A COMPARATIVE STUDY ON THE EFFECTIVENESS OF NEURO DEVELOPMENTAL THERAPY WITH MYOFASCIAL RELEASE OVER NEURO DEVELOPMENTAL THERAPY ON GROSS MOTOR FUNCTION OF CHILDREN WITH SPASTIC CEREBRAL PALSY

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Abstract

Objective-This study analyzed the effectiveness of Neuro-Developmental Therapy (NDT) with Myo-Fascial Release (MFR) as compared to on gross motor function in Children with spastic Cerebral Palsy (CP).

Methodology-Children with Spastic CP(n=20) were selected for the study from Department of physiotherapy, Capital University based upon the inclusion and exclusion criteria. The twenty children were randomly assigned to intervention program with 10 in Group – A and another 10 in Group – B. Group A underwent combined NDT and MFR and Group B underwent NDT as per the needs of the child. Then intervention was provided for a duration of 3days per week for 4weeks then post test scores were recorded using tools. After statical analysis done for obtaining the results.

Results-After analyzing and comparing the pre-test and post-test scores the result turned out to be significant ($p<0.001$).

Conclusion-it is concluded that Neuro-Developmental Therapy (NDT) with Myo-Fascial Release (MFR) can improve gross motor function in Children with spastic Cerebral Palsy (CP) more efficiently than NDT single handedly.

Key words-Neurodevelopmental therapy, Myo-Fascial Release, Gross motor, spastic, Cerebral Palsy

Introduction

Cerebral palsy is the most common cause of motor disabilities in childhood.According to the Centers for Disease Control and Prevention (CDC), it affects 1 to 4 outof every 1,000 children worldwide. Cerebral palsy is caused by abnormal development or damage in one or more parts of the brain that control muscle tone and motor activity (movement). The resulting impairments first appear early in life, usually in infancy or early childhood. Infants with cerebral palsy are usually slow to reach developmental milestones such as rolling over, sitting, crawling, and walking. Common to all individuals with cerebral palsy is difficulty controlling and coordinating muscles. This makes even very simple movements difficult.

- Cerebral palsy may involve muscle stiffness (spasticity), poor muscle tone, uncontrolled movements, and problems with posture, balance, coordination, walking, speech, swallowing, and many other functions.

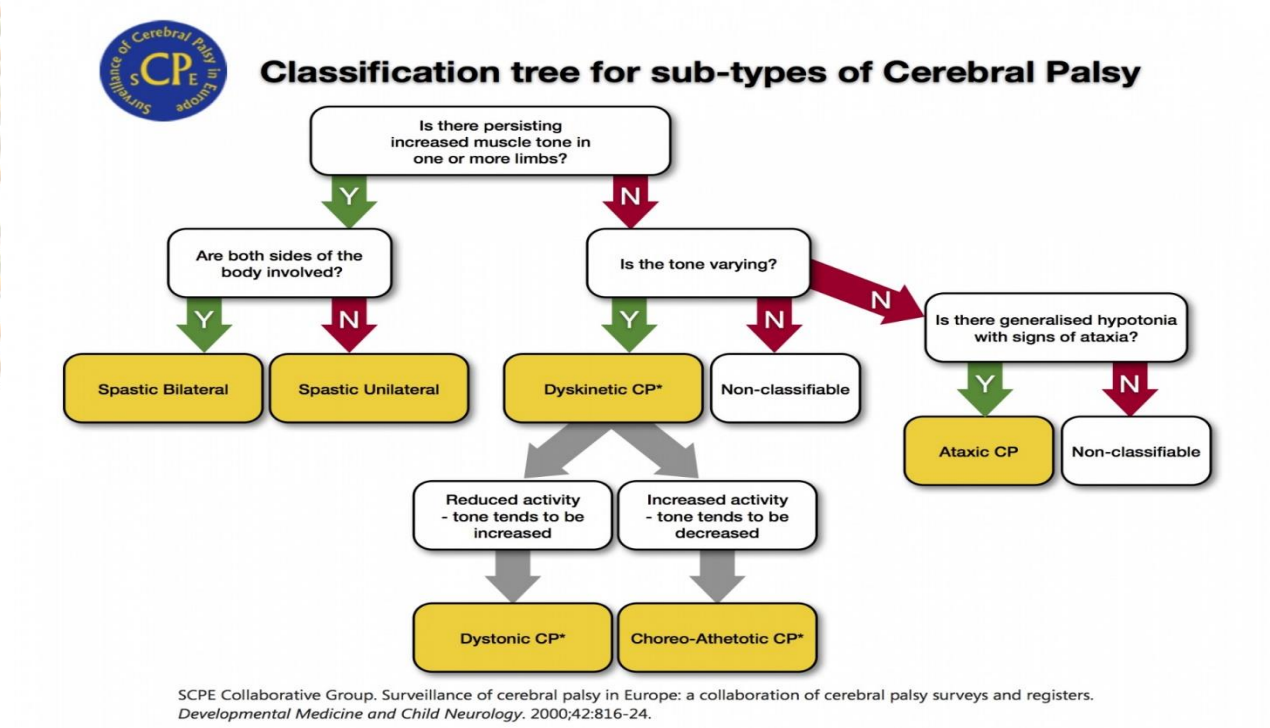
- Mental retardation, seizures, breathing problems, learning disabilities, bowel and bladder control problems, skeletal deformities, eating difficulties, dental problems, digestive problems, and hearing and vision problems are often linkedto cerebral palsy.

- The severity of these problems varies widely, from very mild and subtle to veryprofound.

According to European data, the average frequency of CP is 2.08 per 1000 live births, but in the group of children born with a body weight below 1500g, the frequency is 70 times higher when compared with the group of children with a body weight over 2500gat birth.

Epidemiology

A nationwide survey conducted by the National Sample Survey Organization (NSSO) has estimated that the population with disability in India is approximately 1.9% ofthe total population and 5.3% and 3% of 0–14-year age group are suffering from physical and mental disabilities, respectively.



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Definitions of Spasticity

The most well-known and referenced description of spasticity is the physiological definition proposed by Lance in 1980. 'Spasticity is a motor disorder characterised by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper excitability of the stretch reflex, as one component ofthe upper motor neuron syndrome'.

A definition from Pandyan et al (2005) states that spasticity is: 'Disordered sensorimotor control, resulting from an upper motor neuron (UMN) lesion, presenting as an intermittent or sustained involuntary activations of muscles.

Spasticity can result in functional problems with activities of daily living (ADL) such as gait, feeding, washing, toileting and dressing. Over time, spasticity may also causeproblems, such as muscle pain or spasms, trouble moving in bed, difficulty with transfers, poor seating position, impaired ability to stand and walk, dystonic posturing muscle, contractures leading to joint deformity, bony deformation, joint subluxation or dislocation and diminished functional independence. Contractures occur when there is loss of joint motion due to structural changes in the muscles, ligaments and tendons surrounding the joint. Shortening and stiffness of the soft tissues make the joint resistant to stretching and prevent normal movement. However, spasticity is a benefit for children with cerebral palsy. Increased tone may be useful for the child. It helps to keep the legs straight, thereby supporting the child‘s weight against gravity. The child with increased tone in trunk extensors may stand and take a few steps. Spasticity may help preserve muscle bulk and bone density. The extent and type of spasticity can fluctuate widely according to position of head and limbs, fatigue, stress and mood of children. One limb may have one pattern of spasticity whilst another may have a different pattern.

Effects of Spasticity

- Abnormal posture
- Difficulty in hygiene and dressing
- Difficulty in movements
- Difficulty in sitting and transfers
- Inhibits muscle growth

Negative Effects

- Joint subluxation or dislocation
- Leads to contractures
- Masks contraction in the antagonist muscle pain
- Pressure sores
- Shortening and stiffness of the soft tissues
- Extensor tone in the limbs help standing

Positive effects

- Preserve bone density
- Preserve muscle bulk

Classification of Spasticity into various components of spasticity into sub-definitions

1) **Intrinsic Tonic Spasticity:** Exaggeration of the tonic component of the stretchreflex (manifesting as increased tone)
2) **Intrinsic Phasic Spasticity:** Exaggeration of the phasic component of thestretch reflex (manifesting as tendon hyper-reflexia and clonus), and
3) **Extrinsic Spasticity:** Exaggeration of extrinsic flexion or extension spinalreflexes.

Causes of Spasticity

Spasticity in children can result from any disease process that affects the upper motor neuron within the central nervous system. Injury to the upper motor neuron decreases cortical input to the descending reticulospinal and corticospinal tracts, which causes weakness, loss of motor control, and reduction in the number of voluntarily active motor units. The reduction of these descending tracts removes the normal inhibition of the reflex arcs within the grey matter of the spinal cord, leading to a hyperactive reflex arc andspasticity. While in certain cases there is no identifiable cause, typical causes include problems in intrauterine development (e.g. exposure to radiation, infection), asphyxia before birth, hypoxia of the brain, birth trauma during labor and delivery, and complications in the prenatal period or during childhood. Infections in the mother, low birth weight (less than 2.0 Kg) is a risk factor for CP. Also, between 40 and 50% of all children who develop CP were born prematurely. Premature infants are vulnerable, in part because their organs are not fully developed, increasing the risk of hypoxic injury to the brain that may manifest as cerebral palsy.

Cerebral palsy is a catch-all term for developmental movement disorders caused bya brain injury. Each type of cerebral palsy is caused by damage to a specific part of the brain. Spastic cerebral palsy is caused by damage to the motor cortex and the pyramidal tracts of the brain, which connect the motor cortex to the spinal cord. Understanding the function of the motor cortex and pyramidal tracts helps to explain how damage to these systems affects movement in those with spastic CP.

Damage to the Motor Cortex: The motor cortex is located in the cerebral cortex, whichis the largest part of the brain. The motor cortex is composed of several parts that are responsible for relaying signals to other parts of the brain to control movement. An important aspect of the motor cortex in relation to cerebral palsy is its regulation of voluntary movement. Damage to this region of the brain makes voluntary movement harder to control and less fluid, or "spastic."

Damage to the Pyramidal Tracts: The pyramidal tracts in the brain are the roads of communication between the cerebral cortex and the nerves in the spinal cord. If pyramidal tracts are damaged, the motor cortex can‘t send proper signals to the spinal cord. The spinal cord is one half of the central nervous system, with the other half being the brain and brain stem. These parts of the brain are essential for sensory functions such as sight, touch and movement.

The motor cortex and pyramidal tracts may be damaged by:

- Prenatal brain hemorrhage or infection
- Lack of oxygen to the brain during birth
- Brain trauma or infection after birth

Several risk factors may increase the likelihood of a developmental brain injury occurring. Poor maternal health and a low birth weight are just some of the risk factors for any type of cerebral palsy.

Types of Spastic CP

The various types of spastic cerebral palsy are classified based on the location of movement issues. For example, children with spastic CP may have muscle stiffness in one arm, the lower limbs both or one side of their body.

- **Spastic Diplegia:** Spastic diplegia affects two limbs, which most commonly are the legs. Children with diplegia may have mild movement issues in the upper body as well. Diplegia is commonly a result of premature birth that results in cerebral palsy.
- **Spastic Hemiplegia:** Spastic Hemiplegia affects one entire side of the body. The arm is generally more affected than the leg and is distinguished by a rigidly flexed wrist or elbow. Prenatal brain bleeding can lead to hemiplegia.
- **Spastic Quadriplegia:** Spastic Quadriplegia occurs when all four limbs areaffected. The legs are generally impacted more than the arms. Quadriplegia may cause limited control over facial muscles.

Signs and Symptoms

The signs and symptoms of spastic cerebral palsy are different for every child. Differences in symptoms depend on the severity of the child‘s brain injury and any co- occurring disorders that may be present.

In general, the most common symptoms of spastic CP are:

- Stiff, tight muscles (hypertonia) on one or both sides of the body
- Exaggerated movements
- Limited mobility
- Abnormal gait
- Crossed knees
- Joints don't full extend
- Walking on tiptoes
- Contractures
- Abnormal reflexes

Co-occurring issues may also present themselves, such as hearing and vision impairment, but these aren ‘t directly related to the cerebral palsy; they are caused by the initial birth injury. In the first years of a child ‘s life, it can be very hard to recognize the signs of cerebral palsy. This is because symptoms typically do not present themselves untila child begins missing developmental milestones. During toddlerhood, many children tendto exhibit some of the same jerky reflexes associated with spastic CP. It can take up to 5 years of age before a full cerebral palsy diagnosis is reached.

- The magnitude of the problems may wax and wane over time. However, the cause of the condition, the brain abnormality responsible for the cerebral palsy,does not get worse over time. Nevertheless, the clinical picture may show signsof deterioration as the individual ages.

The Physical examination of the child with Cerebral Palsy should evaluate:

- Posture in Prone Lying, Supine Lying, Sitting, Standing and Walking;
- Muscle Tone of the Extremities, Trunk and Neck, Deep Tendon Reflexes;
- Muscle Strength; and
- Joint Range of Motion at the Hip, Knee, Ankle, Sub-talar and Mid-tarsal Joints.

As Cerebral Palsy is a disorder of movement that commonly presents with muscle tone abnormalities, it is critical to perform an evaluation of muscle tone during the initial and any future physical evaluations. Hypertonia due to an extra pyramidal brain lesion is known as dystonia and presents as involuntary intermittent muscle contractions that cause twisting or repetitive movements of abnormal postures. Hypertonia where a pyramidal brain lesion exists presents as muscle spasticity. Spasticity accounts for 80% of pediatric Cerebral Palsy presentations and is defined as a motor disorder characterized by a velocity dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks. Itresults from hyper excitability of the stretch reflex as one component of the upper motor neuron syndrome. The identification and quantification of spasticity is critical when determining appropriate orthotic intervention. Identifying the joint angles during joint Range of Motion (ROM), testing at slow, medium and fast velocities where an increase in muscle tone is first felt and also at the end of joint ROM, helps establish the angle the anatomical joint will be positioned within any potentially prescribed orthosis. It also determines if, and what type, of mechanical joints may be included in the orthotic design.

Tone: The measurement tools used to evaluate muscle tone in children with Cerebral Palsy can be divided into two main groups according to their assessment technique and method of quantification. The Tardieu Scale (TS) assesses spasticity by passively moving the joints at three specified velocities (slow, under gravity and fast) while the intensity andduration of the muscle reaction to stretch (X) is rated on a 6-point scale, with the joint angle (Y) recorded at where the muscle reaction is first felt.

Table 1: Velocity – Description

Velocity	Description
V1	As slow as possible (slower than the natural drop of the limb segment under gravity)
V2	Speed of the limb segment falling under gravity
V3	As fast as possible (faster than the rate of the natural drop of the limb segment under gravity)

Grade	Description
0	No resistance throughout passive movement
1	Slight resistance throughout, with no clear catch at as precise angle
2	Clear catch at a precise ankle followed by a release
3	Fatigable clonus (<10 seconds) occurring at a precise angle
4	Unfatiguable clonus (>10 seconds) occurring at a precise angle
5	Joint immobile

Due to the large amount of time required to perform the full Tardieu Scale, the Modified Tardieu Scale (MTS) was developed. It records the joint angles during the fast and slow velocities only. It uses the most clinically significant parts of the TS: the angle ofcatch at the most rapid velocity (R1) and the joint angle when the muscle length is at its maximum (R2), assessed by moving the joint through full ROM using slow passive movement. The MTS has been found to be a valid, reliable and sensitive abridged version of the TS. The difference in degrees between the angles R2 and R1 is referred to as the dynamic component of spasticity and estimates the relative contribution of spasticity compared to muscle contracture.

Spasticity Angle

R1 Angle of catch seen at Velocity V2 or V3

R2 Full range of motion achieved when muscle is at rest and tested at V1 velocity

Modified Ashworth Scale:

The Ashworth Scale (AS) grades the intensity of muscle tone through joint ROM on a five-point scale at one non-specified velocity. Modifications of the AS are referred to as the Modified Ashworth Scale (MAS). Literature has also described the MAS to include a 6-point grading scale, a grading for the severity of the muscle tone and also the assessment of the muscle tone at an unspecified _fast‘ velocity.

Table 2: Modified Ashworth Scale

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected joint is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected joint is easily moved
3	Considerable increase in muscle tone, passive movement is difficult
4	Affected joint is rigid in flexion and extension

As with any measurement tool, common sources of error are attributed to the individual taking the measurements, inaccuracies in the measurement instruments and variability in the characteristics being measured. Studies on the reliability of the TS and the MTS have demonstrated high intra and inter rater reliability when assessing children with Cerebral Palsy, provided sufficient time is allowed for training and practice. However, the AS displayed poor test and re-test results for both inter and intra rater reliability.

Spasticity is defined as the velocity dependent increase in muscle tone, which means only the Tardieu Scale is an appropriate assessment tool as it accounts for the velocity dependent nature of spasticity by passively stretching the muscles at three different speeds. The AS assessment tool measures passive resistance to motion at one speed, leading to inconsistencies and over-estimations in the identification of spasticity,

especially in the presence of muscle contracture. Despite the widespread use of the AS andits ability to identify general hypertonia, it is recommended that this tool no longer be usedand that the TS or MTS be used to evaluate the muscle tone in ambulant children with Cerebral Palsy.

Children with Cerebral Palsy who present with altered states in muscle tone often show signs of underlying muscle weakness and it is therefore important to evaluate the lower limb muscle strength in ambulatory children with Cerebral Palsy. The child with Cerebral Palsy who has greater muscle strength will achieve a higher motor function level as muscle strength is more highly correlated to function than the presence of spasticity. There is a direct correlation between muscle strength and a child‘s motor function, walking speed, energy expenditure and the temporo-spatial characteristics of gait. There is also an incremental drop in muscle strength in all muscle groups, with increasing walking difficulty from GMFCS levels I to III.

Strength: The presence of muscle weakness leads to muscle imbalance across other joints. This muscle imbalance is thought to be a factor in the development of muscle shortening, contributes towards rotational deformities and further affects the motor function of a child.Hence, when performing the orthotic assessment of

a child with Cerebral Palsy, a full muscle strength profile of the lower limbs is vital. The Medical Research Council Scale (MRCS) for manual muscle testing is the widely accepted clinical evaluation tool used to grade the muscle strength a child with Cerebral Palsy. During the assessment it is important to note if the child does not cooperate, is unable to isolate the muscle being tested or comprehend what is being asked of them. If further quantification of muscle strength is required, a hand held dynamometer may be used.

Table 3: Medical Research Council Scale (MRCS) for muscle strength evaluation

Grade	Description
0	No movement is observed
1	Only a flicker or trace of muscle movement is seen or felt in the muscle or fasciculation are observed
2	Muscle can only move if the resistance of gravity is removed
3	Muscle strength is reduced such that the joint can be moved only against gravity with resistance removed
4	Muscle strength is reduced but muscle contraction can still move the joint against resistance
5	Muscle contracts normally against full resistance

Range of Movement: Muscle contracture and bony deformities are the commonly observed secondary musculoskeletal problems that children with Cerebral Palsy may develop. These secondary musculoskeletal problems causes a decrease in the child‘s available lower limb joint ROM. Therefore, evaluation and quantification of the passive and dynamic lower limb joint ROM is a crucial part of the orthotic assessment of any ambulant child with Cerebral Palsy. The findings assist with the prescription of orthosis, evaluation of the intervention and the monitoring of change due to growth. The hip joint should be assessed for the amount of available passive and dynamic ROM in flexion, extension, abduction and adduction. Hip flexion contractures are a frequent presentation ina child with a predominantly spastic presentation of Cerebral Palsy.

A primary hip flexion contracture adversely affects the kinematics of a child‘s gait by

- Restricting heel contact at initial contact;
- Altering the position of the body‘s weight line during stance phase;
- Changing the degree of inclination of the femur and the tibia during stancephase;
- Reducing the amount of hip extension possible, causing an interruption oftransfer through the second and third rockers of stance phase.

The knee joint needs to be assessed for flexion and extension in both passive and dynamic ROM. It is also important to assess the joint range of motion of the passive, active and velocity specific knee extension with the child supine and the hip flexed to approximately 30°. This position replicates the degree of the hip flexion that occurs at initial contact during gait and establishes the degree of knee extension that is possible during early stance phase.

To establish the ROM of plantar and dorsi flexion at the ankle joint, it is important the sub-talar joint is maintained in a neutral alignment and the tests are best carried out with a child in a supine position. Movement at sub-talar joint either eversion or inversion while dorsi flexing the ankle affects the length of the gastrocnemius muscle and may produce erroneous findings of the available dorsiflexion ROM. A plantar extensor pattern generally exists in the lower limbs of a child with a spastic presentation of Cerebral Palsy. This often causes either the gastrocnemius or soleus muscles to be affected by increases in muscle tone. The gastrocnemius is a bi-articular muscle, originating proximal to the femoral condyles and inserting at the base of the calcaneus. Flexing the hip and knee to 90° and then dorsi flexing the ankle eliminates the effects of the gastrocnemius muscle on the foot and ankle and makes it possible to check the available ROM and muscle tone specifically attributed to the soleus muscle.

Alternatively, positioning the hip in 30° of flexion, the knee in the maximum attainable extension, the sub-talar joint in a neutral alignment and then dorsi flexing the foot establishes the ROM of ankle dorsiflexion that is attributable to either changes in muscle tone or contracture of the gastrocnemius muscle. Assessing the ankle ROM due to gastrocnemius length ascertains the child‘s plantar flexion-knee extension couple. This is used during the prescription of an AFO to determine the Angle of the Ankle in the AFO (AAAFO) and is the degree of ankle dorsi or plantar flexion the ankle is positioned within the AFO. It is defined as the angle of the foot relative to the tibial shank when viewed in the sagittal plane. Torsional deformities in ambulant children with Cerebral Palsy occur when there are muscle imbalances and abnormal loading and growth of bones due to increased tone or weakness. Therefore it is important to include a rotational assessment of the joints of the lower limbs. The particular areas to assess are hip internal/external rotation, femoral ante/retro version, degree of tibial torsion, sub-talar inversion/eversion and mid-tarsal abduction/adduction. Establishing the torsional profile of a child‘s lower limbs aids orthotic prescription by identifying if a torsional lever arm deficiency is present. Goniometric measures are the most widely used technique to assess either passive or velocity dependent lower limb joint ROM in a child with Cerebral Palsy. Factors suchas the number of assessors, patient compliance and the method used for measuring can affect the reliability and repeatability of measures. Several studies involving children with spastic Cerebral Palsy found that goniometric measurements display high levels of inter and intra reliability and repeatability for observers who are trained and experienced. Thisis provided a strict measuring protocol is adhered to.

Assessment of CP

In Cerebral Palsy (CP), numerous primary problems are observed including muscletone problems, muscle weakness, insufficient selective motor control, postural control, andbalance problems. In the persistence of these problems for a long period, secondary problems including torsional deformities, joint contractures, scoliosis, and hip dysplasia can occur in time, and strategies formed by children to cope with these problems make up the tertiary problems. Hence, the most accurate and brief assessment of all of these problems mentioned above is crucial to determine an effective and precise physiotherapy program. In the assessment of children with CP, it is very important to receive a detailed story consisting of the birth story, to question underlying medical

situations and to carry out physical assessment. In clinics, gross motor function, muscle tone, muscle length, muscle strength, and joint range of motion assessments are the most preferred ones.

Multidimensional assessment in cerebral palsy (CP) is very important for the determination of the fundamental problems of children, to select the most appropriate therapy approaches for these problems and to reveal the changes occurring during time with the therapy.

The assessment should provide information on the primary, secondary, and tertiaryproblems, functional capacity of the children, and the expectations of the children and families. Although various scales and tests prepared for children with CP can be used, observation, photographs, video records, or computer-supported complicated assessment methods can be used as well.

While selecting the outcome measures, psychometric properties should be considered; however, there is no clear information about how the outcome measures will be selected to reveal the function and health of children ideally. In the selection of the assessment methods, it may be beneficial to consider the dimensions of the International Classification of Functioning, Disability and Health Child and Youth Version (ICF-CY) , which is a classification system established by World Health Organization (WHO). When considered in the ICF-CY framework, there are instruments assessing body structures and functions such as problems of muscle tone, muscle strength, and selective motor control; instruments assessing activities and participation such as activities of daily life (ADL) and quality of life; and instruments assessing environmental factors such as impact of the family or the environment. Among these tools, the mostly required ones should be determined for the children. This way, a general opinion can be gathered about the children without much detail. Furthermore, the concerned physicians can examine ultrasound, magnetic resonance (MR), or radiographs as a part of neurologic or orthopedicexamination and their results can be combined with the physiotherapy assessments. All of these assessments are crucial not only for establishing a physiotherapy program or to determine the efficiency of the program but also for clarifying the surgical or medical interventions that need to be carried out for the children.

History and Observation

Detailed information should be received from the family or caretakers in all issues related to the children including family history, prenatal, natal and postnatal period, chronologic and corrected age, other accompanying problems, developmental story, adaptive equipment used, therapy approaches applied, medication taken, and educational status of the family .Observational analysis is crucial to determine children‘s functional skills, spontaneous motions and motion strategies, and the underlying fundamental problems. Thus, it can be decided in which field detailed assessment needs to be carried out. Observational analysis prepared by a specialized physiotherapist completes the standardized tests. During observational analysis, children must be in a setting they can be with their family, and they can feel comfortable and safe. There should be various toys andmaterials in the setting to reveal the children‘s capacity and to draw their attention. The assessment room should not be crowded and noisy. Observations provide a general idea to physiotherapists about the general state of the children, quality of movements, capacity and motor strategies developed by the children, protective

reactions, and upper and lower extremity functions. Video recordings during observation are rather beneficial as well.

Assessment of Reflexes and Reactions

Observation of reflexes is important to illustrate the severity of the influence in the nervous system, and observation of balance and protective reactions is important to support motor developmental process. When these assessments are carried out, the corrected age of the children should be considered. It is known that primitive reflexes continue insistently or disappear later than normal or never occur in children with CP. It can be observed that symmetric tonic and asymmetric tonic neck reflexes still continue in adolescent stage in a case diagnosed with dyskinetic-type CP. Insistence of these reflexes can complicate the therapy. It may be necessary to make various adaptations in the treatment program when the primitive reflexes continue in advanced ages. For example, ina case whose asymmetric tonic neck reflexes continues, orientation of the head and extremities in the midline may be the fundamental target of the therapy. At the same time, the assessment of protective reactions is important for determining a treatment program.

Assessment of Functional Level and Motor Development

Although CP is a non progressive central nervous system problem, emerging physical impairment and functional limitations change with the therapy approaches applied to the children during growth and with the effect of the environmental conditions. It is crucial to assess motor development, functional skills, and activity limitations for determining the current state of the children, and there are frequently used test batteries forthis purpose. Gross Motor Function Measurement (GMFM) is a standardized measurementinstrument frequently used to measure the change in gross motor function. This tool consists of five different dimensions, and all skills of the children during supine/prone position, sitting, crawling, standing up, and walking are assessed in detail. GMFM, with versions consisting of 88 items and 66 items, is accepted worldwide.

Gross Motor Function Classification System is the most frequently used classification system interdisciplinary and intra-disciplinary to define motor level in children with CP. This classification system categorizes the functional skills of children during their daily life under five levels. In addition, for assessing functional level and

motor development various scales are used as well including Activities Scale for Kids, Child Health Questionnaire, Gillette Functional Assessment Questionnaire, Functional Mobility Scale, Pediatric Evaluation of Disability Inventory, Pediatric Outcomes Data Collection Instrument, and Functional Independence Measure for Children.

Assessment of Muscle Tone

Spastic type is the most common one among CP types. Therefore, spasticity is the major problem encountered most frequently by pediatric physiotherapists. Spasticity makes the voluntary and selective motor control more difficult, increases energy consumption, and causes the formation of secondary musculoskeletal

system problems observed in CP. various physiotherapy methods can be effective in mild tone problems; however, medical or surgical interventions are needed for severe increase in tone persisting for a long time. In this context, it is crucial to determine the changes occurred inmuscle tone.

The most affected muscles from spasticity in children with CP are gastroc-soleus, hamstrings, rectus femoris, hip adductors and psoas in lower extremities, and shoulder external rotators, elbow, wrist and finger flexors, and forearm pronators in upper extremities. There are various clinical scales, biomechanical assessment tools, and neurophysiologic assessment methods to assess spasticity; however, there is no consensus about the best assessment.

The most frequently used clinical scales are Ashworth/Modified Ashworth (MAS) and Tardieu/Modified Tardieu (MTS) scales. MTS grades muscle spasticity in three different velocities and goniometric measurements also included for all velocities. According to a study by Numanoglu et. al. the administration of MAS is easier and takes less time than MTS, but MTS gives valuable information about muscle length and dynamic contracture and has better intra observer reliability.

In addition to these, there are scales such as Spasticity Grading, Modified Composite Spasticity Index, Duncan Ely Test, New York University Tone Scale, and the Hypertonia Assessment Tool. Myotonometer, sensors, Wartenberg Pendulum Test, dynamometer, goniometric measurement, and robot-supported assessment instruments are used as biomechanical assessment tools. In the neurophysiologic assessment of spasticity, Hoffmann H reflex occurring with low-threshold electric stimulation, tendon reflex occurring with tendon tap, and M-wave generated by high-intensity stimulation of peripheral nerve are used. However, overlapping of the values of healthy muscles with those of spastic muscles decreases the diagnostic value of these measurements. Furthermore, electromyography methods are also used in spasticity assessment.

In the long term spasticity, intrinsic structure of the muscles changes and this leads to muscle stiffness. In a study, an increase in the extracellular matrix collagen density of muscle fiber bundle in spastic hamstrings was reported to be the reason for an increased passive stiffness of muscle, and indicated that this situation can develop even before 3 years of age in children with CP. From this perspective, it is important to assess not only neural mechanisms of hyper tonus but also non neural mechanism. In recent years, elastography is benefited in the assessment of muscle stiffness in children with CP.

In addition to tone increase in children with CP, hypotonia and muscle fluctuations are observed as well. There are tools to assess dystonia such as the Burke-Fahn-Marsden Rating Scale and Unified Dystonia Rating Scale. There is no tool used routinely by the clinicians to assess hypotonia; it is generally categorized as mild, moderate, and severe.

Assessment of Muscle Strength

One of the primary problems observed in CP is muscle weakness. This situation occurs due to reasons including central nervous system impairment, inactivation, learned nonuse, and inadequate selective motor control. Muscle weakness can be observed in all subtypes of CP, and it is seen that muscular forces of children with CP are less than those of their peers who developed typically. Moreover, children with CP have slower sequential force generation in force application and have influenced motor planning.

Many publications show that strength trainings improve functional capacity without causing any problems in children with CP. In this respect, assessment of muscular force is significant. Muscular force can be assessed as isometric, isotonic, and isokinetic. For muscle strength assessment, the patients should cooperate with the assessor and the target muscle group must contract maximum; however, it could become difficult due to increased co-contractions in agonist-antagonists and due to cognitive limitations. In the assessment of muscular force, manual muscle testing, testing with handheld dynamometer,and isokinetic dynamometer or the measurement of maximum repetition of functional exercises is used frequently.

Usage of handheld dynamometers is suggested in the assessment of upper extremity and lower extremity isometric muscular force and grasping in children with CP. A systematic review about this issue suggested that Jamar dynamometer can be used to measure grasping force and handheld dynamometer can be used to measure the force of other upper extremity muscles. It is also reported that manual muscle testing can be usedto measure the total upper extremity force or hand wrist force in children who have very limited muscular force.

Assessment of Musculoskeletal System Deformities

Children with CP are prone to develop musculoskeletal system deformities. In addition to the major problems generated by central nervous system lesion in CP, secondary problems also exist. The development of musculoskeletal system in children with CP can be affected negatively due to the reasons including muscle weakness, posturalproblems, and muscle tone problems [50]. Musculoskeletal system should be assessed in detail to detect and to prevent from deformities at an early stage. For this purpose, various measurements should be made such as the measurement of muscular force, range of motion, extremity length, and muscle length. X-ray of a child with quadriparetic CP, age 13, GMFCS Level 5. Numerous problems concerned with hips can occur in individuals with CP related to aging. Many children with CP are born with a healthy hip; however, scores of problems cause insufficiencies in femur and acetabulum development. These problems are physical inactivity, severe mental retardation, flexion and adduction contractures, pelvic obliquity, sitting in –W‖ position, excessive tone increase in hip flexor, adductor, and internal rotator muscles, muscular imbalance, and insufficiency in weight bearing. Coxavalga, increased femoral ante version, and acetabular dysplasia are the major problems of hip. Hip subluxation rate in CP is reported to be 75%. Walking ability is the key point in the development of hip problems. Dynamic compressive forces generated during walking are required for the development of the required depth in acetabulum. Hemiparetic and diparetic children, who could walk independently at the age of 30 months, have the lowest risk for hip dislocation. Hip subluxation was reported to

be 11% in ambulatory children and 57% in non ambulatory children. Deterioration of motor level affects hip development directly; it was reported that there was 90% hip displacement in children at GMFCS level V.

Hip surveillance is important for the determination of hip dislocation. Routine radiographic hip assessment is one of the most significant parts of hip follow-up. It was reported that imaging as a part of orthopedic assessment should be carried out at 12–18 months and should be repeated every 6 months. Reimer‘s Migration Percentage and acetabular index are assessments suggested for radiologic hip monitoring. Children whose Reimer‘s Migration Percentage is greater than 33% or whose acetabular index is greater than 30% are at risk and they should be monitored closely. For hip surveillance, the hip abduction range of motion at flexion and extension position, presence of contractures, pelvic obliquity, femoral ante version angle, and spinal deformities should also be assessed.

Assessment of Physical Fitness

Due to physical impairments, individuals with CP have more reduced physical fitness in comparison to their peers who develop typically. Tone disorders, muscle weakness, emotional problems, and unfavorable environmental conditions push individuals with CP to move much less in comparison to their peers during the day and to develop sedentary lifestyle. These risks increase in children who are affected bilaterally or have low GMFCS level. In a study conducted on this matter, it was reported that individuals with CP engage in physical activities 13–53% less in comparison to their peerswho developed typically and the time spent sedentarily is two folds higher than that suggested normally. As the age advances, this situation becomes more serious due to the occurrence of musculoskeletal system deformities and the increase of body weight. Because of the abovementioned reasons, children with CP may face many undesired health conditions such as metabolic dysfunction, cardiovascular illness, and decrease in bone mineral density. There are various measurement methods used to assess physical activity. Maintaining an activity journal may help the assessment. Many surveys such as Activity Scales for Kids, Physical Activity Questionnaire for Adolescents, Children‘s Assessment of Participation and Enjoyment, Canada Fitness Survey, and the Early Activity Scale for Endurance are benefited for this purpose.

General physical endurance can be assessed by a 6-Min Walk Test. In addition to the surveys, equipment such as step counters, heart rate meters, and accelerometers can be used or more complicated assessment methods such as The Doubly Labeled Water Technique can be applied.

Assessment of Gait

Ensuring independent locomotion is one of the basic goals of many physiotherapists and families of children with CP. Children with unilateral CP almost always develop independent locomotion; however, a part of children with bilateral CP walk independently, some of them walk with aids, and some cannot achieve this function during their lifetime. Numerous gait problems such as equinus, crouch gait, jump gait, andscissoring gait are observed in children with CP who can walk independently.

Gait assessment can be used as an outcome measure to determine the reason of the problem in children and to determine the effects of the interventions. Gait assessment in children with CP can be made by observational gait scale-combined video records, time- distance characteristics, and instrumented gait analyses. Instrumented gait analyses made by measuring electromyography activity, three-dimensional joint kinetic, and kinematic values in laboratory setting present an objective assessment of the patients; however, they are not appropriate for routine clinical purposes. These systems require trained personnel, appropriate setting and the evaluation and interpretation of the results lasts for 3–6 h. In this context, observational gait assessment emerges as an important and useful tool for clinicians. Simple gait scales can be used to determine the quantity of the changes in gait pattern, and deviations from normal gait in the stance and swing phases. In these assessments, clinicians record the walking pattern by video and evaluate walking abnormalities in different joints and planes according to the existing scales. Furthermore, there are computer-supported video analysis programs to be used for this purpose. Among the observational gait assessment tools, there are Gillette Functional Assessment Questionnaire, Physician Rating Scale, Observational Gait Scale, Visual Gait Score, Salford Gait Tool, Edinburgh Visual Gait Scale, Observational Gait Analysis, and Visual Gait Assessment Scale. According to Günel et al., GMFM‘s gait domain can also be used as a gait assessment. Among these gait scales, Edinburgh Visual Gait Scale is suggested because it consists of information in each of the three planes for foot, knee, hip, pelvis, and trunk for both stance and swing phases and have good reliability and concurrent validity. It is reported that any of these scales is not equivalent to instrumented gait analyses.

Assessment of Balance

Muscle tone impairments and abnormal postural control in children with CP affect balance capacity negatively. It is known that static and dynamic balance reactions of children with CP are insufficient when compared with their normally developed peers. Pediatric Reach Test, Pediatric Balance Scale, Timed Up and Go Test, Pediatric Clinical Test of Sensory Interaction for Balance, Heel-to-Toe Stand, Timed One-Leg Stance, and Timed Up and Down Stairs are frequently used balance assessments in children with CP. Special equipment such as Wii-Fit and Biodex Balance System can be benefited as well.

Assessment of Trunk Impairment

Problems concerned with the trunk are observed frequently in children with CP and these problems affect both upper and lower extremity functions negatively. There are different methods for assessment of the trunk impairment. Assessment of postural control at the sitting position can be used to determine the weakness of the trunk muscles.

Moreover, the affected trunk control leads to insufficient balance and therefore instruments assessing postural control and balance during sitting can be benefited to assessthe trunk impairment.

In the literature, there are limited numbers of instruments providing information about postural control during sitting and most of the measurements are developed for adults. Some of the scales that could be used to assess trunk impairment in children with CP are listed below:

1) Spinal Alignment and Range-of-Motion Measure assessing spinal alignment and range of motion.
2) Segmental Assessment of Trunk Control assessing static, active, and reactivesitting balance and control level.
3) Seated Postural Control Measure assessing sitting function and alignment.
4) Trunk Control Measurement Scale (TCMS) assessing static and dynamic sittingbalance and dynamic reaching.
5) Level of Sitting Scale classifying sitting ability.
6) Assessment & Coding of Postural and Behavioral Observations assessing headcontrol during sitting, grasping, reaching, eating, and drinking activities.
7) Sitting Assessment for Children with Neuro-motor Dysfunction assessing staticand dynamic postural control during sitting.
8) Seated Posture Control Measurement assessing postural alignment.
9) Sitting Assessment Scale assessing sitting posture and control with video records.
10) Chailey Levels of Ability assessing sitting, reaching, and standing ability.
11) Trunk Impairment Scale assessing static and dynamic sitting balance of trunkcoordination.

Furthermore, scales such as Pediatric Balance Scale, Pediatric Reach Test, Modified Posture Assessment Scale, and Gross Motor Function Measurement provide information about the trunk although they do not assess trunk impairment directly.

Among the scales indicated above, Trunk Control Measurement Scale (TCMS) canbe preferred because it has good inter-rater reliability, does not require equipment other than simple materials such as a measuring tape and a ruler, does not require researcher training, and can be used easily in clinical setting.

Assessment of Health-Related Quality of Life

Although motor function problems are the major problems in children with CP, with the accompanying sensory, cognitive, and mental problems, activities of daily life and functional independence of the children are influenced as well. Not only children but those of the individuals taking care of them are also affected negatively. It was reported that children with CP experience emotional and behavioral problems four folds more than their peers. Quality of life should be self-reported by the person if possible due to its personal nature. However, this may not be possible in children with CP who have severe cognitive impairment; therefore, surveys assessing quality of life need to be answered by family or caretakers. Surveys answered by families are used more in children who are under 18 years of age and have difficulty in communication. For children who have no communication problem and can express themselves, child reports should be used. For this purpose,

questionnaires such as Pediatric Outcomes Data Collection Instrument and Child Health Questionnaire are the most used ones. Child Health Questionnaire-Parent Form 50, Lifestyle Assessment Questionnaire, KIDSCREEN [105], Cerebral Palsy Quality of Life- Child, the Caregiver Priorities and Child Health Index of Life with Disabilities, thePediatric Quality-of-life Inventory CP Module, and the DISABKIDS CP Module that are scored by families are used. According to a systematic review, for children with CP who are at school age, Cerebral Palsy Quality of Life-Child Survey is recommended due to its strongest psychometric properties and clinical utility.

Assessment of Activities of Daily Life

Activities of daily life (ADL) are vital tasks of persons in their school, home, and social environment. According to ICF-CY, these activities are included in the Activity and Participation dimension, including activities such as personal care, nutrition, cleaning, etc. Motor, sensory, perception, cognition, communication, and behavioral problems existing in children with CP can affect ADL performance. Children with CP have difficulty in performing activities of daily life and generally need adaptive equipment or family assistance. Therefore, activities of daily life should be assessed and attempts should be made to develop these activities. According to a systematic review, ADL scales that could be used in children with CP at the age of 5–18 are ABILHAND-Kids, Assessment of Motor and Process Skills, Children‘s Hand-use Experience Questionnaire, Klein-Bell Activities of Daily Living, Functional Independence Measure for Children, Pediatric Evaluation of Disability Inventory, School Function Assessment, and Vineland Adaptive Behavior Scales. Among these scales, Pediatric Evaluation of Disability Inventory was reported to be the best assessment instrument for children at an elementary school age because of its psychometric properties and personal ADL items. Children‘s Hand-use Experience Questionnaire, Vineland Adaptive Behavior Scale, and Functional Independence Measure for Children were reported to be appropriate for adolescent age. Assessment of Motor and Process Skills scale was reported to be the best scale assessing ADL in adolescent children with CP regardless of age.

Assessments of Upper Extremity

The upper extremity problems are observed in children with unilateral or bilateral CP but these problems can be more important for the children with unilateral involvement because the lower extremity functions are managed in this group more easily.

Motor planning, sensory motor integration, and bimanual coordination problems are observed frequently in the upper extremities. Manual Ability Classification System (MACS) classifying the upper extremity function at five levels is used frequently. This system examines the bilateral skills of the extremities during daily life activities. Assisting Hand Assessment scale assesses the use of the affected extremity during bilateral activities. Many different scales such as Melbourne Assessment of Unilateral Upper Limb Function, Jebsen Taylor Hand Function Test, Zancolli Hand Deformity Classification, Shriners Hospital Upper Extremity Evaluation, Upper Extremity Rating Scale, ABILHAND-Kids Questionnaire, Bimanual Fine Motor Function, the Quality of Upper Extremity Skills Test, and the Canadian Occupational Performance Measure are used to assess the upper extremity function in children with CP. Also, musculoskeletal evaluation methods, which are mentioned above,

can be specified for upper extremities.

An item from The Quality of Upper Extremity Skills Test QUEST Systematic review reported that any of the scales listed above did not reveal all ICF dimensions in detail on their own and different assessment methods should be combined to assess the upper extremity performance and function in children with CP.

Infant Assessment

Today, the number of preterm and low birth weight infants is increasing gradually. These infants can present motor impairment findings ranging from developmental coordination disorder to CP in the later stages of development. It may be necessary to waituntil 2–3 years of age to diagnose with CP in many countries. In a study conducted in Denmark, it was reported that although CP diagnosis was made at month 11 on an average, the children were not recorded in CP registry system until 4–6 years old for finalizing that the situation is not progressive.

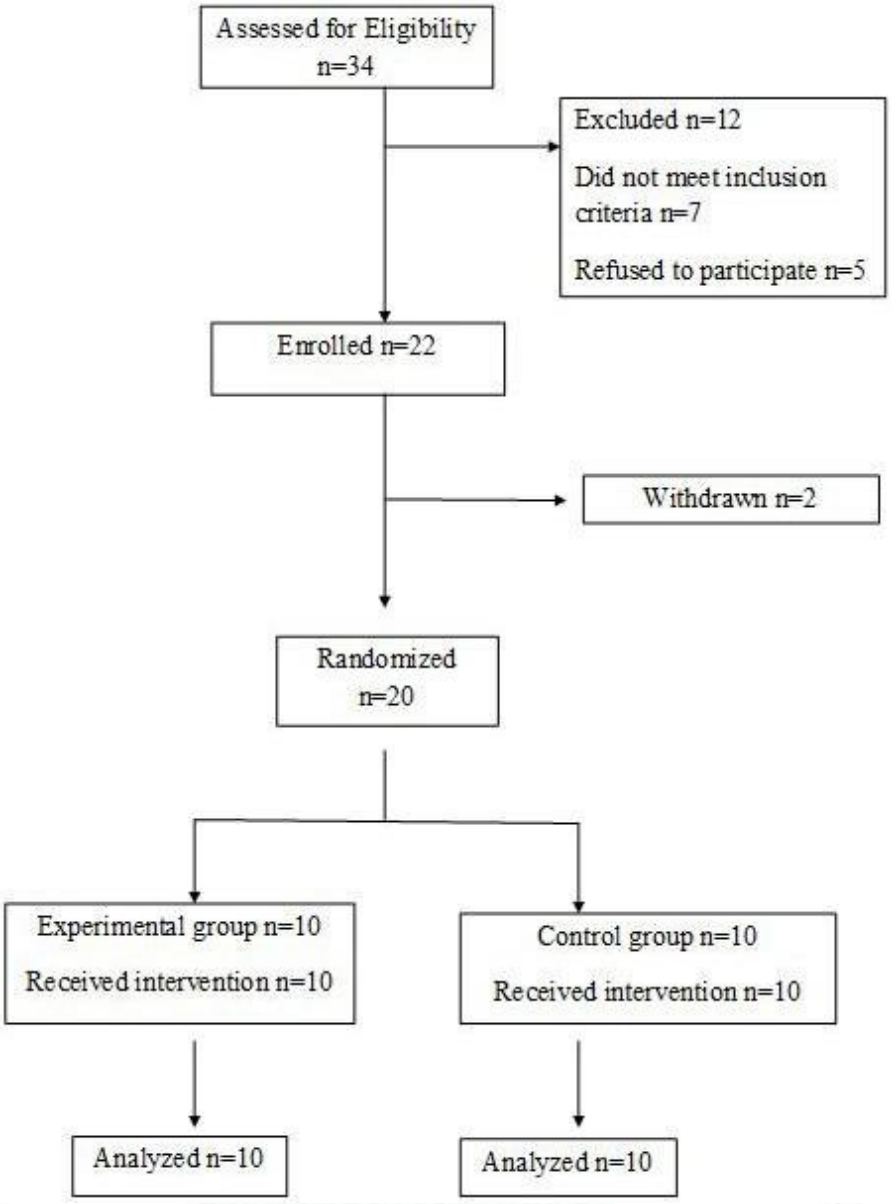
However, prior to diagnosis, various assessments should be carried out and motor development should be monitored in especially risky groups. It is suggested that age- appropriate neuromotor assessments of infants with low birth weight and premature infants are made during the first year of life. These assessments are crucial to ensure the differentiation of the infants with motor dysfunction and typically developing, to predict which infants will have motor influence in the future by considering their current performance and to determine the changes occurring in time. Therapy approaches give thebest results at this stage when brain development continues rapidly. In this context, infant neuromotor assessments are made to determine infants with motor impairment and to start the early intervention program promptly.

The commonly used assessment instruments for this purpose were reported as Alberta Infant Motor Scale (AIMS), Bayley Scale of Infant and Toddler Development, Peabody Developmental Motor Scales, Denver Developmental Screening Test, Prechtl‘s Assessment of General Movements (GMs), Motion Assessment of Infants, Test of Infant Motor Performance (TIMP), Infant Motor Profile, and the Neurological Sensory Motor Developmental Assessment (NSMDA)

Among these assessment methods, some of them such as GMs assess spontaneous movements of infants without any handling and some scales assess both spontaneous behavior and motor behavior occurring with minimal handling. Only TIMP and GMs among the abovementioned tests are appropriate to be used before the term stage. In a systematic review, it was reported that GMs have the best predictive validity for CP duringthe early infancy stage and AIMS and NSMDA are the best scales for motor development prediction in the later months. The authors of this review suggest that more than one scale should be used in infants. They discuss that the utilization of GMS and TIMP in the preterm phase and their use along with AIMS and NDSMA will give best results in terms of predictive, discriminative, and evaluative assessments. Better results can be obtained with the repetition of the assessments in infants in certain intervals.

Methodology

34 children were assessed for eligibility in the present study and 22 were initially enrolled. Before random assignment, however, two families withdrew from the study. The remaining twenty children were randomly assigned to intervention program with 10 in Group – A and another 10 in Group – B.



Pre and Post-test design with comparison treatments – A QuasiExperimental study design was used to collect data from Major Rehabilitation Centre, Department of Physiotherapy, CommandHospital (WC) Chandi mandir, Panchkula, Haryana.

Population and Sampling: Children with Spastic CP from Department of physiotherapy,Capital University were chosen as population for the study. A total of 20 children

With spastic CP, were randomly assigned into 2 groups. Group A of 10 participants (NDTwith MFR) and Group B of 10 participants (NDT).

Inclusion Criteria

1. Children with spastic CP, Age group 2 to 12 years.
2. Gross motor function classification system level I, II and III.
3. Children who are able to follow simple commands were included.
4. Written consent form

Exclusion Criteria

1. Usage of anti-spastic drugs
2. Injection of Botulinum toxin during the study period
3. Orthopedic or neurological procedure during the study
4. Uncontrolled epilepsy
5. Being unable to understand the commands necessary for the procedure
6. Visual and auditory deficits UE fixed deformities / contractures prior orthopedicsurgery
7. Mental retardation associated with CP
8. Have undergone change in dosage of medical drug during the time of study

MATERIALS USED

1. Mat
2. Short wooden stool
3. Wedge
4. Balance board
5. Bolster
6. Swiss ball
7. Play items like balls with various sizes and textures, cubes.

OUT COME MEASURES

1. GMFM-88 was used to measure the gross motor function in children with spastic CP. It is a standardized observational instrument. It comprises of 88 items with 5 dimensions and scored as 0-does not initiate, 1-initiates 2-partially initiates and 3- completes for each item.
2. Quality of Upper Extremity Skills Test (QUEST) and
3. Modified Tardieu Scale (MTS).

PROCEDURE

A written consent was obtained from the parent or caregiver who fulfilled the selection criteria and randomly assigned into two groups**.** 34 children were assessed for eligibility in the present study and 22 were initially enrolled. Before random assignment, however, two families withdrew from the study. The remaining twenty children were randomly assigned to intervention program with 10 children in Group A, and another 10

children in Group B.

Group A underwent combined NDT and MFR and Group B underwent NDT as perthe needs of the child. GMFM-88, QUEST & MTS was used as an outcome measure. During pre-test, each child of both groups was evaluated by using GMFM-88, QUEST, & MTS.

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 group‘s viz. experimental group (Group A) and control group (Group B) by computer generated random number.

A pre-treatment evaluation was done using the GMFM- 88, 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, NDT 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 informif any discomfort was felt during the treatment procedure.

RESULTS

Table 1: Paired ‘t’ test values, the Mean; Mean Difference and Standard Deviation(SD) of GMFM-88 in Group A

Group A			
	Pre - test		**Post-test**
Mean	55.247		74.12
Mean Difference		18.89	
Standard Deviation		8.75	
"t" Value		6.833	
"P" Value		P<0.001	

Graph 1: Mean values of Pre-test and Post-test in Group-A

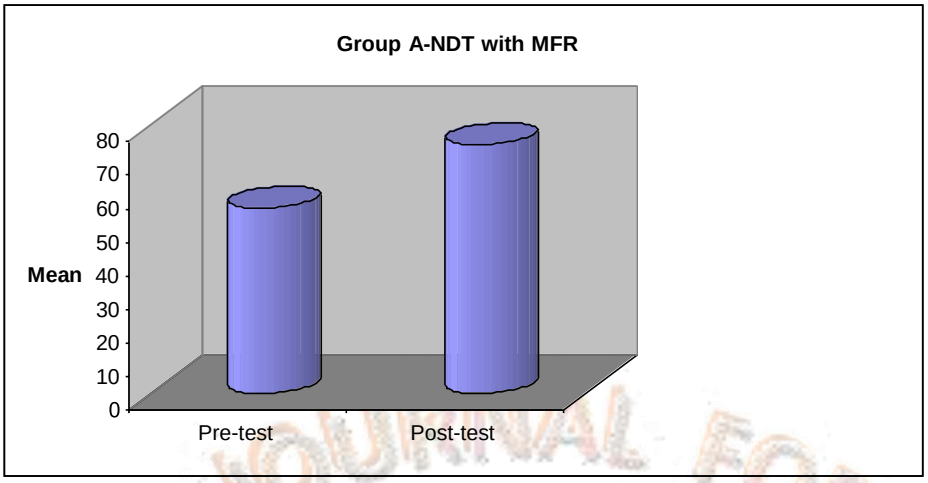


Table 2: Paired 't' test values, the Mean, Mean difference and Standard deviation(SD) of GMFM-88 in Group B

Group B			
	Pre - test		**Post-test**
Mean	52.742		59.967
Mean Difference		7.23	
Standard Deviation		2.13	
"t" Value		10.716	
"P" Value		P<0.001	

Graph 2: Mean values of Pre-test and Post-test in Group B

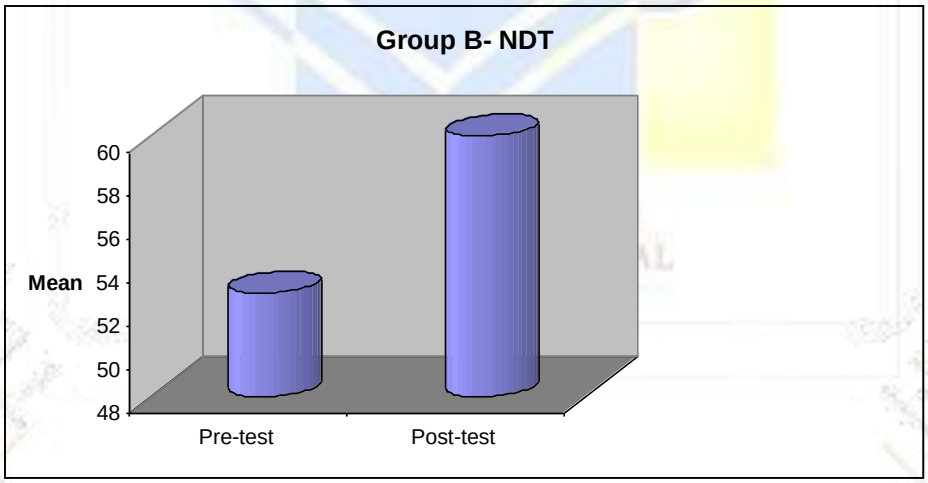


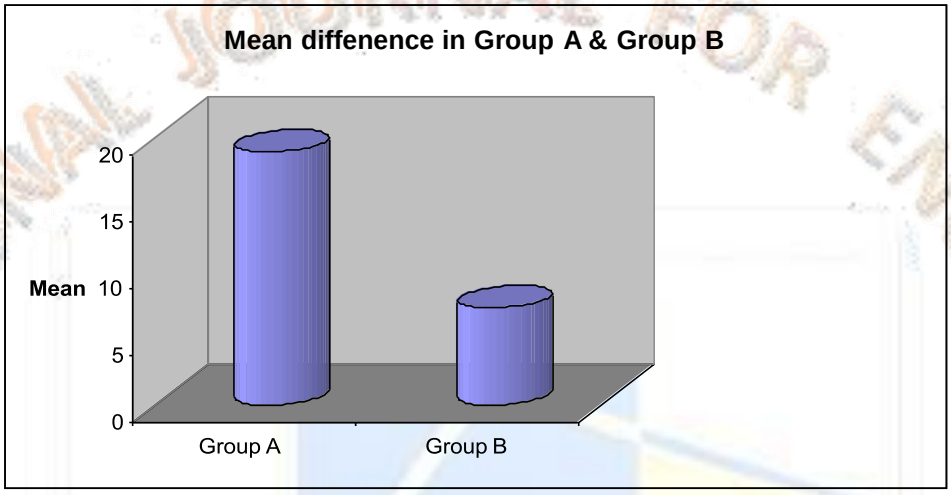
Table 3: Independent 't' test values, Mean Difference and Standard Deviation (SD) of GMFM– 88 between Group A & Group B

	Mean Difference	**Standard Deviation**	**'t' Value**
Out Come Measure	11.67	8.75	4.1
GMFM-88	2.13		(P<0.001)

Based on Table 1, the mean values of pre-test and post-test in Group A was 55.247 and 74.120 respectively, mean difference of group A was found to be 18.89, Standard deviation was 8.75, the _t' value was 6.833 which was greater than the table value at p<0.001.

In Group B the mean values of pre-test and post-test was 52.742 and 59.967 respectively. Mean difference was 7.23, Standard deviation was 2.13, _t' value was 10.716 which was greater than the table value of at p<0.001 which is shown in table 2 and graph 2 & 3.

Graph 3: Mean Difference in Group A & B.



The Mean difference between Group A and Group B GMFM 88 was 18.89 and 7.23. Based on the table 3, the calculated _t' value was 4.1, which was greater than the table value at P<0.001. This shows that MFR along with NDT improved the gross motor function in Spastic CP children. The findings showed that both the groups showed improvements in the gross motor function. Group A which underwent NDT with MFR showed greater improvement in the gross motor function than Group B which underwent NDT only.

Table 4: Intra group analysis of means of MTS

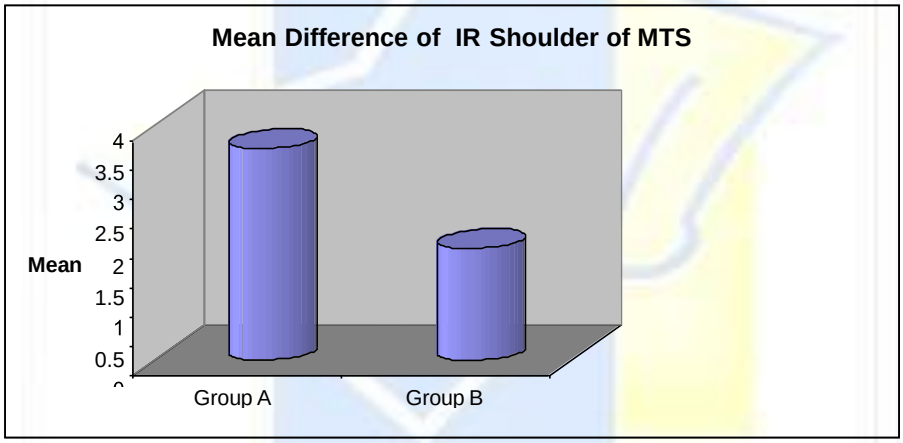
Domain Of Quest	rimental Group(Group A)		_P' Value	ontrol Group(Group B)		_P' Value
	Pre Mean ± SD	Post Mean ± SD		Pre Mean ± SD	Post Mean ± SD	
A	42.25 ± 9.40	42.73 ± 9.20	0.067	40.03 ± 12.55	40.10 ± 12.48	0.085
B	39.45 ± 12.18	40.94 ± 11.95	0.001	33.02 ± 9.45	33.02 ± 9.45	0.001
C	35.87 ± 10.32	36.68 ± 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

Table 5: Intergroup analysis of means of MTS

Muscles	Experimental Group (Group A)	Control Group (Group B)	95% CI	_P' Value
	Mean ± SD	Mean ± SD		
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 Flexor	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

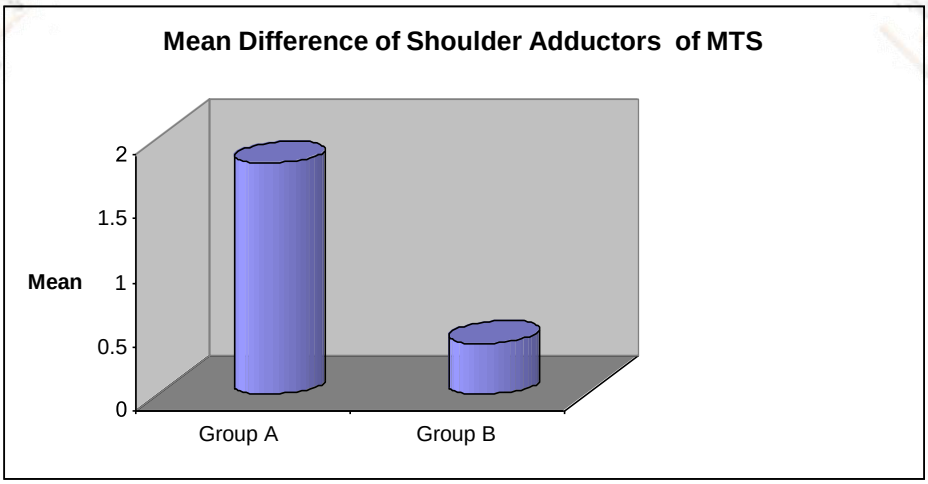
The mean difference between group A and group B MTS values of IR, biceps as well as mean difference between pre and post QUEST components was assessed by unpaired _t' test. MTS values of shoulder flexors, adductors, pronators and wrist flexors were assessed by Mann-Whitney U test. In the entire study,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

Graph 4: Mean Difference in Group A & B of IR Shoulder of MTS.



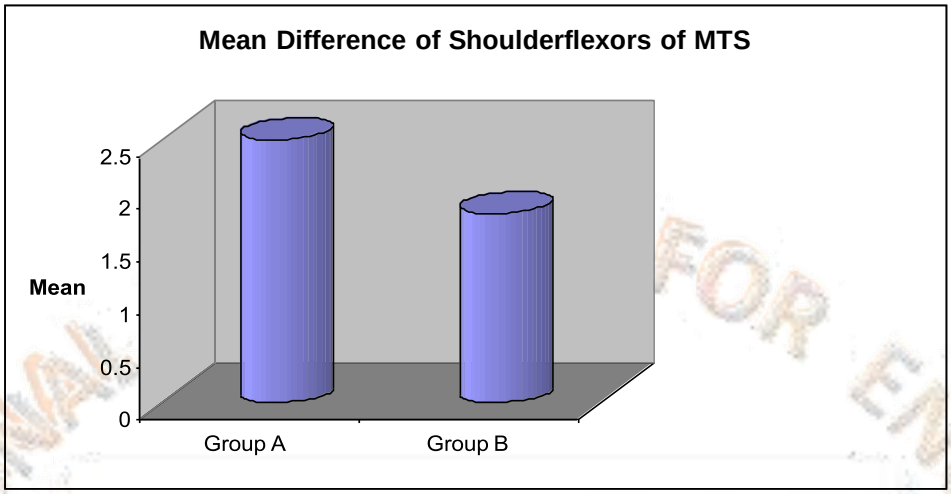
The Mean & SD difference of IR Shoulder MTS between Group A (Experimental Group) was 3.6 ± 2.7 and Group B (Controlled Group) was 1.9 ± 1.6. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 5: Mean Difference in Group A & B of Shoulder Adductors of MTS



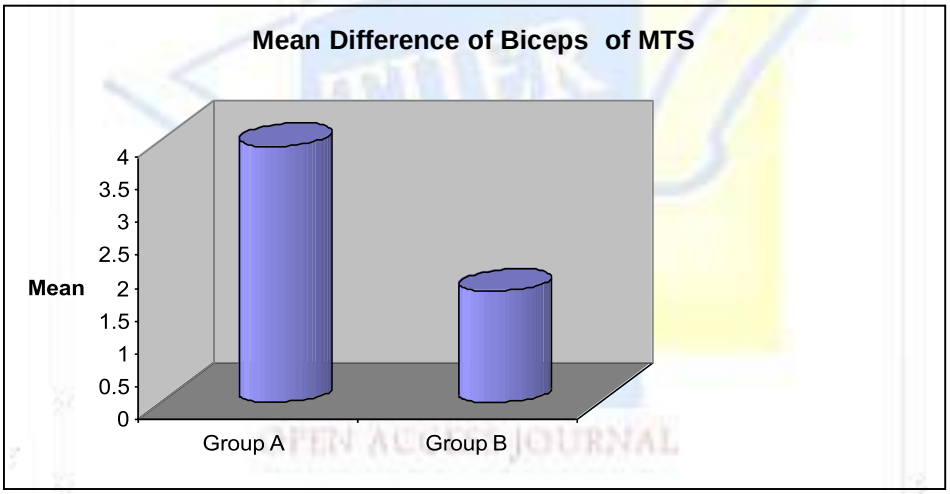
The mean & SD difference of Shoulder Adductors MTS between Group A (Experimental Group) was 1.8 ± 2.4 and Group B (Controlled Group) was 0.4 ± 0.8. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 6: Mean Difference in Group A & B of Shoulder Flexors



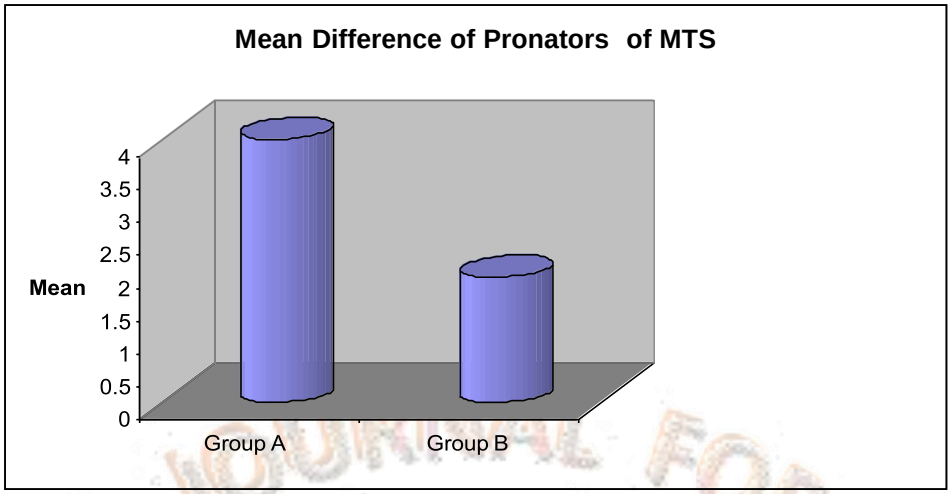
The mean & SD difference of Shoulder flexors MTS between Group A(Experimental Group) was 2.5 ± 0.63 and Group B (Controlled Group) was 1.8 ± 0.66 . The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 7: Mean Difference in Group A & B of Biceps



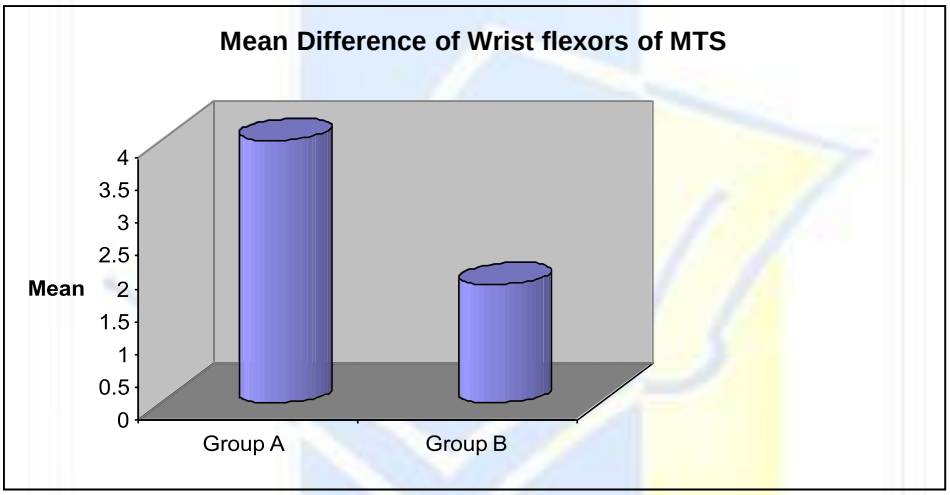
The mean & SD difference of Biceps MTS between Group A (Experimental Group) was 3.9 ± 2.13 and Group B (Controlled Group) was 1.7 ± 1.34. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 8: Mean Difference in Group A & B of Pronators



The mean & SD difference of Pronators MTS between Group A (Experimental Group) was 4.0 ± 1.33 and Group B (Controlled Group) was 1.9 ± 0.87. The differencewas found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 9: Mean Difference in Group A & B of Wrist flexors:



The mean & SD difference of Wrist Flexors MTS between Group A (ExperimentalGroup) was 4.0 ± 1.76 and Group B (Controlled Group) was 1.8 ± 0.63. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

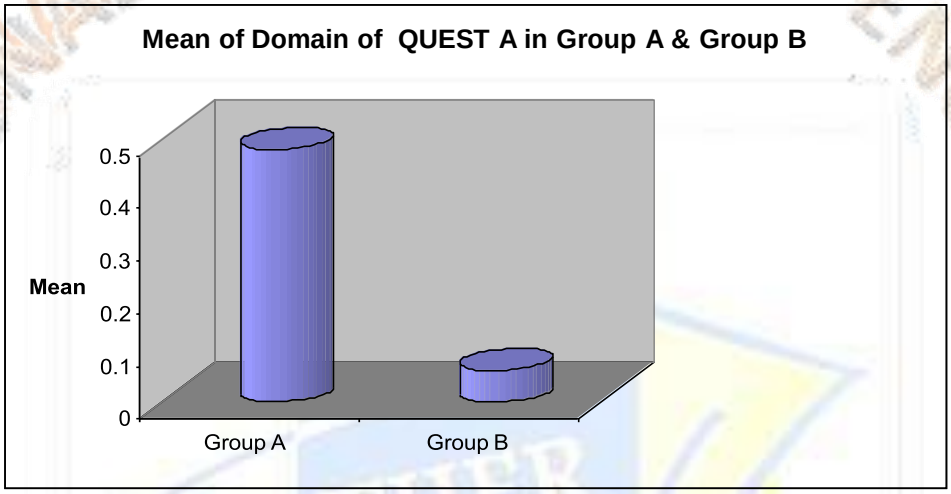
The mean ± SD of age of cases studied in Experimental Group and Control Group which was 5.85 ± 1.23 years and 6.25 ± 1.24 years respectively. (P-value >0.05)

The 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 intra group 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.

Table 6: Intra group and intergroup analysis of means of QUEST

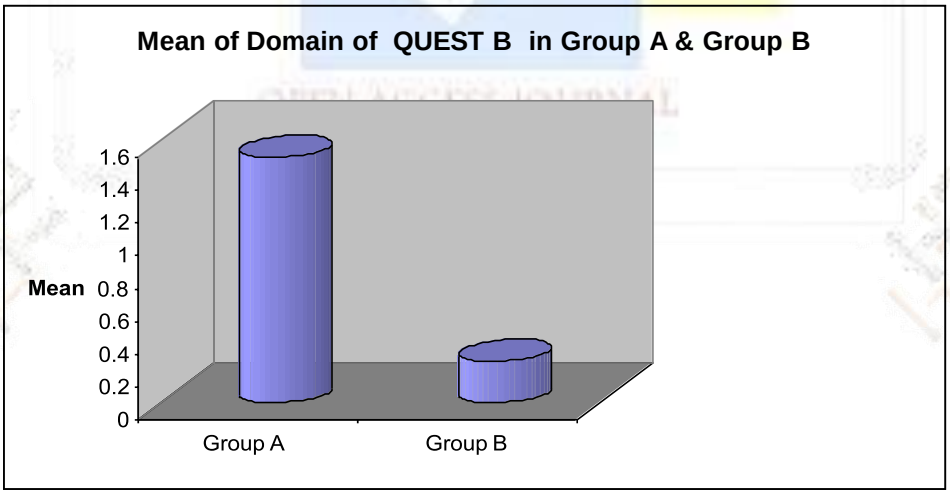
	Experimental Group (Group A)	Control Group (Group B)	_P' Value
Domain of QUEST	Mean ± SD	Mean ± SD	
A	0.48 ± 0.73	0.06 ± 0.11	0.094
B	1.49 ± 0.45	0.25 ± 0.16	0
C	0.80 ± 0.71	0.20 ± 0.17	0.018
D	0.76 ± 0.61	0.14 ± 0.18	0.006

Graph 10: Mean of Domain of QUEST A in Group A & Group B



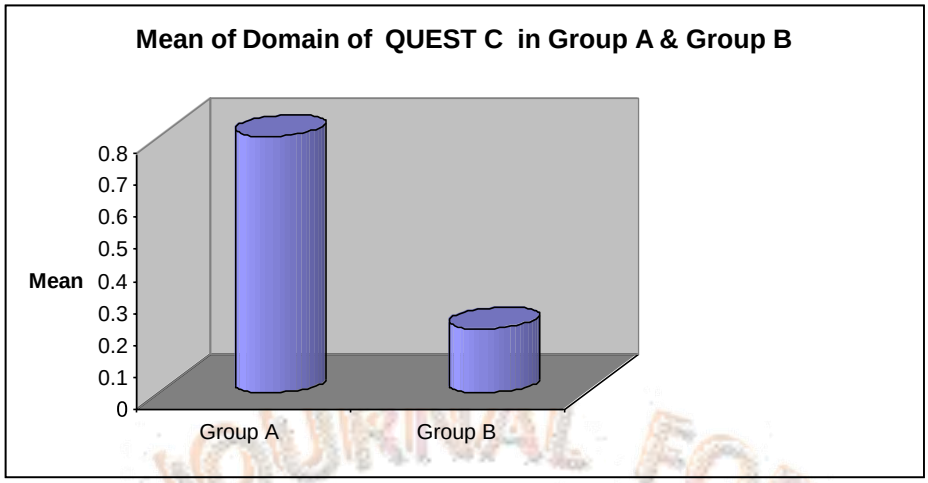
The mean & SD difference of QUEST A between Group A (Experimental Group) was 0.48 ± 0.73 and Group B (Controlled Group) was 0.06 ± 0.11. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 11: Mean of Domain of QUEST B in Group A & Group B



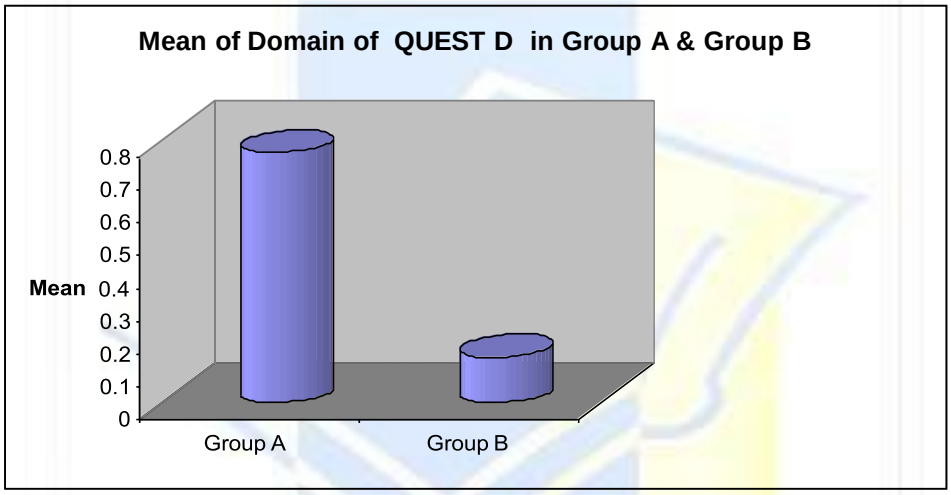
The mean & SD difference of QUEST B between Group A (Experimental Group) was 1.49 ± 0.45 and Group B (Controlled Group) was 0.25 ± 0.16. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 12: Mean of Domain of QUEST C in Group A & Group B:



The mean & SD difference of QUEST C between Group A (Experimental Group) was 0.80 ± 0.71 and Group B (Controlled Group) was 0.20 ± 0.17. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

Graph 13: Mean of Domain of QUEST D in Group A & Group B



The mean & SD difference of QUEST D between Group A (Experimental Group) was 0.76 ± 0.61 and Group B (Controlled Group) was 0.14 ± 0.18. The difference was found to be statistically significant ($p<0.05$) with experimental group showing greater improvement than Controlled group.

A significant improvement in gross motor function was seen in both the groups with a mean difference of 18.89 in group A & 7.23 group B. The calculated _t' value usingthe paired _t' test for group A was 6.833 (P<0.001) & group B was 10.716 (P<0.001). When comparing between the groups using independent _t' test the mean difference was

11.67 and the _t; value was 4.1(P<0 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. Lightpressure 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 beforethe 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 removing hands. Along with this conventional treatment was also given to the same group for half an hour. 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 GMFM- 88, MTS and QUEST.

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 assessedby 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.

Post-test was performed 4 weeks after the treatment using GMFM-88 and the results were compared. Data collected from both the group of children were analyzed using Paired _t'test to measure the changes between the pre-test & post-test values of the GMFM-88 within the group. Independent_t'test was used to measure the changes betweenthe groups. The improvement in gross motor function was assessed using GMFM-88. The mean, standard deviation and Paired —t‖ test values were used to find out whether there was any significant difference between pre-test and post-test values within the groups. TheIndependent —t‖ test was used to find out the significant difference between the groups after Combined NDT with MFR and NDT only.

The measurement tools used to evaluate muscle tone in children with Cerebral Palsy can be divided into two main groups according to their assessment technique and method of quantification. The Tardieu Scale (TS) assesses spasticity by passively moving the joints at three specified velocities (slow, under gravity and fast) while the intensity andduration of the muscle reaction to stretch (X) is rated on a 6-point scale, with the joint angle (Y) recorded at where the muscle reaction is first felt.

CONCLUSION

The present study concludes that NDT with MFR therapy is greater in improving the gross motor function & additional effect on quality of upper extremity function than NDT only in improving gross motor function in children with spastic CP.

This study incorporated combined NDT with MFR treatment and their influence in gross motor function of children with spastic CP. It was found that the NDT with MFR improved the gross motor function in children with spastic CP. Therefore, from the literature available and the statistical analysis of the data obtained, the study concluded that, NDT with MFR is greater in improving the gross motor function than NDT in improving gross motor function in children with spastic CP.

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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