Faculty of Medicine

University of Dhaka

EFFECTIVENESS OF CONSTRAINT INDUCED MOVEMENT THERAPY AND BIMANUAL THERAPY IN CHILDREN WITH HEMIPLEGIC CEREBRAL PALSY

By

Mst. Rabea Begum

Master of Science in Physiotherapy

Session: 2016-2017

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Department of Physiotherapy

Bangladesh Health Professions Institute (BHPI)

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We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for acceptance of this thesis entitled, “Effectiveness of Constraint Induced Movement Therapy and Bimanual Therapy in Children with Hemiplegic Cerebral Palsy”, submitted by Mst. Rabea Begum, for the partial fulfillment of the requirements for the degree of Master of Science in Physiotherapy.

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Declaration Form

This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

- This dissertation is being submitted in partial fulfillment of the requirements for the degree of Master of Science in Physiotherapy.
- This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. A Bibliography is appended.
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Name: Mst. Rabea Begum

Date:

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LIST OF ABBREVIATION

BHPI	Bangladesh Health Professions Institute
BT	Bimanual Therapy
CIMT	Constraint Induced Movement Therapy
CP	Cerebral Palsy
CRP	Centre for the Rehabilitation of the Paralysed
IRB	Institutional Review Board
MACS	Manual ability Classification system
MAS	Modified Ashworth Scale
MDT	Multidisciplinary Team
PAFT	Pediatric Arm Function Test
QUEST	Quality of Upper Extremity Skill Test
ROM	Range Of Motion
SENU	Special Education Needs Unit
UE	Upper Extremity
WHO	World Health Organization

Abstract

***Background*:** The hemiplegic cerebral palsy results the movement disorders in unilateral side of the body. CIMT and bimanual therapy promotes the unimanual and bimanual function and other function of upper extremity. ***Objectives*:** The objectives of this study were-to find out and compare the effectiveness of CIMT and bimanual therapy in muscular tonicity, unimanual function, bimanual function, handle objects and in weight bearing in different position (prone lying, cross-leg sitting, 4-point kneeling) and protective extension in side and backward. ***Methodology*:** This study was an experimental type of equivalence trials. Total 20 participants were included in where 10 participants in CIMT group and another 10 participants received bimanual therapy. The treatment dose was 1 hour, 3 days in a week. After 6 weeks follow up test has done. The outcome was measured by MAS, MACS, PAFT, QUEST. The Wilcoxon signed rank and Mann Whitney *U* test were used to analyze the data. ***Results*:** The CIMT group improved all the components of unimanual function ($p < 0.05$) whereas BT group 50% better in unimanual function. The bimanual function in CIMT improved 100% ($p < 0.05$), BT group improved 60%. Handle objects were improved in both group ($p < 0.05$). Weight bearing and protective extension were upgraded in CIMT group ($p < 0.05$) but in BT group not found better outcome ($p > 0.05$). ***Conclusion*:** This study investigated that CIMT and bimanual therapy are effective intervention in children with hemiplegic cerebral palsy. But CIMT group showed better improvement in all the function for hemiplegic CP.

***Key word*:** Hemiplegic Cerebral Palsy, Constraint Induced Movement therapy, Bimanual therapy

CHAPTER I: INTRODUCTION

1.1.Background

Cerebral palsy (CP) is one of major cause of childhood physical disability that persists throughout whole life and affect 17 million people worldwide (Graham, et al., 2016). CP is a non-progressive brain lesion of posture and movement disorder in prenatal, perinatal, and postnatal period (Jones, et al., 2007). "Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitation that is attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication and behavior by epilepsy and by secondary musculoskeletal problems" (Rosenbaum, et al., 2007).

The prevalence of CP is approximately 3 to 4 per 1000 live births in United Stated. Spastic CP is more common and it is estimated 61% to 76.9 % of all Cerebral Palsy cases (Boyle, et al., 2011). CP prevalence was constant from 1993 to 2010 and consistently higher among males than females (Braun, et al., 2015). In epidemiological studies stated that males are more at risk of CP than females: 1.3:1 (O'Callaghan, et al., 2011). It is estimated that the burden of CP is 5 to 10 times more common in low and middle-income countries (Cruz, et al., 2006).

Bangladesh is an over populated country in South Asia and it is estimated that there are 2.6 million children living with severe disabilities. The estimated prevalence of CP is up to 3.7 per 1000 children in Bangladesh. There are approximately 260,000 children with CP in Bangladesh (Murthy, et al., 2014).

In high-income countries, substantial knowledge on the prevalence, risk factors, distribution, frequency, severity and service of CP has been explored and defined but there are potential gaps in knowledge of CP in Bangladesh (Hurley, et al., 2011). Internationally 85 percent of children with disabilities live in developing countries but less than 5 percent receive rehabilitation services (Maloni, et al., 2010).

The risk can be present in before, during and after birth. In etiology perinatal factors are the leading risk factors in Cerebral Palsy (Fidan and Baysal, 2014) and most frequently hypoxic-ischemic encephalopathy (HIE) is related (Meberg and Broch, 2004). Cerebral palsy was strongly associated with acute delivery due to uterine rupture, and placental abruption. Acute hypoxic situations are indicated by a low Apgar score and low umbilical artery blood pH (Hasegawa, 2016).

A study by Goel and Ojha (2015) found perinatal asphyxia as major cause of cerebral palsy and diplegia as common type of cerebral palsy in Rajasthan, India. Another study from Nigeria found that birth asphyxia, bilirubin encephalopathy and post-infectious brain damage were the major causes of CP (Lagunju, et al., 2009).

In Bangladesh a case control study found that there were more than 2.5 times more chance among the parents who had consanguineous marriage, in case of home delivery there were 2.25 times more chance of developing cerebral palsy than those had the hospital delivery. Among the mothers who were suffering from problem during delivery, 47.5% had prolong labour during delivery, 25.0% had premature rupture of membrane and 20.0% had breech presentation. There were 33 times more risk of developing cerebral palsy among the premature baby than the term birth and 12.5 times more chance of developing cerebral palsy among the low birth weight child than the of normal weight child (Hai, et al., 2015).

The topographical classification of cerebral palsy classified as monoplegia, hemiplegia, diplegia, triplegia, and quadriplegia and the movement disorder type: spastic, athetoid, ataxic and hypotonic cerebral palsy (Reid, 2011). Spastic type of cerebral palsy is the most common type among cerebral palsy children (Bangash, et al., 2014). Spastic CP accounts for 76.9% among all types of CP. Among them 22.6% estimated hemiplegic CP (Allsopp, et al., 2008).

The unilateral or hemiplegic cerebral palsy is one of type based on topographic classification. In hemiplegic CP there is unilateral involvement of upper and lower limb. The dysfunction of upper limb is predominant than lower limb. Term infants are more affected in hemiplegic CP than preterm infants (Sankar and Mundkur, 2005).

In hemiplegic CP, the resulting movement impairments are largely localized to one side, with the upper extremity usually being affected more than the lower extremity. The resulting impairments to upper extremities demonstrate abnormal muscle tone with posturing into wrist flexion, ulnar deviation, elbow flexion, and shoulder internal or external rotation in addition to reduced strength (Schieber and Santello, 2004). They also present in bimanual coordination with unilateral impairments (Wahab and Hamed, 2015).

The management of patients with cerebral palsy must be individualized based on the child's clinical presentation and requires a multidisciplinary (MDT) approach. Management of children with cerebral palsy is involved with an MDT approach from different medical health professionals (Koman, et al., 2003). The rehabilitation of cerebral palsy is always a challenging for professionals and different therapies are listed in literature which follows multiple theoretical framework.

Physiotherapists, viewed as the 'movement expert', play a key role within this MDT. The main aim of Physiotherapy, as identified by Gunel (2011), is to support the child with Cerebral Palsy to achieve their potential for physical independence and fitness levels within their community, by minimizing the effect of their physical impairments, and to improve the quality of life of the child and their family who have major role to play in the process. Physiotherapy focuses on function, movement, and optimal use of the child's potential and uses physical approaches to promote, maintain and restore physical, psychological and social well-being within all environments of the child including home, school, recreation, and community environments.

There are a number of treatments available for the management of cerebral palsy. Constraint Induced Movement Therapy (CIMT) is a neurorehabilitation strategy used to improve the dysfunction of upper extremity for unilateral or hemiplegic adult and children with CP (Sakzewski, et al., 2012). This technique, developed by Edward Taub, applied constraint or restricts through any measure the sound limb in hemiplegic patients rendering it unable to use it. This therapy provides the maximum repetition in functional and daily activities of life and enhances the performance as well as promotes the neural plasticity in brain. The unaffected upper limb need to restraint by using slings, gloves or soft mitt for at least six hours. There are two principles of CIMT, one is restraint of unaffected limb and another is more therapeutic task with affected limb (Hoare, et al., 2007). The task including shaping, grasping or releasing object, turn a knob and other functional task like pour water in a glass. By using this task CIMT can improve functional activities in children with hemiplegic CP (Seema, et al., 2015). In a systematic review by Chen, et al. (2014) supports

constraint-induced movement therapy as an effective intervention to improve arm function in children with hemiplegic cerebral palsy.

Another emerging protocol for the management of hemiplegic CP is bimanual upper extremity training. This upper limb therapy helps children with hemiplegic cerebral palsy learn to use both hands together to complete the activities. The bimanual therapy is suitable for children with hemiplegic cerebral palsy. Bimanual therapy is an interventional approach that aim to increase functional independency by using both hands.

This technique involves task performance using affected limb along with less affected limb in symmetrical or alternating movement pattern which simulates most of our daily activities. The Bimanual approach is very crucial in managing the heavy task and where there is need of both limb involvements for attaining the task completion (Gordon, et al., 2007). In bimanual therapy children with hemiplegic cerebral palsy is facilitate with age appropriate gross motor and fine motor activities or function. The children are engaged in active learning approaches. In this approaches bilateral symmetrical and asymmetrical movements are practiced (Gordon, et al., 2012).

The theory of neuroplasticity is the basic science concept that explains in both CIMT and bimanual training. Neuronal plasticity permits reorganization of the central nervous system through the development of new neural pathways. Lesions or damage to a specific area of the brain lead to impaired function; the structure damaged is directly correlated to the function that is impaired. The reorganization can remain in the affected hemisphere, switch to the opposite hemisphere, or can be shared by both hemispheres (Johnston, 2009). When the unaffected arm is restricted, the affected arm is forced to move during the activity in which the brain creates alternative motor pathways to conduct the desired movement. Both

CIMT and bimanual training use concepts from motor learning principles by incorporating the type of task being practiced. New motor schemas are created through repeated practice which can cause an increase in brain activation patterns and create new neuronal motor pathways. This increases motor neuron groups, which may help retain motor skill learning and help produce functional improvements (Hubbard, et al., 2009).

Duyck (2016) conducted a study on pediatric CIMT and bimanual therapy for hemiplegic CP. The author concluded that there is small variation between CIMT and BT in children with hemiplegia.

Cerebral Palsy (CP) is a disease that affects motor function. The symptoms of CP vary based on the specific types This paper will examine children with spastic hemiplegia/hemiparesis. This type of CP only affects one side of the body and usually impacts the upper extremity more than the lower extremity (CDC, 2012). CP impacts a child's ability to engage in activities that involve both bimanual and unimanual function. A decrease in function can negatively impact a child's functions. The aim of this present study was to find the effectiveness of CIMT and bimanual therapy for improving the motor function of upper limb in children with hemiplegic cerebral palsy.

1.2. Justification of the study

In case of unilateral cerebral palsy upper limb is more affected than lower limb. CIMT is used for dysfunction of upper extremity skills or activity in patients with unilateral CP. By using this technique not only improve function but also reduce disability. The therapeutic strategies of CIMT is focus on development of new patterns of motor movement and pathways with create a connectivity between sensory and motor systems to make new movements (Chorna, et al., 2015). It has been shown that widely changed the cortical reorganization of brain after receiving CIMT. There was also found clinical improvement in children with cerebral palsy and leads to cortical reorganization in a child with hemiplegic cerebral palsy.

Physiotherapist practiced CIMT and as well as bimanual therapy with other multidisciplinary team member to manage the dysfunction of upper limb for children with cerebral palsy. Best of my knowledge there is limited evidence on this issue. Literature shows effectiveness of these strategies. However conflicting evidence is present on which one of these is more effective and no final conclusion can be made to date. This research intends to add to the literature and contribute in reaching final conclusion about superiority of either intervention. This study aimed at determining the effectiveness of constraint induced movement therapy as compared to bimanual therapy for improving functional status in hemiplegic cerebral palsy children. By this study researcher want to emphasize the efficacy of CIMT and bimanual therapy. And also determine which technique is more effective than other. By proving this evidence clinical uses will be also widespread for children with hemiplegic cerebral palsy.

1.3.Operational definition

Constraint induced movement therapy (CIMT):

In constraint induced movement therapy, unaffected side is restraint by using sling and facilitate affected extremity in function or activities.

Bimanual therapy:

The bimanual therapy is one kind of functional training that aim to improve bimanual function.

Unimanual function:

The execution of function in one hand.

Bimanual function:

Involving the use of two hand in functional activities.

Motor function of upper extremity:

The function of upper extremity including; unimanual function, bimanual function, quality of handle objects, movement of involved joint, weight bearing in different position and ability of protective extension in different position. In children with hemiplegic CP, all the functions are impaired.

1.4. Aim of the study

The aim of the study was to find out the effectiveness of constraint induced movement therapy and bimanual therapy on motor function of upper extremity in children with hemiplegic cerebral palsy.

1.5. Objectives

Specific objectives

- To explore the **sociodemographic characteristics** among children with hemiplegic cerebral palsy
- To find out the effectiveness of CIMT and bimanual therapy in changing **muscular tonicity** in children with hemiplegic CP.
- To find out the effectiveness of CIMT and bimanual therapy in **unimanual and bimanual function** in children with hemiplegic CP.
- To find out **the upper extremity skills in** CIMT and bimanual therapy.
- To **compare** the effectiveness of **CIMT and bimanual therapy in tonicity, unimanual, bimanual function and upper extremity skills** among hemiplegic CP.

1.6. Hypothesis statement

The null hypothesis (Ho): The effectiveness of **CIMT and bimanual therapy are equally effective** in children with hemiplegic CP.

Alternative hypothesis (Ha): The effectiveness of **CIMT and bimanual therapy** are **differently effective** in children with hemiplegic CP.

CHAPTER II: LITERATURE REVIEW

In the group of children with CP, about 30% have an involvement mainly on one side of the body (Staudt, 2008). The majority of cases of CP result from the incidence of a lesion or malformation during prenatal development, labour, or early in post-natal development. The injury to subcortical regions such as the basal ganglia, the cortex, and the thalamus are common. Although newer imaging techniques are often useful in aiding clinicians to localize the origin of the pathology in CP (Cowan, et al., 2003).

The most common form of CP is spastic hemiplegic CP, which is characterized by rigid movements as well as asymmetric motor impairment and affects approximately one third of individuals diagnosed with CP (Reid, et al., 2011).

In hemiplegia, one side of the body is more impaired than the other; the upper limb is typically more affected than the lower limb, and the impairments compromise the child's ability to reach, grasp, release and manipulate objects (Sakzewski, et al., 2009). Limited strength and coordination on one side of the body affect many aspects of the child's life, including play, self-care, and overall function in many daily activities, thus interfering with proper motor development on multiple levels (Brady and Garcia, 2009).

In unilateral CP, hand use is limited by several factors related to disturbed hand function. The arm and hand are affected by various degrees of spasticity in some muscles combined with weakness in others, resulting in difficulties extending the wrist, supinating (outwardly rotating) the forearm, and straightening the thumb and fingers (Brown and EG, 2000). These movement restrictions result in slow performance, and sensibility is often impaired (Majnemer, et al., 2008).

Knowing that object handling may be difficult for children with unilateral CP leads to the question of how they can perform daily living activities. The MACS can be used to classify how children with CP handle manual activities in everyday life. Children without restricted independence due to manual ability limitations are on MACS level I or II. However, although independence is not restricted, children in levels I and II may experience limitations. In level I, limitations may be present as regards the ease of performance of manual tasks that require speed and accuracy. In level II, a somewhat reduced quality and/or speed of performance may be present, and some tasks may be avoided or alternative ways of performance may be used. According to three studies, 87%, 92%, and 90% respectively of children with unilateral CP, were classified as level I or II (Eliasson, et al., 2006).

An important aspect of the social environment is the possibility of experiencing involvement in life situations, and this has been defined as participation. A low intensity of participation has been found in children with CP in general, and informal activity is more common than are formal activities with friends in the broader community. Children with unilateral CP have been reported to have fewer socially related problems than children with other forms of CP (Imms, et al., 2009).

CIMT is a therapeutic technique that consists of two main components: restraint of the less-affected limb, and simultaneous practice of the more affected limb (Taub, et al., 1994). The originally proposed recommendations for employing CIMT as a therapeutic technique were to restrain the less-affected limb for 90% of the individual's waking hours, and to perform intensive movement therapy for 6 hours per day over a two-week period (Taub, et al., 1998).

Effective treatment methods for the upper limb impairment observed in CP are needed; constraint-induced movement therapy (CIMT) is a relatively new motor intervention that began gaining attention as a potential therapy for children with CP more than a decade ago (Boyd, et al., 2001).

CIMT is a form of rehabilitative therapy that involves constraining the less affected limb, while simultaneously training the more affected limb. CIMT is now commonly used in children with CP. many studies have shown that CIMT is effective in improving the function of the more affected limb in this population. Several studies have yielded successful results when employing modified forms of CIMT in alternative settings, such as at home, at school, and in community settings, such as during a day cam. In clinic-based CIMT interventions require 60-84 hours of physical therapy per week.

The intervention's setting, motor interventions for CP are based in the knowledge that the human brain has the capacity to reorganize itself by forming and maintaining new connections. The formation of these new connections is activity-dependent and is termed neuroplasticity; specifically, cortical reorganization refers to the reorganization of somatosensory cortical maps whereby areas responsible for other body parts begin to elicit responses for areas that previously had little or no response. CIMT has the ultimate goal of inducing such neuroplasticity, and several studies have begun incorporating neuroimaging techniques such as functional Magnetic Resonance Imaging (MRI) into their research in order to investigate the possible neuroplastic effects of CIMT (Cope, et al., 2010). The factors affect the outcome of CIMT, such as age and level of impairment.

Many studies have tested the efficacy of CIMT in children with hemiplegic CP; these studies have used a variety of methodologies, including differences in therapeutic setting,

duration of CIMT, and activities performed during the intervention. Many positive findings have emerged from the studies conducted, suggesting that CIMT has the ability to induce lasting functional improvements in children with spastic hemiplegic CP.

DeLuca, et al. (2006) conducted a study aimed at testing the efficacy of CIMT in a randomized, controlled, crossover trial. The authors recruited 18 participants, ranging from 7-96 months of age (mean age = 3 years, 6 months); CIMT was administered for 6 hours per day for 21 consecutive days. In this study, the children wore a cast for the duration of the experiment (24 hours per day), removing it only once each week to check for any problems. The authors reported significant motor improvement as indicated by standardized motor assessments at the post-intervention assessment; these improvements were maintained at the 3-week follow-up. As expected, individuals in the control group did not experience a similar improvement; however, once they were crossed over and received CIMT, they similarly experienced a significant improvement in motor function.

On motor function of upper extremity and quality of life a study by Taub, et al., (2004) in patients with unilateral CP. Total 18 children were randomly assign in experimental that used CIMT and control group received conventional physiotherapy. Treatment dose was 6 hours per day in 21 days (CIMT group) and for 2.2 hours per week by control group. Male participants were more than female. The severity of motor deficit ranked of mild, moderate and severe. All data are tested at before, after, after 3 weeks and 6 months. It is revealed that CIMT is effective to improve motor function. The author reported statistically significant results on all assessment measures at each assessment time; improvements were reported for the CIMT group on all measures. Post-assessments were done immediately following the intervention, 3 weeks following the intervention, and at 3 and 6 months

following the intervention. The authors found that children in the intervention group showed a mean of 9.3 new motor patterns following CIMT as measured by the Emerging Behaviors Scale, while the usual care group acquired only 2.2 new motor patterns on average. The authors also reported an increase in the amount and quality of use of the affected limb in the CIMT group, as well as significant between-group differences in the amount and quality of use of the affected limb. They further reported positive subjective feedback from the parents of the participants, who stated that their children demonstrated increased self-confidence, increased interaction with their environment, and new sensory awareness of their affected limb.

Charles, et al. (2006) performed CIMT in 22 children aged 4.5-9 years (mean age = 6 years, 8 months) with spastic hemiplegic CP; the study was a randomized controlled trial with a delayed treatment option for children initially randomized to the control group. In this study, an arm sling was worn for 6 hours per day for 10 out of 12 consecutive days; children were engaged in play and other functional activities in a clinical setting. In addition, a home exercise program was established wherein parents were instructed to have the children practice using the affected limb without restraint at home for 1 hour per day during the two-week trial; the home practice time was increased to 2 hours per day for 6 months following the intervention. The treatment group demonstrated improved movement efficiency and dexterity of the affected upper extremity that was maintained at the 6-month follow-up; no significant changes were observed on measures of strength, sensibility (measured with two-point discrimination), or muscle tone. It was found that the crossover group did not experience similar benefits from the CIMT intervention; the authors

suggested that the group's experience in the laboratory setting may have hindered their motivation following the usual care treatment.

Another study was performed in the same lab using a similar methodology (Gordon, et al., 2006). The authors combined a clinic-based CIMT intervention with a home exercise program for 12 children aged 4-8 years (mean age = 6 years, 8 months) with a diagnosis of spastic hemiplegic CP. The structure of the CIMT intervention was the same as that of Charles, et al. (2006) was found that children demonstrated improved performance on standardized tests of motor function following CIMT, and that these improvements were maintained at the 6-month follow up.

One study specifically attempted to determine the effects of the environment on the outcome of CIMT interventions (Rostami and Malamiri, 2012). The authors investigated the effects of modified CIMT in 14 children aged 4-8.5 years (mean age = 6 years, 2 months); their primary objective was to determine if a home-based intervention would be more beneficial than a clinic-based intervention for children with hemiplegic CP. Children were randomized into either a home-based CIMT group or a clinic-based intervention; the restraining splint was worn by all participants for the majority of waking hours, being removed only for bathing and short periods of rest for both groups. Though the restraint was worn nearly full-time throughout the intervention, modified CIMT was only administered for 1.5 hours, 3 times per week, for a total of 10 sessions. It was found that both groups improved following the intervention; however, only the home group showed continued improvement at the 3month follow-up session on all measures. Overall, the home group's improvement was better than that of the clinic group, and the authors suggested that the application of CIMT in natural settings should be investigated further.

The studies performed in a clinical setting have used wide age ranges and a variety of intervening techniques; these studies have consistently demonstrated that CIMT is effective in inducing lasting functional improvements in children with spastic hemiplegic CP. It appears that the importance of transferring the shaping and practice of the unaffected limb to more natural settings is gaining attention in the field, as an increasing number of studies appear to be implementing home exercise programs and/or deliberately performing the interventions in settings outside of the laboratory.

Several studies have opted to perform the CIMT intervention in an alternative setting**;** such settings include the home, day camps, and some combinations of clinical and community settings. Aloraibi and Eliasson (2011) performed a randomized controlled trial using a home-based model to compare CIMT and NDT in 14 children with spastic hemiplegic CP aged 2-9 years (mean age= 3 years, 11 months). The intervention was 8 weeks in length, and CIMT was administered by caregivers for 2 hours per day, 6 days per week; the NDT group had 1-2 hours of therapy per week. Standardized tests of motor performance were administered before the intervention, immediately following the intervention, and 2.5 months following the intervention's end. At the post-assessment session, it was found that the NDT group showed almost no improvements; the CIMT group improved significantly more than the NDT group on all measures, and the observed improvements persisted at the 2.5-month follow-up. Another group of authors studied the effects of CIMT in a 4-year old child with hemiplegic CP using a home-based model (Brekke, et al., 2004). The unaffected limb was restrained for an average of 2.5 hours a day, for a total of 4 weeks and the standardized motor assessments were performed prior to, immediately following and 3 months following the intervention. In this model, caregivers administered CIMT at home

and encouraged practice of the affected limb on a daily basis (Brekke, et al., 2004). Following the intervention, marked improvements were observed in the child's functional ability to use the affected limb. The results of the studies by Al-Oraibi and Eliasson (2011) and Brekke, et al. (2004) demonstrate the usefulness of CIMT in a home-based setting, even with small sample sizes (and one single subject design); the authors suggest that CIMT can be implemented in various environment.

In everyday life, humans perform activities. Some activities demand the use of two hands and may be challenging to persons with reduced function in one hand. Alternative ways of performing such activities may then have to be used. However, when performing activities, humans also reveal who they are, as performance reflects individual preferences and values. There are many alternative ways of performing a given activity, and in manual activities, one aspect that may vary is how the hands are used, what role each hand is allocated, and how mobility and grasp forces are applied. Children with unilateral cerebral palsy (CP) have reduced hand function due to an early brain lesion. This affects the hand and arm on one side of the body, reducing the range of possibilities to use the affected hand (Skold, 2010).

The "bimanual activities" may give the impression that there is a clear distinction between activities performed using one or two hands, that is however not the case. This is supported by outcomes in young children with CP, aged18 months to 6years of age.

A person makes choices about how to perform an activity and how to use the hands. For example, the activity "taking out money from a wallet" can be performed using one or two hands, and either hand can be selected to hold the wallet while the other picks up the money. The holding and picking up can also be done in several ways as regards the position

of hand and fingers, forces applied, and time taken for the performance. In this study, the term “bimanual activities” refers to activities typically performed using both hands and difficult to perform using only one hand. The term “hand use” will in this thesis refer to whether one or two hands are used and how they are used. Bimanual activities are central to this thesis, because the performance of bimanual activities is often the crucial challenge for people with unilateral dysfunction of the hand and/or arm (Greaves, et al., 2010).

Leconte and Fagard (2006) found that hand use in children aged 5–12 years varied with three types of factors: intrinsic, environmental, and task-related. Guiard (1987) categorises bimanual activities into three categories: unimanual (e.g., dart throwing), bimanual asymmetric (e.g., playing the violin), and bimanual symmetric, in which the two hands play the same role, either in phase (e.g., rope skipping) or out of phase (e.g., rope climbing). This classification has since been used in various contexts. The author suggested that no activity can be proven to be truly unimanual; for example, in dart throwing, the other hand may contribute to postural function, influencing the performance. Thus, some activities obviously demand the use of both hands, while in others, hand use varies and is not always obvious.

Variation in both hand choice and grasping pattern is greater in younger than older children, reflecting the progressive refinement of ability during development (Leconte and Fagard, 2006).

Neural control is guiding the movements also when grasping an object. When lifting an object, grip and load forces act in synergy, the simultaneous initiation and parallel increase of forces producing efficient and smooth movement. The demands of the task are anticipated rather than depending on sensory and proprioception feedback. An internal

representation of an object's properties is built from previous knowledge and may be updated if afferent information indicates miscalculation of the forces needed (Flanagan et al., 2009).

A study by Hoare and Graves (2017) provided a rationale that limitations exist in the application of motor learning principles using CIMT due to the unimanual nature of the intervention. CIMT is effective for development of unimanual actions brought about by implicit learning, however it is not possible to target the cognitive and perceptual skills or explicit learning required for using two hands together. Using cognitive motor and action perception-based strategies in bimanual therapy allows object properties to be used to trigger the goal-related perceptual and cognitive processes required for children to learn to recognize when two hands are required to complete a task. The author proposed that CIMT and bimanual should be viewed as complementary. CIMT could be used to target unimanual actions. Once these actions are established, bimanual therapy could be used for children to learn how to use these actions for bimanual skill development and learning how to perform daily activities with two hands.

CHAPTER III: METHODOLOGY

The purpose of this study was to find out the effectiveness of constraint induced movement therapy and bimanual therapy on muscular tonicity, unimanual function, bimanual function, movement and weight bearing in different position among children with hemiplegic cerebral palsy.

3.1. Study design

This study was an experimental type of equivalence trial. The equivalence trials are the best suitable design. Randomization and the comparison of both groups are utilized in this type of study. Each group has chosen and assigned at random is presented with either the group 1 or group 2. The goal of equivalence studies is to demonstrate the equivalency (Walker and Nowacki, 2011).

3.2. Study area

The data has been collected from two setting of Centre for the Rehabilitation of the Paralyzed, Savar, Dhaka. One was the outpatient services of Pediatric unit, Centre for the Rehabilitation of the Paralyzed, Savar, Dhaka and another was Special Education Needs Unit (SENU) of CRP, Savar, Dhaka.

3.3. Study population

Children with hemiplegic cerebral palsy were the study population for this study at CRP, Savar, Dhaka.

3.4. Study Duration

The study duration was September 2017 to June 2018.

3.5. Sample size

The researcher has taken 20 participants for this study on the period of September 2017 to June 2018. Within this limited time, it was not possible to take a large number of sample for this study.

3.6. Inclusion criteria

- Participants aged 2 to 12 years (Chen, et al., 2014)
- The wrist extension was more than 10◦ (Zafer, et al., 2016)
- The ability to follow instruction of participants (Gordon, et al., 2011)
- Parents of participants' willingness to participate
- That patient was selected who were able to take treatment 3 days in a week up to 6 weeks.

3.7. Exclusion criteria

Children were excluded who had….

- Current/uncontrolled/ untreated seizures
- Any type of surgery for reducing the muscle tightness
- Received botulinum toxin therapy
- Any history of **fracture** in upper extremity
- Hearing and visual impairments which may interfere in treatment or testing

3.8. Sampling procedure

The samples were selected by Simple random sampling (SRS). By flipping a coin, it was decided. In coin head confirmed the CIMT group and tail indicated bimanual therapy group. Total 20 participants met the inclusion and exclusion criteria. All participants had an equal chance to be selected in two groups. Every participants were selected by coin flipping.

In this way researcher had selected total 20 participants for this study where 10 participants were in CIMT group and 10 samples were in bimanual therapy group.

3.9. Data collection method: The researcher has recruited two data collectors for two groups. Before collecting data, appropriate training has given to them. They used structured questionnaire for collecting data from participants.

The full procedure is shown in following consort flow diagram:

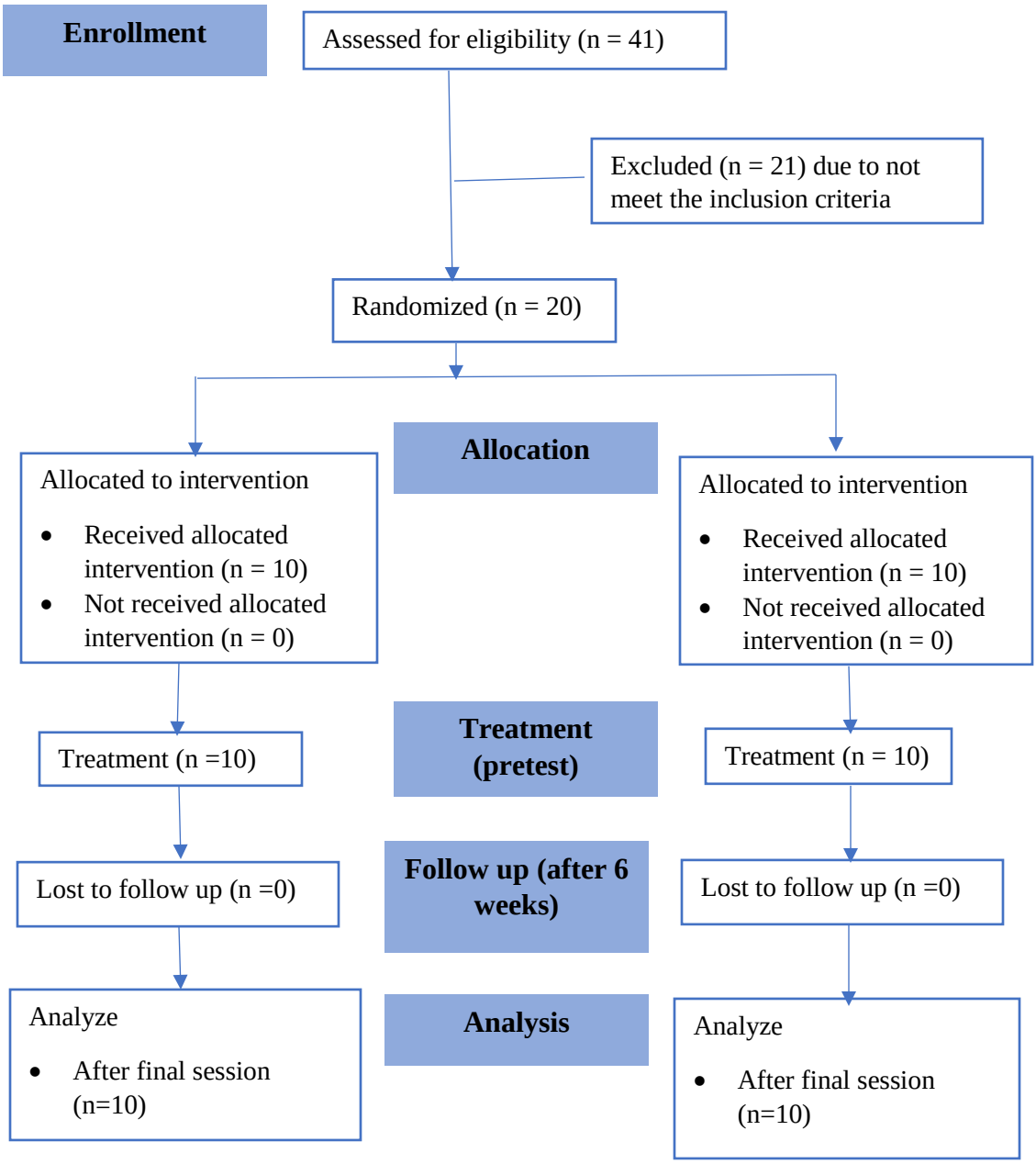

Figure 3.1: Consort Flow diagram

3.9.1. Data collection instruments

The data collection materials were questionnaire, coin, pen, paper, ball and others were needed for collecting data.

3.9.2. Intervention

Participants were randomly divide in two groups where group A was used CIMT and group B was used bimanual therapy. The treatment dose was 1 hour, 3 days/week up to 6 weeks. Then after 1 month follow up testing was needed. All treatment of groups was provided by graduate physiotherapists who are working as a clinical physiotherapist at Pediatric unit and SENU, CRP, Savar, Dhaka. In CIMT group (A), sound side was restrained by using arm sling (elbow bag). Rest interval was given according to child's need. For this group only, participant's carer was advised to use elbow bag at least 6 hours per day at home. In BT group, participants were facilitating to use both hand. The treatment components were including reaching in sitting and standing, grasp and release ball, build tower with large block, ring posting, weight bearing in sitting (in front, backward and sideways, ball throwing in a loop in sitting and standing, coordination practicing movement. Each component was practiced for at least 5 minutes to 10 minutes. At home mothers was advised this type of practice according to therapist advice.

3.9.3. Outcome measurement tools

There are four scales were used as an outcomes measurement tools. Manual Ability Function Classification System (MAC) for assessing handle objects. Modified Ashworth Scale (MAS) to assess the severity of tonicity of upper limb, Quality of upper extremity skills test (QUEST) to evaluate the movement pattern and weight bearing in different position, Pediatric arm function test (PAFT) to assess the unilateral and bilateral function.

3.9.3.a. Ashworth scale

Spasticity is one feature of an upper motor neuron lesion that may affect functionality, limit daily living activities and diminish quality of life in children with spastic Cerebral Palsy. The Ashworth scale is the simple measure for spasticity (Ansari, et al., 2008). It has a number of ordinal scale. Modified ashworth scale had good interrater reliability (Multu, et al., 2008). See the appendix

3.9.3.b. Manual Ability Classification System (MACS)

Manual ability classification system helps to handle objects in children with cerebral palsy. It has 5 level. The MACS was designed to assess how children with cerebral palsy (CP) use their hands when handling. The level I indicate the least impaired where level V being most impaired. The Eliasson, et al. (2006) stated that MACS has good validity and reliability for children with cerebral palsy.

3.9.3.c. Quality of upper extremity skills test (QUEST)

Measurement of upper limb movement and function among children with cerebral palsy (CP) has been investigated for many years. The QUEST is an outcome measure that evaluates movement patterns and hand function in children with cerebral palsy. The four domains evaluated by the QUEST include: Dissociated movement; Grasp; Protective extension; Weight bearing. It is a 34-item criterion-referenced observation test, with higher scores indicating increased levels of achievement on harder items. It can used after 18 month of child age. The QUEST has proven strong reliability for children with CP aged 18 months to above (Thorley, et al., 2012). In another study Thorley, et al. (2012) investigated

that construct validity of the QUEST for use with children aged 2–16 years who have cerebral palsy.

3.9.3.d. Pediatric arm function test (PAFT)

Approximately one-third of children with hemiparesis due to cerebral palsy (CP) exhibit motor deficits in their more-affected arm (Green, et al., 2007). The Pediatric Arm Function Test (PAFT) was developed to evaluate this aspect of arm function in 2–12-year-old. The PAFT Functional Ability scale is a reliable and valid measure of more-affected arm motor capacity in children with CP. The test-retest reliability was adequate (Uswatte, et al., 2011). It consists of 17 unilateral and 9 bilateral tasks.

3.10. Data analysis

The researcher used Statistical Package for Social Science (SPSS) version 16 and others were used to calculate the descriptive statistics and non-parametric test.

3.11. Statistical test

Based on the type of data the researcher was utilized two statistical tests. For between group analysis researcher had done **Mann- Whitney *U*** test and for within group analysis used **Wilcoxon Signed-rank** test.

3.11.a. Level of significance

The significance level refers to the probability of rejecting a null hypothesis when it is true. This quantity ranges from zero (0.0) to one (1.0) and is typically denoted by the Greek letter alpha (α). Significance levels most commonly used in educational research are the 0.05 and 0.01 levels. Before collecting data, the significance level for this study has chosen

and set to 5%. To assess the significance of the study *p* value was considered. The ***p*-value** helps you determine the significance of your results. The *p-value* is the level of marginal significance within a statistical hypothesis test representing the probability of the occurrence of a given event. If *p* value is lower than significance level, the result indicate that is statistically significant ang higher more than significance level indicates the non-significant result (Dahiru, 2008).

3.11.b. Mann Whitney *U* test

The Mann Whitney *U* test is one of the non-parametric test. This is used to compare two sample means that come from the same population and used to test whether two sample means are equal or not. Usually, the Mann-Whitney *U* test is used when the data when the assumptions of the t-test are not met. In this study, researcher was applied this test for analyzing the mean of between two groups (CIMT and bimanual therapy).

Assumption

There was some assumption that are given below:

- The sample was drawn from the population is random.
- The variables were ordinal that assumed
- The data were not normally distributed

Formula

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

In where,

n1=sample size for CIMT group=10

n2=sample size for BT group=10

R1=sum rank of CIMT group

R2=sum rank of BT group

Determine the smallest of U_1 and U_2 as U value.

Procedure of U test for unimanual function in CIMT and BT group

1) State the hypothesis

   Ho: The CIMT and BT are equally effective to improve unimanual function

   Ha: The CIMT and BT are effective differently for improving unimanual function

2) Calculate the rank value (R1, R2)

   R1=79, R2=131

3) Put n1, n2, R1 and R2 in the above formula

   U_1=$10 \times 10 + \frac{10(10+1)}{2} - 79 = 76$

   And $U_2 = 10 \times 10 + \frac{10(10+1)}{2} - 131 = \mathbf{24}$

4) Determine the smallest of U_1 and U_2 as U value=**24**

5) Lastly interpretation

   If U calculated value exceeds the critical value for U at significance level of 0.05, there is evidence to reject the null hypothesis in favor of alternative hypothesis. The calculated U value is 24 that was more than the tabulated value (23). So, the Ho is rejected and Ha is accepted that is CIMT and BT are statistically effective to improve unimanual function.

Table 3.1: PAFT questionnaire between CIMT and BT group (Mann Whitney *U* test)

Unimanual function		**CIMT and BT**	
S/N	**Variables**	***U***	**Sig. (2-tailed)**
1	Reach above head	49	0.966
2	Reach at waist level	38	0.348
3	Reach across midline	24	0.033
4	Grasp ball	47	0.833
5	Carry ball	46	0.737
6	Release ball	45	0.709
7	Throw ball	49	0.968
Bimanual function			
1	Separate toys	32.5	0.155
2	Carry ball	24	0.025*
3	Throw ball	47	0.007*
4	Quadruped	25	0.028*
5	Crawling	32.5	0.125
***=Significant**			

Table 3.2: QUEST between CIMT and BT group (Mann Whitney *U* test)

S/N	**Variables**	***U***	**Sig. (2-tailed)**
1	Weight bearing in prone lying	47	0.810
2	Weight bearing in cross leg sitting	32	0.155
3	Weight beating in 4-point kneeling	48	0.871
4	Protective extension in backward	40.5	0.438
5	Protective extension in sideward	35.5	0.234

3.11.c. Wilcoxon Signed-rank test

The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used to compare two related samples. In this study this test was used to analyze in within group of the CIMT and bimanual therapy.

Assumption

The assumption of the Wilcoxon Signed-rank test is given below:

- The two samples need to be dependent observations of the cases. The Wilcoxon sign test assess for differences between a before and after measurement, while accounting for individual differences in the baseline.
- The variables were ordinal
- The data were not normally distributed

Formula

The formula for the statistic for the Wilcoxon's Signed-Ranks test is:

$T=\min \{W+, W-\}$

Where W+ is the sum of positive ranks, and W− is the sum of negative ranks. When number of pairs is large ($n \geq 30$), then normal approximation can be used, and the following statistic is used:

$$z = \frac{T - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}}$$

Procedure of Wilcoxon Signed Rank test for carry ball in unimanual function in CIMT group

1) State hypothesis

   Ho: The CIMT is no more effective to improve unimanual function in CIMT group

   Ha: The CIMT is effective differently for improving unimanual function in CIMT group

2) Calculate the sum of positive rank R+ or W+ and negative rank R- or W-.
3) Determine the smallest of (8)W+ and (37)W- as the calculated T is 8

   T=min {W+, W−} = min {37, 8} =8
4) Interpretation

   From Wilcoxon table for n=10 and calculated T=8, *p* value is less than 0.05. There is an evidence to reject Ho and accept Ha that is concluding the CIMT is effective differently for improving unimanual function in CIMT group.

Table 3.3: Pediatric Arm Function Test (PAFT) questionnaire (Wilcoxon Signed-rank test)

Unimanual function		**CIMT group**	**BT group**
S/N	**Variables**	**Sig. (2-tailed)**	**Sig. (2-tailed)**
1	Reach above head	0.011*	0.035*
2	Reach at waist level	0.025*	0.011*
4	Reach across midline	0.011*	0.008*
5	Grasp ball	0.024*	0.053
6	Carry ball	0.023*	0.052
7	Release ball	0.008*	0.0059
8	Throw ball	0.009*	0.010*
Bimanual function			
1	Separate toys	0.023*	0.011*
2	Carry ball	0.038*	0.005*
3	Throw ball	0.011*	0.004*
4	Quadruped	0.046*	0.058
5	Crawling	0.025*	0.102

*=Significant

Table3.4: QUEST questionnaire (Wilcoxon Signed-rank test)

S/N	Variables	CIMT group	BT group
		Sig. (2-tailed)	Sig. (2-tailed)
1	Weight bearing in prone lying	0.914	0.118
2	Weight bearing in cross leg sitting	0.025*	0.435
3	Weight beating in 4-point kneeling	0.038*	0.273
4	Protective extension in backward	0.018*	0.131
5	Protective extension in sideward	0.047*	0.273
*=Significant			

3.12. Quality control and assurance

The questionnaire is fully structured that is based on literature review. The data collector was hardly follow the inclusion and exclusion criteria. The investigator also tried to reduce selection bias.

3.13. Ethical consideration

- Ethical permission has been taken from the ethical committee of CRP.
- Before starting data, researcher has taken permission from appropriate authority for data collection
- Hardly maintain the confidentiality
- Verbal and written consent has taken from each participant.

3.14. Informed Consent

Informed consent is a vital part of the research process. Informed consent is an ethical and legal requirement for research involving human participants. According to Parahoo (2006) informed consent is "The process of agreeing to take part in a study based on access to all relevant and easily digestible information about what participation means, in particular, in terms of harms and benefits."The key ethical principle relating to informed consent in research is the belief that everyone should be treated with respect (RCN, 2009). Researchers must respect diversity when gaining informed consent and must take into account factors such as: ethnicity, gender, Religious beliefs, culture, language, level of understanding etc.

The role of informed consent in human research is central to its ethical regulation and conduct (Islam, 2014). It is the process where a participant is informed about all aspects of the trial. Before starting to collect data, researcher followed the consent form. It is necessary to gain consent from the subjects (Baily, 1997). The researcher explained that participants are fully voluntary and they had full right to withdrawal from this study at any time and also assured that he maintained confidentiality. Where research involves children (under the age of 18) consent/permission has to be obtained from parent (Nijhawan, et al., 2013). See the appendix

CHAPTER IV: RESULT

The aim of the study was to find out the effectiveness of CIMT and BT to improve motor function of upper extremity in children with hemiplegic CP. Total 20 participants were recruited in this study. After applying treatment for six weeks post treatment scores were taken. This result section is illustrated descriptive and inferential statistics.

4.1. Baseline Participant Characteristics

The baseline characteristics of CIMT and BT group are given below:

Table 4.1: Baseline characteristics of CIMT and Bimanual Therapy group

Characteristics	**CIMT (n=10)**	**Bimanual Therapy (n=10)**
	Mean with SD	Mean, SD
Age in years	7.10±3.25	5.10±1.97
Gender		
Male	7 (70%)	7 (70%)
Female	3 (30%)	3 (30%)
Paretic arm		
Left	9 (90%)	9 (90%)
Right	1 (10%)	1 (10%)
Study setting		
PU	6 (60%)	8 (80%)
SENU	4 (40%)	2 (20%)

The table 4.1 has shown the baseline characteristics of CIMT and bimanual therapy (BT) group. The mean age and standard deviation in CIMT group was 7.10 and 3.25. In BT group mean age and standard deviation was 5.10 and 1.97. In total (n=20) participants 70%

was in male where 30% was in female. In CIMT and bimanual group the male and female participants were in 70% and 30% also. In all participants 80% were in left sided hemiplegic CP and 20% in right sided hemiplegic CP. In CIMT group 90% participants were in left sided and only 10% in right sided hemiplegic CP. In Bimanual therapy group,70% in left sided and 30% in right sided hemiplegic CP. In all participants 70% (14) were from PU (Pediatric unit) and 30% (6) were from SENU (special education needs unit). In CIMT group 60% (6) participants were in PU and 40% (4) from SENU. In Bimanual group 80% (8) participants were from PU and only 20% (2) participants were from SENU.

4.2: Sociodemographic characteristics of participants

4.2.1: Living area of the participants

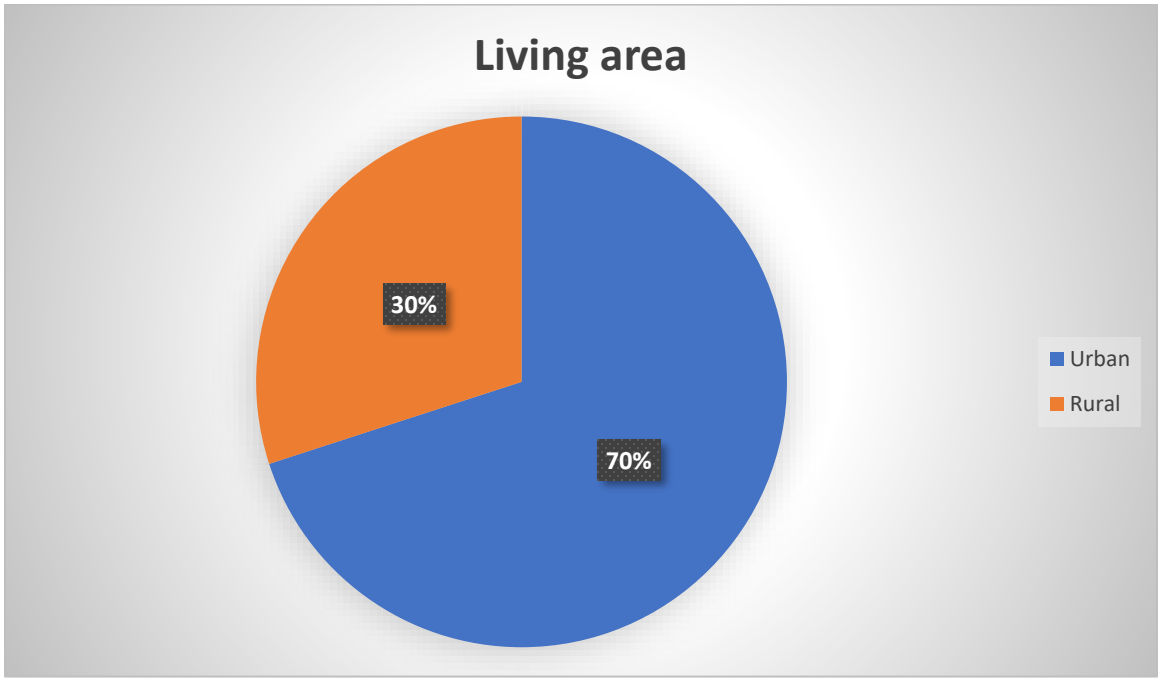

Figure 4.1: Distribution of living area among total participants

Majority of the participants 70% (14) lived in urban area and only 30% in rural area. 90% lived in urban area in CIMT group but in bimanual group 50% lived in rural and 50% in urban area.

4.2.2: Religion among participants

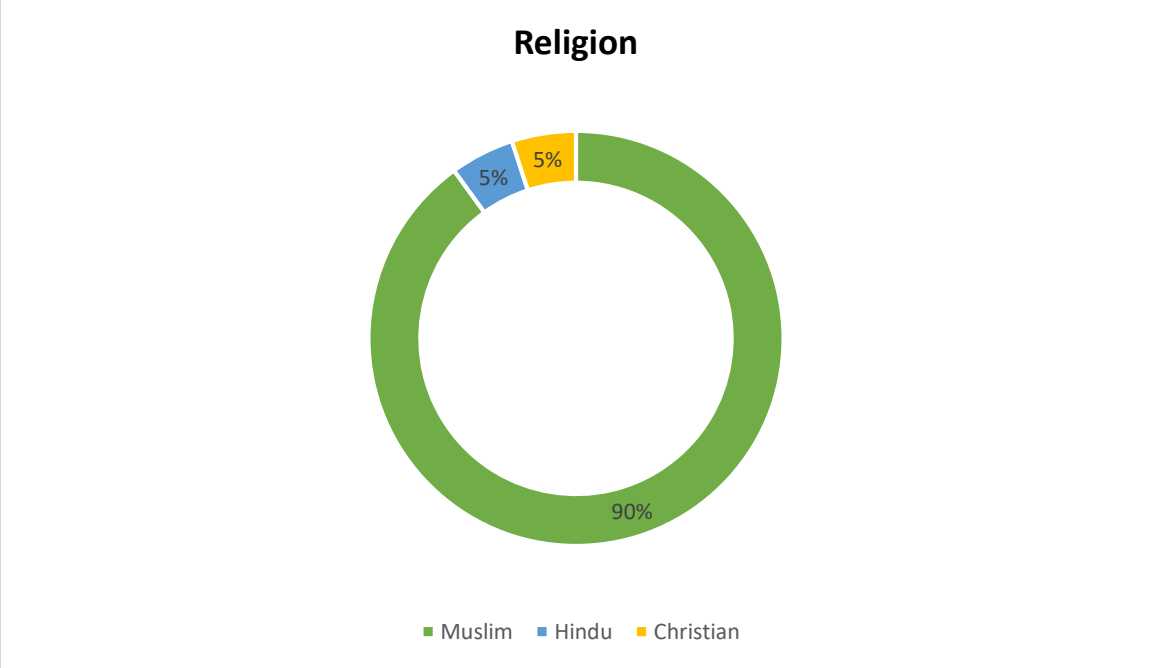

Figure 4.2: Religion among participants

In total participants majority (90%) of the participants were in Muslim. Only 5% participants in Hindu and Christian.

4.3.3: Educational status

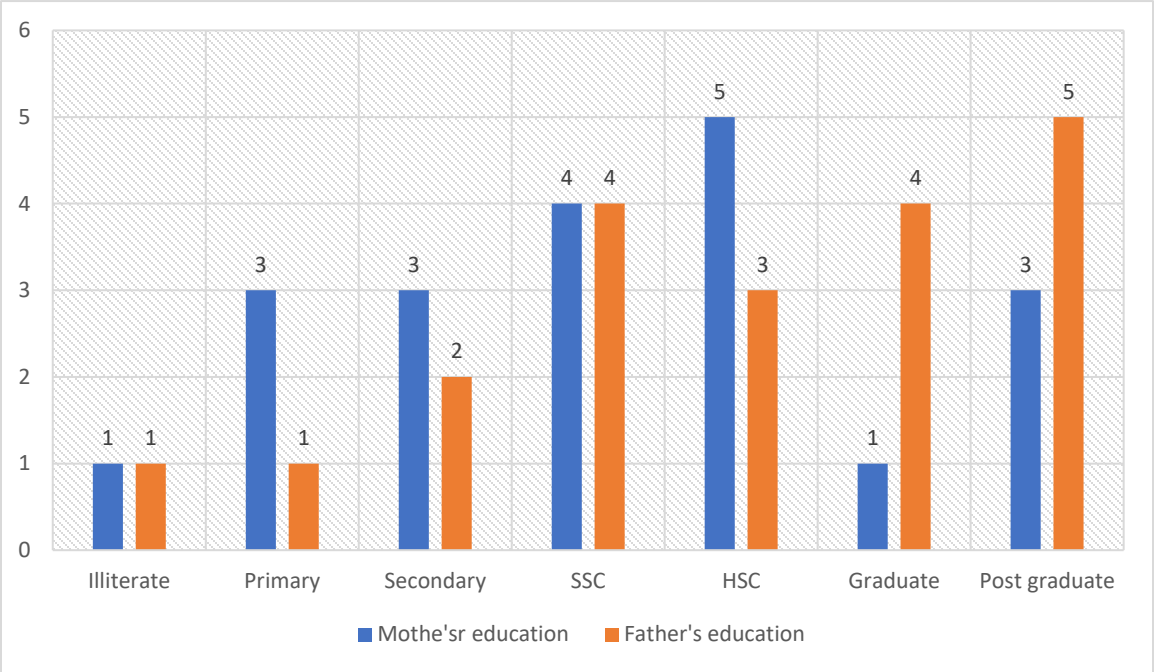

Figure 4.3: Distribution of educational status of child's parent

Among all participants 25% mother of children was graduated; 20% has completed SSC; 15% has completed primary, secondary and post-graduation but only 5% was illiterate and graduate. In father of children education, 25% has completed post-graduation; 20% has done graduate and SSC; 15% has completed HSC; 10% has completed secondary; 5% has done primary and 5% were illiterate.

4.3. Upper motor function information

4.3.1: Tonicity in MAS

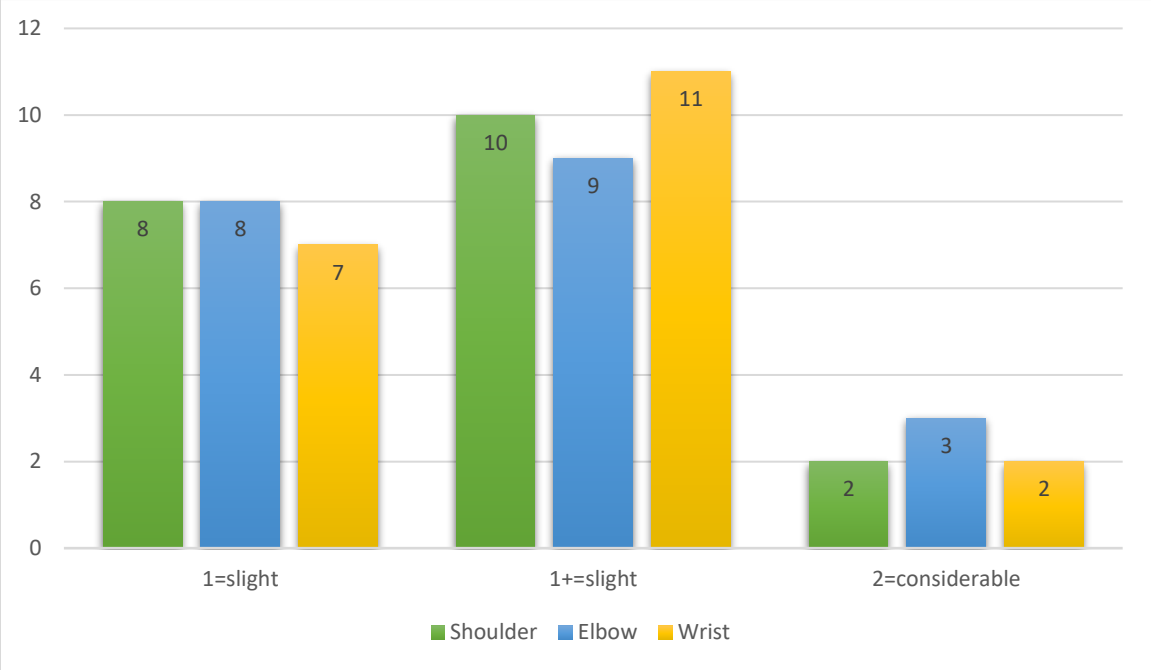

Figure 4.4: Distribution of tone in MAS (modified ashworth scale) in all participants

In all participants the flexor tone was found in shoulder, elbow and in wrist muscle. In CIMT group, 70% of participants has muscle tone in 1+ (slight) and 30% has 1 (slight) in MAS at shoulder; 60% in 1+ (slight), 30% in 1 (slight) and 10% in 2 (considerable) at elbow; 70% of participants has 1 (slight) and only 30% in 1+ (slight) at wrist. In Bimanual group, 50% of participants has muscle tone in 1+ (slight); 30% has 1 (slight) and 20% in 2 (considerable) in MAS at shoulder; 40% in 1+ (slight) and 1 (slight) and 20% in 2 (considerable) at elbow; 40% of participants has 1 (slight), 1+ (slight) and only 20% in 2 (considerable) at wrist in MAS.

4.3.2: Handle objects in MACS (manual ability classification system)

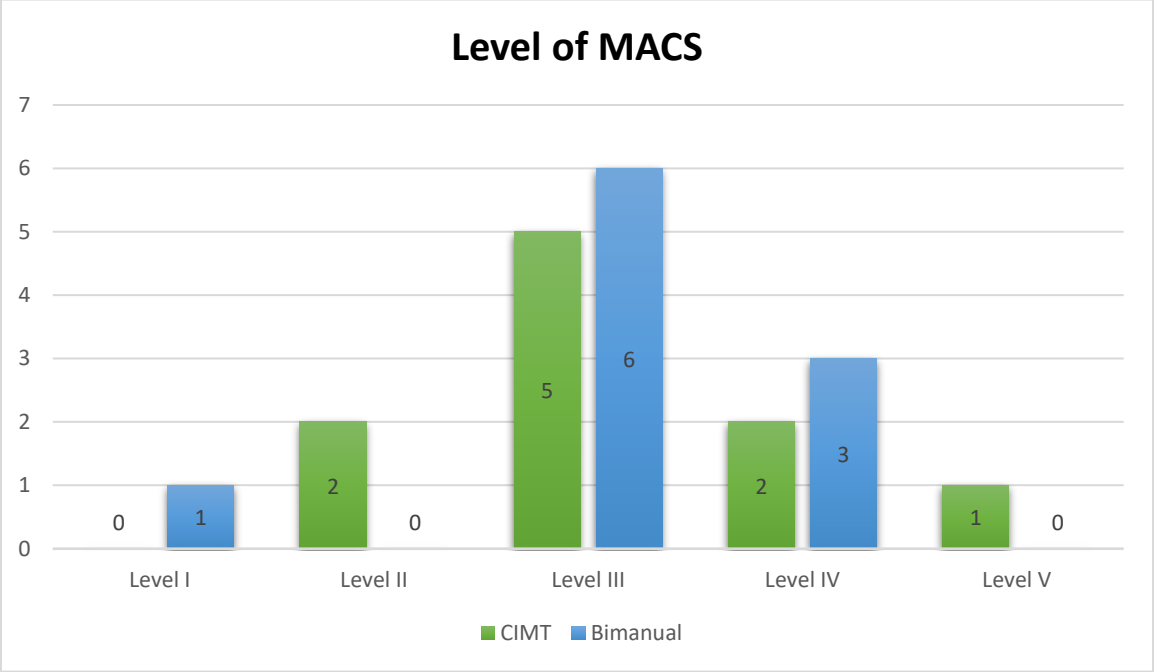

Figure 4.5: Distribution of handle objects in MACS of both groups

In CIMT group, 50% of the participants quality of handle objects were in level III; 20% in level II and IV; 10% participants in level V in MACS.

In bimanual group, 60% of the participants quality of handle objects were in level III, 30% in level IV and only 10% in level I in MACS.

4.4: Cooperativeness during treatment session

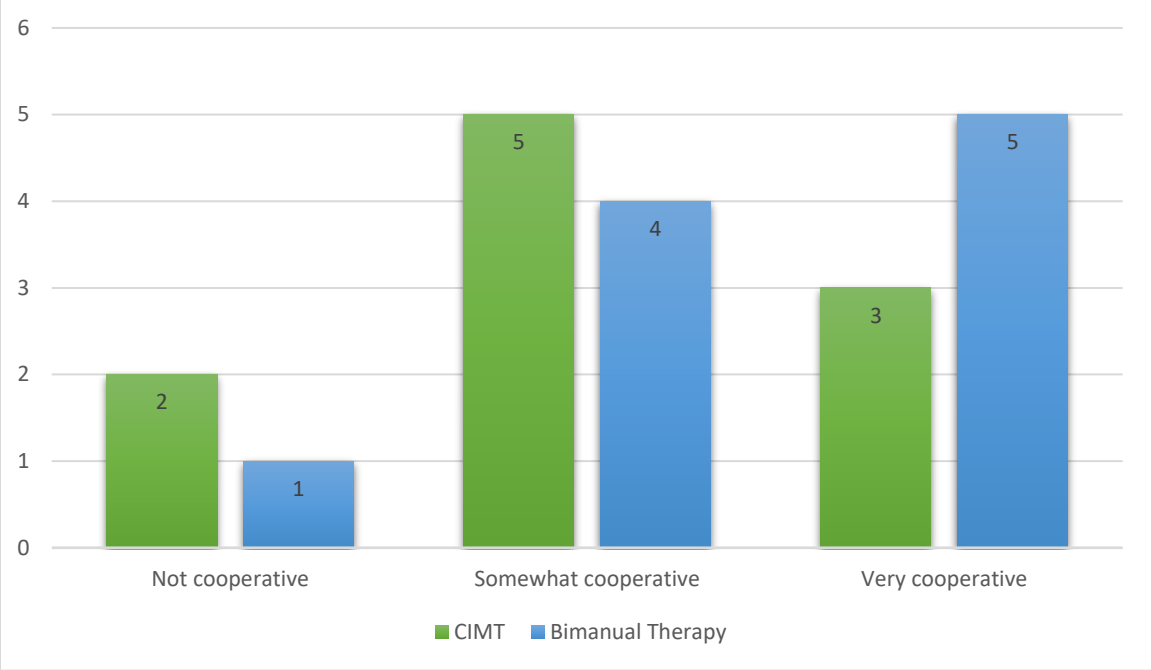

Figure 4.6: Distribution of cooperativeness of participants in both groups

In CIMT group, 50% participants were somewhat cooperative during treatment session; 30% participants were very cooperative and 20% were not cooperative.

In Bimanual therapy group, 50% participants were very cooperative, 40% were somewhat cooperative and only 10% participants were not cooperative in treatment session.

4.5. The muscle tone in CIMT group

Table 4.2: Rank test of the muscle tone in CIMT group

	Negative rank	**Positive rank**	**Ties**	***p* value**
Posttest- pretest of tonicity in CIMT group	2	0	8	0.157

The above table showing the comparison of the muscle tone in CIMT group of pretest and posttest. It showed that 2 participants had reduced muscle tonicity in CIMT group during posttest. No participants had higher reduction of the muscle tone after receiving CIMT in posttest. In addition, 8 participants had equal amount of muscle tone in pretest and posttest after getting CIMT. The *p* value is 0.157 which is more than 0.05. So, this result was not statistically significant.

4.6. The muscle tone in Bimanual therapy group

Table 4.3: Rank test of muscle tone in bimanual therapy group

	Negative rank	**Positive rank**	**Ties**	***p* value**
Posttest- pretest of tonicity in bimanual group	3	0	7	0.83

The above table 4.3 showing that the comparison of the muscle tone in bimanual group of pretest and posttest. It showed that 3 participants had reduced muscle tonicity in bimanual group during posttest. No participants had higher reduction of the muscle tone after receiving bimanual group in posttest. In addition, 7 participants had equal amount of muscle tone in pretest and posttest after getting bimanual therapy. The *p* value is 0.83 which is more than 0.05 that indicate the findings of the result was not significant.

4.7. Changes the Score of muscle tone between CIMT and bimanual therapy group

Table 4.4: Changes the score of muscle tone between two groups

	Group	Number	Mean	Mean Rank	*U* Score	*p value*
Difference between CIMT and bimanual group	**CIMT**	10	2.55	11	45	0.661
	Bimanual Therapy	10	1.50	10		

This table 4.4 showed that the calculated value of *U* is 45 for the muscle tone in CIMT and bimanual group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 45 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis.

4.8. The unimanual and bimanual function in CIMT group

In all the components of **unimanual function** there was increased every mean in posttest from pretest. All the components were improved significantly (*p* value <0.05). So, the result of unimanual function was statistically significant. All the components of **bimanual function** there was increased every mean in posttest from pretest. All the components were improved significantly (*p* value <0.05). So, the result of bimanual function was statistically significant.

4.9. The unimanual function and bimanual function in bimanual therapy group

In unimanual function, all the components in bimanual therapy group there was increased every mean in posttest from pretest. Among component of unimanual function; reach above head, reach at waist level, reach across midline and throw ball improved in posttest after getting treatment from bimanual therapy (*p* value < 0.05). So, the result was significant. But grasp ball, carry ball and release ball were not improved significantly (*p* value > 0.05). All the components of bimanual function there was increased every mean in posttest from pretest. The components; separate toy, carry ball and throw ball were improved significantly (*p* value < 0.05). But quadruped and crawling were not improved significantly (*p* value > 0.05).

4.10. Unimanual function in CIMT and bimanual group

In between group analysis, all the components of unimanual function in between CIMT and bimanual therapy group in posttest. Only one component: reach across midline improved in unimanual function among both group statistically (p value < 0.05). Rest of the components were not improved significantly ((p value > 0.05).

4.11. Bimanual function in between two groups

The Mann Whitney U test has shown the comparison of bimanual function in between CIMT and bimanual group. Carry ball, throw ball and quadruped were improved significantly (p value < 0.05). For this instance, p value is less than 0.05. So, there was strong evidence to accept alternative hypothesis that mean the CIMT and bimanual therapy are effective in carry ball, throw ball and quadruped of bimanual function were improved statistically and significantly. For the separate toy and crawling of bimanual function were not improved significantly. So, in this circumstance, null hypothesis was accepted that indicted that the CIMT and bimanual therapy was equally effective in separate toy and crawling of bimanual function.

4.12. Dissociative movement in QUEST in CIMT and bimanual therapy group

Table 4.5: The Wilcoxon test in CIMT and bimanual group of dissociative movement

Movement	CIMT			Bimanual therapy		
	Pretest (Mean)	**Post test (Mean)**	***p* value**	**Pretest (Mean)**	**Post test (Mean)**	***p* value**
Shoulder flexion	1.80	2.00	0.157	1.90	2.00	0.317
Shoulder abduction	1.90	1.80	0.564	1.80	2.00	0.157
Elbow flexion with supination	1.10	1.30	0.157	1.40	1.70	0.083

This table 4.5 showed that all the mean was increased from pretest in both group (CIMT and bimanual). But *p* value was more than 0.05 in each movement in CIMT and bimanual therapy group. So, this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis.

4.13. Dissociative movement in QUEST between CIMT and bimanual therapy group

Table 4.6: The Mann Whitney *U* test on dissociative movement in QUEST between CIMT and bimanual group

Dissociative movement	Mean Rank		*U* score	*p* value
	CIMT	Bimanual		
Shoulder flexion	10.50	10.50	50	1
Shoulder abduction	9.50	11.50	40	0.146
Elbow flexion with supination	8.50	12.50	30	0.081

The table 4.6 showed that Mann Whitney *U* score of all the components of dissociative movement; shoulder flexion and elbow flexion with supination were 50, 40 and 30 respectively in where the tabulated value is 23 for n1=10 and n2=10. The *p* value of all the components were large or more than 0.05. So, this result was not statistically significant.

4.14. Weight bearing in CIMT group (Wilcoxon signed rank test)

The Wilcoxon test showed that 4 participants had improved weight bearing in **prone lying** in CIMT group during posttest. There were 2 participants had higher improvement of weight bearing in prone lying after receiving CIMT in posttest. In addition, 4 participants had equal amount of weight bearing in prone lying in pretest and posttest after getting CIMT. The *p* value is 0.157 which is more than 0.05. So, this result was not statistically significant for CIMT group. The within group analysis has shown that the comparison of weight bearing in **cross leg sitting** in between CIMT group in posttest from pretest. The *p* value is less than 0.05. So, it indicated CIMT was effective on weight bearing in cross leg sitting in CIMT group. This result was statistically significant. The Wilcoxon test has shown the variation in **4-point kneeling** in CIMT group in posttest from pretest. The *p* value is less than 0.05. So, it indicated CIMT was effective on weight bearing in 4-point kneeling in CIMT group. This result was statistically significant on weight bearing in 4-point kneeling in CIMT group. In **protective extension in backward**, the test showed that 8 participants had improved in CIMT group during posttest. Only 1 participant had higher improvement of protective extension in backward after receiving CIMT in posttest. In addition, 1 participant had equal amount of protective extension in pretest and posttest after getting CIMT. The *p* value is 0.018 which is less than 0.05. So, this result was statistically significant on protective extension in backward in CIMT group. **In protective extension in sideward** the showed that 6 participants had improved protective extension in side in CIMT group during posttest. Only 1 participant had higher improvement of protective extension in side after receiving CIMT in posttest. In addition, 3 participants had equal amount of protective extension in side in pretest and posttest after getting CIMT. The *p*

value is 0.047 which is less than 0.05. So, this result was statistically significant on protective extension in side in CIMT group.

4.15. Weight bearing in bimanual therapy group

In prone lying, 7 participants had improved **weight bearing in prone lying** in bimanual therapy group during posttest. There were 1 participants had higher improvement of weight bearing in prone lying after receiving bimanual therapy in posttest. In addition, 2 participants had equal amount of weight bearing in prone lying in pretest and posttest after getting bimanual therapy. The *p* value is 0.118 which is more than 0.05. So, this result was not statistically significant for weight bearing in prone lying in bimanual group. The **weight bearing in cross leg sitting** was analyzed in bimanual group in posttest from pretest. The *p* value is more than 0.05. So, it indicated bimanual therapy was not statistically effective on weight bearing in cross leg sitting in bimanual group (*p* value > 0.05). This result was not statistically significant. The **weight bearing on 4-point kneeling** in bimanual group was tested in posttest from pretest. The *p* value is more than 0.05. So, it indicated bimanual therapy was not statistically effective on weight bearing on 4-point kneeling in bimanual group (*p* value > 0.05). This result was not statistically significant in bimanual therapy. The **protective extension in backward** in bimanual therapy group of pretest and posttest was tested by Wilcoxon test. It showed that 7 participants had improved protective extension in backward in bimanual therapy group during posttest. There were 3 participants had higher improvement of protective extension in backward after receiving bimanual therapy in posttest. In addition, no participant had equal amount of protective extension in pretest and posttest after getting bimanual therapy. The *p* value is 0.131 which is more than 0.05. So, this result was not statistically significant on protective extension in backward in

bimanual therapy group. The **protective extension in side** in bimanual therapy group has shown that 6 participants had improved protective extension in side in bimanual therapy group during posttest. There were 3 participants had higher improvement of protective extension in side after receiving bimanual therapy in posttest. In addition, only 1 participant had equal amount of protective extension in pretest and posttest after getting bimanual therapy. The *p* value is 0.273 which is more than 0.05. So, this result was not statistically significant on protective extension in side in bimanual therapy group.

4.16. Comparison of the weight bearing in prone lying between CIMT and bimanual group

Table 4.7: The Mann Whitney *U* test on the weight bearing in prone lying in CIMT and bimanual group

	Group	**Mean rank**	***U* score**	***p* value**
Differences between CIMT and bimanual therapy on weight bearing in prone lying	CIMT	10.20	47	0.810
	Bimanual therapy	10.80		

This table showed that the calculated value of *U* is 47 for the weight bearing in prone lying in CIMT and bimanual group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 47 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept

the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on the weight bearing in prone lying between CIMT and bimanual therapy group.

4.17. Weight bearing in cross leg sitting between CIMT and bimanual group

Table 4.8: The Mann Whitney *U* test on the weight bearing in cross leg sitting between CIMT and bimanual group

Differences between	**Group**	**Mean rank**	***U* score**	***p* value**
CIMT and bimanual therapy on weight bearing in cross leg sitting	CIMT	8.70	32	0.155
	Bimanual therapy	12.30		

This table showed that the calculated value of *U* is 32 for the weight bearing in cross leg sitting in CIMT and bimanual group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 32 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on the weight bearing in cross leg sitting between CIMT and bimanual therapy group.

4.18. Weight bearing in 4-point kneeling between CIMT and bimanual therapy group

Table 4.9: The Mann Whitney *U* test on the weight bearing in 4-point kneeling between CIMT and bimanual group

	Group	**Mean rank**	***U* score**	***p* value**
Differences between CIMT and bimanual therapy on weight bearing in 4-point kneeling	CIMT	10.70	48	0.871
	Bimanual therapy	10.30		

This table 4.9 has presented that the calculated value of *U* is 48 for the weight bearing in 4-point kneeling in CIMT and bimanual therapy group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 48 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on the weight bearing in 4 point kneeling between CIMT and bimanual therapy group.

4.19. Protective extension in backward in CIMT and bimanual therapy group

Table 4.10: Mann Whitney *U* test on the protective extension in backward in CIMT and bimanual therapy group

	Groups	**Mean rank**	***U* score**	***p* value**
Differences between CIMT and bimanual therapy on protective extension in side	CIMT	9.55	40.5	0.438
	Bimanual therapy	11.45		

This table showed that the calculated value of *U* is 40.5 for the protective extension in backward in CIMT and bimanual therapy group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 40.5 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on the protective extension in backward between CIMT and bimanual therapy group.

4.20. Protective extension in side in CIMT and bimanual therapy group

Table 4.11: Mann Whitney *U* test on the protective extension in side in CIMT and bimanual therapy group

	Group	Mean rank	*U* score	*p* value
Differences between CIMT and bimanual therapy on protective extension in side	CIMT	9.05	35.5	0.234
	Bimanual therapy	11.95		

This table showed that the calculated value of *U* is 35.5 for the protective extension in side in CIMT and bimanual therapy group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. The calculated value was 35.5 in between two groups. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on the protective extension in side between CIMT and bimanual therapy group.

4.21. Changes of handle objects in MACS in CIMT group

Table 4.12: Wilcoxon test on Changes of handle objects in MACS in CIMT group

	Pretest mean	**Posttest mean**	**Negative rank**	**Positive rank**	**Ties**	***p* value**
Posttest-pretest of handle objects in MACS in CIMT group	3.20	2.60	6	0	4	0.014*

The above table 4.12 showing the comparison of the handle objects in MACS (manual ability classification system) in CIMT group of pretest and posttest. It showed that 6 participants had improved of handle objects in CIMT group during posttest. No participant had higher improvement of handle objects after receiving CIMT in posttest. There were 4 participants had equal amount of handle objects in pretest and posttest after getting CIMT. The *p* value is 0.014 which is less than 0.05. So, this result was statistically significant on the handle objects in MACS in CIMT group.

4.22. Changes of handle objects in MACS in bimanual therapy group

Table 4.13: Wilcoxon test on Changes of handle objects in MACS in bimanual therapy group

	Pretest mean	**Posttest mean**	**Negative rank**	**Positive rank**	**Ties**	***p* value**
Posttest- pretest of handle objects in MACS	3.10	2.50	7	1	2	0.034

The above table showing the comparison of the handle objects in MACS (manual ability classification system) in bimanual therapy group of pretest and posttest. It showed that 7 participants had improved of handle objects in bimanual therapy group during posttest. Only 1 participant had higher improvement of handle objects after receiving bimanual therapy in posttest. There were 2 participants had equal amount of handle objects in pretest and posttest after getting bimanual therapy. The *p* value is 0.034 which is less than 0.05. So, this result was statistically significant on the handle objects in MACS in bimanual therapy group.

4.23 Changes of handle objects in MACS between CIMT and bimanual therapy group

Table 4.14: Mann Whitney *U* test on Changes of handle objects in MACS in CIMT and bimanual therapy group

Differences between	Group	Mean rank	*U* score	*p* value
CIMT and bimanual therapy on handle objects in MACS	CIMT	10.75	47.5	0.831
	Bimanual therapy	10.25		

This table 4.14 showed that the calculated value of *U* is 47.5 for the handle objects in MACS in CIMT and bimanual therapy group. The tabulated value of *U* is 23 in where n1 and n2 =10 for two tailed hypothesis in 5% (0.05) significance level. Though the *p* value is more than 0.05 and also Mann Whitney *U* score is more than tabulated value so this result indicated that there is strong evidence to accept the null hypothesis. Therefore, the result was not significant for two tailed hypothesis on handle objects in MACS between CIMT and bimanual therapy group.

CHAPTER V: DISCUSSION

The aim of this study was to find out the effectiveness of constraint induced movement therapy and bimanual therapy on motor function of upper extremity in children with hemiplegic cerebral palsy.

The baseline characteristics among participants in both group were almost similar.

In this study among total (n=20) participants 70% was in male where 30% was in female. In CIMT and bimanual group the male and female participants were in 70% and 30% also. The mean age of CIMT and bimanual group were 7.10 and 5.10. 50% (5) of the children were in 2 to 4 years of the age group, 40% in 5 to 7 years and 10% in 8 to 10 years of age in bimanual group. In CIMT group 30% of the children were in 2 to 4 years and 8 to 10 years of age group; 20% was in 5 to 7 and 11 to 13 years of age group. In all participants 70% (14) were from PU (Pediatric unit) and 30% (6) were from SENU (special education needs unit). In CIMT group 60% (6) participants were in PU and 40% (4) from SENU. In Bimanual group 80% (8) participants were from PU and only 20% (2) participants were from SENU. In manual ability function classification system (MACS), CIMT group, 50% of the participants were in level III; 20% in level II and IV; 10% participants in level V in MACS. In bimanual group, 60% of the participants were in level III, 30% in level IV and only 10% in level I in MACS. In CIMT group, 60% of the participants were in level II; 30% in level III and only 10% in level I in GMFCS. In Bimanual therapy group, 40% of the participants were in level I and II; only 20% in level III in GMFCS. There were no participants in level IV and V in CIMT and bimanual therapy group. In CIMT group, 40% of the participants were in level II; 30% in level III and only 10% in level I, IV and V. In Bimanual Therapy group, 30% of the participants were in level I, II and III, 10% in level

IV and no participants in level V. in cooperativeness during treatment session, 50% participants were somewhat cooperative during treatment session; 30% participants were very cooperative and 20% were not cooperative in CIMT group and in bimanual therapy group, 50% participants were very cooperative, 40% were somewhat cooperative and only 10% participants were not cooperative in treatment session.

The cluster RCT by Fedrizzi et al. (2012) which included 69 children aged between two and eight years. All degrees of motor disability of the affected upper limb and developmental abilities were included. Participants were randomized to receive one of three interventions (CIMT, bimanual training or usual therapy). CIMT or usual therapy only, was included in this systematic review. Either three hours per day, of CIMT, over a ten-week period or usual therapy, was administered. Restraint of the unaffected upper limb was accomplished by a wrist splint. A total of 210 hours of CIMT was included in the protocol. Two outcome assessments (QUEST and the BESTA scale) were administered immediately post-intervention (ten weeks), to evaluate effectiveness.

By using longer duration in 6 hours 5 days weekly for 4 weeks another study by Kafy, et al. (2014) conducted a randomized controlled trial on 30 children by random allocation from 70 participants. They found that CIMT is effective to improve upper limb function in children with unilateral CP. In previous two studies it was found that CIMT is used for improving quality of life and this study used CIMT on upper limb function. In this study the experimental group (n=14) received CIMT and control group (n=13) used conventional therapy which was not structured practice. The CIMT group used 6 hours daily, 5 days weekly for 4 weeks which also follow the previous study. For measuring upper limb skills used Quality of Upper Extremity Skills Test (QUEST) in this study that showed statistically

significant (p<0.05) in within group and between group analyses and also used Pediatric Arm Function Test that is valid and reliable. So, this study concluded that CIMT is more effective than control group in patients with unilateral CP in 4 to 8 years aged. The aim of this study was to find out the effectiveness of CIMT on upper limb function.

But in this present study showed that in within group analysis only CIMT group improved unimanual, bimanual function and few components in QUEST. Bimanual therapy group not improve significantly (p value >0.05) in unimanual, bimanual function and in upper extremity skills.

In this present study researcher used restraint time was maximum 6 hours/day for CIMT group. By using 2 dose levels of CIMT a study was done by Delucaa, et al. (2012) in patient with hemiplegic CP. The aim of this study was to compare effects of 2 dosage levels of constraint-induced movement therapy (CIMT) for children with CP. Total 18 children randomly assign in two groups and participants age were 3- 6 years. One group received high dose treatment of 6 hours/day (total 126 hours) and control group accepted moderate dose of 3 hours/day (63 hours) for 21 days. Various type of tools are used including; the Assisting Hand Assessment (AHA), QUEST and the Pediatric Motor Activity Log (PMAL). Both groups are showed statistically improvement on this scale. There were no significantly greater short-term benefits from a high dosage of CIMT compared to a moderate dosage.

On motor function of upper extremity and quality of life a study by Taub, et al. (2004) in patients with unilateral CP. Total 18 children were randomly assign in experimental that used CIMT and control group received conventional physiotherapy. Treatment dose was 6 hours per day in 21 days (CIMT group) and for 2.2 hours per week by control group. Male

participants were more than female. The severity of motor deficit ranked of mild, moderate and severe. All data are tested at before, after, after 3 weeks and 6 months. It is revealed that CIMT is effective to improve motor function. According to this study CIMT is more effective. But for severe motor involvement CIMT is not applicable according to the principles for using CIMT.

The present study used elbow bag or sling to restraint the unaffected side. Now a days physiotherapist use mitten, glove and sling or elbow bag more than casting. A systematic review by Chen, et al. (2014) on CIMT to improve upper extremity function in children with unilateral CP. This review used 27 RCTs; only 3 studies used cast and rest of study used mitten, splint, glove, bandage and sling. The included studies compared with other intervention.

Zafer, et al. (2016) conducted a study in where one group received CIMT and another group used BIM. The aim of this study was to find out comparison the effectiveness of constraint induced movement therapy (CIMT) and bimanual therapy (BIM) on upper extremity motor function in children with hemiplegic cerebral palsy. This RCT randomly allocated 20 participants. After that 2 participants were dropped out and experimental group, n=9 and control group, n=9. In inclusion criteria age ranged was 1.5 to 12 years, active wrist extension, and fingers extension having 10 degrees. The dose of treatment was 6 hours, 6 days for 2 weeks. The QUEST (quality of the upper extremity skills test.) was outcome measure tool and CIMT effective significantly than BMT in grasping except in weight bearing (p value< 0.05).

In this present study similarly CIMT group was more effective significantly than bimanual group. The outcome measures were also same. Another similar design study was done by

Gordon, et al. (2011) but aim was to compare CIMT and bimanual intervention to promote hand function in children with hemiplegic CP where previous study investigated the upper extremity function. Total 42 participants divided in two groups; the CIMT group (n=21) and the BIM group (n=21). The dose of treatment was 6 hour per day for 2 weeks in both groups. Used outcome measurement tool Jebsen Taylor Test of Hand Function (JTTHF) is valid and reliable scale in this population. It is concluded that both treatment showed similar effect but CIMT is effective to improve hand function by using Jobsen Tailor Hand Function test and Goal Attainment Scale BIM group showed better improvement but validity and reliability of this scale was not reported in this study. To see the progression of trial consort flow diagram is shown from where dropout rate is clearly perceivable that is used in this study. So lastly it is investigated that CIMT is effective to improve hand function.

A study done by Dong, et al. (2013) on hand function in children with unilateral CP. This systematic review compared the effectiveness of CIMT with bimanual training in improving impaired arm function for hemiplegic CP. The seven RCTs were included in this review. Form result it is concluded that CIMT is effective in unilateral function comparing with bimanual treatment and for bimanual performance bimanual training is effective. In this review treatment duration of the included studies were not equal but therefore decided on treatment dose of CIMT is 6 hours per day, 3 sessions for 10 weeks. But in this present study, CIMT is effective in unimanual and bimanual both function. The bimanual group was not statistically and significantly effective in bimanual as well as bimanual function while between group analysis. In within group analysis CIMT group

improved all the components of unimanual and bimanual function (p value < 0.05). But for bimanual group few components (50%) were improved significantly (p value < 0.05).

A systematic review was done by Chiu and Ada (2016) on upper limb function in children with hemiplegic CP. From 597 studies finally 31 studies were included. In this review the experimental group has received CIMT and control group received no intervention or usual therapy or other intervention. Majority of studies used sling or gloves and used QUEST as outcome measurement tool. All included studies were 100% randomized and 97% done between group analyses so that it is realized that CIMT is more effective than other treatment in measuring upper extremity skills.

In the present study, MAS (modified ashworth scale), QUEST and PAFT were used as outcome measure. In MAS, there were not significantly reduced the tonicity at elbow in CIMT group, bimanual group and between CIMT and bimanual groups.

In PAFT, for unimanual function all the components were improved significantly in CIMT group (p value < 0.05). In bimanual group, 50% components were improved statistically significantly (p value < 0.05) and rest of components p value were more than 0.05. In between group analysis for unimanual function in CIMT and bimanual groups, only one component- reach across midline improved significantly (p value < 0.05) among seven components. In PAFT, for bimanual function all the components were improved significantly in CIMT group (p value < 0.05). In bimanual group, 60% components were improved statistically significantly (p value < 0.05) and rest of components p value were more than 0.05. In between group analysis for bimanual function in CIMT and bimanual groups, only majority of the components (60%) were improved significantly (p value < 0.05) among participants.

In QUEST, the CIMT group improved weight bearing after getting treatment in all components except weight bearing in prone. The bimanual group were not improved significantly (p value > 0.05). Also in between group analysis there was no significantly improved the weight bearing pattern among children with hemiplegic cerebral palsy.

During conducting the study on the effectiveness of constraint induced movement therapy and bimanual therapy in children with hemiplegic cerebral palsy, there were some limitation. Firstly, the small sample size in this study is certainly a limitation. Secondly this study was conducted only within CRP. For this reason, this study cannot generalize for whole population of cerebral palsy. In addition, only participants were blinded during treatment session. Therapists were not blinded which could reduce or minimize the observer bias or experimenter bias or research bias during providing treatment.

CHAPTER VIII: CONCLUSION AND RECOMMENDATION

This thesis has shown that CIMT and bimanual therapy is effective in improving motor function of upper extremity in children with hemiplegic cerebral palsy.

This study has found statistically that only CIMT is effective in unimanual, bimanual and some components of upper extremity skills. In other hand, bimanual therapy is no more effective in unimanual, bimanual and components of upper extremity skills. There was no changing in muscular tonicity in CIMT and bimanual therapy among children with hemiplegic cerebral palsy.

Future studies should consider the importance of the constraint induced movement therapy and bimanual therapy when implementing interventions in the population of children with CP with large sample size as well as more study area.

This study provides primary evidence on the effectiveness of constraint induced movement therapy and bimanual therapy in children with hemiplegic cerebral palsy. Further investigation in the context of CIMT and bimanual therapy for children with hemiplegic CP is needed. Future studies are needed with more study area so that results can generalized for all the population of hemiplegic CP. Future studies should use larger sample sizes. In order to accurately and conclusively demonstrate the effectiveness of CIMT and bimanual therapy in children with spastic hemiplegic CP during the assessment session should be maximized their motor abilities at all assessment times.

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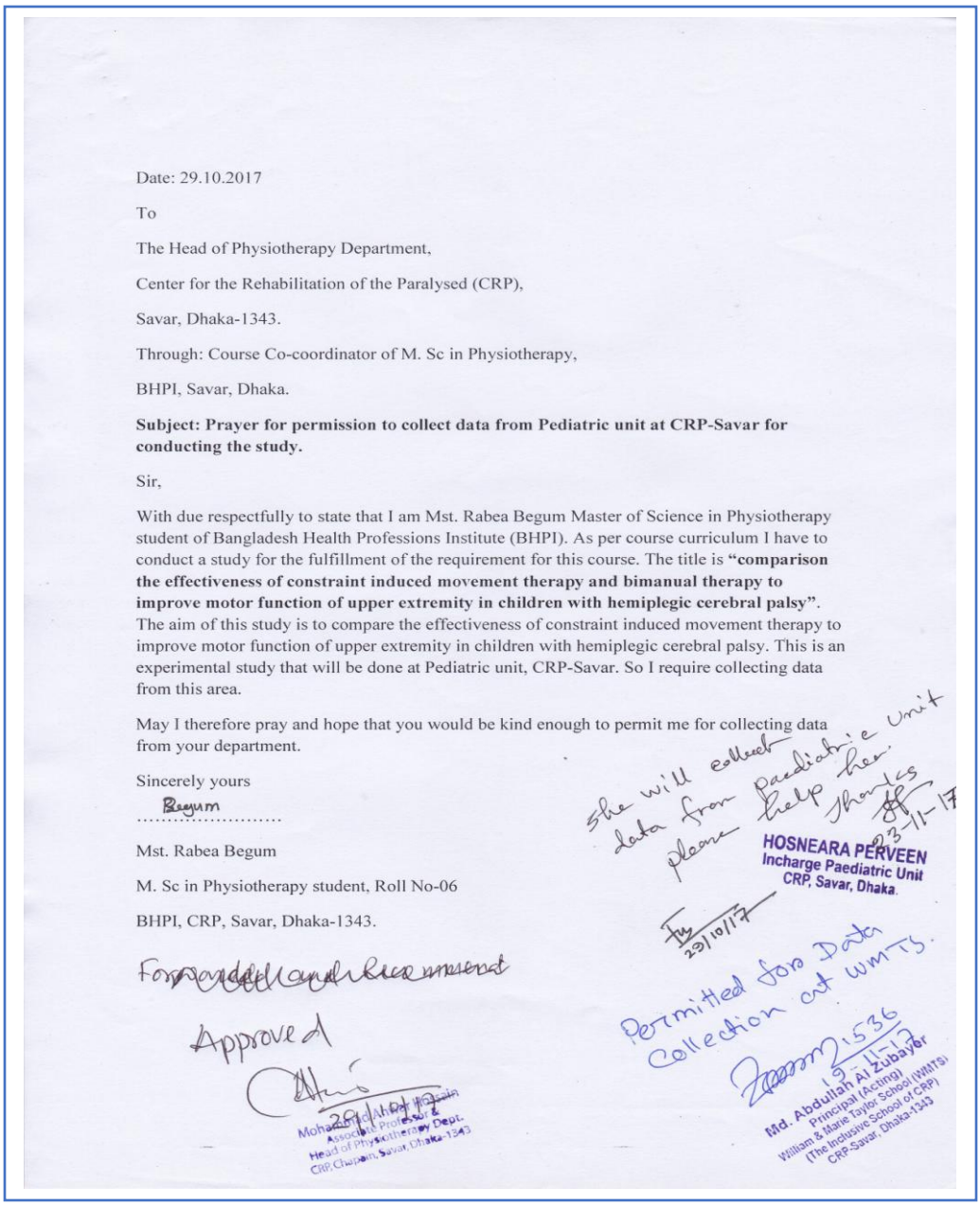
Appendix A

Permission Letter



Date: 29.10.2017

To

The Head of Physiotherapy Department,

Center for the Rehabilitation of the Paralysed (CRP),

Savar, Dhaka-1343.

Through: Course Co-coordinator of M. Sc in Physiotherapy,

BHPI, Savar, Dhaka.

Subject: Prayer for permission to collect data from Pediatric unit at CRP-Savar for conducting the study.

Sir,

With due respectfully to state that I am Mst. Rabea Begum Master of Science in Physiotherapy student of Bangladesh Health Professions Institute (BHPI). As per course curriculum I have to conduct a study for the fulfillment of the requirement for this course. The title is **"comparison the effectiveness of constraint induced movement therapy and bimanual therapy to improve motor function of upper extremity in children with hemiplegic cerebral palsy"**. The aim of this study is to compare the effectiveness of constraint induced movement therapy to improve motor function of upper extremity in children with hemiplegic cerebral palsy. This is an experimental study that will be done at Pediatric unit, CRP-Savar. So I require collecting data from this area.

May I therefore pray and hope that you would be kind enough to permit me for collecting data from your department.

Sincerely yours

Begum

.....

Mst. Rabea Begum

M. Sc in Physiotherapy student, Roll No-06

BHPI, CRP, Savar, Dhaka-1343.

she will collect data from Paediatric Unit please help her. Thanks 23-11-17

HOSNEARA PERVEEN
Incharge Paediatric Unit
CRP, Savar, Dhaka.

29/10/17

Permitted for Data Collection at WMTS.

Md. Abdullah Al Zubayer
Principal (Acting)
William & Marie Taylor School (WMTS)
(The Inclusive School of CRP)
CRP-Savar, Dhaka-1343

Forwarded and Recommended

Approved

Mohammad Ali Hossain
Associate Professor &
Head of Physiotherapy Dept.
CRP, Chapain, Savar, Dhaka-1343

Kiuj Appendix B

Institutional Review Board (IRB) Letter

বাংলাদেশ হেল্‌থ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

BANGLADESH HEALTH PROFESSIONS INSTITUTE

Ref. CRP-BHPI/IRB/11/17/139 *Date:* 12/11/17

To
Mst. Rabea Begum
Student of Master of Science in Physiotherapy
Session: 2016-2017, Roll No: 06
BHPI, CRP, Savar, Dhaka-1343, Bangladesh.

Subject: Approval of the thesis proposal "comparison the effectiveness of constraint induced movement therapy and bimanual therapy to improve motor function of upper extremity in children with hemiplegic cerebral palsy".

Dear Mst. Rabea Begum,

Congratulation!

The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application on October 15, 2017 to conduct the above mentioned thesis, with yourself, as your Principle investigator. The following documents have been reviewed and approved.

SN	Name of the Documents
1	Thesis Proposal
2	Questionnaire
3	Information sheet & consent form

Since the study involves a questionnaire that takes 20 to 25 minutes and have no likelihood of any harm to the participants. The members of the Ethics committee have approved the study to be conducted in the presented form at the meeting held at 10.30 am on October 22, 2017 at BHPI.

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring in the course of the study, any revision in the protocol and patient information or informed consent and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,

Muhammad Millat Hossain
Assistant Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

সিআরপি-চাপাইন, সাভার, ঢাকা-১৩৪৩, বাংলাদেশ, ফোন ঃ ৭৭৪৫৪৬৪-৫, ৭৭৪১৪০৪ ফ্যাক্স ঃ ৭৭৪৫০৬৯
CRP-Chapain, Savar, Dhaka-1343, Tel : 7745464-5, 7741404, Fax : 7745069, E-mail : contact@crp-bangladesh.org, www.crp-bangladesh.org

Appendix C

Informed Consent Form (ICF) in English version

Information

Assalamualaikum, I am Mst. Rabea Begum, Student of Master of Science in Physiotherapy, Bangladesh Health Professions Institute (BHPI) which is the academic institute of Centre for the Rehabilitation of the Paralysed (CRP). I am going to conduct a study on hemiplegic cerebral palsy. The title is "The effectiveness of Constraint Induced Movement Therapy (CIMT) and bimanual therapy in children with hemiplegic cerebral palsy".

I want to give you some information and invite you to have your child participate in this research. Please ask me without any hesitation and I will explain if you could not realise.

Participant selection

CIMT and bimanual therapy both are effective for children with hemiplegic cerebral palsy. But in this study I want to compare which technique is more effective than each other for this type of children. I am inviting you to take part in this research because your participation is important for our physiotherapeutic intervention. I will take some information and provide some treatment if you would allow your child to participate.

Voluntary participation

Your decision to have your child participate in this study is entirely voluntary. It is your choice whether to have your child participate or not. If you choose not to consent all the services your child receives in here will continue and nothing will change.

Confidentiality

The information that we collect from this study will be kept confidential. Information about your child that will be collected from the research will be put away and none but the researchers will be able to see it. Any information about your child will have a number on it instead of his/her name. Only the researchers will know what his/her number is and we will lock that information.

Right to Refuse or Withdraw

You do not have to agree to your child taking part in this research if you do not wish to do so and refusing to allow your child to participate will not affect your treatment or your child's treatment at this Centre. You may stop your child from participating in the research at any time.

Certificate of consent

I have been invited to have my child participate in this research. I have read the foregoing information. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily for my child to participate as a participant in this study.

Name of mother_____

Signature of mother_____

Date _____

If illiterate….

I have witnessed the accurate reading of the consent form to the parent of the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness_____ AND Thumb print

Signature of witness _____

Date _____

Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

Appendix D

Informed Consent form (ICF) in Bangla

কোড নং

অবগত সম্মতি পত্র

”আসসালামু আলাইকুম, আমি মোছা: রাবেয়া বেগম, বাংলাদেশ স্বাস্থ্য প্রফেসনস ইনস্টিটিউট (বিএইচপিআই) এর ফিজিওথেরাপি বিজ্ঞান বিভাগের মাস্টারের শিক্ষার্থী, যা পক্ষাঘাত পুনর্বাসন কেন্দ্র (সিআরপি) এর কেতাবি প্রতিষ্ঠান। আমি হেমিপ্লেজিক সেরিব্রাল পল্সির বাচ্চাদের উপর গবেষণা করতে যাচ্ছি। গবেষণার শিরোনাম হলো- **“হেমিপ্লেজিক সেরিব্রাল পল্সি বাচ্চাদের উপর সি. আই. এম. টি এবং বাইম্যানুয়াল থেরাপির উন্নতি তুলনাকরন”**।

আমি আপনাকে কিছু তথ্য দিতে চাই এবং আপনার সন্তানের এই গবেষণায় অংশগ্রহণ করার জন্য আমন্ত্রণ জানাই। যদি আপনি বুঝতে না পারেন তাহলে দয়া করে আমাকে কোন দ্বিধা ছাড়াই জিজ্ঞাসা করবেন এবং আমি ব্যাখ্যা করব।

অংশগ্রহণকারী নির্বাচন

সি. আই. এম. টি এবং বাইম্যানুয়াল থেরাপি উভয়ই হেমিপ্লেজিক সেরিব্রাল পল্সি বাচ্চাদেরর জন্য কার্যকরী । কিন্তু এই গবেষণায় আমি তুলনা করতে চাই কোন পদ্ধতিটি একে অপরের থেকে বেশি কার্যকরী। আমি এই গবেষণায় অংশ নেওয়ার জন্য আপনাকে আমন্ত্রণ করছি কারণ ফিজিওথেরাপি চিকিৎসার জন্য আপনার অংশগ্রহণ গুরুত্বপূর্ণ। যদি আপনি আপনার সন্তানের অংশগ্রহণ করতে অনুমতি দেন, তাহলে কিছু তথ্য এবং কিছু চিকিৎসা প্রদান করব।

স্বেচ্ছায় অংশগ্রহণ

এই অধ্যায়নে আপনার সন্তানের অংশগ্রহণের সিদ্ধান্ত সম্পূর্ণরূপে স্বেচ্ছামূলক। আপনার সন্তানের অংশগ্রহণ তা আপনার পছন্দ। যদি আপনি সম্মতি না দেন, তাহলে আপনার সন্তান যে সমস্ত পরিষেবাগুলি এখানে গ্রহণ করছে তা অব্যাহত থাকবে এবং কিছুই পরিবর্তন হবে না।

গোপনীয়তা

আমরা এই গবেষণা থেকে সংগ্রহ করা তথ্য গোপন রাখা হবে। আপনার সন্তানের তথ্য যে গবেষণা থেকে সংগ্রহ করা হবে দূরে রাখা হবে এবং কেউই কিন্তু গবেষকরা এটি দেখতে সক্ষম হবে না। আপনার সন্তানের সম্পর্কে কোন তথ্য তার নাম

পরিবর্তে তার উপর একটি নম্বর থাকবে। কেবলমাত্র গবেষকরা জানেন যে তার সংখ্যা কী এবং আমরা সেই তথ্যটি গোপন করব।

প্রত্যাখ্যান বা প্রত্যাহারের অধিকার

আপনি যদি আপনার সন্তানকে অংশগ্রহণের অনুমতি দিতে না চান তবে এই গবেষণায় অংশ নিতে আপনার সন্তানের সাথে একমত হতে হবে না এবং এই কেন্দ্রের আপনার চিকিৎসা বা আপনার সন্তানের চিকিৎসা প্রভাবিত করবে না। আপনি আপনার সন্তানের যেকোনো সময় গবেষণা থেকে অংশগ্রহণ করা বন্ধ করতে পারেন।

সম্মতির শংসাপত্র

আমার সন্তানের এই গবেষণায় অংশগ্রহণ করতে আমন্ত্রণ জানানো হয়েছে। আমি পূর্ববর্তী তথ্য পড়েছি। আমি এই বিষয়ে প্রশ্ন করার সুযোগ পেয়েছি এবং যে প্রশ্নগুলি আমি জিজ্ঞাসা করেছি তা আমার সন্তুষ্টি লাভের উত্তর দেওয়া হয়েছে। আমি এই অধ্যায়নে অংশগ্রহণকারী হিসাবে আমার সন্তানের অংশগ্রহণের জন্য স্বেচ্ছায় সম্মত।

মায়ের নাম----------

মায়ের স্বাক্ষর----------

তারিখ----------

অশিক্ষিত হলে ...

আমি সম্ভাব্য অংশগ্রহণকারীর পিতা বা মাতাকে সম্মতিপত্রের যথাযথ পড়াশোনা দেখেছি এবং ব্যক্তিটি প্রশ্ন জিজ্ঞাসা করার সুযোগ পেয়েছেন। আমি নিশ্চিত যে স্বতন্ত্রভাবে সম্মতি দেওয়া হয়েছে।

সাক্ষীর নাম---------- এবং অংগুষ্ঠ (থাম্ব) মুদ্রণ

সাক্ষীর স্বাক্ষর----------

তারিখ----------

গবেষণার নাম / ব্যক্তি সম্মতি গ্রহণকারীর নাম----------

গবেষণার / ব্যক্তি সম্মতি গ্রহণকারীর স্বাক্ষর----------

তারিখ----------

Appendix E

Questionnaire (English version)

On

"The effectiveness of constraint induced movement therapy and bimanual therapy in children with hemiplegic cerebral palsy"

Instruction: Therapist is requested to write the category number in the code box.

Code no:

Date of interview:

Participants ID:

Type of test: Tick mark below on right side of pre-test or post-test

Pre-test:

Post-test:

PART ONE: SOCIODEMOGRAPHIC DETAIL

Questions	Categories	Code
1.1 Child's age	In years	
1.2 Child's gender	Male=1, Female=2	
1.3 Family income	In BDT	
1.4 Mother's education	Illiterate=1 Primary=2 Secondary=3 SSC=4 HSC=5 Graduate =6 Post graduate and above=7	
1.5 Father's education	Illiterate=1 Primary=2 Secondary=3 SSC=4 HSC=5 Graduate =6 Post graduate and above=7	
1.6 Living area	Urban=1, Rural=2	
1.7 Religion	Islam=1, Hindu=2, Christian=3, Buddha=4	

PART TWO: MEASUEREMENT OF TONICITY IN ASHWORTH SCALE

Questions	Categories	Code
2.1 In which shoulder muscle do feel tonicity?	Flexor=1 Extensor=2 Abductor=3 Adductor=4 Internal rotator=5 External rotator=6	
2.2 How do you feel your shoulder affected muscle?	0=no increase in tone=1 1=slight=2 1+=slight =3 2=considerable=4 3=more marked=5 4=rigid=6	
2.1 In which elbow muscle is affected by tone?	Flexor=1 Extensor=2	
2.3 How do you feel your elbow affected muscle?	0=no increase in tone=1 1=slight=2 1+=slight =3 2=considerable=4 3=more marked=5 4=rigid=6	
2.1 In which wrist muscle do feel tonicity?	Flexor=1 Extensor=2	
2.4 How do you feel your affected wrist muscle?	0=no increase in tone=1 1=slight=2 1+=slight =3 2=considerable=4 3=more marked=5 4=rigid=6	

PART THHREE: LEVEL OF MANUAL ABILITY CLASSIFICATION SYSTEM (MACS)

Questions	Categories	Code
3.1 What is the status of hand function of affected side? (MACS)	Level I=1 • Objects are handled easily Level II=2 • Objects are handled but reduced quality and speed Level III=3 • Objects are handled in difficulty Level IV=4 • Require help to handle the object Level V=5 • Not able to handle the object	

PART FOUR: ABOUT PEDIATRIC ARM FUNCTION TEST (PAFT)

Questions	Categories	Code
4.1 What is the status of unilateral function? PAFT (Pediatric arm function test)	0= not attempt the task 1=very poor function 2=poor function 3=fair function 4=good function 5= normal	
	• Reach above head	
	• Reach at waist level	
	• Reach across midline	
	• Grasp ball	
	• Carry ball	
	• Release ball into cup	
	• Pour ball out of cup.	
	• Throw ball onto target	
4.2 What is the status of bilateral function? PAFT (Pediatric arm function test)	• Separate pull-apart toy	
	• Carry large ball (e.g., basketball)	
	• Throw ball into hoop	
	• Place hat on head	
	• Put on boots (using hands)	
	• Quadruped	
	• Weight-bearing	
	• Crawling	

PART FIVE: STATUS OF QUALITY OF UPPER EXTREMITY SKILLS TEST (QUEST)

Questions	Categories	Code
5.1 Which side is affected?	Left =1, Right=2	
5.2 QUEST (quality of upper extremity skills test) • **Dissociated movement** **-Shoulder** **-Elbow** **-Wrist**	Shoulder flexion <90=1, >90=2	
	Shoulder flexion with fingers extension <90=1, >90=2	
	Shoulder abduction <90=1, >90=2	
	Shoulder abduction with finger extension <90=1, >90=2	
	Elbow flexion with supination <1/2 range=1, >1/2 range=2	
	Elbow flexion with pronation <1/2 range=1, >1/2 range=2	
	Wrist extension with full elbow extension <1/2 range=1, >1/2 range=2	
	Wrist extension with elbow 10º flexion <1/2 range=1 , >1/2 range=2	
	Wrist extension with complete supination <1/2 range=1, >1/2 range=2	
	Wrist flexion with complete supination <1/2 range=1 , >1/2 range=2	
• **Sitting posture during grasp**	• **Head** Normal=1 Atypical- left=2 Atypical- right=3 Atypical- flexion=4 Atypical-extension=5	
	• **Trunk** Forward=1 Lateral=2	
	• **Shoulder** Retracted=1 Elevated=2	

• **Weight bearing**	• **Prone** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	
	• **4 point kneeling** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	
	• **Cross-leg sitting** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	
• **Protective extension**	• **Forward** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	
	• **Side** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	

	• **Backward** Elbow extended, hand open=1 Elbow extended, finger flexed=2 Elbow extended, hand fisted=3 Elbow flexed, hand open=4 Elbow flexed, finger flexed=5 Elbow flexed, hand fisted=6	
• **Spasticity rating**	Normal=1, Mild=2, Moderate=3, Severe=4	
• **Cooperativeness**	Not cooperative=1, Somewhat cooperative=2, Very cooperative=3	

Appendix F

Questionnaire in Bangla

প্রশ্নাবলী

"হেমিপ্লেজিক সেরিব্রাল পল্‌সি বাচ্চাদের উপর সি. আই. এম. টি এবং বাইম্যানুয়াল থেরাপির উন্নতি তুলনাকরন"

নির্দেশ: থেরাপিস্টকে কোড বাক্সে বিভাগ নম্বর লিখতে অনুরোধ করা হলো ।

কোড নং:

পরীক্ষার ধরন: নিচের পূর্ববতী পরীক্ষা / পরবতী পরীক্ষার ডান পাশে টিক দেয়ার জন্য অনুরোধ করা হলো

পূর্ববতী পরীক্ষা:

পরবতী পরীক্ষা:

সাক্ষাত্কারের তারিখ:----------

অংশগ্রহণকারীর আইডি:----------

অংশ এক: আর্থ-সামাজিক প্রেক্ষাপট বিস্তারিত

প্রশ্ন	বিভাগ	কোড
১.৮ শিশুর বয়স	বছর	
১.৯ শিশুর লিঙ্গ	পুরুষ = ১ , মহিলা = ২	
১.১০ পারিবারিক আয়	বাংলাদেশী টাকা	
১.১১ মায়ের শিক্ষা	নিরক্ষর=১ প্রাথমিক=২ মাধ্যমিক=৩ এসএসসি=৪ এইচএসসি=৫ স্নাতক=৬ স্নাতকোত্তরএবং উপরে=৭	
১.১২ পিতার শিক্ষা	নিরক্ষর=১ প্রাথমিক=২ মাধ্যমিক=৩ এসএসসি=৪ এইচএসসি=৫ স্নাতক=৬ স্নাতকোত্তরএবং উপরে=৭	
১.১৩ বসবাসের এলাকা	শহুরে=১ , গ্রাম=২	
১.১৪ ধর্ম	ইসলাম = ১ , হিন্দু = ২ , খৃস্টান = ৩ , বোদ্ধ = ৪	

অংশ দুই: শারীরিক দৃঢ়তা পরিমাপের এ্যাসঅরথ মাপনী/স্কেল

প্রশ্ন	বিভাগ	কোড
২.১ কাঁধের মাংশপেশীর অনৈচ্ছিক আক্ষেপজেনিতকে কেমন মনে করেন?	ভাজ করার মাংশপেশী=১ প্রসারণ করার মাংশপেশী =২ পেশীর সংকোচন করার মাংশপেশী =৩ বিবৃত করার মাংশপেশী =৪ অভ্যন্তরীণ র্ঘূণন মাংশপেশী =৫ বহিরাগত র্ঘূণন মাংশপেশী =৬	
২.২ আপনার কাঁধে আঘাতপ্রাপ্ত পেশী কেমন লাগছে?	০=স্বাভাবিক=১ ১=সামান্য=২ ১+=সামান্য =৩ ২=যথেষ্ট=৪ ৩=আরো চিহ্নিত =৫ ৪=অনমনীয়=৬	
২.৩ কনুই এর মাংশপেশীর অনৈচ্ছিক আক্ষেপজেনিতকে কেমন মনে করেন?	ভাজ করার মাংশপেশী=১ প্রসারণ করার মাংশপেশী =২	
২.৪ আপনার কনুই এর আঘাতপ্রাপ্ত পেশী কেমন লাগছে?	০=স্বাভাবিক=১ ১=সামান্য=২ ১+=সামান্য =৩ ২=যথেষ্ট=৪ ৩=আরো চিহ্নিত =৫ ৪=অনমনীয়=৬	
২.৫ কব্জির মাংশপেশীর অনৈচ্ছিক আক্ষেপজেনিতকে কেমন মনে করেন?	ভাজ করার মাংশপেশী=১ প্রসারণ করার মাংশপেশী =২	
২.৬ আপনার কব্জির আঘাতপ্রাপ্ত পেশী কেমন লাগছে?	০=স্বাভাবিক=১ ১=সামান্য=২ ১+=সামান্য =৩ ২=যথেষ্ট=৪ ৩=আরো চিহ্নিত =৫ ৪=অনমনীয়=৬	

অংশ তিন: হস্তকৃত ক্ষমতা শ্রেনীবিন্যাশ পদ্ধতি

প্রশ্ন	বিভাগ	কোড
৩.১ ক্ষতিগ্রস্ত পার্শ্বের হাতের কাজের কী অবস্থা?	শ্রেনী ও =১ • বস্তুগুলি সহজেই পরিচালিত হয় শ্রেনী ওও=২ • বস্তুগুলি পরিচালনা করা হয় কিন্তু মানের এবং গতি কমে যায় শ্রেনী ওওও=৩ • বস্তুগুলি অসুবিধাতে পরিচালিত হয় শ্রেনী ওঠ=৪ • বস্তুগুটি পরিচালনা করতে সহায়তা প্রয়োজন শ্রেনী ঠ =৫ • বস্তুগুটি হ্যান্ডেল করতে পারবেন না	

অংশ চার: পেডিয়াট্রিক বাহুর ক্রিয়ার পরীক্ষা (পিএএফটি) সম্মন্ধে:

প্রশ্ন	বিভাগ	কোড
৪.১ বাহুর একতরফা কর্মের অবস্থা কী?	০= কাজের চেষ্টা না ১=খুব খারাপ ক্রিয়া ২= খারাপ ক্রিয়া ৩=ন্যায্য ক্রিয়া ৪=ভাল ক্রিয়া ৫= স্বাভাবিক	
	• মাথার উপরে হাত তোলা	
	• কোমর স্তরে পৌঁছানো	
	• মধ্য লাইন দিয়ে পৌঁছানো	
	• বল ধর	
	• বল বহন	
	• বলটি কাপে ছেড়ে দাও	
	• কাপ থেকে বল ঢালা	
	• লক্ষ্যতে বল নিক্ষেপ	
৪.২ বাহুর দ্বিপক্ষীয় কার্যক্রমের অবস্থা কী?	• খেলনা পৃথক	
	• বড় বল বহন	
	• বৃত্ততে বল নিক্ষেপ	
	• মাথার উপর টুপি রাখা	
	• জুতা পরে নাও (হাত ব্যবহার করে)	
	• চতুর্মাত্রিকের মত	
	• ভার বহনকারি	
	• হামাগুড়ি	

অংশ পাঁচ: কাঁধ থেকে কব্জির অঙ্গবিন্যাসের দক্ষতা পরীক্ষার গুণগত মান

প্রশ্ন	বিভাগ	কোড
৫.১ শরীরের কোন দিকে আক্রান্ত?	বাম = ১, ডান = ২	
৫.২ কাধঁ থেকে কব্জির অঙ্গবিন্যাসের দক্ষতা পরীক্ষার গুণগত মানের স্কেল ● বিচ্ছিন্ন নড়াচড়া – কাঁধ – কনুই –কব্জি	কাঁধের ভাজ <৯০=১, >৯০=২	
	কাঁধের ভাজের সাথে আঙ্গুলের প্রসারন <৯০=১, >৯০=২	
	কাঁধের সঙ্কোচন<৯০=১, >৯০=২	
	কাঁধের সঙ্কোচনের সাথে আঙ্গুলের প্রসারন <৯০=১, >৯০=২	
	কনুই ভাজের সাথে হাত চিত করা <১/২ পরিসর=১, >১/২ পরিসর=২	
	কনুই ভাজের সাথে হাত উপর করা <১/২ পরিসর=১, >১/২ পরিসর=২	
	কব্জি প্রসারনের সাথে কনুই পূর্ণ কনুই প্রসারন <১/২ পরিসর=১, >১/২ পরিসর=২	
	কব্জি প্রসারনের সাথে ১০° কনুই প্রসারন <১/২ পরিসর=১ , >১/২ পরিসর=২	
	কব্জি প্রসারনের সাথে পূর্ণ হাত চিত করা <১/২ পরিসর=১, >১/২ পরিসর=২	
	কব্জি ভাজের সাথে পূর্ণ হাত চিত করা <১/২ পরিসর=১, >১/২ পরিসর=২	
● বসার অঙ্গবিন্যাসের সময় দৃঢমুষ্টিতে ধারণ	● মাথা সাধারন =১ বিরলদৃষ্টি–বাম=২ বিরলদৃষ্টি–ডান=৩ বিরলদৃষ্টি–ভাজ=৪ বিরলদৃষ্টি– প্রসারন ––=৫	
	● মধ্যশরীর অগ্রবর্তী=১ পার্শ্বীয় =২	
	● কাঁধ প্রত্যাহৃত =১ উবু =২	
● ভার বহনকারি	● **শুয়ে উপর হয়ে** কনুই প্রসারিত, হাত খোলা =১ কনুই প্রসারিত, আঙুল ভাজ =২ কনুই প্রসারিত, হাত ঘনিষ্ঠ=৩ কনুই ভাজ, হাত খোলা =৪ কনুই ভাজ, আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
	● **চতুর্মাত্রিকের মত** কনুই প্রসারিত, হাত খোলা =১ কনুই প্রসারিত, আঙুল ভাজ =২	

	কনুই প্রসারিত , হাত ঘনিষ্ঠ=৩ কনুই ভাজ , হাত খোলা =৪ কনুই ভাজ , আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
	• **আসন দিয়ে বসা** কনুই প্রসারিত , হাত খোলা =১ কনুই প্রসারিত , আঙুল ভাজ =২ কনুই প্রসারিত , হাত ঘনিষ্ঠ=৩ কনুই ভাজ , হাত খোলা =৪ কনুই ভাজ , আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
• প্রতিরক্ষামূলক প্রসারন	• **সামনে** কনুই প্রসারিত , হাত খোলা =১ কনুই প্রসারিত , আঙুল ভাজ =২ কনুই প্রসারিত , হাত ঘনিষ্ঠ=৩ কনুই ভাজ , হাত খোলা =৪ কনুই ভাজ , আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
	• **পাশে** কনুই প্রসারিত , হাত খোলা =১ কনুই প্রসারিত , আঙুল ভাজ =২ কনুই প্রসারিত , হাত ঘনিষ্ঠ=৩ কনুই ভাজ , হাত খোলা =৪ কনুই ভাজ , আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
	• **পেছনে** কনুই প্রসারিত , হাত খোলা =১ কনুই প্রসারিত , আঙুল ভাজ =২ কনুই প্রসারিত , হাত ঘনিষ্ঠ=৩ কনুই ভাজ , হাত খোলা =৪ কনুই ভাজ , আঙুল ভাজ =৫ কনুই ভাজ , হাত ঘনিষ্ঠ=৬	
• মাংশপেশীর অনৈচ্ছিক আক্ষেপজেনিত নির্ধারণ	স্বাভাবিক = ১ , হালকা = ২ , মাঝারি = ৩ , তীব্র = ৪	
• সহযোগিতা	সহযোগিতা না =১ , কিছুটা সহযোগিতা =২ , খুব সহযোগিতা =৩	

Appendix G

Modified Ashworth Scale (MAS)

Score	Meaning
0	No increase in muscle tone
1	Slight increase in muscle tone and manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) 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 part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part rigid in flexion and extension