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Effect of myofascial release as an adjunct to conventional therapy on quality of upper extremity function in children with hemiplegic cerebral palsy: An experimental study

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Abstract
Objective: To assess the additional effects of Myofascial Release (MFR) on gross motor and fine motor functions and on spasticity.
Design: An Experimental Study
Setting: Tertiary hospitals, private clinics/institutions.
Subjects: 20 patients with hemiplegic Cerebral Palsy (CP) who fulfilled the inclusion criteria were randomly allocated to either experimental group (n=10) or the conventional group (n=10)
Intervention: The experimental group received MFR along with Conventional treatment three times a week for 4 weeks. The conventional group received general exercise protocol for the same duration.
Outcomes: The outcome measures were Quality of Upper Extremity Skills Test (QUEST) and Modified Tardieu Scale (MTS).
Results: A total of 20 subjects completed the 4 weeks study program. Post treatment, there was a significant decrease in the values of the MTS in both the groups.
There was a significant increase in the scores of the QUEST scale within both the groups; as well as significant change between the two groups.
The QUEST's Gross Motor and Fine motor Domains showed a significant improvement in the experimental group. There was a significant difference in the total QUEST score within the groups pre-treatment and post treatment.
Conclusion: The study showed that MFR has an additional effect on quality of upper extremity function.

Keywords: MFR, hemiplegic cerebral palsy, QUEST, MTS

Introduction

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain [1]. It is a well-known neurodevelopmental condition which occurs in early childhood and persists throughout the lifespan. The worldwide incidence of CP is approximately 2 to 2.5 cases per 1000 live births. In India, it is estimated at around 3 cases per 1000 live births [2]. The prevalence of CP occurs in 2.5% per 1000 live births globally [3]. The most common form of CP is diplegia, which is the most prevalent form (30–40%), followed by hemiplegia (20–30%) and quadriplegia (10–15%) [4].

Hemiplegic Cerebral Palsy: It is spastic unilateral paresis wherein upper limbs are affected more severely than the lower limbs [5]. It is commonly observed in term infants (56%) and preterm infants (17%). It has multifactorial pathogenesis. It is the result of early brain damage, including brain malformations, periventricular brain lesions, middle cerebral artery infarctions and non-progressive postnatal brain injuries. Often the integrity of the motor cortex and corticospinal pathways necessary for precision grasping and fine control of the fingers and hand, are compromised. Consequently, skilled independent finger movements and hand skills do not develop normally [6]. Impaired voluntary movements are observed mostly affecting hand functions. Other functions affected are pincer grasp of thumb,

supination of the forearm, and extension of the wrist. In the upper limb, spasticity is most frequently found in the shoulder external rotators, elbow, wrist and finger flexors, and the elbow pronators [7]. Impaired hand function is a major disability in hemiplegic children [8]. So, they learn to perform most tasks with their non-involved UE (i.e. developmental disuse) due to failure of optimal use of the involved extremity. This leads to inability or difficulty to perform activities of daily living (ADLs), which is likely to reduce their independence and increase burden of care [9].

Since CP cannot be cured, management is focused on relieving symptoms and improving motor function. In CP the lesion in the central nervous system (CNS) frequently results in spasticity of various muscle groups. Spasticity is defined as a velocity-dependent resistance to stretch and hyperreflexia [10].

Increasing evidence suggests that structural changes within the spastic muscles and surrounding tissues are associated with creating or increasing muscle stiffness and resistance to stretch [11]. Specific changes include altered fibre size and distribution, proliferation of extracellular matrix, altered matrix mechanical properties, and increased muscle cell stiffness [12]. The extracellular matrix of spastic muscle appears disorganized and hypercellular and thereby may interfere with muscle mechanics [13].

Restriction in the myofascia plays an important role in spasticity [14]. Restrictions within the fascia can limit ranges of movement of a specific joint or joints. These restrictions can have a profound effect on posture and movement and can reduce the extent to which strategies to elicit movement can be effective. Along with restricting range, strength is impacted because of the reduced extensibility of the muscle and consequent inability to fire to maximal contraction [15].

The myofascial release process is initiated by increasing the temperature and energy of the tissue, creating a greater degree of fluidity in the body's ground substance. The elongation of the tissue results in a three-dimensional elongation process which is followed in the patient's fascial system. These characteristics of myofascial release enable the achievement of greater degrees of motion and can be blended with facilitation of normal movement in the treatment of children with cerebral palsy. Thus myofascial release enhances ease of motion while conventional treatment provides greater movement options [16].

In CP, spasticity is often regarded to be the most common motor impairment. The Modified Ashworth Scale (MAS) is the most common clinical scale used to assess spasticity [14]. Despite its widespread clinical use, the reliability of the scale has been questioned in some studies [8, 9]. The MAS is a 6-point rating scale which assesses muscle tone by manually manipulating the joint through its available range of motion and clinically recording the resistance to passive movement.

Like the MAS, the Modified Tardieu Scale (MTS) is another clinical scale used to assess spasticity. Its use is not as widespread as the MAS but it has recently been recommended as a more effective method in assessing spasticity due to its evaluation of the resistance to passive movement using two different velocities [17].

The Manual Ability Classification System (MACS), is designed to classify how children with CP use their hands when handling objects in daily activities. Distinctions between the levels are based on the child's ability to handle objects, i.e. the quantity and quality of performance and need for assistance or adaptations to perform manual tasks in everyday life. Classification is suitable for children aged 8 to 12 years. Reliability coefficients ranged from ICC 0.7 to 0.9 [18].

A measure of the quality of hand and upper extremity function was required to measure important changes of therapy. The Quality of Upper Extremity Skills Test (QUEST) evaluates quality of upper extremity function in four domains: dissociated movement, grasp, protective extension and weight bearing. It is designed to be used with children who exhibit spasticity and has been validated in children with 18 months to 8 years of age. Most available hand and upper extremity assessments focus on the strength and co-ordination and not on the quality of movement performed. As well as they are more focused on the assessment of hand and do not incorporate the components of the joint movement at the shoulder, elbow, forearm and wrist necessary for hand function [18].

Methods

Study design was an Experimental study with convenient sampling and randomization was done by a computer-generated random number table. Sample size was 20 i.e., 10 each in control and experimental group. Ethical clearance was obtained from the Institutional Ethical Committee. Subjects were selected according to the inclusion and exclusion criteria.

Inclusion Criteria were as follows: 1) Spastic Hemiplegic CP children 2) Age group of 4-8 years 3) Children having MACS level 4 or less and 4) Children with MAS 3 or less for most of the Upper Extremity muscles will be included in the study.

Exclusion Criteria were: 1) Being unable to understand the commands necessary for the procedure 2) Children undergone Botulinum toxin treatment in past 6 months. (37) 3) visual and auditory deficits 4) UE fixed deformities/ contractures 5) prior orthopedic surgery 6) Mental retardation associated with CP 7) Have undergone change in dosage of medical drug during the time of study

Prior to selection parents of each subject were given information sheet.

After agreement they were given written informed consent while assent was taken from the subject.

Subjects were divided into two groups viz. experimental group and control by computer generated random number table.

A pre-treatment evaluation was done using the MACS, MAS, MTS and the QUEST scores. The parents/ legal guardians were explained about the effects of MFR, and were asked to examine their child's skin constantly for any discomfort. If any such discomfort was seen the parents/ guardians were asked to report immediately and medical help was provided if needed.

For experimental group (Group A), who received Myofascial Release along with conventional treatment subjects were positioned in supine with the affected upper extremity exposed. The subjects were given enough privacy and their parents were allowed to be with them throughout the treatment. The subjects were instructed to inform if any discomfort was felt during the treatment procedure.

Subjects who received Myofascial release were evaluated for areas of restriction of fascia in upper extremities. The

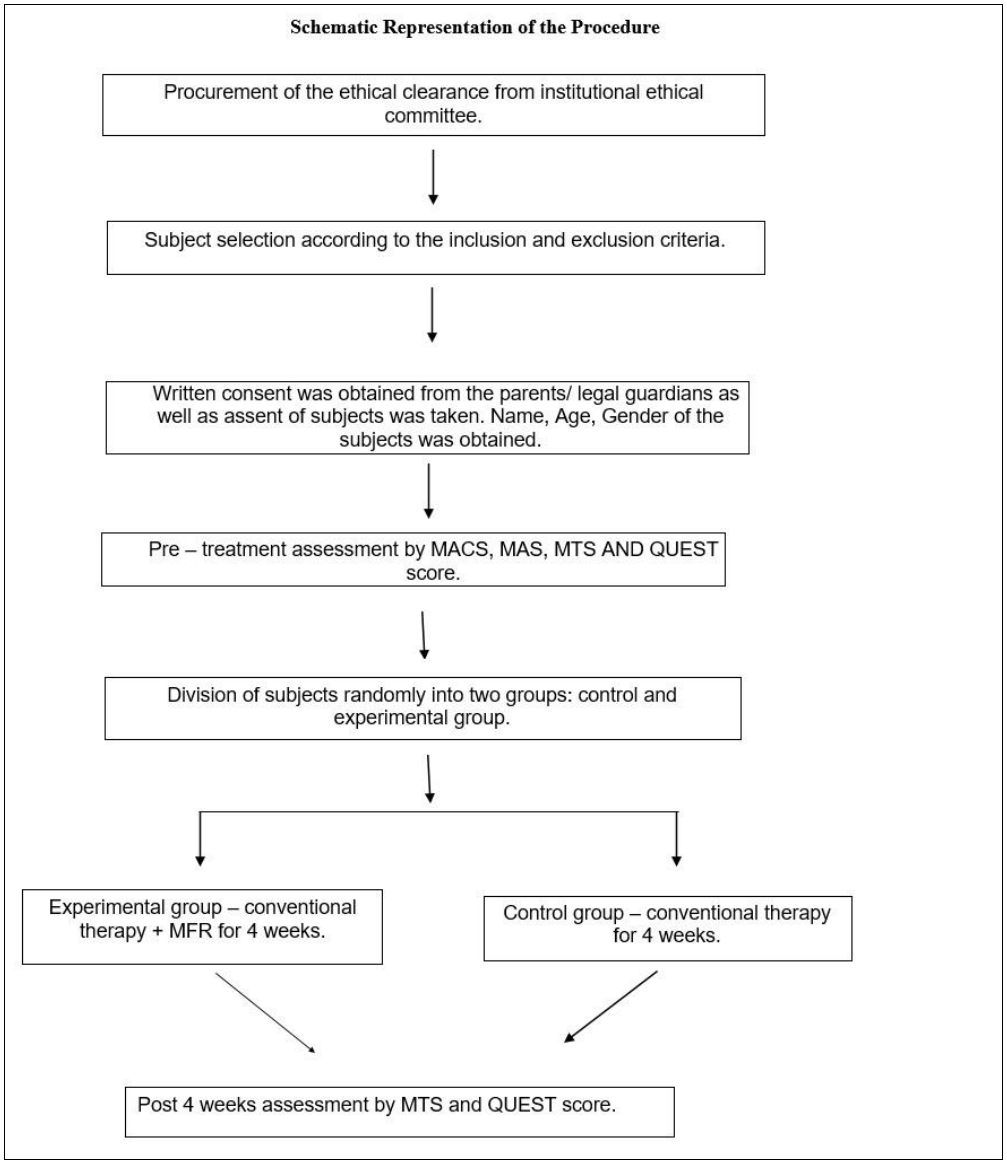
treatment area was cleaned with water using cotton and the area was dried before applying MFR. The part to be released was kept in supported and relaxed position.
Technique was applied in three steps:

Step 1: for larger muscles hands were crossed for increased comfort and endurance. Light pressure was first directed toward the supporting surface. Then the elastic component of tissue was lengthened till the first barrier. The traction was hold for 90-120 seconds before the tissue began to soften and lengthen.

Step 2: As the tissue started to begin soften and lengthen the barrier slowly started fading away. The direction of tissue was followed until the last barrier.

Step 3: traction was released slowly by slowly removing hands.
Along with this conventional treatment was also given to the same group for half an hour.

Conventional treatment included: Stretching of tight muscles, NDT, strengthening exercises: according to individual muscle strength**,** Weight bearing exercises, Manual dexterity exercises like grasp /release, Peg board activities, Functional task practice.
Both the groups received treatment 3 days per week for 4 weeks. At the end of 4th week both groups were evaluated with MTS and QUEST.



Results

The aim of the study was to see additional effects of MFR on quality of upper extremity function in children with hemiplegic cerebral palsy. The data was processed in Winpepi (Version 11.65) and Primer of Biostats (Version 7.0) for statistical analysis. Descriptive statistics were calculated for Demographic variables. Baseline data was assessed for skewness of distribution. The underlying normality assumption was tested using Shapiro Wilk test before subjecting parameters to various tests.

Experimental group: Since the data was normally distributed the mean difference between pre- and post-MTS values of IR, shoulder flexors, biceps, pronators and wrist flexors as well as mean difference between pre and post QUEST components was assessed by paired t test. Mean difference between pre and post MTS values of adductors was assessed by Wilcoxon Signed-Ranks test.

Control Group: The mean difference between pre and post MTS values of IR, biceps, pronators and wrist flexors as

well as mean difference between pre and post QUEST components was assessed by paired t test. Mean difference between pre and post MTS values of adductors and shoulder flexors was assessed by Wilcoxon Signed-Ranks test.

Experimental vs Control group: The mean difference between group A and group B MTS values of IR, biceps as well as mean difference between pre and post QUEST components was assessed by unpaired t test. MTS values of shoulder flexors, adductors, pronators and wrist flexors was assessed by Mann-Whitney U test. In the entire study, the p-values less than 0.05 are considered to be statistically significant.

The mean ± SD of age of cases studied in Experimental Group and Control Group which was 5.85 ± 1.23 years and 6.25 ± 1.24 years respectively. (P-value>0.05).The sex distribution of cases studied did not differ significantly between two study groups (P-value>0.05). Also, the hemiplegic side distribution of cases studied did not differ significantly between two study groups (P-value>0.05).

Muscle	Group (*n*=10)	MEAN ± SD pre	Mean ± SD post	95% CI	P value
IR of Shoulder	Experimental	21.5 ± 16.6	17.9 ± 14.8	1.66 to 5.54	0.002
	Control	22.7 ± 15.9	20.8 ± 15.1	0.71 to 3.09	0.006
Shoulder Adductors	Experimental	11.7 ± 16.64	9.9 ± 14.55	1.24 to 16.48	0.1250
	Control	9.6 ± 14.42	9.2 ± 14.24	0.94 to 13.86	0.5000
Shoulder Flexors	Experimental	15.9 ± 12.69	13.4 ± 11.78	9.00 to 14.00	0.003
	Control	9.7 ± 7.9	3.39 ± 2.87	7.53 to 11.13	0.0625
Biceps	Experimental	-31.1 ± 14.72	-27.2 ± 13.56	-5.43 to -2.38	0.000
	Control	-36.8 ± 11.36	-35.1 ± 11.12	-2.66 to -0.74	0.003
Pronators	Experimental	39.2 ± 15.61	35.2 ± 15.87	3.05 to 4.95	0.000
	Control	38.3 ± 10.84	36.4 ± 10.28	1.27 to 2.53	0.000
Wrist Flexors	Experimental	31.4 ± 10.33	27.4 ± 10.67	2.74 to 5.26	0.000
	Control	28 ± 8.8	26.2 ± 9.2	1.35 to 2.25	0.000
Intergroup Analysis					

The mean ± SD of MACS level among the cases studied in Experimental Group and Control Group was 2.6 ± 1.0 and 2.4 ± 0.8 respectively. The distribution of MACS level among the cases studied did not differ significantly between two study groups (P-value>0.05).

Table 1: Intragroup and intergroup analysis of means of MTS

Domain of quest	Experimental group		P value	Control group		P value
	Pre mean ± SD	Post mean ± SD		Pre mean ± SD	Post mean ± SD	
A.	42.25 ± 9.40	42.73 ± 9.20	0.067	40.03±12.55	40.10 ±12.48	0.085
B.	39.45± 12.18	40.94± 11.95	0.000	33.02 ± 9.45	33.27 ± 9.45	0.000
C.	35.87± 10.32	36.68 ±10.14	0.006	29.78 ± 8.39	29.98 ± 8.38	0.004
D.	31.06 ±13.89	31.83± 14.10	0.003	26.90 ± 6.97	27.04 ± 7.01	0.037
Intergroup Analysis						
Muscle	**Experimental group (*n*=10) Mean ± SD**	**Control group (*n*=10) Mean ± SD**		**95% CI**		**P value**
IR of Shoulder	3.6 ± 2.7	1.9 ± 1.6		0.42 to 3.82		0.109
Shoulder Adductors	1.8 ± 2.4	0.4 ± 0.8		0.32 to 3.12		0.304
Shoulder Flexors	2.5 ± 0.63	1.8 ± 0.66		-1.23 ± 2.63		0.495
Biceps	-3.9 ± 2.13	-1.7 ± 1.34		-3.87 to -0.53		0.013
Pronators	4.0 ± 1.33	1.9 ± 0.87		1.04 to 3.16		0.002
Wrist Flexors	4.0 ± 1.76	1.8 ± 0.63		0.96 to 3.44		0.005

Table 2: Intragroup and intergroup analysis of means of QUEST

Domain of quest	Experimental Group Mean ± sd	Control group Mean ± sd	P value
A.	0.48 ± 0.73	0.06 ± 0.11	0.094
B.	1.49 ± 0.45	0.25 ± 0.16	0.000
C.	0.80 ± 0.71	0.20 ± 0.17	0.018
D.	0.76 ± 0.61	0.14 ± 0.18	0.006

Discussion

Although positive effects of MFR on lower extremity spasticity have been mentioned in many of the studies, its effect on upper extremity spasticity hasn't been studied extensively. The aim of this study was to see additional effects of MFR on quality of upper extremity function in children with hemiplegic cerebral palsy. The first outcome measure of this study is the MTS which determines the passive range of movement at different movement velocities, with the relative difference between a slow and a fast velocity passive stretch determining the dynamic component of the muscle spasticity.

The result of this study showed that there was significant difference in MTS (R2-R1diff) values in both control as well as experimental group when intragroup comparison was done. While intergroup comparison of MTS values suggests that there is reduction in spasticity more in experimental group as compared to control group.

The probable mechanism for positive results in experimental group could deal with neuroreflexive change that occurs with the application of manual force on the musculoskeletal system while giving MFR. The hands-on approach offers afferent stimulation through receptors, which gives response by central processing at the spinal cord and cortical levels.

Afferent stimulation frequently results in efferent inhibition. This principal is used in MFR technique when the afferent stimulation of a stretch is applied and the operator waits for efferent inhibition to occur so that relaxation results.

The second outcome measure is the QUEST which is a scale for the assessment of upper limb function. When each individual domain was compared between the groups there was significant improvement in all domains except domain A which was not statistically significant but clinically significant. Greater improvements were seen in the scores of experimental group.

The probable reason for the positive results could be as suggested by Akta Bhalara *et al.*, who hypothesized in their study that body fascia composed of collagen tissue and elastic fibres may be regarded as a continuous laminated sheet of connective tissue that extends without interruption from the top of the head to the tip of the toes. Because of poor postures over time, the fascial system becomes restricted in concentric layers. These fascial layers help connect muscle throughout the region, creating myofascial chains. Significant loss of ground substance is reported to occur due to restricted mobility. When myofascial release is given, the interstitial fibre signals the blood vessels which increases the renewal speed of the ground substance i.e. extrusion of the plasma from the blood vessels into the interstitial fluid matrix. This in turn causes hydration of the ground substance thus lubricating the space between the fibres and maintaining the inter-fibre distance.

Gentle and sustained stretching of myofascial release frees the adhesions and softens and lengthens the fascia. The effects are because of the force applied in a particular direction which is against the lines of fascial restriction. As the neuromotor system is released from dysfunction via myofascial release, the fascia is stressed by appropriate and orderly movement causing the collagen to lay down in the direction of the stress.

A combination of increased level of ground substance with more orderly arrangement of the fibres therefore causes break down of the cross linkage and increases the extensibility of the muscle thus improving the mobility.

This supports the findings of this study which showed significant improvement in both gross motor as well as fine motor components of QUEST.

The study findings support the hypothesis that MFR has an effect on quality of upper extremity function when used as an adjunct to conventional treatment

Conclusion

This study concluded that there was a positive effect of MFR in reducing spasticity and on quality of upper extremity function. Thus, MFR can be used as an adjunct to Conventional therapy for achieving better quality of upper extremity function.

Limitations and future scope of study

Outcome measures were administered only at the beginning and at the end of the study, intermediate assessment was not done. A similar study can be conducted to administer the long-term effects of MFR and to check the carry - over effect if any.

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