



Efficacy of Kinesiotaping Along with Electrical Stimulation on Reducing Shoulder Subluxation After Stroke: An Experimental Study

Abstract: Post-stroke shoulder subluxation is a frequent complication that restricts arm function and slows recovery. Conventional physiotherapy provides limited relief, whereas kinesiotaping and electrical stimulation can enhance joint stability and neuromuscular activation. This study aims to evaluate the combined effect of kinesiotaping and electrical stimulation on subluxation distance, pain, and shoulder disability. A randomized controlled trial was undertaken with 46 individuals diagnosed with post-stroke shoulder subluxation. Participants were assigned by randomization into two arms: control group receiving conventional physiotherapy and experimental group receiving kinesiotaping combined with electrical stimulation in addition to standard care. Shoulder subluxation was quantified using Finger Breadth Measurement (FB), while pain and functional status were assessed with the Shoulder Pain and Disability Index (SPADI). Statistical analysis was performed using SPSS, employing descriptive statistics, paired t-tests, and independent t-tests, with the threshold for significance set at $p < 0.05$. Within-group analysis revealed significant improvements in finger breadth measurements and SPADI scores across both groups ($p < 0.001$). Follow-up analyses revealed marked improvements in the experimental group compared to controls ($p < 0.001$). The experimental group demonstrated a clinically meaningful reduction of approximately 6 mm in subluxation distance and an improvement exceeding 40 points in SPADI. Our findings show that NMES with taping produced greater improvements in pain, disability, and subluxation than conventional physiotherapy. Follow-up assessments confirmed lasting improvements, supporting multimodal rehabilitation strategies.

Dr. Basetty Praveen Kumar ¹, **Dr. Rajendra Kachhwaha (Phd)** ², **Dr. Smruti swagatika Dash** ³, **Dr. Deepak Jain N** ⁴

Affiliation

¹ Assistant Professor, Narayana Hrudyalaya Institute of Physiotherapy, Bommasandra Industrial Area, Pin Code – 560099, India.

² Principal, Narayana Hrudyalaya Institute of Physiotherapy, Bommasandra Industrial Area, Pin Code – 560099, India.

³ Professor, Narayana Hrudyalaya Institute of Physiotherapy, Bommasandra Industrial Area, Pin Code – 560099, India.

⁴ Associate Professor, Narayana Hrudyalaya Institute of Physiotherapy, Bommasandra Industrial Area, Pin Code – 560, India.

Corresponding Author

Dr. Basetty Praveen Kumar * - basetty.praveenkumar@hrudayalayaafoundation.org

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1.Introduction

Shoulder subluxation, commonly referred to as glenohumeral subluxation (GHS), is a frequently observed complication following stroke, with reported prevalence reaching as high as 80%. [1] Although the glenohumeral joint allows wide mobility, its stability relies heavily on muscular support, which is compromised after stroke. Changes in muscle activity after stroke compromise shoulder stability, predisposing patients to subluxation.



Early after stroke, hypotonia of the hemiplegic arm prevents the rotator cuff from stabilizing the humeral head, predisposing the joint to inferior displacement. In addition, without proper support, the weight of the arm worsens downward displacement of the humeral head.[2]

In the long term, GHS can lead to complications such as hemiplegic shoulder pain, adhesive capsulitis, and reduced proprioception, all of which delay recovery of upper extremity function. Reports indicate Shoulder subluxation is frequently observed after stroke, with most cases appearing in the acute phase.[2] Painful hemiplegic shoulder typically develops within the first two weeks but may present more prominently after two to three months.[3,4] Longitudinal studies have shown that subluxation can worsen over time, with up to 67% of patients experiencing aggravation within ten months.[1,5,7] The risk is highest during the first three weeks of hemiplegia, underscoring the importance of early intervention.

Basmajian and Bazant's model suggests that flaccidity leads to trunk lean and scapular descent, while reduced rotator cuff tone undermines glenohumeral stability. Later spasticity in muscles like the pectoralis major and rhomboids drives downward scapular rotation, worsening instability.[1,12,16,18] Other contributing factors include improper positioning, prolonged gravitational pull without muscular counterforce, lack of support in upright positions, and inappropriate handling during patient transfers.[6-8] Severe motor loss and absence of supraspinatus contraction are also recognized as major risk factors.[10]

Multiple strategies have been trialed to address post-stroke shoulder subluxation. Mechanical approaches such as shoulder supports and orthoses provide temporary relief. [10,11,18]

Positioning strategies using lap trays, pillows, or foam supports help reduce strain and prevent frozen shoulder.[9] Although slings are widely used for alignment, studies report mixed outcomes; they may restrict arm swing and increase abnormal tone.[10,11] Taping approaches, whether longitudinal or circumferential, have demonstrated benefits in pain relief and alignment correction.[12] Neuromuscular electrical stimulation (NMES) has been widely investigated for its ability to recruit supraspinatus and deltoid muscles, thereby resisting gravity-driven humeral head displacement.[9,19,24] Early rehabilitation that combines NMES and taping has been shown to outperform conventional therapy in reducing pain and joint displacement.[12-16]

Given the high prevalence and disabling consequences of shoulder subluxation, there is a clear need for effective interventions. Combining kinesiotaping with NMES may provide both mechanical support and neuromuscular activation, offering a synergistic approach to restoring shoulder stability and improving functional outcomes in post-stroke rehabilitation.

Shoulder subluxation is a common complication after stroke, with prevalence rates varying widely across studies. It is strongly associated with muscle weakness, altered scapulohumeral rhythm, and impaired proprioception. Previous literature has consistently reported its impact on functional recovery and rehabilitation outcomes.[1,5,9] Recent evidence by Qu et al. demonstrated that the acromion-greater tuberosity distance is significantly increased on the affected side, while supraspinatus thickness is reduced, identifying stroke severity and muscle atrophy as key contributing factors.[25] Similarly, Anwer and Alghadir reported that hemiplegic shoulder pain occurs in approximately 10-47% of stroke patients and is influenced by age, gender, muscle tone, and sensory deficits.[7]



Suethanapornkul et al. further confirmed that shoulder pain is strongly associated with subluxation and is more prevalent in patients with proprioceptive loss and hemorrhagic stroke.[2]

Neuromuscular electrical stimulation (NMES) has been extensively explored as a therapeutic intervention aimed at activating shoulder stabilizing muscles. Evidence from systematic reviews suggests that NMES demonstrates greater effectiveness when applied during the early stages of stroke rehabilitation, primarily in preventing progression rather than correcting established deformities.[17,29] Lee et al. demonstrated significant reductions in subluxation in acute and subacute stroke populations, although the effect was less pronounced in chronic cases.[24] Jang et al. reported that brain-computer interface-controlled functional electrical stimulation significantly improved shoulder alignment and motor recovery compared to conventional stimulation.⁽²⁶⁾ Additionally, stimulation targeting multiple muscles, including the supraspinatus and long head of the biceps, has been shown to produce superior outcomes.[20] Randomized controlled trials by Koyuncu et al. and Liu et al. further confirmed improvements in pain, subluxation, and upper limb function following electrical stimulation. [27,28] Earlier foundational work by Faghri et al. also demonstrated that prolonged electrical stimulation reduces subluxation severity and enhances arm function.[30]

Kinesiotaping is increasingly used as an adjunct to enhance alignment and proprioceptive input in hemiplegic shoulders. Evidence shows that kinesiotaping alleviates pain and improves shoulder stability in post-stroke rehabilitation.[31,14] Yim et al. observed reduced subluxation distance and improved pain, ROM, and function with therapeutic taping. [16] Similarly, Yang et al. documented immediate and lasting gains in

muscle activation and pain relief after taping.[15] However, findings are not entirely consistent; Chatterjee et al. demonstrated improvements in pain and shoulder mobility but did not find statistically significant reductions in subluxation. [13] Other studies have also supported the short-term benefits of taping in acute stroke populations, although long-term efficacy remains uncertain. [32,33]

In this study, NMES combined with taping improved both muscle activation and shoulder stability, producing superior results. Studies indicate that combining taping with NMES yields superior improvements in alignment and function compared to using either modality independently.[22,18] These findings reinforce the clinical rationale for adopting multimodal rehabilitation strategies that simultaneously address mechanical stability and neuromuscular activation.

In terms of outcome measures, accurate assessment of shoulder subluxation is critical. Finger breadth palpation remains common in clinical practice, though ultrasound offers superior sensitivity and precision.[34] Ultrasound offers more precise assessment of joint alignment than clinical palpation, detecting subtle displacement change.[23,38] Furthermore, validated clinical scales such as SPADI and functional indices are widely recommended for assessing pain and disability in stroke patients.[16]

Overall, the findings of the present study are consistent with existing literature, demonstrating that combined therapeutic approaches yield better clinical outcomes in reducing shoulder subluxation and improving functional recovery.

Lacunae In Literature

As evident from above review of literature, currently, there is limited evidence regarding



the effectiveness of combined taping and NMES in reducing shoulder subluxation in patients with shoulder subluxation after stroke. While each technique independently reduces subluxation and improves function, comparative evidence on combined versus single interventions remains limited. Thus, further high-quality studies like RCTs need to be performed. Realizing this need, the current study has been proposed.

2. Research Questions

Is kinesiotaping combined with NMES effective in reducing shoulder subluxation in stroke patients?

3. Aims And Objectives

Aim:

To determine the effect of kinesiology taping along with electrical stimulation on subluxation levels in shoulder subluxation after stroke.

Objectives of the study

Primary Objective

To compare post-stroke shoulder subluxation levels between Group A (kinesiotaping with NMES) and Group B (conventional physiotherapy).

Secondary Objective

To compare the subluxation reduction between the group A (kinesiotape & NMES) and group B (conventional physiotherapy) in post-stroke assessment.

Materials and methods

- **Study area:** Adult intensive treatment unit and physiotherapy unit, Narayana institute of cardiac sciences(MSMC), Bangalore

- **Study population:** Subject with shoulder subluxation after stroke
- **Study design:** Randomized Controlled Trial
- **Study duration:** The entire study, from screening to final follow-up and data analysis, spans 3 months (12 weeks) to complete recruitment (n=46), intervention, 4-week post-treatment assessment, and reporting.

Sample size (with justification)

According to the study by Mohamed Hussein El Gendy et al. (2024), the Mean and Standard deviation of post-shoulder Subluxation in Group A and Group B are 14.99 ± 4.4 and 18.73 ± 3.17 , respectively. Expecting a similar difference, the sample size was calculated using 95% Confidence Interval and 90% power.

$$\text{Formula: } n \geq \frac{\left(\frac{z_{1-\alpha} + z_{1-\beta}}{2}\right)^2 \left(\frac{\sigma_1^2 + \sigma_2^2}{r}\right)}{(\mu_1 - \mu_2)^2}$$

Here,

Type I error (α) = 0.05

Type II error (β) = 0.1

Mean in Group 1 = 14.99

Standard Deviation in Group 1 = 4.4

Mean in Group 2 = 18.73

Standard Deviation in Group 2 = 3.17

Ratio (Group1/Group 2) = 1

Minimum Sample size needed in Group 1 = 23

Minimum Sample size needed in Group 2 = 23

4. Eligibility Criteria and Participants recruitment procedure

Inclusion Criteria

Adults of any gender who were 18 years of age or older and had a diagnosis of ischaemic or hemorrhagic stroke of vascular origin confirmed by a CT scan were included in the study. All individuals were aware, orientated, and capable of following basic instructions (MMSE > 24), and they were haemodynamically stable for at least 24 to 48 hours, with blood pressure, heart rate, and oxygen saturation within safe ranges.

Enrolment was limited to the acute phase (within 30 days of onset), and only first-ever stroke cases were taken into account. In addition to having pain and disability scores of ≥ 30 on the SPADI subscales, which ensured both structural displacement and symptomatic burden, eligible participants had a clinically diagnosed shoulder subluxation on the paretic side, which was verified by a gap of at least one finger breadth between the acromion and humeral head.

5.Exclusion Criteria

Patients with known allergies to tape adhesives, metallic implants in the shoulder or trunk region (such as pacemaker leads or orthopaedic hardware), or significant cognitive impairment or aphasia that hindered consent or compliance were excluded. Likewise, individuals with severe comorbidities including cancer, active infections, or open wounds, as well as those with uncontrolled hypertension or major cardiac disease, were disqualified. Additional exclusion factors included the need for invasive ventilator support, burns or fragile skin at the application site, and other musculoskeletal conditions in the thoracic or shoulder region (e.g., rotator cuff tear, acromioclavicular joint pathology). These criteria were applied to minimize confounding influences and ensure participant safety throughout the intervention.

Recruitment and Allocation: Eligible participants who met the inclusion criteria and provided written informed consent were recruited into the study. Following enrollment, subjects were randomly assigned to one of two groups, ensuring balanced distribution and adherence to ethical standards. The trial is registered in CTRI (CTRI/2026/01/102493). Techniques applied in the study will be of standard of care. Participants will be randomized using a computer-generated randomization sequence. subjects will be allocated into two groups.

6.Methodology-A Detailed description of the methodology of the proposed

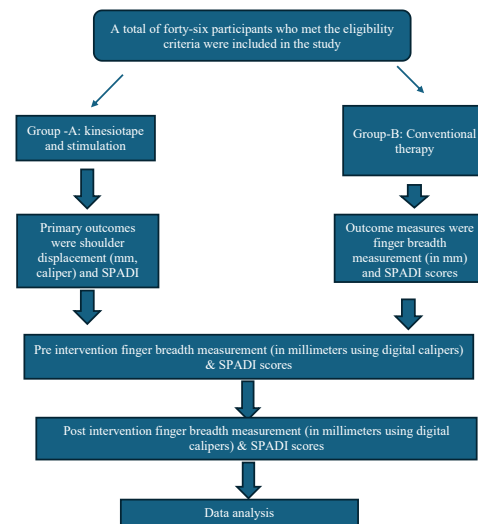


Figure 1: Participant flow diagram based on CONSORT 2010 guidelines.

Experimental group: (Group A)

This group will have electrical stimulation (NMES) along with kinesiology taping treatment.[22]

Electrical stimulation:

Step-by-Step Procedure:

1. Patient Preparation

- Position the patient seated or supine with the affected arm supported.
- Manually approximate the shoulder joint if visibly subluxed.
- Clean the skin and ensure no contraindications (e.g., pacemaker, skin lesions).
- NMES sessions were scheduled daily, applied after tape removal. [22]

2. Electrode Placement

- Place electrodes over:
 - **Supraspinatus:** Just above the spine of the scapula [17-19][21]
 - **Posterior or middle deltoid:** Lateral shoulder area
- For dual-channel stimulators, use separate channels for each muscle group.

NMES-Parameters:

- **Current:** Faradic current
- **Pulse duration:** 200–300 μ s
- **Frequency:** 30–50 Hz
- **Intensity:** Enough to produce visible muscle contraction without discomfort [20]
- **On/Off time:** 10–15 sec on, 30–45 sec off
- **Session duration:** 15–30 minutes, 1–2 times a day, 6 days in a week
- **Study duration:** 4 weeks [22]



Figure 2: Application of neuromuscular electrical stimulation (NMES).

Step-by-Step Taping Protocol:

Kinesiotape can be applied after the electrical stimulation followed with conventional physiotherapy. This procedure can be done for 6 days a week for 4 weeks of duration.

1. Supraspinatus Facilitation

- Apply an **I-strip** from the **medial superior scapula** (origin of supraspinatus) toward the **greater tubercle of the humerus**.
- Use **15–25% stretch** with the shoulder in slight abduction and internal rotation.
- This promotes proprioception and supports elevation.

2. Deltoid Activation

- Apply a **Y-strip** over the deltoid:
 - Anchor at the **deltoid tuberosity**.

- One tail goes over the **anterior deltoid**, the other over the **posterior deltoid**.
- Use **20–30% stretch** to encourage muscle activation and joint congruency.

3. **AC Joint Stabilization:** Apply a short **I-strip** directly over the **acromioclavicular joint** with **100% stretch** to reinforce the joint capsule.





Figures 3–4: Application of kinesiology tape (supraspinatus, deltoid, AC joint)

Control group:(Group B)

Participants in the control group followed the same conventional rehabilitation exercise program, which included both physical and occupational therapy sessions. Standard physiotherapy measures, such as positioning, range of motion (ROM) exercises, and handling techniques, were consistently applied in both the study and control groups. Rehabilitation was delivered over a period of four weeks, six days per week, with each session lasting 60 minutes. Therapists were specifically instructed to avoid commenting on the taping during the daily rehabilitation sessions.

Both groups continued their daily function and rehabilitation routine while using the NMES device. The subjects received only conventional treatment during the follow-up period (2 weeks after the completion of the 6 week treatment). Conventional therapy was provided by a therapist, blinded to group allocation.





Figures 5–7: Conventional physiotherapy (ped-o-cycle, assisted shoulder movement, overhead pulley).

Materials Required:

- Electrical stimulator
- Kinesiotape
- Paper sheets of outcome measure
- Pencil and pen

Outcome measures:

Finger Breadth Measurement:

In assessing shoulder subluxation using the finger breadth method, the therapist palpates the interval between the acromion and the head of the humerus with the patient seated comfortably and the arm in neutral. The number of finger widths that can fit in this space indicates the degree of subluxation, with 0 fingers representing no subluxation and a greater number of finger widths indicating a more severe separation of the humeral head from the shoulder joint. Shoulder subluxation was initially assessed clinically using the finger breadth method by palpating the distance between the acromion process and the head of the humerus.

For objective quantification, the same distance was measured using a digital caliper and recorded in millimeters. While finger breadth provides a quick clinical estimation, digital caliper measurement offers greater precision and reliability; therefore, caliper-measured values were considered the primary outcome for statistical analysis.[34]



Figures 8–9: Finger breadth measurement and digital caliper assessment.

Shoulder Pain and Disability Index (SPADI)

The Shoulder Pain and Disability Index SPADI is a validated self-reported outcome measure consisting of pain and disability subscales used to assess shoulder-related functional impairment. The SPADI pain subscale includes five items assessing pain severity. 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 typically requires 5–10 minutes to complete and is considered a reliable and valid region-specific instrument for assessing shoulder-related pain and disability.[16]

The assessments were performed by physiotherapists with >3 years of experience in stroke rehabilitation, blinded to the participants' group allocation. All the assessments were carried out by the same therapist, to ensure intra-rater reliability.



Risk and Benefits

The study involves using kinesiotape, electrical stimulation, adhesive tape and gel for treatment. Mild skin irritation or discomfort may occur with kinesiotape application. Apart from discomfort, no other risks and side effects have been anticipated with tasks. As mentioned earlier, Participants may experience potential benefits, including reduction in subluxation and improved functional ability, enabling you to carry out day-to-day activities easily after completion of treatment.

Obtaining Informed consent Form

Prior to initiating any study-related procedures, including baseline assessments and randomization, each eligible participant will be requested to provide informed consent. To safeguard privacy and minimize external influence, the process will be conducted in a quiet, confidential hospital setting by the principal investigator or a delegated physiotherapist authorized by the Institutional Ethics Committee (NHH/AEC-CL-2025-1514). The study's purpose, procedures (kinesiotaping, neuromuscular electrical stimulation, and conventional physiotherapy), duration, potential risks (such as mild skin irritation or discomfort), expected benefits, and available alternatives (routine physiotherapy care) will be explained in clear, non-technical language. Participants will be assured that their involvement is voluntary, and refusal or withdrawal at any stage will not compromise the quality of their routine medical or physiotherapy care.

The IEC-approved Participant Information Sheet and Informed Consent Form will be provided in both English and locally understood vernacular languages. For illiterate participants, the documents will be read aloud in the presence of an impartial witness, and sufficient time will be given to consult family members and ask questions before deciding. In

line with national regulations, consent for individuals with impaired decision-making capacity will be obtained from a legally authorized representative, while patient assent will be sought whenever possible. The consent form will be signed (or thumb-impressed) and dated by the participant or representative, the person obtaining consent, and the impartial witness if applicable. One copy will be handed to the participant, while the original will be securely archived in the study file for the required retention period as per institutional and regulatory guidelines.

6. Statistical Analysis:

This will be performed using the SPSS software version 27. All the categorical variables will be expressed in frequency and percentages. All the continuous variables will be expressed in means and standard deviations or median and IQR. The Shapiro-Wilk test will be used to check the normality of the data. The chi-square test will be the test of significance to find the association between the categorical data. The Independent T-test or the Mann-Whitney U-test will be the test of significance to compare the continuous data. A p-value of <0.05 will be considered statistically significant. Statistical analysis was performed using caliper-measured subluxation values (in millimeters), as finger breadth measurement is a subjective clinical estimate.

Observation And Results

Table 1: Comparison of age between the groups

Groups	n	Mean	SD	t value	P value
Control	23	59.0000	3.16228	0.047	0.963
Experimental	23	58.9565	3.16914		

Independent t-test; $P \leq 0.05$ is considered statistically significant



Graph 1: Comparison of age between the groups

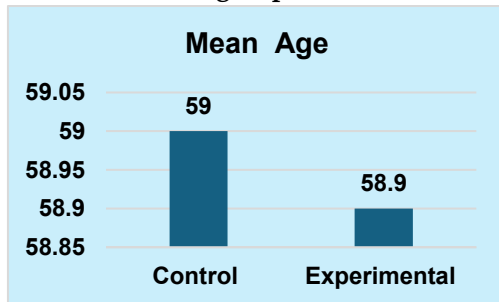


Table 1 shows that the mean age of participants in the control group was 59.00 ± 3.16 years, while in the experimental group it was 58.96 ± 3.17 years. The independent t-test showed no statistically significant difference between the groups ($t = 0.047$, $p = 0.963$), indicating that both groups were comparable in terms of age distribution.

Chi-Square value	0.000
P value	1.000

Chi-Square test; $P \leq 0.05$ is considered statistically significant

Graph 2: Distribution and comparison of groups based on gender

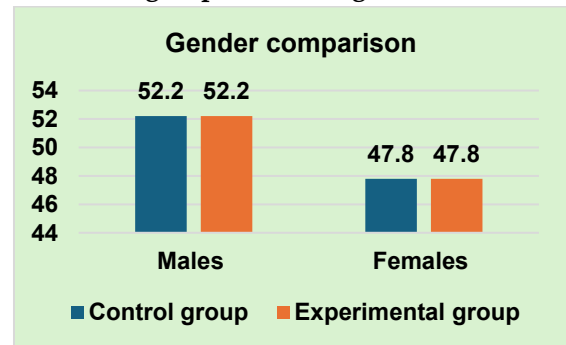


Table 2: Distribution and comparison of groups based on gender

Gender	Control group		Experimental group	
	n	%	n	%
Males	12	52.2	12	52.2
Females	11	47.8	11	47.8

Table 2 explains that the gender distribution was identical in both groups, with 52.2% males ($n = 12$) and 47.8% females ($n = 11$) in each group. The Chi-square test showed no statistically significant difference ($\chi^2 = 0.000$, $p = 1.000$), confirming that the groups were well matched in terms of gender.

Table 3: Mean comparison of finger breadth (mm) within the groups

Groups	Timeline	n	Mean	SD	Mean Rank	Test value	P value
Control group	Pre	23	24.4348	1.12112	3.00	46.000	<0.001*
	Post	23	23.4348	1.12112	2.00		
	Follow-up	23	22.4348	1.12112	1.00		
Experimental group	Pre	23	24.5217	1.08165	3.00	46.000	<0.001*
	Post	23	20.5217	1.08165	2.00		
	Follow-up	23	18.5217	1.08165	1.00		

Friedmann Two-Way ANOVA test; $P \leq 0.05$ is considered statistically significant

Table 3a: Pairwise comparison – post hoc analysis

Comparison between		P value	
		Control group	Experimental group
Pre	Post	0.002*	0.002*
	Follow-up	<0.001*	<0.001*
Post	Follow-up	0.002*	0.002*

Graph 3: Mean comparison of finger breadth (mm) within the groups

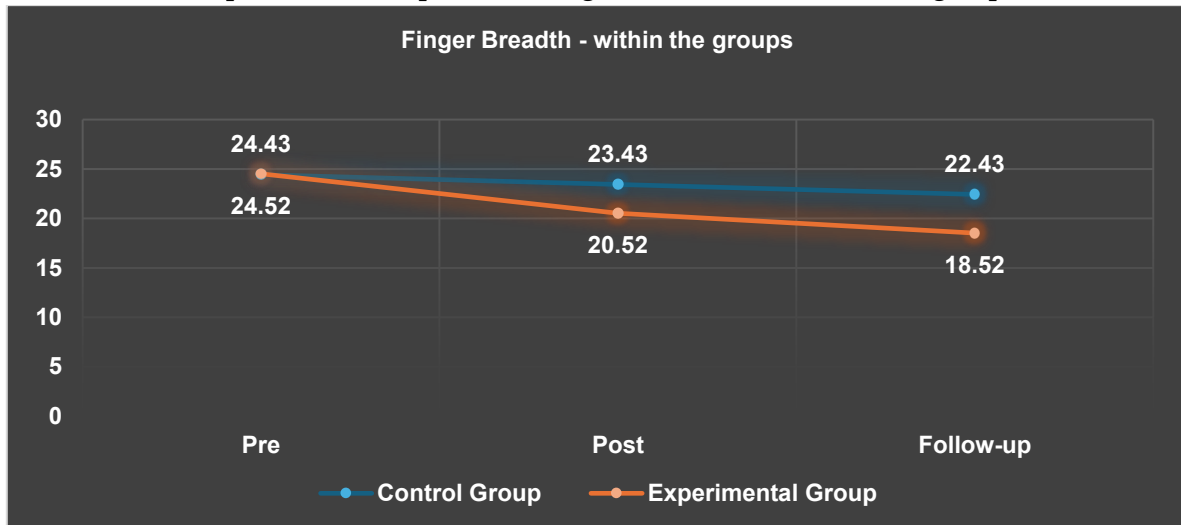


Table 3 shows within the control group, the mean finger breadth decreased from 24.43 ± 1.12 mm at pre, to 23.43 ± 1.12 mm post, and 22.43 ± 1.12 mm at follow-up. In the experimental group, it reduced more markedly from 24.52 ± 1.08 mm at pre, to 20.52 ± 1.08 mm post, and 18.52 ± 1.08 mm at follow-up. The Friedman test showed a statistically significant difference over time in both groups (test value = 46.000, $p < 0.001$). This indicates that both

groups showed improvement, with a greater reduction in the experimental group.

Pairwise comparison revealed that all time intervals (pre-post, pre-follow-up, and post-follow-up) showed statistically significant differences in both control and experimental groups ($p = 0.002$ and $p < 0.001$). This confirms consistent improvement across all time points.

Table 4: Mean comparison of finger breadth (mm) between the groups

Timeline	Group	n	Mean	SD	Mean rank	Test value	P value
Pre	Control	23	24.4348	1.12112	22.98	-0.272	0.785
	Experimental	23	24.5217	1.08165	24.02		
Post	Control	23	23.4348	1.12112	34.35	-5.554	<0.001*
	Experimental	23	20.5217	1.08165	12.65		
Follow-up	Control	23	22.4348	1.12112	35.00	-5.857	<0.001*
	Experimental	23	18.5217	1.08165	12.00		

Mann-Whitney U test; $P \leq 0.05$ is considered statistically significant

Graph 4: Mean comparison of finger breadth (mm) between the groups

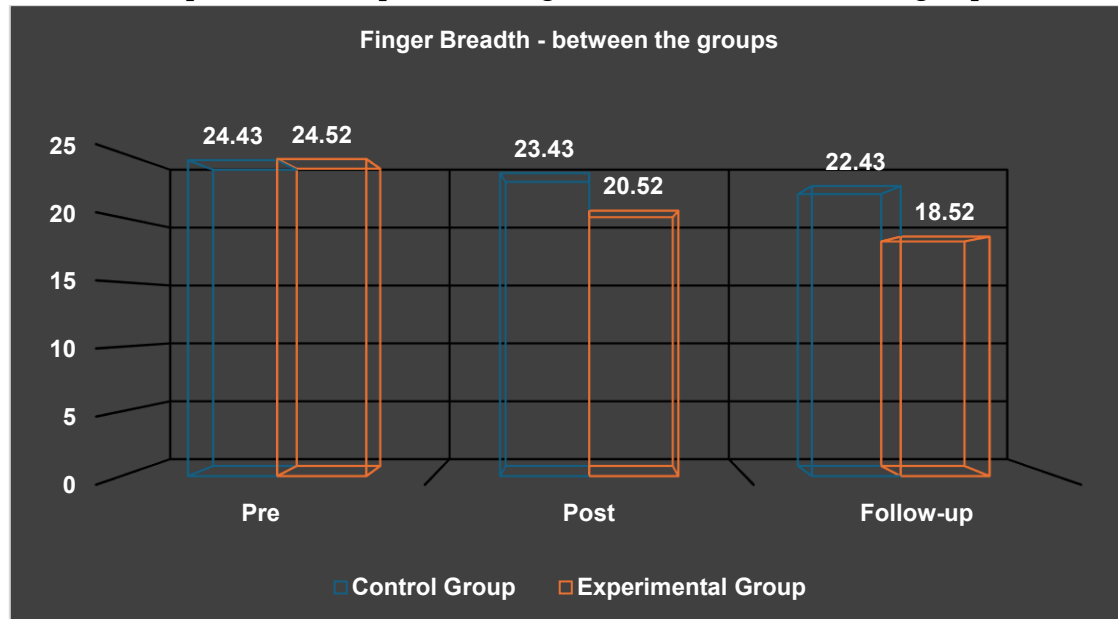


Table 4 explains Between-group comparison showed no significant difference at baseline ($p = 0.785$), indicating comparability. However, at post (control: 23.43 ± 1.12 mm; experimental: 20.52 ± 1.08 mm) and follow-up (control: 22.43 ± 1.12 mm; experimental: 18.52 ± 1.08 mm), the

experimental group demonstrated significantly lower values ($p < 0.001$), indicating superior improvement compared to the control group

Table 5: Mean comparison of SPADI within the groups

Groups	Timeline	n	Mean	SD	Mean Rank	Test value	P value
Control group	Pre	23	71.7391	2.41618	3.00	46.000	<0.001*
	Post	23	67.7391	2.41618	2.00		
	Follow-up	23	65.7391	2.41618	1.00		
Experimental group	Pre	23	71.8261	2.42435	3.00	46.000	<0.001*
	Post	23	36.0870	2.71215	2.00		
	Follow-up	23	30.3478	2.44222	1.00		

Friedmann Two-Way ANOVA test; $P \leq 0.05$ is considered statistically significant

Table 5a: Pairwise comparison – post hoc analysis

Comparison between		P value	
		Control group	Experimental group
Pre	Post	0.002*	0.002*
	Follow-up	<0.001*	<0.001*
Post	Follow-up	0.002*	0.002*

Graph 5: Mean comparison of SPADI within the groups

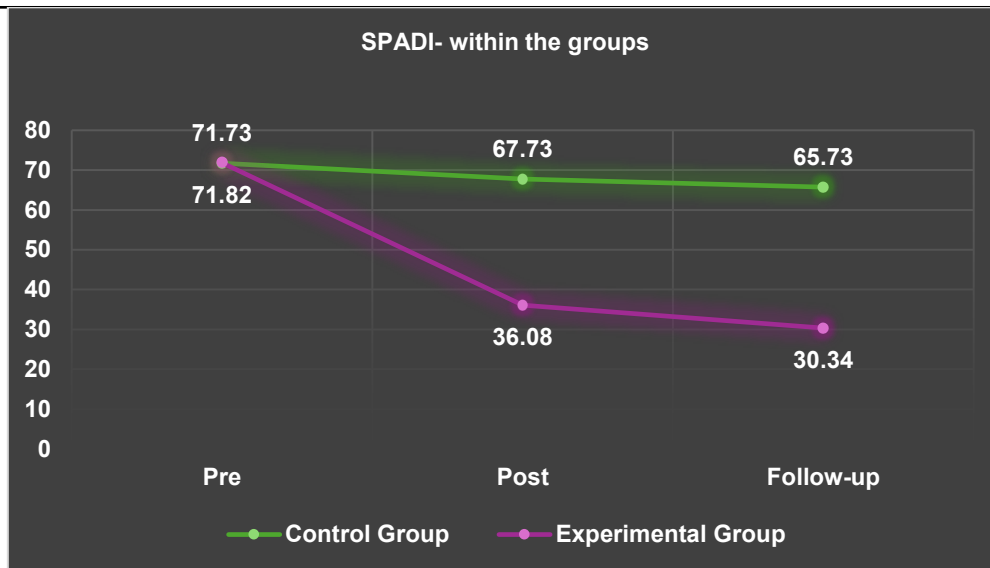


Table 5 shows that within the control group, SPADI scores decreased from 71.74 ± 2.42 at pre, to 67.74 ± 2.42 post, and 65.74 ± 2.42 at follow-up. In the experimental group, a more pronounced reduction was observed from 71.83 ± 2.42 at pre, to 36.09 ± 2.71 post, and 30.35 ± 2.44 at follow-up. The Friedman test showed statistically significant differences over time in both groups (test value = 46.000, $p < 0.001$),

indicating improvement, especially in the experimental group.

Post hoc analysis showed statistically significant differences between all-time intervals in both groups ($p = 0.002$ and $p < 0.001$), confirming continuous improvement across time points.

Table 6: Mean comparison of SPADI between the groups

Timeline	Group	n	Mean	SD	Mean rank	Test value	P value
Pre	Control	23	71.7391	2.41618	23.24	-0.133	0.894
	Experimental	23	71.8261	2.42435	23.76		
Post	Control	23	67.7391	2.41618	35.00	-5.824	<0.001*
	Experimental	23	36.0870	2.71215	12.00		
Follow-up	Control	23	65.7391	2.41618	35.00	-5.831	<0.001*
	Experimental	23	30.3478	2.44222	12.00		

Mann-Whitney U test; $P \leq 0.05$ is considered statistically significant

Graph 6: Mean comparison of SPADI between the groups

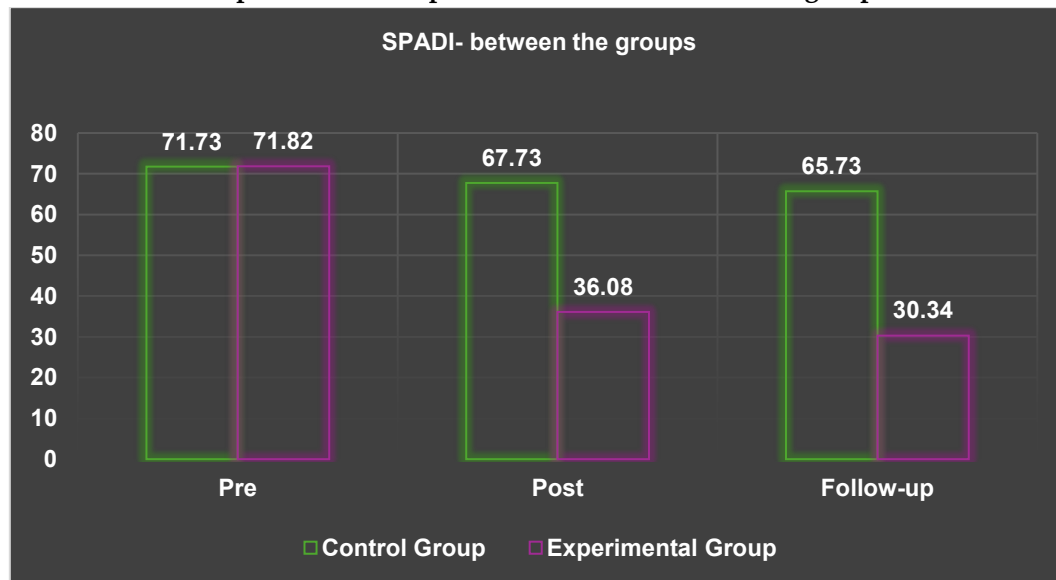


Table 6 explains at baseline, there was no significant difference in SPADI scores between the control (71.74 ± 2.42) and experimental groups (71.83 ± 2.42) ($p = 0.894$). However, at post (control: 67.74 ± 2.42 ; experimental: 36.09 ± 2.71) and follow-up (control: 65.74 ± 2.42 ; experimental: 30.35 ± 2.44), the experimental

group showed significantly lower scores ($p < 0.001$), indicating a greater reduction in pain and disability.

Discussion

This randomized controlled trial evaluated the efficacy of kinesiotaping combined with neuromuscular electrical stimulation (NMES) in reducing shoulder subluxation and improving pain and functional outcomes in post-stroke patients. The findings demonstrated that although both groups showed statistically significant improvements over time, the experimental group exhibited significantly greater reductions in shoulder subluxation and SPADI scores compared to the control group.

The greater reduction in shoulder subluxation observed in the experimental group can be attributed to the combined neuromuscular and

mechanical effects of NMES and kinesiotaping. Neuromuscular electrical stimulation facilitates activation of the supraspinatus and posterior deltoid muscles, which are essential stabilizers of the glenohumeral joint and play a crucial role in preventing inferior displacement of the humeral head.[1,9,24] These findings align with earlier research, possibly due to improved neuromuscular activation provided by NMES.[9,24,30] Similarly, meta-analyses have confirmed that NMES significantly improves shoulder alignment and reduces subluxation when applied during the acute phase of stroke rehabilitation. [29,31]

Kinesiotaping, on the other hand, provides external mechanical support and enhances proprioceptive feedback, thereby improving joint alignment and neuromuscular control. Studies have shown that shoulder taping techniques can reduce pain, improve upper limb function, and assist in maintaining proper glenohumeral positioning.[12,14,32] The California tri-pull taping method and similar approaches have demonstrated effectiveness in reducing pain and enhancing functional ability in stroke patients with shoulder subluxation.[13] Furthermore, systematic reviews have reported that kinesiotaping



contributes to improved motor function and activities of daily living, beyond placebo effects.[14,15]

The combination of NMES and kinesiotaping may produce a synergistic effect, leading to superior clinical outcomes compared to conventional therapy alone. The present results are in agreement with prior studies; however, the greater magnitude of improvement observed in this study may be due to the combined effect of mechanical support and neuromuscular facilitation.[22] The synergistic mechanism may involve simultaneous activation of stabilizing muscles and external support to maintain joint congruency, thereby reducing mechanical stress on periarticular structures.

In addition to improvements in joint alignment, the experimental group demonstrated a marked reduction in SPADI scores, indicating decreased pain and disability. Shoulder pain following stroke is often associated with subluxation, soft tissue strain, and altered biomechanics.[3,5] By improving joint stability and alignment, the combined intervention likely reduced nociceptive input and mechanical irritation, thereby alleviating pain. Moreover, sensory stimulation provided by kinesiotaping may contribute to pain modulation through neurophysiological mechanisms, as suggested in previous studies.[33]

The findings of this study are also supported by epidemiological evidence indicating that shoulder subluxation commonly develops during the acute phase of stroke and can significantly impact functional recovery if not addressed early.[1,2] Early intervention, as implemented in this study (within 30 days post-stroke), is therefore critical in preventing long-term complications such as hemiplegic shoulder pain and reduced upper limb function.[6,7]

Clinically, these results highlight the importance of incorporating combined therapeutic approaches in routine physiotherapy management of post-stroke shoulder subluxation. Compared to conventional methods such as positioning, slings, and passive exercises, the addition of NMES and kinesiotaping offers a more active and targeted approach to restoring joint stability and function.[9,10]

Despite the strengths of this study, including its randomized controlled design and the use of objective measurement tools such as digital calipers (which has demonstrated high reliability with ICC values up to 0.97), certain limitations must be acknowledged. The sample size was relatively small, and the follow-up duration was limited, which restricts the generalizability of the findings and the ability to assess long-term outcomes. Additionally, complete blinding was not feasible due to the nature of the interventions, which may introduce potential bias.

Future studies should focus on larger sample sizes, longer follow-up periods, and inclusion of additional outcome measures such as muscle activity and functional independence scales. Further research is also needed to explore the long-term sustainability of the combined intervention effects.

8. Conclusion

Both control and experimental groups showed statistically significant improvement over time in finger breadth and SPADI scores. However, the experimental group demonstrated a significantly greater reduction in both parameters at post-treatment and follow-up. Thus, the intervention used in the experimental group was more effective than the control treatment in improving outcomes. These results support the incorporation of combined kinesiotaping and NMES as an effective adjunctive treatment strategy in the early



rehabilitation of shoulder subluxation following stroke.

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10. Confidentiality of the study participants:

Your personal data will be the sole responsibility of the investigator, and the research team and complete confidentiality will be maintained to prevent any information leaks. The data collected will be used for statistical analysis for the results of the study from which necessary inferences will be made.

11. Ethical Consideration:

Ethical clearance will be obtained before the commencement of the study from the institutional ethics committee (NHH/AEC-CL-2025-1514). Informed consent will be obtained from the patients before the onset of the study. There are no additional investigations required for my study. Privacy and confidentiality of the patients will be maintained. Management of these patients will be along the standard guideline.

12. Conflict of Interest. There is none among the authors

13. Funding.

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