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Effectiveness of Instrument Assisted Soft Tissue Mobilization Using M^{2}t Blade on Upper Limb Spasticity and Function in Post Stroke Patients: A Pre-Post Experimental Study

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Abstract

Background: The annual incidence of stroke is 124 per 100,000 population whereas the prevalence rate is 136 per 100,000 population in urban area and 165 per 100,000 in rural area. Unilateral weakness or spasticity are the most commonly observed symptoms of stroke leading to a disabled life. Spasticity occurs in 20-30% of all the stroke victims and is more commonly seen in upper extremity as compared to lower extremity. Conventional therapy for spasticity although effective, is physically demanding for physical therapists. Instrument Assisted Soft Tissue Mobilization (IASTM) is a form of mechano-therapy used to treat a variety of musculoskeletal disorders. Myofascial Mobilization Tool (M^{2}T) blade is a recently developed IASTM technique. Although studies have been done on IASTM for spasticity, there is no literature for the same using M^{2}T blade. Hence, this study was undertaken.

Objective: To study the effect of IASTM using on Upper Limb spasticity and function in post stroke patients

Methodology: The ethical clearance was obtained from Institutional Ethical Committee. 43 subjects were screened and 31 were recruited as per inclusion and exclusion criteria. A written informed consent was obtained from all the subjects. These subjects were treated with conventional therapy and M^{2}T blade. Duration of treatment given was 40 minutes per session for 2 weeks (3 sessions per week). Pre and Post assessment of upper limb function using Fugl-Meyer scale for upper extremity (FMA-UE) and spasticity using the Modified Tardieu Scale (MTS) was done, followed by statistical analysis.

Results: Dependent t test was used to analyze the level of significance in MTS and motor function and Joint motion components of FMA-UE. Wilcoxon matched pair test was done to analyze Joint pain component of FMA-UE. Significant differences were noted in upper limb spasticity in all the muscle groups ($p<0.05$). Significant improvement was also observed in upper limb function in all three domains of FMA-UE which were motor function, joint motion and joint pain respectively ($p=0.0001$, $p=0.0001$ and $p=0.04$)

Conclusion: IASTM using M^{2}T blade combined with Conventional therapy is an effective intervention for improving upper limb spasticity and function in Post-stroke patients.

Keywords: stroke, spasticity, upper limb function, IASTM, M^{2}T blade

Introduction

Stroke is a global health problem and one of the leading cause of adult disability. [1] The World Health Organization (WHO) defines stroke as, "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin." [2] According to WHO, in 1990 stroke was the second most common cause of mortality worldwide, leading to about 4.4 million deaths which increased to 5.54 million in 1995, out of which two third deaths were from less developed countries. [3]

India and other developing countries are facing double burden of diseases like stroke. Organized rehabilitation of stroke services are available in India but are mainly available in private hospital in cities. Also, people cannot afford the commonly used secondary prevention drugs. [4]

The primarily observed clinical manifestations of stroke include motor impairments to one side, pain, muscular weakness, altered tone, abnormal synergy patterns, dysreflexia, incoordination, balance, postural problems and sensory disturbances . Other clinical manifestations commonly observed are speech and language disturbances, swallowing difficulty or dysphagia, impaired perception and cognition, emotional and behavioural differences and bowel or bladder dysfunction. [5]

Flaccidity or hypotonia is present immediately after stroke and is mainly due to effects of cerebral shock. Flaccidity is usually short-lived and lasts only for a few days to few weeks. [5] Spasticity or hypertonia develops and comprises of 20-30% of all stroke victims and is more common in upper extremity than lower extremity.[6] Spasticity is defined as velocity-dependent hyperexcitability of muscles to stretch and is characterized by exaggerated tendon reflexes, increased resistance to passive movement and hypertonia due to loss of upper motor neuron inhibitory control. [7] There is increased disability and diminished quality of life associated with upper limb post stroke spasticity. [8]

Effective Conventional rehabilitation therapy for post stroke spasticity includes passive muscle stretching, prolonged positioning, cryotherapy and electrical stimulation of antagonist muscle group which are proved to be useful in reducing spasticity. [9]

The inhibitory techniques commonly used for spasticity or contractures are slow prolonged and firm stretch, low frequency vibration to the agonist, Slow approximation, slow rocking, firm inhibitory pressure on tendons, prolonged icing, neural warmth, maintained touch and slow stroking. [10]

Conventional neuro mobilization techniques, even though effective, are physically demanding for the therapists and may also cause tenosynovitis or other musculoskeletal disorders among the clinicians if inappropriate biomechanics are repetitively applied over time. [11]

Instrument Assisted Soft Tissue Mobilization (IASTM) is a novel treatment of the fascia and connective tissue which allows the therapist to efficiently treat functional disorders of connective tissues. It is a form of mechano-therapy which uses rigid devices made of different materials (steel, ceramic, jade, wood etc.) for treatment. The goal of IASTM is to enhance the healing process by breaking down collagen cross-linkages and increasing blood flow, thereby increasing cellular regeneration. [12]

A South Korean case report proved the inhibitory effect of IASTM on hyperactive Gastrocnemius in a hemiparetic stroke patient, which showed promising effect of neuromuscular imbalance between Tibialis Anterior and Gastrocnemius activation improving gait performance in Stroke case. [13]

Myofascial Mobilization Tool (M^2T) blade is a recently developed IASTM technique. It was first invented by Mr. Adam Boger in Canada. It is designed ergonomically which allows therapists to track down adhesions in the

fascia and to treat them with reasonable pressure to bring about a reduction of pain. This blade is made of stainless steel material and consists of 8 treatment points with different edges for treating muscles of different sizes. Treatment point 1 and 2 are used to treat large muscles whereas 3,4,5,6,7 and 8 are used to treat smaller muscles or small areas of treatment. [14]

A pilot study done by Naik et to evaluate the immediate effects of M^{2}T Blade on Pain and Range of Motion in recreational Badminton Players having shoulder pain was done and has proved to have helped reducing the pain and improving the joint range of motion. [14]

High association of musculoskeletal injuries is present due to conventional physical therapy rehabilitative procedures. [11] Therefore, there is need to conduct studies on alternative protocols to reduce the risk of injuries associated with this profession.

Other technique of IASTM, Dr. You STM technique was found to be effective in improving lower limb spasticity and gait performance in post-stroke patients. [13] But no such studies are done using M^{2}T blade on Upper limb spasticity and function in post-stroke patients.

Moreover, there is dearth of literature on treatment of upper limb spasticity and function in post-stroke patients using IASTM. Thus, this study was undertaken.

Materials and Methods

This study was a Pre-Post Experimental Study, conducted on post stroke patients in tertiary health care center, Belagavi. An ethical clearance was obtained from the Institutional Ethical Committee, prior to the commencement of the study. Thirty-one (31) patients were recruited from and a written informed consent was obtained from the patients wherein they were given detailed information pertaining to the study and the risks and benefits associated.

Study Participants

Inclusion criteria of this study were sub-acute and chronic patients diagnosed with first ever stroke, aged 30-70 and having shoulder adductors, elbow, wrist and finger flexor spasticity with Modified Ashworth Scale (MAS) grade ≤ 3. Subjects with other musculoskeletal injuries of the affected extremity, diagnosed cases of neoplasm and having other neurological conditions were excluded.

Outcome Measures

Modified tardieu Scale (MTS) is a scale that assesses spasticity by taking into account resistance to passive movement at fast and slow speeds. It quantifies the spasticity by measuring the difference in angle obtained at fast and slow speeds. (R1-R2) [15]

Fugl Meyer Assessment Scale for Upper Extremity (FMA-UE) is a stroke specific performance-based measure. It measures 5 domains of performance viz. motor function, sensory function, joint range of motion and joint pain. Items are scored on a 3 point ordinal scale: 0: cannot perform, 1: performs partially and 2: performs fully. [16]

Procedure

All subjects were screened based on the inclusion and exclusion criteria prior to their enrolment into the study. The purpose of the study was explained and a written informed consent was obtained from all the participants. The demographic data of age, gender, height, weight, BMI, duration since onset of stroke and side affected were assessed at baseline.

After inclusion in the study, all the participants underwent a pre-assessment of the upper limb spasticity of Shoulder adductors, elbow, wrist and finger flexors using the Modified Tardieu Scale and upper limb function (motor function, joint motion and joint pain) using the FMA-UE.

The assessment of MTS was done by measuring the R1-R2 value for Shoulder abduction, elbow, wrist and finger extension for assessing the spasticity in Shoulder adductors, elbow, wrist and finger flexors.

After the Pre-assessment, the spastic muscles were treated with conventional treatment for upper limb spasticity including PNF (Proprioceptive Neuromuscular Facilitation) hold-relax technique, range of motion exercises and cryotherapy with the new technique IASTM (M^2T blade).

Conventional Treatment of PNF involved stretching of the target muscle (spastic group of muscles) with resisted isometric contraction and held for a period of 5-8 seconds and then repeated 5 times, with a new range for every repetition. Range of motion exercises were also given passively with proper stabilization to the proximal joint, 10 repetitions for every joint.

Cryotherapy was given in the form of ice packs to be applied for each muscle group for 15-20 minutes twice daily.

IASTM technique using M^2T blade treatment was in the form of slow and long prolonged strokes for inhibitory impact on the hypertonic muscles. A perpendicular force applied in a way that matches the strength of the tissue/ muscle for 7 seconds. The same procedure was repeated for 3-5 times. IASTM using M^2T blade was given by using different treatment points for different muscle groups.

This comprised of one session of treatment which was of 40 minutes duration. 3 such sessions per week were given for 2 weeks. Subjects were also given a home program of stretching, range of motion exercises and cryotherapy to be done on those days in the week when intervention was not given.

Statistical Analysis

Statistical analysis for the present study was done manually and by using SPSS (Statistical Package of Social Sciences) software version 21. Demographic Characteristics like Age, gender, height, weight, BMI, duration since onset of stroke, hand dominance and side affected were taken at baseline. Mean values with Standard Deviation (S.D) for age, height, weight, BMI and duration since onset were calculated and tabulated**. (Table-1)**

Spasticity by MTS

Comparison of pre-test and post-test scores of Shoulder adductors, Elbow flexors, wrist flexors and finger flexors were done using dependent t test separately for each muscle group. The p value was found to be 0.0051, 0.0001, 0.0001 and 0.0001 respectively which indicates there was significant reduction in spasticity in all 4 muscle groups. **(Table-2)**

Function by FMA-UE

Comparison of pre-test and post-test data scores of Fugl-Meyer scale for motor function and joint motion was analysed using dependent t test. The results show significant improvement in motor function and joint motion with p=0.0001 for both which indicates highly significant change. Comparison of pre-test and post-test scores for Joint pain domain of Fugl-Meyer scale was analysed using Wilcoxon matched pairs test. The results show a change in values with p value 0.0408 which is significant. **(Tables 3,4,5)**

Discussion

Present study aimed to study the effects of Instrument Assisted Soft Tissue Mobilization using M^2T blade on upper limb spasticity and function in post stroke patients. Demographic characteristics and effect of spasticity and function was analysed statistically.

In the present study, 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 oestrogen on cerebral circulation.[17] Oestrogen helps in decreasing cerebral vascular tone thereby increasing cerebral blood flow [18] Due to exposure to endogenous oestrogen, women tend to have a shielding effect on development of cardiac illnesses and stroke.

Mean age of the study population in the present study was in middle-age group. This shows that higher prevalence was attributed to increasing age. 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 heart work load and reduced cerebral blood flow. [19] This might be the probable cause of increased prevalence of stroke as the age increases. The peak age of stroke occurrence is 55 to 65 according to a study done by PM Dalal. [20] This age wise prevalence is similar to the age prevalence in present study.

The muscles which were treated for spasticity were shoulder adductors, elbow, wrist and finger flexors as these groups are more affected in upper extremity in post stroke patients. [21] There was significant reduction in spasticity in all four muscle groups that is shoulder adductors, and elbow, wrist and finger flexors. Management of spasticity is directed towards reduction in hyperexcitability of the tissues. The treatment given to the patients in the current study included IASTM using M^2T blade, H-R technique of PNF, cryotherapy and range of motion exercises.

The M^2T blade 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.

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. [22]

Cryotherapy also has an inhibitory effect on the muscle as cold anaesthesia of peripheral sensory end organs will cause change in the balance of facilitatory-inhibitory mechanisms on the Anterior Horn Cell. [23] Cryotherapy has been proved to have antispastic effect by increasing the pain threshold and reducing the muscle spindle sensitivity of low threshold afferents. [24]

The motor function component of Fugl-Meyer Scale also showed significant improvement. The motor function of stroke patients is mainly affected because of the occurrence of spasticity in muscles leading to reduced range of motion at the joint and pain. Due to the reduction in spasticity, there might have caused tissue elongation thereby improving motor function. Also, the range of motion exercises given as a part of conventional therapy might have been beneficial to improve the motor function of this scale because of which the joint motion domain of Fugl-Meyer scale also improved significantly.

The joint pain component of FMA-UE also improved significantly. The probable reason for this can be the analgesic effect produced by the cryotherapy. There is strong association of pain with spasticity. [25] As the spasticity reduced with IASTM and conventional therapy, there might have been reduction in pain. Reduction in pain might also be due to IASTM technique. Baker et al studied the effect of IASTM on tissue extensibility and pain and found significant improvements in both. [26]

A combined effect of all the above-mentioned mechanisms might have led to reduced spasticity and improved upper limb function in upper limb spasticity and function. Therefore, IASTM using M2T blade was beneficial in reducing upper limb spasticity and improving function in post stroke patients.

Conclusion

The results of the present study showed significant improvement in upper limb spasticity and function in post stroke patients, hence M^2T given 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.

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Table 1: Demographic Profile

Characteristics	**MEAN ± S. D**
Age	52.74 ± 11.53
Height	162.03 ± 6.40
Weight	67.52 ± 6.62
BMI	25.76 ± 2.62
Duration since onset of stroke	11.19 ± 8.41
Gender	Males- 70.97%, Females- 29.03%
Hand Dominance	Right- 30 (96.77%), Left-1 (3.22%)
Side affected	Right- 48.39%, Left- 51.61

Table 2: Comparison of Pre and Post Scores of Shoulder Adductors, Elbow Flexors, Wrist and Finger Flexors by Dependent T Test by Using Modified Tardieu Scale.

MUSCLE GROUP	**PRE MEAN ± S.D**	**POST MEAN ± S.D**	**MEAN DIFFERENCE ± S.D**	**% CHANGE**	**t VALUE**	**p VALUE**
Shoulder Adductors	6.35 ± 2.8	10.10 ± 5.2	-3.74 ± 4.32	-58.88	-4.8225	0.0051*
Elbow flexors	9.45 ± 5.42	14.81±6.10	-5.35 ± 6.59	-56.66	-4.5238	0.0001*
Wrist flexors	6.00 ± 2.61	9.74 ± 4.72	-3.74 ± 3.61	-62.37	-5.7641	0.0001*
Finger flexors	4.77 ± 2.17	7.68 ± 4.08	-2.90 ± 2.98	-60.81	-5.4213	0.0001*

Table 3: Comparison of Pretest and Posttest Scores of Motor Function Component of Fma-Ue By Dependent T Test.

Time points	Mean ± SD	Mean Difference ± SD	% change	t value	p-value
Pretest	31.77 ± 6.85	-6.10 ± 3.64	-19.19	-9.3348	0.0001*
Posttest	37.87 ± 6.86				

*P<0.05

Table 4: Comparison of Pretest and Posttest Scores of Joint Motion Component of Fma-Ue by Dependent T Test

Time points	Mean ± SD	Mean Difference ± SD	% change	t value	p-value
Pretest	16.03 ± 4.55	-2.00 ± 2.41	-12.47	-4.6238	0.0001*
Posttest	18.03 ± 3.19				

*P<0.05

Table 5: Comparison of Pretest and Posttest Scores of Joint Pain Component of Fma-Ue By Wilcoxon Matched Pairs Test

Time points	Mean ± SD	Mean Difference ± SD	% change	Z value	p-value
Pretest	18.03± 5.35	-1.29 ± 3.83	-7.16	2.0446	0.0408*
Posttest	19.32± 4.43				