

**PRESENTATION AND TREATMENT MODALITIES OF FOOT AND  
ANKLE DEFORMITIES AMONG PEDIATRIC PATIENTS WITH  
CEREBRAL PALSY ATTENDING CLINIC AT MUHIMBILI  
NATIONAL HOSPITAL AND MUHIMBILI ORTHOPEDIC INSTITUTE**

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**Presentation and Treatment Modalities of Foot and Ankle Deformities among Pediatric Patients with Cerebral Palsy Attending Clinic at Muhimbili National Hospital and Muhimbili Orthopedic Institute**

**By**

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**A dissertation submitted in partial fulfillment for the degree of Masters of Medicine in Orthopedics and Traumatology of the Muhimbili University of Health and Allied Sciences**

**October 2021.**

**CERTIFICATION**

The undersigned certifies that, he has read and hereby recommends for examination by Muhimbili University of Health and Allied Sciences a dissertation entitled: “ **Presentation and treatment modalities of foot and ankle deformities among pediatric patients with cerebral palsy attending clinic at Muhimbili National Hospital and Muhimbili Orthopedic Institute.**” in partial fulfillment of the requirements for the degree of Master of Medicine in Orthopedic and Traumatology of Muhimbili University of Health and Allied Sciences.

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**DR. SAMUEL SWAI**

(Supervisor)

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**Date**

## DECLARATION AND COPYRIGHT

I, **Siime Allen Rukoijo** declare that this, **dissertation** is my own original work and has not been submitted for a similar degree in any other University.

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## **ACKNONWLEGEMENT**

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## **DEDICATION**

I humbly dedicate this work to all the children with physical and mental disabilities, their ever supporting families and friends

This work is also dedicated to my parents Mr. and Mrs. Rukoiyo and to my siblings for their support and unfailing devotion.

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**ABBREVIATIONS**

AFO	Ankle Foot Orthosis
CP	Cerebral Palsy
GMFCS	Gross Motor Function Classification System
GMFM	Gross Motor Function Measure
ICIDH	International Classification of Impairment Disabilities and Handicap
MNH	Muhimbili National Hospital
MOI	Muhimbili Orthopedic Institute
TORCHES	Toxoplasmosis, Rubella, Cytomegalovirus and Herpes Simplex
WHO	World Health Organization
SPSS	Statistical Package for the Social Sciences

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## DEFINITION OF TERMS

- 1) **Spasticity**: This is a condition in which muscles stiffen or tighten, preventing normal fluid movement, usually affecting movement, gait and speech.
- 2) **Rigidity**: This is the inability to bend or be forced out of shape.
- 3) **Orthosis**: a support, brace or splint used to help in the support, align or support a function of the movable part of the body.
- 4) **Orthotics**: This is medical specialty that focuses on the design and application of orthoses.
- 5) **Deformity**: This is an abnormality of the shape of the body part or organ compared to the normal shape of that part.
- 6) **Physical therapy**: Alternatively known as physiotherapy is the treatment of injury, disease or pain by physical method such as exercise, message, manipulation of muscles and joints, electrotherapy and other modalities.
- 7) **Rhizotomy**: Also known as selective dorsal Rhizotomy is a neurosurgical procedure that selectively destroys problematic nerve roots in the spinal cord to relieve negative symptoms of neuromuscular conditions such as spasticity.
- 8) **Osteotomy**: This is a surgical procedure whereby a bone is cut to shorten, lengthen or change its alignment.
- 9) **Toe walking**: This is the pattern of walking in which a child walks on balls of his/her toes with no contact between heels and the ground.
- 10) **Equinus**: This is a condition in which the upward bending motion of the ankle joint is limited. Lack of flexibility to bring toes close to the leg.
- 11) **Planovalgus**: This is a variant foot and ankle deformity consisting of decrease in the medial longitudinal arch and a valgus hind foot and forefoot abduction with weight bearing.
- 12) **Hallux Valgus**: This is progressive foot in which the first metatarsophalangeal joint is affected and is often accompanied by significant function disability and foot pain.

- 13) **Equinocavovarus:** This is the foot deformity characterized by cavus, plantarflexion of the 1<sup>st</sup> ray, hind foot Varus and forefoot adduction.
- 14) **Arthrodesis:** This is a surgical immobilization of joint by fusion by bones.

## ABSTRACT

Foot and ankle deformities are among the common deformities that affect children with cerebral palsy, the variations of the deformities varies greatly in the type and severity among cerebral palsy patients that leads to the various treatment modalities individualized to best fit the patient being treated. There is currently a lack of empirical data with regard to the prevalence and distributions of these deformities and therefore difficult to establish a unified treatment protocol.

This study explores current treatment modalities of foot and ankle deformities and aim to guide clinicians to make informed decisions on the best treatment plans.

**Objective:** To determine clinical profile and treatment modalities of foot and ankle deformities among pediatric patients with cerebral palsy attending clinic at MNH and MOI.

**Study Design:** It is a prospective descriptive cross-sectional study.

**Material and Method:** 196 patients were recruited for the study from cerebral palsy clinics at MNH and MOI after ethical clearance has been given by the governing bodies. Patients were given a verbal and written informed consent. These patients were there interviewed using a guided questionnaire and further examined for foot and ankle deformities

**Results:** 201 patients were recruited for the study, Foot and ankle deformities were found in 119(59.2%) of the patients recruited, the majority of the deformity was Equinus accounting for 42.86%. Treatment were either surgical or non-operative.

**Conclusion:** The management of Cerebral Palsy patients require a multidisciplinary approach, orthopedic surgery plays a key role in the management of musculoskeletal deformities.

## 1. INTRODUCTION

Cerebral Palsy is a neurological disorder caused by a non-progressive brain injury or malformation that occurs to an immature brain while under development up to the age of 2years, Cerebral Palsy is a common neurologic problem in children and is reported as occurring in approximately 2-2.5 of 1000 live births globally (1).

Orthopedic manifestation of cerebral palsy includes contractures and spasticity, fractures, extremity deformities, spinal deformity, foot deformity and gait disorders.

The diagnosis of Cerebral Palsy can currently be done before the age of 6months due to the medical advances, (5). Most children with Cerebral Palsy are typically diagnosed before the age of 2years during routine visits to clinic (6),(7). The assessment of growth and development, muscle tone, control of movement, hearing and vision, posture, coordination and balance may lead to a high index of suspicion to the diagnosis of Cerebral Palsy, further brain scanning can be done to assist in diagnosis including, brain ultrasound, computed tomography, magnetic resonance imaging and electroencephalogram. (6)(7).

The treatment of foot and ankle deformities in cerebral palsy focuses on the management of the sequel of the disease and prevention of musculoskeletal progression of spasticity and deformity. Non operative treatment includes physical therapy, orthotics/bracing and medications for spasticity, operative management includes soft tissue release procedures, selective dorsal Rhizotomy and osseous procedures for deformity correction. (8)

Conservative management of foot and ankle deformities includes repeated stretching of muscles. This process is done repeatedly over time to increase the muscle and tendon length to help reduce spasticity in the foot and ankle deformities. Strap orthosis can be made to fit specific foot deformities and help overall gait and strength of the foot over time (9). The use of Ankle Foot Orthosis (AFO) in stretching as part of treatment for ankle and foot deformities has been done in majority of cases and about 75% of them show significant improvement ( 10).

Injection of Botulinum toxin A (Botox) is used to relieve pain that is mostly caused by spasticity, more than half the patients reported less pain and decrease use of other oral

analgesics after Botox injections, orthosis that cause pain that is too much to bear during treatment can be supplemented by injection of Botox (11)

Operative treatment options for foot and ankle deformities in children with cerebral palsy aims to correct specific defect by bone and soft tissue surgeries. Depending on the deformity type and severity treatment options can be soft tissue procedures like Tendo-Achilles lengthening or skeletal procedures like first metatarsophalangeal joint arthrodesis, proximal phalanx (Akin osteotomy). (25)

This study intends to determine the clinical profile and treatment modalities of the foot and ankle deformities among patients with cerebral palsy attending clinic at MNH and MOI

## **1.1 PROBLEM STATEMENT**

Optimum management of foot and ankle deformities in cerebral palsy patients is essential for their improvement and adaptation to a better functioning quality of life, however optimum management options are not usually explored and handled to the best available treatments because of the current lack of multidisciplinary approach in the management of these patients. Involvement of pediatric orthopedic surgeons among other subspecialties to the treatment will help identify these musculoskeletal deformities early and assist in setting a proper and timely course of management of foot and ankle deformities as well as open up new treatment modalities which could result to a better functioning quality of life.

## **1.2 RATIONALE**

This study will help to explore the treatment options of foot and ankle deformities for patients with cerebral palsy, it will also help identify the current burden of foot and ankle deformities among the cerebral palsy patients and the proportion of them that require operative management.

## **1.3 RESEARCH QUESTIONS**

- 1) What are the treatment options for foot and ankle deformities among pediatric cerebral palsy patients at MNH and MOI?
- 2) What are the benefits of a multidisciplinary approach to the treatment of foot and ankle deformities among cerebral palsy patients?

## **1.4 OBJECTIVES**

### **1.4.1 BROAD OBJECTIVE**

To assess the clinical profiles and treatment modalities of foot and ankle deformities among pediatric patients attending clinic at Muhimbili National Hospital and MOI



#### **1.4.2 SPECIFIC OBJECTIVES**

- 1) To determine the proportion of foot and ankle deformities among patients with Cerebral Palsy attending clinic at the Muhimbili National Hospital.
- 2) To determine the pattern of foot and ankle deformities among patients with cerebral palsy attending clinic at Muhimbili national hospital.
- 3) To determine the proportion of cerebral palsy patients with foot and ankle deformities that require operative management.
- 4) To determine the different treatment modalities for foot and ankle deformities among patients with cerebral palsy attending clinic at Muhimbili National Hospital.

## 1.5 LITERATURE REVIEW

The global prevalence of cerebral palsy has been documented to be between 2-2.5 up to 3 per 1000 live births (1), (14). It is believed that an insult to the brain during the development period will result to cerebral palsy with the leading risk factor for cerebral palsy being neonatal asphyxia among all other factors (2), (14).

The development of medicine has made it possible to detect fetal asphyxia early on during the critical moment of giving birth. The devices such as fetal heart monitoring were first believed they would help in early diagnosis and lead to interventions like caesarian sections that will reduce birth condition like cerebral palsy (15). Though there was an association between electronic fetal heart rate monitoring and cerebral palsy there was a high rate of false results which lead to the conclusion that these findings should not be used in interventions like caesarian section because it will be performed without significant value to the baby. (15),

Developed countries have shown no decrease in the prevalence of cerebral palsy over the past three decades, this is despite the advancement in medical technology, the increase in electronic fetal heart rate monitoring the number of caesarian section done being five times noted over the one recorded three decades ago. (14).

The prevalence of cerebral palsy in the United States of America was noted to be as high as 3.1-3.8 per 1000 live births (16). A multi-site study conducted in Europe showed a successful decrease in cerebral palsy over two decades from 1.90 to 1.77 per 1000 live births done across all the birth weight group in Europe. (17)

There has been several population based studies for the prevalence of cerebral palsy in low income countries to study the overall prevalence, subtypes, risk factors and to establish the overall demographic characteristic. A study in Uganda revealed a crude rate of cerebral palsy to range from 2.7- 2.9 per 1000 live births. (18)

It is estimated that approximately 8 in 10 children that have been diagnosed with cerebral palsy will develop a movement disorder (19). These movement disorders in children with cerebral palsy can be seen in form of spasticity, dystonia, athetosis chorea, ataxia or tremors.

These associated manifestations of cerebral palsy usually leave the children with an impaired gait or complete loss of walking ability.

Upper motor neuron lesion in pediatric patients with cerebral palsy is non-progressive but can result into spasticity and paresis. Long term spasticity results into several joint contractures which at the beginning may be dynamic but in the long run they become fixed joint deformities. (20).

Foot and ankle deformities are amongst the commonest deformities in patients with cerebral palsy. It is estimated that about 70% to 90% of pediatric patients with cerebral palsy have foot deformities (21). These patients face significant challenges in ambulation on top of other comorbid resulting from cerebral palsy.

The different variations of brain injury leads to the different kinds of foot and ankle deformities among patients with cerebral palsy that makes it hard to predict. Muscle spasticity causes different orthopedic variations including foot and ankle deformities among patients with cerebral palsy, secondary manifestation include muscle contractures and eventually bony deformities (22), (23)

Foot and ankle deformities are one of the commonest musculoskeletal deformities among pediatric patients with cerebral palsy but it has been shown that there is lack in empirical data with regard to prevalence and distribution of these deformities (24)

The pattern of foot and ankle deformities vary greatly among patients with cerebral palsy. The variations in the kind of deformities to the severity and the impairment level that they lead to. Pediatric patient with cerebral palsy may have only mild toe walking which may resolve with just physical therapy and orthotics (25).

The natural history of the deformities needs to be understood but unfortunately much of it is not documented in literature and only left to experience based. The common agreed foot and ankle related deformities in children with cerebral palsy includes Equinus deformity, Planovalgus, Hallux valgus and Equinovarus, (25),(26),(27). A combination of these deformities is also possible and they may also happen at different stages of growth.

The management of children with cerebral palsy remains a multidisciplinary approach. This includes the combined teamwork of pediatrician, pediatric orthopedic surgeon, pediatric neurologist, physiotherapist, occupational therapist, psychologists and other health and social related professional specific to the patient's needs.

The foot and ankle deformities of the patients with cerebral palsy are treated on a case to case basis according to the severity and the specific type of deformity seen (25). This management can range from non-operative to operative options

Non operative treatment for the foot and ankle deformities among patients with cerebral palsy includes physical therapy, gentle manipulation with casting of the foot and ankle to injection of botulinum toxin A. The use of orthotics with combination of the above managements also is applied. (28), the above management can also be used in combination to produce better results depending on the specific deformity.

The operative treatment for foot and ankle deformities in children with cerebral palsy aims at correcting the primary defect of the patients. Depending on the deformity the treatment options includes, Tendo-Achilles lengthening, first metatarsophalangeal joint arthrodesis and proximal phalanx (Akin) osteotomy. Other procedures may include calcaneal osteotomy, lateral column lengthening (Evans procedure), and Grice procedure and subtalar arthrodesis (27)

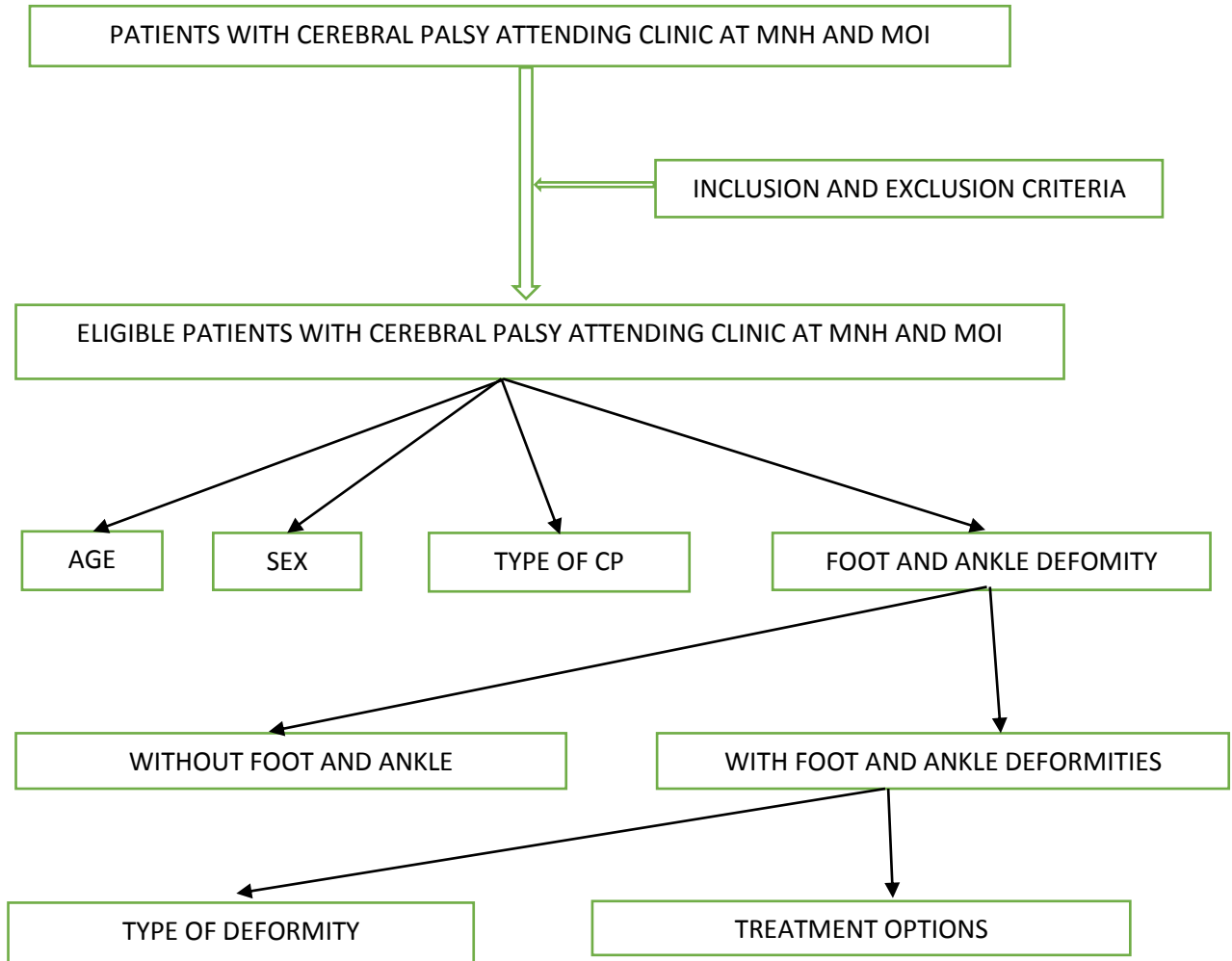
Foot and ankle deformities that are referred as level 1 includes dynamic soft tissue imbalance without skeletal involvement. These deformities are mostly treated by physical therapy and pharmacological supplements such as addition of botulinum toxin injection. Selective dorsal Rhizotomy can also be used in treatment of spasticity. Skeletal surgeries are not indicated for this level of deformity (27).

Level 2 deformities refer to fixed soft tissue involvement that do not involve skeletal parts, the treatment of level 2 deformities uses the same intervention as level 1 deformity with the addition of serial stretch casting and lengthening surgeries, skeletal surgeries are not needed with this level of deformities (27), (28)

The deformities of foot and ankle that are considered level 3 are a combination of fixed soft tissue deformities and skeletal involvement. Treatment for this level of deformities includes a combination of three modalities, pharmacological and neurosurgery options that included injection of botulinum toxin and selective dorsal Rhizotomy to help with spasticity with intrathecal baclofen injections. Skeletal surgery depending of the specific skeletal malformation such as arthrodesis and various osteotomies, these surgeries can also be done with soft tissue procedures and casting (25) (27)

Procedures like selective dorsal Rhizotomy can be performed on patients with cerebral palsy early on in life to reduce spasticity and eventually lower the rate of patients that will require orthopedic procedures for correction (29). It is done on the lower spinal where certain nerves are separated and identified using electrical stimulation then they can be cut. This is done specifically to nerves that lead to too much muscle tone and eventually spasticity.

## 1.6 CONCEPTUAL FRAMEWORK



## **2. METHODOLOGY**

### **2.1 STUDY DESIGN**

It is a descriptive cross-sectional study,

### **2.2 STUDY AREA**

The study was carried out at Muhimbili National Hospital and MOI

Muhimbili National Hospital has a pediatric neurology clinic that is carried out two times a week, the majority of patients at this clinic are patients with cerebral palsy, and every clinic can see around 30 to 40 patients a day usually follow up clinic and about 3 to 5 new cases per clinic. Patients are routinely seen with the team from pediatric neurology and depending on their specific needs sent to physio therapy, occupational therapy or within other pediatric field. Muhimbili Orthopedic Institute sees a relatively smaller number of cerebral palsy patients at the pediatric orthopedic clinic carried out twice a week, there are usually patients with more severe musculoskeletal deformities that seek orthopedic care. Patients are seen with the pediatric orthopedic team and management decision are made collectively.

### **2.3 STUDY TIME**

June 2020 to December of 2020.

### **2.4 STUDY POPULATION**

All pediatric patients with cerebral palsy attending clinic at Muhimbili National hospital and Muhimbili Orthopedic Institute

### **2.5 INCLUSION CRITERIA**

Patients with cerebral palsy that are attending clinic at Muhimbili National Hospital aged from 2years to 17years old.

## 2.6 EXCLUSION CRITERIA

Patients whose parent or legal guardian does not consent for the study

Patients who have undergone previous surgery on the foot and ankle

Patients with neural tube defects and other neuromuscular syndromes

## 2.7 VARIABLES

- 1) dependent variables: treatment options which may include non-operative options like physiotherapy and orthosis and Botox injections, or various surgical procedures
- 2) Independent variables: Age, sex, residential area, type of the deformity and severity grade of the deformity.

## 2.8 SAMPLE SIZE ESTIMATION

A pilot study conducted at the pediatric neurology clinic showed that an average of 85% of cerebral palsy patients have foot and ankle deformities.

Using the Fisher's formula to calculate the sample size

$$N = \frac{Z^2 \cdot P(1 - P)}{\Delta^2}$$

Z is the reliability coefficient for normal distribution, which given a 95% confidence level will be 1.96

P is the proportional estimate, from the pilot study our proportional of interest is 15%

Δ is the desired precision study error (5%)

The sample size from the formula will be **196**

## 2.9 ENROLLMENT AND DATA COLLECTION

Cerebral Palsy patient attending clinic at Muhimbili National Hospital and Muhimbili Orthopedic Institute were recruited as per inclusion criteria of this study. Those who willingly agreed to the terms of the informed consent to be part of the study were given a questionnaire.



Data was obtained from the questionnaire and from the examination of the patients whose parents consented to be part of the study. The questionnaire were filled with data obtained from the parents or guardians and covered mostly the social demographic data part.

The patients of cerebral palsy that attended the clinic and consented to be part of the study were then examined to determine if they had foot and ankle deformities and the data was recorded.

Those with the foot and ankle deformities were further assessed with the principal investigator to determine the exact type of the deformity they have and to form the pattern of the deformities that appear on patients with cerebral palsy to form different groups.

The principal investigator then determined the mode of treatment specific to the patients with foot and ankle deformities, some were grouped into non-operative measures and some grouped in operative group.

Those requiring operative measures were counselled to on the places to seek treatment for the deformities, and the ones that require non-operative measure were advised accordingly on the treatment plan specific to them.

GMFCS was scored to the appropriate level according the level of activity that the patient can do, the principal investigator assessed the level of function of the patient and graded them accordingly.

The deformities were classified to the major criteria as seen in literature as Equinus, Hallux Valgus, Equino-Plano-valgus and Equino-cavovarus. The rare kind of deformities that do not fall in these categories were classified individually by the investigator.

The mode of treatment was set according to the pediatric orthopedic guidelines for foot and ankle deformities, the patients were seen at the clinic with the help of pediatric orthopedic surgeons and all the data was collected by the principal investigator.

## **2.10 DATA ANALYSIS**

The data obtained from the questionnaire was cleaned, coded and entered into a statistical analyzing tool SPSS version 24.

The target population was patients with cerebral palsy attending clinic at MNH and MOI. These patients were screened for foot and ankle deformities

Further assessment of the specific type of foot and ankle deformities was done and classified them in the major types as well as grade the level of the GMFSC.

Patients with foot and ankle deformities were evaluated further to see what type of treatment they required, some were for non-operative management while others were for operative management options.

## **2.11 ETHICAL CONSIDERATION**

The study begun after ethical clearance from Muhimbili University of Health and Allied sciences, the clearance was sought from the MUHAS ethical review board and permission from the management of the Muhimbili National Hospital and Muhimbili Orthopedic Institute. All respondents in the study were given verbal and written consents, and given the opportunity to withdraw from the study at any time without any consequence to their treatment, the data obtained was used for research purposes only and confidentiality was maintained.

This study is not introducing a new treatment rather exploring the treatment modalities that are the standard for foot and ankle deformities, the patients who needs further operative management will receive the same standard of care that is given to any other patients and will continue to receive this care even if they withdraw from the study.

## **2.12 LIMITATION AND MITIGATION OF THE STUDY**

The short duration of the study limits any long term follow up of the deformity after the initial treatment has been offered.

### 3. RESULTS

201 patients were recruited for this study, 102 (50.7%) were females and 99 (49.3%) were males. The majority of patients recruited were 5 years and above 126 (62%) and those under 5 years of age were 75 (38%). The mean age was 5 years and the majority of patients ranged from 3 years to 5 years of age

Commonest type of CP was spastic with 155 (77.1%) followed by mixed with 22 (10.9%) then the other types of Cerebral palsy as shown in the table below.

**Table 1: SOCIAL DEMOGRAPHIC**

<b>Variable</b>	<b>Frequency</b>	<b>Percent</b>
<b>Age group</b>		
5 and above	126	62.69%
Under five	75	37.31%
<b>SEX</b>		
Female	102	50.75%
Male	99	49.25%
<b>TYPE OF CP</b>		
Spastic	155	77.11%
mixed	22	10.95%
hypotonic	11	5.47%
Athetoid	4	1.99%
<b>GMFCS</b>		
level_1	11	5.47%
level_2	48	23.88%
level_3	58	28.86%
level_4	61	30.35%
level_5	23	11.44%
<b>CP DISTRIBUTION</b>		
Quadriplegia	<b>90</b>	44.78%
Diplegia	85	42.29%
Hemiplegia	21	10.45%
Monoplegia	5	2.49%
<b>Ambulation Status</b>		
Ambulant	114	56.72%
Non ambulant	87	43.28%

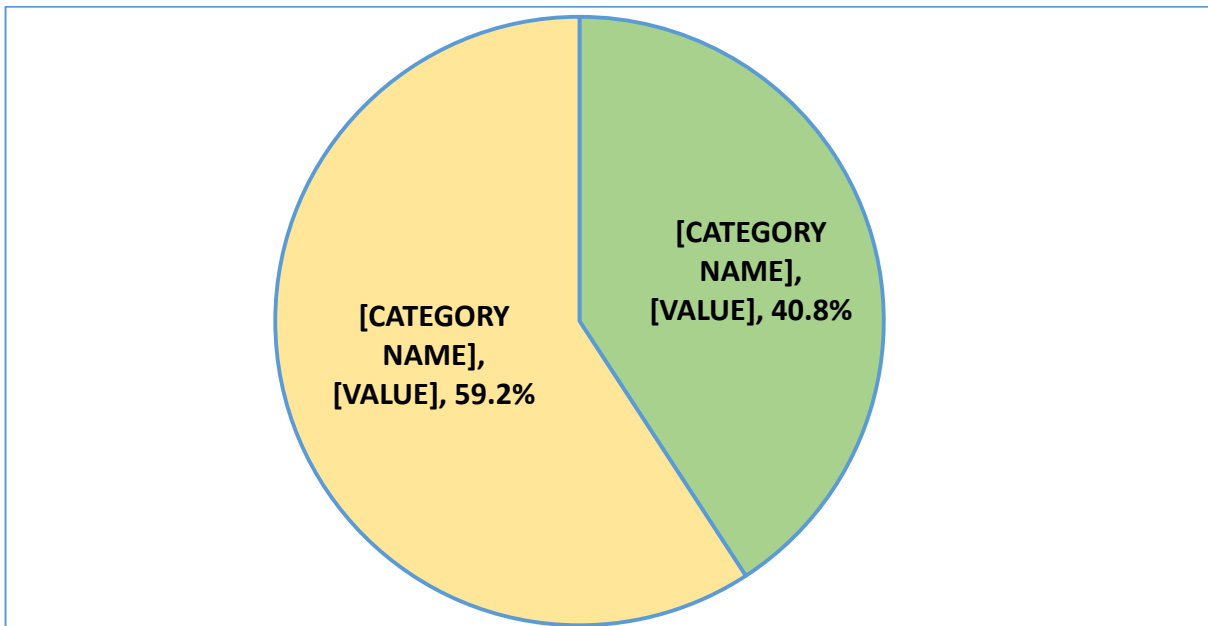
The most common distribution of CP was Quadriplegia with 90(44.78%), followed by Diplegia 85(42.29%), hemiplegia 21(10.45%) and monoplegia 5 (2.49%).

The gross motor function classification system (GMFCS) distribution according to the levels were shown with level 4 being the commonest at 61(30.35%)

Among the patients recruited 114(56.72%) were ambulant which included the fully mobile patients, community and household ambulators, the remaining 87 (43.28%) were non-ambulant.

Foot and ankle deformities were found in 119(59.2%) of the patients recruited, the remaining 82(40.8%) were examined and did not have foot and ankle deformities though some of them had other musculoskeletal anomalies.

**Figure 1: PROPORTION OF CEREBRAL PALSY PATIENTS WITH FOOT AND ANKLE DEFORMITIES**



The 119 patients who had foot and ankle deformities were examined further to see the variations of the deformities amongst them, the most common deformity that was observed was Equinus with 51(42.82%). Other foot and ankle deformities included Plano valgus 33(27.73%), Equino Cavo Varus 21(17.65%), Hallux Valgus 8(6.72%) and the other deformities not on the above categories together consisted of 6(5.04%)

**Table 2: PATTERNS OF FOOT AND ANKLE DEFORMITIES**

<b>Type of Deformity</b>	<b>Frequency</b>	<b>Percent</b>
Equinus	51	42.86%
Hallux valgus	8	6.72%
Plano valgus	33	27.73%
Equino cavo varus	21	17.65%
Others	6	5.04%

The chart above shows different foot and ankle deformities of cerebral palsy of which each one of them has different indications for operations, so each one of them will have to be discussed individually.

### **Equinus**

There were a total of 51 patients with Equinous deformity, those with fixed deformity that could not be passively corrected with increased spasticity and increased dorsiflexion were 16(31.37%), these are the patients that required some form of surgery as manipulation and ankle foot orthosis would not work on them.

### **Hallux Valgus**

There were a total of 8 patients with Hallux Valgus deformity of the foot. 2(25%) patients reported pain and difficult in footwear especially during ambulation which is the indication for surgery

### **Plano Valgus**

There were a total of 33 patients with Plano Valgus deformity, 18(54.55%) were found to have fixed deformities that could not be passively corrected and also reported pain or/and pressure sores in footwear which was the indication for surgery.

**Equino-cavo-Varus**

There were a total of 21 patients that were examined to have Equino-cave-Varus. The requirement for surgery include those with fixed Equinous contracture, fixed Varus hind foot deformity, 9(42.86%) of them required surgical options for their treatment.

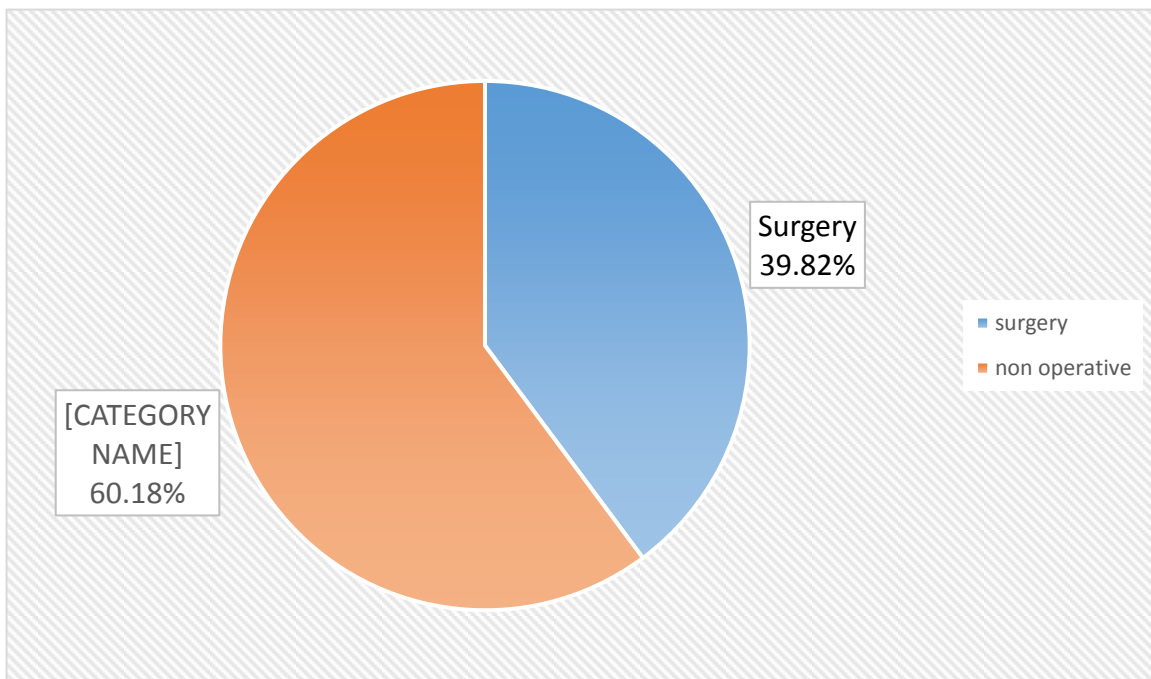
**Table 3: PROPORTION OF THOSE REQUIRING OPERATIVE TREATMENT**

<b>Deformity Type</b>	<b>Surgical</b>	<b>Non operative management</b>	<b>Total</b>
	<b>Frequency (%)</b>	<b>Frequency (%)</b>	<b>N</b>
Equinus	16(31.37)	35(68.63)	51
Hallux valgus	2(25.00)	6(75.00)	8
Plano valgus	18(54.55)	15(45.45)	33
Equino cavo varus	9(42.86)	12(57.14)	21
<b>Total</b>	<b>45(39.82)</b>	<b>68(60.18)</b>	<b>113</b>

The total number of cerebral palsy patients with a known and defined foot and ankle deformities was 113, out of them 45(39.82%) of them fit into the categories that required surgical options.

### OPERATIVE TREATMENT OPTION FOR FOOT AND ANKLE DEFORMITIES FOR PEADIATRIC CEREBRAL PALSY PATIENTS

**Figure 2: TREATMENT OPTIONS**



Surgical treatment for cerebral palys patients depends on many factors includingg the type of the deformity, the degree of the deformity, spasticity, pain on ambulation or foot wear and the GMFCS, to determine the treatment type specific to each patients the defomities will be discussed separately.



## EQUINUS

**Table 4: TREATMENT OPTIONS FOR EQUINUS DEFOFMTY IN CP PATIENTS**

<b>Treatment option</b>	<b>Patients (percentage)</b>
Serial manipulation and casting +/- botox injection	<b>9(17.6%)</b>
Ankle Foot Orthosis	<b>26(51%)</b>
Tendo-Achellis lengthening/ gastrocnemius lengthening	<b>16( 31.4%)</b>
Total	<b>51</b>

There were a total of 51 patients with Equinus deformity recruited for this study, treatment options for patient with cerebral palsy and Equinus deformity includes.

### **Serial manipulation and casting with/without Botulinum toxin A injection,**

This technique is used independently for younger patients with dynamic deformity that can be manipulated passively and with mild spasticity, there were a total of 9(17.6%) patients who fit into this category.

Botulinum toxin A injection works by blocking presynaptic release of acetylcholine, used in mild spasticity may delay the need for surgery.

### **Ankle foot orthosis**

Usually follows after serial manipulation and casting after the foot can be easily manipulated to the desirable position, the orthosis are used to maintain the foot at the position required. The deformities that can be corrected passively and with mild to moderate contractures. There were a total of 26 (50.9%) patients who fit to this specific treatment plan.

### **Surgery: Tendo-Achilles Lengthening (TAL) with/without gastrocnemius recession**

This procedure is used for patient with fixed Equinus deformity, Silverskoid test is used to isolate the deformity to determine the level of the recession, TAL is done in isolated gastrocnemius complex spasticity and Gastrocnemius recession is used in isolated gastrocnemius tightness.

A total of 16(31.3%) patients required this surgical options by using the clinical criteria during history and examination.

### **HALLUX VALGUS**

The indication for operative treatment for patient with Hallux Valgus is whether they have pain on footwear or ambulation, there were a total of 8 patients with Hallux Valgus

#### **Observation**

There were 4 ambulant patients who reported no pain on ambulation or footwear and 2 patients who were non-ambulant who were reported to have no pain on footwear, so a total of 6(75%) of patients with CP and Hallux Valgus deformity required observation.

#### **Surgery: first metatarsal joint arthrodesis or proximal phalanx osteotomy**

The above procedures are the surgical treatment options for patient with painful Hallux Valgus deformity depending on specific needs. There were a total of 2(25%) patients who reported painful Hallux Valgus deformity.

### **PLANO VALGUS DEFORMITY**

#### **Bracing**

Deformities that can be manually corrected to the desirable position for ambulation and footwear for the non-ambulant patients are treated with bracing, 15(45.6%) patients in this group had passively correctable deformities without pain.

### **Surgery**

This group of foot and ankle deformities in Cerebral palsy consisted of 18(54.4%) of the patients with Plano-valgus. These are the patients who presented with pain on manipulation and some with pressure sores when bracing was used.

There are soft tissue and Bony procedures that used for specific patients depending whether the deformity involves the soft tissue only or osseous component in advanced deformities.

Soft tissue procedures **includes TAL, Peroneus brevis lengthening and posterior tibialis tendon advancements,**

Osseous procedures done in this deformity includes **Calcaneal osteotomy, subtalar joint arthrodesis, Grice procedure or Evans procedure.**

### **EQUINO-CAVO-VARUS**

There were a total of 21 patients who were found to have Equino Cavo Varus deformity.

### **Bracing**

This is the treatment of choice for those with supple deformity. It was observed that 12(57.1%) patients had supple deformities and could be treated with bracing.

### **Surgical options:**

Surgical options are reserved for patients with fixed deformities that cannot be manipulated to desirable position or some with passively correctable deformity who presents with spasticity.

It was observed that 9(42.9%) fit the clinical criteria for surgical treatment options.

Soft tissue procedures like **TAL** and **Tibialis tendon transfers** are done independently in cases of fixed Equinous contractures that do not involve the osseous part.

Osseous procedures like **Calcaneal osteotomy** and **Arthrodesis** are done in combination with soft tissue procedures in advanced fixed deformities that have osseous involvement.

#### 4. DISCUSSION

The main purpose of this study was to assess the clinical profile and treatment modalities of foot and ankle deformities among pediatric patients attending clinic at Muhimbili National Hospital and MOI.

In order to determine the burden of the problem of foot and ankle deformities in patients with cerebral palsy the first objective was to determine the proportion of patients with cerebral palsy that have foot and ankle deformities. This study revealed that foot and ankle deformities are common in patients with cerebral palsy with the proportion of 59.2% of all the patients studied. This compares relatively well with some studies that shows close to the same range (21). Other studies identifies that deformities of feet are the most common musculoskeletal disorders (11), (13), (25),

The difference in the pattern of foot and ankle deformities comes from the different variations of brain injury, this lead to the muscle imbalance that start off as contractures and eventually deformities of the bone. This study showed that the common foot and ankle deformities that were noted included Equinus, Plano Valgus, Equino Cavo Varus and Hallux Valgus. This compares well with studies (25), (26) and 27.

This study went further to show that the commonest deformity of foot and ankle among cerebral palsy patients was Equinus which constituted 42.8%, the pure form of Equinus was also noted to be the commonest deformity of foot and ankle in literature that supported this finding (11), (25) and ( 27). This finding however differs from those studies that showed that Planovalgus was the commonest foot and ankle deformities that children with cerebral palsy present with (26), in this study Plano Valgus was the second commonest deformity of foot and ankle only after Equinus, Plano Valgus constituted 27.7% of all the deformities of foot and ankle in this study.

Those children with pure Equinus of the foot showed variations of the deformity, from a soft tissue deformity that was flexible and could be manipulated back to desired position to fixed

contracture deformity and osseous deformity, those with increased spasticity and increased dorsiflexion were 16(31.37%) of all the patients with Equinus deformity.

The distribution of the remaining common patterns of foot and ankle deformities among children with cerebral palsy was shown in the table 2. Plano Valgus was the next common deformity with 27.73% followed by Equino Cavo Varus with 17.65%, Hallux Valgus with 6.72% and the other deformities combined consisted of about 5% of the deformities. This finding compared relatively well with other studies that show almost similar results in distribution of these deformities included (11), (25) and (27).

The goal of treatment of foot and ankle deformities in patients with cerebral palsy is to improve ambulation ability, stop further deformity that may impair ambulation and help to ambulate without pain. Treatment is on a case to case basis as Cerebral palsy has shown great variation in types and severity of the deformity that can result in children with cerebral palsy.

This study has reviewed options of treatment for the patients that presented with deformities of foot and ankle, the options included the currently practices treatment and other options that have been documented for treatment of foot and ankle deformity. The treatment options were grouped in two major groups that included non-operative and surgical options.

The major non-operative options discussed was physical therapy especially for those with flexible deformities that could be manipulated to position, the use of orthotics in combination with physical therapy is also applied (28). The operative treatment of these deformity includes soft tissue release procedure like Tendo Achilles lengthening to various osseous procedures for more advanced fixed deformities (28). Each deformity was studied further to determine the type of treatment that was required.

Equinus was the most common deformity of foot and ankle in this study with 51 patients (42.8%) of all foot and ankle deformity. In this study the Equinus deformity was further classified and patients were examined if the deformity was flexible and could be manipulated back in position, the degree of spasticity and the age. (30), (31)

The younger patients with dynamic deformity and mild spasticity were listed to the non-operative group which comprised of 35patients (68.63%), this finding compares well with

literature from other studies on treatment options (25), (28). These patients are the ones that required physical therapy and orthotics options of treatment while the remaining 16 patients (31.37%) had fixed deformities that required surgical treatment of soft tissue release and osseous procedures as shown in table 3, the operative treatment options are consistent with findings of other studies(25) (27),(28) and (31)

Plano Valgus was the second most common deformity of foot and ankle among patients with cerebral palsy which in this study consisted of 33 patients. Non operative treatment of options like bracing depended on whether the deformity could be corrected passively back to the desirable position without pain for ambulatory children (26). Non ambulatory children were also treated with bracing. The total number of patients treated none operatively was 15 (45.6%). This percentage is higher than that shown in a study (26) which only included ambulatory patients.

The number of patients who required operative management was 18(54.4%) of the 33 patients with Plano-valgus. These are the patients who presented with pain on manipulation, fixed deformities and some with pressure sores when bracing was used, this number is less than those of the study that only included ambulatory children with CP (26)

There were 8 patients with Hallux Valgus deformity, the indications for surgery in patients with Hallux valgus deformity depends on whether they have pain on ambulation or foot wear, 2 patients (25%) presented with pain on footwear and ambulation which was the indication for surgical options, this options for surgery was supported by the study (32) and (33) which studied surgical options for hallux valgus in adolescents

There were a total of 21 patients who were found to have Equino Cavo Varus deformity, the treatment options included non-operative like the use of bracing and surgical options of treatments. Surgical treatments included soft tissue procedures like Tendo Achilles Lengthening, Peroneus brevis lengthening and posterior tibialis tendon advancements. Osseous procedures like Calcaneal osteotomy and Arthrodesis are done in combination with soft tissue procedures in advanced fixed deformities that have osseous involvement

The total number of cerebral palsy patients with a known and defined foot and ankle deformities was 113, out of them 45(39.82%) of them fit into the categories that required surgical options weather soft tissue or osseous and the remaining 68patients (60.2%) required non-operative management.

## **5. CONCLUSION**

In this study where 201 pediatric patients with cerebral palsy were studied it showed that the commonest type of Cerebral Palsy was spastic. The most common distributions were quadriplegic and diaplegic The GMFCS distribution was majority level 4 followed by level 3 and level 2

The majority of the patients were ambulant which included the fully mobile patients and the community and household ambulators.

This study showed that more than half of patients with cerebral palsy developed foot and ankle deformities weather dynamic or flexible

The most common type of foot and ankle deformity among patients of cerebral palsy was Equinus.

This study demonstrated that more than half of the patients of cerebral palsy who develop foot and ankle deformities require non-operative management only and less than half will need surgical intervention.

**6. RECOMMENDATION**

Multidisciplinary approach to the patients of cerebral palsy to cover a wide range of associated deformities.

A larger scale study to observe more musculoskeletal deformities in patients of cerebral palsy

**7. LIMITATIONS**

Long-term treatment follow up was not feasible due to the available time given to conduct this study, the treatment of foot and ankle deformities in cerebral palsy patient needs long term follow up and close monitoring.



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## 9. APPENDICES

### 9.1 QUESTIONNAIRE.

Code number .....

File number .....

#### BIODEMOGRAPHICS

Age..... a) Under 5

b) 5-16

Sex a) Male

b) Female

Place of residence .....

Phone number .....

#### CEREBRAL PALSY BIO DATA

Type of Cerebral Palsy

- 1) Spastic
- 2) Athetoid
- 3) Ataxic
- 4) Mixed
- 5) Hypotonic

Anatomical distribution of the disease

- 1) Monoplegia
- 2) Diaplegia
- 3) Hemiplegia
- 4) Quadriplegia

Presence of foot and ankle deformities: YES

NO

- Type of foot and ankle deformity:
- 1) Equinus
  - 2) Hallux valgus
  - 3) Plano Valgus
  - 4) Equino Cavo varus
  - 5) others ( describe) .....

- Can the deformity be passively corrected to desirable position?
- 1. YES
  - 2. NO

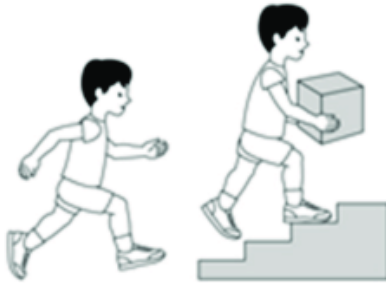
- Spasticity of foot and ankle
- 1) Mild
  - 2) Mild to moderate with contractures
  - 3) Fixed deformity

- Pain on ambulation
- 1) YES
  - 2) NO
  - 3) NON AMBULANT

**Gross Motor Function Classification Scale (GMFCS)**

- 1. LEVEL 1
- 2. LEVEL 2
- 3. LEVEL 3
- 4. LEVEL 4
- 5. LEVEL 5

## GMFCS E & R between 6<sup>th</sup> and 12<sup>th</sup> birthday: Descriptors and illustrations



### GMFCS Level I

Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.



### GMFCS Level II

Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or used wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.



### GMFCS Level III

Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when traveling long distances and may self-propel for shorter distances.



### GMFCS Level IV

Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.



### GMFCS Level V

Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.

### Treatment options

- a. Non operative
- b. Operative

### Non operative options

- a. observation
- b. Physiotherapy
- c. Serial manipulation and casting
- d. Injection of botulinum toxin A
- e. bracing
- f. Ankle foot orthosis



**9.2. CONSENT FORM**

My name is Dr Siime Rukoijo, from Muhimbili University of health and allied sciences. I am conducting a study on patients of cerebral palsy. I have been given permission to conduct this study by the ethical review board of MUHAS

The purpose of my study is to assess the foot and ankle deformities among patients of cerebral palsy and to determine the appropriate treatment.

The patients who choose to participate on the study will be asked a series of questions to obtain basic information, then appropriate examination will be done on the patient and they will be taken to the proper treatment that follows, there will be no new treatment offered for this study and those who refuse to participate on this study will be offered the same treatment.

The information collected for this study will be handed in confidence, no names will be used or published. The information will be used for research purpose only.

There is no expected harm to the participants of the study, and every participant has a right to be withdrawn from the study at any time should they choose to do so. Those who withdraw from the study will be treated just the same and will continue with the standard treatment as per the guideline.

This study is expected to follow up closely and to make sure those who participate and those who refuse to participate get the best care possible and to be of benefit to the future patients.

If you require any further assistance or have any question with regard to this study feel free to contact the principle investigator Dr Siime Rukoijo +255713545714.

**If you have any questions with regards to your rights as a participant you may contact Dr Bruno Sunguya, chairman of the university senate research and publication committee, P.O.Box 65001 MUHAS, Tel No +255713228480, Dar es Salaam.**

I .....have read the consent form and my questions have been answered and I agree to participate on the study.

Signature of the participant .....

Signature of the investigator .....

Date of signed consent .....

### 9.3. FOMU YA IDHINI

Jina langu ni Dkt Siime Rukojo, mimi nimetokea chuo cha mafunzo ya afya na sayansi Muhimbili. Nafanya utafiti kwa watoto wenye ugonjwa wa kupooza kwa ubongo, nimepata ruhusa ya kufanya utafiti huu kutoka chuo na uongozi wa hospitali.

Dhumuni la utafiti wangu ni kuangalia matatizo ya mguu na kifundo cha mguu (ankle) kwa watoto wenye kupooza kwa ubongo.

Wagonjwa watakao ingia kwenye utafiti wangu wataulizwa maswali ili kupata taarifa zao, pia watafanyiwa uchunguzi maalumu wa tatizo lake, tutoa ushauri kuhusu matibabu ya watoto kutokana na tatizo lao, hakutakuwa na matibabu mapya yanayotumika katika utafiti huu pia wale ambao hawatakubali kuingia kwenye utafiti huu watapewa huduma nzuri kama watakaokubali.

Taarifa zitakazopatikana katika utafiti huu itakuwa ni siri, hakuna majina yatakayotumika katika uchapishaji na taarifa zitakazopatikana zitatumika kwa utafiti tuu.

Hakuna matatizo yoyote ya kiafya yanayotarajiwa kuwapata wale wanaoshiriki katika utafiti huu. Kila mshiriki katika utafiti huu ana haki ya kujitua bila lawama yeyote na pia atapewa huduma zote anazostahili.

Utafiti huu unatarajiwa kufuatilia kwa ukaribu kuhakikisha kuwa wagonjwa wote waliopo kwenye utafiti na wasio kwenye utafiti wanapata huduma bora wanayostahili na kuwapa faida wagonjwa wajao.

Kama kuna uhitaji mwingine wowote au kama kuna swali lolote kuhusiana na utafiti huu kuwa huru kuulizia kwa mtafiti mkuu

Daktari Siime Rukojo +255713545714

Kama una maswali yeyote kuhusu haki yako katika ushiriki wako pia unaweza kuwasiliana na mwenyekiti wa kamati ya wa utafiti chuo cha Muhas, P.O. Box 6500 Dar es Salaam, simu namba +255713228480

Mimi ..... nimesoma idhini hii na maswali yangu yamejibiwa na nimekubali kushiriki katika utafiti huu.

Sahihi mbadala .....

Uhusiano na Mgonjwa .....

Tarehe .....