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EFFECTIVENESS OF THERAPEUTIC HORSE BACK RIDING SIMULATORS OVER HIPPOTHERAPY ON SITTING BALANCE IN SPASTIC CEREBRAL PALSY CHILDREN – A LITERATURE REVIEW BASED COMPARATIVE STUDY.

BY

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ABSTRACT

BACKGROUND AND PURPOSE: In the recent literature we can find many articles dealing with effectiveness of therapeutic horseback riding simulator over hippotherapy for the sitting balance in spastic cerebral palsy children. Cerebral palsy (CP) is a static, non-progressive disorder caused by brain insult or injury occurs before birth, around the time of birth. Postural control is key important for performing daily activities like sitting, standing and for gait. Lack of postural control is one of the major problems faced by most of the cerebral palsy children. Horseback riding simulator (THRs) consists of devices that mimic movement of real horse. Hippotherapy is cost effective and it is uncommonly used therapeutic approach in cerebral palsy children in the training of postural control. This study is to review literature and to compare the effectiveness of therapeutic horseback riding simulator (JOBA, Panasonic inc.) over hippotherapy on sitting balance in spastic cerebral palsy children.

AIM AND OBJECTIVES: To review the literature on the comparison of the effectiveness of therapeutic horse back riding simulators over hippotherapy on sitting balance by Pediatric Balance Test (PBS) , Gross Motor Function Measures – 66 Sitting Dimension (GMFM-66) in spastic cerebral palsy children.

METHODOLOGY: Due to Covid-19, we carried the review of literature and analysed the publications from past 20 years. Herewith submitting the review of the study named A Comparative Study on the effectiveness of therapeutic horse back biding simulators over hippotherapy on sitting balance in spastic cerebral palsy children. This literature review focused on controlled randomized studies, reviews, meta-analysis published in the English language from 2000-2020.

The research was conducted by using fallowing search engines: Google scholar, PubMed and MEDLINE with fallowing key words: Cerebral Palsy, Spasticity, Therapeutic Horse Back Riding simulator, Hippotherapy, Sitting Balance.

RESULTS: 40 articles were reviewed in this study,18 were excluded although the current level of evidence is weak, our review found that children with spastic CP, Gross Motor Function Classification System (GMFCS) levels I–III, aged 5 years and above were likely to have significant improvements on gross motor function and their sitting balance , as a result of hippo therapy and therapeutic horse back riding simulator. Evidence indicates that 40-min a session, 3times a week for 8–16 weeks, result in significant effects.

CONCLUSION: This review concluded that sitting balance is recovered by using Therapeutic horse back riding simulator than hippotherapy through the mechanism of sensorimotor stimulation, increased righting and equilibrium reactions. The improvement in functionality was found to be greater in spastic type of CP than the other types. It appears that therapeutic horse back riding simulator has shown more effect on the improvement of gross motor function and sitting balance than hippotherapy in children with spastic cerebral palsy.

KEY WORDS: cerebral palsy, spastic cerebral palsy, Therapeutic horseback riding simulator (THRs), Hippo therapy (HT), equines assisted therapy, paediatric balance Scale (PBS), Gross motor function measure -66 (GMFM-66)

GENERAL INTRODUCTION:

Cerebral palsy (CP) is a static, non progressive disorder caused by brain insult or injury in the prenatal, perinatal, and postnatal time period, is the major developmental disability affecting function in children. The first history of cerebral palsy by Dr William Little in 1860's explains that "A persistent disorder of movement and posture appearing early in life and due to developmental non progressive disorder of the central nervous system.It is a group of permanent movement disorders that appear in early childhood. Signs and symptoms vary among people and over time (1)(2). Often, symptoms include poor trunk balance, coordination, stiff muscles, weak muscles, and tremors(2). There may be problems with sensation, vision, hearing, swallowing, and speaking(3)(4). Spastic cerebral palsy is the type of cerebral palsy characterized by spasticity or high muscle tone often resulting in stiff, jerky movements(5). Spasticity is characterized by muscles that are perceived as stiff in which velocity dependent resistance to passive movement produces increased muscle tone, selective control is limited producing abnormal and limited movement synergies, the active range of motion is limited by co-activation of muscular activity and the timing of muscle activation and postural responses is abnormal. Spastic CP is the commonest type (5).

Despite efforts in prevention and acute treatment, cerebral palsy remains the leading cause of children, adolescent, and adult disability in world. Cerebral palsy can cause substantial motor, sensory and perceptual dysfunction that compromises ability to perform valued activities in children and adult life.

Postural problem plays a central role in the motor dysfunction of children with cerebral palsy. Therefore, children spend more time in sitting than standing to perform vital tasks of daily life. In general, children with CP exhibit muscular activity counter acting forces that disturb equilibrium. Only non-sitting children with CP lack such direction specific adjustment, possibly ruling out achievement of independent sitting (6). A primary goal in rehabilitation is to find a sitting position that gives the child an opportunity to control the arm and the hand in an optimal way in such activities as eating, communication, and dressing (7) .

Hippo therapy (HT): It is a uncommon, new therapeutic technique used to improve postural balance in children with cerebral palsy. The term hippotherapy means treatment with the help of the horse. It was originated from the Greek word hippos, which means horse. More specifically, the warmth, shape, and rhythmical three-dimensional movement produced at the horse's hips and pelvis as the hind legs move forward at the walk, provides a movement challenge to the children(8). Most of the research has been on the rehabilitative or therapeutic benefits, especially as applied to physical impairments, which incorporate primarily the areas of posture, balance, strength, coordination, and sensorimotor programming. It is limited in clinical practice for various reasons such as fear of fall, difficulty of maintaining a horse, climate(indoor) and financial considerations (9).

Therapeutic horse back riding simulator : The therapeutic results obtained from hippotherapy treatment has encouraged research in to developing an advanced hippotherapy simulator that "imitates" the real horse movement. THRs is a device that has an advantage of low cost effect and easily accessible in indoors such as clinics, hospitals, schools and rehabilitation centres. During THRs, 3 dimensional movements such as walk up

and down, side to side, front to back are produced and the device may transmits a sensorimotor experience to the rider which corresponds closely to the input received by normal human gait and improve postural control in CP children (10).

On the basis of this knowledge, we aimed to study and review the literature on the comparison of the effectiveness of therapeutic horse back riding simulators over hippotherapy on sitting balance in children with spastic cerebral palsy.

AIM OF THE STUDY

To review the literature on the comparison of effectiveness of therapeutic horseback riding simulators over hippo therapy on sitting balance in spastic cerebral palsy children.

NEED OF THE STUDY

- Cerebral palsy is a disorder of movement, tone, posture and trunk imbalance.
- This imbalance leads to increased activity in the muscles impacting on posture and walking patterns, which causes limitation of ADL and independence.
- Compared to the other therapies, hippotherapy is a complete playful and enjoyable activity that seems more fun rather than regular therapy work for CP children.
- Riding, touching and simply being around horses can release endorphins which produce happy feeling in a person. It can also help children develop positive traits such as self-esteem, empathy, self-concept, self –control and social interactions (11).
- The main potential beneficial effect of hippotherapy is human - horse interaction acting as a powerful motivator for engaging children to participate in the therapy.
- Hippotherapy is a great choice and helps in multiple aspects of children life through this one activity but it has a limitation like utilizing the live horse due to high cost and unavailability (12).
- Whereas, therapeutic horseback riding simulator has an advantage of easily utilization indoors such as rehab centers, hospitals, schools and home.
- It is effective and easy to handle the device.
- Many studies have been done on the efficacy of hippotherapy and therapeutic horse back riding on sitting balance and postural control in spastic cerebral palsy children. Very few studies were done comparing the effectiveness of one over the other.
- Due to Covid -19, we carried a study by the reviewing of literature on the comparison on the effectiveness of therapeutic horse back riding simulator over hippotherapy on sitting balance in children with spastic cerebral palsy.

OBJECTIVES OF THE STUDY

- To review the literature on the comparison of the effectiveness of therapeutic horseback riding simulators over hippo therapy on sitting balance through PEDIATRIC BALANCE TEST (PBS) in spastic cerebral palsy children.

- To review the literature on the comparison of the effectiveness of therapeutic horseback riding simulators over hippo therapy on sitting balance by GROSS MOTOR FUNCTION MEASURES – 66 SITTING DIMENSION (GMFM-66) in spastic cerebral palsy children.

MATERIALS AND METHODS

A structural literature review based study was done by using electronic and print database.

STUDY DESIGN:

Literature review based study (Articles of duration from 2000 to 2020)

SOURCE OF DATA:

Relevant articles were identified by searching

- Google scholar
- PubMed
- Medline

- Methods: This study was conducted to compare the efficacy of therapeutic horse back riding simulator over hippotherapy on sitting balance in spastic cerebral palsy children. We analysed the publications from these 20 years relevant articles. The key words used were “cerebral palsy”, “Therapeutic horse back simulator”, “Hippotherapy”, “equines assisted therapy”, “Paediatric balance scale” and “Gross motor function measure-66 sitting dimension”. we also searched texts for these terms and their combinations.

- This study included only randomised controlled studies and meta-analysis published in the English languages for which the main judgement criteria included was effectiveness of therapeutic horse back riding over hippotherapy on sitting balance in spastic cerebral palsy. Thus, among 40 initially identified studies,18 were excluded and 22 studies were included for analysis. We differentiated the the type of cerebral palsy and according to the outcome measures available for each study, only gross motor function measure-66 and paediatric balance scale mentioned studies were evaluated.

In the first part, we underlined theoretical frame work and in the second part, we described the application of therapeutic horse back riding simulator and hippotherapy. In the third part, the reviews related to the these therapies were explained and compared.

INCLUSIVE CRITERIA:

- Study population: Age: 5 - 15 years
- Body weight < 35 kg. Sex: both male and female spastic cerebral palsy children.
- Subjects in study have a diagnosis of CP (all types), with GMFCs between (2-4).
- Hippotherapy or Therapeutic horse back riding simulator was the primary intervention.
- A physical therapist, occupational therapist, or an accredited therapeutic riding instructor implemented the intervention
- Time period :2020- 2021 year
- Publication criteria: written in English, any country.
- Search engine words: hippotherapy, therapeutic horseback riding simulator, equines assisted therapy, spastic cerebral palsy.

EXCLUSIVE CRITERIA:

- Studies prior to 2000
- Subjects aged >18 years and older
- Studies which were not available in full text
- Studies which were not available in English
- Studies which have not yet been published (grey literature)
- Studies in which qualitative research design was used.

Child with following complications:

- Uncontrolled seizures.
- Selective dorsal rhizotomy or orthopedic surgery within 1 year.
- Moderate to severe intellectual disability.
- Poor visual acuity.
- Sever auditory problems.
- Child with history of botulism toxin injection within 6 month.
- Child with congenital problems.
- Chronic cardio respiratory disorders.

REVIEW LITERATURE

1. INTRODUCTION:

- Cerebral Palsy is a group of permanent, but unchanging, disorders of movement and/or posture and of motor function, which are due to a non-progressive interference, lesion, or abnormality of the developing/immature brain In 1860s, known as "Cerebral Paralysis" or "Little's Disease" (1, 2 ,13).

- A motor function disorder, caused by permanent, non-progressive brain lesion , present at birth or shortly thereafter. It is a Non-curable, life-long condition Damage doesn't worsen. CP May be congenital or acquired (14) .

- Cerebral palsy (cp) is a static, non-progressive disorder caused by brain insult or injury that occurs before birth, around the time of birth or up to age of about 3 years, while brain is still undergoing rapid development In addition, movement and postural disorders occur due to damage to the motor cortex, and deformations increase with growth as a result of chronic muscle imbalance (14,15).

- One of the biggest problems that children with CP face is defective postural control, as the ability to maintain postural control is a very important element with regard to activities of daily living (ADL) and independent living.

- Although balance maintenance and posture control are automatic responses, these are challenging for children with CP. Cerebral palsy may have several associated comorbidities, including epilepsy, musculoskeletal problems, intellectual disability, feeding difficulties, visual abnormalities, hearing abnormalities, and communication difficulties (1),(2).

- In particular, harmony between the diaphragm, the pelvis, the abdominal wall, and the spinal extensor is essential for the stability of the lower thoracic vertebrae and the lumbar vertebrae (16).

- The harmony of the afferent activities of the diaphragm and the pelvis is achieved by the efferent contraction of the abdominal wall muscles, and this muscular harmony increases pressure on the internal abdominal wall to enhance trunk stability. Therefore, spinal posture is very important for children with CP (17).

- Children with CP have spasticity, musculoskeletal problems, mobility disturbances and decreased pelvic movement that lead to awkward movement and sitting posture.

- Spasticity: "A condition in which certain muscles are continuously contracted, this contraction causes stiffness or tightness of the muscles and can interfere with normal movement, speech, and gait (18).

- Spastic Diplegia: "A form of cerebral palsy, a neurological condition that usually appears in infancy or early childhood, and permanently affects muscle tone which leads to spasticity (stiff or tight muscles and exaggerated reflexes) in the legs(19).

Time frame for brain injury**:**

Cerebral palsy if the brain damage arises during one of the following periods:

A. Prenatal Period - Conception to the onset of labour

B. Perinatal Period - 28 weeks intrauterine to 7 days

C. Postnatal Period -First two (and some say 5) years of life (20).

2. INCIDENCE &PREVALENCE:

- According to World Health Organization (WHO) estimation, 10% of the global population has some form of disability due to different causes; in India, it is 3.8% of the population. Nearly 15-20% of the total physically handicapped children suffer from Cerebral Palsy (21).
- Since the early description of CP, the chief suspects as etiologic factors in CP have been birth asphyxia and obstetric calamities.
- These do occur, but current evidence indicates that they account for only small proportion of CP in western countries. In India still this may be the major cause, however, no data is available. (17) (18).
- Further, it is not clear that these occurrences are preventable without interventions that might harm more mother-infant pairs that they would benefit (22).
- In India, the estimated incidence is around 3/1000 live births. Cerebral palsy is the most common motor disability in childhood (23).

3. CLASSIFICATION INCIDENCE:

- The topographic classification of CP is monoplegia, hemiplegia, diplegic and quadriplegia. Monoplegia and triplegia are relatively uncommon (24).
- There is a substantial overlap of the affected areas, diplegia is the commonest form at 30% – 40%), hemiplegia is 20% – 30%, and quadriplegia accounts for 10% – 15%.
- In an analysis of 1000 cases of CP from India, it was found that spastic quadriplegia constituted 61% of cases followed by diplegia 22%
- Spastic CP is the commonest and accounts for 70%-75% of all cases, dyskinetic for 10% to 15% and ataxic for less than 5% of cases (25).

4. **RISK FACTORS: (26)**

TABLE: 1

S.NO	PRENATAL (MATERNAL/FATAL/PLACENTAL)	PERINATAL	POSTNATAL
1.	Iodine deficiency, iron deficiency and Poor nutrition)	Birth asphyxia	Central nervous system infection such as viral encephalitis, TB meningitis, Pyomeningitis.
2	Intrauterine infection , high fever , Urinary tract infection.	Prematurity	Anoxia
3	Chorioamnionitis	Intrauterine growth retardation, breech, forceps delivery.	Head injuries
4	Maternal diseases such as : Hypertension Diabetes mellitus, hyperthyroidism	Intra ventricular And Intracerebral Bleeds.	Suffocation
5	Teratogens: drugs , radiation ,smoking , alcohol, and environment toxins .	Hypoglycaemia, dyselectrolytemias	Electrocution
6	Fertility problems eg: advanced age at conception, history of infertility, recurrent , fetal wastage.	Sepsis, pneumonia and meningitis	Postoperative cardiac arrest
7	Poor antenatal care, poor socioeconomic status	Premature separation of placenta	Cerebral vascular accident, dehydration.

5. **AETIOPATHOPHYSIOLOGY:**

- There are many ways of classifying CP, but the simplest is according to number and distribution of affected limbs: monoplegia, hemiplegia, diplegia, triplegia, and quadriplegia (24,23).
- As a rule, hemiplegia is associated with late third trimester injuries, by contrast, the risk of brain injury increases with prematurity.
- The relationship between gestational age and CP phenotype is well-established. Knowledge of the sequences of embryonic and fetal brain development establishes the timing of brain injury (27).
- The finding of disordered migration, such as lissencephaly or gray matter heterotopias, indicates damage occurring before 22 weeks' gestation that disturbs normal neuronal migration.
- Periventricular leukomalacia denotes destruction or wasting of the white matter.

- The susceptibility of fetal brain to periventricular leukomalacia varies according to gestational age, peaking at 28 weeks with a steep fall in both early postnatal death and periventricular leukomalacia thereafter (27,28).

- Periventricular leukomalacia presents as diplegia and accounts for about 70% of CP in babies born before 32 weeks' gestation and 30% of CP in term babies suggesting a common antenatal origin during the period of oligodendroglia activity and resultant myelination (27).

- Late third trimester insults tend to affect both gray and white matter structures, resembling the typical stroke patterns encountered postnatal (26).

TABLE: 2 5a. ETIOPATHOLOGY (26, 27).

CP TYPE	PATHOLOGY	UNDERLYING ETIOLOGY
Spastic diplegic	1.Periventricular Leukomalacia 2. Periventricular Haemorrhage. 3.Venous Infraction	1. Prematurity
Spastic quadriplegia	1. Multisystem Encephalopathy with Cortical Atrophy. 2. Selective Neuronal Necrosis. 3. Parasagittal Cerebral Injury. 4. Cerebral Malformation	1.Perinatal/ Intrauterine 2.Hypoxic – Ischemia Events.
Spastic hemiplegia	1. Cerebral Injury Middle cerebral artery Territory. 2. Cerebral Malformation	1.Genetic 2.Prenatal Events Like Hypo Perfusion Haemorrhage 3.Genetic
Dyskinetic	1. Basal Ganglia 2. Stratus Marmoratus 3. Bilirubin Deposition	1.Perinatal Asphyxia 2.Neonatal Hyperbilirubinemia
Ataxic, hypotonic	1.Cerebral Lesions 2.Enlarged Ventricles.	1.Prenatal (Genetic)

6. CLASSIFICATION OF CEREBRAL PALSY:

PHYSIOLOGICAL CLASSIFICATION: (24,26)

A. Spastic Cerebral Palsy

B. Hypotonic Cerebral Palsy

C. Dyskinetic Cerebral Palsy

D. Ataxic Cerebral Palsy

E. Mixed Cerebral palsy

TOPOGRAPHICAL CLASSIFICATION:

A. Monoplegia

B. Paraplegia

C. Diplegic

D. Triplegia

E. Quadriplegia / Tetraplegia.

A. Spastic cerebral Palsy : clinical findings and features:

- Increased stretch reflex in muscle ,
- Clonus, positive Babinski sign ,
- Strabismus ,
- Persistence of primitive reflexes,
- Total pattern of movement ,
- Lack of selective control ,
- Associated reactions ,
- Repetitive stereotyped movement ,
- Exaggerated co-contraction ,
- Disturbance of equilibrium reactions,
- Primary and secondary visual impairments,
- Perceptual problems ,

- Spasticity increasing with emotional states(26).

B. Spastic diplegia:

- Lower limbs primary involved,
- Mild affection of upper limbs (fine-motor),
- 50% of children with spastic cp have diplegia.
- History of prematurity is usual also common in more low birth babies (periventricular leukomalacia).
- Intelligence usually is normal and epilepsy is less common.

C. Spastic quadriplegia:

- In spastic quadriplegia all four limbs,
- The trunk and muscles that control mouth, tongue, and pharynx are involved.
- When one upper extremity is less involved term tetraplegia is used .
- 30% of children with spastic cp have perinatal hypoxic ischemic encephalopathy.

D. Hypotonic cp / flaccid cp:

- Sever hypotonia or flaccidity is present,
- May persist as weakness and a generalized floppiness.
- infants has inability to generate muscle force ,
- Particularly against gravity ,respiration is shallow ,
- Flaring of the ribs seen ,
- Children's take up wider base of support ,
- Cannot generate co-contraction ,
- Processing of proprioceptive ,
- Tactile system affect, strabismus ,
- Visual field defects and refractive error may be present,
- Excessive range of motion, joint laxity, postural control being done by arms.(25).

E. Dyskinetic cp:

- Dyskinetic cp accounts for approx...10-15% of all cases of cp. Hyperbilirubinemia or sever anoxia causes basal ganglia dysfunction. Involuntary movements, quick and changing between rapidly between flexion and

extension(23,24).

Types: 1. Athetosis 2. Chorea 3. Choreoathetosis 4. Dystonia.

Features includes:

- No fixed posture ,
- Lack of fixation ,
- Fluctuating tone , insuffient grading , asymmetry.
- Poor head control ,
- Total pattern of movement ,
- Speech and breathing difficulty ,
- Hearing loss,
- Visual disturbances ,
- Emotionally labile,
- Fleeting irregular irregular localized contraction ,
- Mobile spasm ,
- Alternation of flexion /extension ,
- Pronation/supination.
- And intermittent tonic spasm,
- Wind sweeping hips.

F. Ataxic cp :

- Uncommon in cp , associated with cerebellar lesions ,hydrocephalus, head injury , encephalitis .
- Ataxic is loss of balance , co-ordination ,and fine motor control may be hypotonic during first 2 years of life. muscles tone becomes normal and ataxic becomes normal and ataxia becomes apparent towards age of 2-3 years(26).
- Gait is wide –based, dysmetria, intentional tremors, and titubation of head, and truncal sway, nystagmus, and co –contraction poor, jerky quality of movements.
- Poor proximal fixation, inadequate balance reaction and slow or delayed protective responses(26,27).

BALANCE PATHOMECHANICS IN CP:

- The neuromuscular impairment in children with CP are manifested in abnormal posture and loss of selective motor control, poor and balance which contributes to poor postural control with significant limitation in their activity of daily living. **(28)**

- Balance and upright posture control are fundamental components of movement which plays a major role in maintaining the body in equilibrium in a given sensory environment, with anticipation and automatic postural adjustment (29)**.**

- Postural control developed during early life is complex and term process.

- During this process of development, the postural control mechanism provides a vertical posture of stabilizing head and trunk against gravity to allow a proper base for performing adequate activities like sitting, reaching, standing, and walking **(30)**.

- The trunk plays a key role in maintaining the postural control mechanism **(9)**, and also in the organization of balance reactions in this development process (31).

- The trunk control also required for a stable base of support which is necessary to execute functional activities for limbs movements (32).

- One of the key fundamentals of cp child is a deficient postural control mechanism and it is necessary for the therapist to evaluate trunk impairment and improve the functional performance of such children.

- Posture was defining through reflex terminology and facilitated through controlled sensory feedback. Infants were evaluated for the presence or absence of and the strength of primitive reflexes (32).

- Posture activity is noted when the child has muscle activation against the supporting surface (33).

- In addition, movement and postural disorders occur due to damage to the motor cortex, and deformations increase with growth as a result of chronic muscle imbalance.

- CP child faces is defective postural control and the ability to maintain postural control is a very important element with regard to activities of daily living (ADL) and independent living(33,34).

- Although balance maintenance and posture control are automatic responses, these are challenging for children with CP.

- In particular, harmony between the diaphragm, the pelvis, the abdominal wall, and the spinal extensor is essential for the stability of the lower thoracic vertebrae and the lumbar vertebrae(35).

- The harmony of the afferent activities of the diaphragm and the pelvis is achieved by the efferent contraction of the abdominal wall muscles, and this muscular harmony increases pressure on the internal abdominal wall to enhance trunk stability(36).

- Therefore, spinal posture is very important for children with CP

7. TREARTMENT APPROACHES FOR IMPROVING SITTING BALANCE & POSTURE:

To improve postural control and motor function, an intensive and focused physical therapy is required. Major therapies for posture, balance training includes traditional physiotherapy, neurodevelopmental training(Bobath-method), adeli suit treatment, proprioceptive neuromuscular facilitation, vojta –method, trunk stabilization exercises, Swiss balance exercises etc.

8 a. NEURODEVELOPMENTAL TRAINING (NDT):

- Neurodevelopmental therapy (NDT) is the most widely used therapeutic approach in the treatment of children with CP(37).
- It aims to target the central nervous and neuromuscular systems and teaches the brain to improve motor efficiency and obtain maximal functional independency by facilitating typical postural-controlled movements.
- Task-oriented training, one of the principles of NDT, has shown to be effective in improving the performance, promoting intensive, meaningful, and goal-oriented training(38).
- Task-oriented activities based on neurodevelopmental therapy principles on trunk control, balance, and gross motor function gives beneficial effect in CP children.
- Activities in the NDT were carried out by considering the components of dynamic stability of trunk through active weight shifts, trunk elongation on an optimal alignment to attain a controlled mobility for reaching an object through facilitation by guiding hands on approach would have contributed to achieve optimal motor recruitment required for the improvement in balance, trunk control, and gross motor function in children of NDT.
- NDT gives greater improvement in gross motor function measure and balance with task-oriented training in children with Cerebral palsy. This proves that truncal stability is an essential core component of balance and coordinated extremity use in daily functional activities and performance of higher level motor tasks(38,39).

8b. SWISS BALL TRAINING:

- Swiss ball is an effective and adaptive equipment to develop the trunk balance and postural stability(40).
- Swiss ball training helps the patient to move aligned trunk forward and backward in space, detect weakness in the abdominal muscles, stretch the ventral chain of the trunk, train balance and equilibrium reactions, facilitate lateral flexors, strengthen the abdominal muscles, stabilize the trunk, evaluate trunk balance, facilitate trunk rotation and stabilize trunk extension(41).
- The Swiss ball is an effective tool for developing the trunk muscle activity, strengthen the core muscles of the trunk and maintain the stability in upright positions and it gives freedom to the upper limb activities. In swiss ball training , all types of weight shifting is activated with minimal transitions so that the energy expenditure of

the therapist is less than the other adaptive aids. This approach is more significant than the conventional treatment approach (42).

8c. ADELI SUIT THERAPY:

- The Adeli suit was originally designed for the Russian space program in 1971. The suit was developed for the maintenance of muscle tone in a weightless environment, such as that of a spaceship worker . It was designed to create a normal framework of forces on the body for stabilizing the torso to allow for more fluent and coordinated movement of all limbs. It uses a system of elastic bands and pulleys that create artificial forces against which the body can work in order to prevent muscular atrophy(43).

- The suit is composed of a cap, a vest, shorts, knee pads, shoes with attached auxiliary equipment, and a bungee cord to connect auxiliary equipment. The pieces are laced together with bungee type cords. The cords are adjustable for the application of varying degrees of tension to the child's different muscle groups. The bungee cords are positioned to keep the body properly aligned and to forcibly encourage movement within a normal range of motion (44).

- The Adeli suit treatment (AST) has been proposed as an intensive exercise protocol for use in the management of cerebral palsy (CP).

- The mechanism behind the Adeli suit is that through active movement therapy, the brain is stimulated and thus is retrained to recognize, and eventually initiate, correct movement of the muscles.

- An increase in the input of proprioception and significant information from the vestibular organs can affect body position, balance, and posture tension.Through active movement therapy with AST, the brain is stimulated and thus is retrained to recognize, and eventually initiate the correct movement of the muscles, resulting in the improvement of body alignment through trunk stability, along with improved walking patterns (45).

8d. NECK, TRUNK STABILIZATION EXERCISES:

- During normal development of a child, one of the muscles do7es not affect the body, but it develops through complementary movements, so stabilization of the neck and stabilization of the trunk should be done together.

- Neck and trunk stabilization exercises, postural control exercises that promote a sense of equilibrium and orientation responses(46).

- Trunk stabilization exercises are a basic component of the motility of the distal part of the body, including neck movements. several studies have shown the importance of trunk stabilization exercises for these movements(47).

- Children with spastic cerebral palsy are characterized by trunk muscle weakness, which has direct effects on the functional performance of activities of daily living, and insufficient static and dynamic balance abilities(48).

- Therefore, the recovery of trunk stability and balance ability can be essential for solving these problems among the children with cerebral palsy.

- These exercises can be performed on mat, table, on Swiss ball for better improvement in posture and balance(47,48).

8e. VOJTA THERAPY:

- In between 1950 and 1970 a child neurologist, Prof. Dr. Vaclav Vojta discovered a therapy for trunk and posture control problems that is called vojta therapy. Vojta therapy is based on the principle of reflex locomotion i.e., giving the correct stimulation to the different zone that activate central nervous system (49).

- It is seen that a like stimulation when given to their body in certain positions. Repeating giving these stimulation the previously blocked connections between the spinal cord and the brain become available. Vojta therapy activates the patient's whole body to attain better posture and further particular movements (50).

- Vojta Principles :-. The basic principle of vojta locomotion is the maintenance of posture through isometric contraction of muscle during point stimulation, there by certain constant patterns of muscles contraction. Reflex locomotion means motor reactions occurring throughout the entire body as a result of specific peripheral stimulation given to specific body parts (zone) with the patient placed in specific position. Children responded to certain stimuli in certain body positions with repeated motor reaction in the trunk and extremities. The main positions used are – prone , supine and side lying(51).

8f. PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF):

- PNF is a technique used to facilitate the response of neuromuscular processing through a proprioceptive stimulus (52).

- PNF deploys a distinctive diagonal pattern which in turn stimulates the proprioceptive sensation (muscle spindle and Golgi tendon organ) and it also stimulates other deep sensory receptors for vibration, pressure, tactile discrimination and kinaesthetic sensation (53).

- So it may collectively improve muscle strength, flexibility, inter and intramuscular coordination, balance and other functional activities.

- The principles and techniques of PNF are predominantly beneficial when consolidated along with the proper selection and implementation of joint and soft tissue mobilization techniques. PNF deploys a distinctive helical or diagonal pattern which in turn stimulates the proprioceptive sensation and promotes nerve root response, thus enhancing functional movements and stimulating weakened muscles.

- The weakened muscles, thus functions more constructively and beneficially with the action of the antagonistic muscle when compared to their individual action alone(54).

- It stimulates proprioceptors within the tendons and muscle, thus improving strength of muscle, flexibility, function and balance. As proprioceptive sensation is a key component PNF exercises helps in improving trunk stability (55).

8g. HIPPOTHERAPY:

- Hippo therapy means treatment with the aid of a horse. (56)
- Despite long-term use in history, only a few studies have been performed on its theoretical basis.
- Only scarce information is available on its psychological, physical, social, and educational effects in specially trained children.
- Hippo therapy is a treatment method with concurrently favorable psychological, social, and educational effects on many organ systems including sensory, musculoskeletal, limbic, vestibular, and ocular systems (57).

HISTORY:

Hippo therapy in the world Hippo therapy consists of the words meaning “horse” “hippos”, and “treatment” “therapy” in ancient Greek. It is defined as equine-assisted treatment.

- Firstly, it was mentioned in the works of Hippocrates. However, it has not become a discipline with an established protocol up to 1960s (58).
- During 1960s, it is used as an adjunct to traditional physical therapy in Germany, Austria, and Sweden.
- In countries as Germany, Austria, and Sweden which used the horse in physical therapy the term “hippotherapy” was introduced into medical literature.
- During 1970s in the United States of America, hippotherapy was started to be standardized (57) (58).
- It was standardized by a group of Canadian and American therapists who traveled to Germany in order to learn hippotherapy near the end of 1980s.
- American Hippotherapy association was founded in the year 1992, and established an official and international protocol.
- In the year 1994 certification document and standards for certified hippotherapy clinical specialist were established, and in 1999 the first certification examination was realized (57).
- This certification program consists of three steps, and encompasses a training period of 3 years (59).

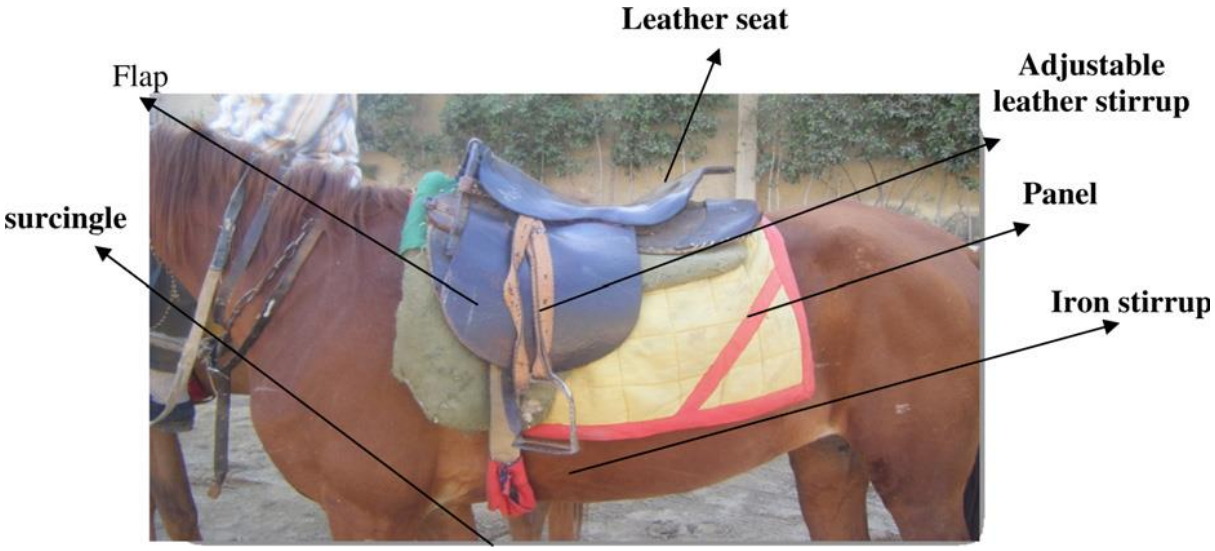


Figure 1: Hippotherapy back sitting

Advantages of Hippotherapy;

1. During ambulation, the horse provides a rhythmic movement which stimulates anterior, and posterior swinging movements.
2. Movements of the horse encourage the rider to achieve a proper balance, and posture.
3. The horse and those around provide the rider a large spectrum of sensory and motor input.

- Horseback riding provides effective and sensory stimulation for its rider through variable, rhythmic, and repetitive movements of the horse (59) (16).

- The movement of the horse mimics the normal movements of the human pelvis during walking.

- Variations in horse gait enable therapist to measure sensory stimulation and integrate these measurements with clinical therapies so as to arrive at desired outcomes (59).

- A horse's pelvis has a multidimensional movement (variable, rhythmic and repetitive) which is similar to the pelvis a human. Sitting astride a horse would involve about every muscle group in the body (58).

- However, about the environment of hippotherapy, it could activate all kinds of sensory integration such as tactile, vestibular, visual, olfactory and proprioceptive stimulation (60).

- Another study has proved that each minute astride a horse stimulate a child's brain with up to 1000 nerve impulses. It has also been clinically proven that just being in the vicinity of horses causes changes in the brainwaves patterns.

- Thus, without even realizing it, this environment presents patients with a range of stimuli for the brain to process (60) (61).

- It is a form of physical therapy, which a therapist uses the characteristic movements of a horse.

- This movement provides physical therapy and sensory input which is variable, rhythmic a repetitive which leads to improvement in spasticity and balance

- It is a form of physical, which a therapist uses the characteristic movements of a horse (62). This movement provides physical and sensory input which is variable, rhythmic a repetitive which leads to improvement in spasticity and balance (63).

Figure 2: Hippotherapy Sessions Sequence.

- These movements while on a horse are especially beneficial for children who have limited mobility because the movement of riding a horse mimics that of a person walking, therefore allowing the rider to experience the motions without needing to actually walk themselves (64).

- Children where a helmet while riding the horse and usually sit on a pad on the horses back rather than in a saddle to get as much natural movement from the horse as possible (65).

8h. THERAPEUTIC HORSE BACK RIDING SIMULATORS:

- Hippotherapy simulator or THR simulator (JOBA, Panasonic Inc., japan) is a mechanical device, core trainer exercise equipment (66).

Figure: 3 THR simulator

- Similar to the movement of a live horse, could be experienced figure shaped movement using 5 axes. THRs is allows working at 9 speeds and 3 pre-defined programmers (basic conditioning, waist, hips).

- This simulator was designed to be in fitness center, and easier to use, this system offers 3 automated training routines, which fits the children such as followings: (23) Workout: Side to Side movement such as forward movement of waist, backward tilt of hip.

- These training routines can automatically modify the speed and tilt of one of each one of the training sub phages in the JOBA or PANASONIC INC JAPAN simulator (23).

- The children were allowed to control their posture, and were instructed or held him/her to maintained tension in cervical spine so that they could keep their back accurately upright when they were sitting on saddle and were instructed to hold the handles using their upper extremity while they were sitting on the horseback riding stimulator (66).

- During therapeutic horse back simulator treatment for safety purpose exercises or implemented with one physical therapist.

- The level of difficulty for the exercise was increased with regard to each child s adaptation capacity and intensity of the exercise by gradually increasing the speed of the movement.

- Therapeutic horseback Simulators is a form of hippotherapy, imitates the passive movement of horseback riding (67)

- It was developed to overcome the limitation of hippo therapy such as unavailabity and high cost (67).

• The device offers an indoor experience of horseback riding, thereby promoting muscular strength and improves sense of balance (68).

Figure: 4 THR simulator equipment

8. **REVIEWS**

9a. Studies Related to GMFM-66 Sitting Dimension in Hippotherapy and Therapeutic horseback riding simulator**:**

1. Borges et al, 2011 conducted a study on therapeutic effect of horse-riding simulator in children with cerebral palsy. 40 samples enrolled in his study and were divided into 2 groups like intervention group with 20 subjects and Control group with 20.Subject had THRs for intervention and conventional physiotherapy treatment for control group with 40min session, 2times/week frequency for 6 week duration. Outcome were measured by gross motor functional classification system and f-mat sensor stabilometric platform were used to assess sitting balance, The result shows that a significant improvement in sitting balance in intervention group compared to control group. Hence proved that, the horse riding simulator produced significant improvement in the postural control of children in sitting position, additionally showing a higher motor functionality and a better acceptance of the therapeutic intervention **(69).**

2. Herrero et al , 2012, conducted study on a study of the therapeutic effect of a hippo therapy simulator in children with cerebral palsy. 38 cp children were enrolled in his study. Samples were divided into 2 groups Intervention group and Control group. Intervention group had a THRs (On mode) and control THRs (off mode) treatment for 15min/1 time/week for 10 week duration. GMFM-66 in sitting dimension was taken as outcome measure. Author stated that a significant improvement in sitting balance by improved by trunk muscle strength was found in intervention group than in control group. Author stated that, Hippotherapy with a simulator can improve sitting balance in cerebral palsy children who have higher levels of disability (70)..

3. Choi et al. 2014, proposed study on effect of horse riding simulation exercise on spinal alignment of children with cerebral palsy, 30 CP child enrolled in his study and they randomly divided into 2 groups such as intervention group -15 with intervention of therapeutic horse back riding simulator and conventional physiotherapy and control group -15 with intervention of conventional therapy for 45min/4times/week for 10 week duration. outcome measured by PBS he found that there is a significant effect intervention group on trunk balance with therapeutic horseback riding simulator therapy compared to conventional therapy. Hippotherapy with a simulator can improve sitting balance in cerebral palsy children who have higher levels of disability. However, this did not lead to a change in the overall function of these children .Hence by this study, balance increased in order to maintain the balance of the body on the horseback simulator, and the movements of the body were remembered. The memories of the movements were used to make movements to control posture and horseback riding simulation exercise was shown to be effective for the spinal alignment of children with cerebral palsy (71).

4. Ki- jong kim et al 2014, conducted a study on the effect of horseback riding simulator exercise on spinal alignment of children with cerebral palsy. This study conducted with 30 cp children and subject were randomly divided into a control group and a experimental group (THRs group). Both control and experimental group were given NDT for 30 min/session 4times/week for 10 weeks, while experimental group also received THRs (JOBA, Panasonic) for 15 min /4times/for 10 weeks after NDT. Trunk balance, pelvic tilt and torsion as taken outcome measures and after 10 week of session, both outcomes have shown significant interaction effect between the groups and the periods ($p<0.05$).This is because of the adductor muscles of the lower extremities were relaxed and the lumbar and abdominal muscles were reinforced while the subject was sitting on the horseback riding simulator(72).

5. Bouisset S, zattara M, et al 1987 conducted a study on biomechanical study of the programming of anticipatory postural adjustment associated with voluntary movement. Author reported that balance increased in order to maintain the balance of the body on the horse back simulator, and the movement of the body were remembered. The memories of the movement were used to make movement control posture. That is when the four extremities were moved swiftly, the centre of gravity moved and a repulsive force was generated and caused postural sways in the entire body, including vertebral column (73).

6. Massion j, loffe m, Schmitz et al 1999, conducted a study on acquisition of anticipatory postural adjustment in bimanual load –lifting task: normal pathological aspects. Author reported that the basal ganglia , supplementary motor area ,and the primary motor area on the opposite side of the agonistic muscles proactively activates the posture controlling muscles which helps to provide to timing signals for agonistic contraction ,when this proactive postural control has been learned(74).

7. Forget R, et al 1995; done a study on postural adjustment associated with different unloading of the forearm: effect of proprioceptive and cutaneous afferent deprivation. In this study concluded that stable kinaesthetic memories are constructed in the central nervous system so that posture can be controlled for movement even without any afferent input. (75)

8. Fleck et al 1992 conducted a study on hippotherapy mechanics of human walking and horseback riding**.** Author stated that the movement of the pelvis of the humans during horseback riding exercise stimulate balance and postural control because of the similarity in the movement of pelvis of the humans during walking. The 3 dimensional movements and the changes in the centre of gravity help children with cerebral palsy to experience normal movements for the first time , which effect the pelvic torsion (**76**).

9. Kwon et al. (2015) conducted a trial in Korea to find the gross motor improvements in children who participated in hippotherapy. The study used 92 children diagnosed with cerebral palsy, ages 4 to 10. Of the 96 children in this study, they were split in half for a hippotherapy group and a control group (each having 46 children). Their hypothesis were that children receiving hippotherapy would have improvements in their gross motor functioning and that the amount of improvement may differ depending on the severity of the disability (77).

- Therapy sessions were 30 minutes each, twice per week, administered by a physical therapist trained in technique through the American Hippotherapy Association. Children assigned to the control group practiced 30 minutes of aerobic exercise, including walking or cycling, in their homes twice per week for 8 weeks as well. Children in both groups (hippotherapy and control) were also participating in physiotherapy simultaneously.

- The study measured the children's functioning levels with the Gross

  Motor Function Measure. This assessment has 88 items in five dimensions:

  (a) Lying and rolling; (b) sitting; (c) crawling and kneeling; (d) standing; and

  (e) Walking, running, and jumping Children were administered the Gross

  Motor Function Measure before therapy sessions.

- Started, as a baseline, as well as after the 16-week program to obtain the results. Independent t-tests, Wilcox on signed-rank tests, and Mann-Whitney tests were used to analyse data.

- The researchers found a significant increase in scores of the children assigned to the hippotherapy group, from baseline to post-intervention, while there was not a statistically significant difference between scores of the children in the control group (

- The areas where children improved are: sitting, crawling, kneeling, and standing, walking, running, and jumping. There was no significant improvement in the lying and rolling area of functioning.

- This study supports hippotherapy as a beneficial way to improve gross motor function. The large sample size, the diverse range of functioning levels, and the criteria on which participants were chosen, are all strengths of this study (77).

10. Purohit, Vyas, and Sheth (2015) conducted another study in India finding beneficial effects of hippotherapy on children with spastic diplegia (a form of cerebral palsy)(78).

- Researchers hypothesized those hippotherapy sessions would improve gross motor function, balance, and spasticity in children with spastic diplegia. This study took place in India and included 16 children ages 3 to 10 who had spastic diplegia (a form of cerebral palsy).

- Two groups were made with 16 children each, for a control group and an experimental group. Children in each group received neurodevelopment therapy, while the experimental group received hippotherapy in addition to neurodevelopment therapy.

- Therapists use neurodevelopment therapy as a sensorimotor approach to improve physical abnormalities through physical stimulation, task performance, and certain physical activities aimed toward the use of certain muscles.

- Children in the experimental group received an additional 15 minutes of hippotherapy twice weekly for 4 weeks.

- This study measured balance, gross motor function, and spasticity with the paediatric balance scale, gross motor function measure, and the modified ashworth scale. Children were assessed before therapy as a baseline and again after the 1-month trial period for post intervention scores.

- Hence proved that short duration Hippo therapy and NDT leads to more improvement in gross motor measures and tone of adductor muscle group than NDT alone and leads to some improvement in balance and tone of hamstring and plantar flexor group of muscle as NDT alone (78).

- Author stated that he walking horse transmits some 110 three-dimensional movement impulses per minute onto the person on its back: forward-backward, side to side, up and down, and rotational movements. This is why hippotherapy is so effective because it can provide all that movement and stimulation without the person needing to be able to bear their own weight. This gives the rider many benefits from gross motor function and balance to decrease in spasticity, as well as others (79).

10. **Danielle champagne et al 2016** conducted a study on the effect of hippotherapy on motor proficiency and function in children with cerebral palsy how walks. It is quasi experimental study design .Author enrolled l13CP subjects with age between 4 to12 years and GMFCS-level 1 or 2.The study design was prospective quasi experimental study design participants received 10 week of hippotherapy 30 min/day twice a week and post outcome measure of GMFM-66,88 are taken. Author found that significant improvement in sitting (P= 0.005) and balance (P=0.03) are improved by between base line and post intervention. Hence author found that the improvement is because of increasing in the trunk musculature which allowed better stabilization of the posture (80).

11. **Guoguin Wang et al-2014** conducted a reviewing study on the effect of riding as an alternative treatment for children with cerebral palsy. Author were included all randomized and non-randomized clinical hippotherapy (HT) therapeutic horse back riding simulator to treatment of cerebral palsy children. A systemic search was made in google scholar, CHINAL, Pedro databases up to 2017. In that 6 studies have shown

significant improvement in 66 item gross motor function measure (GMFM-66) sitting dimension score. These review concluded that HT, THRs seen to improve the total score of grass motor function via a siting, walk, running, jumping dimension (81).

12. **Juan G, Dominguez - romero at all** 2019 conducted a review of literature study on the effectiveness of the mechanical horseback riding simulator on postural balance in neurological rehabilitation. Search was conducted on PubMed, Pedro and CINAHL.

The methodical quality of the studies were evaluated thereby Pedro scale, by this study author stated that 7 articles were statically showed favourable for balance in cerebral palsy children (82).

13. **Monikal Zadinkar, et all 2011,** conducted a study of effect of hippo therapy on therapeutic horseback riding on postural control or balance in children with cerebral palsy. Author reviewed by quantitative study design. The treatment effect was coded as a dichotomous outcome (positive effect or no effect), 39 studies shows positive effects , 8 studies shows positive effect on postural control and balance were improved during hippo therapy and therapeutic horseback riding and consequently showed influence on functioning of ADL and quality of life (82).

14. **Mackinnon et al 2012 ,** conducted study on therapeutic benefits of horseback riding for children with cerebral palsy.19 children (aged 4-12 years) with mild or moderate degrees of cerebral palsy were recruited. Prior to randomization, the children were stratified according to their degree of disability. 10 children were allocated to a riding (experimental) group, and participated in one-hour weekly riding classes for six months. The remaining nine children were put on a waiting list for riding (control group). Pre and post values were measured by GMFM-66 . Author concluded that significant results were seen in therapeutic horseback riding group (83).

15. **Sterba et al 2002** conducted study on The effects of recreational horseback riding therapy on gross motor function in children with cerebral palsy: spastic diplegia, spastic quadriplegia, and spastic hemiplegia) were determined in a blinded study using the Gross Motor Function Measure sample size =17 subject equally divided randomly, BRT were given 1 hour per week for three riding sessions for total duration of 6 weeks. GMFM Total Score (Dimensions A-E) increased 7.6% ($p<0.04$) after 6 weeks, hence this study suggest that therapeutic horse back riding simulator may improve gross motor function in children with CP, which may reduce the degree of motor disability (84).

16. **Macphail et al 2000** conducted a study on whether hippotherapy has short- and long-term effects on postural control in an adolescent with cerebral palsy (CP). Sample n=13, subject were n= 6 with cerebral palsy (intervention group) and n= 7 (control group) without cerebral palsy, subject were received THRs for 10 week, 1hour for session. Pre-and post-treatment follow-up with 5-week intervention. Quantitative stabilometric and a modified sensory organization test were performed to determine the subject's response after hippotherapy. The total path length and the lengths of the mediolateral and anteroposterior centre of pressure (COP) movements were calculated. Hence by this study the modified sensory organization test on the force plate was sufficiently sensitive to detect fluctuation changes in the COP. Therefore it is appropriate for continued use. Similarly, HT

was found to have a positive effect on postural control by normalizing equilibrium reactions(84).

8b. Studies Related to PBSB In THBR and HT

17. **Jeong jh et al 2010 ,** conducted a study on the effect of hippotherapy simulator over 8 weeks on trunk proprioception, stability and posture in cerebral palsy patients. This study concluded an increase in symmetry in shoulder, scapula, spine and pelvis posture on the postural assessment scale (PAS) and (PBS) which were used to measure the quality of postural control and symmetry after applying hippo therapy simulator to children with CP. This study suggest that horseback riding simulator exercise programs which have shown an increase evidence in symmetry and these are considered to be useful for children with CP regarding the improvement of spinal structure characterized by asymmetry(85).

18. **Sang Su Na et al 2014,** conducted a study on the effect of hippotherapy and a horse back riding simulator on the balance of children with cerebral palsy. Author compared the hippotherapy group with therapeutic horseback riding group. Author included 26 CP children and was randomly divided into hippotherapy group that included 13 cp subjects and horseback riding simulator (JOBA, Panasonic) group that included 13 children. Both groups were participated in 1 hour of exercises per day, 3 times a week for a total duration of 12 weeks. Subject's dynamic balance outcomes were measured by PBS and static balance by BPM. Results found that both groups have shown a significant improvement in static balance and dynamic balance because of change in the asymmetry of spine and lumbar musculature that lead to an increase and maintenance of sitting posture. He suggested that THRS is a useful alternative to hippo therapy for improving static and dynamic balance of children with cp (86).

19. **Silkwood-Sherer et al.201**2 done a research to find out hippotherapy is a beneficial intervention for increasing balance in children with movement disorders. The study was conducted in the United States and included 16 children ranging from 5 to 16 years old. The study participants had the following diagnosis: pervasive developmental delay, autism, cerebral palsy, down syndrome, visual impairment, cerebellar hyperplasia, and developmental coordination disorder. The children participated in two hippotherapy sessions per week, 45 minutes in length, for 6 weeks. During therapy sessions, the horse was led by an experienced horse handler and a second person walked alongside the horse in addition to the main person providing the hippotherapy treatment. The horses were trained for hippotherapy treatments along with the therapist. Therapy sessions were tailored individually for each participant based on their responses to the activities and fatigue level, however, all participants experienced similar activities (87).

20. **Silkwood-Sherer et al. (2012)** used the Paediatric Balance Scale to score participants on their balance, both before (as a baseline) and after the 6 weeks of hippotherapy sessions. Before therapy sessions began, participants were tested twice to obtain two baseline measurements, thus ensuring the reliability of the measurements (88).

To further give reliability to this study, participants were videotaped while being administered the Paediatric Balance Scale examination for baselines and results. Those videos were then sent to three paediatric physical

therapists in random order and scored by them, not knowing which were baseline videos versus results videos to increase the interpreter reliability of the study. The results of this study have shown statistically significant scores on the Paediatric Balance Scales from the baseline to the results.

There was not a significant difference between the two baseline scores according to post hoc analysis. Researchers did an analysis to find the correlation of each subtest with the overall score in order to see which subtests had the biggest increases.

The following were the test items with the highest correlation in order from highest first: single-leg stance, tandem stance, alternating stool touch, and forward reach (89).

Overall, results found hippotherapy sessions to be beneficial for improvements in balance as found through the Paediatric Balance Scale.

21. Benda et al, 2003 conducted a study on improvements in muscle symmetry in children with cerebral palsy after equine-assisted therapy (hippotherapy) children ranging from 4 to 12 years of age diagnosed with spastic cerebral palsy enrolled his study ,children meeting inclusion criteria were randomized to either 8 minutes of hippotherapy or 8 minutes astride a stationary barrel. With outcome of GMFM-66, PBS and pre/post-test muscle symmetry: EMG was taken. Author concluded improvement seen in muscle symmetry, GMFM in children with cerebral palsy after an 8- min hippo therapy and therapeutic horseback riding simulators (90).

22. Brogen et al 2004 conducted a study on postural control in children with spastic diplegia on muscle activity during perturbation in sitting. Author stated that rider with diplegia CP on THRs respond with similar pattern as time delays as , who were on hippotherapy. Rider with CP found attempting to use their equilibrium reaction to respond to horse pelvic movement, found that maintenance of postural muscle tone and co–activation of antagonist muscle of postural /trunk muscles. This study concluded that both hippotherapy and THR simulator provides normal equilibrium response therapies (91).

8b. **REVIEW LITERATURE**

S.NO	TITLE OF THE ARTICLE	AUTHOR AND PUBLICATION YEAR.	STUDY DESIGN AND PARTICIPANT CHARACTERS/ INTERVENTIONS	OUTCOME	RESULTS/ CONCLUSION	LIMITATION
1.	Effect of hippotherapy on gross motor function in children with spastic CP.	Kwon et al. 2011.(32,52)	Randomized control trail. CP of GMFC S 1-2. Sample size (N= 92) Intervention group (n=45) and in the control group (n=46) INTERVENTION: Hippotherapy/THBR in addition to conventional treatment. setting: therapy centre Providers: physical therapist Session: 30 minutes/session, twice weekly for 8 consecutive week	GMFM-66,88	Differences in improvement on all three measures significantly differed between groups after the 8-week study period. Dimensions of GMFM-88 improved significantly after hippotherapy.	1. Study did not determine Cost effectiveness. 2.Problems associated with maintaining horses, an arena, and training Volunteers.
2	Impact of therapeutic horse riding on children with CP.	Davis et al.2009(69)	Randomized control trail on the impact of therapeutic horse riding on children with CP of GMFCS levels I-III sample N=72 (n=35) intervention group and control group (n=37) INTERVNTION hippotherapy /THBR. setting: individual (hospital) Providers: hippo therapist Session: 10-wk study period.	GMFM-66 Sitting Dimension	No significant difference on GMFM-66.	1. Study did not determine Cost effectiveness. 2. Problems associated with live horse utilization.
3.	Effect of THR on gross motor function	Sterba et al., 2002 (84)	Randomized control trails Sample size (N= 30) Intervention group: 15 Control group: 15 GMFCS level I–III; Age :(5–16 yr.) INTERVENTION:	GMFM -66 Sitting Dimension	Significant increase on GMFM-66 sitting dimension . total score after 18 weeks ($p < .04$).	1.limitations of these studies include lack of specificity and detail in descriptions of the intervention.

			THR with THR instructor only; 18 weeks; 1x/week; 1 h			
4	Effect of hippotherapy on performance on PEDI and GMFM	Casady & Nichols-Larsen, 2004(57)	Randomized control trail: N=10 Intervention group :5 & Control group :5 Age :4-10yr INTERVENTION: Hippotherapy/ THRs with conventional physiotherapy for 10 weeks; 1 per week; 45 min (20–30) min on horse/ simulator)	GMFM- 66 ,88.	Significant change in all PEDI subscales ($p < .05$). Significant change on all GMFM dimensions except dimension A (lying/rolling).	1.Small sample. 2.Cost effective.
5	Effect of hippotherapy on performance on GMFM and postural control	Hamill et al., 2007(58)	Randomized control trail Sample N= 30, intervention group:15 and control group :15 INTERVENTION Hippotherapy/ simulator with conventional therapy,10 weeks; once a week; 50 min	GMFM-66 Sitting Dimension, Assessment Scale	No significant differences on GMFM-88 after 10 weeks of hippotherapy	1.Small sample size 2. Duration less
6	Immediate effect of hippotherapy on spatiotemporal parameters of gait in CP children	McGee & Reese, 2009(59)	One group, Pre test–post test. INTERVENTION: Hippotherapy with PT only (one session); 30–45 min	GMFM-66 Sitting And Walking Dimension	No significant differences were found immediately after therapy on spatiotemporal parameters of	1.A majority of the studies were repeated-measures within-subject or one group pre-test–post-test designs
7	Effect of hippotherapy on head/trunk stability and reaching speed/efficiency in cp children	Shurtleff et al., 2009 (69)	One group, pre-test–post-test total sample N=11 spastic diplegia age between (5–13 year). INTERVENTION: Hippotherapy with PT & OT; 12 weeks; 1x/week; 45 min.	Video motion capture of control of head and trunk movements on a barrel, upper-extremity functional reach test. GMFM-66	Significant improvement in head and trunk stability and upper extremity functional reach test (improvements in reaching/targeting, elapsed time, & efficiency).	1.A majority of the studies were repeated-measures within-subject or one group pre-test–post-test designs. Small sample. 2. Lack of comparison groups and randomization in a majority of the studies makes it difficult to draw conclusion

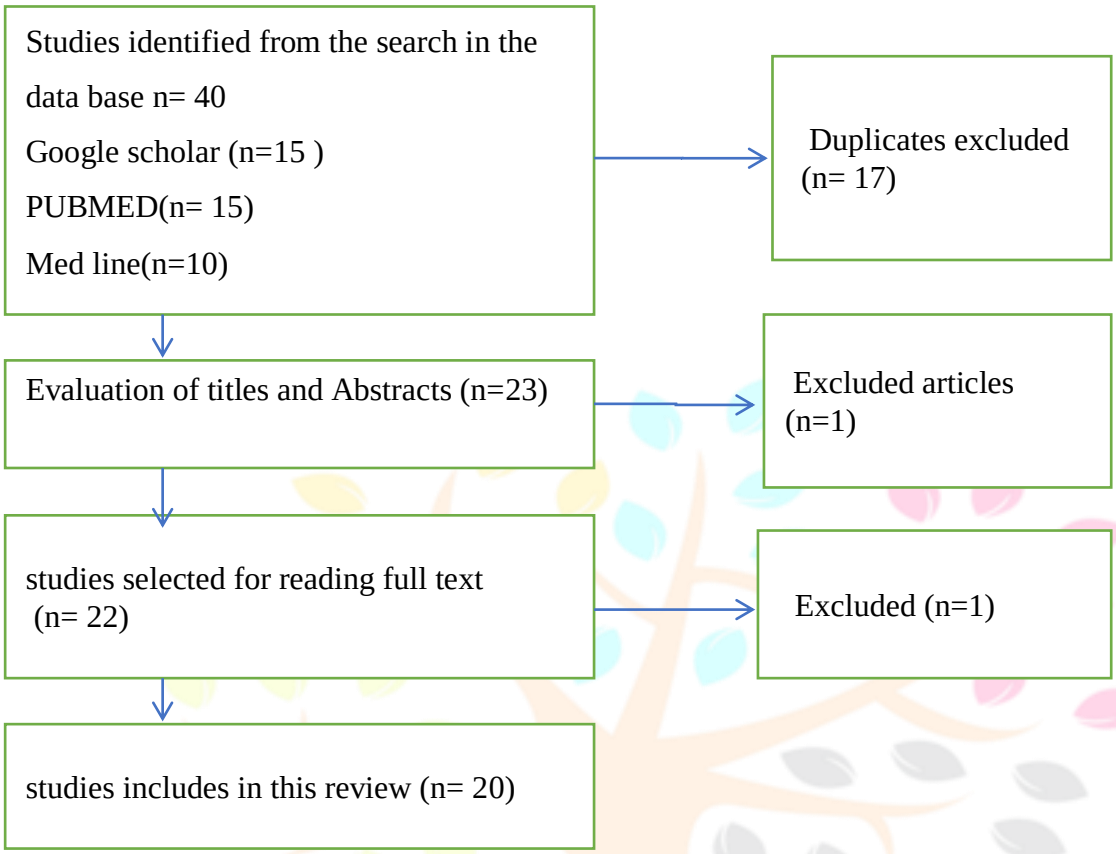
8	hippotherapy effects on gross motor function and functional performance of children with CP.	Park et al.2014 (70)	Randomized control trail Sample size N= 49 GMFCS levels I-iv intervention group (n=28) and of the control group (n=21) INTREVENTION hippotherapy /therapeutic horse back riding Format setting: community Providers: occupational therapist ,Session: 45 minutes/session twice a week for 8 week.	GMFM-66 sitting dimension	Improved GMFR-66 sitting dimension	1.Small sample. 2.Less duration
9	Study of the therapeutic effects of a hippotherapy simulator in children with cerebral palsy: a stratified single-blind randomized controlled trial	Herrero et al.2012(52)	A stratified single-blind randomized control trail of the effects of a simulator on children with CP of GMFCS levels I-V intervention group (n=19) or on the control group (n=19), sample size N=38. INTERVENTION Hippotherapy with active extension of the trunk Format. setting: school 15 minutes/session once a week for 10-week Follow-up: 3 month post-training.	GMFM-66 sitting dimension	Improved GMFM-66 Improved sitting balance	1.THRS imitates the mechanical pattern of movement and loses all the psychological aspects related to traditional hippotherapy. 2. SUGGESTION: Greater effects of treatment were seen in children with higher levels of disability.
10	The effect of weight-support treadmill training on the balance and activity of daily living of children with spastic diplegia	Cherng et al.2004(68)	Randomized control trail Sample size N= 15 Spastic CP intervention group (n=9) and in the control group (n=5). INTERVENTION Therapeutic horseback riding in addition to regular treatment. Setting: training centre Providers: paediatric physical therapist / Session: 40 minutes/session 2 sessions/week for 16 week.	GMFM-66 dimension	Improved GMFM-66	1.Small number of study targets and a focus on spastic diplegia that prohibits independent walking. 2.It cannot represent the entire population of children with cerebral palsy.
11	Impact of hippotherapy on gross motor function and quality of life in children with bilateral cerebral palsy: a	Deutz et al 2018 (69)	A randomized open-label crossover study of hippotherapy effects on children with bilateral CP of N=65 GMFCS levels II-IV in early (n=35) and late (n=38) treatment groups	GMFM-66 sitting dimension	Significant improvement GMFM	1. Small number of study. 2.Study did not showed its cost effectiveness

	randomized open-label crossover study		INTERVENTION hippotherapy with THRs setting: hospital (centre) Providers: physical therapist Session: 1-2 sessions/week for 16-20 week.			
12	Improvements in muscle symmetry in children with cerebral palsy after equine-assisted therapy (hippotherapy) the journal of alternative and complementary	Benda et al.2003 (61)	A randomized control trail study design. Sample size N=13 Intervention group 7 and control group 6 of cerebral palsy children. INTERVENTION Intervention group were received hippotherapy for 8 min / control group :8 min sitting THR simulator /sitting on barrel for 8 min.	GMFM-66,88, Muscle symmetry : electromyography 10 sec ,sitting.	Significant results seen in GMFM and muscle symmetry of electromyography.	1.Statistical power was limited by the small number (n) of this study. 2.Findings need to be replicated with a larger cohort. 3.Suggest but in no way confirm lasting effect of the therapy, and do not address possible extinction of effect after a series of sessions is completed
13	Trunk postural reaction in children with and with out cerebral palsy during horse back riding stimulation	Macphail et al-2010 (70)	Quasi experiment design total 12 CP children with intervention group 6, control group 6 intervention group: THRs simulator. Control group :hippotherapy ,16weeks frequency;30min/d twice/week	GMFM-66. , video in frontal plane	Improved in GMFM-66 P<0.001	1.Small sample size, which did not allow for the use of control group of the disease
14	The effectiveness of therapeutic horseback riding in children with spastic cerebral palsy	Chang, Yi, Lee, 11.Shin, & Kim (2015) (50)	Systematic review Sample number N=92 children Disability: Cerebral Palsy, Age 4-10 years old. INTERVENTION Therapeutic horseback riding simulator / NDT Duration :16weeks frequency;30min/d twice/week.	Gross Motor Function Measure- 88,66	Significant improvement in gross motor function and balance: sitting, crawling	1.Lack of comparison groups and randomization in a majority of the studies makes it difficult to draw conclusion
15	Effect of hippotherapy on balance and function in children with spastic diplegia. International Archives of Integrated	Purohit, Vyas, & Sheth (2015)(46,47)	Randomized control trails Sample size N=16 CP - Disability: Spastic diplegia - 3-10 years old. INTERVENTION	Gross Motor Function Measure- 66, 88	Significant improvement in gross motor function scores: walking, running, and jumping	1.Limitations for the presen study were cost for hiring the horse and due to this reason the study was not performed for a longer time

	Medicine		Control group: NDT for 30 min/day twice a week and experimental group :hippotherapy +NDT 30+15 min/day twice/week.			2.Long term follow up was not taken.
16	Effect of hippotherapy on motor proficiency and function in children with cerebral palsy who walk	Champagne, Corriveau, & Dugas (2017) (71)	prospective quasi experimental study sample size N :13 children Disability: Cerebral Palsy Age 4-12 years old INTERVENTION Hippotherapy/therapeutic horse back riding simulator Duration:10 weeks Frequency&intensity:30min/day twice a week.	Gross Motor Function Measure-66,88	Gross and fine motor functions and performance was improved: sitting, standing, walking, running, and jumping.	1.The main limit in this research protocol not assigned 2.The small number of participants, which prevents the generalizability of the results. 3.Consequently, with a small sample size
17	Postural control in children with spastic diplegia ; muscle activation during perturbation in sitting	Mcgibbon et al - 2009(72)	Randomized control trial . Sample size N=12 spastic CP children. Age: 4-12 years control group:6 comparison group: 6 GMFCS-1-4. INTERVENTION Hippotherapy /therapeutic horse back riding simulator for both groups. Duration -12 weeks Frequency& intensity:30min/ day 2 times /week	GMFM-66 sitting dimension	Improved on GMFM-66 total score, -maintained the improvement after a 12-week washout period	1.Small sample, less duration.
18	Hippotherapy: An intervention to habilitate balance deficits in children with movement disorders	Silkwood-Sherer, Killian, Long, & Martin(2012) (58,59)	Randomized control trails Sample size N=16 Disabilities: cerebral palsy, Age 5-17 years old. Intervention group 8, control group 8. INTERVENTION Hippotherapy in addition to conventional	Paediatric Balance Scale	- Significant improvement on single-leg stance, tandem stance, Alternating stool touch, and forward reach.	1.The lack of a control group without the hippotherapy intervention is a study limitation, as is the short duration between baseline measurements.

			treatment setting: riding ground Providers: physical therapist Session: 30 minutes/session 2 days/week for 8 week.			
19	Effect of hippotherapy on gross motor function in children with cerebral palsy: A randomized controlled	Chang, Yi, Lee, Shin, & Kim 2(2015) [45]	Randomized control trail, sample size N= 92 Disability: Cerebral palsy Age 4-10 years old. Intervention group 46, control group 46. INTERVENTION Therapeutic horseback riding simulator / NDT Duration: 16weeks frequency; 30min/d twice/week.	Paediatric Balance Scale .	Significant improvement in was found PBS. -Significant change on PBS post-test ($p < 0.05$)	1.Study did not determine Cost effectiveness 2.Problems associated with maintaining horses, an arena, and training Volunteers.
20	Effect of hippotherapy on gross motor function in children with cerebral palsy: a randomized controlled trial	Kwon et al. 2011 (45)	Randomized control trail. sample size N=90 with GMFCS levels I-IV intervention group (n=45) and in the control group (n=46) INTERVENTION Therapeutic horseback riding/ hippotherapy Duration:8weeks, Intensity& frequency: 30min/day twice /week.	Paediatric Balance Scale	Significant change on PBS post- test ($p < 0.05$)	1.Study did not determine Cost effectiveness

CONSORT FLOW DIAGRAM



OUTCOME MEASURES

A. GROSS MOTOR FUNCTION MEASURE -66 SITTING DIMENSION. (GMFM- 66). The Gross Motor Function Measure (GMFM) is an observational clinical tool designed to evaluate the changes in gross motor function in children with cerebral palsy. There are two versions of the GMFM - the original 88-item measure (GMFM-88) and the more recent 66-item GMFM (GMFM-66).

- The objective of gross motor function Measure is to evaluate the gross motor functions in children with cerebral palsy (76).
- Method of Use: The GMFM-88 item scores can be summed to calculate raw and percent scores for each of the five GMFM dimensions of interest, selected goal areas and a total GMFM-88 score. For the GMFM-66, a free computer program and the gross motor ability estimator (GMAE) are required.
- Reliability: Refers to dependability, consistency and stability of scores on an assessment tool. Both versions of GMFM were shown to be highly reliable, with ICCs of greater than 0.98 (95% confidence interval=0.965-0.994) and both of them can be used in clinical practice or research, calculate total scores. (76)
- Validity and Responsiveness: Validity includes responsiveness, which is defined as the ability to differentiate clinically important differences. Both versions of GMFM also demonstrated high levels of validity, with an ICC of .99 (95% confidence interval=0.972-0.997), reflecting associations with the GMFM-66. (77)

B. PAEDIATRIC BALANCE SCALE (PBS) :The Paediatric Balance Scale is a modified version of the Berg Balance Scale that is used to assess functional balance skills in school-aged children. The scale consists of 14 items that are scored from 0 points (lowest function) to 4 points (highest function) with a maximum score of 56 points. (78)

RELIABILITY: Reliability testing performed with a sample of 20 children ages 5- 15 years old with mild to moderate motor impairments showed good test-retest reliability (ICC=0.998) and good interpreter reliability (ICC=0.997).(79)

VALIDITY: Validity testing performed with a sample of 30 children aged 4-10 years old with spastic cerebral palsy in GMFCS Levels I-III showed a strong correlation between the Paediatric Balance Scale, self-care ($r=0.73$, $p<0.001$) and mobility ($r=0.82$, $p<0.001$) dimensions of the Paediatric Disability Evaluation Inventory (PEDI)(58). Validity testing performed with a sample of 23 children ages 6-15 years old with spastic cerebral palsy (hemiplegia or diplegia) showed a strong correlation ($r=0.797$, $p<0.05$) between the Paediatric Balance Scale and the Selective Control Assessment of Lower Extremity (Scale) (80)

DISCUSSION

- The aim of the study was to review the literature on comparison of the effectiveness of therapeutic horse back riding simulator over hippotherapy on sitting balance in children with spastic cerebral palsy.

- The search was conducted during the period of 2021 by using search engine such as google scholar, PubMed, and Medline.

- Postural control and sitting balance are important element of motor task, the postural control is maintained by the integrated action between the sensorimotor system of central nervous system and spinal cord i.e., vestibular, visual and proprioception and motor system's cerebral palsy children have several sensory deficits including problems with visual and proprioception and cutaneous perception and their deficits may contribute to impaired postural and balance control.(81)

- Hippotherapy is an effective method used in rehabilitation on cp children. It works under the principle of generation of motor impulses from the back of the horse to the rider. These locomotors impulses transformed from the horse's body to the rider in three movement planes. These rhythmical movements and the three dimensional sway of horseback riding stimulate the postural reflex mechanism resulting in balance and coordination training in patients with neurological impairment (Janura, Peham, Dvorakova, & Elfmark, 2009). But, it is limited in clinical practice for various reasons such as fear of fall, difficulty of maintaining a horse, climate and financial considerations.(82)

- The therapeutic results obtained from hippotherapy treatment have encouraged research into developing an advanced hippotherapy simulator that imitates the real horse movement. THRs is a device that has an advantage of low cost effect and easily accessible in indoor such as clinics, hospitals, schools and rehabilitation centres.(31)(32)(33)

- During THRs, 3 dimensional movements such as walk up and down, side to side, front to back. During this session, device may transmits a sensorimotor experience to the rider which corresponds closely to the input received by normal human gait.(27)

- This sensory motor experience involves receiving vestibular input which stimulates the riders balance mechanism by adjusting the movement of horse back of simulator (83).

- The act of adjusting to the horse movement facilitates the development of righting and equilibrium reactions and thus leads to improvement in postural control (84).

- Hippotherapy and therapeutic horseback riding simulator are comprehensive strategies to improve postural control and balance in children with cerebral palsy(84).

- In this study 8 reviewed articles have shown a significant effect in improving the activities of daily living and

quality of life in children with spastic cp (31, 13,23, 84, 85,86,87,88).

- The THRs has shown significant improvement, When it is compared to the hippotherapy with therapeutic horse back riding and it has shows significant improvement in gross motor functions measure 66 sitting dimension and paediatric balance scale and decreasing the spasticity of lower limb in spastic cp children due to mechanism of heating pad, leg stretched sitting and low frequency vibration of saddle (88).

CONCLUSION

- This study has been conducted to compare the effectiveness of therapeutic horse back riding simulator over hippotherapy on sitting balance in children with spastic cerebral palsy.
- Previous reviews stated that sitting balance is recovered by using THRS and HT through the mechanism of sensorimotor stimulation, increased righting and equilibrium reactions. The improvement in functionality was found to be greater in spastic type of CP than the other types of CP.
- Most of the reviews with outcome measures GMFM-66, GMFC and paediatric balance scale were used in treatment of CP by THRS and HT treatment.
- Many of the reviewed articles have shown effective improvement in sitting balance, with the treatment application time for 8 to 16 weeks with 30 minutes a session for 3 days a week.
- Previous reviews have shown an improvement in sitting balance by both THRs and HT, but THRs has shown additional effect on improvement of sitting balance due to its designed structural frame work and mechanism of action when compared to hippotherapy.

ANNEXURE: I

ASSESSMENT PROFORMA

Name of child: Age/Gender: DOB:

Date: Address: Contact no:

Physiotherapist name:

Provisional diagnosis:

Type of cerebral palsy:

Side and site involved:

Chief complaints:

1. **HISTORY**:

PRENATAL	NATAL	POSTNATAL

2. Family history:

a. Number of family member, their age.

b. H/o consanguinity

H/o Epilepsy

3. H/O present Medical history :
4. H/o surgical intervention
5. H/O present Medical history

7. Dependency status:

a. Dependent completely
b. Dependent but participates
c. Independent but fully assisted
d. Independent but need supervision
e. Independent completely

8.Developmental history:

a. Gross Motor
b. Fine Motor Speech& Language
c. Vision
d. Social/ Emotional
e. Cognition.

Reference age	Developmental milestones	Achieved age
1-2 hours	Gaze contact (social /cognitive)	
2-3 months	Social smile (social/cognitive)	
2-4 months	Begins to lift head in prone position (grass motor)	
4-6 months	Bimanual(visually guided)coordination in reaching objects (fine motor)	
6 months	Rolling over-prone to supine (grass motor)	
7 months	Rolling over -supine to prone (grass motor)	
5-10 months	Pulls to stand holding onto furniture (grass motor)	
7-10 months	Sits steadily unsupported (grass motor)	
8-10 months	Sits upright on floor (grass motor)	
9-12 months	Pincer grip (fine motor)	
9-12 months	Holds out object to adult but will not release it (fine motor)	
10-16 months	Walks unsupported (grass motor)	
11-14 months	Holds out object to adult and will release it (fine motor)	

ON OBSERVATION:

1. Built : Endomorphic / Monomorphic / Ectomorphic

2. Ambulation mode :

3. Attitude of the limbs:

4. Deformities and contractures: describe, if any

5. Hand functioning:

- Mode of communication: verbal non verbal

6. Level of understanding commands :

Behavioral state during assessment:

State 1 - deep sleep, no movement, some movement, regular breathing.
State 2 - light sleep, eyes shut, some movement,
State 3 - dozing eyes opening and closing
State 4 – awake eyes open, minimal movement
State 5 -wide awake, vigorous movement.
State 6 – crying

ONPALPATION:

7. Tone of the muscles: hypotonicity / hypertonicity
8. Deformity and contractures status : describe if any

ON EXAMINATION:

Tone of the muscles: Hypotonicity / Hypertonicty

Table 3
Tardieu scale

Velocities	
V1	As slow as possible, slower than the natural drop of the limb segment under gravity
V2	Speed of limb segment falling under gravity
V3	As fast as possible, faster than the rate of the natural drop of the limb segment under gravity
Scoring	
0	No resistance throughout the course of the passive movement
1	Slight resistance throughout the course of passive movement, no clear catch at a precise angle
2	Clear catch at a precise angle, interrupting the passive movement, followed by release
3	Fatigable clonus with less than 10 s when maintaining the pressure and appearing at the precise angle
4	Unfatigable clonus with more than 10 s when maintaining the pressure and appearing at a precise angle
5	Joint is immovable

9. Deep tendon reflex :

Biceps Reflex : : C5/C6

Brachio Radialis : C6

Triceps ; C7

Patella : L4

Achilles Tendon ; S1

Plantar Response :

Developmental reflexes (Spinal reflexes.) : describe , if any along with the response:

Reflex	Stimuli	Expression	Integration	Remarks
Crossed extension	Noxious stimuli to ball of foot	28 weeks gestation	1- 2 month	
Flexor withdrawal	Noxious stimuli to sole of foot	28 weeks gestation	1-2 month	
Rooting	Touch cheek	28weeks gestation	3-month	
Suck – swallow	Object in mouth	28 weeks	2-5 month	

		gestation		
Traction	Grasp forearm to pull up	28 weeks gestation	2-5 month	
Moro	Ext/Abduction of Upper extremity Weight /Position Change	28 Weeks Gestation	5-6 Month	
Plantar Grasp	Pressure To Ball Of Foot	28 Weeks Gestation		
Gallant	Infant Turns When Stoked	32 Weeks Gestation		
Positive Support	Rigid WB With Foot Contact	32 Weeks Gestation		
Spont Stepping	Stepping Movement. In Supine	37 Weeks Gestation		
Tonic Lab	Prone =Increase Flexion &Supine =Increase Extension	Birth		

Developmental reflexes: tonic /brainstem

Reflex	Stimuli	Expression	Integration
ATNR	Rotation of head=fencing posture	Birth -2 month	4-6 month
STNR	Neck flexion / extension	4-6 months	10-12 month
Neck righting	Rotate head = body rotates	4-6 moths	5 years
Landau	Prone arches back to raise head	3-4 month	12-24 months
Palmar grasp	Pressure palm of the hand	Birth -2months	4-6 month
Body righting	Rotation of body	4-6 month	4-5 years

SENSORY EXAMINATION:

A. superficial sensation

B. deep sensation

C. cortical sensation

SPECIAL SENSORY EXAMINATION

A. Vision. B. Auditory. C. Tactile. D. vestibular. E. perception.

MOTOR EXAMINATION:

A. Tone of the muscle.

B. Range of Motion.

C. Muscle Girth

D. Muscle Length

E. Limb Length: (True, Apparent) .

POSTURE EXAMINATION:

SITTING (preferred long sitting):

1. Can the child get in this posture?

2. Can the child get out of this posture and to which posture?

3. Stability in this posture: mention time in this posture, if any

4. Extent of support, if given any?

5. Describe posture:

Posture parts	Right side	Left side	Remarks
Head	_	_	
Neck	_	_	
Trunk			
Shoulder			
Elbow			
Hand			
Pelvis			

Hip			
Knee			
Ankle			
Toes			

6. Pictorial diagram of the posture:

HAND FUNCTION EXAMINATION:

A. Dominating Hand

B. Attitude of the hand

C. Reaching of hand

BALANCE EXAMINATION: Static Balance Dynamic Balance

A. Sitting balance: Paediatric balance scale, and

Gross motor functional measure -66 sitting dimension.

C. Standing balance: Burg balance scale

CO-ORDINATION EXAMINATION:

A. Non Equilibrium Test

B. Equilibrium Test

GAIT EXAMINATION:

Observational analysis of gait:

Type of gait:

PHYSIOTHERAPY INTERVENTION :

HOME PROGRAMME:

RE- ASSESSMENT:

GMFM -66

GROSS MOTOR FUNCTION MEASURE (GMFM)

SCORE SHEET (GMFM-88 and GMFM-66 scoring)

Child's Name: _____ ID _____

Assessment date: _____
Year / month /day

Date of birth: _____ GMFCS LEVEL: _____
Year / month /day

Chronological age: _____ Testing Conditions_____
(E.g., room, clothing, time)

Evaluator's Name: _____

The GMFM is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with cerebral palsy. The scoring key is meant to be a general guideline. However, most of the items have specific descriptors for each score. It is imperative that the guidelines contained in the manual be used for scoring each item.

SCORING KEY 0 = does not initiate.

1 = initiates

2 = partially completes

3 = completes

NT = Not tested [used for the GMAE scoring*]

It is now important to differentiate a true score of "0" (child does not initiate)

From an item which is Not Tested (NT) if you are interested in using the

GMFM-66 Ability Estimator Software.

- The GMFM-66 Gross Motor Ability Estimator (GMAE) software is available with the GMFM manual (2002). The advantage of the software is the conversion of the ordinal scale into an interval scale.
- This will allow for a more accurate estimate of the child's ability and provide a measure that is equally responsive to change across the spectrum of ability levels. Items that are used in the calculation of the GMFM-66 score are shaded and identified with an asterisk
- The GMFM-66 is only valid for use with children who have cerebral palsy.

Item: SITTING DIMENSION	SCORE
18. Sup: Hands grasped by examiner: Pulls self to sitting with head Control _____	0 1 2 3
19. Sup: rolls to r side, Attains sitting _	0 1 2 3
20. Sup: rolls to l side, Attains sitting _____.	0 1 2 3
21. Sit on mat, supported at Thorax by therapist: Lifts head upright, maintains 3 Seconds	0 1 2 3
22. Sit on mat, supported at Thorax by therapist: Lifts head midline, maintains 10 seconds.....	0 1 2 3
23. Sit on mat, arm(s) propping: Maintains, 5 seconds.....	0 1 2 3
24. Sit on mat: maintains, Arms free, 3 seconds.....	0 1 2 3
25. Sit on mat with small Toy in front: leans forward, Touches toy, re-erects without arm prop pin	0 1 2 3
26. Sit on mat: touches Toy placed 45° behind Child's r side returns to start.....	0 1 2 3
27. Sit on mat: touches Toy placed 45° behind Child's l side returns to start.....	0 1 2 3
28. R side sit: maintains, Arms free, 5 seconds	0 1 2 3
29. L side sit: maintains, Arms free, 5 seconds.....	0 1 2 3
30. Sit on mat: lowers To Pr with Control.....	0 1 2 3
31. Sit on mat with Feet in front: attains 4 point over r side.....	0 1 2 3
32. Sit on mat with feet in Front: attains 4 point Over l side.....	0 1 2 3
33. Sit on mat: pivots 90°,	

Without arms assisting 0 1 2 3

34. Sit on bench: maintains,
Arms and feet free,
10 seconds..... 0 1 2 3

35. Sit: attains sit on
Small bench..... 0 1 2 3

36. on the floor: attains
Sit on small bench..... 0 1 2 3

On large bench..... 0 1 2 3

TOTAL DIMENSION: _____

GMFR RAW SUMMARY CALCULATION

DIMENSION CALCULATION OF DIMENSION % SCORES GOAL AREA

(Indicate with right mark)

A. Lying & Rolling: total dimension A
_____ =_____ ×100 =_____% A. --------
51 51

B. Sitting : Total Dimension B
_____ = _____ × 100 = _____% B.--------
60 60

C. Crawling & Kneeling: Total Dimension C
_____ =_____× 100 = _____ % C. ------
42 42

D. Standing : Total Dimension D = _____ ×100 =_____ % D. ---------
_____
39 39

E. Walking, Running: Total Dimension E = _____ × 100 =_____ % E.--------
72 72

TOTAL SCORE = %A + %B + %C + %D + %E
_____
TOTAL # DIMENSION

\+ + + +
= _____ = _____ =_____ %
5 5

GOAL TOTAL SCORE = Sum of % scores for each dimension identified as a goal area
_____ =_____ %

Of Goal areas

GMFM-66 Gross Motor Ability Estimator Score

GMFM-66 Score = _____ _____TO _____

95% Confidence Intervals

Previous GMFM-66 Score = _____ _____To _____

95% Confidence Intervals

Change in GMFM-66 = _____ from the Gross Motor Ability Estimator (GMAE) Software.

PEDIATRIC BALANCE TEST:

Name …….

Date: ……..

Address:…….

Examiner:……..

Item description:	**score (0-4)**
1. Sitting to standing	_____
2. Standing to sitting	_____
3. Transfers	_____
4. Standing un supported	_____
5. Sitting unsupported	_____
6. Standing with eye 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 SCORE: _____.

S.no	Items	Date : Score(0-4) Time optional	Date Score (0-4) Time optional	Date Score (0-4) Time optional
1.	Sitting to standing “Hold your arm up and stand ‘’. 4. Able To Stand Without Using Hands And Stabilizing 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 minimal assist to stand.	–	–	–
2	Standing to sitting: sit down slowly without use of hands. 4. Sits safely with minimal use of hands. 3. Controls descents by using hands. 2. Uses back of legs against chair to control descents. 1. sits independently , but has uncontrolled descent 0. Needs assistance to sit.			
3.	Transfers 4. able to transfers 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 person to assist or supervise (close guard) to be safe.			

4.	Standing un supported. Stand for 30 seconds without holding on or moving his/her feet. 4. Able to stand safely 30 seconds. 3. Able to stand for 30 seconds with supervision. 2. Able to stand 15 seconds un supported. 1. Needs several tries to stand 10 seconds. 0. unable to stand 10 seconds unassisted.			
5	Sitting with back unsupported and feet supported on the floor. 'Please sit with arms folded on your chest for 30 seconds." 4.Able to sit safely and securely 30 seconds 3.Able to sit 30 seconds under supervision 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.			
6	Standing unsupported with eyes closed. "Stand still with feet shoulder with apart and close his/her eyes for 10 seconds. 4. Able to stand for 10 seconds. 3.Able to stand 10 seconds with supervision 2.Able to stand 3 seconds 1. unable to keep eyes closed for 3			

	seconds but stays steady. 0. Needs help to keep from falling.			
7.	Standing unsupported with feet together. Place his/her feet together and stand still without holding on. 4. Able to place feet together independently and stand 3o seconds safely. 3. Able to place feet together independently and stand for 30 seconds with supervision. 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.			
8.	Stand unsupported one foot in front. “Stand with one foot in front of other, heels to toe. 4. Able to feet tandem independently and hold 30 seconds. 3. Able to place foot ahead of other and hold 30 seconds. 2. Able to take small slep independently and hold 3o seconds, or require. 1. Needs to slep, but can hold 15 seconds. 0. Loses balance while stepping or standing.			
9	Standing on one leg. 4.able to lift 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 -5 seconds. 1.Tries to lift leg to hold 3 seconds but remains standing 0. Unable to try or needs assist to prevent fall.			
10	Turns 360 degrees “Turn completely around in a full circle. Stop then turn opposite side. 4. Able to turn 360 degree safely in 4 seconds or less. 3. Able to turn 360 degrees safely in one direction only in 4 seconds or less but other direction takes more than 4 seconds. 2. able to turn 360 degree safely but slowly. 1. Needs close supervision or constant verbal cueing. 0. Needs assistance while turning.			
11	Turning to look behind left and right shoulders while standing still. 4. looks behind /over each shoulder, weight shift includes trunk rotation looks behind. 3. looks behind /over one shoulder with trunk rotation; weight shift in the opposite direction. 2. Turns head to look to level of shoulder, no trunk rotation. 1. Needs supervision when turning, the chin moves greater than half the distance to the shoulder. 0. need a assistance to keep from losing balance or falling; 12. Pick up objects from the floor			

	from a standing position. 4. able to pick up an easer safely. 3. Able to pick up easer but needs supervision. 2. Unable to pick up easer but reaches 1-2 inches from eraser and keeps balance independently. 1. Unable to pick up easer, needs supervision while attempting. 0. Unable try, needs assist to keep from losing balance or falling.			
13	Placing alternate foot on step stool while standing un supported. 4. Stand 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 2 steps; needs minimal assistance. 1. Needs assistance to maintain balance or keep from falling, unable to try.			
14	Reaching forward with outstretched arm while standing 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 0.loses balance while trying ,requires			Maximum Score = 56.

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