the pattern your elbows are extending and you are lifting upward.

**End Position.** The scapula is up and forward with the acromion close to the patient's nose. The angulus inferior is moved away from the spine. In the end position, the muscular activity moves the scapula in this direction. The scapular retractor and depressor muscles are taut.



Anterior Elevation

Resistance to anterior elevation

**Anterior Depression**

**Grip:** Place one hand posteriorly with the fingers holding the lateral (axillary) border of the scapula. The other hand holds anteriorly on the axillary border of the pectoralis major muscle and on the coracoid process. The fingers of both hands point toward the opposite ilium, and your arms are lined up in the same direction.

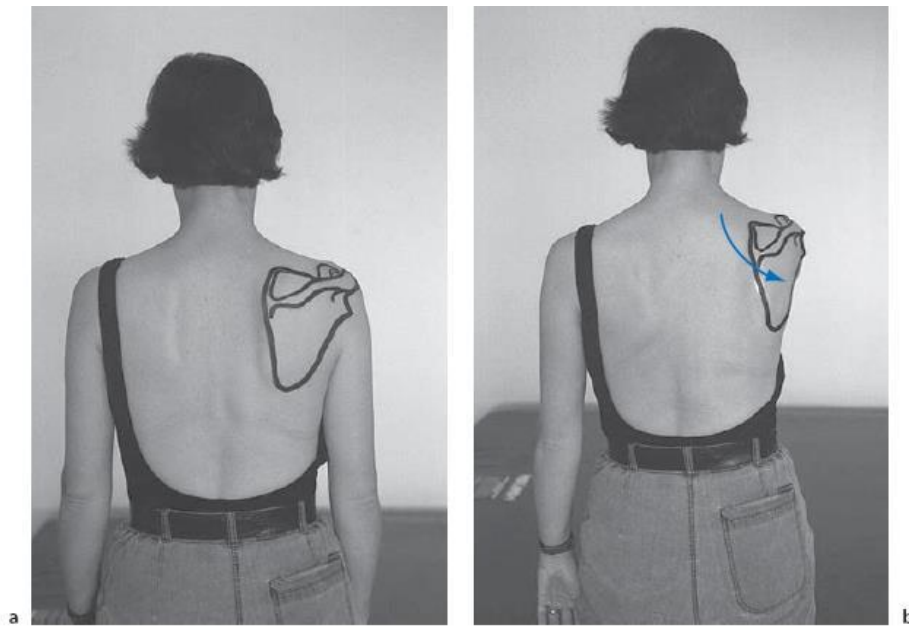
**Elongated Position:** Lift the entire scapula up and back toward the middle of the back of the head (posterior elevation). Be sure that the glenohumeral complex is positioned posterior to the central anteroposterior line of the body (midfrontalplane). You should see and feel that the abdominal area is taut from the ipsilateral ribs to the contralateral pelvis. Continued pressure on the scapula should not cause the patient to roll back or rotate the spine around one segment. **Command:** "Pull your shoulder blade down toward your navel." "Pull."

**Movement:** The scapula moves down and forward, in a line aimed at the opposite anterior iliac crest. The scapula moves forward with the inferior angle in the direction of the spine.

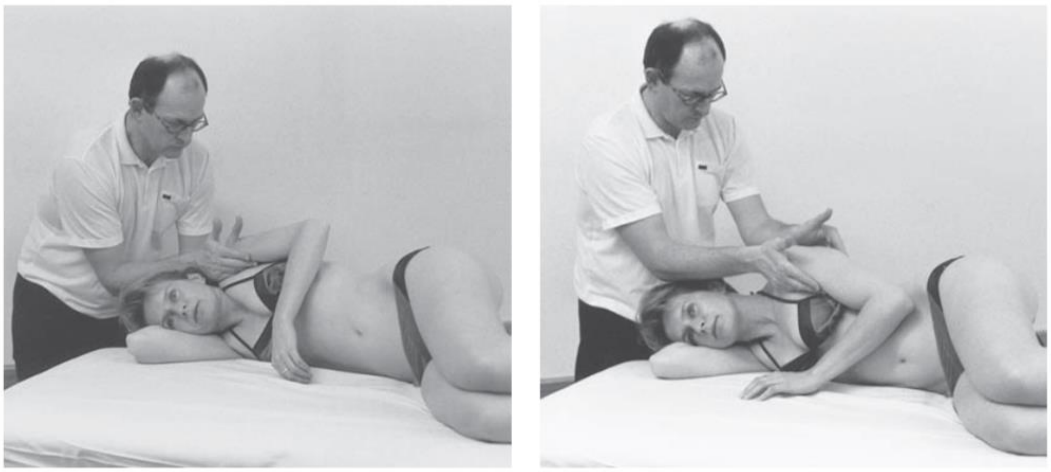
**Body Mechanics:** Let the resistance come from your body weight as you shift from the back to the front leg.

**Resistance:** The resistance follows the curve of the patient's body. At the end of the pattern you are lifting in a line parallel to the front of the patient's thorax.

**End Position:** The scapula is rotated forward, depressed, and abducted. The glenohumeral complex is anterior to the central anteroposterior line of the body.




Anterior depression



Resistance to anterior depression

## 3.11 STATISTICAL TOOLS

### Paired ‘t’ test

Paired ‘t’ test was used to compare the pre-test and post-test values.

### Formula

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

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

Where,

$d$ = difference between the pre-test and post-test

$\bar{d}$ = mean difference

$n$ = total number of subjects

$s$ = standard deviation

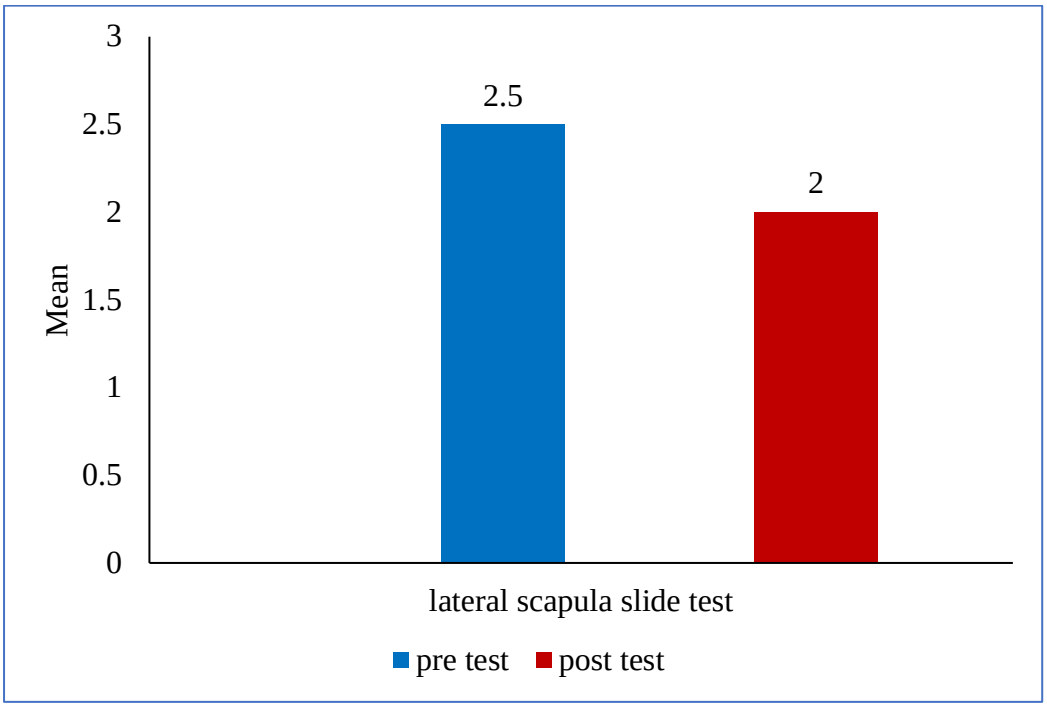
# *Data Analysis And Interpretation*

# 4. DATA ANALSYSIS AND INTERPRETATION

**Table 1: Lateral Scapular Slide Test (Position 1)**

| S. No | Pre test | Post test | d | $d^2$ |
|---|---|---|---|---|
| 1 | 2.8 | 2.1 | -0.7 | 0.49 |
| 2 | 2.6 | 2.0 | -0.6 | 0.36 |
| 3 | 2.3 | 1.9 | -0.4 | 0.16 |
| 4 | 2.5 | 1.9 | -0.6 | 0.36 |
| 5 | 2.8 | 2.2 | -0.6 | 0.36 |
| 6 | 2.6 | 2.0 | -0.6 | 0.36 |
| 7 | 2.4 | 2.1 | -0.3 | 0.9 |
| 8 | 2.6 | 2.0 | -0.6 | 0.36 |
| 9 | 2.5 | 2.0 | -0.5 | 0.25 |
| 10 | 2.3 | 1.9 | -0.4 | 0.16 |
| 11 | 2.6 | 2.1 | -0.5 | 0.25 |
| 12 | 2.4 | 1.8 | -0.6 | 0.36 |
| 13 | 2.5 | 2.1 | -0.4 | 0.16 |
| 14 | 2.4 | 2.0 | -0.4 | 0.16 |
| 15 | 2.3 | 1.8 | -0.5 | 0.25 |

**Graph 1 : Lateral Scapular Slide Test (Position 1)**

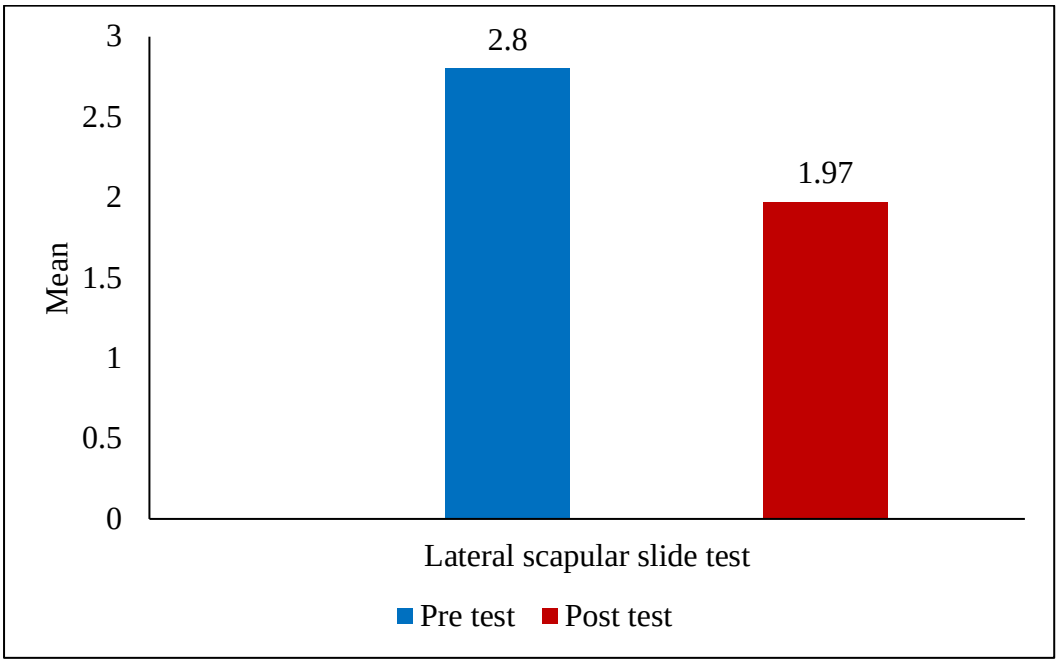



| Outcome Measure | N | Test | Mean | Standard Deviation (SD) | Calculated 't' test | Table 't' value |
|---|---|---|---|---|---|---|
| Lateral Scapular Slide Test | 15 | Pre test | 2.50 | 0.27 | 7.3551 | 2.048 |
| | 15 | Post test | 2 | | | |

**Table 2: Lateral Scapular Slide Test (Position 2)**

| S. No | Pre test | Post test | d | $d^2$ |
|---|---|---|---|---|
| 1 | 2.7 | 2.0 | -0.7 | 0.49 |
| 2 | 2.9 | 2.1 | -0.8 | 0.64 |
| 3 | 2.8 | 1.9 | -0.9 | 0.81 |
| 4 | 3.0 | 2.1 | -0.9 | 0.81 |
| 5 | 2.6 | 1.8 | -0.8 | 0.64 |
| 6 | 2.8 | 2.1 | -0.7 | 0.49 |
| 7 | 2.7 | 2.0 | -0.7 | 0.49 |
| 8 | 3.0 | 2.0 | -1 | 1 |
| 9 | 2.7 | 1.9 | -0.8 | 0.64 |
| 10 | 3.0 | 2.0 | -1 | 1 |
| 11 | 2.6 | 1.9 | -0.7 | 0.49 |
| 12 | 2.9 | 2.0 | -0.9 | 0.81 |
| 13 | 2.7 | 1.9 | -0.8 | 0.64 |
| 14 | 2.8 | 1.9 | -0.9 | 0.81 |
| 15 | 2.8 | 2.0 | -0.8 | 0.64 |

**Graph 2 : Lateral Scapular Slide Test (Position 2)**

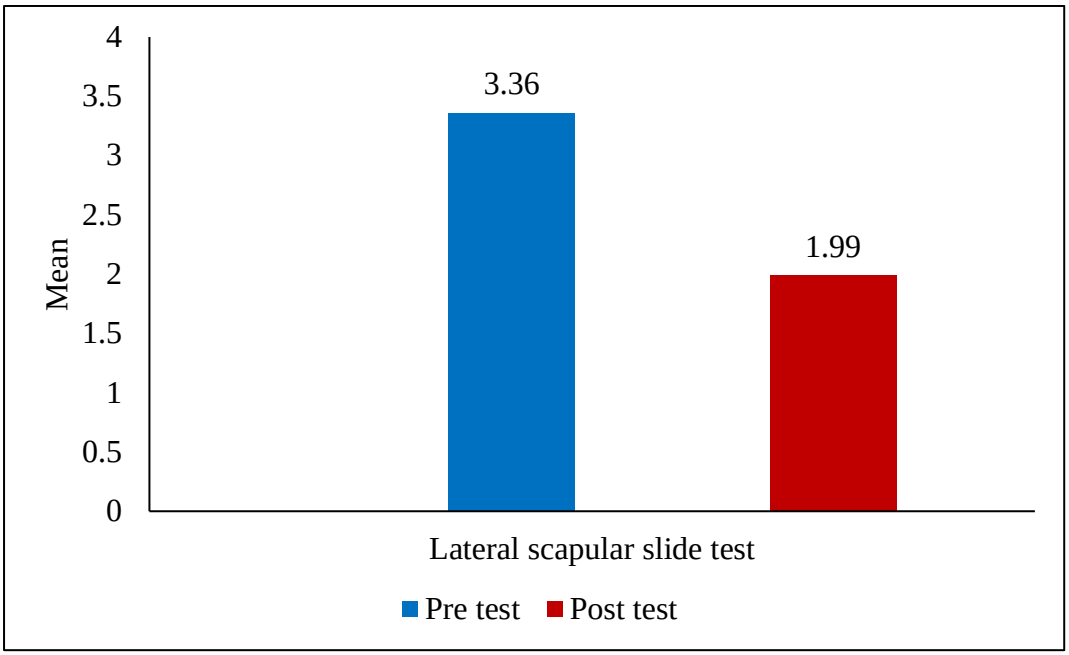



| Outcome Measure | N | Test | Mean | Standard Deviation (SD) | Calculated 't' test | Table 't' value |
|---|---|---|---|---|---|---|
| Lateral Scapular Slide Test | 15 | Pre test | 2.80 | 0.84 | 3.826 | 2.048 |
| | 15 | Post test | 1.97 | | | |

**Table 3 : Lateral Scapular Slide Test (Position 3)**

| S. No | Pre test | Post test | d | $d^2$ |
|---|---|---|---|---|
| 1 | 3.5 | 2.3 | -1.2 | 1.44 |
| 2 | 3.1 | 2.0 | -1.1 | 1.21 |
| 3 | 3.4 | 2.3 | -1.1 | 1.21 |
| 4 | 3.6 | 2.6 | -1 | 1 |
| 5 | 3.1 | 2.1 | -1 | 1 |
| 6 | 3.3 | 2.1 | -1.2 | 1.44 |
| 7 | 3.1 | 2.4 | -0.7 | 0.49 |
| 8 | 3.7 | 2.6 | -1.1 | 1.21 |
| 9 | 3.3 | 2.5 | -0.8 | 0.64 |
| 10 | 3.4 | 2.3 | -1.1 | 1.21 |
| 11 | 3.5 | 2.2 | -1.3 | 1.69 |
| 12 | 3.8 | 2.5 | -1.3 | 1.69 |
| 13 | 3.2 | 2.1 | -1.1 | 1.1 |
| 14 | 3.3 | 2.2 | -1.1 | 1.21 |
| 15 | 3.2 | 2.0 | -1.2 | 1.44 |

**Graph 3: : Lateral Scapular Slide Test (Position 3)**




| Outcome Measure | N | Test | Mean | Standard Deviation (SD) | Calculated 't' test | Table 't' value |
|---|---|---|---|---|---|---|
| Lateral Scapular Slide Test | 15 | Pre test | 3.36 | 0.63 | 5.0371 | 2.048 |
| | 15 | Post test | 1.99 | | | |

# Discussion

# 5. DISCUSSION

In normal individuals voluntary movement patterns utilize functionally linked muscles or synergies that are constrained by the CNS to act cooperatively to produce an action. This movement may be disturbed in Stroke patients. Thus, the patient is unable to perform an isolated movement. In scapula there is a force coupling between serratus anterior, trapezius and rhomboids which gets disturbed post stroke hence there is over activation of rhomboids this disturbance is seen when the movement is bought about actively.

During the flaccid stage, the trunk tends to lean or shorten toward the hemiplegic side, which causes the scapula to descend from its normal horizontal level. The trapezius and the serratus anterior also become flaccid, causing the scapula to rotate downwardly. During the spastic stage, the pectoralis major and minor, rhomboideus, elevator scapulae, and latissimus dorsi can become hypertonic, further rotating the scapula downward.

Many studies have suggested that strength training for the glenohumeral and scapulothoracic regions improves the functionality of the paretic upper extremities. After NJF intervention, reported that these muscles play an important role in the stability of the shoulder complex and that stability is necessary to achieve an appropriate range of motion in the shoulder joint. **Mandalidis and O'Brien** reported that the efficient movement and proper range of motion of the muscles that act on a distal joint are only possible when the proximal joints are efficiently stabilized by the surrounding musculatures[15]. They suggested that it is important to strengthen the scapular stabilizers in order to restore the function of the distal joints of the upper extremity.

Relatively small changes in the scapular muscle affect the alignment and forces around the shoulder complex. Because the scapula plays a critical role in controlling the shoulder joint position and joining it with the humeral head, **Kibler** 2003 stated that muscle imbalance or weakness, scapular muscle fatigue may lead to altered glenohumeral proprioception, muscular inhibition, impaired coordination and timing of movements are the causes for scapular dyskinesia[16]. **Edward et al**.

stated that proprioceptive dysfunction, injury to joint can alter sensory information provided by mechanoreceptors etc, direct trauma and indirect trauma to be the causes for scapular dyskinesia.

**DePalma et al.** notes that the scapula is central in proficient shoulder activity, and rotator cuff muscles will not operate optimally if the scapula is poorly positioned[17]. As has already been noted, the scapula can only be stabilized dynamically if the thoracic spine and the ribs can provide adequate anchorage or foundation for the relevant muscle groups. Poor position, alignment, or stability of the scapula on the chest wall will significantly impact the available range of motion of the shoulder

The objective of the study was to prove the improvement of scapular dyskinesis through application of scapular Neuromuscular Joint Facilitation technique inmates with sub-acute stroke and improvement was measured using Kibler's Lateral Scapular Slide Test (LSST) using post intervention readings.

**Lateral Scapular Slide test(LSST):**

Lateral Scapular Slide test was used to measure the inter scapular distance at three varying positions in the coronal plane.

**Position 1: Patient's arms relaxed at rest**

The pre intervention average distance for LSST in the scapular NJF participants was **2.50cm**. After 4 weeks of intervention period the average distance for LSST was **2cm**. The value of the **standard deviation** for pre-test and post-test are **0.27** respectively. The "**t**" value for the **dependent 't' test** calculated is **7.3551** which is significant at the level **0.05%** at **14** degrees of freedom .

**Position 2: Patient's hands to be placed on the hips with the fingers directed anteriorly and thumbs posteriorly, with approximately 10°of shoulder extension**

The pre intervention average distance for LSST in the scapular NJF participants was **2.80cm**. After 4 weeks of intervention period the average distance for LSST was **1.97cm**. The value of the **standard deviation** for pre-test and post-test are **0.84** respectively. The "**t**" value for the **dependent 't' test** calculated is **3.826** which is significant at the level **0.05%** at **14** degrees of freedom .

**Position 3: Patient's arms were positioned at or below 90° of elevation with maximal internal rotation of the glenohumeral joint**

The pre intervention average distance for LSST in the scapular NJF participants was **3.36cm.** After 4 weeks of intervention period the average distance for LSST was **1.99cm**. The value of the **standard deviation** for pre-test and post-test are **0.63** respectively. The "**t**" value for the **dependent 't' test** calculated is **5.0371** which is significant at the level **0.05%** at **14** degrees of freedom.

Neuromuscular Joint Facilitation (NJF) is a new therapeutic exercise based on kinesiology. It integrates the facilitation element of proprioceptive neuromuscular facilitation (is a therapeutic exercise method introduced by Dr. Herman Kabat in 1940s) and the joint composition movement, aiming to improve the movement of the joint through passive exercise, active exercise and resistance exercise. Neuromuscular Joint Facilitation to the scapula, regains its normal original excursion and thus the scapula serves as a mobile as well as stable base for upper extremity movements. The scapular dyskinesis improved significantly after the NJF intervention.

# *Conclusion*

# 6. CONCLUSION

The conclusion of this study is based on the post mean measures of Lateral Scapular Slide Test and concluded that there is significant improvement in scapular dyskinesis in sub acute stroke patients who received scapular NJF for a duration of 4 weeks.

Thus Null hypothesis is rejected and Alernate hypothesis is accepted which states that "There is a significant effect of Neuromuscular Joint Facilitation (NJF) therapy on scapular dyskinesia by tactics of improving upper limb scapular pattern in patients with sub-acute stroke".

The shoulder complex must be considered a part of a larger kinetic chain made up of several joints. It is obvious that the glenohumeral joint and scapula cannot function independently. Clearly, dysfunction at either joint has a direct effect on the other. The function of the scapula and surrounding mus- culature is vital to the normal function of the glenohumeral joint. As knowledge regarding the role of the scapula continues to grow, improved evaluation and treatment approaches for dyskinesis continue to evolve.

## 6.1 RECOMMENDATIONS FOR THE STUDY

- Large sample size.
- A more precise assessment tool could be helpful.
- Use of EMG, to record muscle activity.
- Gait alterations and upper limb function due to Scapular orientation could `be studied.

## 6.2 LIMITATIONS OF THE STUDY

- lack of a control group.
- Small sample size.
- Short time bound study.

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# *Appendices*

# APPENDICES

## APPENDIX-I

## PARTICIPANT CONSENT FORM

I, MR / MRS _____ of my own free will of choice, hereby give my consent to be included in the study **"EFFECTS OF NEUROMUSCULAR JOINT FACILITATION (NJF) THERAPY ON SCAPULAR DYSKINESIA INMATES WITH SUB-ACUTE STROKE"**

I have been clearly informed to my satisfaction the purpose of the study and thus, I agree To fully cooperate and participate in the study.

I have been informed that no part of my information shall be revealed except the data which will be used for the study and adequate secrecy will be maintained.

Also, no part of the information will be used against me.
I am also aware of my right to opt out at any time and prevent my data to be utilized at any phase of the study if I desire.

Signature_____

I, confirm that I have explained the purpose of the study and answered all the questions related to my study.

Therapist signature _____

**Investigator Certificate**

I certify that all the elements including the nature, purpose and possible risks of the above study as described in this consent document have been fully explained to the subject. In my judgment, the participant possesses the legal capacity to give informed consent to participate in this research and is voluntarily and knowingly giving informed consent to participate, Signature of the Investigator:

_____ Dated: _____

Name of the Investigator: _____

## APPENDIX II

## NEUROLOGICAL EVALUATION CHART

### SUBJECTIVE EXAMINATION

Name:

Age/ sex:

Occupation:

Address:

Date of admission:

Date of assessment:

Handedness:

Chief complaints:

History:

Present history:

Past history:

Personal history:

Surgical history:

Familial history:

Social history:

Associated problems:

### OBJECTIVE EXAMINATION

General examination:

Vitals: BP: Temperature: PR:

HR:

On observation:

Body built:

Attitude of limb:

Swelling, redness:

Deformity:

Posture:

Gait:

External appliances:

On palpation:

Muscle firmness:

Swelling:

Warmth:

Tenderness:

**NEUROLOGICAL EXAMINATION:**

Higher mental function:

Level of consciousness:

Attention:

Orientation:

Memory:

Language:

Calculation:

Judgment:

Proverb interpretation:

Cranial nerve examination:

Sensory examination:

Superficial:

Touch

Pain

Temperature

Pressure

Deep:

Joint position

Kinesthetic sensation

Vibration

Cortical:

Touch localization

Two point discrimination

Stereognosis

Baragnosis

Motor examination:

Muscle tone:

Muscle power:

Reflexes:

Superficial:

Plantar reflex

Abdominal reflex

Anal reflex

Bulbo cavernous reflex

Cremasteric reflex

Deep:

Upper extremity: biceps, triceps, supinator, fingers.

Lower extremity: quadriceps, hamstrings, achilles tendon.

Muscle girth:

Range of motion:

Active ROM:

Passive ROM:

Coordination:

Posture:

Balance:

Gait:

Activity of daily living:

**INVESTIGATION:**

Blood test:

CSF examination:

Other medical investigation:

Anatomical study: X-Ray, CT scan, MRI

Physiological study: NCV, EMG, SD Curve

**DIFFERENTIAL DIAGNOSIS:**

**PROVISIONAL DIAGNOSIS:**

**FUNCTIONAL DIAGNOSIS:**

Impairment:

Structural

Functional

Activity limitation

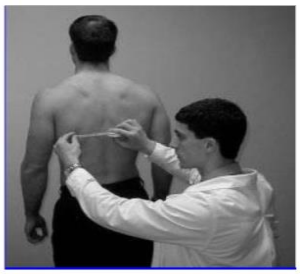
Participation restriction

## APPENDIX-III

## KIBLER'S LATERAL SCAPULAR SLIDE TEST

In Lateral Scapular Slide Test, the distance between the inferior angle of scapula and the closest spinous process was measured bilaterally with a tape measure at 3 different upper extremity positions. The measurement will be referred to as scapular distance. In the first position, the subject's arms were relaxed at the sides. The second position required the subject's hands to be placed on the hips with the fingers directed anteriorly and thumbs posteriorly, with approximately 10°of shoulder extension. In the third position the subject's arms were positioned at or below90° of elevation with maximal internal rotation of the glenohumeral joint. Kibler established a threshold of 1.5 cm asymmetry between the unaffected and affected sides in any of the 3 positions as the point of significant asymmetry, indicating the presence of shoulder dysfunction.

POSITION 1



POSITION 2

POSITION 3