PAKISTAN BIOMEDICAL JOURNAL
https://www.pakistanbmj.com/journal/index.php/pbmj/index
Volume 5, Issue 5 (May 2022)

Original Article

Effects of Neurodynamics on Spasticity in Upper Extremity of Stroke Patients

Nafeesa Zamurd[1], Mirza Obaid Baig[1], Aamir Gul Memon[1], Muhammad Khan Bugti[2], Mazhar Ali Butto[3], Maryam Sulaiman[4], Umar Shakoor[5], Amber Shakoor [5], Muhammad Adnan[6] and Saman Jahangir[7]

[1]Riphah International University Islamabad, Pakistan
[2]Begum Nusrat Bhutto University Sukkur, Pakistan
[3]Sindh Govt Civil Hospital Khairpur, Pakistan
[4]Comwave Institute of Science & Information Technology, Islamabad, Pakistan
[5]University of Lahore Gujrat, Pakistan
[6]Khyber Teaching Hospital Peshawar, Pakistan
[7]Shaheed Zulfiqar Ali Bhutto Medical University

ARTICLE INFO

Key Words:
Neurodynamic, spasticity, stroke.

How to Cite:
Zamurd , N., Obaid Baig , M. ., Gul Memon , A. ., Khan Bugti , M. ., Ali Butto, M. ., Sulaiman , M. ., Shakoor , U. ., Shakoor , A. ., Adnan , M. ., & Jahangir, S. (2022). Effects Of Neurodynamics on Spasticity in Upper Extremity of Stroke Patients: Neurodynamics of Spasticity in Upper Extremity of Stroke Patients. Pakistan BioMedical Journal, 5(5). https://doi.org/10.54393/pbmj.v5i5.443

***Corresponding Author:**
Nafeesa Zamurd
Riphah International University Islamabad, Pakistan

Received Date: 14th May, 2022
Acceptance Date: 24th May, 2022
Published Date: 31st May, 2022

ABSTRACT

Stroke leads to long term disability and spasticity is one of them. Neurodynamic is a movement which aimed to restore the electrical signal directed to the nerve and the spinal cord. The neural mobilization is used to restore the movement and improve elasticity of nervous system to improve the arm function and regain the motor ability in patients with stroke. **Objective:** To assess the effects of neurodynamics on spasticity in upper extremities of stroke patients. **Methods:** It is a Randomized controlled trial. Data was collected from 46 stroke Patients. Simple Random Sampling was done through tossing a coin and data was collected from District headquarters hospital (DHQ) Jhelum. Patients with chronic stroke, age 40-60 years, Modified Ashworth Scale (MAS) ≥1 to 3 and both male and female were included in this study. For 6 weeks, the experimental group received conventional therapy with neurodynamics (10 reps/ set, 1 set/ day, 3 days/week), whereas the control group received conventional treatment (12 reps/ set, 1 set/ day, 3 days/week). The MAS, Fugl Meyer Upper Extremity Scale (FMUE), goniometry and Action Research Arm Test were used to examine the participants at zero, three, and six weeks (ARAT). The *Shapiro-Wilk test* was used to ensure that the data was normal, and statistical analysis was performed using SPSS 21. **Results:** Statistically significant improvement was found in between group analyses in MAS, FM-UE motor score and AROM as the *p-value* was <0.05. There was no significant difference in ARAT, FM-UE sensation, joint pain, passive joint motion, coordination and PROM as *p-value was >0.05*. Statistically significant improvement was found in within group analyses in MAS, FM-UE motor score, sensation, joint pain, AROM and PROM as the *p-value was <0.05* except in ARAT and FM-UE coordination. **Conclusion:** The result shows that neurodynamic combined with conventional treatment was more effective than conventional treatment alone to reduce spasticity, improve upper extremity function and AROM. The result also shows that there was significant improvement in upper extremity joint pain, sensation and PROM and no improvement occurred in coordination and fine task performance within groups. The study concludes that neurodynamic is effective for spasticity and has additional benefit in improving UE functional performance and active range of motion but the effects of neurodynamic combined with conventional treatment are no different than conventional treatment alone on passive range of motion, joint pain, coordination, fine task performance and sensation.

INTRODUCTION

Stroke leads to disability and spasticity is one of them [1]. Major cause of stroke is disturbance of blood supply to brain which results in sudden loss of neurological function. Stroke results in variety of deficits including motor, sensory, cognitive, language, perceptual deficits and also affect level of consciousness. In motor deficit hemiplegia

DOI:https://doi.org/10.54393/pbmj.v5i5.443

occurs on affected side. Neural and muscular changes occur after stroke which leads to abnormally increased tone and muscle stiffness [2,3]. Spasticity is a motor disorder in which resistance increases with the speed of movement [4]. Spasticity is the consequence of damage to upper motor neurons which results from brain lesion e. g. stroke [5]. Spasticity is common in upper motor neuron disorder. Muscle hypertonia also results from shortening of muscle. It results from imbalance between excitation and inhibition [6]. In Asia, prevalence of spasticity is 30-80 percent. Spasticity affects 27 percent of stroke patients during 1st month, 28 percent during 3rd and 43 percent during 6th month [7]. Neurodynamic is the application of mechanics and physiology of the nervous system integrated with musculoskeletal system [8], which comprises of three-part system. Mechanical interface involve interaction between the nervous and musculoskeletal systems, neural structures and innervated tissues at zero level neurodynamic testing is contraindicated and at different level [9]. The neural mobilization is used to restore the movement and improve elasticity of nervous system to improve the arm function and regain the motor ability [10] in patients with neurological diseases such as stroke [11]. Neurodynamics is a movement which aimed to restore the electrical signal directed to the nerve and the spinal cord. Treatment mechanism of nerve comprises of movement, elasticity, conduction and reduction of axoplasmic flow, nerve conduction is promoted by decreasing pressure, and recovery occurs in soft tissues which include injured nerve and muscles, and the function is improved in the relevant region [12]. This study concluded that neurodynamic was effective to increase ROM but not effective to reduce spasticity. A majority of these studies concluded a positive therapeutic effect from using Neurodynamic for improving range and overall performance of upper limb. Several studies have been conducted in the past to examine the benefits of various physiotherapy treatment options for spasticity, but the current study will look at the effects of Neurodynamic on spasticity and motor function in stroke patients.

METHODS

Patients were randomized to experimental group (n=23) and control group (n=23) using simple random sample with randomization by tossing a coin. Data was gathered from 46 patients with hemiplegia induced by stroke from DHQ hospital Jhelum after informed permission was obtained. Three patients in the experimental group and two in the control group were dropped out (Figure 1). From January to June 2019, a six-month study was carried out. The study comprised male and female volunteers aged 40 to 60 years old who were scored on the Modified Ashworth Scale (MAS) 1 to 3 and chronic stroke (6 to 12 months) patients. Patients with a MAS of 1 to 4, pain in the upper extremity, upper extremity orthopedic issue (e.g. fracture), upper motor neuron illnesses other than stroke Acute stroke patients (1 to 6 months) and patients with evidence of significant pathology (e.g., cancer, inflammatory condition, infection) were excluded from the research. Data collection variables were spasticity, range of motion and upper extremity function. The Action research arm test (ARAT) was used to examine upper limb performance, Goniometry was used to assess range of motion, Fugl-meyer upper extremity scale (FM-UE) was used to assess motor functioning, sensation, and joint functioning, and the modified ashworth scale MAS was used to assess spasticity. In the control group (n=23), the intervention consisted of stretching (static stretching for 20 seconds) and active range of motion exercises (within range of motion). Over the course of 6 weeks, the intervention was provided one set each day (12 reps per set) with four repetitions for each movement direction (abduction, flexion, and adduction), three times per week. Traditional therapy (static stretching for 20 seconds) and active range of motion exercises (within limits of range were combined with Neurodynamic (Dynamic neural mobilization technique) which included median, ulnar, and radial nerve mobilization in the experimental group (n=23). Dynamic neural mobilization was progressed from grade 2 to grade 3(a, b, c, d), with dynamic openers applied at the lower level, dynamic closers applied at the higher level, and dynamic closers applied at grade 3. The peripheral nerve was stretched for 20 seconds, with dynamic movement added every 2 seconds for a total of 20 seconds. 13 Over the course of six weeks, one session of neurodynamic was performed every day (10 reps each set) for three days a week. Appropriate analytical abilities were used using SPSS version 21 and Microsoft Excel 2007. For between group comparisons and repeated measure analyses, the effectiveness of the intervention was assessed using one-way ANOVA and the Kruskal Wallis test for normally distributed and skewed data, respectively. For within-group analyses, the ANOVA and Friedman tests were used for normally distributed and skewed data, respectively. There was no significant difference ($P \leq 0.05$).

The anatomical zones were classified on MAUC criteria

"Zone H = central face, eyelids, eyebrows, nose, lips, chin, ear, periauricular sulci, temple, hands, feet, ankles, genitalia, nipples, and nail units"

"Zone M = cheeks, forehead, scalp, neck, jawline, and a pretibial leg"

"Zone L = trunk and extremities excluding areas included in

DOI:https://doi.org/10.54393/pbmj.v5i5.443

Zone H"
The Chi-Square test, with a significance threshold of p0.05., was used to determine the relative frequency of MH in the study populations and subgroups.

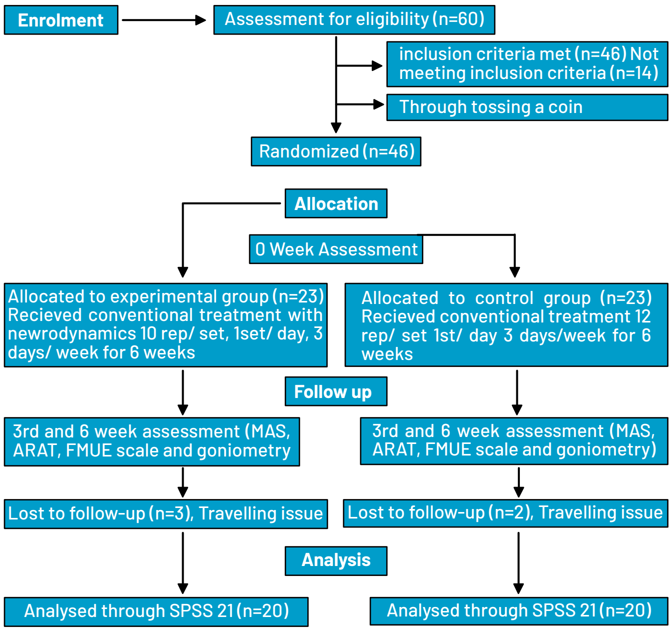

Figure 1: CONSORT Flow chart

RESULTS

Between group and within group analyses for MAS:

Kruskal Wallis test was used for between group analyses for MAS. *P- value* was 0.000 which was < 0.05 which shows that there was improvement in experimental group (neurodynamic After 6 weeks, the combination therapy group outperformed the control group (traditional treatment alone); *Friedman test* was used for within group analyses for MAS. *P-value* was 0.000 for experimental group of MAS was < 0.05 which shows that that there was improvement within experimental group. *P-value* was > 0.05 in control group of MAS which indicates that there was no improvement within control group after 6 weeks

Between group and within group analyses for FM-UE motor score:

Kruskal Wallis test was used for between group analyses for FM-UE motor score, *P-value* was 0.04 which was < 0.05 which shows that there was improvement in experimental group in comparison to the control group (neurodynamic coupled with conventional therapy) (conventional treatment alone) 6 weeks later; *ANOVA* was used for within group analyses for FM-UE motor score for experimental group as data was normally distributed. *P-value* was 0.000 for FM-UE motor score for experimental group which was < 0.05 which shows that there was improvement within experimental group after 6 weeks. *Friedman test* was used for within group analyses for FM-UE motor score for control group as data was skewed. *P-value* was 0.006 for control group which was < 0.05 which shows that there was improvement within control group after 6 weeks.

Between group and within group analyses for ARAT:

Kruskal Wallis test was used for between group analyses for ARAT. *P-value* was 0.099 which was > 0.05 which shows that there was no difference between neurodynamic and conventional treatment applied in After 6 weeks, the experimental group and the control group received just conventional therapy. *Friedman test* was used for within group analyses for ARAT. *P-value* was > 0.05 in experimental and control group of ARAT which was > 0.05 which shows that there was no improvement in both experimental and control group after 6 weeks.

Between group and within group analyses for active range of motion:

Because the data was skewed, *Kruskal Wallis* was employed for between group comparisons for active range of motion. The *P-value* was 0.05, indicating that the experimental group (neurodynamic combination with conventional therapy) outperformed the control group (conventional treatment alone) for shoulder, elbow and wrist joint motion in all degree of freedom; so, we rejected null hypothesis that neurodynamic is not effective for active range of motion in upper extremity of stroke patients after 6 weeks. Repeated measure *ANOVA* was used for within group analyses for AROM for shoulder extension, wrist flexion, extension and ulnar deviation in experimental group. *P-value* was 0.000 for AROM which was < 0.05 which shows that there was improvement within groups after 6 weeks. *Friedman test* was used for within group analyses for active range of motion of shoulder, elbow and wrist joint except shoulder extension, wrist flexion, extension and ulnar deviation in experimental group for which repeated measure *ANOVA* was used. *P-value* was < 0.05 which shows that there was improvement within groups in all shoulder, elbow and wrist active joint motion expect in control group of radial deviation after 6 weeks.

Median (IQR)					
Measure	Group	0 week	3rd week	6th week	P-value
MAS	Control	1(1)	1(1)	1(1)	-
	Experimental	1(0)	1(0)	0(0)	0.000

Table 1: Within group analysis for Modified Ashworth Scale

MAS is for Modified Ashworth Scale, while IQR stands for Interquartile Range. Friedman test is used to report the data as Median (IQR). There is no significant difference between groups (P ≤ 0.05). There is a significant difference between groups (P≤ 0.05).

DOI:https://doi.org/10.54393/pbmj.v5i5.443

FM-UE motor Score	Median (IQR)		P-value
	Control	Experimental	
0 week	28(27.5)	34(16.5)	0.08
3rd week	30(27.5)	37(18.75)	0.06
6th week	32(29)	41(19.75)	0.04

Table 2: Between group analyses for FM-UE motor score

IQR = Interquartile range, FM-UE = Fugl Meyer upper extremity. The data is provided as a median (IQR) with a Kruskal Wallis post-hoc test. There is a significant difference between groups (P≤ 0.05). There is no significant difference between groups(P≤0.05).

Shoulder flexion	Median (IQR)						P-value
	Control			Experimental			
	0 week	3rd week	6th week	0 week	3rd week	6th week	
	120(142.5)	120(140)	123(139)	145(57.5)	150(59.25)	155(59)	0.025
Shoulder Extension	10(27.50)	10(27.50)	10(28.50)	27.50(23.75)	29(24.50)	31.50(25)	0.007
Shoulder abduction	100(127.5)	105(131.5)	108(128.5)	135(62.5)	138(65.5)	142(65.5)	0.013
Shoulder Internal rotation	20(60)	20(61)	23(63)	70(55)	70(53.75)	70(48.75)	0.002
Shoulder external rotation	10(60)	10(60)	10(62)	70(70)	71(71.75)	74(73.5)	0.012
Elbow flexion	120(110)	122(115)	125(114)	132(25)	138(25)	142(22)	0.021
Elbow extension	0(5)	0(5)	0(4)	0(3.75)	0(3.75)	0(1.50)	0.487
Forearm supination	20(65)	22(65)	25(67)	60(37.50)	61(39)	64.50(39.75)	0.047
Forearm pronation	40(75)	40(75)	40(72.50)	72.50(35)	74.50(34.50)	80(38.50)	0.035
Wrist flexion	10(50)	10(50)	13(49.50)	35(40)	37.50(42.50)	41(43.5)	0.017
Wrist extension	10(32.50)	10(36)	12(38)	25(40)	27(41.5)	31(42)	0.039
Radial deviation	0(5)	0(5)	0(5)	10(12)	10(12)	12(15)	0.004
Ulnar deviation	0(5)	0(5)	0(6)	10(15)	10(15)	13(17.50)	0.014
Thumb abduction	20(50)	20(52.50)	22(52.50)	50(37.5)	50(37)	54(37)	0.022

Table 2: Between group analysis for AROM

AROMs is for active range of motion, whereas IQR stands for interquartile range. Kruskal Wallis test is used to report the data as Median (IQR). There is no significant difference between groups (P ≤ 0.05). There is a significant difference between groups(P≤0.05).

DISCUSSION

The findings from this study suggest that neurodynamic is effective for spasticity, upper extremity function and active range of motion. The current study demonstrates that neurodynamic combined with conventional treatment was more effective than conventional treatment alone in reducing spasticity as P- value was 0.000 which was < 0.05. Within group analyses for MAS also demonstrates that improvement occurred in experimental group to which neurodynamic combined with conventional treatment was applied as p-value was 0.000 which was <0.05 and no improvement occurred in control group to which conventional treatment was applied as p-value was >0.05. Alan Carlos et al., in 2016 Neurodynamic therapy has been shown to lower tone, enhance range, and improve function in stroke patients [14]. Sequence of movements in neurodynamic helps in the maintenance of elasticity resulting in increased extensibility of nervous system, increased axonal and dendritic sprouting and increased nerve conduction by reducing pressure on nerve which leads to increase range of motion, decrease tone and improvement in upper extremity function. Dynamic neural mobilization had a statistically significant influence on - waves and -rhythms in regions of the cerebral cortex in stroke patients. Dynamic neural mobilization was shown to be more successful than traditional neural mobilization in increasing -waves and decreasing -rhythms in the cerebral cortex by Kang JI and colleagues in 2018 [15]. The study was done on 20 hemiplegic stroke patients; interventions were applied for 4 weeks. Nowak et al., in 2009 stated that brain has ability to regenerate or transform by increasing axonal and dendritic sprouting as a result of which neuroplasticity occurs in central nervous system [16]. Jeong Kang et al., in 2017 determined that Rhythmic Neurodynamic accelerated the nerve conduction velocity resulting in improvement in upper extremity function more than the general neurodynamic [17] p-value was <0.05. The study was done on 18 hemiplegic stroke patients; interventions were applied for 2 weeks. Treatment mechanism of nerve comprises of movement, elasticity, conduction and reduction of axoplasmic flow, nerve conduction is promoted by decreasing pressure, and recovery occurs in soft tissues and the function is improved in the relevant region. The current study demonstrates that neurodynamic combined with conventional treatment was more effective than conventional treatment alone in improving upper extremity performance as the p-value was 0.04 which was < 0.05 which shows that neurodynamic is effective for upper extremity performance in stroke patients. This study also demonstrates that for Action Research Arm Test p-value was 0.099 which was > 0.05 which shows that neurodynamic is not effective for upper extremity fine task performance in stroke patients. Raid Saleem et al., 2017 determined a positive therapeutic benefit of using neural mobilization but limited evidence is available to determine the effect of neural mobilization techniques [18]. The present study found significant improvement occurred in spasticity, upper extremity function and active range of motion and no significant improvement occurred in passive range of motion, upper extremity sensation, coordination, joint pain and fine task performance between experimental and control group; significant improvement occurred in upper extremity function, active range of motion, passive range of motion, upper extremity sensation and joint pain and no significant improvement occurred in coordination and fine task performance within groups. Treatment mechanism of

DOI:https://doi.org/10.54393/pbmj.v5i5.443

CONCLUSION

The result shows that neurodynamic combined with conventional treatment was more effective than conventional treatment alone to reduce spasticity, improve upper extremity function and active range of motion AROM. The result also shows that there was significant improvement in upper extremity joint pain, passive joint motion, sensation and passive range of motion PROM and no improvement occurred in coordination and fine task performance within groups. Thus, the study concludes that neurodynamic is effective for spasticity and has additional benefit in improving UE functional performance and active range of motion but the effects of neurodynamic combined with conventional treatment are no different than conventional treatment alone on passive range of motion, joint pain, coordination, fine task performance and sensation.

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