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Effect of Neuro Dynamic Technique (NDYT) Versus Instrument Assisted Soft Tissue Mobilization (Iastm) in Post-Stroke Muscle Tone and Functional Performance of Upper Extremity - A Comparative Study

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Abstract: ***Background: Stroke is the sudden loss of neurological function manifested by Motor deficits on one side mainly (altered tone and postural control). Post-stroke UE altered tone mainly Hypertonicity in which neuromuscular imbalance of agonist and antagonist strength, soft tissue stiffness which may be causing Abnormal postural limb patterns and severe functional limitations decreased quality of life. velocity-dependent increase in tonic stretch reflexes, can distinguish Spasticity from other similar movement disorders such as rigidity, hyperreflexia. NDYT reduces tension of neural tissue with neural sliding phenomenon, to inhibit hypertonic muscle and lengthen muscle fiber IASTM is used. Method: 39 Participants were selected on basis of inclusion criteria & exclusion criteria. Pre and post measurement of FMA-UE, MAL and MTS was administered for Shoulder adductors, elbow, wrist and finger flexors. 3 sessions per week for 2 weeks, all participants were given 40-minutes Tailored Protocol (TP), and 15-minute per session additionally for IASTM and NDYT group. Result: There is significant difference in all 4 domains of MTS (P<0.05) between three groups and no difference in FMA-UE and MAL scale. Conclusion: IASTM technique shows better improvement of upper extremity muscle tone and reduces spasticity.***

Keywords: Stroke, Spasticity, IASTM, NDYT.

1. Introduction

Stroke is the sudden loss of neurological function manifested by Motor deficits on one side mainly (altered tone and postural control, muscular weakness, dysreflexia, incoordination, balance) and other manifestations like (sensory, perception and cognition disturbances, dysphasia, dysarthria, emotional/ behavioural, bowel-bladder dysfunction).[1]

In India, According to the India stroke factsheet of (2012) the estimated prevalence rate for stroke ranges between 84/100,000 and 262/100,000 in rural and between 334/100,000 and 424/100,000 in urban areas. [2,3]Role played by residual motor function level of affected Upper-Extremity (UE) in domestic functions such as cutting food, pushing buttons and grooming are strongly relevant to gain ADL independency. [4-6]

Post-stroke UE altered tone mainly Hypertonicity is a common but not an inevitable syndrome with pain, muscle weakness affecting voluntary movement relevant to neuromuscular imbalance of agonist and antagonist strength, soft tissue stiffness due to tendon retraction leading to joint contracture which may be causing Abnormal postural limb patterns and severe functional limitations decreased quality of life, increased treatment cost, and caregiver burden. [7-10]

The incidence of post-stroke spasticity in early stroke was 4–27%, in post-acute stroke was 19–26.7%, and in chronic stroke was 17–42.6%. [11]

Spasticity first described by Lance as motor disorder is useful in clinical practice because "velocity-dependent increase in tonic stretch reflexes," can distinguish Spasticity from other similar movement disorders such as rigidity, hyperreflexia but ignores important aspect of sensory input. Neurophysiologic mechanism involvescortical disinhibition occurs after cerebral diaschisis cause loss of supra-spinal inhibitory controlalong with abnormal processing of sensory inputs from muscle spindles via primary group Ia afferent fibers to spinal cord (SC) which transmits excitatory neuronal signals via alpha and gamma motor neurons cause excessive reflex muscle activation. Whereas SPASM definition counting contribution of viscoelastic properties of soft tissue to joint stiffness and roles of proprioceptive and cutaneous sensory pathways. Hypertonia can be divided into two components: mediated by the stretch reflex which corresponds to spasticity, and due to soft tissue changes, which is often referred as non-reflex or intrinsic hypertonia. [12-13]

Subsequently, excitatory neuronal impulses contribute to hyper tonicity of the antagonist and resulting in reciprocal inhibition of the agonist due to reduced recruitment perceived as weakness counted in Negative features of upper motor neuron syndrome (UMN) including loss of dexterity, particularly fine manual manipulation along with positive Features abnormal posture, spasticity, exaggeration of some exteroceptive reflexes.[14]

A conservative way to treat abnormal tone is physical therapy intervention comprises applying electrical modalities, somato sensory stimulation by local vibration, Cryotherapy inducing release of tightness heating prior to intervention for calming anxiety, sustained stretching to increase soft tissues elasticity even Neuromobilization techniques, including hold-relax (HR), strain-counterstrain, soft tissue mobilization have been commonly used to improve hypertonicity and associated flexibility.[15-22]

Newer among these, neural dynamic technique (NDYT) is therapeutic approach that reduces tension of neural tissue with the neural sliding phenomenon, and eases flow of blood supply through nerve, to help in recovery of nerve and soft tissue, reduces dynamic sensitivity of neural tissue and enhances tissue compliance for alleviating the symptoms. [23-24]

Moreover, conventional manual techniques are often physically demanding, which can result in some musculoskeletal impairment (e.g. Tenosynovitis) among clinicians if improper biomechanics is used over time.[25] So, to mitigate risk recently Instrument Assisted Soft Tissue Mobilization (IASTM), a novel treatment having pros to specifically inhibit hypertonic muscle and lengthen muscle fiber is used. The IASTM form of mechano-therapy of fascia and connective tissue by using different rigid materials devices (steel, wood etc.) works on principle triggering partial inflammatory response in region to resynthesize blood flow, fiberglia, and collagen with goal to enhance healing process by breaking down collagen cross-linkages thereby increasing cellular regeneration in-turn reduces tension of tightened muscular tissue and relaxes fascia helps in recovering functional movement with increased flexibly and efficiency.[26,27] Recent studies in stroke demonstrated inhibitory impact on hyperactive muscle using EMG measures with IASTM on reciprocal inhibition reveals promising effect of neuromuscular imbalance between reduced antagonist activation and facilitate agonist of lower limb muscles which can enhance gait function whereas Castilho et al. stated reduced biceps brachii activation for after executing NDYT.[28,29] Furthermore, shuti et.al, stating significant difference in muscle tone and functional improvement of UE executing IASTM.[30] Myeong-jun kim et.al studied effect of NDYT and IASTM technique for lower limb in acute stoke suggesting IASTM reduced tone and stiffness but no significant difference in Balance ability.[31]

However, there is scarcity of such promising inhibitory evidence focused on post-stroke UE performance. Therefore, study using UE functional measures on neuromuscular imbalance would generate significant information about comparative effect between IASTM, NDYT and control group.

2. Literature Survey

a) Myeong-Jun Kim and Tae-Ho Kim (2020) studied "effect of neuro dynamic technique and instrument assisted soft tissue mobilization on lower extremity muscle tone, stiffness, static balance in stroke patients". 26 subjects randomly assigned in two groups were given 30-minutes of general Physical therapy with 15-minutes of IASTM to group-A and NDYT to group-B respectively 5 times per week for 6 weeks suggesting IASTM is effective method for decreasing muscle tone and stiffness in acute stroke.
b) Shruti deshpande and jeba chitra (2018) studied "Effectiveness of Instrument Assisted Soft Tissue Mobilization Using M2t Blade on Upper Limb Spasticity and Function in Post Stroke Patients". 31 patients were treated with conventional therapy and M2t blade of IASTM for 40-minutes per session for 2 weeks study shows IASTM with conventional treatment is improving upper limb spasticity and function in post-stroke patients.
c) Jeong jae lee et al., (2014) studied "inhibitory effect of instrument assisted neuromobilization on hyperactive Gastrocnemius in hemiparetic stroke patients". 22-year-old male was treated with IASTM concluded Gastrocnemius deactivation 43% and Tibialis anterior activation 150% promising improvement neuromuscular imbalance between both can increase gait performance.
d) Jorge. H. Villafane et al., (2012) had conduct case study "Botulinum toxin type-A combined with Neurodynamic mobilization for upper limb spasticity after stroke: a case report", in this patient underwent combined treatment with BoNT-A and NM of upper limb in 6 monthly applications which measured pain by using Numeric Rating Scale, Spasticity by MAS, acceptance and emotional reaction to treatment by Hospital Anxiety and Depression Scale, and functionality by ROM. Patient improved in all outcomes after treatment which maintained during the follow-up sessions.
e) j. casthilo et al., (2011) studied "Analysis of electromyography activity in spastic biceps brachii muscle following neural mobilization". Upper Limb Neurodynamic Test (ULNT1) mobilization technique was given with repeated pre and post-test EMG measurements performed on six stroke victims with grade 1 or 2 spasticity (MAS). This showed EMG activity in biceps brachii decreased by 17%.

3. Methods

Study Site: Vadodara
Study Design: Interventional comparative study
Study Population: Post-Stroke participants.
Sampling Methods: convenient samplings
Proposed Sample Size: The calculated sample size is 39 (13 in each group).

Inclusion Criteria:

- Subject who are willing to participate.
- First episode being diagnosed as unilateral stroke with onset period of 1 year
- Male and female both included.
- Age group between 30-70 years.
- According to MAS grade ≤4

Exclusion Criteria:

- Any musculoskeletal disorder & pain limiting movements of affected arm.
- Any other neurological and psychiatric conditions.
- Any skin allergies
- Any cognitive and perception disorder such as (unilateral neglect, apraxia)

Materials to be used:

- Consent form
- Low Plinth
- Goniometer
- IASTM Tool
- Lubricant (Petroleum Gel)
- Disinfectant

Approach

Participants who have been diagnosed from first stroke by neurologist were selected on basis of inclusion criteria & exclusion criteria. Pre and post measurement of FUGL MEYER-UPPER EXTREMITY (FMA-UE, Motor Activity Log (MAL) and Modified Tardieu Scale (MTS) was administered for Shoulder adductors, elbow, wrist and finger flexors. Most of participants were already receiving physiotherapy before initial evaluation considering that it's an effective intervention that patients already follow; we ethically decided not to modify it to adapt our study to hospital routine and adding 3 sessions per week for 2 weeks, all participants were given 40 minutes Tailored Protocol (TP), and 15 minute per session additionally for IASTM and NDYT group. Participants were received home program for those days when intervention was not given in week. Participants were allocated randomly in 1:1:1 ratio either of control group, IASTM and NDYT.

Group-A: participants received Tailored Protocol
Group-B: Participants received IASTM with Tailored Protocol
Group-C: Participants received NDYT with Tailored Protocol

Tailored Protocol: - [16,30.,33]

A Tailor-made protocol based on mixed techniques with different approaches to rehabilitate UE. Task- oriented exercises were customized according to participant's needs and motor ability as per result of functional assessment to facilitate re-learning of motor skill adapting inhibitory technique (E, g. PNF technique, Cryotherapy, slow approximation, rocking, stroking, Function Re-education). Intervention session in all groups will be progressively increased in complexity focusing on strength training through series of motor task addressed to reach best functional performance.

IASTM treatment protocol: - [31,34]

Participants were supine with UE rested on a plinth comfortably. A lubricant (Petroleum gel) applied to skin around the area prior to treatment and IASTM tool were cleaned with disinfectant. First, the IASTM tool was used to find the exact areas of restriction in the Shoulder adductors, elbow, wrist and finger flexors then it was used, at an angle of 45° to apply slow strokes along muscle fibers, without causing any discomfort or pain from muscle origin to its insertion for approximately 5-minutes per muscle and applied for a total of 15-minutes. Post IASTM treatment, cold pack was given for 10-minutes to avoid muscle soreness and erythema.

NDYT treatment protocol: - [31,32]

NM consisted of a sliding mobilization of the proximal-distal radial and median nerves. NM of median nerve consisted of alternation of elbow extension (loading) and wrist flexion (unloading) with elbow flexion (unloading) and wrist extension (loading).NM of radial nerve consisted of shoulder depression applied simultaneously with elbow flexion and wrist extension, and then was performed with elbow extension and wrist flexion and ulnar deviation. These motions were alternated at a rate of 2-seconds per cycle (1-second each into extension and flexion). Every session will be given for 15-minutes, one cycle median nerve (7-min) and radial nerve (7-min) applied to UE with pause (1-min) between each application.

4. Result

Data was entered in excel sheet and analysis was done using SPSS software 20.0.1.1 and Microsoft excel 2019. Within group analysis was done by Paired t-test and between group analysis was done by ANOVA test.

Table 1: Baseline data of participants in all groups

	Group-A		Group-B		Group-C		P-Value	Result
	Mean	SD	Mean	SD	Mean	SD		
Age	54.61	10.44	50.38	7.65	57.84	10.46	0.15	N/S
Height(CM)	164.15	8.24	164	6.45	161.84	8.51	0.7	N/S
Weight(KG)	61.23	6.72	60.38	6.97	61.46	9.53	0.93	N/S
BMI	22.7	1.71	22.5	2.88	23.4	2.64	0.62	N/S

(N/S = Not Significant)

Table 2: Comparison of Pre – Post Value for MTS, FMA-UE, Mal Within Group-A (Control Group).

		Pre		Post		T- Value	P- Value	Result
		Mean	SD	Mean	SD			
MTS	Shoulder Adductors	18.07	3.70	19.76	3.72	-8.12	0	S
	Elbow Flexors	50.15	3.72	53.08	2.81	6.00	0.00	S
	Wrist Flexors	25.61	4.61	27.84	4.21	-7.36	0	S
	Finger Flexors	50.92	4.97	52.53	5.62	-4.88	0.0003	S
FMA-UE		46.53	5.37	46.92	4.95	-1.44	0.17	N/S
MAL	AOU	68.53	6.62	68.69	6.68	-1	0.33	N/S
	QOM	67.84	5.66	68.00	5.58	-1	0.33	N/S

(S = Significant, N/S = Not Significant)

Table 3: Comparison of Pre – Post Value for MTS, FMA-UE, Mal within Group-B (IASTM Group)

		PRE		POST		T- Value	P- Value	Result
		MEAN	SD	MEAN	SD			
MTS	Shoulder Adductors	19.61	3.17	24.07	2.13	-5.89	0	S
	Elbow Flexors	46.84	5.01	57.46	3.82	-6.93	0	S
	Wrist Flexors	26.30	4.09	33.38	4.21	-21.48	0	S
	Finger Flexors	48.76	5.59	56.38	3.40	-7.73	0	S
FMA-UE		45.76	4.95	47.15	4.94	-2.56	0.25	N/S
MAL	AOU	76.15	10.47	76.69	10.91	-2.007	0.06	N/S
	QOM	69.38	10.12	71.23	9.19	-3.57	0.04	S

(S = Significant, N/S = Not Significant)

Table 4: Comparison of Pre – Post Value for MTS, FMA-UE, Mal within Group-C (NDYT Group)

		PRE		POST		T- VALUE	P- VALUE	RESULT
		MEAN	SD	MEAN	SD			
MTS	Shoulder Adductors	20.30	3.32	22.07	3.09	-4.48	0.01	S
	Elbow Flexors	52.07	5.88	54.00	6.41	-5.52	0	S
	Wrist Flexors	29.00	4.04	31.38	4.27	-7.20	0	S
	Finger Flexors	50.92	3.94	52.38	4.23	-6.008	0	S
FMA-UE		46.46	6.09	46.76	5.62	-1.47	0.16	N/S
MAL	AOU	71.46	9.51	71.84	9.48	-1.44	0.17	N/S
	QOM	65.00	6.25	65.38	6.37	-1.44	0.17	N/S

(S = Significant, N/S = Not Significant)

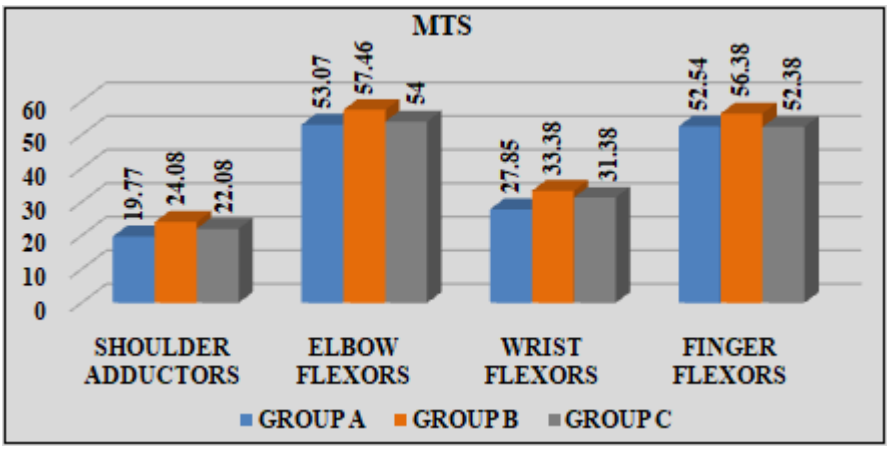
Table 5: Between Group Comparison of MTS

ANOVA TEST FOR MODIFIED TARDIEU SCALE							
		Group A	Group B	Group C	F-Value	P-Value	Result
Shoulder Adductors	Mean	19.77	24.08	22.08	6.47	0.003	S
	SD	3.72	2.14	3.09			
Elbow Flexors	Mean	53.07	57.46	54	3.27	0.04	S
	SD	2.81	3.82	6.42			
Wrist Flexors	Mean	27.85	33.38	31.38	5.69	0.007	S
	SD	4.22	4.21	4.27			
Finger Flexors	Mean	52.54	56.38	52.38	3.28	0.04	S
	SD	5.62	3.4	4.23			

(S = Significant)

Pairwise comparison of groups by Tukeys multiple post-hoc procedures for MTS				
	Shoulder Adductors	Elbow Flexors	Wrist Flexors	Finger Flexors
GROUP A VS B	0.002*	0.05*	0.006*	0.08
GROUP A VS C	0.14	0.86	0.09	0.07
GROUP B VS C	0.23	0.15	0.45	0.99

(p<0.05 = significant)



Graph 1: Mean of MTS within Group-A, Group-B and Group-C

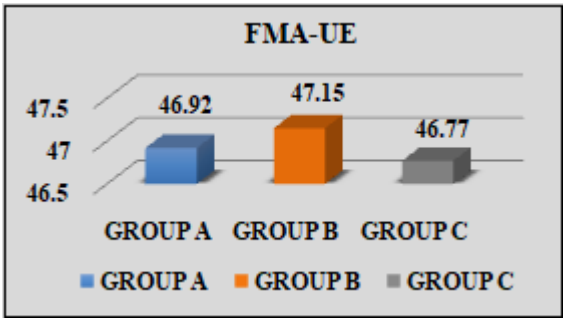
Table 6: Between Group Comparison of FMA-UE

ANOVA TEST FOR FMA-UE							
		Group A	Group B	Group C	F-Value	P-Value	Result
FMA-UE	Mean	46.92	47.15	46.77	0.018	0.98	N/S
	SD	4.96	4.9	5.63			

(N/S = Not Significant)

Pairwise comparison of groups by Tukeys multiple post-hoc procedures for FMA-UE	
	FMA-UE
GROUP A VS B	0.99
GROUP A VS C	0.99
GROUP B VS C	0.98

(p<0.05 = significant)



Graph 2: Mean of FMA-UE within Group-A, Group-B and Group-C

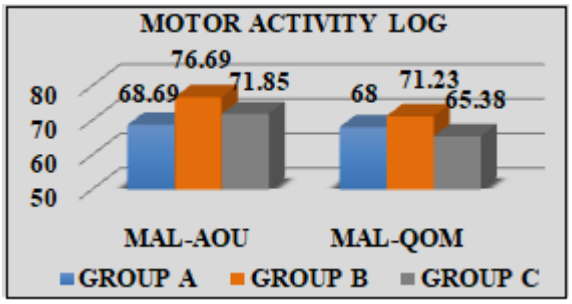
Table 10.1: Between Group Comparison of Mal

Anova Test For Mal							
		Group A	Group B	Group C	F-Value	P-Value	Result
AOU	Mean	68.69	76.69	71.85	2.49	0.09	N/S
	SD	6.69	10.92	9.48			
QOM	Mean	68	71.23	65.38	2.14	0.13	N/S
	SD	5.52	9.19	6.37			

(N/S = Not Significant)

Pairwise comparison of groups by Tukeys multiple post-hoc procedures for MAL		
	AOU	**QOM**
GROUP A VS B	0.08	0.49
GROUP A VS C	0.66	0.62
GROUP B VS C	0.38	0.11

(p<0.05 = significant)



Graph 2.11: Mean of Mal Within Group-A, Group-B and Group-C

5. Discussion

Stroke is a rapidly advancing clinical sign of localized (or global) brain function disruption with symptoms lasting 24 hours or more with no clear cause other than vascular origin. Where, neurological functions manifested by motor and sensory deficits such as altered tone, postural control, muscular weakness, dysreflexia, incoordination, balance, perception and cognition disturbances, dysphasia, dysarthria, bowel-bladder dysfunction.[1] In which Post-stroke altered tone mainly Spasticity or Hypertonicity is a common but not an inevitable syndrome with pain, muscle weakness affecting voluntary movement relevant to neuromuscular imbalance of agonist and antagonist strength.[7-10]

According to **Thibaut A et al.** the muscles which treated for spasticity were shoulder adductors, elbow, wrist and finger flexors as these groups are more affected in upper extremity in post stroke patients. [40]

To treat abnormal tone, A conservative or conventional treatment was given in neurological rehabilitation, in which neural dynamic technique (NDYT) is therapeutic approach that reduces tension of neural tissue [23] and Instrument Assisted Soft Tissue Mobilization (IASTM), was novel treatment to inhibit hypertonic muscle and lengthen muscle fiber. [25]

The present study demonstrates compelling therapeutic effect of neuro dynamic technique (NDYT) versus instrument assisted soft tissue mobilization (IASTM) along with conventional therapy muscle tone and functional performance of upper extremity in post stroke. Demographic characteristic and effect on muscle tone and functional performance was analyzed statistically. The prevalence of stroke was found to be higher in males than in females. The probable reason for this difference can be the protective effect of endogenous estrogen on cerebral circulation in women, which have a shielding effect on cardiac illness and stroke. [41]Estrogen helps in decreasing cerebral vascular tone thereby increasing cerebral blood flow. [42]

The peak age of strokeincidence is 55 to 65 according to a study done by **PM Dalal**. [43] This age wise prevalence is similar to the age prevalence in present study. Aging leads to structural and functional changes in the blood vessel walls causing increased arterial wall stiffness and decreased vascular distensibility which may lead to increased work load on heart and reduced cerebral blood flow. [44] This might be the probable cause of increased prevalence of stroke as the age increases.

In this present study, first objective was to study the pre and post effect of IASTM with Tailored Protocol in post-stroke muscle tone and functional performance of Upper Extremity. The result of this study shows significant difference in pre and post data of Shoulder adductors (T=-5.88, P=0.00), Elbow flexors (T=6.93, P=0.00), Wrist flexors (T=21.48, P=0.00), Finger flexors (T=7.73, P=0.00) and parameter of MAL-QOM (T=3.57, P=0.04). There was no significant difference in pre and post data of FMA-UE (T-=2.56, P=0.25), MAL-AOU (T=2.007, P=0.06). **Bakheit AM et.al,** stated from their study that exaggerated stretch reflex is a hallmark of spasticity and is caused due to increased alpha motor neuron activity which is reduced with passive sustained stretching. IASTM was given in the form of prolonged and slow strokes to provide an inhibitory effect to the excessively contracting spastic muscles. This inhibitory technique might have cause similar effect as that of prolonged firm pressure and slow stroking, leading to inhibition of motoneuron pool. As this pressure is given by an instrument, it might have given more deep pressure as compared to manual inhibitory techniques which can be one of the reasons for reduction in the spasticity. [45] Due to the reduction in spasticity, there might have caused tissue elongation thereby improving motor function. **Shruti Deshpande** and **Jeba Chitra** Conducted a study and reported that IASTM using M2T blade combined with conventional therapy is an effective intervention to improve upper limb spasticity and function in post stroke patients. [30]

The second objective was to study the pre and post effect of NDYT with Tailored Protocol in post-stroke muscle tone and functional performance of Upper Extremity. The result of this study shows significant difference in pre and post data of Shoulder adductors (T=-4.48, P=0.01), Elbow flexors (T=5.52, P=0.00), Wrist flexors (T=7.27, P=0.00), Finger flexors (T=6.008, P=0.00). There was no significant difference in pre and post data of FMA-UE (T-=1.47, P=0.16), MAL-AOU (T=1.44, P=0.17), MAL-QOM (T=1.44, P=0.17). **Davis S. Butler et.al,** propose that the improvements may be due to the sliding techniques are aimed to induce biomechanical effects, which permit to re-establish optimal movement of the nerve and its surrounding tissues. Regarding these effects, there is supporting evidence from post-mortem studies that showed that a sliding technique for the median nerve could improve longitudinal excursion of the nerve. [23] Neural mobilization (NM) works on the nervous system as a whole, which could be one of the reasons the technique obtains positive results in the treatment of a range of conditions, as musculoskeletal disorders can cause a “crushing” or “double crushing” of peripheral nerves, which is related to spasticity. This crushing leads to reductions in nerve conductibility, axoplasmic flow within the neurons and somatic activity. [46] **Jorge H. Villafane et.al** stated the NM and BoNT-A treatments decreased pain and spasticity, and improved joint range of motion. [32]

The third objective of present study was to compare the pre and post effect of NDYT and IASTM with Tailored Protocol in post-stroke muscle tone and functional performance of Upper Extremity. The result of this study shows significant difference in all 4 domains of MTS. Shoulder adductors (F=-5.88, P=0.00), Elbow flexors (F=3.47, P=0.042), Wrist flexors (F=5.69, P=0.007), Finger flexors (F=3.28, P=0.049). There was no significant difference in FMA-UE (F=0.018, P=0.98) and MAL-AOU (F=2.49, P=0.09) and MAL-QOM (F=2.14, P=0.13). few studies have attempted to examine such techniques. It has been reported that IASTM was beneficial for inhibition of the hypertonic muscle and an increase in muscle fiber length in tight or shortened muscles in healthy subjects. [47,48]**J.J. Lee et.al,** concluded that the IASTM neuromobilization technique showed a promising improvement of neuromuscular imbalance between TA and GCM activations in stroke. [28] **Markovic et al.** [49] explained that increasing temperature of the corresponding local region during application of stroking results in increased sliding of the fascia layer, and decreased collagen resistance. Furthermore, according to **Schleip et al.**[50] , muscle tone is lowered since the IASTM activates the mechanoreceptor of the inner layer of fascia and converts it into proprioceptive stimulation to affect the central nervous system. **Simatou et al.** [51] conducted a study which suggest that IASTM uses the narrow surface area so that deeper penetration into the target is performed, with stimulation strength of the mechanoreceptor being different from that of another intervention method. The results of **Myeong-Jun Kim et al.** suggest that IASTM is appropriate intervention method with no adverse effect used in stroke patients. [31]

The result of between group comparison of FMA-UE and two domains of MAL (AOU, QOM) IN GROUP A, B and C shows no significant difference. So, it suggested that both protocols are equally effective to improve functional performance.

6. Conclusion

In conclusion, the present study shows all the groups are equally effective to improve upper extremity functional performance with FMA-UE and two domains of MAL (AOU, QOM), whereas the group of participants who received IASTM technique shows reduction of upper extremity muscle tone in terms of MTS for Shoulder Adductors, Elbow Flexors, Wrist Flexors and Finger Flexors.

7. Limitation

The limitation of present study is small sample size of 39 participants, 13 in each group cannot cover the whole population of stroke. Another limitation is that, long follow-up for post-stroke spasticity is needed.

8. Future Scope

The present study acknowledged that future studies are required for better understanding of the effect of the IASTM technique along with Tailored Protocol in various condition. Large sample size and long-term follow-up may give a more précised results for the efficacy of the intervention protocol.

Clinical Implication

IASTM in combination with conventional therapy should be considered as an effective modality to reduce spasticity and improve function of upper extremity in stroke rehabilitation on a regular basis, also reduces musculoskeletal disorders and decreases physical stress among the clinicians.

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