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THE EFFECT OF NEOPRENE THUMB ABDUCTOR SPLINTS ON UPPER LIMB FUNCTION IN CHILDREN WITH CEREBRAL PALSY

ASHLEIGH ANN HUGHES

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Occupational Therapy.

Johannesburg, 2013

Declaration

I, Ashleigh Ann Hughes, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Occupational Therapy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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Abstract

Hand function deficits are associated with Cerebral Palsy (CP), and lead to diminished participation in activities of daily living (ADL's), play and school. A longitudinal experiment incorporating a pre-test-post-test design was used with a convenience sample of 28 children with spastic quadriplegic CP randomly assigned to two groups. Both groups received monthly occupational therapy and a home programme over the three month period, the intervention group received an additional neoprene thumb abductor splint. The Quality of Upper Extremity Skills Test (QUEST) was administered at baseline and again at 3 months to assess changes in underlying impairments contributing to hand function. There were no statistically significant differences between final scores in the control and intervention groups, but a clinically significant improvement in score with the splint on for the intervention group was found. Wearing the splint during functional tasks may be beneficial in improving underlying impairments.

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Operational Definitions

Adherence – The extent to which the caregivers carry out the home programme, with limited supervision, away from therapy sessions.

Cerebral palsy – a group of disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing foetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, cognition, communication, perception, and/or behaviour, and/or by a seizure disorder (1).

Hand function – For the purpose of this study hand function refers to the ability of an individual to handle and manipulate objects, this includes: grasp, release, in-hand manipulation and bilateral integration (2).

Home programme – A therapy programme which has been adapted, for the parents to carry out at home with the child. It contains preparatory stretches and activities which they can practice with the child in between therapy sessions. Programmes given out in this study were designed specifically for the study and were graded over the 3 month period.

Hypertonicity – Increased resistance to passive stretch can be present with or without spasticity (3).

Upper limb function – For the purpose of this study upper limb function refers to the way in which the upper limb and the hand work together as a functional unit, including: range of motion, the ability of the individual to position the upper limb appropriately, grasp, manipulation and release of and objects as well as the quality of movement in the upper limb.

Soft neoprene splint – An appliance made of soft, stretchy, non slip material which fits over the thumb and around the hand, pulling the thumb into abduction while allowing movement of the fingers, thumb and hand.





Spasticity – Spasticity is a motor disorder characterized by a velocity dependent increase in tonic stretch reflexes ("muscle tone") with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron syndrome (4).

Splinting – The use of devices which are applied to the body in order to provide protection, position, immobilise, correct or prevent deformities (5).

Weight bearing Splint – A splint applied to the hand which places the hand in the correct position for weight bearing. It maintains the natural arches of the hand and allows normal weight bearing through the lateral borders of the hand and the fingertips.

Abbreviations

ADLs:	Activities of Daily Living
CNS:	Central Nervous System
CP:	Cerebral Palsy
ROM:	Range of Motion
EDPA:	Erhardt Developmental Prehension Test
FHGT:	Functional Hand Grip Test
GMFCS:	Gross Motor Function Classification Scale
MACS:	Manual Ability Classification Scale
MAULF:	Melbourne Assessment of the Unilateral Upper Limb Function Test
MUUL:	Melbourne Assessment of Unilateral Upper Limb Function
NDT:	Neurodevelopmental Therapy
QUEST:	Quality of Upper Extremity Skills Test
PDMS- FM:	Peabody Developmental Fine Motor Scales
WeeFIM:	Functional Independence Measure for Children

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Skilled use of the hands and upper limb in activities enables us to interact with our environment in a functional way, and is thus essential to our participation in the occupational performance areas of personal management, work and even leisure activities (6). There are many components that are needed to facilitate the use of the hands in functional activities, including biomechanical factors, postural mechanisms, cognition, sensation and visual perceptual skills which all play a role (6). When one or more of these factors are disturbed it can result in deficits in occupational performance and an inability to participate in activities of daily living (ADLs) (7).

This is true for a large number of children with cerebral palsy (CP), the most common cause of disability in childhood (8) (9). It is estimated that in South Africa alone there are about one million disabled children (10). Problems with upper limb function in children with CP are associated with deficits in motor control, weakness, dystonia, sensation and the persistence of the grasp reflex (11). This can result in deforming postures, reduced muscle length and disuse which further limits upper limb function which is associated with difficulties with reaching, pointing, grasping, releasing and manipulating objects (12). While the impact of upper limb dysfunction varies from child to child, it has been well documented that this has a pronounced effect on their self care activities (13), leading to an inability to accomplish ADLs and becoming independent (14). If the child cannot interact with the environment or is dependent on someone else for that interaction to occur, occupational deprivation transpires, resulting in poor quality of life for the child and their caregivers (15).

One of the main goals of occupational therapy is to improve quality of life of individuals by using occupations as both a means and an end of therapy (16). In the case of children with CP, intervention goals may vary from enabling the client to participate independently in an activity, to enabling the client to assist in a few steps of the activity or preventing further deformities and maintaining current function, depending on the child's abilities. In order to do this, various techniques may be used to promote function, one of which is splinting

which is used as an adjunct to therapy (17). The rationale behind using splinting as an intervention to improve hand and upper limb function is that the child will be more able to participate in activities of daily living and play (6).

Past studies have shown that splinting can facilitate function in the hand and upper limb of children with CP with improvements such as active range of motion (ROM), grip strength and manipulation (11). Both hard and soft splints have been used and research has been done with casting or static splinting to reduce contractures and maintain ROM (18) in children with CP who exhibit static or dynamic deformities, or a mixture of the two (19). It has been suggested that soft neoprene splints are prescribed to position the thumb and facilitate hand function as research indicates that these splints apply low stretching force to the hand without compromising comfort or functional use of the upper limb (18). It has also been suggested that these splints can be used to decrease the effect of dynamic deformities which occur during voluntary movements, where a child with full passive range of motion, is unable to fully obtain the correct active movement needed to complete a given task (19). Contradicting research available on the optimum time a splint should be worn makes judging the effectiveness of the splint difficult, because therapists need to balance the use of assistive devices without impacting on the child's ability to participate in activities. However there is little research supporting these assumptions and the use of these splints in the child with CP in South Africa.

1.2 PROBLEM STATEMENT

Although numerous studies have been conducted on the use of splinting in neurological patients, there is no clear evidence to support the use of splinting in children with cerebral palsy. Research has indicated that splinting may have a short-term benefit on the quality of movement in some children with CP but it is not clear what effect this improvement in quality of movement has clinically on function and varied results have been obtained (17) (19)(20). There was only one study found that examined the effectiveness of soft splinting to position the thumb out of the palm. This study, which was at a level IV of best practice, reported an improvement in-hand function, ROM, dexterity and grasp strength over a four week period (21). Soft splinting of the thumb into the abducted position is still commonly used to improve hand function mostly because of ease of use and comfort (22).

There is only one available study regarding splinting children with CP in a South African context, but this does not consider the soft neoprene thumb abductor splint which was used in this study (23). The South African context is different to first world countries where other research on this splint has been completed, in that access to resources is limited and funding is not always available for splinting materials. Therefore it is important that this treatment modality is examined in this setting.

There is contradicting research available on the optimum time a splint should be worn. As therapists it is important that assistive devices are effective without impacting on the child's ability to participate in activities. Wearing a splint for too short a time may not be effective and wearing it for too long may be uncomfortable and therefore impact on adherence (23). It is important to determine the optimum treatment time so that resources are used effectively and efficiently to enhance function and participation.

1.3 PURPOSE OF STUDY

There is currently limited South African research regarding the use of splinting in treating children with CP. While the use of soft neoprene splinting for thumb abduction is commonly advocated for children with CP, the limited resources available in public hospitals means the treatment modalities used must be evidence based and successful as well as cost effective.

Therefore the purpose of this study is to evaluate the effectiveness of a soft neoprene thumb abductor splint on the upper limb function of children attending the CP clinic at the Steve Biko Academic Hospital to establish if this treatment modality should be added to the intervention presently offered to children with CP.

1.4 AIM OF THE STUDY

To investigate the effectiveness of neoprene thumb abductor splints on upper limb and hand function in children with CP.

1.4.1 OBJECTIVES

- To establish the external and demographic factors in a sample of children and their caregivers attending the CP clinic at Steve Biko Academic Hospital that may affect adherence to a home and splinting programme

- To compare the change in the upper limb function in children with CP, involved in a home programme, who are or are not prescribed a neoprene thumb abductor splint over a three month period.
- To determine if there is any difference in the upper limb function in children with CP, following the splinting programme for three months with and without the splint on.
- To establish the association between change in upper limb function in children with CP and reported adherence to a home and splinting programme.

1.5 HYPOTHESES

1.5.1 Null Hypotheses

There will be no difference in the upper limb function of children with CP following a home programme, who are or are not prescribed a neoprene thumb abductor splint for a three month period

There will be no difference in the upper limb function of children with CP at the end of a three month intervention programme when assessed with the splint on and the splint removed.

There is no association between the hours spent on the home programme and the change in upper limb function in children with CP.

There is no association between the number of hours that the splint is worn and the change in upper limb function in children with CP.

1.5.2 Alternative Hypotheses

There will be a difference in the upper limb function of children with CP following a home programme, who are or are not prescribed a neoprene thumb abductor splint for a three month period

There will be a difference in the upper limb function of children with CP at the end of a three month intervention programme when assessed with the splint on and the splint removed.

There is an association between the hours spent on the home programme and the change in upper limb function in children with CP.

There is an association between the number of hours that the splint is worn and the change in upper limb function in children with CP.

1.6 JUSTIFICATION OF STUDY

The results of this study may provide evidence for the use of splints in clinical practice and will therefore enable clinicians to choose the most appropriate treatment using evidenced based practice. The results of this research will also contribute to the existing body of knowledge in this field and could be the basis for further studies in this area. Information regarding the efficacy of splinting is also crucial to enable therapists and parents to make informed decisions regarding appropriate treatment methods for children with cerebral palsy (19)(20).

The need to motivate for more resources in the public hospital system in terms of splinting materials and other techniques to provide the best outcome in therapy when treating upper limb function in children with CP may also be addressed by the results of this study.

CHAPTER 2
LITERATURE REVIEW

This literature review will consider international as well as South African research on the intervention of splint wearing in the management of the upper limb in cerebral palsy. The value of upper limb and hand function and typical development in the upper limb as well as the importance of upper limb and hand function in cerebral palsy will be discussed. The management of the upper limb and hand in cerebral palsy in relation to frames of reference supporting occupational therapy as well as the occupational therapy process in terms of assessment, treatment modalities and outcomes with special reference to splinting will be reviewed. The impact of adherence on treatment will also be explored.

2.1 INTRODUCTION

The use of the hand in activities of daily living (ADLs) is inextricably linked to the upper limb and they function as an entity, with each joint and unit dependent on the other. The upper extremity is divided into five functional units which include the shoulder girdle, glenohumeral joint, elbow, radio-ulnar joint and the wrist and hand (24). These functional units work together to promote efficient upper limb function, used by a typically developing child with normal function to practice skills over months and years before being able to master them in order to carry out all required tasks and activities needed to perform in all areas of life (13).

It is only when disability occurs that the true importance of optimal upper limb and hand function is realised. If development is interrupted by disability the acquisition of the skill does not follow the orderly progression of development and results in a discrepancy in task performance (7)(13). The amount as well as the quality of upper limb and hand function a child with a neurological condition, like CP, has influences their independence in activities of daily living (13). The better the function the more activities the child will be able to complete without assistance and the less dependent on caregivers the child will be in all areas of life. Everyday tasks, required for occupational performance of everyday activities, require adequate fine motor skills and are reliant on intact anatomy and function in both hands.

Occupational therapists are concerned with the ability to adapt tasks or provide assistive devices to improve independence as allowed by the disability, in all areas of life (25). They may focus on the improvement of underlying impairments affecting function in the upper limb and hand. If these are improved, with the use of a splint or assistive device, it may allow for better physical interaction with as well as better use of sensory input from the environment (6). The result of an improved ability to participate in activities may bring meaning to the lives of the children and give them a sense of purpose (14).

In order to improve the limitations in occupational performance in relation to the problems faced by children with disability, with regards to upper limb and hand function, it is imperative that the typical developmental sequence is well understood.

2.2 TYPICAL UPPER LIMB DEVELOPMENT

It has been shown that the development of upper limb and hand function starts as early as 15 weeks in utero. This can be seen when a 15 week old foetus rotates its head and brings its hand towards its mouth, at this point the movements of the upper limb are generalised and non specific (26). Studies have shown that this haphazard movement can be attributed to the development of the nervous system, thus showing that direct connections from the pyramidal tracts to the motor neurons are present before birth (26).

After birth the development of upper limb and hand function is dependent on the development and refinement of other factors, these can be broadly grouped into motor, sensory, cognitive and social components (6). In a study on newborn infants it was found that immediately after birth neonates were able to imitate finger extension movements, which differed from their regular hand movements (26).

During the first few weeks of life the infant begins to show increasing interest in stimuli close him or her, and so visual tracking of an object begins. Reflexes become integrated and therefore movement becomes easier (6)(26). Over the next few months the infant starts to make sweeping movements towards objects but is unable to grasp the object at this stage. During this time midline orientation begins, the infant will show increased visual regard for his or her hands and will often bring them together, at first close to the body then further away as proximal stability develops. As the infant starts to play with his or her hands and fingers so the ability to grasp objects which are placed in the hand improves (6). Throughout

this stage visual and tactile input are important to promote the development of hand skills (6)(26).

As the infant approaches the age of six months so the ability to reach accurately towards objects improves. This is the beginning of symmetrical bilateral reaching, first in supine and then later in sitting. At this stage the infant starts to require the use of cognitive skills in order to plan and execute specific movements that will assist in achieving his or her goal (6). By six months the infant is able to precisely orientate, reach and grasp an object as well as adjust his or her grip around the object by interpreting visual and tactile cues (26). The infant will use both hands together to explore and manipulate objects (6)(26).

As symmetric hand and arm patterns are refined so the infant develops the ability to use their upper limbs independently of one another and unilateral reaching begins. They begin to anticipate the required movement and will open their hands in preparation for grasping the object. The infant is now able to stabilise the object with one hand and explore or manipulate the object with the other hand (6). Voluntary release of objects has not been as extensively studied, but it is agreed that it develops after grasp from around six months and becomes more controlled and purposeful towards ten months (6)(26).

As the child grows so use of thumb opposition and isolated finger movements begin to develop, allowing for greater agility of movements and forming the basis of numerous grasp patterns (26). By one year children are able to pick up small objects using an immature precision grasp and are able to demonstrate graded object release (6)(26). Over the next few years this unilateral reaching pattern progresses, allowing the child to accurately move and place the arm, grade finger extension appropriately for the size of the object and to perfect the timing of various elements in the sequence. In-hand manipulation of objects becomes refined permitting the child to develop skills such as writing, buttoning and tying shoelaces (26).

By the age of two years all the components of upper limb and hand function including reach, grasp, bilateral hand use, in-hand manipulation and voluntary release, have adequately developed. From this age on there is refinement of these patterns and skills. In addition to this the quality and strength of grasp continues to increase throughout childhood (6).

Other factors which contribute to the development of hand skills are the ability to adequately visually track objects or focus on an object. The skills to recognise discriminate and process sensory information through the visual and tactile pathways as well the capability to understand the task requirements are also important. It is also essential that the child has developed adequate postural control and has good range of motion in all upper limb joints and adequate strength to perform the required movement (6).

Thus in order for a child to successfully complete a task, motor, sensory and cognitive systems need to be functioning adequately. Sensory feedback regarding the task and the environment assists with motor planning, this allows the child to plan appropriate movement patterns to carry out the activity. Once the movement is planned the messages need to be sent to the various muscle groups so that the movement can be carried out. Sensory information is essential in providing feedback to the central nervous system (CNS) regarding the efficiency and effectiveness of the movement, allowing the brain to then adjust the messages being sent and improve performance (6). In a child with CP one or more of the components described above may be present with deficits leading to a discrepancy in task performance (7).

There is little or no research on the effect of splinting on the development of hand function and therefore this will not be discussed in detail.

2.3 PHYSICAL FACTORS AFFECTING UPPER LIMB FUNCTION IN CHILDREN WITH CEREBRAL PALSY

For children with CP damage to the CNS occurs either prenatally or perinatally, this affects their capacity to move and participate optimally in activities of daily living, school and play, all of which impact on their ability to achieve independence in these occupational performance areas (26).

An intact CNS is required for co-ordinating movement, motor planning and cognition. These functions are often also affected in children with CP along with postural control or the ability to maintain certain positions, which are needed to support distal movement of the hands while holding or carrying objects (27). Thus the development of skilled hand function is closely linked to the development of postural control and the ability to stabilise more proximal parts (6). If external stability is provided, the child no longer needs to use their

upper limbs to assist them in stabilising their trunk but this does not automatically result in better upper limb and hand function (6). In order to reach and grasp an object there also needs to be adequate integration of vision and somatosensory perception in order to construct an accurate representation of the object in space and to be able to act in relation to it (28)

2.3.1 The relationship between posture and upper limb function

Muscle tone and distribution of motor impairment in CP result in fluctuations in posture, postural control and anticipatory postural adjustment mechanisms which interfere with the ability of the child to maintain their posture and adapt to postural adjustments needed during activities (29). These children need to use their upper limbs and hands to maintain balance in sitting or standing (6)(27). This significantly impacts on their ability to participate in tasks and also affects the development of skilled hand function. These children often learn to compensate for their lack of stability by fixating some body parts to provide some steadiness and stability and the use of compensatory movements which in conjunction with changes in posture and postural control especially increased thoracic flexion cause premature scapula rotation. This position limits the effectiveness of the entire shoulder girdle complex limiting reach (30) . Movements like shoulder full flexion and horizontal adduction are therefore difficult for children with CP, resulting in the increased abduction and internal rotation of this joint even when they are not using their upper limbs for balance. They therefore have difficulty generating smooth, controlled movement in the more distal body parts, which also diminishes their ability to carry out fine motor activities accurately in the completion of tasks (6)(27)(31)(32). This lack of adequate movement in the upper limbs and hands limits the development of fine motor skills and mature movement patterns (6)(27).

2.3.2 Movement interactions in the upper limb and hand in Cerebral Palsy

On analysis of movement required in the upper limb and hand for occupational performance, a number of authors have highlighted the problems commonly identified in children with CP. Four underlying components which frequently influence upper limb function are: dissociation, grasp, weight bearing and protective extension.

2.3.2.1 Dissociation

Movement of the limbs as a single unit is seen in CP with isolation of movement in the upper limb joints often being absent (33). The lack of disassociation between the movement elements means that movement in the shoulder girdle affects movement components in the forearm and wrist. This leads to the use of compensatory patterns of movement in the limbs, to substitute for the pattern which the child is unable to carry out. Shoulder abduction and internal rotation result in the use of forearm pronation and limited supination resulting in significant activity and occupational limitations. Some authors suggest that these compensatory movements are actually a result of adaptation for function rather than true movement impairments (34). Abnormal patterns may also be caused by biomechanical changes in the muscles such as shortening of internal rotators and elbow and wrist flexors (35). Whatever the cause, significant elements of movement needed for manipulative function in activities of daily living are either impaired or missing (36).

Even when they do allow for the completion of functional activities the compensatory patterns often hinder the development of advanced skills and can impact on the range of motion, speed and accuracy of the movement when using the hand as well as contributing to the formation of contractures especially when they result in limited active movement (6)(19). If an adequate full range of passive motion is not maintained, there is an adaption of the muscle with a combination of shortening of muscle fibres and remodelling of muscle connective tissue, which results in contractures or static deformities, these often occur later on in CP children. It is therefore important to address this when the CP child is young in order to prevent it from developing (18)(35). When adequate range has been maintained in the absence of adequate active movement the deformities are dynamic and intervention can continue in terms of facilitation or splinting to encourage the development of mature movement patterns (6). The neoprene splint which was used in this study allows for active movement but at the same time exerts a pull on the muscles, maintaining length.

2.3.2.1.1 Reaching

Children with cerebral palsy have difficulty with reach, they are unable to accurately control the speed and velocity of the movement toward the object and either move too fast or too slow (26)(37). Research has shown that the most common problem with reach in children with cerebral palsy is that they are unable to decelerate their movement toward the object

and as a result often miss the target. Their movements are also more erratic than normal developing children and they have an increase of sub movements, so instead of reaching in one fluid action their reach appears to be made up of multiple smaller movements which give it an uncoordinated effect (26). Decreased dissociation between joints can lead to the child using more movement than what is required for the task. A typically developing child is able to stabilise at the shoulder girdle and elbow joint and just use the forearm and wrist to reach for the object. Children with CP are often unable to stabilise at the elbow and instead they use the entire arm to grasp, this may lead to difficulty in accurately coordinating the movement and placing their hand at the correct point to grasp the object. This also uses far more energy than only using the required movement and therefore will also impact on the endurance of the child.

2.3.2.1.2 Positioning

Positioning of the upper limb, during reach, is important as it brings the hand into the vicinity of the object to allow grasp with the correct position of the wrist and forearm in order for manipulation to be carried out (38). Due to hypertonicity and weakness in the trunk and upper limb muscles, children with cerebral palsy often have poor alignment and decreased range of motion in the shoulder and the arm. This compromises the ability of the upper limb to move through full range of motion and consequently affects the positioning of the arm and hand (32). Limited active elbow and wrist extension and supination means the upper limb is not positioned correctly resulting in positions of pronation and wrist flexion being used when attempting to grasp an object (36). Unfortunately even when the correct position can be achieved it often cannot be maintained for the appropriate amount of time needed due to weakness in the muscles. The splint which has been used in this study can be adapted to include a supination strap, which assists in pulling the wrist into a more supinated position and therefore places the hand in a better position for grasping. Over time, pull would be exerted on the muscles in the forearm and would allow for lengthening of those muscles (39).

2.3.2.1.3 Release

The ability to place and release an object is just as important as the ability to grasp and lift objects, there has however been much less research dedicated to understanding release in children with cerebral palsy. Release develops after grasp around 5-6 months of age but

only becomes controlled around 12 months. Initially infants use another object to roll the object from their fingers or to inhibit finger flexion and later they move to controlled extension (6). Children with cerebral palsy who still have a primitive hand grasp are often unable to release objects as they do not have active extension of the fingers and consequently objects have to be pulled out of the hand or need to use another object to assist with release as seen in infants (6)(26)(40). Research has shown that this could be due to inadequate ability to use tactile input received or difficulty performing the required motor components (40). Children with neurological impairments have been shown to place the object much more abruptly and with less control and coordination than their typically developing peers (40). It also took them much longer to extend their fingers and release the object (40). Smooth downward placement of an object requires steady and controlled release of the muscle contraction with adequate interaction between the agonist and antagonist muscles to create a smooth fluid movement. Children with cerebral palsy have difficulty coordinating movement of these muscles and hence struggle to control placement of an object (40).

2.3.2.2 Grasping

In a child with CP, flexion at the elbow and wrist, results in the use of a tenodesis action at the wrist and the use of extrinsic finger muscles to control the digits resulting in a claw deformity which makes grasp difficult (22). Grasp is inhibited by excessive flexion in the interphalangeal joints of the fingers or wrist due to spasticity of the flexors as well as biomechanical shortening of muscles, tendons and connective tissue making it difficult to voluntarily open hands and pick up objects. Mass grasps are then used to compensate and thus hinders the development of adequate pincer or lateral grasps which are used to pick up small objects or manipulate zips or buttons (6)(26)

If primitive hand grasps are still present the child's hand will close when anything, including the thumb, is placed in the palm making voluntary grasping difficult (26). Deformities of the web space of the thumb and hypermobility in the metacarpophalangeal and distal interphalangeal joints of the thumb are common in children with CP, these thumb deformities significantly impede hand function (36). Another common position of the thumb is adduction and flexion, which blocks hand function by occupying space in the palm. The result of this is a lack of active thumb movement out of the palm, affecting the ability to

grasp and impacting on hand function (41). The splint used in this study focuses specifically on positioning the thumb out of the palm, if a gentle but constant pull is exerted on the muscles around the thumb it leads to lengthening of those muscles. This will allow the thumb to be in an abducted position with the splint on, allowing for better use of the hand (42).

Research has shown that children with cerebral palsy tend to use a greater load force when grasping objects than typically developing children (43). They also have prolonged delays between movement phases and production of grip and load forces (43). It was also shown that children with cerebral palsy struggle to adapt their grip force to different textured objects and also struggled to alter their force in response to object weight. Although the research did show the children had the ability to alter grip forces, according to texture and weight, when the same object was presented to them repeatedly over a period of time. However it took them longer to learn than typically developing children (43).

2.3.2.2.1 Manipulating

There are two types of manipulation: Object manipulation involves the ability to grasp and release an object and to transfer it from one hand to another, while in-hand manipulation refers to the ability to translate (move an object from the palm to the fingers), rotate (change the direction of the object in the hand) and shift (move the object up and down between the thumb and fingers). In-hand manipulation develops over time and it is only fully developed in typical developing children by the age of 7 years (26) (43).

Object manipulation initially develops as a reflexive mechanism and then becomes more voluntary as the child learns to control the object (26). Manipulation of objects beyond grasping and lifting demands consecutive increases and decreases in fingertip forces (40). Children with cerebral palsy often use a mass grasp to grasp an object. They have limited isolated finger movements, and this makes it difficult to manipulate an object. In order for in-hand manipulation to occur isolated finger movements are needed. Children with cerebral palsy take longer to develop isolated finger movements and as a result struggle to manipulate objects (26). They also struggle to produce an appropriate grip force when holding objects, which also impacts on their ability to manipulate objects and makes doing buttons, a zip or picking up small objects very difficult (43). The splint used in this study, allows movement of the intrinsic muscles and active movement of the thumb, while it

restricts adduction of the thumb, it does not prevent it altogether (42)(44). This allows for some manipulation of objects but does not necessarily improve isolated finger movements. Such movements still have to be taught in therapy sessions in order to fully improve manipulation of smaller objects (6).

2.3.2.3 Weight bearing

Weight bearing in terms of neurodevelopmental therapy is seen as an inhibitory technique which provides a prolonged stretch to the upper limb and is used to elongate soft tissue structures (36). It is also used as a preparation technique to improve mobility of the wrist and finger flexors in order to prepare the hand for function (36). Weight bearing on the upper limb, in prone, provides tactile and proprioceptive input through the hands, across the palmer surface which is important for the sensory development of the hand (45). Proprioceptive input allows for increased muscle contraction in the scapulohumeral area as well as around the elbow and wrist, thus improving stability and strengthening the arm and hand. Internal stability of the upper limb is important in the prehension of small objects using a pincer grasp (45). A study by Pehoski (1992) showed that while weight bearing on the upper limb improves some components of upper extremity movement there were no statistically significant changes to suggest it improves grasp or the release of objects (46). Therefore while it is important to incorporate weight bearing into the treatment of children with cerebral palsy other aspects, with a specific focus on distal function needs to be included in treatment as well (46). It is important to be aware of the length of the muscles involved in weight bearing, as often children with cerebral palsy have excessive fisting in their hands and do not have sufficient length in their finger flexors to have their hands fully open and their wrist in extension. For this reason a weight bearing splint or curved surface may be more beneficial (46). The splint used in this study positions the thumb into abduction allowing for increased dissociation of movement between the thumb, fingers and hand. This would allow the child to open their hand more effectively and consequently improve the position of the hand during weight bearing. In some cases it might be useful to start with a weight bearing splint or include a stretching programme until range of motion in the finger flexors has been improved and thereafter use only the neoprene splint (46).

2.3.2.4 Protective extension

Protective extension is a reflexive reaction which is designed to protect one from falling, and it develops as a result of neuronal maturation occurring in the CNS and environmental experiences (27).

In a child with CP, tendon and stretch reflexes are hyperexcitable and are associated with activation of both the agonist and antagonist muscles (27). In many children with CP muscle groups adjacent to those stimulated are activated as well, this is known as overflow. Quick stretch of a spastic muscle activates the same reflex and therefore has the same effect on the surrounding muscles. This explains why when the protective extension reaction is evoked in a child with CP, the deltoid, coracobrachialis, biceps brachii, brachialis, flexor carpi radialis, flexor carpi ulnaris, palmaris longus, flexor digitorum profundis, flexor digitorum superficialis and flexor pollicis longus muscles are all activated leading to poor control of the movement and a decreased ability to stop the fall effectively, as active extension is not possible (27).

Another reason that children with CP struggle with protective extension may be that righting reactions often take longer to initiate than in a normal developing child therefore the vestibular system will be activated during this time and tone could increase making it difficult for the child to extend his/ her arms appropriately to stop himself/ herself falling (45). According to the Neurodevelopmental therapy (NDT) approach, vestibular input is a facilitatory neurotechnique and therefore may increase muscle tone in the trunk and limbs (45).

There is no direct relation between protective extension and hand function and research has shown that intervention which focuses on improving hand function has little or no effect on protective extension (47).

An understanding of all the factors affecting upper limb function in children must be taken into account by the occupational therapist in order to address these in an effective intervention programme. This treatment should be based on appropriate frames of reference and evidence from research as well as the context in which the child lives and receives health care as well as the needs of the child and their family.

2.4 MANAGEMENT OF UPPER LIMB AND HAND FUNCTION IN CHILDREN WITH CEREBRAL PALSY

The management of the hand in cerebral palsy in dependent first on understanding how frames of reference can be used to influence change in the upper limb of children with cerebral palsy and then on the application of these in the occupational therapy process including assessment and intervention evidence.

2.4.1 Frames of Reference used in the Management of Upper Limb and Hand Function in Cerebral Palsy

2.4.1.1 Neuroplasticity

Neuroplasticity describes the brain's ability to modify neural circuits and structure during development, by experience and learning as well as in response to CNS lesions (48). While the exact mechanisms behind neural plasticity are still not fully understood, it is clear that synapses are strengthened and remodelled by experience. Nerve cells and neural circuits that are used often strengthen their connections while those that are not used weaken and may even disappear (48). Research has shown that cortical map representation (i.e. representations of different motor or sensory systems within the cortex) changes with stimulation of specific senses or movements. It has also been shown that cortical map size correlates with the age the skill was learnt. Children that learnt skills at an early age (before 11 years) had a larger area of cortex which was activated when that skill was performed (48).

The learning process can be divided into two phases, the early learning phase, where rapid improvement of skills takes place and the second extended phase, this is where there is a more gradual improvement and then the skills become more automatic (48). The more automatic skills become, the less the amount of neural activity is required to perform the skill. During theses phases changes are also visible in other areas of the cortex such as the temporal and parietal lobes. These areas are responsible for receiving and integrating visual and sensory information which serve as a foundation for motor planning (48)(49).

Neuroplasticity is present during development and learning and is a key factor in supporting rehabilitation after a brain lesion. Nudo et al (1996) have shown that recovery of motor function, in monkeys, is dependent upon the expansion of cortical maps post lesion (48).

This and other studies have shown that training improves both function and produces structural organisation of the motor cortex, in children as well as adults. According to the neuronal selection theory or neuroplasticity, connections in the nervous system emerge in synchrony with motor behaviour such that connections between various aspects of the nervous system are strengthened as various motor behaviours are practised (27).

Brain lesions which occur during development differ from those occurring in adults. During development, various neural systems are still competing for synaptic space. If there are no competing circuits, due to lesions or changes in neural activity, other neural pathways which typically should disappear may remain and become active. There is currently no conclusive research as to how this affects the function in children compared with adults. However, the neural changes which take place during development and in response to training seems to be important for the correct development of neural circuits, thus indicating the importance of early intervention in these children (48).

While the splint itself does not have a direct effect on neuroplasticity it does improve the underlying components needed for hand function. This allows the child to use their hand more and provides the child with opportunities to use their hand more. The splint alone cannot improve hand function, but purposeful active movements are needed for neuroplasticity to occur and therefore the child must attend OT and the home programme must include functional tasks.

2.4.1.2 Early Intervention

Early intervention has been defined as an attempt to minimize, if not prevent the impact of disability or delay by addressing any negative, disabling effects that a developmental delay or disability might have on the developmental process in general (50). Early intervention essentially targets vulnerable children, whose development has been compromised by environmental or biological circumstances. The goal of the above is to enhance the competence of participants in all developmental areas and minimise delays (51). While there have been a number of studies conducted into the effects of early intervention the results are contradicting (51). Some studies found that while there may be short term gains in development, there is no long term difference on follow up. Others found that children who attended an early intervention programme had around a 5 - 10 point advantage in IQ

scores twelve years later. Unfortunately the majority of studies have been conducted on high risk groups rather than children who already have a delay or disability. However among the studies which have been done on children with disabilities, there is a broad consensus that early interventions provide positive effects and even more so if the family members are actively included in the intervention through home programmes and parent meetings (51). It is however important to keep in mind that most of the studies which have been done have poor methodology, such as a small sample size or no control group (due to ethical violations of withholding treatment). Therefore further research will need to be done on the effects of early intervention as well as the long term effects on children with disability (51).

In terms of splinting there is little or no research on early intervention and splinting. It is however clear than splinting prevents deformities such as contractures from occurring, therefore by starting splinting early, underlying impairments are corrected or prevented allowing for improved range of motion and function. While the children are too young to actively participate in activities and function independently, the splint can be worn and still benefit the child (39)(44).

2.4.2 Assessment of Upper Limb and Hand Function in Children with Cerebral Palsy

The assessment of a child with cerebral palsy is complex all the aspects affecting performance described above need to be analysed and it needs to be decided which deficits are most limiting to occupational performance. In order to provide the best intervention it is imperative that the treating therapist has a good understanding of the child's strengths and difficulties, in order to target the underlying impairments and improve function. A variety of assessment methods are used in order to capture this information. The general severity of the condition and the distribution and degree of movement impairment also can be a guide.

2.4.2.1 Classification of Cerebral Palsy

There are various ways in which cerebral palsy can be classified and this can cause confusion as different authors use different terms leading to inconsistencies between definitions (52). Classifications can be either based on motor type, e.g. spastic, dyskinetic, hypotonic, or according to distribution, e.g. hemiplegia, diplegia, quadriplegia (52). These classification systems do not provide any information regarding the function of the child. Due to the

nature of cerebral palsy function can differ greatly within groups, for example children with spastic quadriplegia can range from severe (dependent in all ADL's) to mild (able to complete most ADL's independently).

The Gross Motor Function Classification Scale (GMCFS) was developed to try and address the above mentioned shortfall in classification. The GMFCS looks at the child's ability to initiate movement, specifically looking at sitting and walking. It is a simple, easy to use, five level grading system that considers gross motor function, explicitly evaluates what movements the child is able to initiate and carry out independently (2)(52). Classification of gross motor function is dependent on age and therefore it has been divided up into age groups (under 2 years, 2-4 years, 4-6 years and 6- 12 years), each age group looks at gross motor function which is relevant for that particular age (53). The GMFCS has been found to be useful as a prognostics indicator for gross motor function and therefore can be used to assist with planning appropriate interventions for the child (8). Unfortunately the GMFCS is not sensitive enough to change after intervention and therefore cannot be used as an assessment tool but only as a classification measure (52). For this study children with a GMFCS level of II, III, or IV were used as these children have some active movement but still have noticeable impairments in gross motor function.

The Manual Ability Classification System (MACS) looks at bilateral hand function in children with cerebral palsy from 4 – 18 years. Due to the fact that gross motor and fine motor development occur separately it was felt that there was a need for a fine motor classification measure which looks specifically at functional capacity (54). The MACS assesses the child's ability to handle objects in their personal space, it evaluates the use of both hands together and was not designed to distinguish capabilities between hands (54). The MACS has been shown to have good interater reliability between therapists, intra-class correlation (ICC) was 0.97. Interater reliability between parents and therapists was also found to be good, ICC was 0.96. Both the above indicate excellent agreement (54). For this study children with a MACS level of II, III, or IV were used as these children have some active range of motion but have poor quality of movement and decrease co-ordination which impacts on hand function.

There are two studies which have examined correlation between the Manual Ability Classification System and the Gross Motor Function Classification Scale, and in both cases a

poor correlation between the two scores was found, with one study showing an agreement of 0.35 and the other 0.79 (54)(55). It is therefore recommended that therapists use both measures when describing a child's level of functioning in order to give a clear picture (55).

Occupational therapists have a number of options in the specific assessment of the upper limb of children with CP including standardised tests. These however are often too expensive and complex to be easily used every day and therefore using direct observation is one of the best options available in clinical practice (36).

2.4.2.2 Observation and tools

Client factors like upper limb deformity and function, muscle tone, passive and active range of motion, motor control and sensation could be assessed using observation. Observations are one of the many tools occupational therapists use to obtain information about a client or child (56)(57). Skilled observations are non-standardised methods which have been developed and used by therapists as a means of gathering data about a child's performance in certain skills and occupational areas (56). Observations provide rich information about quality of movement and possible underlying impairments which may be affecting performance but they are used in conjunction with standardised assessment to provide a holistic picture with regards to the outcomes of the child's functioning (56)(57)

2.4.2.3 Standardised Tests

Standardised tests provide a scientific approach to assessment, and give the therapist a numeric score which allows for comparison with normative data for that population (58). Some advantages of using standardised tests are that they are commercially available and having a numerical score makes it easy to monitor progress (58). However, there are also downfalls to using standardised tests, for example most tests tend to focus on assessing performance skills and not areas of occupation. This does not always provide adequate information about how the child is functioning on a day to day basis, it is therefore important to use a combination of sources when assessing a child (58). The majority of standardised test are developed in developed countries and may not always be applicable to a South African population. Standardised outcome measures related to function of the upper limb and hand in activities are often more useful. Tests like the Melbourne Assessment of the Unilateral Upper Limb Function Test (MAULF), Functional Hand Grip Test

(FHGT), and Functional Independence Measure for children (WeeFIM) as well as the Erhardt Developmental Prehension Assessment (EDPA), which measures both involuntary and voluntary components of hand function are often used for this purpose. A test of upper limb and hand function that that been used extensively, in the evaluation of children with neurological conditions is the Quality of Upper Extremity Skills Test (QUEST). This assessment is used throughout the world however it has only been used in one other research study in South Africa. As this is the assessment tool used in this study, a detailed description will now follow.

2.4.2.3.1 The Quality of Upper Extremity Skills Test (QUEST)

This test was developed for children who have neuromotor dysfunction along with spasticity or hypertonicity in the upper limb. It measures the components of hand function as well as the quality of upper limb movement (59). The QUEST assesses four aspects: dissociated movements, grasps, weight bearing and protective extension. The QUEST score is sensitive to disability rather than age and thus can be used on children ranging from 18 months to 8 years. The assessment has been tested for use on children with cerebral palsy and has been found to have good inter-observer reliability, 0.96, good observer reliability, 0.51 – 0.94, and good test-retest reliability, 0.75 – 0.95 (59). The QUEST was also compared to the Peabody Developmental Fine Motor Scales (PDMS-FM), and Melbourne Assessment of Unilateral Upper Limb Function (MUUL) both of which have excellent internal consistency, test-retest reliability, and inter- and intra-rater reliability. Construct, content, criterion and evaluative validity was high with a correlation of 0.84 between the QUEST and PDMS-FM and a correlation of 0.83 between the QUEST and MUUL. The QUEST has also been reported to be responsive to change over time (59) (60).

2.4.3 Intervention for the Upper Limb and Hand of Children with Cerebral Palsy

Planning appropriate interventions in occupational therapy, when treating the upper limb and hand function of children with CP, requires setting appropriate goals. The selection of purposeful activities and the outcomes as directed by the Occupational Therapy Practice Framework II should be meaningful to the child and their family and result in improvement in occupational performance (61). There are a number of different interventions used for children with CP, in South Africa the most commonly used interventions are NDT, motor

learning and splinting. Individual therapy while using adjunctive techniques like NDT and splinting to achieve these outcomes is usually supplemented by a home programme. This is because children with CP need long-term support and individual therapy is not always affordable or available in South Africa (62).

2.4.3.1 Neurodevelopmental therapy (NDT)

This treatment uses therapeutic handling techniques to improve motor skills, reduce underlying impairments and facilitate postural control and movement synergies. This therapy is compatible with occupational therapy, especially when it is offered as an activity based therapy which has a good evidence base promoting the use of functional tasks as part of therapy to improve performance. This intervention focuses on practicing the task in natural settings to encourage neuroplasticity through experience and repetition (63).

Measuring individual goals showed the greatest change in upper limb function in children with CP using NDT, but this was based on parental perception of their child's performance. In studies using other outcome measures the use of NDT has a poor evidence base and studies report conflicting results (64) (65). Judgment about the efficacy of NDT has been addressed in high level evidence studies, like systematic reviews and meta-analysis. While these methods are limited by the availability of good quality research, both Brown and Burns (2001) and Butler and Darrah (2001) reported numerous problems in completing a systematic study of NDT (66)(67), and therefore there are limited good quality studies regarding the effectiveness of NDT.

From these limited studies, it was concluded that the efficacy of NDT has not yet been shown although there were statistically significant results in studies that emphasised interventions based on theories of motor learning and skill development (36). However it may be a lack of good research rather than lack of efficacy of NDT that is reflected in the findings (67).

The same problems with research methodology were reported again by Sakzewski, Ziviani and Boyd (2009) in their systematic review of non surgical interventions for the upper limb in CP. They found that NDT remained the most commonly used technique in occupational therapy (68) and that NDT and splinting yielded a medium treatment effect for the quality of upper limb movement and small effect for fine motor skills as measured by the QUEST.

2.4.3.2 Motor Learning Theory

"Motor learning is a set of processes associated with practice or experience leading to relatively permanent changes in the capability for responding" (Schmidt and Lee, 2004) (69).

Research has shown that, with practice, children with CP are able to form internal models of movement. However they may only have a limited number of movement repertoires available to them and therefore may not always be able to choose the most energy efficient or appropriate movement (69). Therapy is important as it enables the child to increase available resources by targeting underlying impairments such as strength, range of movement, grasp and reach (69). Practice is the factor that influences motor learning the most, the key to practice is that it must occur within a functional task. Intervention is best accomplished in a natural and realistic environment through the achievement of whole occupations and not just parts of them (65)(70). Practice should take place in different environments in order to optimise motor learning, a variability of activities should also be used (69).

An important aspect to motor learning is active participation, in order for learning to occur the child must be actively engaged in the task. This is done by presenting the child with a task that forces them to plan and execute purposeful, goal directed movement **(69)**.

A study by Eliasson et al (2003) shows that when adolescents with hemiplegic CP practiced in-hand manipulation tasks daily for 2 weeks, a significant improvement in performance was seen (69). This study supports the notion that physical practice can improve the acquisition of fine motor skills.

While not much research has been done on motor learning in children, with and without neurological impairments, motor learning has shown great potential for use with adults who have neurological impairments (71).

It is important for therapist to uses the principles of motor learning along with principles from neuroplasticity in order to design goal orientated task practice that is optimally complex and challenging for the child (69). Such interventions will maximise independence and participation in daily tasks.

2.4.3.3 Splinting the Upper Limb and Hand in Cerebral Palsy

Splints are used with children with CP to stabilise and protect joints, stretch and lengthen muscles, prevent contractures or to regain range of motion in various limbs and joints. Splints may be static or dynamic and can be either thermoplastic or soft splints (72). There are many different designs of splints each with its' own benefit. Splints need to be prescribed and selected with a specific goal in mind and the needs of the individual must be taken into account to ensure that the use of a splint facilitates function rather than hinders it (72).

The two main types of hard splints used in patients with neurological disorders are a resting splint or an anti-spasticity splint. Resting splints are applied on the volar surface of the hand and forearm. These splints are worn primarily when sleeping to keep the hand in a functional position, this helps to maintain range of motion by prolonging stretch of the flexor muscles of the digits (72). These splints are contra indicated in clients with hypertonia as pressure is placed in the palm and may therefore elicit the instinctive grasp reflex (73). One disadvantage of this splint is that it is difficult for the client to apply, but it has been reported that it is fairly easy for caregivers or nurses to apply (74).

Anti-spasticity splints on the other hand can be made in the shape of a ball or cone and are applied to the volar surface of the arm. These splints maintain muscle length and prevent subluxation of the metacarpal phalangeal joints. While the ball splint maintains the hand in a reflex inhibiting position which reduces spasticity (75). The cone splint places deep tendinous pressure over the metacarpal phalangeal joints of the finger flexors, this also decreases spasticity in the hand (39).

A second type of anti-spasticity splint commonly used in patients with neurological disorders covers the volar surface of the fingers up to the metacarpal phalangeal joints and then is applied on the dorsal surface of the hand and forearm. Dorsal splints have been shown to be most effective in children with weakness or with mild to moderate increased tone (6). These splints maintain the hand in a reflex inhibiting position without eliciting an instinctive grasp reflex (73) (75) and also apply deep tendinous pressure over the metacarpal phalangeal joints of the finger flexors influencing tone in the hand (39). This splint cannot be used if there is oedema of the hand and it can also place pressure over the ulnar styloid, this should be carefully monitored to prevent pressure sores (72).

Disadvantages of these splints are that they use a large amount of material to make and therefore are costly. They are also incredibly difficult for the client and caregiver to apply.

Splints that support the wrist but allow for active movement of the fingers include wrist extension splints which are used to prevent subluxation of the wrist and to maintain the wrist in correct alignment. Theses splints are not very successful in clients with neurological disorders as they place pressure in the palm encouraging the grasp reflex and therefore a tenodesis action of the fingers flexing (73). This splint also does not maintain length of the finger flexors or of the webspace.

Soft splints are made from materials which are supple therefore reducing the risk of developing pressure sores. These materials apply a constant pressure to the muscles therefore enabling a slow stretch. Due to the fact that these splints are malleable they allow a certain amount of function in the hand while stretching. There are a number of different materials that are used to make soft splints, the most common being neoprene and Lycra. These splints are made usually to provide elbow extension, supination of the forearm, wrist extension and abduction of the thumb. Only the splint for the thumb will be reviewed.

2.4.3.3.1 Neoprene thumb abductor splints

In children with CP the thumb adductors are hypertonic which leads to shortening of the webspace, this makes grasping objects difficult as there is limited opposition (70). The aim of splinting is to maintain the thumb carpometacarpal joint in abduction and opposition to prevent contractures of the web space. The splint that will be used is a soft thumb splint, it fits on the thumb, in the web space and around the palmer and dorsal surfaces, securing on the ulnar aspect of the hand. This splint was chosen because it allows movement of the intrinsic muscles and active movement of the thumb, while it restricts adduction of the thumb, it does not prevent it altogether. The splint fabricated from neoprene, which provides neutral warmth to the hand and has an inhibitory effect on spasticity (42).

There is currently great controversy surrounding splinting in patients with spasticity and hypertonicity. Numerous studies have been done on the subject of splinting and hand function but with conflicting results. Most studies have had a small sample size and therefore results may not be statistically significant (76) or the measure used to evaluate has not been sensitive enough to pick up change. In a study by Law et al, it was found that

there was initially a change in quality of movement and wrist extension but that after three months the changes were no longer significant (19)(77). In another study results differed between participants, with some experiencing an improvement whilst others did not (19)(60). Other studies by Copley et al, Goodman & Bazyk and Yasukawa & Cassar report good improvement in quality of movement as well as function (19)(22)(32)(78). Goodman & Bazyk found that wearing a short opponens splint for 6 hours a day over a 4 week period improved range of motion, dexterity and quality of movement but had no effect on strength (22). Copley et al used a plaster cast over a 4 – 6 week period, they showed changes in range of movement which were maintained at a six month follow up.

There are a wide variety of materials and designs available for splinting, however there is no conclusive evidence to state that one design is superior to another. For this study the researcher decided to use a neoprene thumb abductor splint as it allows movement of the thumb and fingers which allows for some use of the hand. Using the hand in functional activities is important for motor learning and neuroplasticity to occur and therefore the researcher felt this splint would be more beneficial than a static splint or cast.

2.4.3.4 Home Programmes

When skills are practiced in the home environment and are incorporated into everyday routines, there is a functional change which allows the skill to be generalised to other situations and thus allowing for better function (79). Activity selection and monitoring of these programmes need to be parent-directed, but the parents must be provided with support to implement programmes.

Research has shown that occupational therapy home programmes for improving function and quality of upper-limb movement have been beneficial over a four, eight and 26 week period (62). It was also shown that caregivers only had to carry out the programme 17.5 times a month for roughly 16 minutes per session for improvements to occur (62). The addition of casting or splints to these programmes has also shown benefit (62).

2.4.3.5 Intervention for Children with Cerebral Palsy in South Africa

The treatment of children with CP in South Africa still remains a challenge. Changes in the health care system have occurred since 1994, but rehabilitation services in the public sector have not developed to provide adequate management of children with CP. This is

compounded by the fact that most families with children who have CP cannot afford to access even the free care offered because of transport costs (80). Due to the increase in the number of patients using public health services, the public health care system is not able to keep up with the demand for professional services but even so most public hospitals and clinics run CP clinics where some form of rehabilitation is offered. Most clinics offer monthly treatment sessions and provide home programmes for continuation of therapy between these sessions.

Although functional outcomes related to occupational performance are of great concern to occupational therapists the most common intervention approach adopted by them for the management of children with cerebral palsy in South Africa is Neurodevelopmental Therapy (NDT) (80). Although there is inadequate evidence to promote the use of NDT only as a treatment modality, it is easily accessible in South Africa as the courses are run regularly and little equipment is needed to carry out the techniques. However NDT does promote the use of block therapy, intensive, daily, therapy for a week or two weeks and then a break, this is not always practical to do in a South African setting as caregivers would be required to come to the hospital daily for treatment and this has financial implications. Other intervention techniques when resources are available include the provision of splints and assistive devices.

In the under-resourced sectors in South Africa, children with CP are dependent on their caregivers and family to carry out intervention because there are currently insufficient professional services to provide regular intervention and address the needs of these children. Home programmes are a useful tool in a South African setting, where most children only receive individual or group occupational therapy at most once a month and often less than this (80).

2.5 ADHERENCE TO INTERVENTION

Compliance has been defined as active engagement by the client or family members in the rehabilitation process. It has been shown that clients who closely follow treatment recommendations have better outcomes (81)

2.5.1 Home Programmes

Research has shown that mothers are more likely to implement home programmes when the programme is minimally disruptive to their routine or when programmes are flexible and allow mothers to implement the activities that work for them and discard the ones that do not. It has also been shown that adherence to these programmes is better when caregivers understand and accept the diagnosis and when there is a good relationship between caregivers and therapists (79)(81). It was also demonstrated that caregivers who feel more confident in carrying out the home programme are more likely to comply (81). Therefore it is important that therapists give time to practice the skills needed, in the session, before sending the client home with the home programme. If caregivers observe positive changes in their child they are more likely to be confident in what they are doing and therefore more likely to comply with the programme (81).

Therapists have to manage clients from a diversity of cultures when providing knowledge and support that will allow home programmes to be understood and completed by families for the carryover of therapy into home environments (62). It has been shown that adherence to these programmes is influenced by multiple factors such as the time it takes to administer, the parents daily routines, flow of family activities and the understanding of the parents regarding what has to be done (79).

2.5.2 Splinting

In order for splints to be effective the splint needs to be worn correctly. Compliance can have a substantial effect on the efficiency of an intervention (81)(5), as incorrect splint wearing may cause more harm than good. In terms of splinting it is important to consider comfort as well as appearance when constructing a splint. If it is not comfortable the child is less likely to want to wear it. One study showed that patients with arthritis were more likely to wear a soft splint rather than a thermoplastic splint (5). Comfort is subjective therefore it is imperative that client and their families are included in the decision making process as much as possible so that the splint meets their needs as well as the goals of the therapist (19)(5). When fabricating splints for children it is important that the therapist fabricates the splint as child friendly as possible by using bright colours or allowing the child to decorate their own splint with stickers or crayons (19)(42). The wearing schedule should be designed

in conjunction with the caregivers so that it can be easily included in the child's daily schedule.

Research has shown that splinting programmes are more likely to be carried out when they are minimally disruptive to their routine or when programmes are adjustable (79). It is essential to educate the caregivers and the child, where possible, about the importance of wearing the splint (19)(5). Children are more likely to wear a splint if they are able to achieve success or improvement, for example if they feel that they are better able to grasp with the splint on, they are more likely to adhere to this splinting programme (19)(42). This should be taken into account when considering a splint, the benefits of the splint should outweigh the inconvenience (60)(82). Splints should also be easy to use, the caregivers should be able to put them on correctly when the therapist is not present, the more difficult to don the less compliant the caregivers will be with the splinting programme (42).

2.6 SUMMARY

Occupational therapists are concerned with function and believe the ability to participate in tasks, no matter how small the contribution, brings meaning to the lives of individuals and contributes to improving their quality of life (16). The upper limb is an important focus in therapeutic interventions as it has an important role to play in improving function and participation in occupational performance of an individual.

The neoprene thumb abductor splint allows for movement of the hand while stretching the intrinsic muscles, this means that the splint can be worn during functional activities and allows for more opportunities to practice skills while the correct position of the thumb and hand is maintained (42)(44). When tasks are practiced in a familiar environment it allows for motor learning to occur which improves functional skills, because the splint can be taken home and is worn by the child throughout the day it increases the chance of motor learning occurring (65)(71)(70).

In South Africa, access to therapy is hindered by multiple factors such as a large portion of the population staying in rural areas where there are no therapists and consequently they have to travel long distances to receive therapy. High unemployment means that a large number of people can simply not afford transport to their nearest facility for therapy. There are not always enough therapists at facilities to see all the people requiring therapy this

means that a number of clinics prefer to use group therapy as opposed to individual therapy due to staff shortages and time constraints.

It is important for occupational therapists to focus on function in order to improve quality of life in individuals with cerebral palsy. It is clear from the research that one approach is not necessarily better than another and it is therefore of utmost importance that the therapist completes a thorough assessment of the child before beginning therapy. The selection of intervention should be based on a family-centred approach.

CHAPTER 3
METHODOLOGY

3.1 RESEARCH DESIGN

This was a quantitative study, using a longitudinal experimental design. Experimental designs test the possible effect an intervention has on an outcome (83). This was done by comparing the outcome of an intervention group, who had a splint, to a control group who had no splint, limiting the effect of a type I error (83).

The study also incorporated a pre-test-post-test design (83). A baseline measure was obtained before the intervention, which allowed progress to be measured on an individual basis for each subject when compared to a final measure. Having a baseline measurement permitted for statistical procedures that control for individual differences therefore limiting the chances of a type II error occurring.

In order to establish the effect of a thumb abductor splint on hand function in children with cerebral palsy participants in two groups, an intervention group and a control group, were therefore assessed at the beginning of the study and were issued with a home programme. Participants in the intervention group were fitted with a thumb abductor splint and prescribed a splinting programme while the control group did not receive a splint.

Participants in both groups continued with regular therapy at their local clinic, if this was part of their routine intervention. All participants also received one treatment session a month from the researcher for the duration of the study. During these sessions therapy was given and a new home programme was issued. Participants in the intervention group also had their splints checked for pressure and fit. The study took place over a period of 12 months with each participant receiving therapy over a three month period and assessments being administered at the beginning and the end of the three month period.

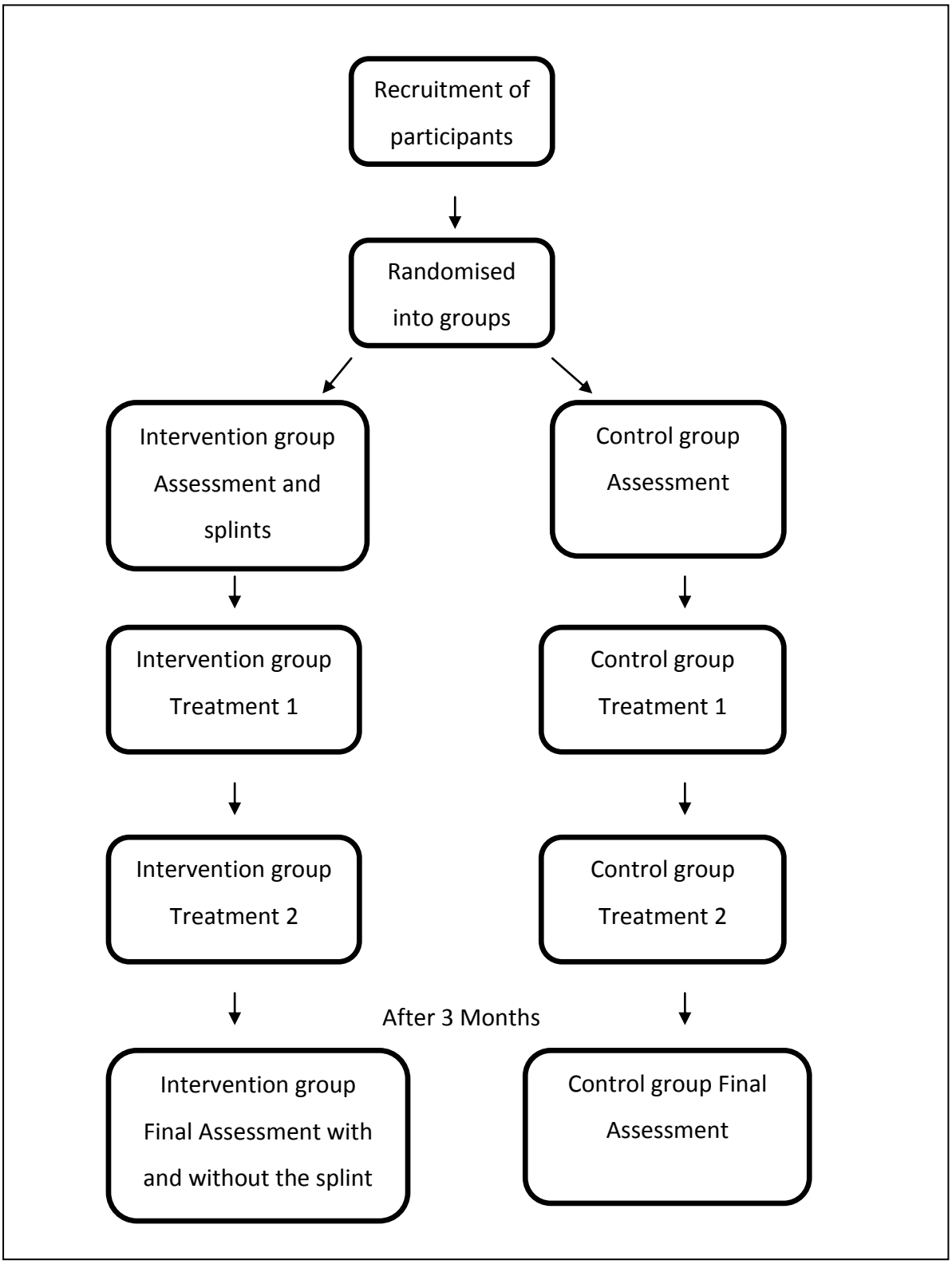

Figure 3.1 Outline of the study design

3.2 SAMPLE

Convenience sampling was used in this study. Participants were selected from the particular clinic to which the researcher had access and where the participants could be recruited (76). The sample was therefore selected from the Paediatric Neurology Clinic at Steve Biko Academic Hospital (SBAH) in Pretoria. Most of the participants attending the clinic had a similar background and relied on public health care. Only two of the participants were on private medical aids. Participants were randomly assigned into the intervention or control group using a random numbers table.

3.2.1 Inclusion Criteria

Participants had to comply with the following inclusion criteria:

- Diagnosed with cerebral palsy by the Paediatric Neurologists at the clinic
- Regularly attending the Paediatric Neurology Clinic at SBAH and thus fairly compliant to treatment
- Ages 18 months to 6 years
- Male and Female
- Level II or III or IV on the Gross Motor Function Classification Scale (GMFCS)
- Level II, III or IV on the Manual Ability Classification Scale (MACS)

* Regularly refers to 1-3 months depending on when the doctor required them to follow up.

3.2.2 Exclusion Criteria

Participants with the following characteristics were excluded from the study:

- Co-morbid or previous diagnosis of hydrocephalus, tuberculosis meningitis or meningitis
- Progressive upper motor neuron lesion
- Static contractures of the thumb adductors or wrist
- Acute illness

3.2.3 Sample Size

With reference to the QUEST assessment, the component of grasp was felt to play the most significant role in determining hand function in patients with CP and therefore the sample size was calculated using this component of the assessment, as well as a power analysis (76). In patients with CP it is expected that the score range at baseline on the QUEST for the dominant hand would be 4 – 10 points. Considering change from baseline, an estimate for standard deviation is (range/4)*√2 = 1.5 points. For an improvement in change from baseline for therapy and a splint of 2 points compared to therapy only, a total sample size of 40 (with 20 in the experimental group and 20 in the control group) will have a 90% power. Testing is one sided at a 0.05 level of significance. Due to difficulty recruiting participants the total sample size for the study was 28 child participants, 14 in each group.

3.2.4 Recruitment of participants

Participants were selected from patients attending the Paediatric Neurology Clinic at Steve Biko Academic hospital. They were approached to participate if they met all the inclusion criteria. If they agreed to participate in the study they were randomly assigned into either the control or intervention group using a random number generator.

3.3 ETHICAL CONSIDERATIONS

Ethical clearance for the study was obtained from the Human Research Ethics Committee at the University of the Witwatersrand (M101020) (Appendix B). Dr Tanna, the superintendent of Allied Health at Steve Biko Academic Hospital, granted permission for the study to be carried out at the necessary clinic (Appendix C).

All caregivers of the selected children were invited to attend a group where the research study and requirements were explained to them along with the possible benefits and risks. They were then given the option to take part in the study and an information sheet was given to them which explained the study (Appendix D). This information was also discussed with them and informed consent obtained from the caregivers who agreed to participate (see Appendix D). The caregiver was required to give consent for their own participation as well as the participation of their child in the study. It was also explained to the caregiver that they could withdraw from the study at any point and that withdrawing from the study would not affect their future medical or therapeutic treatment in anyway. Confidentiality

was explained and caregivers were told that records would be kept securely in a locked office at all times so that no one would be able to identify them or their children. They were also informed that feedback on the study would be provided on request.

For those children old enough to understand they were asked if they would be willing to be assessed, do the exercises and wear the splint. Very few of the participants were old enough to understand what was required but verbal assent was obtained from the participants over the age of five years (Appendix E). Children with moderate and severe cognitive impairment were not asked to provide verbal assent.

Data was coded and only the researcher had access to which code belonged to which child participant. All data collected was kept in a locked office at all times and all records have since been safely stored in a locked cupboard.

3.4 MEASUREMENT TOOLS

The tools that were used in the study comprised of a standardised assessment – the QUEST, a demographic questionnaire as well as an adherence diary and a caregiver questionnaire which was completed by the caregivers at the end of the intervention period.

3.4.1 Quality of Upper Extremity Skills Test (QUEST)

This assessment was chosen for the study as it was designed specifically to assess children with CP. The assessment measures the components of hand function as well as the quality of upper limb movement (59) (Appendix A). The QUEST assesses four aspects: dissociated movements, grasps, weight bearing and protective extension as described in the literature review.

This standardised assessment is easily accessible and any qualified therapist is able to administer the test. There has only been one previous study that used the QUEST in South Africa (23). The equipment required to administer the test is comprised of everyday objects and is readily available. The QUEST assesses dissociated movements, grasps, weight bearing and protective extension. For each section there are subsections consisting of different movements or grasps, each of these either gets a tick or a cross depending on whether or not the child can complete the movement. If it cannot be tested then it is marked as N.T.

(not tested). The ticks, crosses and N.T.'s are added up for each section and a total is calculated using the given formula (59) (See Appendix A).

The therapists observe the child's movement during set activities which are done seated at a table or on a mat on the floor. In the dissociated movement and grasps section, movement is observed while getting the child to reach for objects such as a puppet or blocks. The therapist observes how much range of movement the child has in the shoulders (flexion, extension, and abduction), the elbow (flexion and extension), the forearm (supination and pronation) and the wrist (flexion and extension) and whether the movement is less than 90 degrees or more than 90 degrees. Grasps are observed by getting the child to pick up objects, such as blocks, crayons and cereal, off the table or mat, the type of grasp is scored (palmer, digital pronate, tripod, pincer, radial palmer). The therapist also looks at the child's ability to release objects (59).

Weight bearing is performed in either prone or four point kneeling. The child may not have any equipment assisting them to maintain the position (e.g. a wedge or roller). The position of the hand and arm is then scored (elbow flexed or extended, hand open or closed) (59).

Protective extension evaluates the child's ability to prevent themselves from falling when their weight is displaced. This is done in cross legged or ring sitting and again considers whether the elbow is extended or flexed and whether the hand is open or closed (59).

Each item is scored as yes (tick) or no (cross) depending on whether or not the child can complete the movement. If it cannot be tested then it is marked as N.T. (not tested). In order to calculate the total score, the ticks, crosses and N.T.'s get added up for each section and a total is worked out using the four scores from the four sections applying the given formula (59). Since this is a criterion referenced test each child's score is used to establish a baseline and then identify if any improvement has occurred.

3.4.2 Caregiver questionnaire

This questionnaire was also administered to the main caregiver of the child (See Appendix F). The questionnaire was drawn up by the researcher and included questions about demographics and medical history. Information necessary for this study included the home environment, social economic status and a history of the child's treatment including the

range of health professions involved. The questionnaire was used to identify factors which may have had an impact on the child's progress throughout the study.

3.4.3 Adherence diary

An adherence diary was also issued to the caregiver of each participant (Appendix G). The adherence diary was developed by the researcher and was presented in the form of a tick sheet, to make it as easy as possible for the caregivers to fill in. The diary was designed to enable them to document, as best they could, the amount of time the splint has been worn each day as well as how many times the home programme was carried out each week as well as how many times therapy was attended in a month.

All caregivers had to record every therapy session the child attended during the time of the study; as well as the number of times the home programmes was carried out each day. The intervention group had to also record how many hours the splint was worn for each day. For the home programme caregivers had to tick whether they carried it out in the morning, afternoon or evening or more than once in a day. The splint adherence diary was divided into hourly units and caregivers had to tick how many hours the splint was worn for each day. All the adherence diaries had the pages with dates for the duration of the study so the caregiver was not required to fill in any extra information.

3.4.4 Post study questionnaire

A post study questionnaire was issued to caregivers in the intervention and control groups which allowed caregivers' to comment on any difficulties they had with carrying out the splinting regime or the home programme. It has been shown that adherence, to home programmes, is influenced by multiple factors such as the time it takes to administer, the parents daily routines, flow of family activities and the understanding of the parents regarding what has to be done (79). The questionnaire was designed by the researcher with the view of obtaining information about factors which may have influenced wearing of the splint or carrying out of the home programme (Appendix H). This section was open-ended and allowed for qualitative analysis. It also allowed for the researcher to gather information concerning the participant's splint which may have affected the overall outcome.

3.5 HOME PROGRAMME

The home programmes were drawn up by the researcher and contained exercises which focussed mainly on the upper limb and functional activities which could be incorporated into everyday routines.

Generally the caregivers of the children are given passive stretches to do by the therapists who see them at their local clinic. This is what most of the caregivers who took part in the study do daily with their child. Research by Carr and Shepherd (2011) has shown that passive stretches show a short term increase in length of the muscle but that this is not maintained (71). Passive stretches are useful in acute cases where the client does not yet have active movement or is unable to actively move through full range of motion in order to prevent shortening of the muscles (71).

While the researcher included some passive stretches in the home programme these were only used when the child could not carry out the movement independently, through full range of motion, and were used in order to maintain muscle length. The rest of the time the caregivers were encouraged to let the child initiate as much of the movement as possible, by providing motivation through the use of play, and then to facilitate the child through the rest of the required movement (65)(84). They were told to try decrease the amount of support that they give the child over the period of the home programme and to encourage the child to start moving more and more by themselves. Active stretch is necessary to preserve functional length of muscles and therefore the caregivers were urged to allow the child to move as much as they could independently and then assist rather than just moving the child themselves (71).

Exercises which were used were based on principles from the neurodevelopmental therapy (NDT) approach. This is a problem solving approach to the assessment and treatment of individuals with disturbances of motor performances secondary to an upper motor neuron lesion (84). The NDT approach includes elements of motor learning as well as dynamics systems theory and looks at the interaction between the child, environment and task (65). Both motor learning and dynamic systems theory were also taken into account when designing the home programmes.

Each home programme started with some basic NDT preparation techniques, to influence tone in the trunk and upper limb. These consisted of trunk rotation, which then lead into rolling and reaching in later programmes as well as shoulder mobilisation (84). Then exercises of the upper limb were covered, these exercises were graded, starting with proximal joints such as the shoulder and moving to more distal joints such as the wrist and fingers. It was recommended that the caregivers allowed the child to initiate the movement and move as much as they could independently and only when the child could not move any further then to facilitate the rest of the movement with the child (84). The last part of each home programme contained skills which could be incorporated into daily tasks to increase participation in activities of daily living and to facilitate functional skills (Appendix I).

Carr and Shepherd (2011), state that training aimed at improving performance should be specific to the action and the context (71). This infers that skills needed for a specific task should be practised in the context of that task. Dynamic systems theory takes this idea one step further stating that intervention is best accomplished in a natural and realistic environment through the achievement of whole occupations and not just parts of them(65) (70). It was for this reason that functional activities were included into the home programme, this allows the children to practice ADL's in the context of their home environment and allows for better learning to occur (65).

Currently the caregivers carry out all ADL's for the children and they are often not given the opportunity to participate. The researcher felt it was important to include functional activities so that the children were given opportunities to attempt basic ADL's and show their caregivers that they are capable of doing some activities themselves or with minimal assistance. Learning also occurs when a child is actively engaged in the activity. Functional activities capture the attention of the child and allow them to engage in the activity which promotes learning (65). Manipulation of objects' with different characteristics; size, shapes and textures, encourages interaction of visual and somatosensory information which increases attention and therefore encourages active involvement of the child, this also promotes learning (65) (70). Therefore different ADL activities were included, using different objects such as wiping their mouth and holding their bottle or cup.

The developmental approach was used in grading the home programmes (65). The home programmes followed a developmental sequence. Each month new exercises were given

which built on the previous month's exercises. All home programmes used simple language that could be easily understood and contained diagrams of the exercises to make it as straightforward as possible for the caregivers to use.

In order to accommodate for the language barrier the home programme used mainly pictures and a few words to explain what was required. The pictures were taken out of the book Disabled Village Children as they use simple illustrations which can be clearly seen and showed what the researcher wanted to include (85). A few words were used to explain the pictures in short simple sentences as to not overwhelm the caregivers. There were an estimated four to eight exercises per programme and there were two to four functional tasks. The caregivers were not required to do all the exercises every day. But it was recommended they did at least 3 of the exercises during the day and attempted involving the child in at least one functional task per day. This means that in the month they would have covered all the exercises 3 times a week and the functional task 1- 2 times a week. Repetition and practice is key for learning to take place, in many frames of reference, and therefore it was important that the exercises and functional tasks were completed multiple times to allow for learning to occur (84) (65)(71).

The home programmes were translated into Zulu, by one of the research assistants. They were then translated back to English by one of the assistants in the physiotherapy department of the hospital, where the study was carried out, to check for accuracy. Each participant received the home programme in English and in Zulu. At least one of these languages could be read by the caregiver or by someone living with the child. Exercises were also demonstrated during the therapy sessions to ensure adequate understanding and carry over.

3.6 RESEARCH PROCEDURE

Two research assistants were recruited to assist with the data collection in this study. Both were colleagues of the researcher and trained occupational therapy or physiotherapy staff. One research assistant (physiotherapist) acted as a translator and the other (occupational therapist) assisted with the data collection by assessing some of the participants.

3.6.1. Training of the Research Assistants

The research assistant who assisted with translation of informed consent, home programme and the questionnaires when necessary, was completing her Master's degree and therefore had a thorough understanding of the informed consent process so was able to accurately convey the necessary information. She was briefed on the study so that she had a good understanding of the research being undertaken. The researcher also informed her about the questionnaires and she had a good understanding of what the researcher wanted to obtain from the use of the questionnaires. She was also fully informed about the home programme and was able to adequately explain and demonstrate the components where needed.

Due to the fact that the assessments were quite comprehensive and took around 30 minutes for each child and that there were 90 assessments administered in total throughout the study it was not practical to ask another therapist to complete all the assessments. Another occupational therapist who also acted as the research assistant was trained by the researcher to administer the QUEST. She also studied the QUEST manual to ensure she had an adequate understanding of the assessment so she could assist with assessments.

Because blinding was not possible, as the intervention group was assessed with the splint on and then without the splint, the assessments were administered by both the researcher and the research assistant.

To ensure inter-rater reliability the other therapist and the researcher assessed six of the same children separately. The assessments were then marked and the two therapist's scores were compared with each other. A correlation between the two assessors' scores was done.

3.6.2 Data Collection

Data collection took place over a 12 month period with each participant's intervention taking place over a three month period during that year. Participants were divided into smaller groups to make the assessment more manageable. Each group consisted of four to six children.

Once the caregivers of the participants had been recruited they were then invited to attend a group where the research study and requirements were explained to them along with the possible benefits and risks. They were given the choice to participate and informed consent was obtained from the caregivers who agreed to participate (Appendix D). A research assistant helped to translate the information sheet and to explain the study to some of the participants so that they fully understood what the study entailed. Caregivers were then given an opportunity to ask questions. Verbal assent was obtained from child participants over the age of three years, whose caregivers had agreed to participate in the study (Appendix E).

Caregivers were asked to complete the caregiver questionnaire and the adherence diary was given and explained to them. The research assistant translated the questions and answers and wrote down the caregivers answers if this was required.

The hand and upper limb assessments of the child participants, using the QUEST took place at Steve Biko Academic Hospital, in the occupational therapy department. There was a treatment room set aside for the assessments to take place so that they always occurred in the same place. The QUEST was administered on each child.

The exercises and activities that were in the home programme were then demonstrated one at a time to the caregivers by the researcher, and the caregivers were given an opportunity to try the exercises on the participants during the session. The researcher could then check that they understood the instructions and home programme and were able to carry them out.

The caregivers were then given another opportunity to ask questions regarding the home programme and adherence diary.

The hands of participants in the intervention group were individually measured and a splint was made for each participant.

The splint that was used is a soft thumb splint. It fits on the thumb, in the webspace and around the palmer and dorsal surfaces, securing on the ulnar aspect of the hand. This splint was chosen because it allows movement of the intrinsic muscles and active movement of the thumb, while it restricts adduction of the thumb, it does not prevent it altogether. The splints were made from neoprene, which provides neutral warmth to the hand and has

been shown to have an inhibitory effect on spasticity (42). All splints were made and fitted by the researcher.

Caregivers were shown how to apply the splint and were given an opportunity to practice during the first session to check they understood how to fit the splint. The importance of checking for pressure sores was also explained and caregivers were told what to look for to prevent the development of pressure sores. No pressure sores developed in any of the participants for the duration of the study.

Thereafter participants in both the control and intervention group were given an appointment once a month. The caregivers handed in their previous adherence diaries, fetched a new adherence diary and attended a group therapy session where a new section of the home programme was demonstrated and instructions given, to take home. The group session lasted approximately 90 minutes. During this time caregivers were shown basic NDT preparation techniques and a task orientated approach to facilitate functional skills by the researcher with the help of the research assistant who acted as a translator. (Appendix I)

The intervention group also had their splints checked during this time to ensure no pressure areas were forming and to check the splints still fitted correctly. Adjustments to the splints were made as needed, new Velcro was attached if needed or new splints were issued if the splints were too small.

The QUEST assessment was then repeated at the end of the three month period, the participants in the intervention group were also assessed with the splint on for the final assessment to determine if there was any carry over after the splint is removed. Thus the control group has a total of two QUEST scores while the intervention group has a total of three QUEST scores.

The adherence diaries were collected from the caregivers at the end of each month intervention period and they were asked to complete the post study questionnaire at this time. Data from all questionnaires and assessments as well as the diary were entered into a Microsoft Excel spreadsheet.

3.6.3 Control of Variables

Language barriers and cultural sensitivity were taken into account at all times. There was a translator available constantly to translate should one of the caregivers not fully understand something.

All the splints were measured, made and adjusted by the researcher, this meant all measurements were taken at the same points on the child participant and all splints were made using the same pattern and had the same amount of pull.

The participants from the intervention group and the control group had appointments on different days to ensure no contamination took place between the groups (83).

Loss to follow up is of concern in a longitudinal study of this nature as this can have an impact on the validity of the study and dropouts for the duration of the study needed to be minimised as much as possible. An intention to treat analysis was used to account for dropouts to reduce bias. The outcomes for all participants were included even if they discontinued the intervention to which they were assigned (83).

3.7 DATA ANALYSIS

The mean, standard deviation and 95% confidence intervals were reported using descriptive statistics (76). Should distributions be skewed geometric means and 95% confidence intervals will be reported for demographic data and adherence data. The items from the demographic questionnaire were also summarised using frequencies, percentages and cross- tabulation. Group scores were compared using the student's two sample t-test to ensure there was no significant difference between the groups at baseline.

The change in QUEST scores for each participant was established to determine the effect size of the intervention given as well as if change was significant. The change in the QUEST scores from baseline score to the final score (change within the groups) for the participants in intervention and control groups (change between groups) were also compared, using the student's two sample t-test and the nonparametric Wilcoxon's rank sum test. Testing was done at the 0.05 level of significance. An ANCOVA will be superior to its ANOVA counterpart in two distinct respects (i.e., increased statistical power and control), so long as a good covariate is used. The covariate role is to reduce the probability of a type II error when tests

are made of main or interaction effects, or when comparisons are made within planned or post hoc investigations (83).

A qualitative content analysis of the adherence diaries was done using descriptive statistics to establish how compliant participants were. The average hours the splint was worn and compliance to home programme in terms of number of sessions was calculated. This was correlated to the change in each participants QUEST score using the non parametric Spearman's correlation coefficient because of the small sample size.

The caregiver questionnaire was analysed using content analysis to obtain any factors which may have affected the use of the home programme and splints.

CHAPTER 4
RESULTS

The results of this study will be discussed under the following headings, demographics of the caregiver participants, demographics of the child participants and socioeconomic status. The results of the QUEST assessment will then be looked at as well as the rate of compliance with the home programme and splinting regime. The total number of participants at the beginning of the study was 28, split equally among the control and intervention groups with 14 in each group. It was not possible in the time set aside to collect data to recruit a total of 40 children into the study.

At the end of the study there was a dropout rate of 32% with a total of 19 participants being assessed, 10 participants in the control group and 9 participants in the intervention group.

4.1. DEMOGRAPHICS

4.1.1 Demographics of the Caregiver participants

All primary caregivers were the mothers of the children, except in one case where the primary caregiver was the uncle. Therefore all except one caregiver were females and their ages ranged from 20-40 years.

The child participants were randomised into groups however the majority of the caregivers in the control group fell between 20 - 29 years whereas the majority of caregivers in the intervention group were older, falling between 30 – 39 years (Table 1). There was no significant difference between the control and intervention groups for caregiver age (p=0.06). The two groups were also comparable for all the home languages and education level where p values ranged from 0.45 to 1.00. Caregivers in some households spoke more than one home language, in this case both languages were counted as their home language (Table 4.1).

The level of education of the caregivers varied with the majority of caregivers having achieved matric or less. Approximately 20% of caregivers had post school education in both groups (Table 4.1). Again the education level of the caregivers was comparable as there was no significant difference between the groups in these levels (p= 0.68).

Most caregivers in the control group, 64.29% and intervention group 71.43% were unemployed. Only 21.43% of caregivers in each group were employed full time. The types of employment included chef, teacher, security guard, as well as domestic work. The groups were therefore comparable for the caregiver variable of employment status (p= 1.00).

Table 4.1: Age, home language, education level and employment status of the caregivers n=28

		Control Group n= 14	Intervention Group n= 14	p
Age Groups	**20- 30 years**	71.43 %	30.77 %	0.06
	30 – 40 years	28.57 %	69.23 %	
Home Language	**Zulu**	64.29 %	42.86 %	0.45
	Sepedi	28.57 %	21.43 %	1.00
	Sotho	7.14 %	0 %	1.00
	English	0 %	14.29 %	0.48
	Afrikaans	0 %	7.14 %	1.00
	Other	14.29 %	28.57 %	0.64
Level of Education	**Grade 7- 10**	28.57 %	42.86 %	0.68
	Grade 12 (matric)	50 %	35.71 %	
	College or Technikon	14.28 %	21.43 %	
	University	7.14 %	0 %	
Employment status	**Full time**	21.43 %	21.43 %	1.00
	Piece jobs	14.29 %	7.14 %	
	Not working	64.29 %	71.43 %	

4.1.2 Demographics of the child participants

The ages of the children ranged from 18 to 68 months with the average age being 2 to 3 years old (Table 4.2). There was no significant difference between the mean ages of the children in the control and intervention groups (p = 0.54). The majority of children in the

control group were female (57.14%) while the majority of the intervention group were male (78.57%), but the difference was not significant in terms of gender (p=0.12). Overall there were a greater percentage of male children who participated in the study (60.71 %).

Table 4.2: Age and gender of children (n=28)

		Control group n= 14	Intervention group n= 14	p
Age in months	**Mean (SD)**	36.57 (16.34)	33.5 (13.89)	0.54
Gender	**Male**	42.86 %	78.57 %	0.12
	Female	57.14 %	21.43 %	

4.2 SOCIOECONOMIC STATUS OF FAMILIES OF PARTICIPANTS

4.2.1 Areas of residence

The majority of participants' families lived in Mamelodi and this was true for almost half of participants in the control group (46.15 %), compared to 28.57% in the intervention group. Approximately two thirds (35.71%) of the intervention group lived in other areas in Mpumalanga including Kwamhlanga (Figure 4.1). Only one participant from each group lived in Shoshanguve and Attridgeville. Figure 4.1 shows the areas of residence of the care givers and participants.

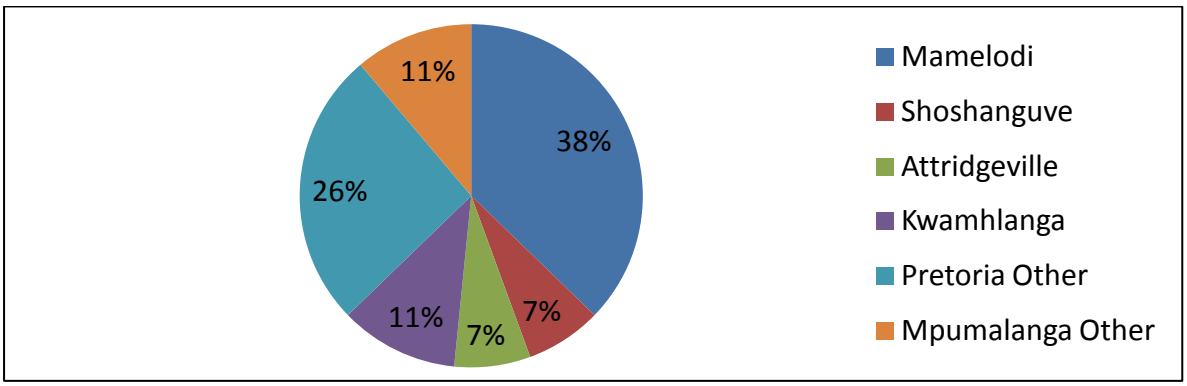

Figure 4.1: Areas of residence (n=28)

All participants except two are residing in township areas. The other two participants live in areas with a higher socioeconomic status, Centurion and Arcadia. Fisher's exact test showed no significant difference between the control and intervention groups for place of residence (p=89).

4.2.2 Types of housing and number of people living in the household

The majority of the participants (67.86%) lived in brick houses, with slightly fewer (64.29%) of the intervention group living in this type of dwelling compared to the control group (71.43%). Only three (10.71%) of participants in the intervention group live in informal housing consisting of tin shacks. Four of the participants in the control group and one in the intervention group lived in Reconstruction and Development Programme (RDP) housing (17.86%), or low cost brick houses which are partly subsidised by the government. One participant lived in a flat (3.75%) (Figure 4.2) Again the groups were comparable as to the type of housing they lived in (p= 0.16) and the number of people living in the household (p=0.29).

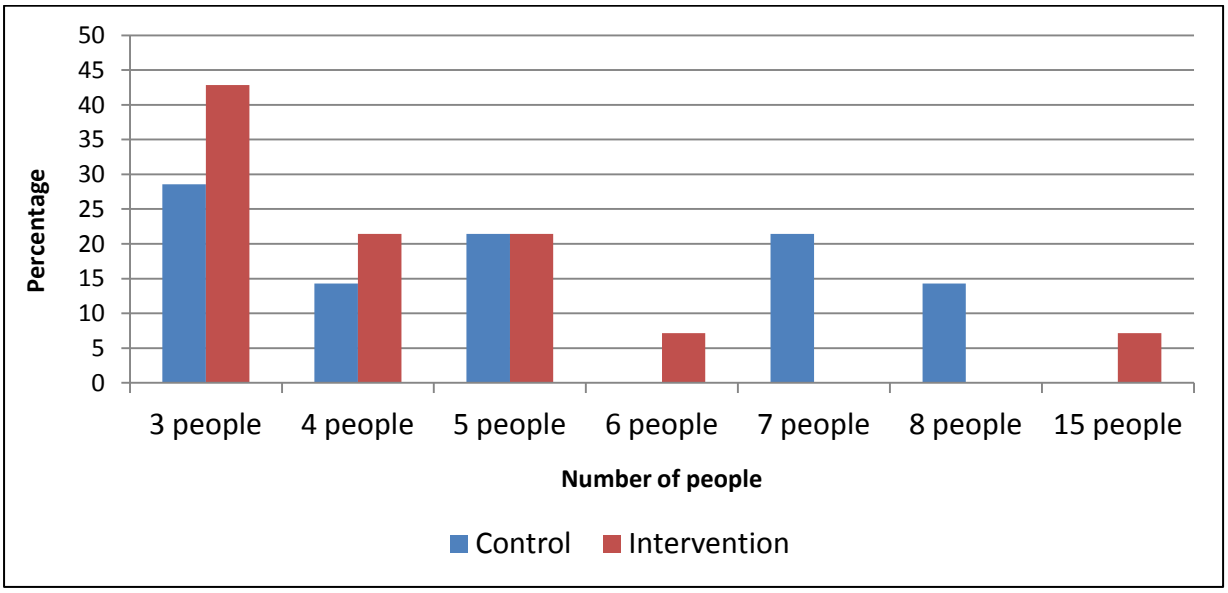

Figure 4.2: Number of inhabitants in a household (n=28)

The majority of the intervention group, 85.72 %, live in a household consisting of three to five people, one child lives with six people and one (7.14%) in a household with 15 people. In the control group, 64.29% of caregivers and participants stayed in households with three

to five people and 35.72% living in households with seven to eight people Figure 4.2 shows the number of people living in each household.

4.2.3 Household income and breadwinners

Not all of the caregivers responded to this question in the questionnaire. The results showed that in 36.36% of the control group and 77.78% of the intervention group, the father of the child is the main breadwinner (Table 4.3). The type of breadwinner in the control and intervention groups were not significantly different (p=0.45), therefore the groups were comparable for this variable.

According to the caregiver questionnaire, some caregivers in the control group also relied on the earnings of the grandparents of the child or on other family members such as an aunt or uncle.

In the control group 37.50% of breadwinners were domestic workers as opposed to only 10% in the intervention group. Half of breadwinners in the intervention group were professionals such as teachers, engineers, accountants or police officers and 40% held other employment such as self-employed, informal drivers or security guards. A quarter of breadwinners in the control group were professionals while 37.50% held other occupations. The type of occupation (p= 0.52) and the income (with the p value ranging from 0.71 to 1.00) did not differ significantly between the two groups, but the intervention group showed a larger percentage for the higher income brackets.

Table 4.3: Breadwinners for the families of the child participants

Breadwinner	Control Group n=11	Intervention Group n=9	p
Child's Father	36.36 %	77.78 %	0.45
Child's Mother	9.09 %	11.11 %	
Child's Grandfather	18.18 %	0 %	
Child's Grandmother	18.18 %	11.11 %	
Other	18.18 %	0 %	

Nearly a third of the households' monthly income in both the control and intervention groups is less than R1000. A similar percentage of the control group's households earn between R 1000 and R5000 per month while 28.57% of the intervention group have a monthly household income of R5000 – R10,000.

Only one household in the intervention group earns more than R10,000 per month. A large number of caregivers in both groups did not know how much the household's monthly income was.

75% of households receive salaries or wages. While 53.57% receive disability grants for their children and 25 % a child support grant. Only one household relied on a grandmother's old age pension and one household had no income at all.

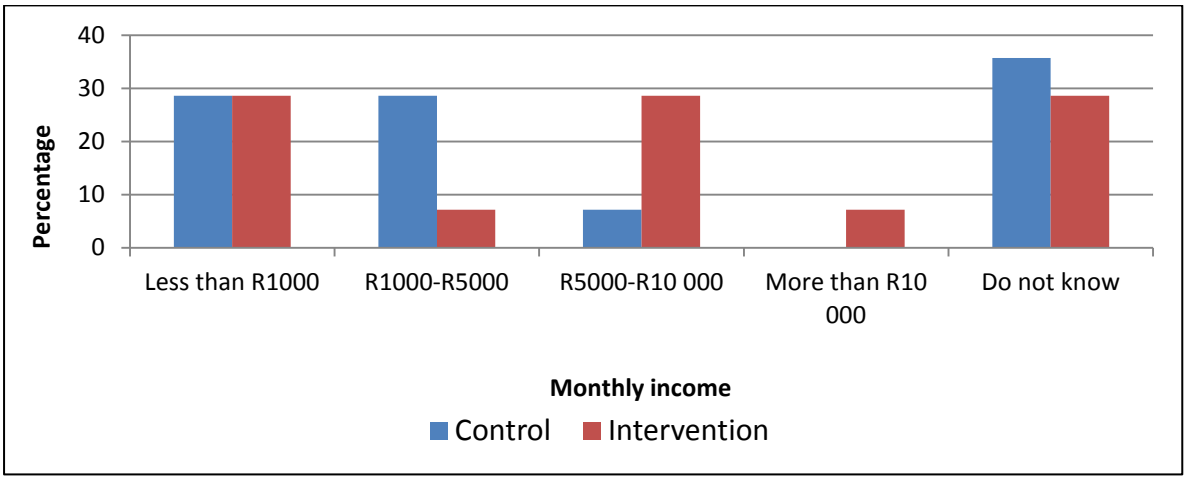

Figure 4.3: Average monthly household income (n=28)

4.3 TREATMENT RECIEVED

4.3.1 Treatment received by child participants

The majority of the participants (78.57 %) consult the medical doctor regularly, with a large number attending occupational therapy (71.43 %) and physiotherapy (75 %) on a regular basis. Speech therapy and dieticians were consulted by fewer participants, 28.57% and 14.29% respectively. Only one participant consulted a traditional healer (3.57%).

Participants in the intervention group received more intervention from health professionals than those in the control group. The intervention group also received a greater range of treatment when compared to the control group. The only significant difference in the

attendance at health care for the various health professions and traditional healer between the control and intervention group was attendance at occupational therapy which was significantly higher for the intervention group (p≤ 0.03).

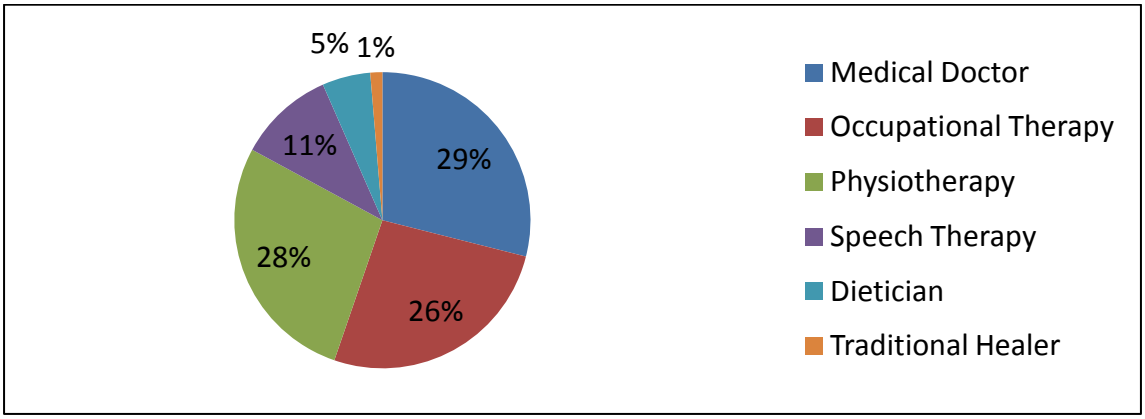

Figure 4.4: Treatment received (n =28)

The majority of both groups attend therapy on a monthly basis, with 57.14 % of the control group and 64.29% of the intervention group receiving monthly therapy.

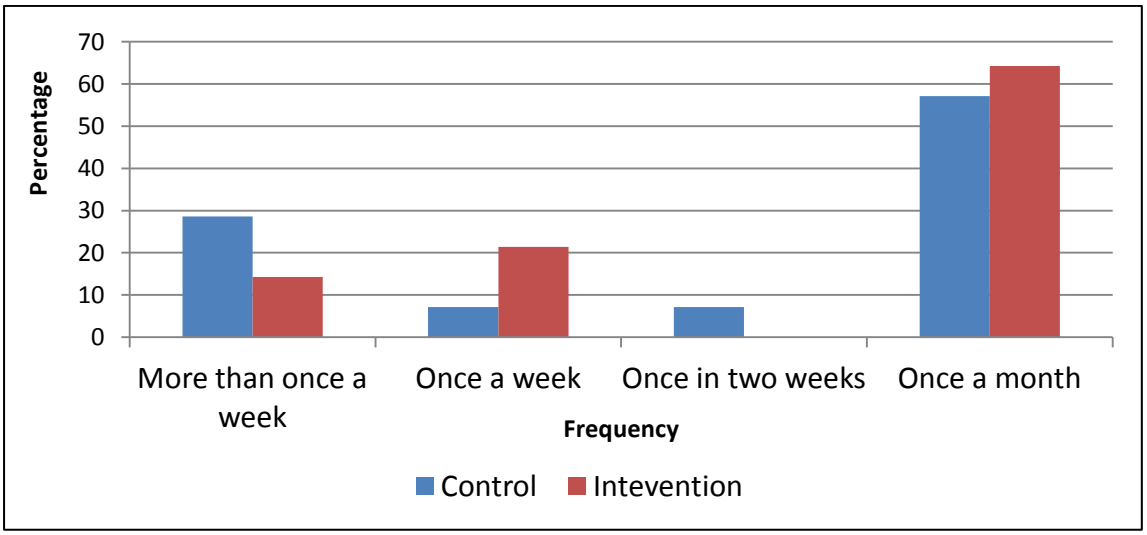

Figure 4.5: Frequency of therapy (n=28)

A small percentage of the control group, 28.57%, and intervention group 14.29% receive therapy more than once a week. All of these children were in schools for learners with special educational needs (LSEN) and therefore receive therapy more regularly.

The two groups were comparable with regards to the amount of times they received therapy (p=48), the explanation of the diagnosis to the caregiver (p=0.68) and their

understanding of the diagnosis (p=1.00) as well as their perceived support given to the child by the health professionals (p= 0.48). Figure 4.5 shows the frequency of therapy received.

4.4 RESULTS OF THE QUALITY OF UPPER EXTREMITY SKILLS TEST (QUEST)

4.4.1 Comparison between the control and intervention groups

An analysis of covariance was used (ANCOVA) to analyse the difference from baseline to the final assessment for the intervention and control group. This was done to reduce the risk of a type II error occurring. An intention to treat analysis included the results of all participants who were assessed initially.

There was no statistically significant difference between the control and intervention groups for any of the scores when the baseline assessments were compared (Table 4.4). The large standard deviations indicate large variation within both groups. Although the QUEST scores differed between the groups at baseline the groups were comparable.

Table 4.4: Comparison of baseline scores for control and intervention groups (n=28)

	Control Group	**Intervention group**	
	Baseline assessments Mean (SD) **n=14**	**Baseline assessments Mean (SD)** **n=14**	**P**
Dissociated movements	46.48 (12.64)	44.34 (11.76)	0.71
Grasps	11.90 (20.35)	3.72 (11.00)	0.54
Weight Bearing	45.56 (19.36)	41.66 (14.31)	0.76
Protective Extension	51.51. (25.50)	51.25 (16.67)	0.73
Total	38.26. (15.42)	33.26 (9.32)	0.28

While there was an overall improvement in scores in both groups in the dissociated movements (p=0.53), grasps (p=0.46) and weight bearing (p=0.46), none of the differences

were statistically significant (Table 4.5). Scores for protective extension (p= 0.96) showed a deterioration and the total improvement (p= 0.91) was also not statistically significant.

Table 4.5: Comparison of final assessment scores for control and intervention groups (n=19)

	Control Group		Intervention group			
	Final Assessments Mean (SD) n=10	**Mean Change from Baseline Assessment**	**Final Assessments Mean (SD) n=9**	**Mean Change from Baseline Assessment No splint**	**p**	**Confidence Interval (CI)**
Dissociated movements	55.63 (12.13)	9.15	53.12 (17.39)	8.78	0.53	-11.88 to 16.90
Grasps	12.25 (11.61)	0.35	8.35 (10.62)	4.63	0.46	-3.12 to 13.4
Weight Bearing	45.80 (17.05)	0.24	60.44 (24.88)	18.78	0.46	-21.77 to 9.45
Protective Extension	48.81 (18.90)	-2.7	48.33 (20.75)	-3.19	0.96	-17.79 to 13.33
Total	39.95 (11.20)	0.69	40.35 (13.73)	7.09	0.91	-14.4 to 19.58

There was no statistically significant difference between the control group and intervention group for dissociated movements.

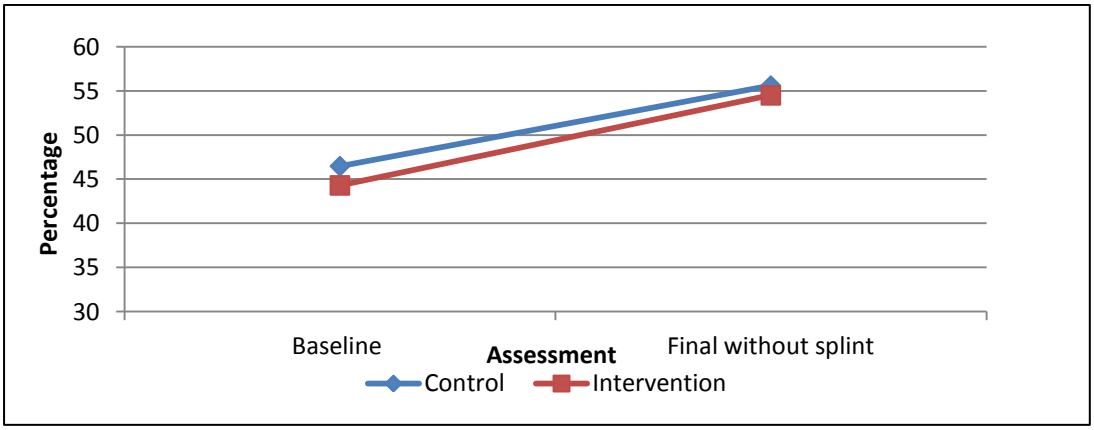

Figure 4.6: Comparison of dissociated movements between control and intervention groups (n=19)

There was greater improvement which occurred in the intervention groups for grasps, however it was not statistically significant when compared with the control group.

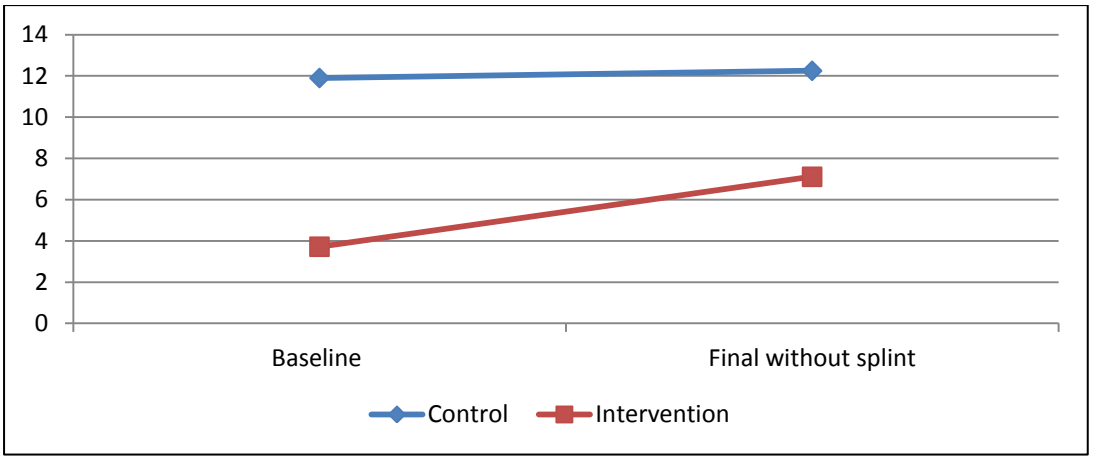

Figure 4.7: Comparison of grasps between control and intervention groups (n=19)

There was a definite improvement in weight bearing for the intervention group but there was no statistically significant difference between the control group and intervention group.

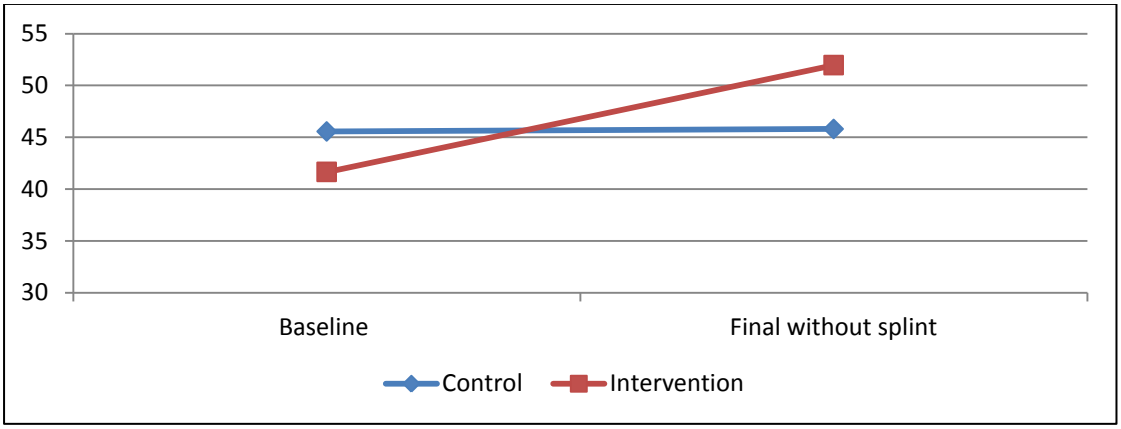

Figure 4.8: Comparison of weight bearing between control and intervention groups (n=19)

Protective extension decreased in both groups but there was no statistically significant difference between the two groups.

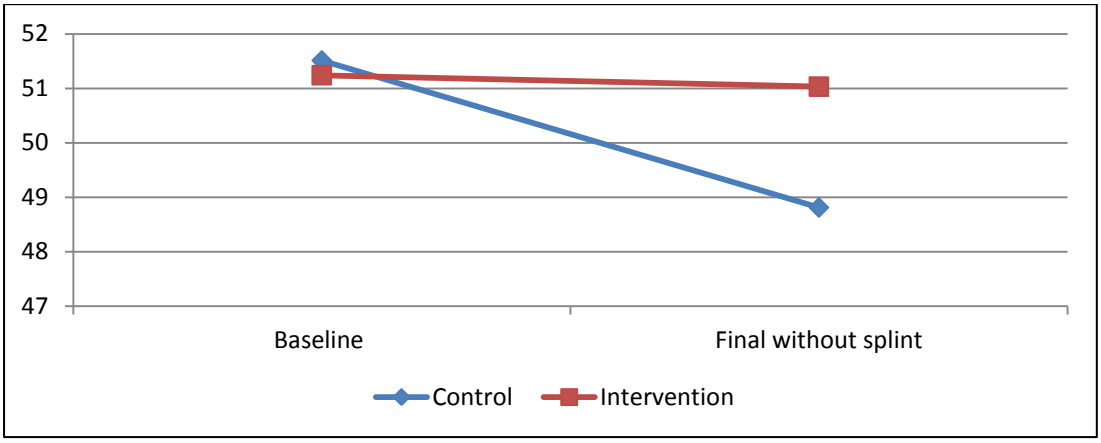

Figure 4.9: Comparison of protective extension between control and intervention groups (n=19)

There was a slightly greater increase in the total QUEST score for the intervention group when assessed without their splints, but this was not statistically significant when compared to the control group with the scores for both groups being similar after intervention

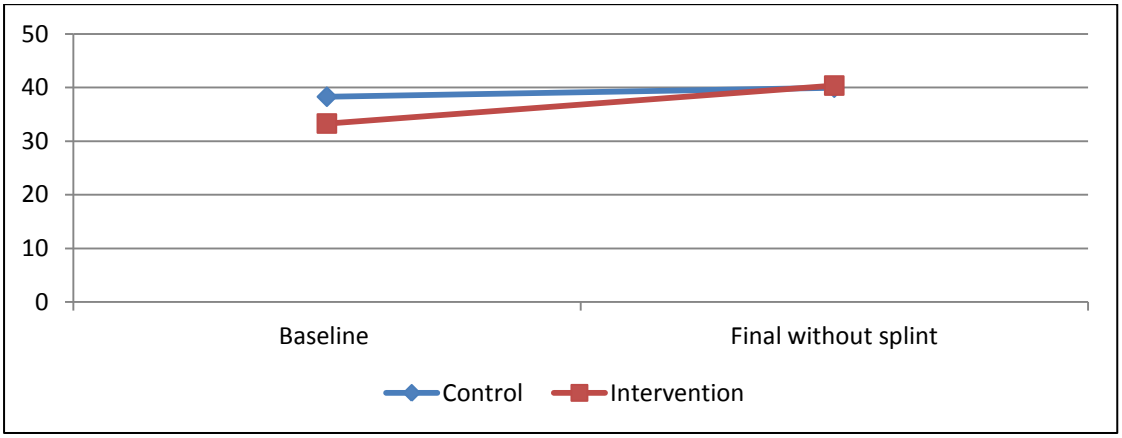

Figure 4.10: Comparison of total scores between control and intervention groups (n=19)

4.4.2 Comparison within the control and intervention groups

The within group comparison analysed the changes that occurred within the control and intervention group over the intervention period.

There was no statistically significant change in the control group for any of the components of the QUEST between the baseline and final scores. Confidence intervals set at 95% also showed there was no clinically significant change and effect sizes were all very small except

for the dissociation of movement of the upper limb which had a medium effect. The effect size is used to measure the magnitude of the treatment effect, independent of sample size (86). A medium effect size is between 0.60-0.99 and a large effect size is ≥1.00 (Table 4.6).

Table 4.6 Baseline and final scores for the control group (n=10)

	Baseline assessments Mean (SD) n= 14	Final Assessments Mean (SD) n =10	p	CI	p	Effect size
Dissociated movements	46.48 (12.64)	55.63 (12.13)	0.74	-19.83 to 1.53	NS	0.72
Grasps	11.90 (20.35)	12.25 (11.61)	0.88	-15.22 to 14.52	NS	0.03
Weight Bearing	45.56 (19.36)	45.80 (17.05)	0.11	-16.08 to 15.60	NS	0.01
Protective Extension	51.51 (25.50)	48.81 (18.90)	0.11	-17.07 to 22.47	NS	-0.14
Total	38.26 (15.42)	39.95 (20.92)	0.12	-13.58 to 10.20	NS	0.10

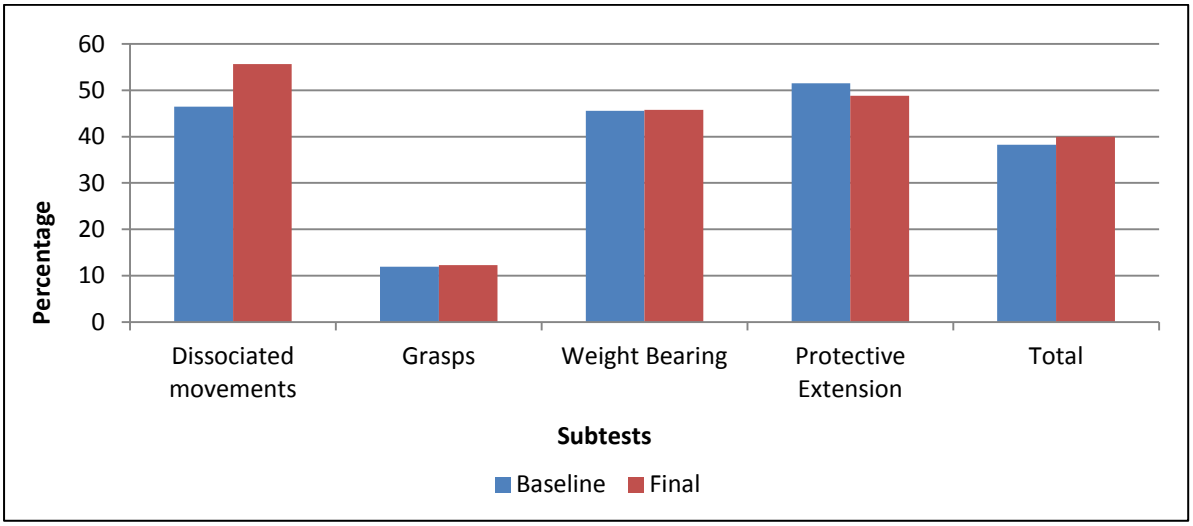

Figure 4.11: Comparison of scores within the control group (n=10)

A t-test and Wilcoxon's matched pairs signed rank test were used to compare the results of the intervention group's final assessment with the splint off and then with the splint on. Although there was no statistically significant difference found confidence intervals showed

a clinically significant improvement (p= >0.05) for dissociated movement with the splint on with a large effect size equivalent to more than 1 SD.

Weight bearing also had a clinically significant difference with a medium or less than 1 SD change with the splint off and a large effect size or more than 1 SD change with the splint on. Grasp only showed a clinically significant change with the splint on (p= >0.05) and here the effect size was medium or less than 1 SD change with a large difference between the scores when the splint was and was not worn.

Protective extension showed little change with a decrease when assessed without the splint on. Overall there was a clinically significant difference for the total score with the splint on (p= >0.05) with a large effect size of 1.28 which is equivalent to a change of over 1 SD in the scores.

Table 4.7 Baseline and final scores for the intervention group (n=9)

	Baseline assessments Mean (SD) n = 14	Final Assessments Mean (SD) n = 9	p	CI	p	Effect size
Dissociated movements *	44.34 (11.76)	53.12 (17.39)	0.48	-19.93 to 3.17	NS	0.87
Dissociated Movements **		56.25 (14.69)		-21.71 to -1.31	≤ 0.05	1.01
Difference		3.12 (9.17)				
Grasps*	3.72 (11.00)	8.35 (10.62)	0.37	-13.03 to 3.77	NS	0.31
Grasps**		11.11 (6.93)		-14.53 to -0.25	≤ 0.05	0.67
Difference		2.76 (6.22)				
Weight Bearing*	41.66 (14.31)	60.44 (24.88)	0.60	-34.31 to -3.25	≤ 0.05	0.72
Weight Bearing**		56.60 (20.55)		-28.42 to -1.26	≤ 0.05	1.04
Difference		-3.84 (15.36)				
Protective Extension*	51.25 (16.67)	48.33 (20.75)	0.26	-11.70 to 17.54	NS	-0.01
Protective Extension**		56.66 (24.58)		-21.73 to 10.91	NS	0.32
Difference		8.33 (14.43)				
Total*	33.26 (9.32)	40.35 (13.73)	0.13	-16.31 to 2.03	NS	0.52
Total**		45.16 (13.57)		-20.94 to -2.96	≤ 0.05	1.28
Difference		2.59 (3.15)				

* Without splint ** with splint

Improvement for all components was greater with the splint on except for weight bearing where it decreased slightly when the splint was worn during assessment.

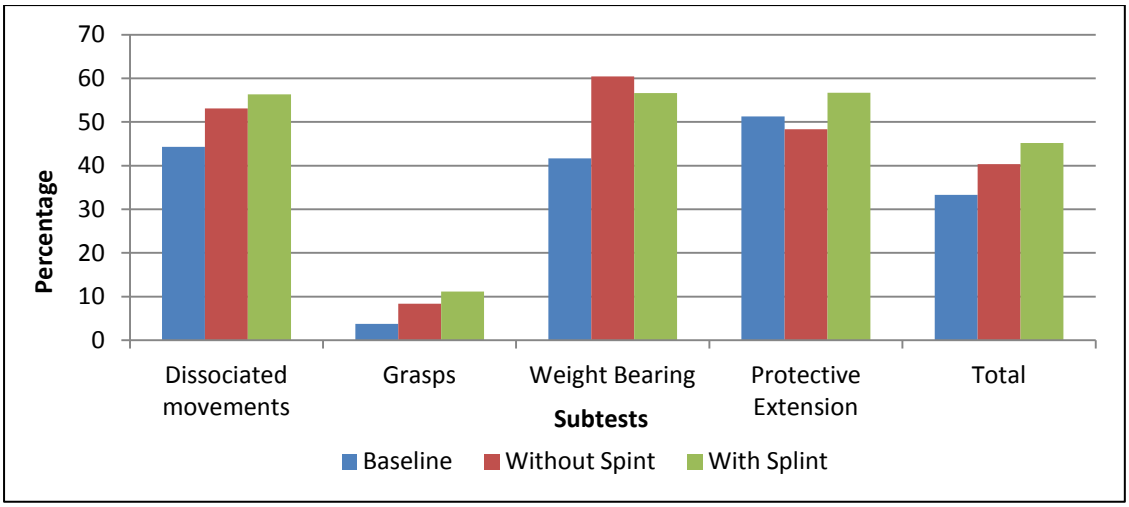

Figure 4.12: Comparison of scores within the intervention group

4.5 INTERATER RELIABILITY OF QUEST

A total of six participants' were assessed by the researcher as well as an external therapist in order to establish inter-rater reliability as blinding of the assessor was not possible. A one way analysis of variance was used to correlate data. Inter-rater agreement for application of the QUEST assessment was measured using the intra-class correlation (ICC) and was interpreted against a maximum possible value of 1.

There was insufficient data available to correlate the protective extension subtest of the assessment. The dissociated movement and weight bearing subtests have an excellent correlation, 0.82 and a high correlation, 0.73 respectively. The correlation of the total scores is also excellent, 0.95. The grasps subtest scores had a poor correlation(r= 0.00).

Table 4.8: Interater reliability

	Correlation
Dissociated Movements	0.82
Grasps	0.00
Weight Bearing	0.73
Total	0.95

4.6 CORRELATION BETWEEN THE QUEST SCORES AND HOURS SPENT ON HOME PROGRAMME

4.6.1 Correlation of adherence to the Home programme and improvement on QUEST scores

Adherence diaries were kept by the caregiver participants; they recorded the number of times they carried out parts of the home programme in a day. This was kept for the duration of the study. The data obtained from these adherence diaries was then analysed and correlated, using Spearman's rank order correlation, with the score from the QUEST assessment to see if any correlation could be made between the number of times a day the home programme is carried out and an improvement in QUEST scores. Only 15 of the participants' returned their adherence diaries for the home programmes.

There was a positive moderate correlation between the time spent on the home programme and an improvement in dissociated movement for the intervention group. All other scores were not significant when compared with the time spent on the home programme.

There were moderate negative correlations in relation to weight bearing, protective extension and grasp.

Table 4.9 Correlation between time spent on home programme and QUEST scores (n=15)

	Control Group (r)	Intervention Group (without splint) (r)	Intervention Group (with splint) (r)
Dissociated Movement	- 0.33	0.42	0.46
Grasps	0.03	- 0.09	- 0.20
Weight Bearing	- 0.14	- 0.21	- 0.60
Protective Extension	0.31	- 0.48	- 0.61
Total	0.26	- 0.14	- 0.60

4.6.2 Correlation between the QUEST scores and hours splint wearing time

The caregiver participants were required to keep an adherence diary indicating the number of hours per day the child participant wore the splint. The diary was kept for the duration of the study. The splint wearing time in hours was correlated, using Spearman's rank order correlation, with the scores from the QUEST assessment, taking into account results with the splint and without the splint. With the splint, there was a high correlation between grasps and an excellent correlation between weight bearing, protective extension and the total score. Without the splint there was a moderate correlation found between grasps and weight bearing.

Table 4.10: Correlation between splint wearing time and QUEST scores (n=7)

	Intervention Group (without splint) (r)	**Intervention Group (with splint) (r)**
Dissociated Movement	-0.54	0.31
Grasps	0.40	0.60
Weight Bearing	0.42	0.80
Protective Extension	0.02	0.80
Total	0.37	0.80

4.7 FEEDBACK FROM CAREGIVERS

At the end of the study caregivers completed a post study questionnaire about their experience of participating in the research. These questionnaires were administered during the final session and so all the remaining participants (n=19) completed one. Of caregivers, 95% felt that the home programmes were easy to follow. Only one participant said they were not. Some quotes taken from the feedback, when asked if the home programme was easy to carry out and what made it easy to do, which support this are:

"*pictures made it easy for everyone in the family"*

"because they show me how to do it and I make exercises everyday"

"because we are having the time tables u must tick whenever you do the exercise."

Only one participant gave feedback that the home programme was not easy to implement and the reason she gave was: *"Because I hope that if I do the exercise right my child will get better."*

Some difficulties which were mentioned by 52.6 % of participants were that they did not have toys to stimulate their child, they sometimes did not have enough time and that it was difficult to carry out exercises when the child was sick.

Feedback from one of the caregiver participants, when asked what made it difficult to carry out the home programme was:

"write out what did (tick sheet)"

Other reasons that were given for difficulties carrying out the home programme were:

"We don't have enough toys to do the exercise"

"Sometimes he doesn't want to do the exercise if I am doing it every day he just gets too tired"

Of the intervention group 100% of the caregivers stated that the splint was easy to don and doff. Some of the caregivers (22%) experienced difficulties with the splint at some point in the study. All the caregivers felt that there was some improvement in their child over the duration of the study with 66.6% reporting improvement in upper limb functioning specifically.

Feedback from the caregivers when asked if the splint was easy to use and why, supports this:

"I was putting the splint at 6 in the morning and take it out at night was easy for me cause I was using time"

"easy to put on, comfortable for child"

The only feedback received about difficulty using the splints were:

"when he want to play and the splint disturb the hand and the touching of some toys"

"when he didn't open the thumb its difficult"

The caregiver participants from the intervention group also reported that they could see a change in their children, the clinical significance shown from the scores supports this. The following quotes were taken from feedback given by the caregiver participants, post study, when asked if they noticed any change over the past 3 months:

"*yes the hand was always closed now I can see the difference, the child can use the hand better than before"*

"yes because now she can hold her toys if I give her something she put in her mouth"

"My child can open her hands she can at least control her neck and roll by her own"

Table 4.11: Feedback from caregivers

Factors		**Number of responses**	**Percentage**
Home Programme	Easy to carry out	18 / 19	94.7 %
	Reported results in upper limb function	12/19	63.15%
	Quick to do	5/19	26.4%
	Good handouts with pictures	10/19	52.6%
	Difficulties in carrying out	10/ 19	52.6%
Use of splint:	Easy to use	9/9	100%
	Accepted by child	9/9	100%
	Reported results in upper limb function	6/9	66.6%
	Difficulties in splint use:	2/9	22.22%

4.8 SUMMARY OF RESULTS

There were no statistically significant differences between the groups at the start of the study, demographics of the caregiver participants and child participants, and therefore the two groups were comparable at baseline. There were no significant differences in the socioeconomic statuses between the control and intervention groups. The only significant difference was the intervention group has a significantly higher attendance for occupational therapy than the control group ($p=\leq 0.03$). However a substantial number of participants dropped out of the study over the three month period of intervention and even those who came for the final assessment did not attend the monthly therapy sessions.

There were no statistically significant differences between the baseline QUEST results for the control and intervention groups. The intervention group however had a much lower score on the QUEST for grasp. Changes over three months for both groups also showed no significant differences and therefore the null hypothesis related to the difference in the upper limb function of children with CP following a home programme, who are and are not prescribed a neoprene thumb abductor splint is accepted.

There were no significant changes for the control group between baseline and final QUEST scores and confidence intervals showed no clinically significant change in scores. There were no statistically significant changes for the intervention group between baseline and final scores, however confidence intervals showed a clinically significant change in dissociated movements, grasps, weight bearing and total score with the splint. Thus the null hypothesis that there is no difference in the upper limb function of children with CP at the end of a three month intervention programme when assessed with the splint on and the splint removed is rejected in terms of clinical significance for dissociated movements, grasps weight bearing and total QUEST score

When the time spent on the home programmes was correlated with the scores from the QUEST, a moderate positive correlation in dissociated movements for the intervention group was found. The moderate negative correlations indicate there is no association between improvement in upper limb function and the time spend on the home programme and therefore the null hypothesis for this aspect is accepted.

There was a high correlation between the amount of wearing hours of splint and improvement of grasps, weight bearing, protective extension and the total score with the splint, a moderate correlation was found between grasps and weight bearing without a splint. The null hypothesis for no association between the hours spent wearing the splint and the improvement in upper limb function in children with CP is rejected.

Feedback from the caregivers was positive with most seeing improvement in their child's upper limb function and finding it easy to use the home and splinting programmes. Difficulties in carrying out the home programme related to lack of resources and problems with the child being sick or resisting the exercises.

CHAPTER 5
DISCUSSION

This discussion will be structured under the following headings: participant information and implications of the drop out from the study. The effect of demographics and socioeconomic status of the caregiver and the child participants as well as the medical information of the child, on the intervention will be reviewed. The implications of the splinting intervention in children with CP will be considered in relation to the results of the QUEST assessment.

The initial loss to follow up in the study of 32% is higher than the 27.3% found in a longer study on CP children in Europe and the criterion expected of studies with repeated measures as key outcomes (87). Compared to other intervention studies involving children with CP in other developed countries the dropout rate was large with less than 85% of participants being reassessed for at least one post-treatment assessment. No published studies on dropout rates in developing counties were found (88).

This large loss to follow may be a potential source of bias, as bias increases with the proportion of participants lost to follow up. This occurs as participants lost to follow-up may differ from those who remain in the study, with the small samples in this study this may lead to a type II error and limit the applicability or ability to generalise conclusions of this study. Results therefore need to be interpreted with caution (89).

5.1 PARTICIPANTS

To some extent the dropout rate in this study may have been affected by the South African context. In order to address the first objective about factors that affect adherence to the home and splinting programme in this study the demographics and socioeconomic status of the participants, both caregivers and the children with CP will be discussed. Research in other areas indicates that external factors, important in home programme adherence include education level, support provided, the use of a diary and availability of resources (90)(91).

It was important to collect demographic data from the primary caregiver and the family of each child participant as these various aspects impact on the ability of the caregivers to

assist with making sure that the children attend therapy and carry out a home programme, an essential feature of the intervention in this study over the period set aside for the data collection. This also provided a profile of the patients with CP who may require splinting, as part of their therapy that accessed the services at Steve Biko Academic Hospital, a large public hospital.

5.1.1 Demographics of the caregiver participants and their families

All the primary caregivers were the biological mothers of the children except one who was the uncle of the child. Thus there was a predominance of female caregivers and not unexpectedly the child's mother. A study by Klankaradi (2008) showed that commonly the mother of the child was the primary caregiver and most involved in their rehabilitation in a developing country (92). When the mother was not able to do this then another family member was chosen who was available – in this case an uncle.

The language which was spoken most regularly was Zulu (n=15), with Sepedi (n=7) being the second most spoken (Table 4.1). It is important to note that all caregivers understood English or Afrikaans as well as their home language and that translators were available for all sessions to make sure that they understood what was required of them. The home programmes were translated into Zulu, therefore the majority of the caregivers were able to understand them, the home programmes and the preparatory stretches and skills were also demonstrated. These aspects of a home programme were indicated as important for both understanding and adherence in a review of occupational therapy home programmes (93).

The demonstration and training given to the caregivers should match their learning style and take their level of education into account (93). This was attempted as far as possible by adapting the home and splinting programme and education to the caregivers' level of education as the level of education differed quite dramatically between groups (Table 4.1). The majority of the intervention group had only achieved between a Grade 7 to Grade 10 qualification, whereas in the control group the majority of caregivers had received a Grade 12 qualification. There was only one caregiver out of the whole group who had a university degree. This is most likely due to the fact that a large amount of caregivers did not complete matric, a requirement for entering tertiary education. The majority of caregivers reported that the splint and home programme was easy to understand and carry out, so it would

appear that the programmes were adapted adequately for the caregivers to comprehend and implement, even with a low level of education.

The education level of the caregivers may also account for the low employment rates and a large number (28.57%) in both groups have an income of less than R10,000 per month (Table 4.1; Figure 4.3). Research has shown that poverty remains prevalent in households headed by persons with an education level of grade 10 – 12 (94). In 2010 the South African poverty line was set at R515 per capita per month. This means that a household of four people requires an average income of R2060 per month in order to survive (95). Considering most households support between three and five people, this may not be sufficient for the basic necessities (Figure 4.2).

A greater percentage of the family members of the caregivers in the intervention group had professional jobs which may account for the higher income, between R5000 and R10,000 per month and better support in terms of income from the father of the child (Table 4.3). This may explain why participants in this group receive occupational therapy more regularly (Figure 4.4). If their income is higher they have more money that they can spend on transport to and from therapy appointments. While the caregivers view therapy as beneficial it is not a priority in their lives and they only attend appointments when they can afford it. The caregiver participants are between 30 to 39 years in the intervention group compared to the 20 - 29 years in the control group and therefore are also in an age group less at risk for unemployment which is highest between 16 to 24 years (94). The effect of an older mother on adherence to intervention with children who have CP does not appear to have been researched. It is not known if this fact also increased therapy attendance. It was interesting to note that the mothers in the intervention group were more compliant and their children attended occupational therapy more often so a higher age may have an influence on their compliance and willingness to take their children for therapy.

The majority of participants and their families, due to their lack of socioeconomic resources, live in government subsidised township areas which means that running water and toilets are generally located outside of the house and are shared between houses, close to where the families live (Figure 4.1). Participants who live in more rural areas such as Kwamhlanga or other areas in Mpumalanga probably have to walk further to obtain water and may thus

need longer to complete household chores like washing by hand leaving less time for the home programme to be carried out.

Most of the participants live in brick houses which typically consist of one or two rooms and are shared on average between 3-5 people, with some households having more than 5 people. The space for carrying out home programmes is therefore limited. From their feedback it was apparent that the caregivers found it difficult to carry out the home programme when the child was sick or due to not having adequate resources. The researcher gave the parents ideas for cost effective toys and each child was given a rattle at the start of the study. Suggestions were also given to substitute objects such as rollers which were used for two of the preparatory stretches. A lack of space at home and a possible lack of understanding of where or how the home programme could be carried out may have affected compliance of the home programme.

Research shows that compliance to home programmes is also closely linked with the ease in which the home programme can be slotted into daily routines and the flow of family activities. Therefore if caregivers have a heavy domestic load as well as a lack of resources, it may be more difficult for them to fit the home programme into their schedule (59)(79). However only 26.4% of caregivers reported that time was a problem in their feedback on the home programme.

There were no significant differences between the caregivers in the intervention and control groups in terms of employment. In both groups most of the caregivers were unemployed. Unemployment rates in South Africa have decreased slightly since 2001 but are still high, with more females (30.1%) being unemployed than males (17.1%) (94). The average unemployment rate among the caregiver participants was above average (67.9%), and for this reason they were most likely to be attending a clinic at a government hospital, which provides free healthcare. Most child participants receive therapy on a monthly basis (Figure 4.5). This is due to the fact that most families cannot afford the transport to get therapy more often. Understaffed clinics and hospitals cannot keep up with the demand for therapy and therefore can only see children once a month at the most (80). This sample of caregivers represented a group with limited resources in terms of education and socioeconomic status who access their health care in a system with limited resources in this

case resulting in this research to establish the value of including splinting which is not routinely provided in the treatment of the child participants with CP.

5.1.2 Demographics of and Interventions attended by the child participants

Ages of the child participants ranged from 18 months to 68 months with the mean age being 35 months (Table 4.2). Most of the child participants are still considered young enough for early intervention which research has shown in, children with disabilities, provides positive effects, even more so if the caregivers and families are involved (51). The incidence of cerebral palsy is higher in males than in females (1.4:1), which is supported by this study as the majority of the child participants were male (96). There were no significant differences between the child participants in the intervention and control groups at the start of the study.

Most of the child participants see the doctor regularly for medical follow-up visits. The majority also receive either occupational therapy or physiotherapy or both on a regular basis while a few of the children receive speech therapy or consult the dietician regularly (Figure 4.4). The intervention group received more therapy than the control group and also received a greater range of therapies. The only significant difference between the groups was the attendance of occupational therapy, which was significantly higher for the intervention group. As discussed, the socio-economic and background situations may have affected this.

Due to limited attendance of therapy by children in this study, the majority of which attended once a month, which is not effective in promoting a change in function the therapy included splinting for the intervention group and home programmes for both the intervention and control group (62). Research has shown that when skills are practiced in the home environment and are incorporated into everyday routines, there is a functional change which allows the skill to be generalised to other situations and thus allowing for better function (79). All caregiver participants reported that they found the home programme easy to carry out, except for one. This shows that home programmes can be beneficial in low resourced areas, even with all the above mentioned challenges taken into account.

Splinting however is a passive intervention, and the children in this study were too young to follow home programmes and therefore the splinting programme provided constant stretch to the hand when it was being worn. This was based on the principle that in a child with CP the development of grasp is starting but they generally struggle to open the hand to grasp and they also have difficulty with voluntary release of objects. The use of a neoprene thumb abductor splint was considered to be beneficial at this stage as it positions the thumb out of the palm allowing for easier grasp and release of objects (42). As positioning of the thumb and fingers improve, more active rehabilitation would be beneficial as the child participants grow older (71).

5.2 EFFECTIVENESS OF THE SPLINTING AND HOME PROGRAMMES ON THE UPPER LIMB FUNCTION OF THE CHILD PARTICIPANTS

Before the effectiveness of the splinting and home programmes could be established it was important to ensure no researcher bias occurred, because blinding was not possible as is often the case with occupational therapy research, where the researcher completes the intervention (22). The researcher and an external therapist therefore scored the QUEST on six of the same child participants. There was an excellent correlation between the scores of the researcher and the therapist for dissociated movement and total scores and a high correlation of the weight bearing subtest. There was insufficient data to correlate the protective extension subtest. The grasp subtest had a poor correlation, this was due to the fact that the external therapist used preparation techniques on the arm before testing reach and grasp and the researcher did not. It was therefore accepted that these subtests were conducted and scored fairly and without bias by the researcher.

The second objective of the study was to determine the effectiveness of a neoprene thumb abductor splint in children with CP who were following a home programme. To achieve this, the QUEST was used to measure upper limb function between the intervention and control groups, the scores of which were comparable at baseline. When considering the changes in the scores over the period of the study between the two groups there was improvement for both groups in dissociated movements with minimal change in the scores for grasps, weight bearing and the total scores for the control group (Table 4.5). There was greater improvement seen in the intervention group but the changes in this group were not

statistically significantly or as analysis with confidence intervals indicated clinically significantly greater than those in the control group.

Scores for protective extension in both groups showed deterioration over the 3 month period, this could be attributed to the fact that not all the children were assessed at baseline for protective extension, for various reasons (Figure 4.9). Another reason might be that the home programme and therapy sessions did not specifically address balance or protective reactions for the duration of the study. Another reason may be that the sample was too small to reflect changes between the groups resulting in a Type II error, or that the assessment was not sensitive enough to detect small changes which may have occurred in the child's upper limb or hand, even though there were improvements in scores.

The changes from baseline to final scores, within each group, were also not statistically significant. The improvement within the control group scores for dissociated movements, grasps, weight bearing and total scores showed no statistically significant change for any of the subtests from baseline to final assessment when the means were compared (Table 4.6; Figure 4.11). The same result was found when using confidence intervals which did not indicate a clinically significant change in scores either.

The third objective of the study was to establish the effect a neoprene thumb abductor splint has on upper limb function in children with CP. To determine if the wearing of neoprene thumb abductor splints have a lasting effect on upper limb function of children with CP both when it was on the hand and when it was removed after a home programme intervention. The difference between the baseline and final scores for the intervention group did not show statistically significant improvement in the mean scores either (Table 4.7; Figure 4.12). Confidence intervals showed there was a clinically significant change in some aspects, when participants were reassessed while wearing the neoprene thumb abductor splint ($p \leq 0.05$). This shows similar findings to a study carried out by Reid and Sochaniwskj (1992) which looked at the effect of a hand positioning splint on hand function. Their study also showed clinical changes but no statistically significant changes (22).

The effect size was established for all the subtests and total QUEST score for both groups. It is clear that the only effect size (0.72) showing a medium change in the control group was for dissociated movement. A similar change was seen in the intervention group thus

indicating that the home programme appears to have had an effect on this aspect of upper limb function although neither of these changes were clinically significant when confidence intervals were analysed. Interestingly when the participants in the intervention group were assessed with their splints on, the size effect for dissociated movement was greater than 1.00 (a change of more than 1 SD) and the confidence intervals showed a clinically significant improvement ($p \leq 0.05$). The dissociated movement subtest specifically evaluated the movement of individual joints in the upper limb and the range that the child can move through. It also evaluates the ability of the child to grasp and release a block. The splint directly influences the position of the thumb, pulling it into abduction which then allows for better finger movements which will have an effect on the grasp and release of objects. This is most likely why dissociated movements were also enhanced by the wearing of the thumb abductor splint.

This finding supports the third objective indicating the effect of the splinting on upper limb function was clinically significant as this finding was also true for grasp and weight bearing as well as the total QUEST scores for the intervention group when reassessed with their splints on. In the intervention the principle of slow stretch on the hand was to improve grasp and release (42). In the intervention group the grasp scores were much lower than those of the control group at baseline indicating that their hand function in terms of grasp and release was more affected than that of the control group (Figure 4.7). This imbalance in severity of the condition can be ascribed to the small sample size and dropout in this study. However when the grasp of the intervention group was assessed while wearing the splint the participants in the intervention group achieved a score similar to those in the control group and this subtest indicated a clinically significant ($p \leq 0.05$) improvement although the effect size was medium and did not reach 1 SD. Therefore in the intervention group reassessment with the neoprene thumb abductor splint on showed that this type of splinting is valuable in improving grasp as long as the splint is used in conjunction with hand function in activities. This is most likely due to the underlying changes that take place in the length of the muscle over time (19). More time wearing the splint provides a longer stretch to the muscles surrounding the thumb allowing for lengthening of the adductor muscles to take place. The grasp subtest tests the way in which the child grasps the object and what type of grasp they use to do so. The neoprene thumb abductor splint positions the thumb out of the palm and into abduction, thus freeing up the palm, which makes it easier for the

child to grasp and to hold objects in the hand. The type of grasp the child used differed with the splint as they tended to use a more functional grasp such as a radial palmer or digital pronate grasp when wearing the splint as opposed to a palmer or palmer supinate grasp thus improving their score for the section. The child participants were also able to grasp a greater variety of objects with the splint on.

The other subtest where clinically significant ($p \leq 0.05$) improvement was seen in the intervention group with the splint on was for weight bearing on the limb (Figure 4.8). The effect size here was over 1SD when participants were reassessed with the splint on. This is an aspect where a substantial improvement was seen in the intervention group, there was no change observed in the control group. Thus when the intervention group was assessed at the end of the study with their splints on the total QUEST score also showed a clinically significant ($p \leq 0.05$) improvement and the effect size was well over 1 SD at 1.28 confirming this result. Weight bearing subtests evaluates the position of the elbows, hands and fingers when weight bearing in different positions. Due to the soft tissue changes which occur as a result of the splint, the hand is more open allowing for a better position of the fingers and hand when weight bearing thus improving the score.

When protective extension was assessed at the end of the study with the splint on a small improvement that was not clinically significant was observed (Table 4.7). This subtest evaluates the position of the hand and elbow when the child is displaced outside of their base of support. When the splint was worn, the thumb is positioned out of the palm and the hand is less fisted. The child could probably open his fingers more easily as there is increased dissociation between the thumb and the hand. Therefore when the protective extension subtest was carried out at the end of the study with the splint on there was an improved position of the hand while wearing the splint which improved the score for this section.

The home programme is particularly beneficial in improving dissociated movements, although this is further improved by the wearing of the splint as well. However the number of participants reassessed with their splints on was very small which is of concern as not all caregivers brought the splints to the final assessment. The results of this study, while confirming that splinting the hand of the child with CP may be valuable and that when

casting or splinting is added in the intervention then outcomes improve, cannot be generalised to the CP population (62).

The third objective of the study was to establish what carryover there was, in terms of the improvement in upper limb function, when the splint was removed. Smaller effect sizes and no clinically significant difference for any subtest, except weight bearing, was found on reassessment at the end of the study. There was no significant difference in the change from baseline to the final assessment when scores between the control and intervention groups were compared. The improvement in the scores for the intervention group when they were reassessed with the splints removed was lower. This indicated that there was little carryover of the improvement when the splints were removed.

Without the splint on the change of grasp in the intervention group and the effect size was negligible. Thus the results for this subtest did not show splinting to be as beneficial as expected on reassessment with the splint off. This was probably due to the relatively short duration of the study as research shows when a joint is held in a position of stretch the number of sarcomeres in the muscle increase and results in a permanent increase in the muscle length (19). The length of the intervention probably means that permanent changes were starting to occur in muscle length but these did not yet allow the results achieved with the splint on to be achieved with the splint removed.

However this finding was not true for weight bearing where the score with the splint removed was greater. It appears that the splinting programme had a positive effect with carry over on weight bearing when the splint was removed. This is probably accounted for by the fact that the splint does not affect the weight bearing itself but due to muscular changes which occur in the hand, the position of the hand will improve the weight bearing position as a whole.

There was however no clinically significant difference in the protective extension and the total QUEST score with the effect size of change being only moderate for the intervention group. When protective extension was reassessed there was no carryover of the splint on the position of the hand when protective extension was tested without the splint. Although the subtest evaluated the position of the hand, similarly to the weight bearing subtest, protective extension required quick displacement out of their base of support. This did not

allow the child any time to adjust the position of their hand and this may explain why there was no retention of the improvement seen with the splint off. In a child with cerebral palsy righting reactions often take longer to initiate than in a normal developing child therefore the vestibular system will be activated during this time and spasticity could increase making it difficult for the child to extend his/ her arms appropriately to stop himself falling (45). Vestibular input, according to the NDT approach, is facilitatory and therefore may increase muscle tone in the trunk and limbs. This could explain why the scores decreased in both the control and intervention groups' final assessment without the splint.

It is thus clear that both the home programme and splinting were beneficial for different aspects of upper limb function. The size effects for the intervention group were larger with some clinically significant improvement especially when child participants were assessed with the neoprene thumb abductor splint on (Figure 4.12). This suggests that the participants should continue to wear their neoprene thumb abductor splints while doing functional activities, especially for the improvement of grasp as there is little carryover when the neoprene thumb abductor splint is removed at this stage. Weight bearing on the upper limb also benefits from the wearing of a splint and carryover in this aspect is positive and appears to have been retained in upper limb function once the splint is removed.

The adherence of the caregivers and child participants to the home programme and splinting regime was essential to the intervention in this study. Caregivers were asked to keep a diary to assess their compliance with the home programme given to all the participants in both the groups.

5.3 ADHERENCE TO THE HOME PROGRAMME AND IMPROVEMENT IN UPPER LIMB FUNCTION

Objective four was to establish the association between the time spent carrying out the home programme and wearing the splint and the improvement in upper limb function in the child participants. There was a mixed result with the correlation found between reported time spent in the diaries on the home programme and improvement in the subtests of the QUEST (Table 4.9). Since most of the correlations were negative these results must be considered in light of the home programme instructions and the understanding of the caregivers of and their use of the diaries.

Caregiver participants were not given any prescribed time that they had to carry out the home programme. Research shows that spending just 16 minutes per time and carrying out the home programme 17.5 times a month improves function (62). From the data collected home programmes were carried out on average 9.2 times per month for the duration of the study. It is not clear how long each session was carried out for and how accurately the caregivers filled in the diaries. It must be accepted that perhaps another way of recording adherence to the programme is needed, in a study of this nature, as feedback obtained from the caregiver participants at the end of the study indicates that the home programme was easy to follow. Caregivers reported difficulties with completing the tick off form. Another reason for the adherence for the home programme being so low could be that the adherence diaries were difficult to fill in and many caregiver participants may not have filled in all the times they did the home programme.

As indicated under treatment received, for the 14.29 % of child participants who attended LSEN schools, the home programme was most likely not carried out during the day while they were at school as it would be difficult to incorporate it into their school routine, however these children receive other therapy at school at least once a week. The home programmes were carried out in the evenings, after school for most of these child participants.

Some of the primary caregivers work during the day (32.14%), and someone else may be looking after the child during the day. The poor understanding and compliance to the home and splinting programmes may be affected by the fact that the home programme was not adequately demonstrated to whoever looks after the child during the day and therefore the carer did not feel confident enough to carry out the home programme in those times. Some caregiver participants only brought the child to the first and last session but did not attend the treatment sessions in between, due to financial reasons, which may have affected the implementation of the home programme as they had to attend the treatment sessions in order to get the next home programme and tick sheet.

It is therefore possible that they were doing the first home programme but never kept record of it as they did not have the tick sheet. This would have affected the improvement of these child participants as their home programme would have remained the same for the entire three months of the study, instead of being graded to more complex skills. Caregiver

participants would then often call other caregiver participants to get the date of the next group. It must be accepted therefore that there were too many factors affecting the use of the adherence diaries in this aspect of the study for these results to have any value, and a more accurate method should be used to record adherence in similar studies.

5.4 ADHERENCE TO THE SPLINTING PROGRAMME AND THE IMPROVEMENT IN UPPER LIMB FUNCTION

When the changes in the QUEST scores were correlated with the time wearing the splint there was a high correlation between grasps and an excellent correlation between weight bearing, protective extension and total scores with the splint on (Table 4.10). These scores reflect the results of the improvements seen over the three months of intervention for grasps and weight bearing where the splint opens the hand allowing for better grasp and release and contraction of muscles around the wrist and fingers when weight bearing on the arm. The longer the splint was worn the longer the prolonged stretch would have been applied to the muscle, increasing the length of the muscles and therefore these findings are not unexpected (19). The same reason could be attributed to the excellent correlation between the time the splint was worn and protective extension when reassessed with the splint on.

On average splints were worn for 39.9 hours per month for the duration of the study. This may be why there is a better correlation between QUEST scores and splint wearing time than home programmes (Table 4.9). It appears that recording the time the splint was worn was easier for the caregivers and this may be a more accurate reflection of adherence for the splinting programme. Many of the caregiver participants found the splint easy to apply and felt it was comfortable for the child. They could also apply the splint quickly and then carry on with their daily routine and remove it a few hours later. This may be a reason why there was better adherence to wearing the splints as it did not disrupt the daily routine as much as the home programme might have and did not require as much hands on time as the home programme. For the child participants who attended school many wore their splints to school for the entire school day while others wore the splints in the morning before school and in the afternoons and evenings after school.

Thus the wearing time for the splints has been shown to be related to the improvement in the upper limb function of the child participants in this study. This finding must be considered in recommending the splint regime and wearing time in future interventions and research.

5.5 LIMITATIONS OF THE STUDY

The intervention and adherence to the home programme was affected in this study by the external factors related to the participants, as was their attendance at monthly therapy sessions at the hospital. The socioeconomic status of the caregivers meant that follow up appointments were not kept on a regular basis. Some caregiver participants only brought the child to the first and last session but did not attend the treatment sessions in between. The dropout rate which affected the validity of the study could have been for the same reason as the families would rather spend the little income they had on necessities such as food and clothing as opposed to coming to the hospital. The researcher did try to cover the cost of transport where possible but was also on a limited budget which was inadequate to compensate for transport costs and all the trips the participants had to make. It also appears that there may be a loss of one-third of these children who should be attending therapy and who are not receiving early intervention.

The medical history of the participants was not recorded with no indication of the type of CP and although they all fell into Level II or III or IV on GMFCS and Level II, III or IV on the MACS) the level for each participant was not specified. The randomisation of the groups made this unnecessary initially but the smaller than expected number of children recruited and the dropout rate meant that differences in grasp scores in the groups may have affected this result.

The use of the QUEST assessment meant that only four factors which play a role in upper limb function were evaluated. The sensitivity of the test to assess small changes over the period of three months in a chronic condition was also brought into doubt. The test is designed for children with CP but usually reassessments are done after a longer period. The QUEST however is one of the few that has been tested and validated for use with children with CP and considers bilateral hand function (59).

Although the home programme appeared to have been explained and demonstrated at the correct level for the caregiver participants they need more support initially to gain confidence in carrying out the programme. Some caregivers that did not attend therapy on a monthly basis did not receive the grading within the programme as well as no support when they found difficulties. Therefore a different way of offering support and ensuring the caregivers are confident in carrying out the home programme or ensuring that it is taught to the person who will actually carry it out needs to be considered. Perhaps more structure in terms of time and the provision of resources would have benefitted the participants.

Aspects like wearing time for the splint were not specified in the programme and thus the time the splint was worn varied considerably. This variable should have been controlled and specified to obtain a better idea of what an ideal wearing time might be.

5.6 SUMMARY

While the splinting programme definitely shows potential to improve some of the underlying components needed for hand function it is not suitable for use with all children with CP. Some active movement should be present in order to gain maximal function from splint wearing. A thorough assessment needs to be done of the child and his/her caregiver in order to determine their living environment and daily routines. In order to use the splint to its maximum potential splinting needs to be carried out in conjunction with therapy and a home programme. Research has shown that when skills are practiced in the home environment and incorporated into an everyday routine there was a functional change which could be generalised to other situations for these participants, but adherence and regular participation which have been reported to be key to the success of a home programme was not necessarily achieved in this study (97). A better adherence to the splinting programme was reported with clinically significant improvement being seen in three of the four components of the upper limb function measured in this study.

CHAPTER 6
CONCLUSION

The aim of this study was to investigate the effectiveness of neoprene thumb abductor splints on upper limb and hand function in children with CP. This chapter will summarise the conclusions reached in relation to the objectives of this study. Recommendations for future research have also been made.

6.1 CONCLUSIONS OF OBJECTIVES

This study was able to identify numerous external and demographic factors which impacted on adherence to the splinting and home programme, the two main factors reported were a lack of time and not enough space. Other factors which were identified were a lack of resources and decreased support.

There was no statically significant or clinically significant difference between the control group and intervention group at the end of the study. However both groups showed some improvement which indicates that, the home programme has some effect on improving the underlying components related to hand function. Thus the null hypothesis that there will be no difference in the upper limb function of children with CP following a home programme, who are and are not prescribed a neoprene thumb abductor splint for a three month period, is accepted.

There was no statistically significant difference in final assessment scores, within the intervention group, with the splint and without the splint. However there was a clinically significant improvement in score when the QUEST assessment was administered with the splint on. This indicates that wearing the splint during tasks may be beneficial in improving dissociated movement, grasps and weight bearing. Thus the null hypothesis that there will be no difference in the upper limb function of children with CP at the end of a three month intervention programme when assessed with the splint on and the splint removed is rejected based on clinically significant results.

There was no correlation between hours spent on the home programme and an improvement in QUEST scores, therefore the null hypothesis that there is no association

between the hours spent on the home programme and the change in upper limb function in children with CP is accepted as true. However it is important to note that there were various factors that affected implementation of the home programme and so these results should be interpreted with caution.

There was a high correlation between hours that the splint was worn and an improvement in grasp, weight bearing, protective extension and total scores on the QUEST assessment. This indicates that there is an improvement in underlying components, contributing to hand function, when the splint is worn. Thus the null hypothesis that there is no association between the hours for which the splint is worn and the change in upper limb function in children with CP is rejected.

There is inadequate evidence to support the belief that targeting one impairment will improve function, it is important to remember that multiple factors contribute to function and therefore all these factors need to be addressed in the treatment of a child with cerebral palsy (22).

6.2 RECOMMENDATIONS FOR FUTURE RESEARCH

To repeat this study with a longer follow up period, changes which may not be visible after only three months of splint wearing, may occur over time.

Ideally the study should be done over a longer period to recruit more participants and aspects of the diagnosis may need to be considered.

It is not clear what impact the splint has on the development of hand function, this needs to be looked at in more detail by including an assessment of hand function with functional tasks in an evaluation, and not just movements of the upper limb. Another assessment should be used in conjunction with the QUEST to achieve this.

A support system via call phone is an option to provide support for caregivers that cannot attend regular therapy.

A study evaluating the exact wearing times of the splint through more accurate measurements of wearing time should be done with guidance of how long this should be.

Looking at different splinting materials, NuStim^{TM} wrap is thinner and the effectiveness of this material needs to be compared to neoprene for these young children.

Looking at each factor, dissociated movement, grasps, weight bearing and protective extension, and how it affects hand function.

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APPENDIX A

QUEST©

Quality of Upper Extremity Skills Test

Carol DeMatteo, Mary Law, Dianne Russell, Nancy Pollock, Peter Rosenbaum, Stephen Walter

Child's Name: _____ Date: _____ (year/month/day) Time of Day: _____

Evaluator: _____ Age: _____ years _____ months

Testing Conditions:

Room _____

Seating (e.g., insert) _____

Table (e.g., cutout) _____

Orthotics (e.g., splints/AFOs) _____

Others Present (e.g., parent) _____

Score Key

✔ = Yes (able to complete item according to specification)

✘ = No (can not or will not complete item)

NT = Not Tested (not able to administer item)

*If a complete section is not tested, insert **NT** in summary score*

MAKE SURE THERE IS A SCORE ENTERED IN EVERY SCORING BOX

SUMMARY SCORE (transfer from QUEST Scoring Sheet)

A:	DISSOCIATED MOVEMENTS	☐
B:	GRASPS	☐
C:	WEIGHT BEARING	☐
D:	PROTECTIVE EXTENSION	☐

$$\text{TOTAL SCORE} = \frac{\text{SUM OF SCORES FOR EACH SECTION TESTED}}{\text{TOTAL \# OF SECTIONS TESTED}}$$

$$= _____$$

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A. DISSOCIATED MOVEMENTS
Shoulder Items

Start Position: sitting in chair no table hands on lap

ITEM "SHOULDER"	SCORE L <90	SCORE L ≥90	SCORE R <90	SCORE R ≥90	CRITERIA
1. Flexion 	☐	☐	☐	☐	elbow: complete extension wrist: neutral to extension
2. Flexion with Fingers Extended 	☐	☐	☐	☐	elbow: complete extension wrist: neutral to extension
3. Abduction 	☐	☐	☐	☐	elbow: complete extension wrist: neutral to extension
4. Abduction with Fingers Extended 	☐	☐	☐	☐	elbow: complete extension wrist: neutral to extension

✔ ☐ ✘ ☐ NT ☐ 2.

A. DISSOCIATED MOVEMENTS continued
Elbow Items

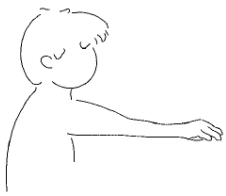
Start Position: sitting in chair no table hands on lap

ITEM "ELBOW"	SCORE L half <range	SCORE L half ≥range	SCORE R half <range	SCORE R half ≥range	CRITERIA
1. Flexion	☐	☐	☐	☐	forearm: complete supination
2. Extension	☐	☐	☐	☐	forearm: complete supination
3. Flexion	☐	☐	☐	☐	forearm: complete pronation
4. Extension	☐	☐	☐	☐	forearm: complete pronation





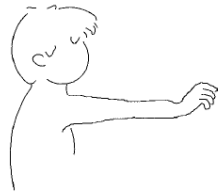




✔ ☐ ✘ ☐ NT ☐ 3.

A. DISSOCIATED MOVEMENTS continued
Wrist Items

Start Position: sitting at table forearms may be on table

ITEM "WRIST"	SCORE L half <range	SCORE L half ≥range	SCORE R half <range	SCORE R half ≥range	CRITERIA
1. Extension 	☐	☐	☐	☐	elbow: complete extension* *see manual for definition of complete extension
2. Extension 	☐	☐	☐	☐	elbow: at least 10° flexion
3. Extension 	☐	☐	☐	☐	forearm: complete pronation
4. Extension 	☐	☐	☐	☐	forearm: complete supination
5. Flexion 	☐	☐	☐	☐	forearm: complete supination

✔ ☐ ✘ ☐ NT ☐ 4.

A. DISSOCIATED MOVEMENTS continued
Finger Items

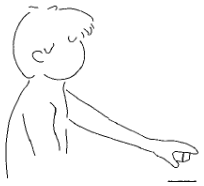
Start Position: sitting at table forearms must rest on table

ITEM	SCORE L	SCORE R	CRITERIA
1. Independent Finger Wiggling 	☐	☐	dissociation of all fingers no associated reactions
2. Independent Thumb Movement 	☐	☐	no associated reactions

Grasp of 1" Cube

Start Position: sitting at table cube at distance requiring elbow extension

Note: If Item 1 is performed, then Item 2 should also be scored YES

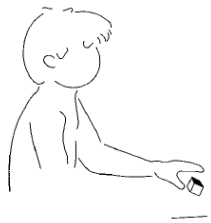
ITEM	SCORE L	SCORE R	CRITERIA
1. Grasp Using Thumb 	☐	☐	shoulder: neutral elbow: extension wrist: neutral to extension
2. Grasp Using Palm 	☐	☐	shoulder: neutral elbow: extension wrist: neutral to extension

✔ ☐ ✘ ☐ NT ☐ 5.

A. DISSOCIATED MOVEMENTS continued
Release of 1" Cube

Start Position: sitting at table cube in child's hand *

*** Allowable to put cube in child's hand if he/she can't actively grasp**
Note: If Item 1 is performed, then Item 2 should also be scored YES

ITEM	SCORE L	SCORE R	CRITERIA
1. Release from Thumb and Fingers 	☐	☐	shoulder: neutral elbow: extension wrist: neutral to extension
2. Release from Palm 	☐	☐	shoulder: neutral elbow: extension wrist: neutral to extension

✔ ☐ ✘ ☐ NT ☐

Scoring for Part A: DISSOCIATED MOVEMENTS *(pages 2-6)*

Total ✔ : ☐ = a

Total ✘ : ☐ = b

Total NT : ☐ = c

TRANSFER TO QUEST SCORING SHEET ON PAGE i

6.

B. GRASPS
Sitting Posture *during grasps*

Note: Observations for scoring this item should be made while administering the grasp items in the following section.

ITEM	SCORE	
	NORMAL	**ATYPICAL**
Head	☐	☐ Left Right Flexion Extension *circle atypical posture*
Trunk	☐	☐ Forward ☐ Lateral *check off position*
Shoulders	☐	☐ Retracted ☐ Elevated *check off position*

Scoring for Part B1: GRASPS - Sitting Posture *(page 7 only)*

Total Normal (max. = 3) : ☐ = d

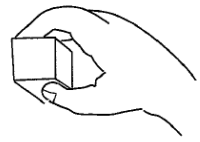
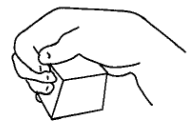
Total Atypical (max. = 5) : ☐ = e

TRANSFER TO QUEST SCORING SHEET ON PAGE **ii**

B. GRASPS continued
Grasp of 1" Cube

Start Position: sitting at table cube on table within comfortable reach

Note: Once a grasp has been performed, give a YES score for all those below it. If grasp observed is not listed, then score NO in all boxes and describe it under "Other" below.

ITEM	SCORE L	SCORE R	CRITERIA
1. Radial Digital	☐	☐	wrist: neutral to extension
			
2. Radial Palmar	☐	☐	wrist: neutral to extension
			
3. Palmar	☐	☐	
			

Other:

_____

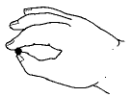
_____

✔ ☐ ✘ ☐ NT ☐ 8.

B. GRASPS continued
Grasp of Cereal

Start Position: **sitting at table**

Note: **Once a grasp has been performed, give a YES score for all those below it. If grasp observed is not listed, then score NO in all boxes and describe it under "Other" below.**

ITEM	SCORE L	SCORE R	CRITERIA
1. Fine Pincer 	☐	☐	wrist: neutral to extension
2. Pincer 	☐	☐	wrist: neutral to extension
3. Inferior Pincer 	☐	☐	
4. Scissor 	☐	☐	
5. Inferior Scissor 	☐	☐	

Other:

_____

_____

✔ ☐ ✘ ☐ NT ☐ 9.

B. GRASPS continued
Grasp of Pencil or Crayon

Start Position: **sitting at table** **pencil placed midline vertical with point facing child**

Note: **Child must pick up pencil on his/her own.**
Once a grasp has been performed, give a YES score for all those below it.

Circle one of: **L** Dominance **R** Dominance **L** Preference **R** Preference

Circle one of: grasp of **Pencil** grasp of **Crayon**

ITEM	SCORE L	SCORE R	
1. Dynamic Tripod (pencil, grasped distally - precise opposition of thumb, index & middle finger)	☐	☐	
2. Static Tripod (pencil grasped proximally - crude approximation of thumb, index & middle finger)	☐	☐	
3. Digital Pronate	☐	☐	
4. Palmar Supinate	☐	☐	

Other: _____

✔ ☐ ✘ ☐ NT ☐

Scoring for Part B: GRASPS *(pages 8-10)*

Total ✔ : ☐ = f

Total ✘ : ☐ = g

Total NT : ☐ = h

TRANSFER TO QUEST SCORING SHEET ON PAGE **ii**

10.

C. WEIGHT BEARING

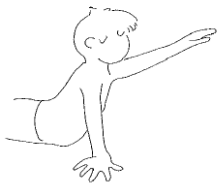
Start Position: **prone** *or* **4 point**

Note: Once a position is scored, give a YES score for all those below it

ITEM	SCORE L	SCORE R	CRITERIA
Circle test position: prone 4 point			
1. Weight Bearing			
a) elbow extended, hand open	☐	☐	Thumb must be out of palm for all weight bearing items or they are scored "NO".
b) elbow extended, fingers flexed	☐	☐	
c) elbow extended, hand fisted	☐	☐	
d) elbow flexed, hand open	☐	☐	
e) elbow flexed, fingers flexed	☐	☐	
f) elbow flexed, hand fisted	☐	☐	



ITEM	SCORE
2. Weight Bearing with Reach	
a) Bears weight on **LEFT** hand with **LEFT** elbow completely extended and reaches with other arm.	☐
b) Bears weight on **RIGHT** hand with **RIGHT** elbow completely extended and reaches with other arm.	☐



✔ ☐ ✘ ☐ NT ☐ 11.

C: WEIGHT BEARING continued
Sitting

Start position: sitting on floor preferably cross-legged

ITEM	SCORE L	SCORE R	CRITERIA
1. **Hands forward** - circle test position: cross-legged ring other _____			
 a) elbow extended, hand open	☐	☐	Thumb must be out of palm for all items.
b) elbow extended, fingers flexed	☐	☐	
c) elbow extended, hand fisted	☐	☐	
d) elbow flexed, hand open	☐	☐	
e) elbow flexed, fingers flexed	☐	☐	
f) elbow flexed, hand fisted	☐	☐	
2. **Hands by side** - circle test position: cross-legged ring other _____			
 a) elbow extended, hand open	☐	☐	Thumb must be out of palm for all items.
b) elbow extended, fingers flexed	☐	☐	
c) elbow extended, hand fisted	☐	☐	
d) elbow flexed, hand open	☐	☐	
e) elbow flexed, fingers flexed	☐	☐	
f) elbow flexed, hand fisted	☐	☐	
3. **Hands behind** - circle test position: cross-legged ring other _____			
 a) elbow extended, hand open	☐	☐	Thumb must be out of palm for all items.
b) elbow extended, fingers flexed	☐	☐	
c) elbow extended, hand fisted	☐	☐	
d) elbow flexed, hand open	☐	☐	
e) elbow flexed, fingers flexed	☐	☐	
f) elbow flexed, hand fisted	☐	☐	

✔ ☐ ✘ ☐ NT ☐

Scoring for Part C: WEIGHT BEARING *(pages 11-12)*

Total ✔ : ☐ = i

Total ✘ : ☐ = j

Total NT : ☐ = k

TRANSFER TO QUEST SCORING SHEET ON PAGE **iii**

12.

D: PROTECTIVE EXTENSION

Start position: **preferably ring sitting** *or* **kneeling**

Note: Once a position is scored, give a YES score for all those below it.

ITEM	SCORE L	SCORE R
1. **Protective Extension - Forward** - circle start position: ring sit kneeling other _____		
a) elbow extended, hand open	☐	☐
b) elbow extended, fingers flexed	☐	☐
c) elbow extended, hand fisted	☐	☐
d) elbow flexed, hand open	☐	☐
e) elbow flexed, fingers flexed	☐	☐
f) elbow flexed, hand fisted	☐	☐
2. **Protective Extension - Side** - circle start position: ring sit kneeling other _____		
a) elbow extended, hand open	☐	☐
b) elbow extended, fingers flexed	☐	☐
c) elbow extended, hand fisted	☐	☐
d) elbow flexed, hand open	☐	☐
e) elbow flexed, fingers flexed	☐	☐
f) elbow flexed, hand fisted	☐	☐
3. **Protective Extension - Backward** - circle start position: ring sit kneeling other _____		
a) elbow extended, hand open	☐	☐
b) elbow extended, fingers flexed	☐	☐
c) elbow extended, hand fisted	☐	☐
d) elbow flexed, hand open	☐	☐
e) elbow flexed, fingers flexed	☐	☐
f) elbow flexed, hand fisted	☐	☐

✔ ☐ ✘ ☐ NT ☐

Scoring for Part D: PROTECTIVE EXTENSION *(page 13 only)*

Total ✔ : ☐ = l

Total ✘ : ☐ = m

Total NT : ☐ = n

TRANSFER TO QUEST SCORING SHEET ON PAGE **iv**

E: HAND FUNCTION RATING

Please rate this child's hand function (circle a number)

Guidelines for scoring hand function:

POOR: minimal independent hand grasps, no active release, unable to combine reach and grasp
GOOD: spontaneous reach, grasp and release, good eye-hand coordination

	POOR										GOOD
Left Hand	0	1	2	3	4	5	6	7	8	9	10
Right Hand	0	1	2	3	4	5	6	7	8	9	10
Bilateral	0	1	2	3	4	5	6	7	8	9	10

F: SPASTICITY RATING

Please rate this child's spasticity

Guidelines for scoring spasticity:

MILD: good spontaneous movement, normal tone at rest, associated reactions present
MODERATE: tone interferes with spontaneous movement, may be present at rest
SEVERE: minimal spontaneous movement, stiff limbs, tone present at rest

	NONE	MILD	MODERATE	SEVERE
Left Hand	☐	☐	☐	☐
Right Hand	☐	☐	☐	☐

G: COOPERATIVENESS RATING

Please rate this child's level of cooperation during this assessment.

NOT cooperative	SOMEWHAT cooperative	VERY cooperative
☐	☐	☐

14.

QUEST *Scoring Sheet*

A. DISSOCIATED MOVEMENTS

1. Transfer score information from page 6 of QUEST.

Total ✔ = ☐ = a

Total ✘ = ☐ = b

Total NT = ☐ x 2 = c

2. Calculate unstandardized score.

$$\text{Score A} = \frac{2(a) + b}{128 - c} \times 100$$

c **a** is multiplied by 2 because each ✔ scores 2 points.

$$\text{Score A} = \frac{2(\quad) + (\quad)}{128 - (\quad)} \times 100$$

c The **128 - c** calculation adjusts the score for any items not tested.

Score A = ☐

c Round to two decimal points.

3. Obtain a standardized score ranging from zero to 100.

(Score A - 50) x 2 = (- 50) x 2 = ☐

This is the dissociated movements score and can be transferred to the front page of the QUEST.

B. GRASP

1. Transfer score information on sitting posture from page 7.

Total Normal = ☐ x 2 = d

Total Atypical = ☐ x (-1) = e

Score B1 = d + e = ☐

2. Transfer score information on grasps from page 10.

Total ✔ = ☐ = f

Total ✘ = ☐ = g

Total NT = ☐ x 2 = h

3. Calculate unstandardized score.

$$\text{Score B} = \frac{\text{Score B1} + 2(f) + g}{54 - h} \times 100$$

c The **54 - h** calculation adjusts the score for any items not tested.

$$\text{Score B} = \frac{(\quad) + 2(\quad) + (\quad)}{54 - (\quad)} \times 100$$

Score B = ☐

c Round to two decimal points.

4. Obtain a standardized score ranging from below zero (if a child scores ✘ on all items and has atypical posture) to 100.

(Score B - 50) x 2 = (- 50) x 2 = ☐

This is the grasps score and can be transferred to the front page of the QUEST.

ii.

C. WEIGHT BEARING

1. Transfer score information from page 12 of QUEST.

Total ✔ = [ ] = i

Total ✘ = [ ] = j

Total NT = [ ] x 2 = k

2. Calculate unstandardized score.

$$\text{Score C} = \frac{2(i) + j}{100 - k} \times 100$$

c The **100 - k** calculation adjusts the score for any items not tested.

$$\text{Score C} = \frac{2(\quad) + (\quad)}{100 - (\quad)} \times 100$$

Score C = [ ]

c Round to two decimal points.

3. Obtain a standardized score ranging from zero to 100.

(Score C - 50) x 2 = (- 50) x 2 = [ ]

This is the weight bearing score and can be transferred to the front page of the QUEST.

D. PROTECTIVE EXTENSION

1. Transfer score information from page 13 of QUEST.

Total ✔	= ☐		= l
Total ✘	= ☐		= m
Total NT	= ☐	x 2	= n

2. Calculate unstandardized score.

$$\text{Score D} = \frac{2(l) + m}{72 - n} \times 100$$

c The **72 - n** calculation adjusts the score for any items not tested.

$$\text{Score D} = \frac{2(\quad) + (\quad)}{72 - (\quad)} \times 100$$

Score D = ☐

c Round to two decimal points.

3. Obtain a standardized score ranging from zero to 100.

(Score D - 50) x 2 = (- 50) x 2 = ☐

This is the protective extension score and can be transferred to the front page of the QUEST.

APPENDIX B

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Miss Ashleigh Ann Hughes

CLEARANCE CERTIFICATE	M101020
PROJECT	The effect of neoprene thumb abductor splints on hand function in children with cerebral palsy
INVESTIGATORS	Miss Ashleigh Ann Hughes
DEPARTMENT	Department of Occupational Therapy
DATE CONSIDERED	29/10/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 12/15/2010 CHAIRPERSON .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Jennifer Hooper

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress report.
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

APPENDIX C

GAUTENG APPLICATION TO CONDUCT A CLINICAL TRIAL/EVALUATION

Faculty of Health Sciences Research Ethics Committee
University of Pretoria
Pretoria Academic Hospital
Tel: 012 354 1330 / 012 354 1677
Fax: 012 3541367
E Mail: manda@med.up.ac.za - Main Committee
E Mail: deepeka.behari@up.ac.za - Student Committee

31 Bophelo Road, HW Snyman South Building
Level 2 - Rooms 2.33 & 2.34
P O Box 667, Pretoria, 0001

GAUTENG HEAD OFFICE USE	
DATE RECEIVED	
PROTOCOL NUMBER	
REPORT DUE DATE	
FILE REFERENCE	

GENERAL INFORMATION AND AGREEMENT BY APPLICANT

APPLICANT: Investigator ASHLEIGH ANN HUGHES

HOSPITAL MEDICAL APPOINTEE: Investigator Name ASHLEIGH HUGHES

Designation/Rank: JUNIOR OCCUPATIONAL THERAPIST

Telephone Number: (012) 354 1665 / 3808

Fax Number: (012) 354 3810

Email address: hghash002@gmail.com

Name of Hospital: STEVE BIKO ACADEMIC HOSPITAL

Postal Address of Hospital: _____

SPONSOR FIRM:

Name of firm: N/A

Telephone Number: _____ Fax Number: _____

E-Mail address: _____

Postal Address: _____

Name of representative: _____

Designation: _____

VAT Registration Number: _____
(Must be submitted for Invoice purposes)

FULL TITLE OF CLINICAL TRIAL: THE EFFECT OF NEOPRENE THUMB ABDUCTOR SPLINTS ON HAND FUNCTION IN CHILDREN WITH CEREBRAL PALSY.

OUTLINE DETAILS OF PREVIOUS TRIALS/EVALUATIONS CONDUCTED IF ANY:

N/A

TRIAL/EVALUATION PRODUCT (S) Name the product(s) and state the mode of application(s)

NEOPRENE SPLINT - IT WILL BE APPLIED TO THE HAND.

REGISTRATION

PHARMACEUTICAL N/A

State MEDICINE CONTROL COUNCIL registration number: _____

If not registered state MCC trial approval number and attach officially approval letter.

_____

NON-PHARMACEUTICAL N/A

State registration/code number : _____

What is the estimated cost of these investigations?_____

Who will be responsible for these costs?_____

What other equipment will be required for the trial?_____

_____

What arrangements have been made for those investigations and with whom?

_____

ARE ANY SPECIAL PRECAUTIONARY MEASURES TO BE TAKEN AND BY WHOM?

_____

_____

INDICATE EXPECTED DATE OF TRIAL / EVALUATION REPORT :

DAY	MONTH	YEAR
	Jonary	2011

INDICATE NUMBER OF PATIENTS INVOLVED :

		5	0

THE NAME OF THE HEAD OF THE DEPARTMENT:

Mashudu Mphaphani

WILL SUFFICIENT TRIAL/EVALUATION MATERIAL BE SUPPLIED? (✓) Yes ✓ | No

INVESTIGATIONS

WHAT LABORATORY AND OTHER INVESTIGATIONS WILL BE REQUIRED OVER AND ABOVE THOSE NORMALLY REQUIRED.

_____

AGREEMENT BY APPLICANT

- The applicant(s) agree(s) as follows
- To conduct the trial/evaluation recorded in and under the conditions set out in this application form.
- To conduct this trial/evaluation at no additional expense to the Gauteng Department of Health whatsoever.
- To accept full responsibility for any or all-possible harmful effects on a patient using my/our/ the product recorded in his application form.
- To exonerate the Gauteng Department of Health from all liability of damages, legal,financial or otherwise, including my claim instituted by a patient using my/ our/ the product recorded in this application form, but excluding negligence on the part of the medical officer and/ or employee of the Gauteng Department of Health using the said product on the patient's concerned: provided that the medical officer and/ or employee is not the applicant.
- To inform the Superintendent General: Gauteng Department of Health and other relevant authorities should it be deemed necessary to deviate from protocol or stop this trial/ evaluation.
- To make available without delay all the results of this trial/ evaluation to the Superintendent General: Gauteng Department of Health.
- I/ We understand that the Superintendent-General: Gauteng Department of Health having allowed this trial/ evaluation to be conducted places himself or herself or the Gauteng Department of Health under no obligation whatsoever and to leave the final choice of the institution where the trial/ evaluation will be conducted to the Superintendent- General: Gauteng Department of Health.

THE APPLICANT MUST SIGN HERE

APPLICANT- INVESTIGATOR			DATE		
Signature	Initial(s)	Surname	Day	Month	Year
Hughes	A.A.	Hughes	26	08	10

Designation/ Rank: JUNIOR OCCUPATIONAL THERAPIST.

SPONSOR FIRM - IF THERE IS A FIRM INVOLVED- THEY MUST SIGN HERE

MANAGING DIRECTOR OR REPRESENTATIVE			DATE		
Signature	Initial(s)	Surname	Day	Month	Year

Designation/ Rank:

IT IS VERY IMPORTANT THAT 2 WITNESSES MUST SIGN IF A FIRM IS INVOLVED!

WITNESSES			DATE		
Signature	Initial(s)	Surname	Day	Month	Year
1.					
2.					

INITIAL CONSENT BY DEPARTMENTAL HEAD

I MASHUDU MPHOHONI head of OCCUPATIONAL THERAPY department of STEVE BIKO ACADEMIC hospital in consultation with the Chief Executive Officer / Superintendent of this Hospital grant permission to submit an application to conduct a clinical trial/evaluation to the Chairperson (s) of the relevant Ethics, Research and Therapeutic Committees of this Hospital.

The officer conducting the trial/evaluation will be AA Hughes

Designation / Rank OCCUPATIONAL THERAPIST

THE HEAD OF THE DEPARTMENT MUST SIGN HERE!

HEAD OF DEPARTMENT			DATE		
Signature	Initial(s)	Surname	Day	Month	Year
	M.R.	MPHOHONI	27	08	2010

THE APPLICANT MUST SIGN HERE

TRIALIST-INVESTIGATOR			DATE		
Signature	Initial(s)	Surname	Day	Month	Year
	A.A.H	HUGHES	26	08	'10

THE APPLICANT THAT APPLY FOR THIS STUDY MUST SEE TO IT THAT THE SUPERINTENDENT / C.E.O. OF THE HOSPITAL WHERE THE STUDY WILL BE DONE - SIGN HERE BEFORE THE ETHICAL COMMITTEE RECEIVE THIS APPLICATION FORM.

APPROVAL BY HOSPITAL CHIEF EXECUTIVE OFFICER:

I DL H TANNA Chief Executive Officer / superintendent of Steve Biko Academic Hospital, hereby agree that this trial / evaluation be conducted in the Occupational Therapy Department of this hospital.

The officer conducting the trial will be : (M.R. MPHOHONI) AA. H. Hughes (Head of Dept.)

The officer controlling supplies will be: _____

HOSPITAL C.E.O. / Superintendent			DATE		
Signature	Initial(s)	Surname	Day	Month	Year
Hanna	H.	TANNA	30	8	2010

APPENDIX D

Caregiver Information Sheet 1

Good Day,

My name is Ashleigh Hughes; I am currently busy with my masters in Occupational Therapy (Neurosciences) at the School of Therapeutic Science, University of the Witwatersrand. I would like to invite you to consider participating in a voluntary research study, which is looking at the Effect of Neoprene Thumb Abductor Splints on Hand Function in Children with Cerebral Palsy.

WHY ARE WE DOING THIS?

Research in this field has shown very mixed results, and therefore I would like to see if wearing a splint is a successful way of treating hand function in children with cerebral palsy. Other therapists will then be able to use this study's outcome as guide to future treatment.

WHAT DO WE EXPECT FROM THE PARTICIPANTS IN THE STUDY?

Some studies have shown that splints are able to improve hand function in children with Cerebral Palsy, while other studies have shown that it does not. I would like to see if the use of a splint can make the hand work better. I will select a group of participants all with the same medical problem and level of function.

If you decide to participate in this study, your involvement will last approximately 4 Months. In these 4 months the participants will be required to continue with their regular therapy sessions that they currently are receiving at their local clinic/hospital. In addition to their normal routine therapy I as the principal researcher and therapist would like to see the participants only 4 times, once at the beginning of the study for an assessment, and thereafter once a month for a therapy session.

Both the groups will be assessed at the beginning of the study and then again at the end of the 4 months, the assessments will be videotaped and marked by another therapist. The child's face will be blocked out in the video so that the child can not be identified. I will then compare the results from both tests for each child to see if there is improvement or not.

As part of the above study it is required that the caregivers of each child fill in a questionnaire. The reason for this is so that we can get some information about your family, your home and your work. This will help us to link the findings together and to find factors which may lead to better results.

WHAT DO WE EXPECT FROM THE CAREGIVERS OF THE PARTICIPANTS?

You will have to answer some questions for me. Some of these questions may be personal, if you do not want to answer them you may leave them out. All questionnaires will be kept confidential and will be coded so only I will know whom the questionnaire belongs to. The questionnaire will take about 20 minutes for you to complete.

ARE THERE BENEFITS TO THE PARTICIPANTS?

There will be no direct benefits to you for taking part in the study. This research may help us to understand if splints are useful in improving hand function in children cerebral palsy and will enable therapists to make better decisions regarding future treatment. The research may help with the treatment of future patients who have the same problem as your child.

ARE THERE RISKS TO THE PARTICIPANTS?

There is a risk for participants to develop pressure points if the splint is not put on properly. Normal precautions will be taken to make sure this does not happen. You, the caregiver will also be shown what to look out for and if you are concerned you may contact the researcher for a check up.

MAY I WITHDRAW MYSELF OR MY CHILD FROM THE STUDY?

Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you do not take part in the study, there will be no penalty. You are also allowed to stop your child taking part in the study at anytime, this will not have any impact on the current treatment/therapy your child receives.

WHAT ABOUT CONFIDENTIALITY?

You and your child's details will be kept private. A code will be used instead of names on all results. Only I will have a list of names and codes to enable the code to be linked to a particular child. This list will be kept locked in an office.

If you have any queries or concerns you may contact Professor Keaton-Jones, at the Human Research Ethics Committee on (011) 717-1234.

If you are happy to allow your child to take part in the study, please read and sign the attached consent form.

Thank you

Ashleigh Hughes

CONSENT FORM

I have read each page of this paper about the study (or it was read to me). I understand what the study involves. I know that being in this study is voluntary and I choose to allow my child to be part of this study. I know I can stop my child being part of this study without penalty. I will get a copy of this consent form now and can get information on results of the study later if I wish.

I, _____(your name), give permission for myself, _____(your name) and my child, _____(child's name) to take part in the following study: The Effect of Neoprene Thumb Abductor Splints on Hand Function in Children with Cerebral Palsy.

I understand that I am required to attend 4 therapy appointments at Steve Biko Academic Hospital and that I can withdraw from the study at any point should I wish to do so.

Caregivers signature: _____ Date: _____

Researcher's name: _____

Researchers signature: _____ Date: _____

Witness 1 name: _____

Witness 1 signature: _____ Date: _____

APPENDIX E

Child Participant Information Sheet

Good Day,

My name is Ashleigh Hughes, I would like to know how I can help you to use your hand better. I have made a splint which is like a glove that goes on your hand, I want to see if you can pick up toys better when you wear the splint.

WHY ARE WE DOING THIS?

I would like to see if wearing a soft splint will allow you to use your hand better when you are doing things like playing, eating and at school.

WHAT DO YOU HAVE TO DO?

You will have to come to the hospital sometimes to do some exercises for your hand. This will be done 4 times. You will also be given some exercises to do at home, it is important that you try doing these.

CAN IT HURT YOU?

The splint is not supposed to hurt you so if it does you need to tell me so that I can fix it and make sure it fits you better.

MAY YOU STOP WEARING THE SPLINT?

If at any time you do not want to wear the splint anymore you are allowed to stop taking part in the study. Your other therapy will not stop if you stop wearing the splint.

WHAT ABOUT CONFIDENTIALITY?

You will get a special number and no one will know what your name is or what you look like, only me.

APPENDIX F

Caregiver questionnaire

How to fill in the questionnaire:

* Please draw a cross in the box next to the choice which applies best to you or your child
* You may cross more than one box
* Please fill in details where it is marked “please specify”
* Please try to answer every question
* If there is any other information that you feel is important, please write it at the end of the questionnaire under the “comments” section

Subject Code:_____

Date of interview:_____

FAMILY INFORMATION:

1. Are you the primary caregiver of the child with Cerebral Palsy (CP)?

1.1	Yes	
1.2	No	

2. How are you related to the child?

2.1	Mother	
2.2	Father	
2.3	Grandparent	
2.4	Sibling	
2.5	Sibling of a parent	
2.6	Other: Please specify	

3. If the biological mother of the child is not the primary caregiver, why not?

3.1	Mother passed away	
3.2	Mother works	
3.3	Mother is at school	
3.4	Mother disappeared	
3.5	Mother is sick	
3.6	Other: Please specify	

4. How old are you?

4.1	20-30 years	
4.2	30-40 years	
4.3	40-50 years	
4.4	50-60 years	
4.5	60-70 years	
4.6	Younger than 20 years	
4.7	Older than 70 years	

5. Your gender?

5.1	Male	
5.2	Female	

6. To which group do you and your family belong?

6.1	White	
6.2	Black	
6.3	Mixed race/ Coloured	
6.4	Indian	
6.5	Other: please specify	

7. What language do you speak at home?

7.1	English	
7.2	Afrikaans	
7.3	Zulu	
7.4	Sotho	
7.5	Sepedi	
7.6	Other: Please specify	

8. What other languages do you speak/understand?

8.1	English	
8.2	Afrikaans	
8.3	Zulu	
8.4	Sotho	
8.5	Sepedi	
8.6	Other: Please specify	

9. Where do the child and his/her caregiver live?

Suburb:_____

Town:_____

10. What type of house do the child and caregiver live in?

10.1	Informal housing	
10.2	RDP house	
10.3	Brick house	
10.4	Other: Please specify	

11. How many rooms does the house have? _____

12. How many people live in the house? _____

13. How many people living at home are:

13.1	18 years or older, please specify:	
13.2	6 to 18 years, please specify:	
13.3	Younger than 6 years, please specify:	

14. What is your highest level of education?

14.1	Less than grade 7 (std 5)	
14.2	Grade 7 – 10 (std 5 to std 8)	
14.3	Grade 12 (matric)	
14.4	College or Technikon	
14.5	University (Undergraduate)	
14.6	Other: Please specify	

15. Are you currently working?

15.1	Yes, full time	
15.2	Yes, part time	
15.3	Yes, piece jobs	
15.4	No	

16. What is your occupation?_____

17. What is the primary breadwinner's occupation?_____

18. What is the family's average income per month?

18.1	Less than R1000/month	
18.2	R1000 – R5000/month	
18.3	R5000 – R10 000/month	
18.4	Over R10 000/month	
18.5	No regular income	
18.6	I don't know	

19. What does your family's income consist of?

19.1	Salary/ wages from working	
19.2	Pension	
19.3	Child grant	
19.4	Disability grant	
19.5	No income	
19.6	Other: Please specify	

INFORMATION ABOUT YOUR CHILD:

20. How old is your child? _____

21. What is the gender of your child?

21.1	Male	
21.2	Female	

22. Which health professionals does your child see regularly?

22.1	Doctor	
22.2	Dietician	
22.3	Occupational therapist	
22.4	Physiotherapist	
22.5	Speech therapist	
22.6	Traditional healer	
22.7	Other: Please specify	

23. If your child attends therapy, how often does he/ she go?

23.1	Once a week	
23.2	Once every two weeks	
23.3	Once a month	
23.4	More than once a week	
23.5	Less than once a month	

24. Did someone explain your child's diagnosis to you?

24.1	Yes	
24.2	No	
24.3	I don't remember	

25. Do you understand your child's diagnosis?

25.1	Yes	
25.2	No	

26. Do you feel you receive adequate support regarding your child?

26.1	Yes	
26.2	No	

Is there any other information which you would like to share about you or your child?

Thank you for taking the time to fill out the questionnaire, your participation is appreciated.

APPENDIX G

THERAPY SESSIONS

Please mark each time you attend therapy at your local clinic.

	1	2	3	4	5	6	7	8
January								
February								
March								
April								

Please tick the appropriate box for each hour your child has the splint on during the day.

WEEK 1	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
Monday /01/2011												
Tuesday /01/2011												
Wednesday /01/2011												
Thursday /01/2011												
Friday /01/2011												
Saturday /01/2011												
Sunday /01/2011												

Please tick the appropriate boxes for when the home programme was carried out.

Week 1	Morning	Afternoon	Evening
Monday /01/2010			
Tuesday /01/2010			
Wednesday /01/2010			
Thursday /01/2010			
Friday /01/2010			
Saturday /01/2010			
Sunday /01/2010			

APPENDIX H

POST STUDY QUESTIONNAIRE (CONTROL GROUP)

1. Did you find it easy to carry out the home programme?

   _____

   _____

2. What made it easy to do the exercises?

   _____

   _____

   _____

3. What made it difficult to do the exercises?

   _____

   _____

   _____

4. Did you notice any change in your child over the last 3 months and what did you see?

   _____

   _____

   _____

5. Is there anything else you would like us to know?

   _____

   _____

   _____

POST STUDY QUESTIONNAIRE (INTERVENTION)

1. Did you find it easy to carry out the home programme?

   _____

   _____

2. What made it easy to do the exercises?

   _____

   _____

   _____

3. What made it difficult to do the exercises?

   _____

   _____

   _____

4. Did you find it easy to use the splint?

   _____

   _____

   _____

5. What made it easy use the splint?

   _____

   _____

   _____

6. What made it difficult to use the splint?

   _____

   _____

   _____

7. Did you notice any change in your child over the last 3 months and what did you see?

   _____

   _____

   _____

8. Is there anything else you would like us to know?

   _____

   _____

   _____

Compiled by Ashleigh Hughes

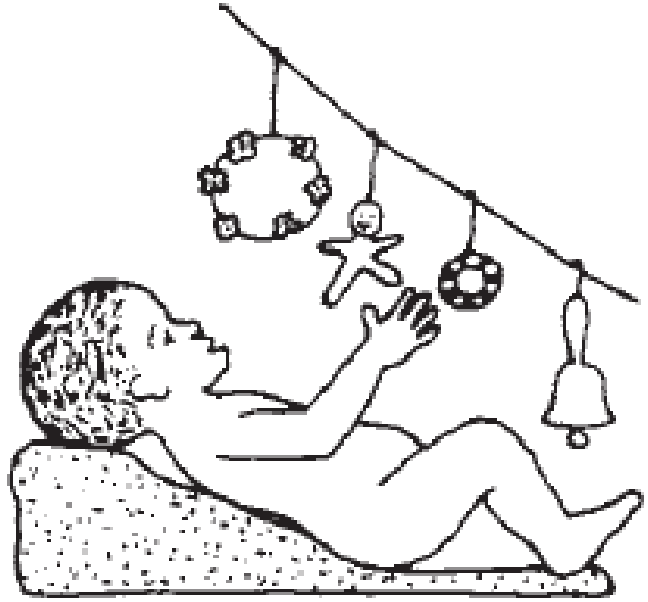
Pictures from Disabled Village Children

By David Werner

APPENDIX I

HOME PROGRAMME 1

HAND FUNCTION



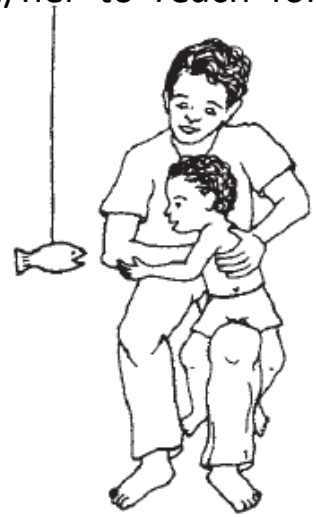
First help your child to relax, move his/her legs from side to side.



You can curl the child up in a ball and slowly roll his hips and legs up and down and side to side.



You can twist his/her body to one side and then the other. Help him/her to reach for something they like.



- Help your child to hold their own bottle or cup and then help them move it to their mouth.
- Let you child help to feed himself/herself by helping them to hold the spoon and moving it to their mouth.
- Let your child help wash themselves by putting the cloth in their hand and help move it over their body.
- Remember try and let your child take part in as many activities around the house as they can.

Teach your child to hold objects by placing them in the hand and bending his/her fingers around it. Make sure the thumb is opposite the fingers.



Slowly let go of his/her hand and move the object against the fingers.



When you think the child is holding the object let go and see if they can keep it there. Try in both hands.

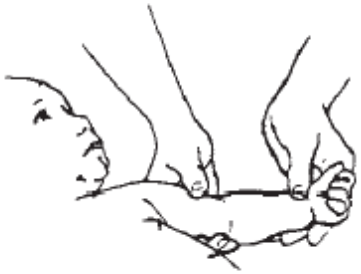


SHOULDER: Arm up and down



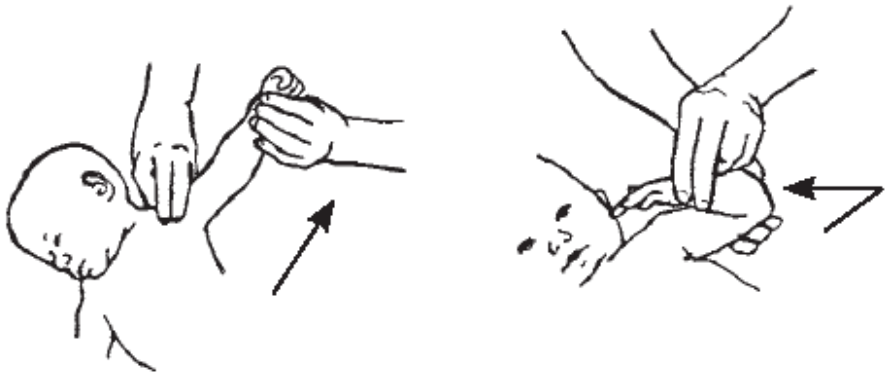


SHOULDER: Arm back and forward





ELBOW: Straighten and bend



Straighten the arm out from the side,

then bend the elbow to bring hand up to shoulder.

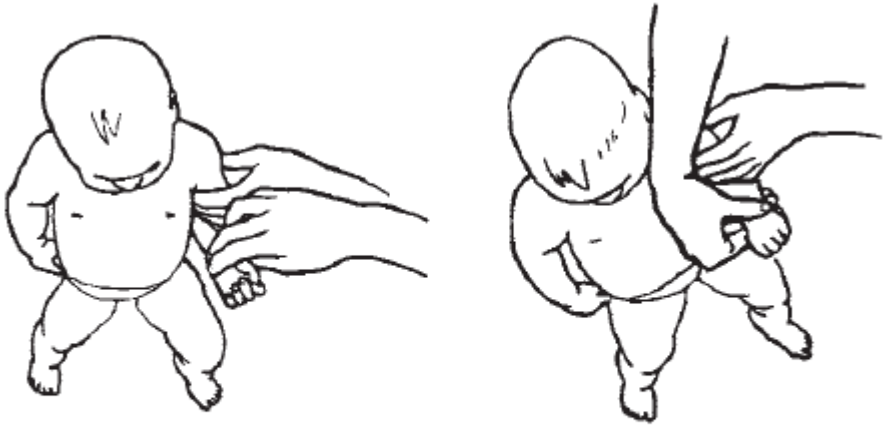
FINGERS: Open and close



Make a fist.

Straighten gently.

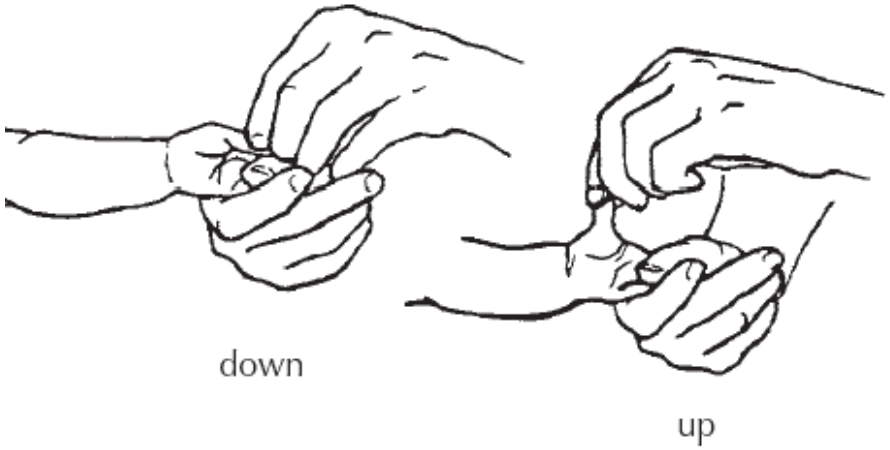
FORARM: Twist



Holding the wrist twist the hand up,

and then twist it down (gently).

THUMB: Up and Down



Move straightened thumb down and then up, with palm flat and fingers open.

HOME PROGRAMME 2

HAND FUNCTION



Compiled by Ashleigh Hughes

Pictures from Disabled Village Children

By David Werner

To help your child's balance, sit them on your knees facing you. Slowly lift one knee up. The child will now lean to one side.



Then put the first leg down and lift the other leg up so that the child leans to the other side. This will teach the child to bend their body while staying seated.

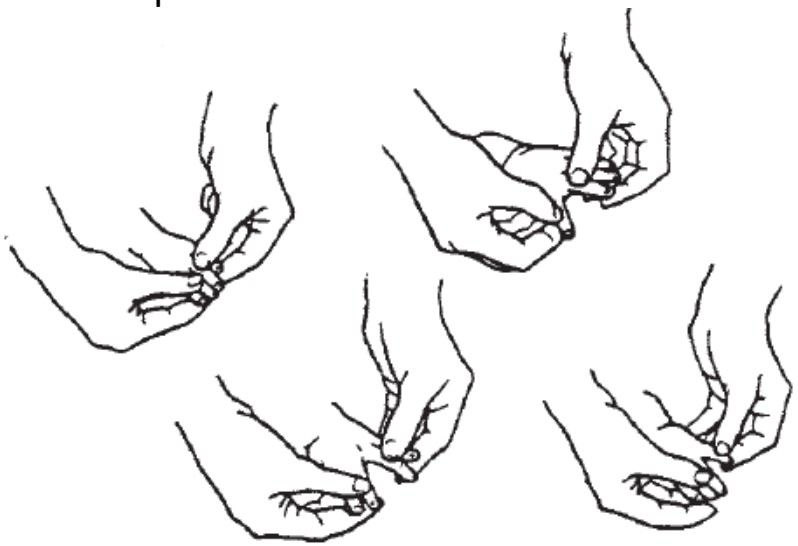


You can change the child's position later to make it



- REMEMBER try and let your child take part in as many activities around the house as they can.
- Put the cloth in their hand and help them to wipe the table after eating
- Help the child to hold their toothbrush and brush their teeth
- Let the child try and stir soft mixtures in a bowl.
- Help the child to reach for and hold objects e.g.: cup, spoon, toys

FINGERS: Spread



Spread each finger one at a time.

THUMB: Open and close



Bend the joints of the thumb in all the way,



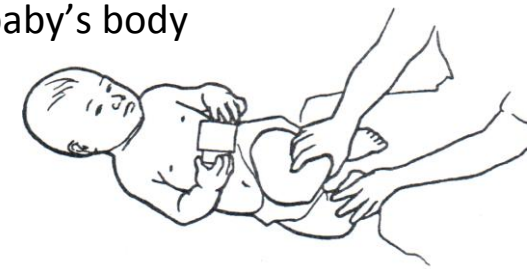
then open thumb all the way to the side.

We are going to teach the child to start rolling over by themselves. First bend the knee of one leg.



Step 1

While keeping the other leg straight,
Roll bent leg over baby's body



Step 2



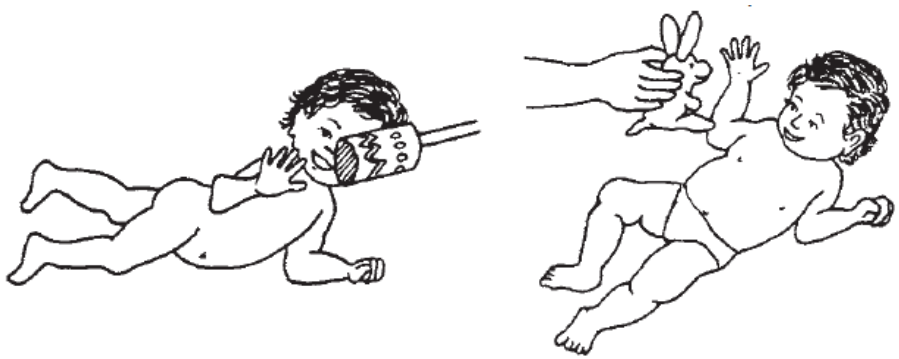
Step 3

Assist baby into tummy lying



Step 4

When the child is on their tummy encourage them to reach for objects to the side of them this will help them to roll over onto their back.



Also let them play lots on their tummy, this will help them to have better head control. Try getting them to push up on straight arms.



If it is difficult for your child to lift their head, you can put a rolled up towel under their arms to help them.

WRIST: Up and down



Bend wrist back,

and then forward.

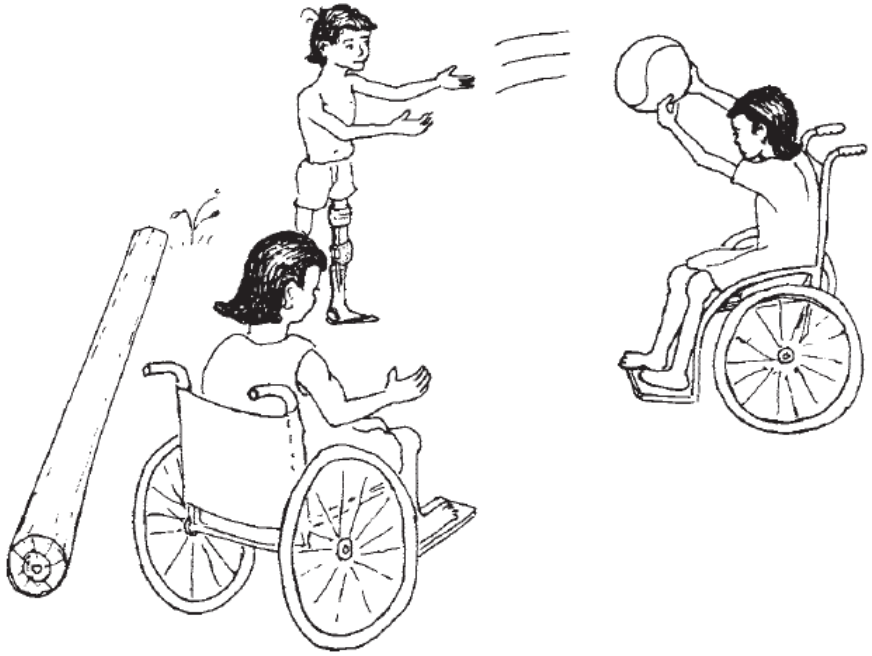
WRIST: Side to side



Bend to outside.

Bend to thumb side. (It will not bend very far to thumb side. Do not force.)

HOME PROGRAMME 3
HAND FUNCTION

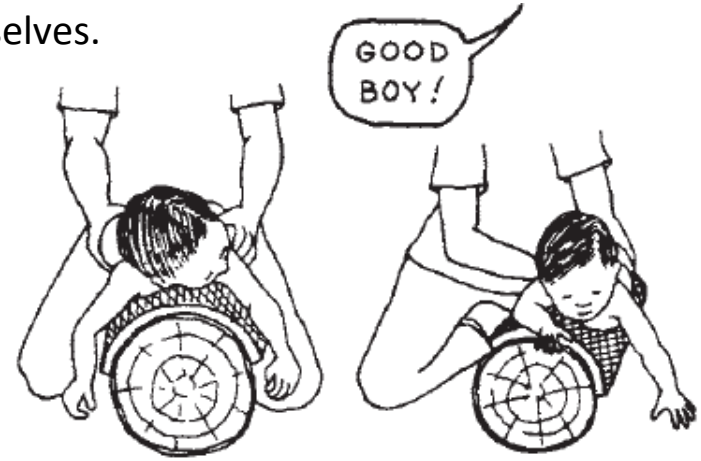


Compiled by Ashleigh Hughes

Pictures from Disabled Village Children

By David Werner

Teach your child to put their arms out when they start falling over. First start in lying over a log, hold his hips and slowly roll them sideways. Help the child to put their hand out and then let them try themselves.

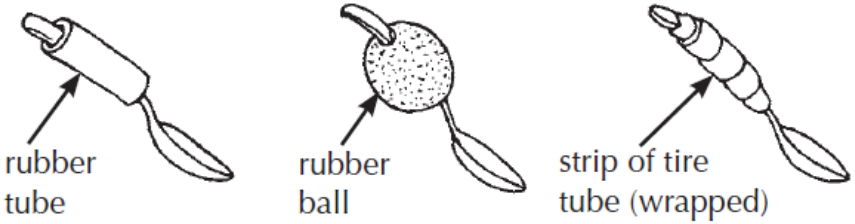


Try this in sitting, hold the child's hips and gently move him/ her to the side.

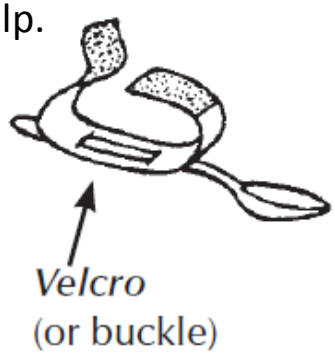


Later you can try this in other positions like on a ball

If it is difficult for a child to hold an object, try and change to grip. You can make it bigger by using foam, bandages or rubber.

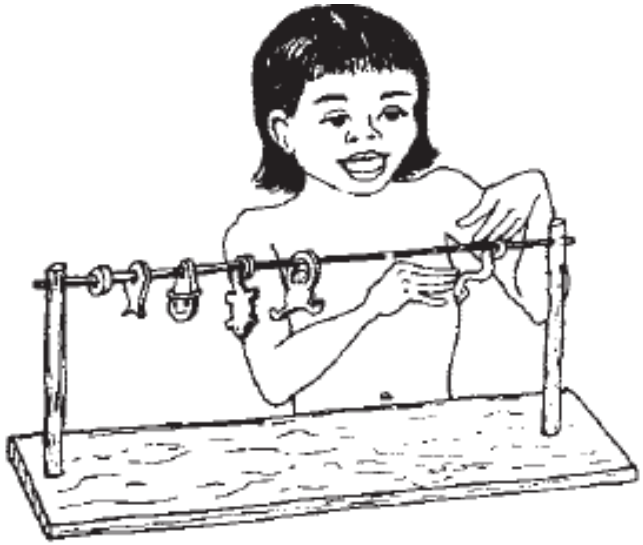


You can even use Velcro to make a strap to fit around your child's hand so that they can hold the object with help.

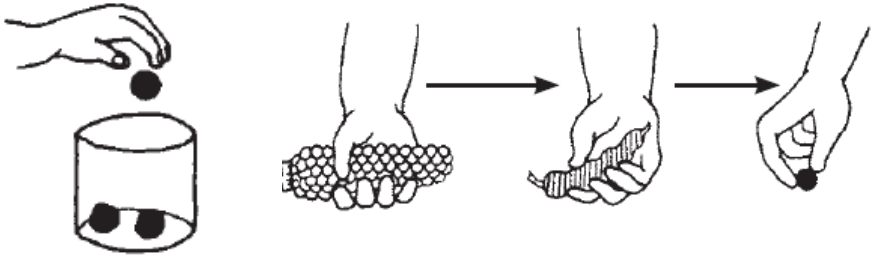


- REMEMBER try and let your child take part in as many activities around the house as they can.

Let your child move the objects along the rope, this will help with grasp and arm movement.



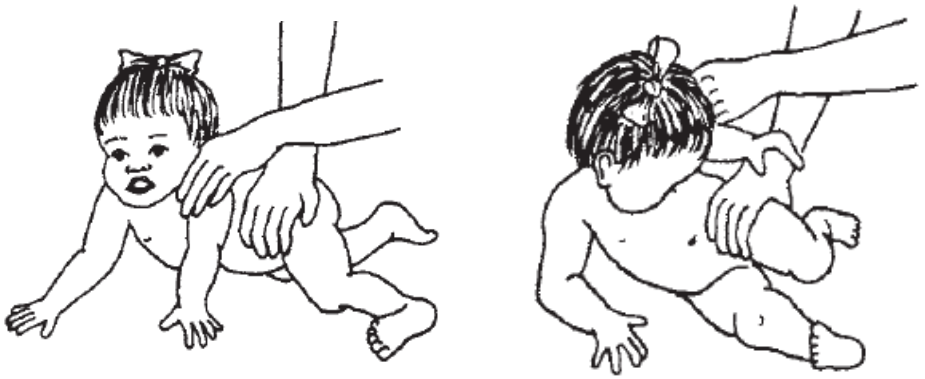
Help your child to put objects into a container and take them out again.



Let you child pick up objects that are different sizes and shapes to develop better hand function

We are going to teach the child to start sitting up by themselves. You can either help them from their back or their tummy.

First get them onto their side them push down on the top hip, bringing in backwards.



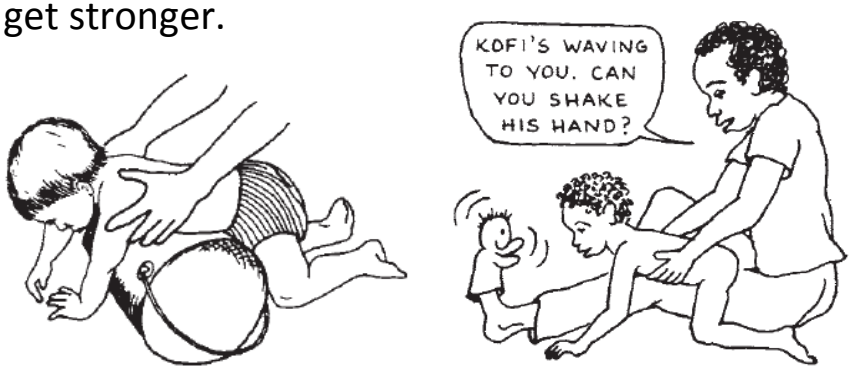
While doing this help the child to push up onto their arm. The more they do this the less you need to help them.



You also want to encourage your child to move when they are on their tummy. Do this by putting toys a little bit further away. You can also push their feet a little to teach your child to move their legs.

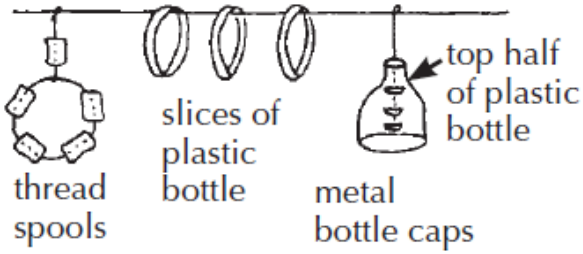


You want them to try crawling on their arms and legs. If they are struggling to stay up you can put them over your leg or a log till their arms and legs get stronger.

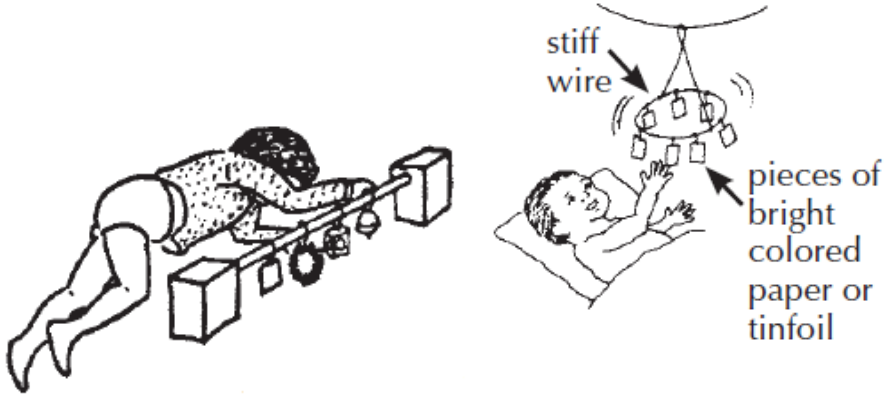


Push down gently on their shoulders to make the arms stronger

We want the child to experience different textures, things that are hard, soft, smooth and rough.



Hang different materials on a rope in front of your child, encourage them to reach for the objects.



Have some objects which make noises as they touch them. This will encourage reaching.