Effect of a Combination of Myofascial Release Technique to Conventional Physiotherapy Program on Functional Outcomes in Pediatric Cerebral Palsy Post Achilles Tendon Surgery in the Gaza Strip

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Contents

List of Abbreviations

CP	Cerebral Palsy
GMFM-66	Gross Motor Function Measure-66
ROM	Range of Motion
RCT	Randomized Controlled Trial
PT	Physical Therapy
QoL	Quality of Life
SPSS	Statistical Package for Social Science
WHO	World Health Organization
MFR	Myofascial Release
MoH	Ministry of Health
UNRWA	United Nations Relief and Works Agency

Chapter One: Introduction

1.1 Introduction

Cerebral palsy (CP) is a group of permanent movement and posture disorders caused by non-progressive disturbances in the developing fetal or infant brain (Odding et al., 2006) It is the most common motor disability in childhood, often associated with spasticity, muscle weakness, and impaired coordination. These neuromotor deficits contribute to a spectrum of functional limitations, varying in severity and presentation across individuals. Children with CP often experience abnormal muscle tone, joint contractures, and impaired motor control, making functional mobility a significant challenge (Odding et al., 2006).

Functionally, CP affects a child's ability to perform age-appropriate activities such as standing, walking, and maintaining balance. Within spastic CP, balance impairments are highly prevalent due to deficits in postural control, sensory integration, and muscle coordination. Such impairments increase the risk of falls and restrict participation in daily activities. Therefore, balance is a critical outcome to assess, in addition to gross motor function and joint range of motion.(Araújo et al., 2020)

One of the most frequent musculoskeletal deformities in spastic CP is equines foot, commonly resulting from tightness or contracture of the gastrocnemius-soleus complex (Sarathy et al., 2019). This condition significantly affects gait and postural alignment. In more severe cases, surgical interventions like Achilles tendon lengthening are required to improve ankle dorsiflexion and facilitate better gait mechanics (Tateuchi, 2019). However, even after surgery, many children continue to face functional limitations due to persistent muscle tightness, fascia restrictions, and poor motor coordination. Surgical correction addresses structural deformity but often fails to resolve underlying neuromuscular dysfunction. Studies have shown that recurrence of equine deformity post-surgery is not uncommon, with rates reported up to 43% in some cohorts, particularly among those with severe preoperative contractures or younger age at surgery. Additionally, muscle-tendon lengthening procedures can lead to significant and prolonged muscle weakness, which may impede functional recovery and necessitate extended rehabilitation periods. These findings

underscore the importance of comprehensive postoperative rehabilitation strategies that address not only the structural corrections but also the persistent neuromuscular impairments to optimise functional outcomes.(Sala et al., 1997)

Post-surgical rehabilitation is crucial in enhancing outcomes, and physiotherapy plays a central role in this process. Conventional physiotherapy aims to improve muscle strength, range of motion, balance, and gait through stretching, strengthening, and task-specific training(Jain et al., 2023). Despite its importance, standard physiotherapy may not fully address deep soft tissue restrictions and altered fascial dynamics. In some cases, progress may plateau due to residual stiffness and abnormal tone, which can limit functional recovery.(Kilbride & McDonnell, 2000)

Myofascial Release (MFR) is a manual therapy technique designed to reduce fascial restrictions, improve tissue extensibility, and restore functional mobility. It involves gentle, sustained pressure into the fascial system to release adhesions and improve neuromuscular function (Ajimsha et al., 2015a). In recent years, growing evidence has supported its use in children with spastic CP. For example, studies have shown that MFR may help reduce spasticity, improve joint mobility, and enhance gross motor function when added to conventional physiotherapy (Chen et al., 2022). However, there remains a lack of focused research on the use of MFR in the postoperative context, especially following Achilles tendon lengthening procedures.

To date, to our knowledge no studies have specifically explored the effect of integrating MFR into rehabilitation programs for children with CP, after Achilles tendon surgery. Given the complexity of CP-related impairments and the potential of MFR to enhance tissue mobility and motor outcomes, this study aims to address gap in this area.

1.2 Problem Statement

Cerebral palsy (CP) is a prevalent neurological disorder in children, characterised by motor impairments, abnormal muscle tone, and movement dysfunction (Patel et al., 2020). Globally, CP affects approximately 2 to 2.5 per 1,000 live births, making it the most common motor disability in childhood (McIntyre et al., 2022). In certain areas within the Middle East and North Africa (MENA) region, such as Al-Quseir City in Egypt, the prevalence of cerebral palsy has been reported to reach 3.6 per 1,000 live births, potentially due to limited access to maternal and neonatal care (Shehata et al., 2014).

In Palestine, particularly in the Gaza Strip, the true prevalence is unclear due to the lack of national registries; however, regional clinical data and observations suggest a notably high rate, especially in areas affected by limited healthcare access, poverty, and repeated conflict-related trauma.

In cases of spastic CP, equinus deformity is common, resulting in altered gait patterns and reduced mobility (Horsch et al., 2021). Surgical options, such as Achilles tendon lengthening, aim to correct equinus and improve ambulation. However, many children continue to face limitations in range of motion, muscle stiffness, and balance even after surgery and physiotherapy, which hinders their ability to perform daily functional tasks (Horsch et al., 2021).

Children with CP face long-term functional limitations that severely impact their daily activities and overall well-being, including decreased muscle strength, joint contractures, poor postural control, and impaired motor coordination (Mutlu et al., 2017). They often struggle with walking, climbing stairs, maintaining balance, and engaging in play or recreational activities, leading to dependence on caregivers and assistive devices (Sutapa et al., 2021). These impairments also restrict participation in educational and social contexts, contributing to social isolation, reduced self-esteem, and a lower quality of life (Maciver et al., 2019). Additionally, chronic movement difficulties and fatigue may reduce physical activity and exacerbate secondary health complications (Mahindru et al., 2023).

Despite the importance of post-operative physiotherapy, current rehabilitation strategies for children with CP, following Achilles tendon lengthening are often limited to

conventional techniques such as stretching, strengthening, and balance training. However, few studies have investigated the integration of advanced manual therapy techniques, particularly Myofascial Release (MFR), into post-surgical rehabilitation (Page, 2012). Most research either focuses on pre-operative conditions or lacks specificity in addressing fascial restrictions and biomechanical deficits that persist after surgery.

This gap in the literature limits our understanding of how combining MFR with standard physiotherapy may affect gross motor function, balance and range of motion (ROM), in pediatric CP patients. Without evidence-based protocols incorporating MFR, clinicians may miss critical opportunities to optimize recovery and improve long-term outcomes. Thus, this study seeks to evaluate the effectiveness of adding MFR to conventional physiotherapy on functional outcomes in children with CP, following Achilles tendon surgery in the Gaza Strip — a setting with unique challenges and an urgent need for enhanced rehabilitation solutions.

1.3 Justification of the Study

This study provides critical evidence on the role of MFR as a complementary approach in rehabilitating children with CP after Achilles tendon lengthening surgery. While conventional physiotherapy is the standard in postoperative rehabilitation, many children still show persistent limitations in functional mobility, muscle tightness, and postural control. These outcomes suggest that traditional methods may not fully address the complex neuromuscular and fascial restrictions associated with CP.

This research addresses a significant gap in pediatric rehabilitation by integrating manual resistance therapy (MRT) with conventional therapy. While evidence supports MFR's effectiveness in reducing spasticity and improving motor performance in children with CP, few studies have explored its role in postoperative recovery. Investigating this integration is crucial, as fascial restrictions may limit the benefits of surgical correction and hinder long-term functional gains.

This study may refine rehabilitation protocols by showing if MFR improves gait quality, range of motion, and daily activity independence. It could also inform therapists and

healthcare planners about cost-effective strategies that enhance recovery and functional independence in children with CP. Ultimately, this research aims to improve the quality and efficiency of rehabilitation services for children with complex motor impairments.

1.4 Objectives of the Study

1.4.1 General Objective:

To evaluate the effectiveness of adding Myofascial Release (MFR) to conventional physiotherapy on functional outcomes and balance in children with cerebral palsy following Achilles tendon lengthening surgery in the Gaza Strip.

1.4.2 Specific Objectives:

1. To evaluate the effectiveness of conventional physiotherapy on functional outcomes in children with cerebral palsy following Achilles tendon lengthening surgery in the Gaza Strip.
2. To evaluate the effectiveness of conventional physiotherapy on balance in children with cerebral palsy following Achilles tendon lengthening surgery
3. To evaluate the effectiveness of adding Myofascial Release (MFR) to conventional physiotherapy on functional outcomes and balance in children with cerebral palsy following Achilles tendon lengthening surgery.

1.5 Research questions

1. Does conventional physiotherapy alone improve gross motor function, balance, and ankle range of motion (ROM) in children with cerebral palsy following Achilles tendon lengthening surgery?
2. Does the addition of Myofascial Release (MFR) to conventional physiotherapy result in greater improvement in gross motor function compared to conventional physiotherapy alone?
3. Does the addition of Myofascial Release (MFR) to conventional physiotherapy result in greater improvement in balance compared to conventional physiotherapy alone?
4. Does the addition of Myofascial Release (MFR) to conventional physiotherapy result in greater improvement in ankle range of motion (ROM) compared to conventional physiotherapy alone?

1.6 Context of the Study

Sociodemographic Context:

The Gaza Strip, a densely populated region with over 2.3 million inhabitants, faces numerous socioeconomic challenges due to prolonged political instability, blockade, and recurrent conflicts. More than 70% of the population are refugees, and a significant proportion lives below the poverty line. Children with disabilities, including those with CP, face multiple barriers in accessing education, healthcare, and social inclusion. Limited community awareness and stigmatization further contribute to their marginalization. The socioeconomic hardships often lead to reduced family resources, transportation difficulties, and limited parental engagement in rehabilitation services.

Palestinian Healthcare System:

The Palestinian healthcare system in Gaza is composed of three main providers: the Ministry of Health (MoH), the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), and non-governmental organizations (NGOs). While efforts are made to offer rehabilitation services for children with disabilities, the sector suffers from chronic underfunding, shortage of specialized staff, outdated equipment, and limited access to advanced physiotherapy modalities. The majority of rehabilitation services are provided by NGOs with external funding, and continuity of care is often interrupted by supply shortages or unstable security conditions. These challenges underscore the need for cost-effective, evidence-based interventions—such as combining Myofascial Release (MFR) with conventional physiotherapy—to optimize functional outcomes for children with CP post-surgery.

1.7 Operational Definition of Key Terms

Cerebral Palsy (CP):

A group of permanent disorders affecting the development of movement and posture, causing activity limitations, that are attributed to non-progressive disturbances occurring in the developing fetal or infant brain. While the injury itself is non-progressive, the resulting neuromuscular and musculoskeletal impairments, such as tone abnormalities,

joint contractures, and motor coordination deficits, may evolve over time. (Blair & Cans, 2025; Panda et al., 2024)

Spastic CP:

The most common type of cerebral palsy, characterized by increased muscle tone (hypertonia), stiffness, and restricted joint movement.(Novak et al., 2012)

Equine's Deformity:

A musculoskeletal condition commonly observed in children with spastic CP, involving excessive plantarflexion of the ankle, which impairs gait and balance.(İğrek et al., 2022)

Achilles Tendon Lengthening Surgery:

A surgical procedure performed to release or elongate the Achilles tendon to correct equinus deformity and improve ankle dorsiflexion.

Conventional Physiotherapy:

A structured rehabilitation program including stretching, strengthening, gait training, and balance exercises delivered by a licensed physiotherapist.

Myofascial Release (MFR):

A hands-on manual therapy technique aimed at relieving fascial restrictions to improve range of motion, reduce pain, and enhance movement efficiency.(Ajimsha et al., 2015b)

Chapter Two: Conceptual Framework and Literature Review

2.1 Conceptual Framework

Cerebral palsy (CP) is a group of permanent movement disorders caused by non-progressive disturbances in the developing fetal or infant brain. These neurological impairments frequently result in spasticity, joint contractures, and musculoskeletal deformities—most notably equinus foot due to gastrocnemius-soleus spasticity. Surgical interventions such as Achilles tendon lengthening are often employed to correct these deformities and improve gait. However, postoperative outcomes depend heavily on the quality of rehabilitation.

Conventional physiotherapy (CPT) is the cornerstone of post-surgical rehabilitation. It aims to improve muscle strength, range of motion (ROM), balance, and gross motor function through structured exercises and task-specific training. However, conventional techniques may not adequately address soft tissue and fascial restrictions that persist after surgery.

Myofascial Release (MFR) is a manual therapy technique that applies gentle, sustained pressure to fascial structures to reduce adhesions and restore tissue extensibility. When integrated with CPT, MFR may enhance the effectiveness of rehabilitation by improving tissue flexibility and reducing muscle tone, thereby allowing better engagement with physiotherapy exercises.

2.1.1 Independent Variables

Conventional Physiotherapy

This includes standard rehabilitation interventions provided to children with cerebral palsy post-Achilles tendon surgery. It typically consists of stretching, strengthening, balance training, and gait re-education to improve functional outcomes.

MFR

A manual therapy technique applied to the fascia and soft tissues to reduce tightness, improve tissue mobility, and support better functional movement. When added to conventional physiotherapy, it is hypothesized to enhance motor recovery and joint mobility.

2.1.2 Dependent Variables

Gross Motor Function

This refers to a child's ability to perform large muscle activities, such as sitting, standing, and walking. It will be measured using the Gross Motor Function Measure (GMFM), a validated scale for children with CP.

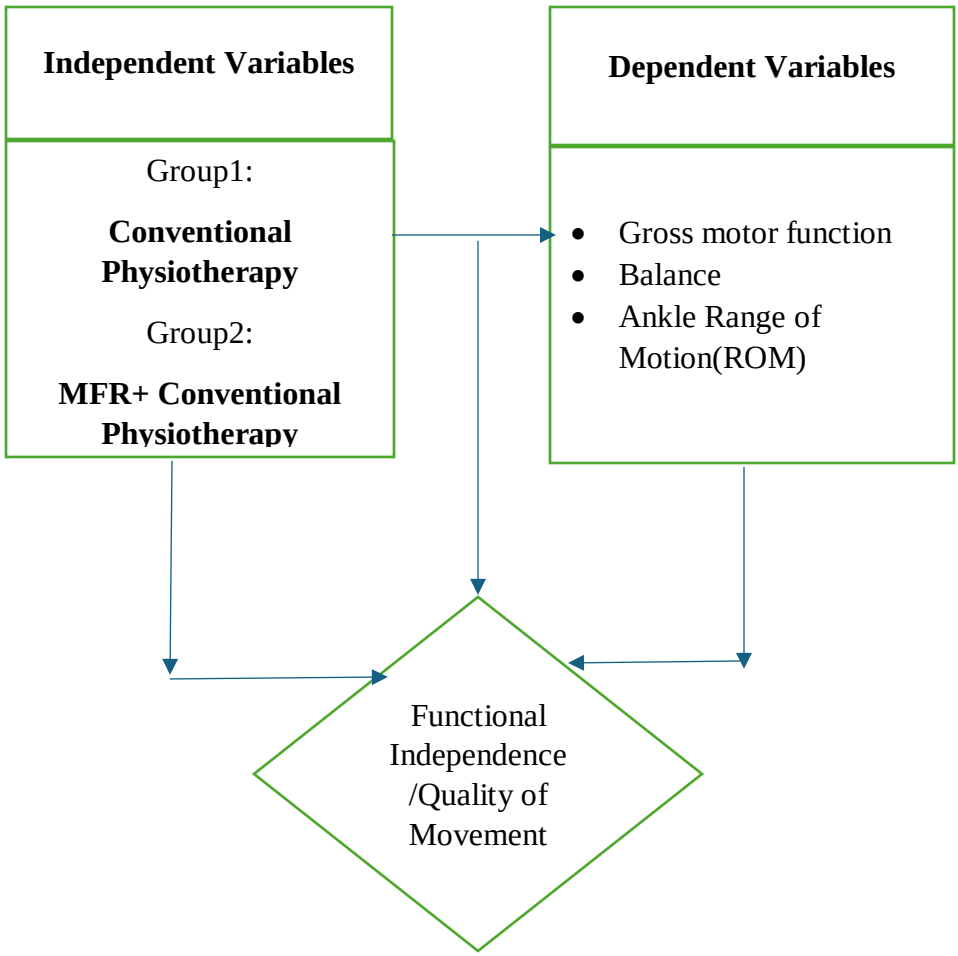
Range of Motion (ROM)

Specifically focused on ankle dorsiflexion and plantarflexion, ROM will be measured using a goniometer to assess joint mobility post-surgery and throughout rehabilitation. Improved ROM is essential for better gait and balance.

Balance:

The ability to maintain upright posture and stability during static and dynamic tasks. It will be measured using the Pediatric Balance Scale (PBS), a validated tool for young children with CP.

In this study, the independent variables—CPT and MFR—are expected to influence the dependent outcomes: gross motor function, balance, and ankle ROM. MFR is hypothesized to enhance the structural readiness of muscles and fascia, reducing tone and improving tissue mobility. This, in turn, may augment the efficacy of CPT by enabling more effective execution of strengthening, balance, and gait exercises. The synergistic combination is thus anticipated to yield greater improvements in functional outcomes compared to CPT alone.



Conceptual framework (Self developed)

2.2 Literature Review

CP is one of the most prevalent motor disorders affecting children worldwide, characterised by spasticity, muscle stiffness, impaired motor control, and poor functional mobility. Numerous interventions have been proposed to enhance motor function and quality of life in children with CP, among which MFR has gained increasing attention as a complementary technique to conventional physiotherapy. This literature review explores existing evidence on the effectiveness of MFR and related interventions, particularly after Achilles tendon lengthening (ATL) surgery, and highlights current gaps in the research.

(Khanna et al., 2023) Compared Neurodevelopmental Therapy (NDT) alone to NDT combined with MFR in children with spastic CP. The study found that the combined therapy group demonstrated significantly greater improvements in gross motor function, as measured by GMFM-88, suggesting that MFR may enhance the outcomes of conventional approaches.

(Avilash Mohapatra et al., 2024) Investigated the comparative impact of MFR and Deep Oscillation Therapy (DOT) on hamstring flexibility and muscle tone. Their results showed that both techniques effectively reduced spasticity and improved ROM, with MFR being slightly more effective.

(Paul et al., 2018) focused on MFR's effectiveness in reducing hamstring spasticity among diplegic CP children. The findings confirmed that MFR significantly decreased spasticity and enhanced knee ROM, thus supporting its inclusion in pediatric CP rehabilitation programs.

(Curtis et al., 2018)evaluated the effects of trunk and head control training on functional changes in children with CP. The study highlighted improvements in gross motor function, emphasizing the importance of integrated therapeutic strategies.

(Kwan et al., 2023) explored the biomechanical impact of tendon release surgery on gait and stiffness control in spastic diplegic CP children. Post-surgical improvements in inter-limb leg stiffness were observed, indicating that ATL surgery positively influences gait mechanics but still requires adjunctive therapy for optimal results.

(Horsch et al., 2022) provided a meta-analysis on the recurrence of equinus deformity following ATL in CP patients. The recurrence rate was significant, underlining the necessity for effective postoperative rehabilitation methods such as MFR.

(Usta Ozdemir et al., 2024) Presented a case report involving electromyographic biofeedback training post upper limb tendon transfer surgery in a CP patient. The intervention yielded functional improvements, illustrating the benefit of integrating novel physiotherapy techniques.

Dietz et al. (2006) provided a medium-term follow-up of patients after ATL surgery. Despite improvements in ankle ROM, continued physiotherapy was deemed essential to sustain functional gains, reinforcing the role of adjunctive therapies.

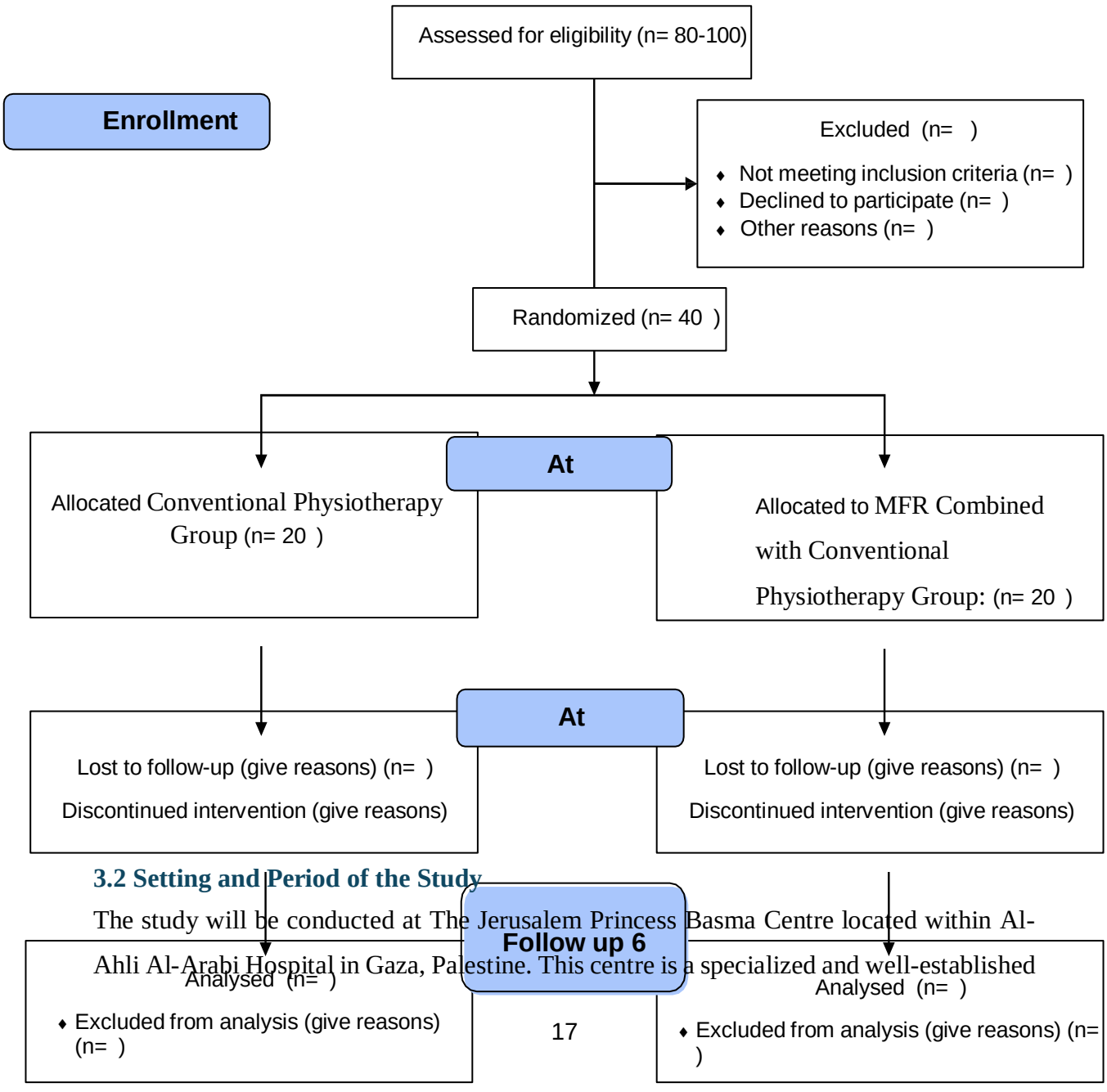
In summary, while existing literature demonstrates the potential benefits of MFR in improving gross motor function and ROM in children with CP, few studies have directly examined its effect post-Achilles tendon surgery. Most research has been limited by small sample sizes, short follow-up periods, or lack of standardized protocols. This gap underscores the need for further investigation into the combined use of MFR and conventional physiotherapy, particularly in the post-surgical context. The present study aims to address this gap by evaluating the effectiveness of adding MFR to conventional therapy on gross motor function and ROM in pediatric CP patients post-ATL in the Gaza Strip.

Chapter Three: Materials and Methods

3.1 Study design

A single-blind randomized controlled trial (RCT) will be conducted to evaluate the effect of adding Myofascial Release (MFR) to conventional physiotherapy on functional outcomes in children with cerebral palsy after Achilles tendon surgery. Participants will be randomly assigned to either an intervention group (MFR + physiotherapy) or a control group (physiotherapy only). Assessments will be conducted at baseline and after 8 weeks of intervention.

Flow Diagram



3.2 Setting and Period of the Study

The study will be conducted at The Jerusalem Princess Basma Centre located within Al-Ahli Al-Arabi Hospital in Gaza, Palestine. This centre is a specialized and well-established

rehabilitation facility that offers multidisciplinary services for children with neuromuscular disorders, including cerebral palsy. It is equipped with qualified rehabilitation professionals, physiotherapy units, and child-friendly environments tailored to the needs of pediatric patients. The center regularly manages post-operative cases of Achilles tendon lengthening, providing an appropriate setting for the implementation of structured physiotherapy programs, including advanced manual techniques such as Myofascial Release (MFR).

The feasibility of conducting the study at this center is considered high due to the presence of skilled staff, consistent patient flow, and administrative support for research activities. The center's rehabilitation protocols and follow-up systems also support the monitoring and documentation required for clinical research. The study period will span from March to August 2025, covering participant recruitment, delivery of the intervention, and pre- and post-intervention data collection.

3.3 Study Population

The study population will comprise children aged 2 years and older who have been diagnosed with spastic CP and have undergone Achilles tendon surgery within the past 3 months. Participants will be sourced from the patient registry at The Jerusalem Princess Basma Centre at Alahli Al-arabi hospital, a specialised rehabilitation centre in Gaza, ensuring they meet the eligibility criteria outlined in section 3.4.

3.4 Eligibility Criteria

Inclusion Criteria:

1. Children aged 2 to 5 years.
2. Diagnosed with spastic cerebral palsy (GMFCS levels I–IV).
3. Have undergone Achilles tendon lengthening surgery within the past 3 months.
4. Medically stable and cleared to begin physiotherapy.
5. Parental/guardian consent to participate in the study.

Exclusion Criteria:

1. Diagnosis of other neuromuscular or developmental disorders.
2. Received Myofascial Release therapy in the past 6 months.

3. Severe cognitive or behavioral impairments that interfere with following instructions.
4. Participation in another rehabilitation study in the past 3 months.

3.5 Sample Size and Sampling Process

A sample size of 40 participants (20 per group) will be targeted, based on feasibility, resource availability, and statistical power considerations. A consecutive sampling method will be employed, selecting eligible participants who consent to participate during the recruitment period.

3.6 Data Collection Procedure

Data collection will be conducted using standardized, validated tools and structured clinical procedures to ensure reliability and accuracy in assessing the functional outcomes of children with cerebral palsy following Achilles tendon lengthening surgery.

3.6.1 Assessment study Tools

The following tools will be used to collect data on the primary outcome measures:

Gross Motor Function Measure-88 (GMFM-88):

This is a standardised observational instrument designed to measure changes in gross motor function in children with cerebral palsy. It consists of 88 items categorised into five dimensions: lying and rolling, sitting, crawling and kneeling, standing, walking, running, and jumping. GMFM-88 has been validated and widely used in pediatric rehabilitation settings (Choi, 2024).

Pediatric Balance Scale (PBS):

An adapted version of the Berg Balance Scale for children, used to assess functional balance in sitting and standing tasks. It consists of 14 items scored on a 5-point scale, and has demonstrated strong validity and inter-rater reliability in children with CP.

Range of Motion (ROM):

Passive ankle dorsiflexion will be measured using a standard universal goniometer. Measurements will be taken with the knee both flexed and extended to assess the length and flexibility of the gastrocnemius-soleus complex. This will provide an objective evaluation of the effect of the interventions on joint flexibility.

3.6.2 Timing of Data Collection

Data will be collected at the following time points:

Pre-Intervention (Baseline):

Before to the start of any physiotherapy sessions, baseline data will be recorded to establish initial levels of function and range of motion.

Post-Intervention (After 8 weeks):

After the completion of the intervention period, a post-treatment assessment will be conducted to measure changes in gross motor function and ankle dorsiflexion ROM.

3.6.3 Data Collectors

Trained physiotherapists who are not involved in the intervention sessions will perform all assessments to avoid bias. They will undergo calibration and training sessions to standardise the assessment procedures and ensure inter-rater reliability.

3.7 Intervention:

This study will include two intervention arms:

3.7.1 Control Group: Conventional Physiotherapy Program

Duration: 8 weeks

Frequency: **3** sessions per week

Session Duration: **45** minutes

Intervention Content:

Passive and active stretching for gastrocnemius-soleus complex

Strengthening exercises for lower limb muscles (especially tibialis anterior and quadriceps)

Balance and postural control training

Functional task training including sit-to-stand, step-ups, and gait training

Use of assistive devices if needed

Objective: To enhance muscle flexibility, improve gross motor performance, and facilitate independence in functional mobility after Achilles tendon lengthening surgery.

3.7.2 Intervention Group: Myofascial Release + Conventional Physiotherapy

Duration: 8 weeks

Frequency: 3 sessions per week

Session Duration: 60 minutes

Intervention Content:

The intervention will be conducted over a period of 8 weeks, with three sessions per week, totaling 24 sessions. Each session will last approximately 60 minutes, divided as follows:

45 minutes for Conventional Physiotherapy (CPT), described above

15 minutes for Myofascial Release (MFR)

Myofascial Release (MFR):

MFR will be administered by a physiotherapist using 4 selected techniques based on individual patient needs and tissue restrictions. Each MFR session will focus on releasing soft tissue restrictions in key muscle and fascial structures involved in gait and postural control in children with spastic cerebral palsy, particularly post Achilles tendon lengthening surgery.

The selected MFR techniques will be drawn from evidence-based protocols described in advanced myofascial release manuals and include:

1. Cross-Hand Release
2. Plantar Fascia Release
3. Gastrocnemius–Soleus Complex Release
4. Hamstring Fascial Lengthening

Each technique will be applied for 2–3 minutes, with gentle, sustained pressure held until tissue "melting" or release is palpated. Sessions will be performed in a calm, supportive environment, ensuring that the child is relaxed and comfortable throughout the treatment.

All sessions will be individualized based on functional level and tolerance, and monitored for consistency and safety.

Rationale: MFR may help release fascial restrictions, improve tissue mobility, reduce muscle tone, and promote better joint ROM and gross motor function—especially after surgical correction.

3.8 Instruments of the Study

To evaluate the functional outcomes of adding Myofascial Release (MFR) to conventional physiotherapy in children with cerebral palsy following Achilles tendon lengthening surgery, the study will utilize the following validated instruments:

3.8.1 Gross Motor Function Measure-88 (GMFM-88)

What it assesses:

Gross Motor Function – the child's ability to perform age-appropriate motor activities such as sitting, standing, crawling, walking, and jumping.

How it will be assessed:

The GMFM-88 includes 88 items divided across five domains:

Lying and Rolling

Sitting

Crawling and Kneeling

Standing

Walking, Running, and Jumping

Each item is scored on a 4-point ordinal scale from 0 (does not initiate) to 3 (completes the task fully). The total and domain-specific scores will be calculated.

3.8.2 Pediatric Balance Scale (PBS)

What it assesses:

Functional balance — the child's ability to maintain equilibrium during various static and dynamic tasks in sitting and standing positions.

How it will be assessed:

The PBS consists of 14 tasks such as sitting to standing, turning, reaching, and standing with eyes closed. Each item is scored on a 5-point scale (0 to 4), with a total score out of 56. This tool has demonstrated strong reliability and validity in children with cerebral palsy and will be administered pre- and post-intervention.

3.8.3 Goniometric Measurement of Ankle Range of Motion (ROM)

What it assesses:

Passive dorsiflexion of the ankle joint – to determine changes in muscle length, joint flexibility, and soft tissue extensibility after intervention.

How it will be assessed:

A standard universal goniometer will be used to measure passive ankle dorsiflexion:

With the knee flexed (isolating the soleus)

With the knee extended (measuring the gastrocnemius-soleus complex)

Measurements will be taken in degrees and documented pre- and post-intervention.

3.9 Pilot Study:

Prior to the commencement of the main trial, a pilot study will be conducted at the same setting (The Jerusalem Princess Basma Centre at Al-Ahli Al-Arabi Hospital). The aim of the pilot is to assess the feasibility and practicality of the intervention protocol, data collection tools, and logistical arrangements. A small number of participants (e.g., 5–8 children) who meet the inclusion criteria will be involved. This pilot phase will help identify any challenges related to participant recruitment, administration of Myofascial Release (MFR), timing of assessments, or issues with outcome measurement tools such as GMFM-88 and goniometric ROM assessment.

Findings from the pilot study will be used to refine the intervention schedule, improve data collection processes, and ensure clarity and reliability of the instruments. The data

collected during the pilot will not be included in the final statistical analysis of the main study.

3.10 Validity and Reliability

This study will utilize three validated assessment tools: the Gross Motor Function Measure (GMFM-88), Pediatric Balance Scale (PBS), and Goniometry for ankle Range of Motion (ROM). All instruments are well-established in pediatric rehabilitation and have demonstrated strong validity and reliability in children with cerebral palsy.

3.10.1 Gross Motor Function Measure (GMFM-88)

Validity:

The GMFM-88 has demonstrated high content and construct validity for assessing gross motor function in children with cerebral palsy (2024).

Reliability:

The tool shows excellent test-retest and inter-rater reliability, with Intraclass Correlation Coefficients (ICCs) exceeding 0.95, confirming its consistency across different evaluators and over time.

3.10.2 Pediatric Balance Scale (PBS)

Validity:

PBS is adapted from the Berg Balance Scale and has shown strong concurrent validity with other motor performance measures in pediatric populations.

Reliability:

The scale exhibits high inter-rater and intra-rater reliability in children with CP, with reported ICCs ranging from 0.92 to 0.98 (Franjoine et al., 2003).

3.10.3 Goniometer for Range of Motion (ROM)

Validity:

Goniometry is a widely used method with established face and criterion validity when performed by trained professionals.

Reliability:

Goniometric assessments of the ankle have shown high intra-rater and inter-rater reliability, with ICCs ranging from 0.86 to 0.98, making it a dependable tool for clinical and research use (Menadue et al., 2006).

3.11 Statistical Management and Procedures

Data will be analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Descriptive statistics will summarize demographic and clinical characteristics. Inferential statistics, such as paired t-tests or Wilcoxon signed-rank tests, will compare pre- and post-intervention scores within groups. Independent t-tests or Mann-Whitney U tests will compare changes between groups. A significance level of $p < 0.05$ will be set for all analyses.

3.12 Ethical and Administrative Considerations

1. The researcher will obtain all the necessary ethical documents to conduct the study.
2. Approval from the Helsinki committee in Gaza will be obtained to conduct the study.
3. An official letter of approval to conduct the research will be obtained from Al-Azhar University, Gaza.
4. The researcher will explain the purpose and objectives of the study to all participants, and written informed consent will be obtained from each participant before their participation.

3.13 Gantt Chart: (Timetable for research activity)

This study is expected to take six months, commencing in June 2025 and concluding in November 2025. This period will be divided into two main phases, illustrated in the table below:

Activity	Month (2025)					
Date	**June.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**
Preparation of proposal and obtaining permissions						
Development of research tools						
Sample selection and implementation study program						
Data collection						
Data entry and data analysis						
Evaluation of results						
Review of literature						
Thesis report writing						
Submitting						

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Appendix

GMFM-88 SUMMARY SCORE

DIMENSION	CALCULATION OF DIMENSION % SCORES	GOAL AREA (indicated with ✓ check)
A. Lying & Rolling	$\frac{\text{Total Dimension A}}{51} = \frac{\quad}{51} \times 100 = \quad\%$	A. ☐
B. Sitting	$\frac{\text{Total Dimension B}}{60} = \frac{\quad}{60} \times 100 = \quad\%$	B. ☐
C. Crawling & Kneeling	$\frac{\text{Total Dimension C}}{42} = \frac{\quad}{42} \times 100 = \quad\%$	C. ☐
D. Standing	$\frac{\text{Total Dimension D}}{39} = \frac{\quad}{39} \times 100 = \quad\%$	D. ☐
E. Walking, Running & Jumping	$\frac{\text{Total Dimension E}}{72} = \frac{\quad}{72} \times 100 = \quad\%$	E. ☐

TOTAL SCORE = $\frac{\%A + \%B + \%C + \%D + \%E}{\text{Total \# of Dimensions}}$

$= \frac{\quad}{5} = \quad = \quad\%$

GOAL TOTAL SCORE = $\frac{\text{Sum of \%scores for each dimension identified as a goal area}}{\text{\# of Goal areas}}$

$= \quad = \quad\%$

GMFM-66 Gross Motor Ability Estimator Score [1]

GMFM-66 Score = _____ _____ to _____ 95% Confidence Intervals

previous GMFM-66 Score = _____ _____ to _____ 95% Confidence Intervals

change in GMFM-66 = _____

[1] from the Gross Motor Ability Estimator (GMAE-3) Software

TESTING WITH AIDS/ORTHOSES USING THE GMFM-88

Indicate below with a check (✓) which aid/orthosis was used and what dimension it was first applied. (There may be more than one).

AID	Dimension	Orthosis	Dimension
Rollator/pusher	☐ ____	Hip Control	☐ ____
Walker	☐ ____	Knee Control	☐ ____
H Frame crutches	☐ ____	Ankle-foot Control	☐ ____
Crutches	☐ ____	Foot Control	☐ ____
Quad Cane	☐ ____	Shoes	☐
Cane	☐ ____	None	☐ ____
None	☐ ____	Other	☐ ____
Other ____ (please specify)	☐	____ (please specify)	

GMFM-88 SUMMARY SCORE USING AIDS/ORTHOSES

DIMENSION	CALCULATION OF DIMENSION % SCORES	GOAL AREA (indicated with ✓ check)
A. Lying & Rolling	Total Dimension A / 51 = ____ / 51 × 100 = ____ %	A. ☐
B. Sitting	Total Dimension B / 60 = ____ / 60 × 100 = ____ %	B. ☐
C. Crawling & Kneeling	Total Dimension C / 42 = ____ / 42 × 100 = ____ %	C. ☐
D. Standing	Total Dimension D / 39 = ____ / 39 × 100 = ____ %	D. ☐
E. Walking, Running & Jumping	Total Dimension E / 72 = ____ / 72 × 100 = ____ %	E. ☐

TOTAL SCORE = (%A + %B + %C + %D + %E) / Total # of Dimensions

= ____ / 5 = ____ = ____ %

GOAL TOTAL SCORE = Sum of %scores for each dimension identified as a goal area / # of Goal areas

= ____ = ____ %

A

PEDIATRIC BALANCE SCALE

Name: _____ Date: _____

Location: _____ Examiner: _____

Item Description		Score 0 - 4	Seconds optional
1.	Sitting to standing	_____	
2.	Standing to sitting	_____	
3.	Transfers	_____	
4.	Standing unsupported	_____	_____
5.	Sitting unsupported	_____	_____
6.	Standing with eyes closed	_____	_____
7.	Standing with feet together	_____	_____
8.	Standing with one foot in front	_____	_____
9.	Standing on one foot	_____	_____
10.	Turning 360 degrees	_____	_____
11.	Turning to look behind	_____	
12.	Retrieving object from floor	_____	
13.	Placing alternate foot on stool	_____	_____
14.	Reaching forward with outstretched arm	_____	
	Total Test Score	_____	

General Instructions

1. Demonstrate each task and give instructions as written. A child may receive a practice trial on each item. If the child is unable to complete the task based on their ability to understand the directions, a second practice trial may be given. Verbal and visual directions may be clarified through the use of physical prompts.

2. Each item should be scored utilizing the 0 to 4 scale. Multiple trials are allowed on many of the items. The child's performance should be scored based upon the lowest criteria, which describes the child's best performance. If on the first trial a child receives the maximal score of 4, additional trials need not be administered. Several items require the child to maintain a given position for a specific time. Progressively, more points are deducted if the time or distance requirements are not met; if the subject's performance warrants supervision; or if the subject touches an external support or receives assistance from the examiner. Subjects should understand that they must maintain their balance while attempting the tasks. The choice, of which leg stand on or how far to reach, is left to the subject. Poor judgement will adversely influence the performance and the scoring. In addition to scoring items 4, 5, 6, 7, 8, 9, 10, and 13, the examiner may choose to record the exact time in seconds.

Figure. No caption available.

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B

Equipment

The Pediatric Balance Scale was designed to require minimal use of specialized equipment. The following is a complete list of items required for administration of this tool:

adjustable height bench
chair with back support and arm rests
stopwatch or watch with a second hand
masking tape - 1inch wide
a step stool 6 inches in height
chalkboard eraser
ruler or yardstick
a small level

The following items are optional and may be helpful during test administration:

2 child-size footprints
blindfold
a brightly colored object of at least two inches in size
flash cards
2 inches of adhesive-backed hook Velcro
Two 1 foot strips of loop Velcro

****

1. **Sitting To Standing**

* ***Special instruction***: *Items #1 and #2 may be tested simultaneously if, in the determination of the examiner, it will facilitate the best performance of the child.*

INSTRUCTIONS: **Child is asked to "Hold arms up and stand up."** The child is allowed to select the position of his/her arms.

EQUIPMENT: A bench of appropriate height to allow the child's feet to rest supported on the floor with the hips and knees maintained in 90 degrees of flexion.

Best Of Three Trials

( ) 4	able to stand without using hands and stabilize independently
( ) 3	able to stand independently using hands
( ) 2	able to stand using hands after several tries
( ) 1	needs minimal assist to stand or to stabilize
( ) 0	needs moderate or maximal assist to stand

Figure. No caption available.

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c

2. **Standing To Sitting**

* ***Special instruction***: *Items #1 and #2 may be tested simultaneously if, in the determination of the examiner, it will facilitate the best performance of the child.*

INSTRUCTIONS: **Child is asked to sit down slowly, without use of hands.** The child is allowed to select the position of his/her arms.

EQUIPMENT: A bench of appropriate height to allow the child's feet to rest supported on the floor with the hips and knees maintained in 90 degrees of flexion.

Best Of Three Trials

( ) 4	sits safely with minimal use of hands
( ) 3	controls descent by using hands
( ) 2	uses back of legs against chair to control descent
( ) 1	sits independently, but has uncontrolled descent
( ) 0	needs assistance to sit

3. **Transfers**

INSTRUCTIONS: Arrange chair(s) for a stand pivot transfer, touching at a forty-five degree angle. **Ask the child to transfer one way toward a seat with armrests and one way toward a seat without armrests.**

Equipment: Two chairs, or one chair and one bench. One seating surface must have armrests. One chair/bench should be of standard adult size and the other should be of an appropriate height to allow the child to conformably sit with feet supported on the floor and ninety degrees of hip and knee flexion.

Best Of Three Trials

( ) 4	able to transfer safely with minor use of hands
( ) 3	able to transfer safely; definite need of hands
( ) 2	able to transfer with verbal cueing and/or supervision (spotting)
( ) 1	needs one person to assist
( ) 0	needs two people to assist or supervise (close guard) to be safe

Figure. No caption available.

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D

4. **Standing Unsupported**

INSTRUCTIONS: **The child is asked to stand for 30 SECONDS without holding on or moving his/her feet.** A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. The child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Weight shifting and equilibrium responses in feet are acceptable; movement of the foot in space (off the support surface) indicates end of the timed trial.

EQUIPMENT: a stop watch or watch with a second hand
a twelve inch long masking tape line or two footprints placed shoulder width apart

( ) 4 able to stand safely 30 SECONDS
( ) 3 able to stand 30 SECONDS with supervision (spotting)
( ) 2 able to stand 15 SECONDS unsupported
( ) 1 needs several tries to stand 10 SECONDS unsupported
( ) 0 unable to stand 10 SECONDS unassisted

_____Time in seconds

Special Instructions: If a subject is able to stand 30 SECONDS unsupported, score full points for sitting unsupported. Proceed to item #6

5. **Sitting With Back Unsupported And Feet Supported On The Floor**

INSTRUCTIONS: **Please sit with arms folded on your chest for 30 SECONDS**. Child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Time should be stopped if protective reactions are observed in trunk or upper extremities.

EQUIPMENT: a stop watch or watch with a second hand
a bench of appropriate height to allow the feet to rest supported on the floor with the hips and knees maintained in ninety degrees of flexion.

( ) 4 able to sit safely and securely 30 SECONDS
( ) 3 able to sit 30 SECONDS under supervision (spotting) or may require definite use of upper extremities to maintain sitting position
( ) 2 able to sit 15 SECONDS
( ) 1 able to sit 10 SECONDS
( ) 0 unable to sit 10 SECONDS without support

_____ Time in seconds

Figure. No caption available.

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E

6. **Standing Unsupported With Eyes Closed**

INSTRUCTIONS: The child is asked to stand still with feet shoulder width apart and close his/her eyes for ten seconds. **Direction: "When I say close your eyes, I want you to stand still, close your eyes, and keep them closed until I say open."** If necessary, a blindfold may be used. Weight shifting and equilibrium responses in the feet are acceptable; movement of the foot in space (off the support surface) indicates end of timed trial. A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position.

EQUIPMENT: a stop watch or watch with a second hand
a twelve-inch long masking tape line or two footprints placed shoulder width apart
blindfold

Best Of 3 Trials,

( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision (spotting)
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays steady
( ) 0 needs help to keep from falling

_____ **Time in seconds**

7. **Standing Unsupported With Feet Together**

INSTRUCTIONS: **The child is asked to place his/her feet together and stand still without holding on**. The child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Weight shifting and equilibrium responses in feet are acceptable; movement of the foot in space (off the support surface) indicates end of timed trial. A taped line or footprints may be placed on the floor to help the child maintain stationary foot position.

EQUIPMENT: a stop watch or watch with a second hand
a twelve inch long masking tape line or two footprints placed together

Best Of 3 Trials

( ) 4 able to place feet together independently and stand 30 seconds safely
( ) 3 able to place feet together independently and stand for 30 seconds with supervision (spotting)
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 30 seconds with feet together
( ) 0 needs help to attain position and/or unable to hold for 30 seconds

_____ **Time in seconds**

Figure. No caption available.

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F

8. **Standing Unsupported One Foot In Front**

INSTRUCTIONS: **The child is asked to stand with one foot in front of the other, heel to toe.** If the child cannot place feet in a tandem position (directly in front), they should be asked to step forward far enough to allow the heel of one foot to be placed ahead of the toes of the stationary foot. A taped line and/or footprints may be placed on the floor to help the child maintain a stationary foot position. In addition to a visual demonstration, a single physical prompt (assistance with placement) may be given. The child may be engaged in non-stressful conversation to maintain his/her attention span for 30 seconds. Weight shifting and/or equilibrium reactions in the feet are acceptable. Timed trials should be stopped if either foot moves in space (leaves the support surface) and/or upper extremities support is utilized.

EQUIPMENT: a stop watch or watch with a second hand
a twelve inch long masking tape line or two footprints placed heel to toe

Best Of Three Trials

( ) 4 able to place feet tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds. *Note*: The length of the step must exceed the length of the stationary foot and the width of the stance should approximate the subject's normal stride width.
( ) 2 able to take small step independently and hold 30 seconds, or required assistance to place foot in front, but can stand for 30 seconds.
( ) 1 needs help to step, but can hold 15 seconds
( ) 0 loses balance while stepping or standing

_____ **Time in seconds**

9. **Standing On One Leg**

INSTRUCTIONS: **The child is asked to stand on one leg for as long as he/she is able to without holding on.** If necessary the child can be instructed to maintain his/her arms (hands) on his/her hips (waist). A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. Weight shifting and/or equilibrium reactions in the feet are acceptable. Timed trials should be stopped if the weight-bearing foot moves in space (leaves the support surface), the up limb touches the opposite leg or the support surface and/or upper extremities are utilized for support.

EQUIPMENT: a stop watch or watch with a second hand
a twelve inch long masking tape line or two footprints placed heel to toe

3 Trials Average Score

( ) 4 able to lift leg independently and hold 10 seconds
( ) 3 able to lift leg independently and hold 5 to 9 seconds
( ) 2 able to lift leg independently and hold 3 to 4 seconds
( ) 1 tries to lift leg; unable to hold 3 seconds but remains standing
( ) 0 unable to try or needs assist to prevent fall

Figure. No caption available.

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G

10. **Turn 360 Degrees**

INSTRUCTIONS: **The child is asked to turn completely around in a full circle, STOP, and then turn a full circle in the other direction.**

EQUIPMENT: A stop watch or watch with a second hand

( ) 4 able to turn 360 degrees safely in 4 seconds or less each way (total of less than eight seconds)
( ) 3 able to turn 360 degrees safely in one direction only in 4 seconds or less completes turn in other direction requires more than four seconds
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision (spotting) or constant verbal cueing
( ) 0 needs assistance while turning

_____ **Time in seconds**

11. **Turning To Look Behind Left & Right Shoulders While Standing Still**

INSTRUCTIONS: **The child is asked to stand with his/her feet still, fixed in one place. "Follow this object as I move it. Keep watching it as I move it, but don't move your feet."**

EQUIPMENT: a brightly colored object of at least two inches in size, or flash cards
a twelve inch long masking tape line or two footprints placed shoulder width apart

( ) 4 looks behind/over each shoulder; weight shifts include trunk rotation
( ) 3 looks behind/over one shoulder with trunk rotation; weight shift in the opposite direction is to the level of the shoulder; no trunk rotation
( ) 2 turns head to look to level of shoulder; no trunk rotation
( ) 1 needs supervision (spotting) when turning; the chin moves greater than half the distance to the shoulder
( ) 0 needs assist to keep from losing balance or falling; movement of the chin is less than half the distance to the shoulder

12. **Pick Up Object From The Floor From A Standing Position**

INSTRUCTIONS: **The child is asked to pick up a chalkboard eraser placed approximately the length of his/her foot in front of his/her dominant foot.** In children, where dominance is not clear, ask the child which hand they want to use and place the object in front of that foot.

EQUIPMENT: a chalkboard eraser
a taped line or footprints

( ) 4 able to pick up an eraser safetly and easily
( ) 3 able to pick up eraser but needs supervision (spotting)
( ) 2 unable to pick up eraser but reaches 1 to 2 nches from eraser and keeps balance independently
( ) 1 unable to pick up eraser; needs supervision (spotting) while attempting
( ) 0 unable to try, needs assist to keep from losing balance or falling

igure. No caption available.

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H

13. **Placing Alternate Foot On Step Stool While Standing Unsupported**

INSTRUCTIONS: **The child is asked to place each foot alternately on the step stool and to continue until each foot has touched the step/stool four times.**

EQUIPMENT: a step/stool of four inches in height
a stop watch or watch with a second hand.

( ) 4 stands independently and safely and completes 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps >20 seconds
( ) 2 able to complete 4 steps without assistance, but requires close supervision (spotting)
( ) 1 able to complete 2 steps; needs minimal assistance
( ) 0 needs assistance to maintain balance or keep from falling, unable to try

_____ **Time in seconds**

14. **Reaching Forward With Outstretched Arm While Standing**

General Instruction And Set Up: A yardstick affixed to a wall via Velcro strips will be used as the measuring tool. A taped line and/or footprints are used to maintain a stationary foot position. The child will be asked to reach as far forward without falling, and without stepping over the line. The MCP joint of the child's fisted hand will be used as the anatomical reference point for measurements. Assistance may be given to initially position the child's arm at 90 degrees. Support may not be provided during the reaching process. If 90 degrees of shoulder flexion cannot be obtained, then this item should be omitted.

INSTRUCTIONS: **The child is asked to lift his/her arm up like this. "Stretch out your fingers, make a fist, and reach forward as far as you can without moving your feet."**

3 Trials Average Results

EQUIPMENT: a yardstick or ruler
a taped line or footprints
a level

( ) 4 can reach forward confidently >10 inches
( ) 3 can reach forward >5 inches, safely
( ) 2 can reach forward >2 inches, safely
( ) 1 reaches forward but needs supervision (spotting)
( ) 0 loses balance while trying, requires external support

_____ **Total Test Score**
Maximum Score = 56

Figure. No caption available.

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