Kerala Journal of PMR

'The feather touch of rehabilitation is healing you...
Welcome my friend to our colourful childhood dreams.'

2022
Vol 19 issue 4

From the Editor's Desk

Time flies so swiftly, & it's time for another issue to be rolled out. This issue is on Cerebral Palsy rehabilitation. Again we have good academic material between the covers of this issue. Reading this issue will give you a well rounded picture about this entity & it's rehabilitation.

The first known case of this condition can be traced back to ancient Egypt, where a Pharaoh Siptah's (who ruled from 1196 to 1190 B.C) mummified body suggested that he had Cerebral Palsy. However official reports of this entity came much later. Dr. William John Little was the first to meticulously define Cerebral Palsy in 1853. He expounded that children with this condition had a damaged nervous system which resulted in spasticity. At that point in time these disorders were referred to as 'Little's disease' or 'Cerebral Paralysis'. The etiology was explained to be due to difficult child birth, especially due to lack of Oxygen at the time of delivery, by Dr. Little.

The term 'Cerebral Palsy' was coined by Dr. William Osler in 1887, who as you all know is considered to be the Father of Modern Medicine. Dr. Sigmund Freud was the first to state that CP might be caused by abnormal development before birth. He hypothesized that something might have occurred during fetal development and that CP was associated with other disorders, such as intellectual disabilities, visual impairments, and seizures. In 1893, in his book, 'On the Knowledge About Cerebral Diplegias of the Childhood Age', he dilated on his theories. During the time, Dr. Feud's theories were largely ignored, as the majority of medical professionals still relied on Dr. Little's findings. Years later, Dr. Freud's theories were reconsidered when extensive research proved that oxygen deprivation accounted for only 10% of cases[1].

As we all know Cerebral Palsy is now a well defined entity with risk factors, diagnostic criteria, treatment guidelines, rehabilitation measures & even prognostic factors. Early intervention programs & comprehensive rehabilitation can change the final picture to a great extent. Ensuring medical stability before rehabilitating a patient, warrants a thorough knowledge of medical management of this group of disorders & also the conditions that mimic it. Functional classification systems help in assessment, management & prognostication of CP. Moreover with newer developments in imaging, Rehab protocols, Orthotics, Assistive Technology & Artificial Intelligence, the modern day Physiatrist has a lot to update himself/herself with, if he/she wants to provide the best treatment & rehabilitation to a CP child. Rehabilitation medicine, like all fields of modern medicine is in a state of flux. There was a time when aerobic exercise & strength training were contraindicated in Cerebral Palsy[2]. Now these exercises are routinely employed in rehabilitation plans. I honestly considered titling this issue 'Cerebral Palsy Rehabilitation 1O1'!! I hope this issue will stimulate everyone to read & research more. I extend my heartfelt gratitude to all the contributors & to all the PMR faculty…

Our next issue will be on Interventional Physiatry, articles are more than welcome…Happy reading everyone…

1. The History and Origin of Cerebral Palsy - Cerebral Palsy Foundation (yourcpf.org)
2. Braddom's Physical Medicine and Rehabilitation, 6th Edition

Dr. Bineesh Balakrishnan

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***Cover Art by Dr.Sudheera V. T.**

"Articles are the responsibility of the Authors"

A Brief Introduction to The Regional Early Intervention Centres

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The Convention on the Rights of the Child along with the Convention on the Rights of Persons with Disabilities (CRPD) have recognized the human rights of all children including those with disabilities. According to CRPD, children with disabilities are "those who have long term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis". It is said that nearly 240 million children in the world have some form of disability, with most children having disability in more than one domain resulting in many functional difficulties.

Indian scenario

2.21% of Indian population has one or other type of disability. 29% of all disabilities are in children below 19years. Life has never been easy for these children as the public attitude towards disability was mainly pity and prejudice instead of support and inclusion. Over years there has been tremendous improvement in the societal attitude towards disability. India as a signatory of the NCRPD Act 2007 showed its commitment towards people with disability by enacting The Rights of Persons with Disabilities Act in 2016 to promote and protect the rights and dignity of people with disability in the various aspects of life – educational, social, legal, economic, cultural and political.

Risk factors for developmental disabilities.

Causes of developmental disabilities may be genetic or environmental or sometimes multifactorial. Around 50% of these can be prevented or their effects minimized with simple steps. Improved survival of preterm and low birth weight newborns leaves us a large number of babies with various risk factors for neurodevelopment disabilities. The effect of family oriented Developmentally Supportive Newborn Care for optimum neurodevelopment has been well proven by the NIDCAP program in Sweden and the Infant Health and Development Program in the US. Taking cues from this knowledge, National Health Mission in India has implemented Facility as well as Home based newborn care and through community participation to reduce neonatal mortality and morbidity. This has contributed tremendously in ensuring intact newborn survival.

According to the March of Dimes (2006), out of 100 babies born in India, 6-7 have birth defects, accounting for 9.6% of newborn deaths. Various nutritional deficiencies are seen in 4-70% of the preschool children. Development delays are seen in 10% of children. All this result in a large number of

poorly functioning, sick child population. Hence Rashtriya Bal Suraksha Karyakram (RBSK) program was initiated to address the 4 'D's affecting children's health- Defects at birth, Deficiencies, Diseases, Development delays including disability. Early identification of the "at risk population' and early intervention were identified as the most important methods for minimizing childhood disability. This was made possible through the setting up of District Early Intervention Centers (DEIC) throughout India under the National Health Mission.

In addition to setting DEICs in the district headquarters hospitals, Govt.of Kerala also started the Regional Early Intervention and Autism Centres in five Government Medical Colleges ie; Thiruvananthapuram, Kottayam, Alappuzha, Thrissur and Kozhikode and an Autism centre at Govt. Medical College Manjeri under Kerala Samoohya Suraksha Mission (KSSM).

Regional Early Intervention Centres (REIC)

REICs have been formed in the Medical Colleges in addition to DEICs in the District hospitals due to the fact that the sickest tiniest high risk babies are taken care of in the Medical Colleges and early detection and intervention is the only way a near normal survival can be guaranteed. Once the disability is already established then the intervention would include enhancement of child development for the child to reach the highest potential possible and prevent progression to handicap that may arise from activity limitation. All REICs are functioning attached to the Department of Pediatrics of Government Medical Colleges with a faculty from the Department of Pediatrics functioning as the Nodal Officer. All REICs have a uniform staff pattern.

Staff Pattern of REIC

- Nodal officer from the institution
- REIC Medical Officer
- Manager
- Data Entry Operator
- Staff nurse
- Development Therapist
- Occupational Therapist
- Physiotherapist
- Audiologist cum Speech Therapist
- Optometrist
- Special Educator
- Clinical Psychologist
- Social worker
- House Keeping

Services provided by the REICs include:

- ❑ Early intervention therapy in the High Risk Newborns starting from the New Born ICU
- ❑ Early identification of disabilities in the high risk babies during follow up and early interventions
- ❑ Medical evaluation of the children attending REIC
- ❑ Development assessment and therapy
- ❑ Occupational therapy & Physio therapy
- ❑ Psychological evaluation and interventions
- ❑ Audiology evaluation, Speech-language interventions
- ❑ Visual assessment and stimulation
- ❑ Social support services
- ❑ Special Education
- ❑ Lactational counselling and growth monitoring

Documentation and maintenance of case records, data storage, follow up is done by the data entry operator. REIC Manager coordinates the activities of REIC and liaises

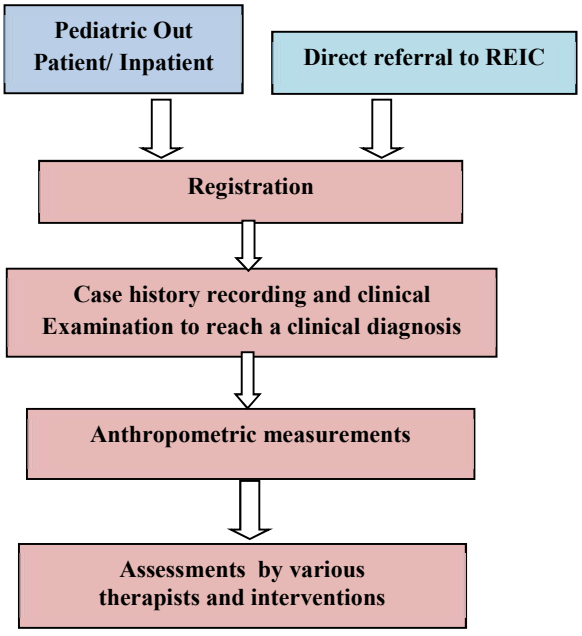
with other departments and governmental agencies for the benefit of these children.

REIC also serves as a training centre for post graduates, nursing students and peripheral health workers. REIC is involved in the training and strengthening of community health workers and works in coordination with the DEICs.

Experiences from REIC Thrissur

The first REIC in the state was started under the Dept. Of Pediatrics, at Govt. Medical College, Thrissur on August 1st, 2018 in the Play room within the department with Dr.Parvathi R. as the nodal officer. LREIC Thrissur shifted to the new Child Health building on July 29th 2020.

Children with various disabilities referred to REIC are first registered by the Data Entry Operator and their case history will be entered in a case record. The child is examined and growth parameters recorded by the staff nurse. He or she is in turn examined by the Medical Officer who identifies the various problems and the child is referred for detailed evaluation and intervention by the different therapists.



REIC functions with the aim to recognize deviations and disabilities and intervene early so as to reduce the impact of disabilities. For this purpose, REIC staff visit the Newborn Intensive care unit regularly to start early intervention for high risk new born babies who are at high risk of having motor, hearing, visual, behavioural problems. Parents are taught about home based care and the intervention is continued at home .The active role taken by parents helps them to understand their babies well and being confident in taking care of their tiny preterms. These babies are reassessed by the development therapist and physiotherapist and the interventions reinforced or modified on follow up. Retinopathy of prematurity screening is done by the ophthalmologist and REIC optometrist and treatment initiated. These babies are regularly followed up at the newborn follow up clinic till 1 year of age. After that they are followed up at REIC till at least 5 years of age. Those children identified to be having disabilities are taken up for regular therapy sessions.

In addition to providing medical care, REIC also helps in providing socio economic support, to the parents of children with disabilities by coordinating peer groups like groups for children with Down syndrome, Cerebral palsy, Autism spectrum disorders, ADHD, Learning disabilities etc. This helps parents of children with disabilities to look positively at their lives and to take care of their children in a better way. Group therapy sessions are also organized for these children and parents. Social worker creates awareness among parents about their rights and helps the parents to avail the benefits due to them and procure the equipments and aids for therapy. We also conduct special clinics for children with Down syndrome, Cerebral Palsy, Cerebral Visual impairment etc.

Training sessions are done regularly for these patient groups and this ensures follow up of these children. Special days like World CP day, Down syndrome day and days of national importance are observed, highlighting the talents of our tiny kids as well as reinforcing the training of parents and children.

We had conducted a series of training, both online and offline for Anganwadi teachers in Thrissur district to enable them to detect disabilities in preschool children which would ensure early intervention.

REIC Thrissur caters to differently abled children from Thrissur, Malappuram and Palakkad districts. Number of children attending the REIC has increased over years.

Year	New cases	Follow up cases
2018	583	917
2019	1535	4579
2020	1006	9614
2021	1601	7207

The major challenge faced during the COVID pandemic, was the practical problem in continuing therapy. This was partly solved by initiating teletherapy. In the post Covid period major challenges faced were language delay, hyperactivity, regression in motor skills due to lack of adequate therapy.

The role of REIC in the life of differently abled children is aptly described by the editor of the Lancet, Richard Horton through this statement:

"It is not a drug, it's not a vaccine and it's not a device. It is a group of therapists working together, solving problems and enhancing capabilities".

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Cerebral Palsy Mimics

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Cerebral palsy (CP) describes a group of permanent disorders of movement and posture caused by non-progressive disorders affecting the developing brain.[1-4]CP is an umbrella term and many conditions with similar clinical presentation can masquerade as cerebral palsy but have normal MRI brain or minor changes and are included in the term cerebral palsy mimics.[3,5,6]

"The latter is defined as a neurodevelopmental disorder that initially presents with a CP phenotype, but with a differing natural history and prognosis."

These include many neurodegenerative and metabolic conditions, especially slowly progressing ones. However, imaging can be normal in up to 15% of children with established CP. Hence these cases need to be carefully distinguished from other metabolic and genetic conditions, which may also show normal imaging or only slowly evolving change.[6] The possibility of a treatable component and with advances in genetic engineering envisages the importance of accurate determination of etiology of CP and identification of mimickers. With the recent discovery of CP genes using SNP microarray to exclude pathogenic CNV (Copy number variants) followed by Whole Exome Sequencing has identified around 200 genes associated with CP/mimics.[3]

Metabolic – genetic conditions mimicking CP[5]

These are common in highly consanguineous populations. With recent advances like Whole exome sequencing we can identify the majority of these conditions.

When to suspect CP mimickers?[6]

The most important step in approach is to search for a progressive illness and to determine if the disorder is non-progressive/static encephalopathy as CP was traditionally said to be.

Red flag signs which should alert the physician in this regard are[5]:

History:

- No risk factors in birth history (prematurity, kernicterus, sepsis,

seizures, hypoxic brain injury, asphyxia, hypoglycaemia, injuries, IC bleed)
- Positive family history
- Regression of motor milestones
- Progression of neurological symptoms
- Fluctuation in motor symptoms(day/activity/fasting)

Physical examination:

- Dysmorphic features
- Head size abnormalities
- Skin findings-ichthyosis, neurocutaneous markers, abnormal odour to sweat/urine
- Isolated ataxia/hypotonia in absence of spasticity/dystonia
- Peripheral nervous system abnormalities/sensory findings
- Eye movement abnormalities
- Optic atrophy/retinopathy
- Hepatosplenomegaly

MRI Brain:

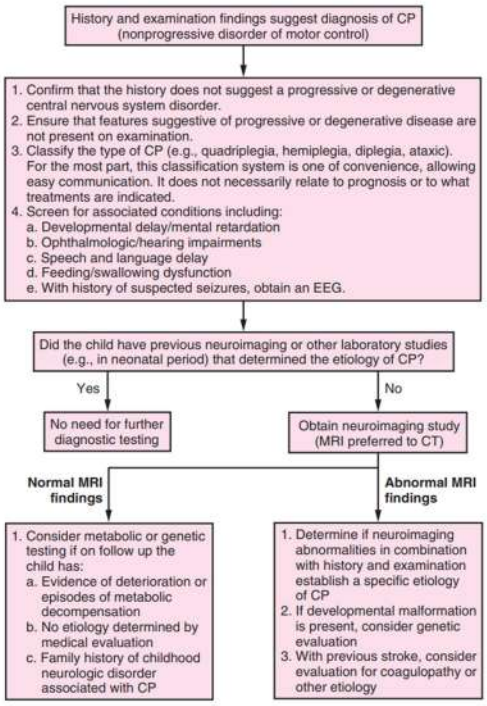
- Normal neuroimaging (can be seen in 15% of CP)
- Nonspecific brain abnormalities {isolated Globus pallidus involvement- MMA}
- Specific abnormalities (leukodystrophies, Joubertsyndrome, glutaric aciduria)

The following criteria was described by Pearson et al for diagnosis of a child with motor symptoms consistent with CP.

- symptom onset before 2 years of age
- non progressive clinical course with no milestone regression
- exclusion of disorders with predominant cognitive dysfunction, encephalopathy, seizure

CP mimics may have history of neuroregression with loss of attained milestones and have associated intellectual and communication problems, visual deficits ,seizures and recurrent attacks of encephalopathy triggered by infections, fasting, activity etc.

Flowchart for cerebral palsy diagnosis is attached below.[2]



Common metabolic-genetic conditions mimicking CP[5,6,7,8]

Disorders with predominant spasticity:

-Hereditary spastic paraplegia

-Arginase deficiency

-Biotinidase deficiency

-Aicardi syndrome

-Col4a1 related spastic cp

-Sulfite oxidase def/molybdenum cofactor def

-Leukodystrophies- ald, mld

-Adrenomyeloneuropathy

-Sjogren-larsson syndrome

-Holocarboxylase synthetase deficiency

-Prenatal iodine deficiency (neurological cretinism)

- TORCH infections

Disorders with predominant dyskinesia:

-DOPA- responsive dystonia

-Pantothenase Kinase associated Neurodegeneration (PKAN)

-Leigh syndrome

-Juvenile Neuronal ceroid Lipofuscinoses

-Rett syndrome

-Sepiapterin reductase deficiency

-Glutaric aciduria type 1

-Glucose transporter deficiency type 1

-Neurodegeneration with brain iron accumulation

-Cerebral creatine deficiency syndrome

-LeschNyhan syndrome

-3 Methyl glutaconic aciduria

-3 Methylcrotonyl Co-enzyme A carboxylase deficiency

-Cerebral folate deficiency

-ADCY5 related dyskinesia

-PCDH12 gene related dyskinesia

-NKX2-1 related ataxic dyskinesia

-TSEN54 gene related pontocerebellar hypoplasia

Disorders with prominent ataxia

-Abetalipoproteinemia

-Glucose transporter def type 1

-Pelizaeus- Merzbacher disease

-Hereditary ataxias(SCA X-linked)

-Ataxia Telangiectasia

-Friedreich ataxia

-Joubert syndrome

-Mitochondrial cytopathies(NARP mutation)

-Pontocerebellar hypoplasia/atrophy

-Cockayne syndrome

-Niemann Pick Disease Type C

-Angelman syndrome

-Gangliosidosis type 1

-Non ketotic hyperglycinaemia

-MSUD

-Posterior fossa tumours

-NKX2-1 related ataxic dyskinesia

Disorders with predominant bulbar & oromotor dysfunction

-Worster-drought syndrome/ bilateral perisylvian / opercular syndrome

-Polymicrogyria

-Zellweger syndrome

Disorders with true muscle weakness

-Muscular dystrophies-DMD/BMD

-Infantile neuro-axonal dystrophy

-Mitochondrial cytopathies

-Cerebral white matter disease

-GM1 gangliosidosis type 2

-Hereditary motor sensory neuropathies

In conclusion, a large number of conditions can present as CP phenotype: careful history taking and examination with judicious use of investigations and NGS have helped us a lot in distinguishing those mimicking CP. An accurate diagnosis is important for possible treatment, genetic counselling, prognostication and helps in decreasing the burden of CP.[9]

Some of the common clinical scenarios are given below:[1-2,8]

1. A six year old child with previously diagnosed dystonic cerebral palsy presented with aggravation of the movement disorder and on detailed interrogation was noted to have transient improvement after the

afternoon nap. Further detailed history revealed loss of previously attained motor milestones and positive family history and was hence diagnosed as a case of *Dopa Responsive Dystonia (DRD) or Segawa syndrome.* The child dramatically responded to small doses of Levodopa.

2. An infant with hypotonia and delayed milestones presented with excessive head nodding and nystagmus with roving eye movements. Family history was positive for spastic paraparesis, and baby was noted to have optic atrophy. MRI revealed symmetric pattern of white matter non myelination and was diagnosed as *Pelizaeus- Merzbacher disease (PMD).*

3. Two-year-old girl with motor and language delay reported for evaluation of not walking. On further questioning had recent regression of milestones with fine tremor of hand movements and hypotonia. Microcephaly++. Gene studies showed MeCP2 gene mutation – *Rett syndrome.*

4. An infant with recurrent episodes of apnoea and hyperpnea was brought with failure to thrive and developmental delay. His physical examination showed hypotonia .MRI brain image showing molar tooth sign with hypoplasia of cerebellar vermis.

Diagnosis- *Joubert Syndrome.*

5. A five year old girl with spastic diplegia was noted to have generalised ichthyosis and intellectual disability with intractable epilepsy.

Diagnosis- *Sjogren-Larsson syndrome*

6. A female baby was noted to have recurrent epileptic spasms since early infancy.Baby had microcephaly,dysmorphic features and hypertonia. EEG showed independent activity from both cerebral hemispheres and MRI showed agenesis of corpus callosum.Diagnosis-Aicardi Goutieres syndrome

7. A six year old child was brought with poor scholastic performance and was noted to have auditory deficits,ataxia,visual deficits,hyperactivity and deterioration in communication. Physical examination revealed ataxia and mild hyperpigmentation.There was history of similar involvement in few family members. A diagnosis of *Adrenoleukodystrophy* was confirmed by TMS and MRI.

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Medical management in Cerebral Palsy- Part 1

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1. Introduction

Cerebral palsy(CP) is the leading cause of neurological morbidity worldwide. It has diverse clinical presentations and its management is a formidable challenge for families and healthcare providers. The motor and cognitive disabilities, along with the need for prolonged therapy, educational prospects, and integration into mainstream society, are some of the primary considerations in the holistic care of these children. Even though technological advancements have substantially improved these children's functional measures and quality of life, they also have significant financial implications for families. The ultimate success of a rehabilitation program depends on the effective use of clinician skills and the health care system resources.

Managing children with CP requires the expertise of various specialists to effectively deal with the physical and cognitive problems encountered during their care. In essence, there are two primary components in the management, i.e., neurorehabilitation and co-morbidities. The neurorehabilitation component primarily addresses motor or tone abnormalities and facilitates the achievement of appropriate motor goals, for example, ambulation and Activities of Daily Living(ADL).The second management target is to prevent further injuries and optimize the quality of life of children with CP by appropriate management of various co-morbidities **(Figure 1).**

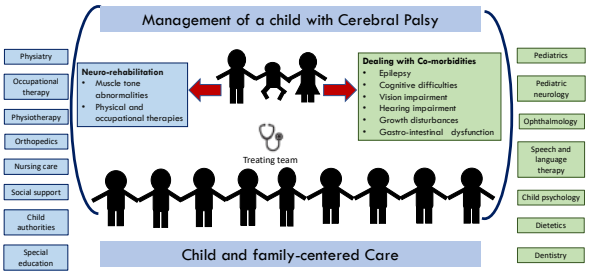


Figure 1: Multidisciplinary and interdisciplinary management of children with cerebral palsy

2. Treatment of children with cerebral palsy

2.1 Principles of treatment

An essential aspect of management is setting realistic goals and mobilizing resources to achieve those goals. It is imperative to discuss with the family that:-

- CP is not a curable condition, and there are no easy fixes or alternative medicines to achieve a rapid cure.
- The most critical measures of success in the treatment programs are independence, social integration, and mobility.
- Mobility is not equivalent to walking.
- The treatment aims to fulfil the child's maximum physical, intellectual, and psychological capabilities and attain self-sufficiency.
- Functional improvements are achieved by individualizing the therapies by considering the child's abilities and interests.
- Apart from the primary pathology of motor involvement, there can be a lot of secondary or associated complications that may mandate specialist consultations or additional treatments.
- An open dialogue between the primary health care providers and the family is necessary to prevent delays or loss of follow-up to therapies.

2.2 Clinical evaluation before commencing therapy

The first and foremost step is to establish the diagnosis with the help of a detailed history and examination. The extent of functional defect and details of associated co-morbidities needs to be evaluated before commencing individualized therapy.

A comprehensive evaluation includes investigations such as MRI brain, hearing assessment, vision assessment, EEG in cases with seizures, and a thorough functional assessment of each child. The most widely used objective scale for functional evaluation in CP is the Gross Motor Function Classification system (GMFCS, 1997).GMFCS is a validated scale for quantification of functional status in children >2 years of age and is based on ambulation capabilities such as sitting, walking, and the use of mobility devices **(Table 1).** It contains five age groups: under two years, 2 to 4 years, 4 to 6 years, 6 to 12 years, and 12 to 18 years. In 2007, an updated version (GMFCS-E & R) was introduced, which can be used for infants under two years of age through to their 18th birthday.

The GMFCS score grading ranges from levels 1-5.Level 1 corresponds to a

minimal disability, and level 5 indicates complete dependence on equipment or carers to maintain posture. Motor ability plateaus in the years sooner in the more severe GMFCS levels, so this information can help to give a prognosis for walking. For GMFCS level 1, 90% of potential motor development occurs at around five years; 4.5 years for level 2, 3.75 years for level 3, 3.5 years for level 4, and 2.75 years for level 5.For example, a child with cerebral palsy aged four and GMFCS level 4 is unlikely to achieve independent walking in later life.

Table 1: Gross Motor Function Classification System

GMFCS (Gross Motor Function Classification System)	
Level	Ability
1	Walks without restrictions
2	Walks without assistive devices but limitations in a community setting
3	Walks with assistive devices
4	Transported or uses powered mobility
5	Severely limited /dependent on a wheelchair

2.3 Treatment team

The spectrum of impairments in CP range from perception-sensory issues, cognitive difficulties, problems related to communication, feeding, excessive drooling, sleep disturbances, behavioural issues, and epilepsy. All these problems are amenable to medical management and require expertise from various specialists that form a team and work proficiently to resolve these problems. Once the extent of the functional defect and the associated co-morbidities are identified, a multidisciplinary team of doctors needs to be identified to plan a tailored treatment plan for each individual case. Physicians, physiatrists, occupational therapists, and child development professionals play a central role in the management, and other allied professionals are key players in selected cases that require specific treatment procedures and need to work in tandem with each other keeping the patient and family at its center. All efforts are directed towards improving quality of life and minimizing disability.

2.4 Medical management of Cerebral Palsy

It is a two-pronged approach with the central element addressing the tone abnormalities and therapies directed at achieving optimal mobility with a secondary aim to control factors that affect the quality of life or co-morbidities that can potentially impact the child's growth and development.

A. Neurorehabilitation- management of motor impairment

A comprehensive, objective tone evaluation is a pre requisite to formulating treatment strategies in a child with CP. It also helps assess the responses before and after a trial with specific therapies/ drugs such as baclofen or botulinum toxin. The most commonly used scales for tone evaluation are the Modified Ashworth Scale (MAS) and the Modified TardieuScale(MTS).The MAS is a widely used tool in adults and children. It uses a 6-point numerical scale that grades spasticity from 0 to 5, with an additional 1+ grade incorporated to enhance sensitivity. In contrast, the MTS measures the degree of spasticity by velocity-dependent stretch applied to muscle groups. MTS is used more commonly in children and compares the muscle's resistance to passive stretch at both slow and fast velocities **(Table 2).**

Table 2: Scales used for tone evaluation in children with CP

Modified Ashworth Scale	
0	No increase in muscle tone.
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the part is moved in flexion or extension/abduction or adduction, etc.
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM.
2	More marked increase in muscle tone through most of the ROM, but the affected part is easily moved.
3	Considerable increase in muscle tone, passive movement is difficult.
4	Affected part is rigid in flexion or extension (abduction, adduction, etc).
Modified Tardieu Scale Quality of muscle reaction is measured as:	
0	No resistance throughout the course of the passive movement
1	Slight resistance throughout the course of the passive movement
2	Clear catch at precise angle, interrupting the passive, followed by release
3	Un sustained clonus (less than 10 sec when maintaining the pressure) occurring at a precise angle
4	Un sustained clonus (more than 10 sec when maintaining the pressure) occurring at a precise angle
Angle of muscle action is measured relative to the position of minimal stretch of the muscle (corresponding to angle zero) for all joints except the hip, where it is relative to the resting anatomical position.	

1. Physical Therapy (PT)

Physiotherapy is a fundamental part of CP management. It is a set of interventions to optimize posture, mobility, and transfer by lengthening the overactive muscles and reducing contracture formation. It uses positioning, stretching, range of motion, strengthening, and conventional exercises to optimize movements across the affected joints. Other newer modalities used in physiotherapy include neuro-facilitation and electrostimulation. The amount of clinical benefit it provides is uncertain. However, it does help in enhancing caretakers' confidence in the care of CP children, such as feeding, toileting, washing, etc. It can be initiated as early as infancy to facilitate normal neuromotor development and targets a specific functional goal. However, the eventual success of treatment depends on the severity of neurological impairments in the patient.

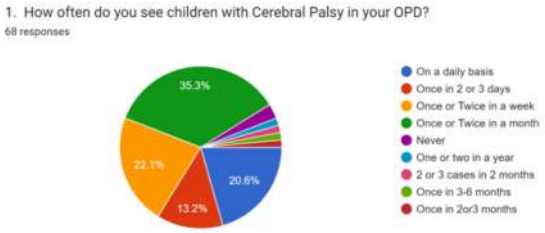
2. Occupational Therapy (OT)

The primary aim of OT is to promote hand coordination and upper limb function through play and purposeful activities. It seeks to optimize hand function, thus facilitating the ADL, such as education and work. Examples include bimanual training for hemiplegic CP, where the child is trained to use both hands together through repetitive tasks, or Constraint-induced movement therapy which involves constraining the unaffected limb to enhance the use of the affected limb. Treatment is initiated around 1-2 years, and the child is trained to carry out age-appropriate self-care activities such as bathing, brushing, etc.

Contd… Page 19

CP Survey – Part 1

By Dr. Anne Mary John & Dr. Bineesh Balakrishnan



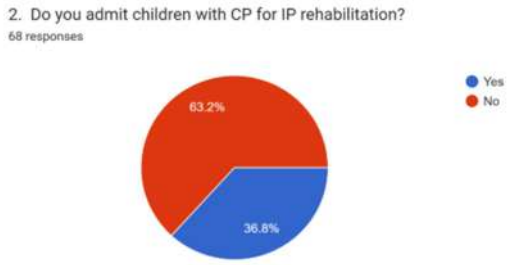
The responses this question are a little varied. While 35.3% of the respondents see CP patients once or twice in month, 22.1% see such patients once or twice in a week. 20.6% of the respondents see such patients on a daily basis, while 13.2 % see them once in 2 or 3 days. Surprisingly 2.9% respondents never see CP patients. The other responses obtained include:-

One or two in a year- opted by 1 person (1.5%)

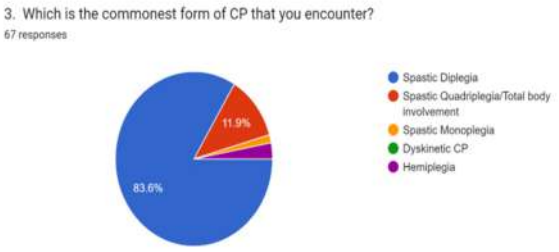
2 or 3 cases in 2 months – opted by 1 person (1.5%)

Once in 3-6 months – opted by 1 person (1.5%)

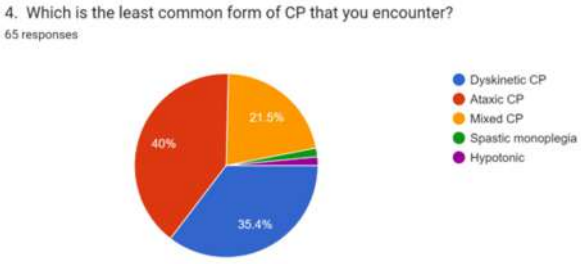
Once in 2 or 3 months – opted by 1 person (1.5%)



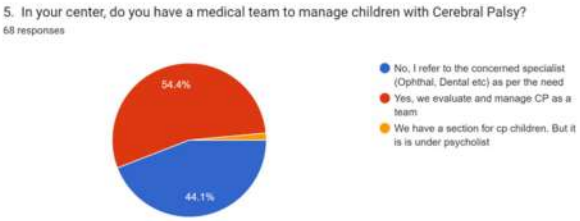
Only 36.8% of Physiatrists who took this survey admit CP patients for rehabilitation, while the remaining 63.2% don't do so.



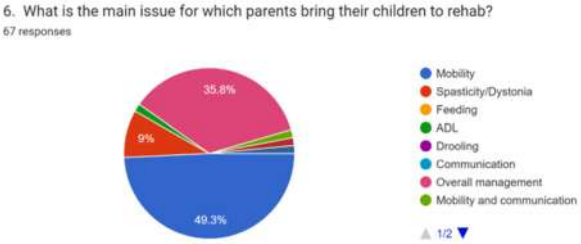
The responses show that the most common form of CP encountered by the respondents is Spastic Diplegia, as chosen by 83.6%, followed by Spastic Quadriplegia accounting for 11.9%. 3% opted for Hemiplegia, while 1.5% for Spastic Monplegia.



The least common form of Cerebral Palsy attended to by the Physiatrists who took this survey was Ataxic CP which was opted by 40% of them, followed by Dyskinetic CP opted by 35.4%. 21.5% opted for Mixed CP as the least common form of CP they encounter. 1.5% of the respondents chose spastic monoplegia & hypotonic CP as their preferred options.



Majority , 54.4% of the respondents evaluate & manage CP as a team. As we all know CP management needs a multi disciplinary team. 44.1% refer CP patients to other specialists as needed. 1.5 % have a separate section for CP but it is under Psychologist.



Mobility issues are the reason why parents bring their children to Rehab Physicians/Physiatrists, which was selected by 49.3% of respondents. 35.8% of the responses point to the fact that parents needed help in the overall management of CP children. Dystonia & spasticity were complaints that led parents to seek help from Physiatrists, an option selected by 9% of the

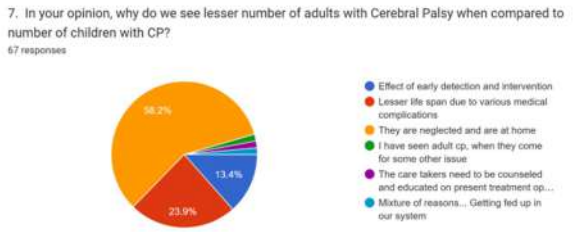
respondents. The other responses received were..

ADL issues- opted by 1 person (1.5%)

Development issues – opted by 1 person (1.5%)

Mixture of problems- opted by 1 person (1.5%)

Mobility & communication – opted by 1 person (1.5%)

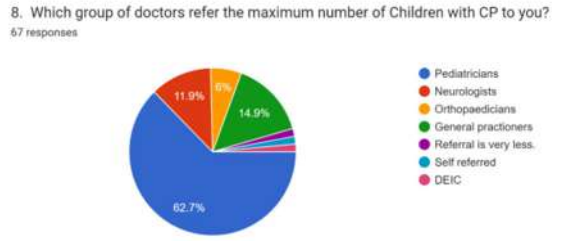


The reason we see fewer adult CP cases according to the respondents is because they are neglected & at home, as opted by 58.2% of the people who responded to this survey. 23.9% of the respondents believe that the shorter life span due to various medical complications in CP patients results in lesser CP patients coming to our OPD. 13.4% of respondents believe that early detection & intervention helps CP children almost achieve normal lives, & hence negates the need for OPD visits during adulthood. The other outlying responses include..

I have seen adult CP when they come for some other issue- opted by 1 person (1.5%)

The caretakers need to be counselled & educated on present treatment options as their previous experiences at treatment maybe very rudimentary- opted by 1 person (1.5%)

Mixture of reasons..Getting fed up with our system- opted by 1 person (1.5%)

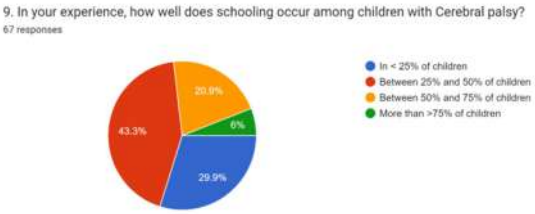


Most cases of CP are referred to Physiatrists by Pediatricians as selected by 62.7% of respondents. While 14.9% chose General Practitioners as the best response, 11.9% selected Neurologists as the response. Orthopedicians were the doctors who referred the maximum number of CP children to them according to 6% of the Physiatrists. The other responses include..

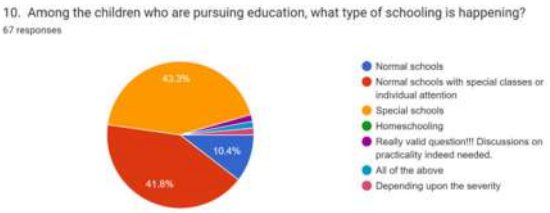
Referral is very less – opted by 1 person (1.5%)

Self- referred- opted by 1 person (1.5%)

DEIC- opted by 1 person (1.5%)



43.3% of the respondents felt that between 25-50% of CP children get good schooling, while 29.9% felt less than 25% of the children in this group get these services. 20.9% of the respondents claim that between 50 -75% of CP children get access to good schooling, while 6% of the respondents chose the option that more than 75% of children with CP have access to good schooling.



According to the responses obtained for this survey, 43.3% chose Special schools as the type of schooling pursued by CP children, while 41.8% chose normal schools with special classes or individual attention. Normal schools was opted as the answer by 10.4%. The other responses were .

Really valid question!! Discussions on practicality indeed needed – opted by 1 person (1.5%)

Depending upon the severity – opted by 1 person (1.5%)

All of the above – opted by 1 person (1.5%)

Medical Management of Cerebral Palsy- Part 2

By Dr. Rohit Sasidharan & Dr. Nisha Toteja

Management of Spasticity

The primary pathology in cerebral palsy is tone abnormalities, which can lead to impaired mobility and pain. Appropriate management has been associated with improved quality of life. The two of the most common tone abnormalities are spasticity and dystonia. Though preventive therapy and physiotherapy play a key role in its management, pharmacological measures are indicated when there is associated pain, muscle spasm, or functional disability. All treatment procedures aim to modulate the stretch reflex. Oral diazepam and baclofen are two of the most commonly used drugs for spasticity. Diazepam is indicated in situations requiring immediate relief (e.g., painful night spasms), while baclofen provides sustained long-term effects (e.g., to relieve continuous discomfort).

a. Oral Medications

Even though a wide variety of medications are available to reduce spasticity, their systemic side effects pose significant limitations in clinical use. The primary indication is the presence of generalized spasticity in nonambulatory children or those in which a mild tone reduction offers clinical benefit in the treatment program. Commonly used medications include oral baclofen, tizanidine, and diazepam. The adverse effects include drowsiness, sedation, and generalized weakness. These can sometimes clinically appear as loss of head or neck control or feeding difficulties. Hence, benefits and risks must be evaluated at least every 3 -6 months, and the treatment plan reviewed according to the child's response to therapy. Any de-escalation should be gradual to avoid precipitating withdrawal syndrome commonly seen with these medications. Commonly used antispastic oral medications are depicted in **Table 5.**

Table 5: Oral medications for spasticity

Drug	Mechanism of action	Dose	Adverse effects
Baclofen	Binds to GABAB receptors in the spinal cord-inhibits the release of neuro-excitatory neurotransmitters.	Initiated at a lower dose and then hiked up over four weeks to achieve a therapeutic effect. The onset of action is at 1 hour post-ingestion, and the effect lasts up to 8 hours requiring TDS dosing. Usual starting dose is 0.3 mg/kg/day in 3-4 divided doses and titrated to maximum of 0.75-2 mg/kg/day in divided doses	Side effects are also dose-dependent. Worsening of axial hypotonia Constipation Respiratory depression Increased risk of seizures in infants <2 years of age. Withdrawal of the drug should also be gradual as sudden withdrawal may precipitate baclofen withdrawal syndrome characterized by hallucinations, increased spasticity, seizures, and hyperthermia
Diazepam	Binds to specific sites in GABAA receptor to enhance its endogenous neuroinhibitory activity. Diazepam helps in decreasing	It has a fast onset of action and a longer duration of therapeutic effect. Starting initial	Drowsiness/ sedation Hypersalivation Respiratory depression at higher doses Tolerance and dependence phenomenon

	painful muscular spasms and improves sleep.It is primarily used in nonambulatory or severely affected children and sometimes postop to enhance their tolerance and participation in the rehabilitation	doses program<1 2 m: 0.25 mg/kg twice daily 1-5 yr: 2.5 mg twice daily 5-12 yr: 5 mg twice daily >12 yr: 10 mg twice daily	with long-term use.
Tizanidine	Central alpha-2 agonist.Reduces the release of excitatory neurotransmitters at the brain and spinal cord level.	Initial dose: <10 yr: 1 mg twice daily. >10 yr: 2 mg OD Maximum dose: 0.05 mg/kg/d or 2 mg TDS in >12 yrs of age	Sedation Hypotension Agitation Depression Gastrointestinal problems
Dantrolene sodium	Blocks the release of calcium from the sarcoplasmic reticulum in the muscle fiber.	0.5 mg/kg to 3 mg/kg in four divided doses	Hepatotoxic Muscle weakness Diarrhea sedation

b. Chemical neurolysis

Chemically induced denervation is a modality used to treat focal spasticity severe enough to result in impaired mobility or contractures.

1.Botulinum Toxin-Botulinum toxin type A (BTX-A)given via injection acts at the neuromuscular junction by blocking the release of acetylcholine, causing reversible chemo-denervation. It prevents muscle contraction and reduces tone. It works well in both focal spasticities as well as dystonias. The procedure is generally safe and can be done by any trained professional (surgeon, pediatrician, physiatrist) under sedation or general anesthesia. The best candidates for this therapy are children with localized spasticity preventing optimal mobility or causing discomfort, pain, or abnormal posture. Evidence suggests good clinical response in those with selected deformities such as equines varus. Younger children without fixed contractures derive the most benefit from this treatment. It has a good safety profile with minimal transient side effects such as localized weakness, continence, and swallowing difficulties. Anecdotal reports indicate severe toxicity resulting in generalized weakness, visual disturbances, ptosis, and respiratory depression. In specific cases, suggested doses range from 4 U/kg to greater than 16 U/kg. Cost is a significant constraint, especially in resource-limited settings like India.

2. **Phenol and Alcohol-** Other recently tried agents are injectable aqueous phenol(3-6%) and absolute alcohol (30%–50%).These agents cause axonal degeneration when injected perineurally resulting in chemodenervation of affected muscles. The procedure requires sedation or anesthesia in children. It is generally a low-cost, well-tolerated procedure with few side effects, such as localized pain and paresthesia. Phenol blocks are typically preferred for lower extremity spasticity.

c. **Intrathecal Baclofen-** Intrathecal baclofen (ITB) is indicated in children with severe spasticity or dystonias refractory to oral treatments or in those where side effects of oral medications preclude their use. Since intrathecal doses are merely 1% of oral doses, systemic side effects are avoided. Baclofen is administered continuously through a subcutaneous catheter by a programmable pump. Studies suggest better efficacy and functional improvement in patients with these devices. However, high infection rates (18%) are significant limitations. Accidental programming errors can potentially cause fatal outcomes due to overdose and respiratory depression. Hence, careful case selection and vigilant monitoring for pump-related accidents are advisable.

d. Surgical Therapy

Selective Dorsal Rhizotomy (SDR)- It is a surgical procedure where selective nerve roots from L2-S1 are surgically divided, thus resulting in an interruption in the afferent component of the reflex arc and reduced spasticity. Ideal candidates are those with GMFCS level 2 or 3.It is indicated in selected cases with an aim to improve their walking ability. Careful case selection and a rigorous postoperative physical therapy program for at least 6-12 months are essential for successful outcomes.

e. Deep Brain Stimulation(DBS)

Not much scientific evidence exists regarding the use of DBS in children with CP. Most clinical studies have used it for the treatment of dyskinetic CP. The technique requires the implantation of electrodes in basal ganglia and delivers low-voltage stimulation to effect neural reorganization, especially in the globus pallidus. However, scientific evidence generated so far is not very convincing about the general use of this treatment modality.

1. Management of Dystonia and Mixed Movement Disorders

Sometimes motor dysfunction in CP results in complex clinical movements, including dyskinesias or rigidity due to brainstem or basal ganglia lesions. Certain oral medications can be used for effective symptom control in such cases. Commonly used medications for managing dystonias are trihexyphenidyl and tetrabenazine. Trihexyphenidyl is an anticholinergic agent that works at the level of basal ganglia. Its use may be associated with anticholinergic side effects such as blurred vision, dry mouth, urinary retention, and constipation. Usual starting doses are 1-2mg/day with gradual titration upto 2-60mg/day in 2-3 divided doses. Tetrabenazine is a dopamine depleter that prevents neurotransmitter degradation, and side effects include akathisia, depression, and agitation.

A. Management of co-morbidities

Several co-morbidities often accompany the motor difficulties faced by a child affected with CP. These associated impairments significantly impact the quality of life and can often be distressing for the caretakers of these children. Some of these problems have been enlisted in **Table 6.**

S.No	Co-morbidities	Remarks
1.	Intellectual disability	Seen in 50 % of patients with CP More severe in children with spastic quadriplegia.
2	Neurobehavioral/ neurodevelopmental disorders	Seen in 25 % of patients with CP Common disorders seen are behavioural, emotional, and/or psychotic disorders Autistic disorders are seen in 7% of children with CP, more common in non-spastic CP.
3	Epilepsy	Seen in 25-45% of patients with CP More common with spastic quadriplegia.
4	Visual disorders	See in 30-40% of CP More common in premature infants who develop CP. common eye conditions seen are cortical visual impairment, strabismus, amblyopia, refractive errors, and visual field defects.
5	Hearing/speech impairment	Seen in 30-40% Common conditions are aphasia, dysarthria, or mutism.
6	Growth failure and nutritional deficiencies	Secondary to inadequate intake, feeding issues, and other GI problems.
7	Gastrointestinal disorders	90% of children with CP have concurrent constipation, gastro-esophageal reflux, vomiting, swallowing disorders, or abdominal pain.
8	Pulmonary disorders	Chronic pulmonary diseases due to recurrent aspiration, scoliosis, and respiratory muscle incoordination.
9	Orthopedic disorders	Common orthopedic conditions are subluxation, dislocation, progressive hip dysplasia, foot deformities, and scoliosis.
10	Urinary disorders	30-60% of children with CP have dysfunctional voiding symptoms.
11	Pain	Seen in 50-70%.Pain may go unrecognized due to communication difficulties.
12	Sleep disturbance	Difficulty in sleep-wake transitions and excessive daytime sleepiness are common.

1. Feeding and Nutrition

Many children with CP struggle with feeding issues and suffer from malnutrition. Suboptimal nutrition often

stems from the various oromotor dysfunctions commonly encountered in these children. These include drooling, chewing and swallowing difficulties, and dysarthria. Other contributing factors include poor hygiene, inadequate nutritional intake, and frequent aspiration due to gastroesophageal reflux and pseudobulbar palsy. This causes a vicious cycle of malnutrition-induced immunosuppression, predisposing them to frequent infections and worsening their nutritional status. These children should have a regular dietary assessment; modified diets and alternative feeding techniques (nasogastric tubes, gastrostomy feeds) may be required in selected cases.

2. Drooling

Normal salivary continence is achieved by 15–18 months in most typically developing children. Sialorrhea beyond the age of 4 years is considered pathological and requires evaluation and therapy. In CP, the prevalence of drooling can be as high as 30-53% and may even cause difficulties in socialization. Usual causative factors are weak tongue and oropharyngeal musculature, poor lip closure, and postural factors. A multidisciplinary evaluation by speech and language therapists, dentists, ENT surgeons, and pediatricians can help uncover the treatable causes, such as oromotor inflammation or dental malocclusions. Quantification of severity may be done by a standardized tool such as Thomas Stonell and Greenberg classification. Alternatively, a bibometer or bib diary may be used. Management options range from conservative to medical and surgical modalities. The basic step would require addressing postural factors and avoiding fizzy drinks, which can increase saliva production. Oromotor exercises, including biofeedback systems, have been successful in some studies. Some intraoral devices, like palatal training appliances, can also be beneficial. In selective cases, some medications can be used on a short-term basis. These include hyoscine patches, oral trihexyphenidyl, oral glycopyrrolate, benztropine, and inhaled ipratropium. Most of these agents are used as off-label indications. In refractory cases, sialorrhea is controlled by injectable botulinum toxin in the salivary gland. Surgical treatments include rerouting of salivary ducts, ligation, or excision. These modalities lack a robust scientific basis for their use and are primarily based on physicians 'experience.

3. Social Support

Care of a child with CP is exhaustive, never-ending, and emotionally draining task for the caregivers. A primary health care provider is in a key position to deliver support to the parents and family. Social support is often an underscored element in managing a child with CP. This may require multiple sessions of empathetic listening and advice. It can help resolve feelings of guilt and despair that often weighs heavily on the caretakers and family. As far as possible, an honest dialogue is necessary to prevent misinformation or false hopes about their child's prognosis.

4. Musculoskeletal problems

Studies indicate that hip dislocations and scoliosis are quite common in children with CP. This has prompted several nations to adopt screening policies regarding these issues for early detection and treatment. Certain orthopedic surgeries may be required in cases with fixed deformities or contractures. The standard surgical procedures are tendon lengthening (Tendoachilles, hamstring), muscle release, tendon transfers, pronator rerouting, split posterior tibial /tibialis anterior transfers, semitendinosus transfer, and osteotomy for correction of bony abnormalities.

5. Chronic pain

Pain is a frequent accompaniment to mobility impairments in children with CP. In normal children, self-reporting is the only way of quantifying pain. However, even this is not a feasible option in children with CP who can have associated cognitive and communication difficulties. Some pain scoring tools have been devised to circumvent this problem. In terms of treatment, NSAID analgesics are the first line of management which can be stepped up by various other medications for optimal pain control. With adequate analgesia and access to social and educational environments, these children can attain a quality of life at par with their peers in most domains.

6. Epilepsy

Seizures are found in nearly 30-40% of children with CP. Uncontrolled epilepsy can cause further neurological injury and cognitive decline. Most seizures occur in infancy and require polytherapy. They can have varied semiology and can be challenging to control. CP is also the leading cause of west syndrome in India. While choosing anti-epileptic drugs (AEDs), one must consider the type of seizures, age, adverse effects profile, drug interactions, and co-morbidities. Hence, early and effective control of seizures with appropriate doses of AEDs can facilitate reasonable developmental goals.

7. Speech and language difficulties

Poor hearing and vision interfere with development and should be screened for all children with cerebral palsy. Efforts should be made to facilitate communication in these children, as difficulties with speech are one of the most important factors determining social and educational integration. The communication aids must be tailored to the child's learning level and may range from simple pictures to electronic devices. Speech and language therapists play a crucial role in achieving communication skills in children with cerebral palsy.

8. Bowel and bladder dysfunction

Constipation is common and is multifactorial due to tone abnormality, poor nutrition, and mobility. Constipation also worsens urinary symptoms. Urinary incontinence due to poor control of bladder muscles can be treated with biofeedback exercises, drugs, and occasionally surgery, although the evidence for these treatments is lacking. Regular water and fiber intake, along with oral laxatives such as lactulose, may be advised.

9. Vision impairments

In practice, the most common ocular problem is squint due to extraocular muscle incoordination. Other common ophthalmological issues include Cerebral visual impairment (CVI) and myopia. CVI results from damage to retro-chiasmatic neuronal pathways to the occipital cortex This causes functional blindness which can be mapped by using the CVI inventory. Management includes visual stimulation techniques and stem cell therapy. Early screening and timely intervention can help deal with some ocular issues. Additionally, caretakers may need to be advised regarding environmental modifications to prevent injuries and accidents. Social integration and educational aspects have to be considered in older children, and social and welfare schemes may be availed to further their prospects

3. Prognosis

The clinical spectrum of CP is dynamic. Thus it is difficult to predict prognosis accurately. The most crucial factor is the extent of neurological injury and the severity of resulting impairments.

.The key influencing factors include

the timing of major motor milestones, environmental factors, the severity of involvement, presence of co-morbidities, family participation, and treatment compliance. The most frequent concern of parents is, "When will my child be able to walk?". Independent ambulation is indeed a landmark achievement. Studies indicate that most potential walkers begin ambulating between 2-7 years of age. The ability to sit independently and roll over at two years of age predicts future ambulation. Nearly 85% of children with mild-moderate impairments can achieve independent ambulation. However, only 15% can achieve ambulation among those with severe involvement. Similarly, the type of CP also determines the prognosis. Most spastic hemiplegics and diplegics have an excellent response to therapies, including Occupational therapy (OT), Physiotherapy (PT), and other assistive modalities. In contrast, children with dyskinetic CP show poor functional gains despite therapy.

Table:- Prognostic factors for independent ambulation

S.No	Motor milestones	Poor prognosis for independent ambulation
1	Head control	Not achieved by 20 months
2	Sitting	Not achieved by 48 months
3	Floor mobility	Not achieved by 48 months

4. Future directions

Despite the advances in neonatal care, the prevalence of CP has largely remained static over the last few decades. It is still the leading cause of neuro-disability worldwide. In India, a staggering number of children and their families suffer from its long-term effects. The available healthcare resources are often overburdened and overwhelmed. This provides sufficient scientific impetus to look for better therapeutic options in the care of CP. A novel development in this direction is the advent of stem cell therapy. Some studies have reported its benefits in selected cases. Other interventions being tried worldwide in the care of CP children are robot-assisted devices to improve motor learning and enhance limb function.

AFOs Everywhere, Only a SAFO to Spare: Lower Extremity Orthotics in Cerebral Palsy

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He completed Primary certification in Hyperbaric and Underwater Medicine in 2013, from National Baromedical services, Columbia, South Carolina, USA. He also completed his training in Spasticity Surgery and Rehabilitation in 2014, from Tokyo Women's University, Shinjiku, Tokyo, Japan.

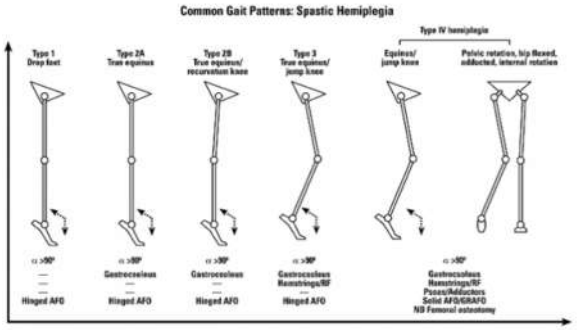
He was the Chief Editor of the Kerala Journal of PMR from 2019 to 2022. His areas of interest include Spasticity, HBOT, Neurorehabilitation & Pain rehabilitation.

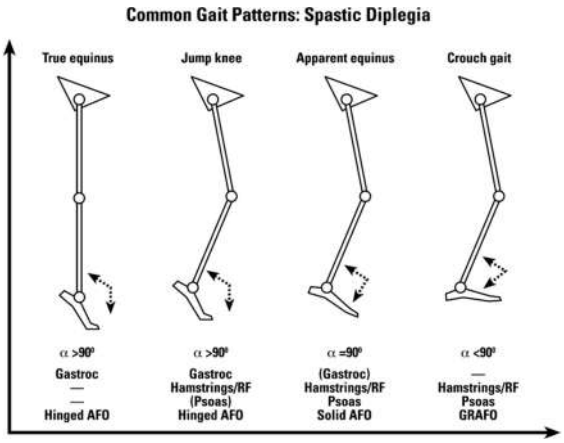
Most orthotic prescriptions for people with cerebral palsy are written by practitioners who may not be fully informed. They treat what is in front of them, while lacking a deeper understanding of why it is happening. The result is KAFOs and other useless orthotics that are counter-productive. Why this article? A senior consultant called once and asked me what types of AFOs I used in CP. Referring them to Winter's and Rodda's classifications wasn't good enough for the need. I sought out Freeman Miller's book. Here's the integration of a few approaches juxtaposed. Warning, I'm not an expert, just synthesizing data and filling in the gaps along the way.

In 2010 the Kerala chapter of IAPMR mid-term CME was held in the Hyson hotel. A senior consultant assigned to talk on gait said something interesting. 'Kids with CP walk like ducks, and if you operate they then walk like operated ducks'. The point was 'Why interfere? 'The idea to all these interventions is to keep a child on their current position in the Gross Motor Functional Classification Scale curve. As people age deterioration in function is inevitable.

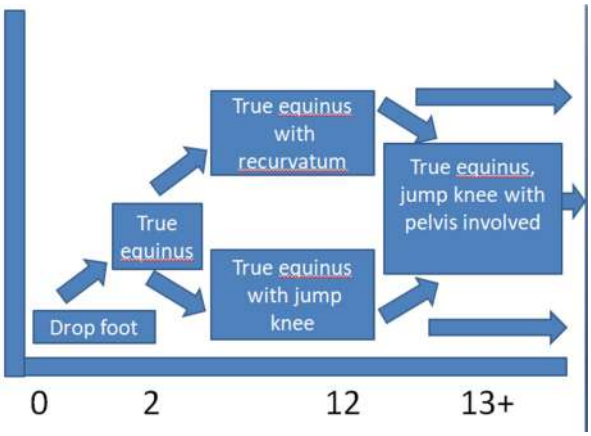
Evolution of gait in CP: Usually babies start walking around age. If you read Pediatric development by Levangie you'll see all the steps leading up to this point. Depending on GMFCS, trajectory may vary. Once they stand (or fail to) we have to consider topography. Both Hemi and Di-plegia will start with poor selective activation of tibialis anterior. Rodda for some reason doesn't consider this, but Winter does. As weight bearing through the foot begins the intrafusal fibers of gastroc activate and the AHC gets stimulated inducing spasticity. With sustained spasticity an equinus deformity emerges. Neglected this evolves into a contracture that affects the joints above. Taking hemiplegia this becomes

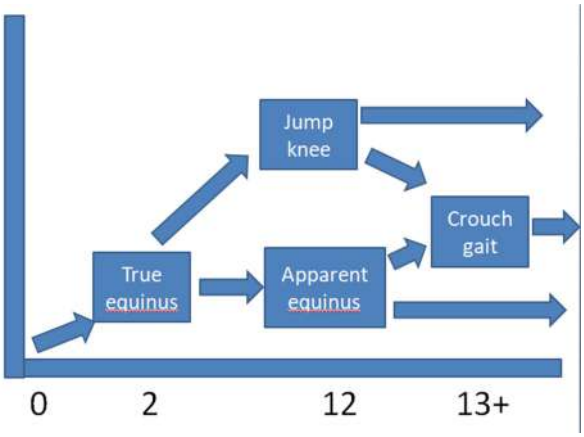
either a recurvatum or a jump knee, because body weight and height are increasing rapidly. Eventually this may stabilize by involving the hip, and by extension the spine. It may just continue as is. Diplegia on the other hand bifurcates into a jump knee or apparent equinus, or a mix of both (one for each leg), and continues as the same or degenerates into crouch gait and stabilizes there. What determines where the patient's gait pattern stabilizes? Selective voluntary motor control, control of hypertonia, quality of rehabilitation, pharmacological agents employed, skill of the treating Physiatrist, Orthopedician and therapists, patient's IQ and motivation level, and accessibility to appropriate care, ending with compliance. That is how big the mess is. A categorization system could show trajectory and help plan further interventions. Enter Winter's and Rodda's classifications.





These are not without problems. The treatment proposed is biased towards articulated AFOs, which not all patients can use. They do provide an evolution pattern, the one we discussed below (see figures 1 and 2). As the patient grows we know which 'box' they roughly fit into. Another shortcoming is its failure to detail the subtalar joint, forefoot and toes. They are only concerned with the ankle, knee, and hip.





The crux of utilizing the models is having a scale to measure them with. Simple models are inaccurate, and if precise too complicated to use. Brunnstrom's motor recovery scale is flawed. It has no representation for severe damage, and looks at a limb as a whole rather than the joints within it. Since spasticity evolves, one joint might be flaccid and the other hypertonic, or one hypertonic and the other in contracture. The Ashworth being simple is limited also. The flaw is voluntary motor control is neglected. The Tardieu scale covers all the needed domains for us to make an informed decision. The remaining confounder will be the impact of interventions.

This is the Tardeiu scale. For some reason a few variables overlap. To stream line the approach to a spastic limb let's distill the scale with rationale.

	X	V1	V2	V3	R1	R2	ARoM	MAS	MRC
Muscle group	0	full	full	full	0	full	full	0	5

Tardieu variables are as specified: X= Quality of muscle reaction, V1= as slow as possible (tells about PRoM), V2= speed of the limb segment falling, V3= as fast as possible, R1= Angle of catch seen at Velocity V2 or V3, R2= Full range of motion achieved when muscle is at rest and tested at V1 velocity, ARoM= self explanatory, MAS= read it up if needed, MRC= read it up if needed

What information do the remaining variables provide us as far as measures and anatomic correlates?

Variable	Informs of	Anatomic correlate
R1	Presence of contracture	Extrafusal fiber
R2	Tone	AHC/ Intrafusal fiber
X	Tone	Golgi tendon organ
ARoM	Selective Voluntary motor control	Betz cell
MRC	Selective Voluntary motor control	Betz cell

Essentially we have one or more of three problems to identify: poor to no Selective Voluntary motor control, Hypertonia, and contracture.Having distilled the scale to its components we can now connect clinical exam to orthotic prescriptions.

Steps to building your AFO

1. What is their Topography? Informs of whether to use Winters or Rodda's classification
2. What subtype are they? Sets the range on AFO bodies
3. What is the Tardeiu like? Informs which AFO body is needed: more supportive or more dynamic.
4. Is the hind foot involved? Look for supination/ pronation
5. Is the forefoot involved? Check for too many toes/ too few toes
6. Do we need Durable Medical Equipment to supplement the orthotic?

Step 1: Pick out the classification and figure out the subtype after clinical exam

Step 2: Subtype

Winter's classification of hemiplegic CP gait

Drop foot

Predominant mechanism: Poor selective voluntary motor control

Problems- weak to no tibialis anterior action

Solutions-full height Posterior Leaf Spring AFO if Subtalar Joint control is good, ½ height AFO if Subtalar Joint control is not good

True equinus

Predominant mechanism: Hypertonia >=Contracture

Problems-gastroc contracture

Solutions- articulated AFO

True equinus with Jump knee

Predominant mechanism: Hypertonia <=Contracture

Problems- variable Gastrocnemius contracture

Solutions-articulated AFO in 5° Dorsiflexion

True equinus with Recurvatum

Predominant mechanism: Hypertonia <=Contracture

Problems-equinus contracture, Patellofemoral ligament laxity, strong quads, overstretched hamstring

Solutions- Solid (ankle) AFO with a heel raise to accommodate the equinus

True equinus with Recurvatum and hip involvement

Predominant mechanism: Hypertonia <=Contracture

Problems-equinus contracture, Patellofemoral ligament lax, strong quads, overstretched hamstring, Hip Internal Rotation/ Hip Flexion

Solutions- Solid (ankle) AFO with a heel raise and a elbow crutch or cane

Rodda's classification of spastic diplegic gait framed in slim-Tardieu

True equinus

Predominant mechanism: Hypertonia

Problems- equinus with knees straight

Solutions-Articulated AFO, this may result in recurvatum if contracture is more than hypertonia

Jump knee

Predominant mechanism: Hypertonia >=Contracture

Problems- knee flexed, equinus, quads overstretched, tight hamstrings

Solutions- Solid (ankle) AFO or Ground Reaction AFO

Apparent equinus

Predominant mechanism: Hypertonia ><=Contracture

Problems- knee flexed equinus, hamstring tight, weak quads

Solutions-articulated Ground Reaction AFO

Crouch gait

Predominant mechanism: Hypertonia <=Contracture

Problems-weak, tight gastroc, weak quads, tight Iliopsoas,ankle Plantar Flexors

In crouch gait, there is spasticity / contracture of hip flexors and knee flexors with weak soleus causing dorsiflexion (gastrocnemius mechanically ineffective due to knee flexion); quads is overstretched but has to be strong to keep balance

Solutions-articulated AFO

Having modeled the gait patterns we can now consider deficits to address per Miller with proposed treatment options.

Flexed spastic toes= biomechanical footplate, or standard footplate to toe tips

Forefoot abduction/ adduction= thin plastic wrap-around or solid plastic AFO w/ rigid counters

Hindfoot varus/ valgus- depends on degree of deviation, hypertonia, and ligament laxity

Mild= lateral or medial sole or heel wedge

Moderate= Ankle boot with heel or sole wedge

Severe= AFO with heel wedge plus T strap

What is treatment success?

The usual thought process is 'I did this and it worked so it must be ok'. That analysis needs to be made deeper by asking:

How long did you follow-up?

What was the patient compliance rate?

What were the noted objective benefits?

With this we can refine ourselves as clinicians.

Special thanks to Dr. George Joseph sir for his valuable feedback & suggestions.

Botulinum Toxin in Cerebral Palsy

Abstract:

Botulinum Toxin (Btx) is considered to be one of the foremost agents used in management of spasticity in neurological rehabilitation. Focal spastic conditions causing various deforming conditions like equinus, crouch gait, scissoring, shoulder internal rotation, elbow flexion, forearm pronation or wrist and finger flexion are managed better with Btx injections followed by specific physical or occupational therapy to improve muscle control. It is necessary for clinicians using this agent to consider the positive effects of spasticity in maintaining posture before recommending this procedure. It is difficult to use electromyography (EMG) or ultrasound (USG) guidance in children and hence clinicians must be familiar with using this drug with only anatomical knowledge in these patients. The dose ranges and inter-injection period must also be known to avoid poor outcomes or antibody formation. Used correctly, Btx is a safe and effective option for management of spasticity in childhood cerebral palsy.

Keywords:

Cerebral Palsy, Botulinum toxin, Spasticity

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Introduction:

Cerebral Palsy is a non-progressive encephalopathy causing delayed acquisition of motor milestones in children, deformities in the limb and spine and consequent disability. It is the most common cause of spasticity in children [1]. Botulinum toxin (Btx) combined with multi-disciplinary measures including physical and occupational therapy, orthotics, casting and deformity correction surgeries are used to manage spasticity.

Pharmacology of Botulinum Toxin:

The neuromuscular junction (NMJ) consists of the terminal motor neuron axon, the muscle fiber that it innervates and the synaptic cleft in between. Acetylcholine (Ach) is synthesized and stored in the synaptic vesicles which is then released into the synaptic cleft by fusion with the pre-synpatic membrane through exocytosis. A protein called as Synapsin 1 binds the synaptic vesicle to the cytoskeleton. Synapsin 1 phosphorylation, which is a calcium dependent process occurring at the time of arrival of an action potential at the terminal membrane, leads to release of the vesicle from the cytoskeleton. The synaptic vesicle

also has other important proteins like synaptobrevin and syntaxin and another protein called synaptosome associated protein 25 (SNAP 25) which are all necessary to maintain integrity of the synaptic vesicle. It is clear that any process which interferes with the integrity of the synaptic vesicle affects the release of acetylcholine, thus retarding muscle contraction [2].

This entire complex is called soluble N-ethylmaleimide sensitive factor attachment protein receptor (SNARE). Btx A, when introduced at the NMJ, is endocytosed into the pre-synaptic axonal terminal, where it is cleaved into its constituent light and heavy chains. The light chain binds with the SNARE protein complex and prevents the release of Ach containing vesicle thus resulting in lack of Ach at the NMJ which causes failure of muscle contraction thus resulting in muscle weakness and reduction in hypertonia [3].

Patient Selection:

Increase in tone of individual muscles or muscle groups result in certain characteristic postures of the limbs. The drug is injected into specific muscles to achieve reduction in tone and opens up a "therapeutic window" to enable rehabilitation measures to bring about more lasting changes. In the lower limb, similar to single-event multi-level surgery concept there is a single event botulinum toxin injection to improve overall functioning and gait and correct lever-arm abnormalities thus resulting in postponement or avoidance of surgical interventions [4].

Table 1: Pattern of Muscle Involvement in Upper Limb Spasticity [5]

Indication	Muscle Involved	Dose of Botulinum toxin A
Externally rotated shoulder	Infraspinatus Teres minor	1-2 U/Kg
Internally rotated and adducted shoulder	Pectoralis major Subscapularis	2-3 U/Kg 1-2 U/Kg
Flexed Elbow	Biceps brachii	2-3 U/Kg
Pronated forearm	Pronator teres	1 U/Kg
Flexed Wrist	Flexor carpi radialis Flexor carpi ulnaris	1-2 U/Kg
Clenched fist	Flexor digitorum sublimis Flexor digitorum profundus Flexor pollicis longus Lumbricals Palmar interossei	1-2 U/Kg 0.5-1 U/Kg 0.5 U/Kg
Thumb in palm	Adductor pollicis brevis Flexor pollicis brevis Flexor pollicis longus Dorsal interossei 1	0.5 U/Kg

Table 2: Pattern of Muscle Involvement in Lower Limb Spasticity [6]

Indication	Muscle Involved	Dose of Botulinum toxin A
Flexed hip	Iliopsoas	2-4 U/Kg
Scissoring gait/adducted thighs	Adductor longus Adductor brevis Gracilis	1-3 U/Kg 1-2 U/Kg
Crouch gait	Semitendinosus Semimembranosus Biceps femoris	1-3 U/Kg
Striatal toe	Extensor hallucis longus	1-2 U/Kg
Toe clawing	Flexor digitorum longus Flexor hallucis longus	1-2 U/Kg
Equinovarus Foot	Gastrocnemius – medial and lateral Soleus Tibialis posterior	1-3 U/Kg

Table 3: Maximum Possible Dose of Botulinum Toxin [2,6]

	Omnabotulinum toxin A	Abobotulinum toxin A
Maximum dose per site	10-50 U	50-250 U
Maximum total dose	400 (~600)	500-1000
Range (U/Kg body weight)	10-20 U	1-20 U

If the muscle gets saturated with the toxin, it can leak out of the muscle and get carried to

distal sites where they can cause serious and life-threatening side-effects. Hence it is advisable to inject at 2 or more sites in larger muscles with no more than 25-50 U or 1 ml volume at a single site.

Injection Technique: [7]

1. Palpation

It Is necessary to know the anatomical landmarks of each muscle to successfully inject by this method. It is most suitable for larger and more superficial muscles. After inserting the needle into the muscle, the distal joint may be moved in the opposite direction to the muscle action, which would stretch the muscle and make the inserted needle move, thus confirming the entry of the needle in the muscle.

2. Stimulation

Stimulation either by electromyography (EMG) or electrical stimulation with a stimulator unit can more accurately localize the muscle for injection, particularly in deep or slender muscles. However, the need for multiple passes to locate the muscles and patient co-operation needed for these methods make it slightly impractical in children. Electrical stimulation (not EMG) can however be used in a sedated child.

3. Ultrasound

Ultrasound can directly visualize the muscle to be injected and is increasingly being used as a substitute to stimulation techniques in guiding the needle to the target muscle. It does require specialized equipment and training in using the ultrasound machine in addition to onerous legal undertaking in many states.

Evaluation and Assessment of Patients:

Use of assessment devices to record the change in patient's condition after the injection is necessary to provide feedback to the treating team and parents regarding further course of action. In non-ambulatory patients, the goal may be to reduce the pain from spasticity, or promote hygiene improvement impaired due to a closed fist or an adducted thigh. Assessment of range of motion of the affected joints is also necessary to show if there has been any improvement thus preventing contractures or subluxations or facilitating the use of an orthosis [8]. In ambulatory patients of course, it is necessary to record the changes in gait parameters either by video analysis or by an instrumented gait analysis device. Measurement of tone by modified Ashworth scale or modified Tardieu scale, recording of gross motor functioning classification system (GMFCS) and using a specific function scale like pediatric evaluation of disability inventory (PEDI) is also recommended in all cases. In addition to limb spasticity, Btx has also been reported to be used in control of hypersalivation in this population [9].

Post-Injection Care:

The maximum effect usually occurs 2-4 weeks after the injection and may last for 3-6 months in most patients. Post injection casting (after 2 weeks) may increase the efficacy of the drug. Post injection rehabilitation program, stretching and functional re-training is necessary to gain functional improvement after botulinum toxin therapy. Repeated injections may lead to range of motion improvement but the data does not support the use of Btx for contracture prevention [10].

Adverse Effects:

Generally, the drug is very safe and adverse effects are few, provided the procedure is performed by experienced hands. Local side-effects are generally mild and include redness, muscle hematoma and injection site pain. Systemic side-effects like flu-like illness are generally rare. More troublesome are the distal side-effects like dysphagia or diplopia which may happen due to systemic spread of the toxin [11]. Bulbar paralysis can be potentially life-threatening and may require ventilatory support till the action of the toxin dissipates. Failures of injection treatment may be due to wrong choice of muscle, wrong injection technique or failure to institute a rehabilitation plan. In patients who have taken multiple injections in the past, antibody formation may lead to therapeutic failure and in such cases a different botulinum toxin preparation may be tried.

Conclusion:

Untreated spasticity in cerebral palsy can potentially lead to multiple issues like contractures, pain and loss of function which can be tackled with botulinum toxin in well-selected cases. This agent can be tried for spasticity control in children after the age of 2 and is generally well-tolerated. Used correctly it can lead to functional gains, postponement or avoidance of surgery and improve the compliance of the patient to the rehabilitation program. Use of appropriate injection technique and dose of the medication with an inter-injection period of atleast 3 months is necessary for good outcomes. Formal assessment of the effects of the drug in each patient is recommended in all cases.

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Orthopaedic interventions in Cerebral Palsy

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Introduction:

Cerebral palsy (CP) is a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to nonprogressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour, by epilepsy, and by secondary musculoskeletal problems. Although CP is a static encephalopathy, the associated musculoskeletal pathology is often progressive. CP affects muscle growth leading to a discrepancy between muscle growth and bone growth. This in turn may lead to deformities of bones and joints, a loss of function, pain, and make care more difficult. These problems get accentuated with increasing age.Orthopedic intervention has a critical role to play in the overall management of a person with CP. Conservative management by a Physical medicine and Rehabilitation team is the first step in the treatment of cerebral palsy. It improves motor skills, prevent movement problems getting worse and also physical therapy implements range of movement exercises, strength and flexibility exercises. It relives Spasticity. The aim of this article is to review how and when and which orthopaedic interventions in CP is Ideal

Classification of cerebral palsy

There are three major classification systems.

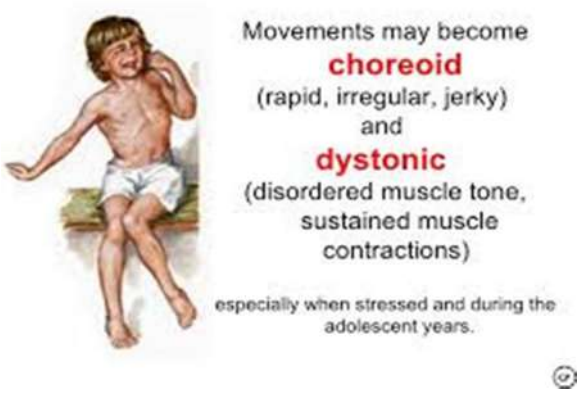
These are: Physiologic, Geographic & Functional.

- **Physiologic classification**

There are four main types of cerebral palsy in the physiologic classification.

1. Spastic. The most common form of cerebral palsy is spastic CP, in which a child has increased muscle tone/tightness. A child's legs, arms, and back are stiff and contracted, which makes movement difficult.

2. Athetoid. A child with athetoid CP has low muscle tone/looseness, which makes limbs weak and floppy. Athetoid CP causes uncontrolled and involuntary movements of the entire body. It may be difficult for a child to sit up straight or walk and speech can often be difficult to understand.



3. Ataxic. This rare form of CP affects balance and depth perception. There is poor coordination, with a wide-based and clumsy gait. There is also difficulty with precise movements, such as using a pen or buttoning a shirt.

4. Mixed. In mixed CP, there are symptoms of both spastic and athetoid CP. Some muscles are tight and others are loose. There is both stiffness and involuntary movements.

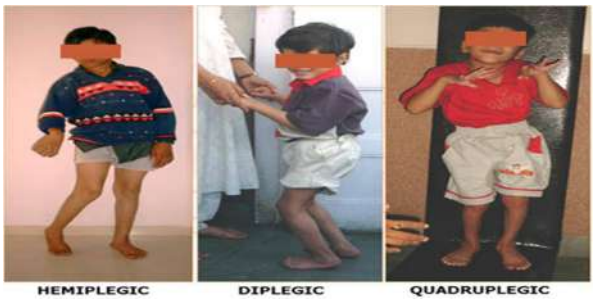
- **Geographic classification**

  1.Diplegic. Both legs are affected. Tight muscles in the hips and legs often cause the legs to turn inward and cross at the knees when walking, called "scissoring."

2.Hemiplegic. One side of the body is affected. The arm is often more severely affected than the leg.

3.Triplegic. Both legs and one arm are affected.

4.Quadriplegic or total body involvement. All four limbs and the trunk are affected. Independent walking may be difficult, or even not possible. In addition, the muscles of the mouth and tongue also may be affected, making swallowing and eating difficult.



- **Functional classification**

The Gross Motor Functional Classification System (GMFCS) is most commonly used to describe how independently a child with CP is able to function.

There are five functional levels:

I. Able to walk without restrictions and is able to keep up with their peers.
II. Able to walk indoors and outdoors but is often unable to keep up with peers and will sometimes require leg braces.
III. Uses walking aids, such as crutches or a walker , for shorter distances and may use a wheelchair when traveling for long distances.
IV. Able to propel own wheelchair, usually non-ambulatory.

V. Unable to be independently mobile and support trunk.

Role of Orthopaedic Surgery :

Surgery is one of the many options available to help CP children to improve mobility, posture, and ensure healthy growth.Physical therapy and medications are recommended before surgery.Conservative treatment in the form of Heat, Exercises, Splints, improving cognitive functions, hearing, Vision ,invasive techniques as required is done and maximum flexibility spasticity reduction has to be done. Surgery aims to give children the greatest chance of living as independently as possible.

Requirements for Orthopaedic Surgery:

The team of medical and rehabilitation professionals who are going to treat a person with CP must have: Knowledge of normal anatomy and physiology, particularly regarding ambulation. A good understanding of the functional pathology present in CP, Realistic goals/objectives for treatment that are shared commonly by the patient, family, and others concerned with the child's welfare. Knowledge and ability to carry out any of the treatments that are required, and a facility with the resources to carry out the necessary evaluations/treatments.

Considerations before settling on surgery :

- Child that cannot walk, either at all or without an assistive device, surgery makes life more comfortable.
- If the child can walk independently or with assistive device, surgery helps to gain more independence.
- Thus it is impossible to offer a one-size-fits-all treatment plan for children with CP.
- A surgery that is successful in one child may not be in another.

Main types of orthopaedic procedures done are:

- **Muscle lengthening**: Surgical lengthening of muscles is used to relieve tightness in hands, legs and fingers.
- **Tendon lengthening**: Lengthening tendons can reduce painful contractures. This surgery is used to improve the child's ability to walk and sit upright.
- **Tendon transfer**: The goal of tendon transfer is to ensure whether the muscle in the body is properly aligned. This surgery also helps to reduce pain and walking problems that CP children experience. It also improves extension and flexibility of joints
- **Tenotomy/ Myotomy**: This procedure is used to improve muscle function, increase control of upper and lower limbs, enhance ability to grasp objects, maintain posture & walk
- **Osteotomy**: This realigns joints for better posture and mobility. Commonly used for hip dislocation in CP children
- **Arthrodesis** – in severe cases of spasticity when splints and casts aren't enough, arthrodesis maybe used to permanently fuse bones. This makes it easier for the child to walk, when done in bones of ankle and foot.

Orthopedic intervention in Non ambulatory children

In non-ambulatory children the goal of orthopaedic surgery is more centered around increasing comfort and avoiding further mobility complications.

Surgery is done mainly for:

1. Relieving pain
2. For caretakers for taking care of the child
3. For maintaining personal hygiene

Benefits of orthopaedic surgery aren't immediate; children often require physical therapy to ensure successful recovery and to keep muscles strong and flexible.

Factors Affecting Outcome of Orthopaedic Surgery :

- Dysfunction of lever arm in the lower extremities
- Epileptic episodes in last 2 years
- Excessively lengthened tendons (e.g., due to previous botulinum toxin injections or tendon lengthening surgery)
- Postoperative complications in relation with severity and its duration
- Abnormalities of bone mineralization (low bone mineral density or Vitamin D)
- Known cognitive deficits
- Sensory problems, e.g., visual or auditory impairments
- Hand function
- Age at the time of surgery
- Rehabilitation in terms of intensity, quality and duration
- Achieved level of gross motor function at the time of surgery
- Neurosurgery (rhizotomies, fasciculotomies) in the past
- Socioeconomic background.

Conclusion :

Orthopaedic intervention in a person with CP is a process rather than an isolated event which has the potential to significantly improve function in the short term and reduce the burden of care in the long term. A continuing improvement in the functional outcome of Orthopaedic intervention in persons with CP is only possible in the presence of meticulous preoperative assessment and preparation, expert perioperative management and long term follow up, within the setting of a multidisciplinary service and in partnership with the person with CP and family and Rehabilitation Physician.

Orthopaedic intervention that simultaneously and effectively addresses spasticity, abnormal movement patterns and followed by intensive, Rehabilitation Physician- led protocol-based functional rehabilitation and long term follow up provides the person with CP the best functional outcome.

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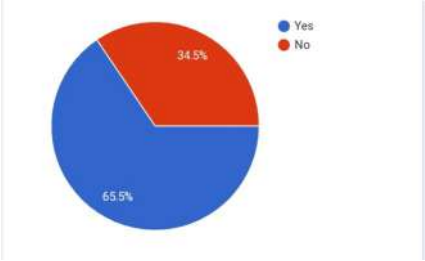
3)Optimizing Function and Mobility: An Interview with Dr. David M. Scher.

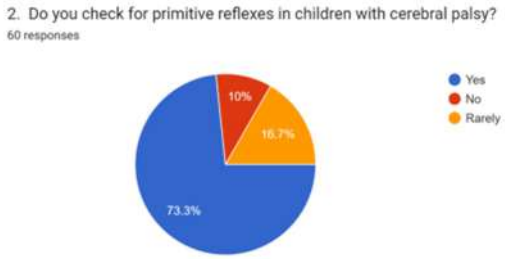
CP Survey – Part 2

By Dr. Anne Mary John & Dr. Bineesh Balakrishnan

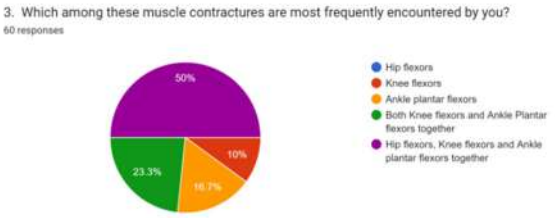
1. Master B, 1 year old child with gross developmental delay is brought to the OPD by his parents. He has never been evaluated prior to this visit. Child has poor voluntary motor control and spasticity of the lower limbs. He has never been investigated, although there is a clear history of prematurity, premature rupture of membranes and low birth weight. Would you prefer an MRI to support your clinical diagnosis of Cerebral palsy?



As expected the majority, 65.5% of the respondents opted to take an MRI to confirm the diagnosis of Cerebral Palsy, & rule out CP mimics, while 34.5% opted against the use of MRI.

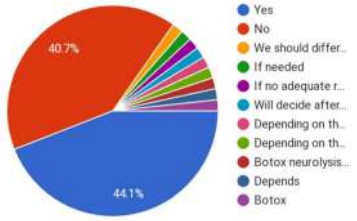


73.3% of the respondents check for primitive or developmental reflexes while assessing a CP child, while 16.7% do so rarely & 10% don't look for primitive reflexes.



50% of the Physiatrists encountered Hip flexors, Knee flexors & Ankle plantar flexors together. 23.3% of the respondents opted for the Bothe Knee flexors & Ankle Plantar flexors together. According to 16.7% of the respondents Ankle plantar flexor contractures were the most commonly encountered in CP children, while knee flexor contractures were opted by 10% of the respondents.

4. Master C, 4 year old boy with Cerebral Palsy had come to your OPD with history toe walking. You had advised stretching exercises and given AFO in the first OPD visit. Would you consider applying POP cast for this child in the subsequent visits?



44.1% of the respondents decided in favour of the POP cast, while 40.7% decided against it. The other responses were

We should differentiate between contracture and gastrosoleus sapasticity by nerve block, after that we can choose afo/cast/ surgery depending upon outcome – 1 person opted for it (1.7%)

If needed – 1 person opted for it (1.7%)

If no adequate relief with above techniques. Would also like to add baclofen – as opted by 1 person (1.7%)

Will decide after evaluation of walking – opted by 1 person (1.7%)

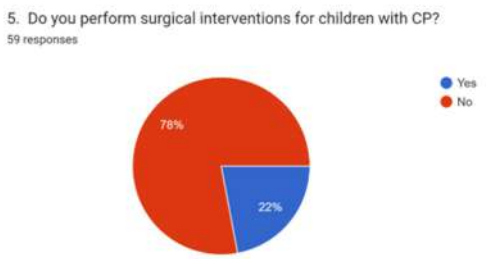
Depending on the correction with the AFO- as opted by 1 person (1.7%)

Depending on the spasticity will advise- opted by 1 person (1.7%)

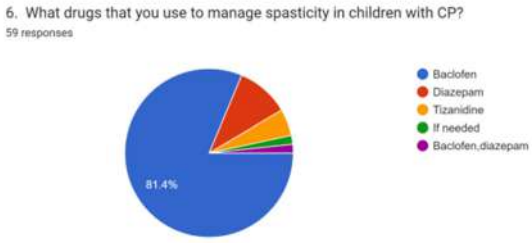
Botox neurolysis to Gastrocsoleus- as chosen by 1 person (1.7%)

Depends- as selected by 1 person (1.7%)

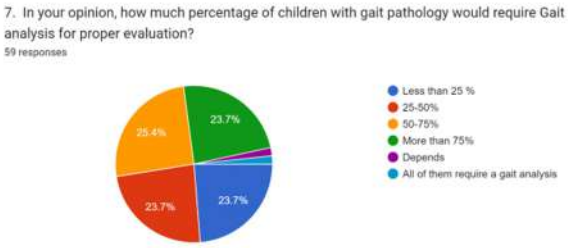
Botox – as opted by 1 person (1.7%). Botox thus was opted for by two persons, as can be seen by going through the responses.



Surgical rehabilitation in Cerebral Palsy is challenging & rewarding. Unfortunately 78% of the Physiatrists don't perform surgical interventions on CP children, while the remaining 22% do so.



81.4% of the Physiatrists who took this survey chose Baclofen as the optimal drug for managing spasticity in Cerebral Palsy, while 10.2 % opted for Diazepam. Tizanidine was chosen by 5.1% of the respondents, while there was one respondent who only uses medications sparingly, & another person who chose both Diazepam & Baclofen.



Really interesting question with some really eye opening answers. While 25.4% of the respondents believe that 50-75% of the CP children with gait pathology need Gait analysis, the next set of responses go like this..

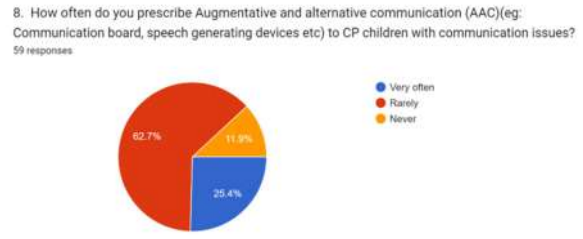
23.7% believe that 25-50% of these children need gait analysis

Another 23.7% believe that more than 75% of these children need gait analysis

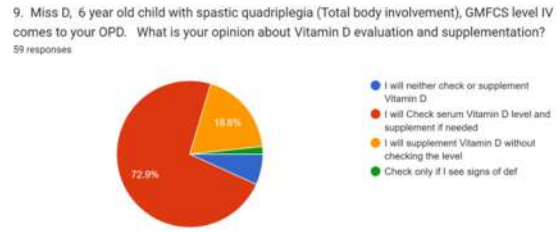
While yet another 23.7% believe that less than 25% need gait analysis

1.7% (1 person) responded with Depends

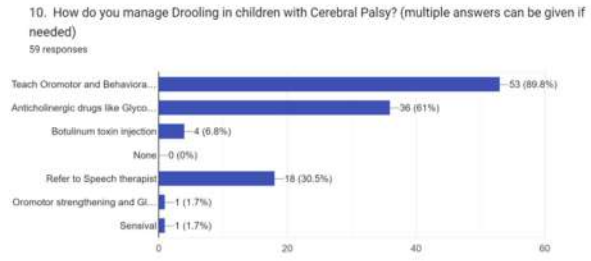
While another person responded with all CP children with gait abnormalities need Gait analysis(1.7%)



Since AAC devices have entered the Indian market in a big way, I guess it's high time Physiatrists start prescribing these devices. 62.7% of the respondents rarely prescribe these devices for their CP patients, while 25.4% prescribe them very often, & 11.9% don't prescribe them at all.



72.9% of the respondents prefer to check Vitamin D levels & supplement it if needed, while 18.6% would like to supplement Vitamin D without checking the level. 6.8% opted not to check or supplement Vitamin D & 1.7% will check only if there are signs of deficiency.



Unlike the previous questions this was one question where the same respondent could choose more than one option while choosing. The most opted option among all was to teach oromotor & behavioural skills, opted by 89.8%. The next most opted option was to use Anticholinergic drugs like Glyopyrrholate, opted by 61%. 30.5% prefer to refer to a Speech therapist. 6.8% will use Botulinum toxin. 1.7% claim oromotor strengthening & Glycopyrrolate is effective, while 1.7% prefer to use Sensival (Nortryptyline).

Role of Upper limb Surgeries in Cerebral Palsy

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Cerebral Palsy(CP) is described as a group of movement disorders resulting from nonprogressive injuries to the developing foetal or infant brain [1]. Spastic, dyskinetic, ataxic, and mixed types are different presentations out of which spastic types of CP are the most common types seen in clinical practice. Spasticity leads to the shortening of musculotendinous units which in turn leads to contractures, deformities, and instabilities around joints that further exacerbate the impairment [2]. The prominent upper extremity deformities from spasticity in CP present with shoulder adduction, elbow flexion, forearm pronation, wrist flexion, ulnar deviation, and flexion adduction of the thumb[3].(Fig 1)

Figure 1: Upper extremity deformity in CP

The deformities here are often dynamic in nature with or without associated fixed contracture. The surgeon should have a definite plan before venturing into surgery. After induction of anesthesia, the deformity may disappear. A thorough evaluation of the hand and its function is essential prior to surgery. All possible nonsurgical treatments such as physical therapy, orthosis, occupational therapy interventions, and medical management towards reducing spasticity should be tried beforethe decision of surgery. Parents and caregivers need to be explained that the goal of surgery is not aimed at gaining normal extremity function but to improve assistive function, posture, and hygiene. The procedures may help in

improving ADL,quality of hand function, and improvement of the rotational axis of the forearm.

The principle of surgical management for spastic upper extremity is based on certain principles such as weakening of hyperactive and strengthening of underactive muscles, and stabilization of joints for efficient muscle function. The hyperactive muscle can be weakened surgically by releasing its origin or detaching from insertion, lengthening the muscle in the musculotendinous area called fractional lengthening or lengthening at the tendinous area by Z plasty. Fractional lengthening is most preferred as it reduces spasticity and preserves function. Strengthening of a weak muscle is achieved by the tendon transfer of a muscle with good voluntary control. However, the efficiency of spastic muscle after tendon transfer is not as effective as seen in reconstructive surgery in flaccid paralysis. Tendon re-education of the antagonist's muscle, when used for the transfer, is difficult in CP. Hence it's preferable to use a synergistic donor tendon that works in phase with the desired function.

Outcomes of upperlimb surgery in CP are not as appreciable as for lower limb for many reasons such as upper limb tasks are more sophisticated and require high levels of coordination. Children prefer to use the good limb for most of the activities, especially in hemiplegic CP. Hence it is difficult to train the operated limb which is suffering from learned non-use. Spastic upper limbs are more often associated with dystonia, sensory impairments, and poor selective motor control, which further limit the outcome of upper limb surgery. Retraining of the upper limb after surgery is difficult as it lacks repetitive motor tasks unlike walking in case of lower limb surgery. The voluntary attempt of the child for using the spastic upper limb for different activities is an important predictor of outcome. Surgery cannot induce activities in a functionally ignored limb [4]. The goal and objective of surgery are drawn by the shared decision of the patient, family member, and surgeon considering the patient's existing level of function[5].

The optimum age for surgery is controversial but presumed to be between 4 -6 years age as the brain is matured by this age and deformities are mostly confined to soft tissue levels. However relative overage is not a contraindication provided voluntary control is fair enough for surgery [6]. As age advances, the spastic muscle fall short in length with respect to normally growing bone leading to the development of fixed contracture. Shortening of the bone procedure will be required to achieve stability of joint by tendon transfer.

Patient evaluation:

Deformities of the upperlimb are spastic dynamic deformities; hence, evaluation findings vary with emotional status and fatigue level. Assessment must be based on activity or analysis of video recordings of different activities of daily living. Lengthy examinations should be fragmented into different specific activities. The limb position should be observed at rest, during walking and running which shows the real cosmetic and functional disability. The prehensile function of the hand can be simply evaluated by asking the child to pick up blocks of different sizes and shapes. This also gives a gross idea about the contribution of the whole limb to that function. A comprehensive assessment of motor, sensory and intellectual function is essential for preparing a definite plan of surgery. Motor evaluation of spastic extremity in CP includes: i) voluntary control of different muscle groups, ii) strength and voluntary control of spastic deforming muscle, iii) strength of weak, non-functioning muscle, iv)

Strength and voluntary control of potential donor muscle, v) functional deficit of the CP child.vi) Active and passive range of motion of the joint across which tendon transfer would be done. A selective peripheral nerve block test can be used to evaluate motor involvement and differentiate between spasticity and fixed contracture[7]. A global motor control assessment is done by head-to-knee test in which the patient is asked to keep his hand overhead and then move it to the contralateral knee. The speed and precision of performance are recorded. The intelligence level of the child has some impact on the outcome of surgery. Some of the studies suggest that reconstructive surgery should not be undertaken if the IQ level of the child is less than 70[8]. However, it is less significant when a procedure is done that does not require any active therapy or re-education program.

There are several classification systems used for the evaluation of upper limb function in CP [9]. House's classification system is found to be more reliable and clinically useful [10]. It contains nine subgroups that describe different functional levels.(Table 1)

Table 1: House's classification system for the evaluation of upper limb function

Class	Designation	Activity level
0	Does not use	Does not use
1	Poor passive assist	Uses as stabilizing weight only
2	Fair passive assist	Can hold onto an object placed in the hand
3	Good passive assist	Can hold onto an object and stabilize it for use by other hand
4	Poor active assist	Can actively grasp object and hold it weakly
5	Fair active assist	Can actively grasp object and stabilize it well
6	Good active assist	Can actively grasp object and then manipulate it against other hand
7	Spontaneous use	Can perform bimanual activities easily and occasionally uses the hand spontaneously
8	Spontaneous use	Uses hand completely independently without reference to the other hand

Another classification system of practical use in clinical practice is described by Samilson and Moris [11]. It has four sub-groups described in Table 2.

Table 2: Samilson and Moris classification of hand function

Poor	No effectual Use of the hand Poor or absent grasp and release Poor control
Fair	Use of the hand as a helping hand but no effectual use of the hand in dressing, Moderate grasp and release Fair control
Good	Use of the hand as help in dressing and eating and general activities, Effectual grasp and release Excellent control
Excellent	Good use of the hand in dressing and eating, Effectual grasp and release Good control

Motivation and parental support are important determinants of functional outcomes. The child is called the most ideal candidate for surgery who has stable family support, spastic upper limb deformity, hemiplegic or monoplegic type with satisfactory hand sensibility[12]. The surgeries can be done as a single-stage procedure targeting the proximal joint correction first or can be done as a single event multilevel surgery as done for the lower limb in CP.

The common surgical procedures done for deformities of the spastic upper extremity include correction of shoulder adduction and internal rotation, elbow flexion, forearm pronation, wrist flexion, clenched hand, and thumb in palm deformity. The anatomic region deformities and the surgical procedure for its corrections are described below.

Shoulder adduction and internal rotation deformity:

Pectoralis major, subscapularis, and Latismusdorsi are the muscles responsible for shoulder adduction and internal rotation deformity in the spastic upper extremity. In nonfunctional limbs, the range of movement can be improved by the release of the insertion of these muscles. Axillary hygiene and shoulder pain are indications of surgery. However, in the case of the functional shoulder, fractional lengthening of these musclesis indicated to improve active abduction and internal rotation of the shoulder. It helps in improving axillary hygiene and overall shoulder function [13].

Elbow flexion deformity

Elbow flexion $<45^0$ can be managed initially with stretching of elbow flexors or sustained stretching with serial plaster casting or splinting. Upon failure, fractional lengthening of elbow flexors such as Brachialis, the proximal release of brachioradialis, and Z plasty of the biceps tendon are done to improve elbow extension. Deformity $>45^0$ requires radical release of elbow flexors from its origin with Z plasty of the Biceps tendon [14].

Pronation deformity of the forearm:

Both pronation and supination movement of the forearm is required for the proper functioning of the hand. Extreme pronation deformity obstructs the visual stimulus with compromised stereognosis. Movement upto midprone is essential for most dexterity functions. Passive and active supination of the forearm is assessed to find out pronator teres and pronator quadratus spasticity.

Treatment of pronation deformity in CP is aimed at restoration of active supination without compromising the existing pronation movement. The side of extremity involvement is also an important factor to consider. In a good functional right hand, limitation of supination beyond neutral makes it difficult to eat, whereas the same deformity in the left hand is manageable. The left hand is used for perineal care for which forearm supination is useful. The deformity can be managed with the proximal release of pronator teres along with common flexor pronators or distal release with or without rerouting of the tendon. The surgical decision depends on the active and passive range of supination [15]. Pronator teres tendon rerouting is the preferred option where there is a significant discrepancy between the active and passive range of supination (Fig 2 & Fig 3).

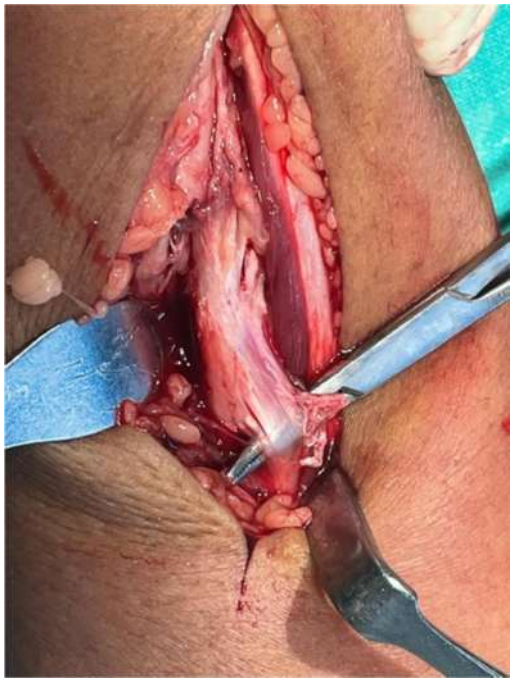


Figure 2: Isolation of Pronator teres for rerouting.

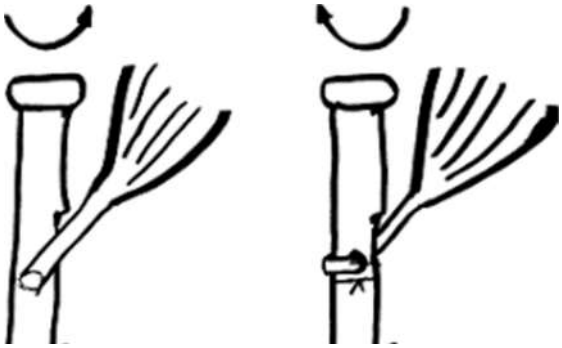


Figure 3:Schematic diagram of Pronator teres rerouting

Pronator teres release is reserved for poorly functioning limbs.Hypersupination deformity may occur after release if the wrist can come to mid-prone or some supination preoperatively [16]. Pronator quadratus release is rather a better option. Classification of pronation deformity and its group-wise management has been described by Gschwind and Tonkin[15].[Table 3]

Table 3: Classification of pronation deformity and their management

Group	Classification	Recommended operative procedure
Group 1	Active supination beyond neutral position	No specific treatment
Group 2	Active supination to less than, or to, neutral position	Pronator quadratus release ±Flexor aponeurotic release
Group 3	No active supination Free passive supinatio	Pronator teres transfer
Group 4	No active supination No passive supination	Pronator quadratus release ±Flexor aponeurotic release

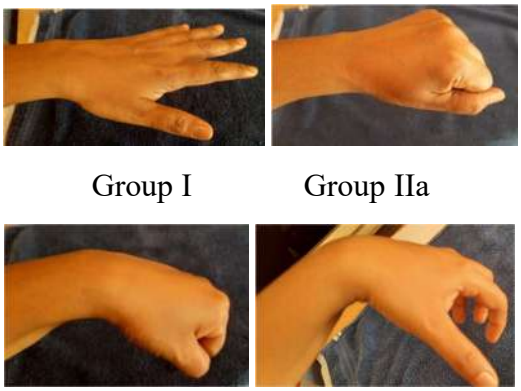
Forearm pronation with wrist flexion deformity can be managed by transfer of flexor carpi ulnaris (FCU) to extensor carpiradialis brevis (ECRB). It helps in augmenting wrist extension along with correction of forearm pronation [17].

Wrist and Finger flexion

The most common deformity in CP is caused by spasticity of long flexors of the wrist and hand, predominantly Flexor Carpi Ulnaris muscle. Other possible causes may be contracture of the volar wrist capsule or weakness of wrist extensors. There is substantial hand dysfunction with fingers in flexion. The mechanical disadvantage of long flexors with wrist flexion reduces the effective grip power. With a better wrist position, the active finger flexion and grip can be improved. Based on the predominance of localization of spasticity, wrist and finger deformity has been classified by Zancolli into 3 groups [18]. [Table 4]

Table 4: Zancolli classification of spastic hand deformity

Group I	Complete extension of the fingers with the wrist in neutral position or with less than 20^0 flexion
Group IIa	Active extension of the wrist with the finger flexed
Group IIb	No active extension of the wrist even with fingers flexed
Group III	No active extension of the fingers even with maximal wrist flexion



Group I Group IIa

Group IIb Group III

Figure 4:Classification of spastic hand deformity by Zancolli

Patients coming under the group II category are the most suitable candidates for reconstructive surgery. In most spastic hands, fingers are released by actively flexing the wrist. Some flexor power must be retained for effective use of the hand. Hence any planning for the transfer of wrist flexor to obtain wrist extension must consider retaining wrist flexion. Flexor carpi ulnaris transfer to extensor carpi radialis brevis is the most commonly performed procedure to achieve wrist extension provided flexor carpi radialis muscle has fair power. Besides wrist stabilization, this transfer secondarily helps in forearm supination as well [19].When the patient has no active wrist flexion and the fingers remain permanently flexed reconstructive surgery is not effective. The pathomechanics of hand deformity in each Zancoli's group and their management are enumerated in table 5.

Table 5: Treatment guidelines for spastic hand

Groups	Pathomechanics	Treatment guidelines
Group I	Spasticity localized to FCU	Generally no treatment required. Occasionallytenotomy of the FCU is required
Group IIa	Spasticity localized to the finger flexors, FCU may be spastic, wrist extensors are active	Flexor aponeurotic release(FAR) or fractional lengthening of the finger flexors, tenotomy of the FCU if it is spastic
Group IIb	The wrist extensors are not active, spasticity of wrist and finger flexors	Transfer of FCU to ECRB with fractional lengthening of the finger flexors or aponeurotic release
Group III	Marked spasticity of wrist and finger flexors and paralysis of the wrist extensors	Poor candidates for surgeries aimed to improve function. Can consider for operations aimed to decrease spasticity or improve the position

Flexor aponeurotic release (FAR) in CP is done for adaptive shortening of long flexors. The fascia, aponeurosis, and intermuscular septums are composed of collagen fibers, hence difficult to stretch by therapy or splinting. Surgical release of these structures is done in FAR procedure. A band of the one-inch wide deep fascia of the forearm along with the intermuscular septum is excised through a transverse incision about 6cm distal to the medial epicondyle. Stretching of long flexors is done upto wrist neutral and finger extension. Nonfunctional hands with severe flexion contracture of wrist and fingers and tenotomy of extrinsic flexors may be considered to improve hand hygiene. FDS to FDP transfer can improve gross hand function in such cases [20]. (Fig 5)

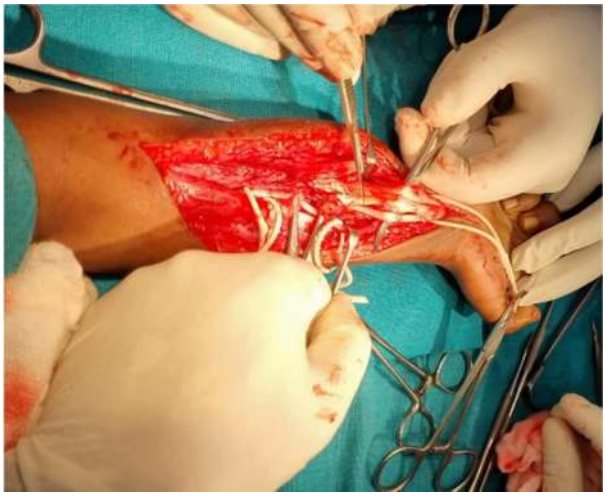


Figure 5: FDS tenotomy and transfer to FDP

Thumb deformity in CP is mostly due to spasticity of thumb adductors and flexor muscles. The thumb remains flexed inside the palm impairing grip, and grasp and limiting the function of other fingers(Fig 6).

Figure 6:Thumb in Palm deformity

Lack of thumb abduction and extension also limits the size of the object that the hand can grasp. Spasticity of adductor pollicis (AP), flexor pollicis brevis (FPB), flexor pollicis longus (FPL) must be assessed. Hypermobility of MCP joint and 1st web space contracture need to be excluded. Depending on the pathoanatomy, thumb deformity can be classified into 6 types[21]. [Table 6].

Table 6:classification of the thumb deformity in CP

Type	Description	Defect	Main component of treatment
I	Simple metacarpal adduction	AP spastic	Release of AP
II	Metacarpal adduction with MCP flexion	AP and FPB spastic	Release of AP and FPB
III	Metacarpal adduction with MCP hyperextension	AP spastic with unstable MCP	Release of the AP and stabilization of MCP
IV	Metacarpal adduction with MCP and IP flexion	AP and FPB spastic with FPL spastic	Release of the AP,FPB and FPL
V	IP flexion with less marked metacarpal adduction	FPL spastic with weak EPL	Release of FPL +/– augmentation of EPL
VI	Weakness of extensors with less marked spasticity (with or without unstable MCP	Weak extensors	Augmentation of the thumb extension and abduction

The main objectives of thumb in palm deformity are to achieve a strong lateral pinch with the middle phalanx of the 2nd finger and to maintain sufficient abduction during grabbing [22]. The preoperative assessment would help in formulating a proper surgical plan. The thumb must be stabilized by balance action between flexor adductors and extensor abductors of the thumb. The adductor and flexor spasticity or contractures can be relieved with the release of adductor pollicis (AP), 1st dorsal interossei, and flexor pollicis brevis (FPB) by fractional lengthening at origin or over the muscle belly. Release at insertion is better avoided as it leads to gross weakness of the flexor adductors of the thumb. The flexor pollicis longus (FPL) spasticity and tightness can be treated by fractional lengthening of FPL at a level proximal to the wrist. Reinforcement of extensor abductors of the thumb can be done by tendon plication, tendon transfer, or tenodesis actions. Rerouting of abductor pollicis longus (APL) tendon volarly provides a mechanical advantage for the abduction of the thumb. Tenodesis of the Palmaris longus (PL) with volarly routed APL further augments the thumb abduction [23]. Rerouting of Extensor Pollicis longus(EPL) through the 1st dorsal compartment can augment abduction along with the extension of the thumb [24]. Other simplest procedures for the thumb in palm deformity are plication of APL and extensor pollicis brevis.

Conclusion

Deformities of the upper limb in cerebral palsy are secondary manifestations of cerebral injury. A meticulous evaluation and planning are required before venturing into surgery. In addition to that, functional evaluation of the patient, intelligence level, voluntary use of an upper extremity, and motivation of the patient as well as caregivers are extremely important. The patient and family members must be convinced that the surgery is aimed at correcting the deformity and improving function, not for the treatment of the primary cerebral injury. A dedicated rehabilitation team including a physiatrist and occupational therapist needs to be involved in the entire process of surgical planning and postoperative management. Post-operative rehabilitation plays a key role in the ultimate outcomes of the surgery.

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Lower Extremity Surgeries in Cerebral Palsy

Dr. Anil Kumar Gaur, DNB (PMR), DPMR

Professor of Physical Medicine and Rehabilitation &

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Cerebral Palsy is caused by irreversible damage to a developing brain. Prevalence of this damage depends on many factors. In spite of steadily increasing contribution of prematurity and its complications to the prevalence of this syndrome, the total prevalence rate of cerebral palsy is relatively stable.[1] The damage can present clinically in many ways. Spasticity is the commonest presentation. Involvement of lower extremities in spastic type of cerebral palsy may be part of diplegia, hemiplegia or of total body involvement. Spasticity itself or its complications can affect posture and ambulation of a child with cerebral palsy. So, management of these patients should be started early. Non-surgical management is the mainstay of treatment in the early period. As required exercises, splints, oral medications and injectables like Botulinum toxin and Phenol etc. are used to manage the spasticity. When the condition cannot be managed conservatively surgical interventions may be required.

Use of surgical interventions to manage spasticity and its complications in cerebral palsy requires thorough evaluation of the child including mental assessment. Gait of the child is assessed preferably by instrumental gait analysis. Gait analysis helps in taking a more objective decision. To minimise recurrence, the surgeries should preferably be done at around school going age. Before that the deformity should be managed using conservative measures as far as possible. Family of the child should understand the requirement of the surgical procedure and should be willing to take care of the child in the peri-operative period and post-surgical training period.

Managing contractures or spasticity surgically at one joint and not managing at the other joints of the lower extremity may be harmful. For example, if hamstrings are lengthened but equinus is not corrected, the chances of the knee going in recurvatum while standing or walking increase. So, if the child's condition permits, the procedures should be performed in one stage. In this era of single event multi-level gait improvement surgeries (SEMLS), which has become standard of care in many institutions for the treatment of walking children with cerebral palsy, the surgical procedures are not performed in isolation and more commonly performed in concert with other surgical procedures designed to correct lever arm function, improve the biomechanics of

plantar flexion /knee extension couple and correct fixed musculoskeletal deformities.[2]

Hip adduction deformity

Spasticity in adductor muscles of hip leads to true scissoring of the lower limbs. Even when scissoring is not present, walking with spastic adductors is difficult. Adductor spasticity along with hip flexor spasticity makes the child prone to hip subluxation and dislocation. If adductor muscles are contracted, they are released from their attachment through a high incision on the medial side of the thigh. Which muscles out of gracilis, adductor longus and adductor brevis are to be released depends on the severity of the deformity. While releasing adductor brevis, care is needed to prevent injury to obturator nerve.

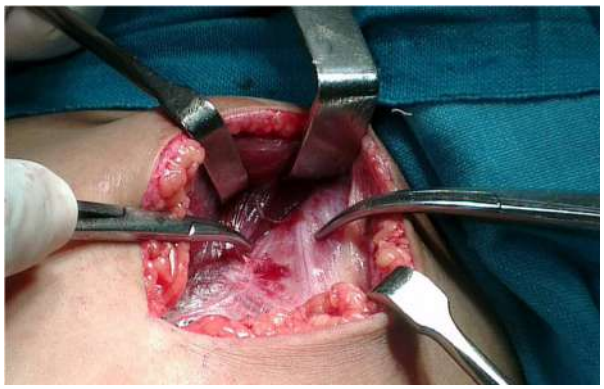

Fig.1. Surgical exposure of anterior obturator nerve

Obturator neurectomy is a useful procedure in severe spasticity of adductors. But the decision to do the procedure should be taken carefully as this may cause abduction deformity of the hip in some cases particularly when both obturator neurectomy and adductor tenotomy are done together. In most of the non-ambulatory patients both the procedures, adductor tenotomy as well as obturator neurectomy, are required.

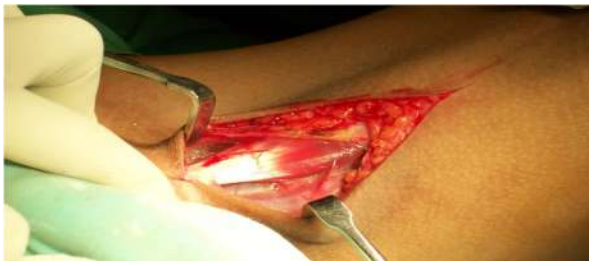

Fig.2. Surgical exposure of hip adductors

Once the deformities are corrected, the hips are kept in abducted position using an abduction bar for about 3 weeks and after that, if required, by using an orthosis.

Hip flexion deformity

Development of hip flexion deformity is a common problem in children with cerebral palsy**.** Hip flexion deformity is caused by spastic hip flexors like iliopsoas and rectus femoris muscle. When iliopsoas muscle is responsible for the deformity of a hip, psoas tenotomy at brim of ilium bone or near insertion at lesser trochanter is done. Intrapelvic psoas tenotomy and intramuscular lengthening of rectus femoris at the proximal level have proved their effectiveness in correcting the position of pelvis while preserving hip flexors strength.[3]When iliopsoas release was done at the level of lesser trochanter, maximum hip extension improved and no change in maximum and total flexion power generation was found.[4]

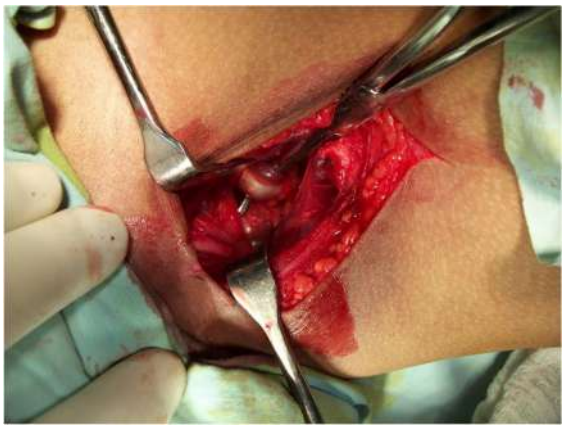

Fig.3. Surgically exposed psoas major tendon

For rectus femoris contracture a procedure, other than intramuscular lengthening, that has been found useful is Z lengthening of straight head of rectus femoris. But no supportive data for this procedure is available.

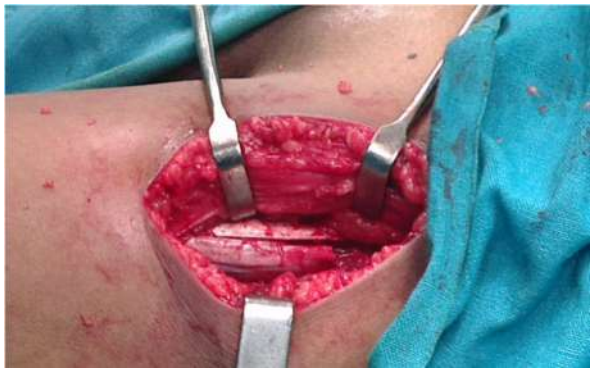

Fig.4. Lengthening of straight head of rectus femoris

Knee Flexion deformity

As hamstrings spasticity increases, it becomes increasingly difficult for quadriceps to straighten the knee from flexed position. In standing posture, quadriceps try to straighten the knee by continuous firing but they may not be able to do that. In such cases, with time the quadriceps get stretched. Persistent flexed posture of knee helps in development of contracture of the hamstrings resulting in knee flexion deformity. To correct the knee flexion deformity and to get an energy efficient gait, lengthening of hamstrings is the surgical option. Which hamstrings are to be lengthened and which technique is to be used is decided based upon clinical examination. On operation table examination under anesthesia effect is also useful.

Hamstrings lengthening procedures are usually adequate for correcting knee flexion deformity in cerebral palsy. In very few cases supracondylar extension osteotomy of femur is also required. It is preferable to lengthen tendons of gracilis and semitendinosus by Z lengthening, tendons of semitendinosus by fractional lengthening by Z-incision procedure and tendons of biceps femoris by fractional lengthening or intramuscular Z-lengthening.

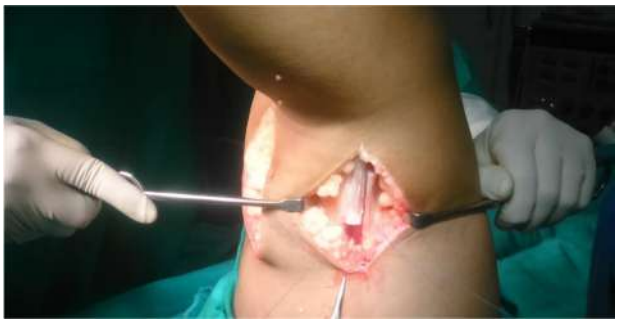

Fig.5. Lengthening of hamstrings

The operated limb is kept in plaster cast for 6 weeks. Once the cast is removed, knee orthosis with lock or knee ankle foot orthosis with knee lock is given as required. Range of movement and strengthening exercises are started. Over stretching of operated muscles is avoided and postural care is taken. Following removal of the plaster cast, gait training with the orthosis is started at the earliest Use of the orthosis is continued for the next few months till the weaker muscles are strengthened enough to achieve maximum control over the gait and posture. After that the child is assessed periodically for his potential to ambulate without orthosis and if found satisfactory the child is slowly weaned off the orthosis. After that the gait training is continued without the orthosis.

Hamstrings also act as hip extensors. When spasticity of hamstrings dominates at hips the hips get extended in standing position. When hamstrings lengthening is done the hip flexor spasticity may dominate and may require surgical intervention.

Equinus deformity

The commonest ankle foot problem in cerebral palsy is equinus deformity.The deformity usually is because of contracture or spasticity in gastro-soleus complex. In an ambulatory child with cerebral palsy, if the problem is mild, there may be simply an early heel off but if it is severe the child

walks on toes. Mild equinus may force the knee in recurvatum when hamstrings are not spastic and the child tries to strike the heel while walking.

If there is equinus deformity and Silfverskiold test is negative, the equinus deformity is corrected by lengthening of tendoachilles by Z-lengthening procedure. Percutaneous or open tendoachilles lengthening procedures like Hoke's procedure in which three cuts in the tendoachilles are given and White's procedure in which two cuts are given can be considered as alternatives. If the test is positive, lengthening of gastrocnemius by Baumann's procedure[5](intramuscular lengthening), Strayer's procedure, Vulpius procedure or Baker's procedure is done

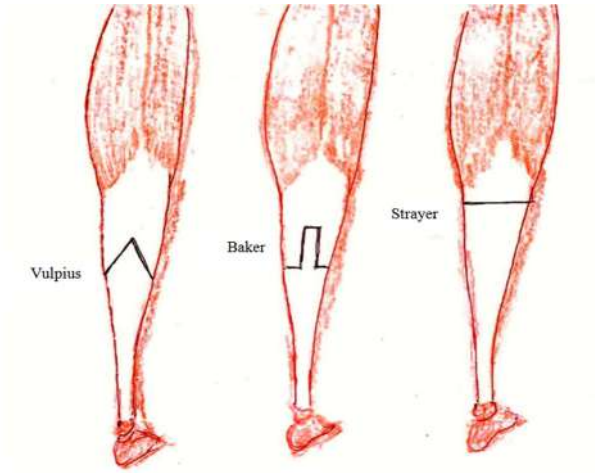

Fig.6.Vulpius, Baker and Strayer techniques

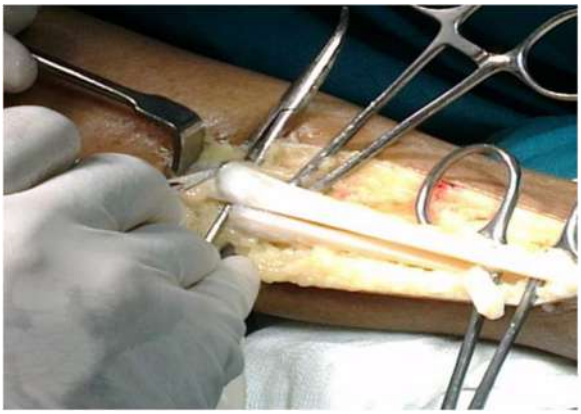

Fig.7.Z lengthening of tendoachilles

Post-operatively a knee Plaster of Paris (POP) cast with ankle in 10 degree dorsiflexion is applied. The cast is removed after 6 weeks. After removal of the cast, a knee ankle foot orthosis is given and range of the ankle movement and strengthening exercises are started for the weaker muscles. Use of the orthosis is continued till a satisfactory muscle strength level and control is achieved.

Equinovarus deformity

In spastic children, feet deformities in addition to equinus are common. The ankle and foot may not remain in pure equinus position because of the force imbalance created by the spasticity in other muscles of ankle and foot and may lead to other deformities. One of the common ankle and foot deformities that develops, particularly in hemiplegic cerebral palsy, is equinovarus deformity. This is caused by the force imbalance created by spasticity in tibialis posterior and tibialis anterior or both of them. The deformity of the foot is also affected by spasticity in other muscles.

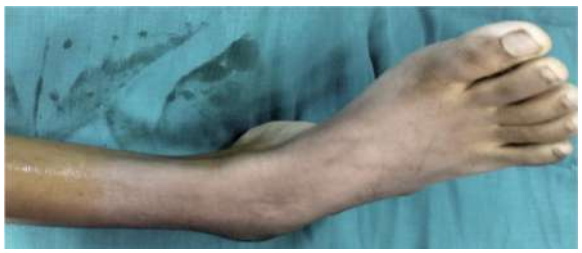

Fig.8. Equinovarus deformity

In equinovarus foot when tibialis posterior is the dominating force and the hind foot deformity is not fixed, it can be corrected by procedures like lengthening of tibialis posterior tendon, split transfer of the tendon and transfer of the whole of the tendon but once it becomes fixed, one or more bony procedures like calcaneal osteotomy or triple arthrodesis are required.

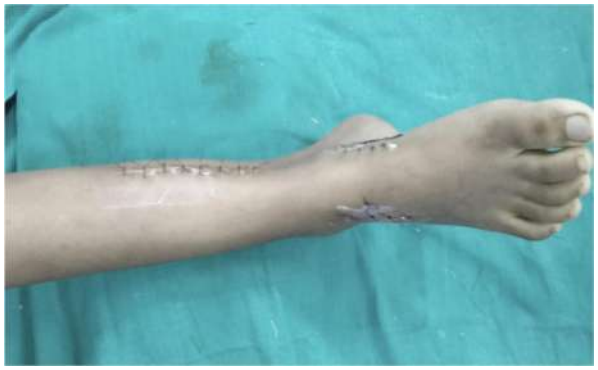

Fig.8. Tibialis posterior transfer to dorsum of foot

In split tendon transfer of tibialis posterior, the tibialis posterior tendon is split in halves and its plantar half is detached. The detached half is taken behind the tibia, re-routed and sutured to peroneus brevis. This slip now provides the balancing force to keep the foot in neutral position. If tibialis anterior is the dominating force, split tibialis anterior transfer (SPLATT) to cuboid procedure is done. As alternatives to the above two procedures, transfer of whole of the tendon of tibialis posterior and tibialis anterior to the dorsum of the foot can be done respectively. These procedures are not the preferred procedures as following these procedures inversion or eversion foot imbalance is a frequent problem. This imbalance may require further procedures like osteotomies or arthrodesis for correction of the deformities. In the preferred technique for transfer of whole of the tibialis posterior tendon, the tendon is released from its insertion, pulled back into the leg, passed through the interosseous membrane and is inserted into dorsum of the foot.

When tibialis anterior muscle also contributes to equinovarus deformity of foot, a combination of procedures including tendoachilles lengthening, supramalleolar lengthening of tibialis posterior and split transfer of tibialis anterior (SPLATT) may be required. The combination is very useful in correcting the deformity.[6]In children with plantar flexors muscle power greater than their dorsiflexor counterparts, SPLATT and fractional lengthening of tibialis posterior tendon is recommended over split posterior tibial tendon transfer[6].For split tibialis anterior transfer, the lateral half attachment of tibialis anterior is detached from its attachment on the base of 1st metatarsal and pulled up proximal to the extensor retinaculum. It is then routed under the retinaculum to cuboid and is inserted into the bone.

When the foot is not corrected early, it can progress to a fixed deformity. A fixed deformity cannot be corrected by the tendon transfers and requires bony surgical procedures in the form of osteotomies or arthrodesis. For hind foot deformities, calcaneal sliding or lateral based closing wedge osteotomy are useful. For mid foot deformities, cuboid closing and medial cuneiform osteotomies can be used to correct the deformities. If the deformities are still not corrected, arthrodesis like triple arthrodesis may be required.

Equinovalgus deformity

Equinovalgus deformity is caused by peronei when in a foot with equinus they are more spastic than the invertors. The foot gets pronated and the talus head projects on the medial side of foot. In mild early equinovalgus deformities, the surgical procedures like tendoachilles lengthening and lengthening of peroneal tendons may be sufficient. But usually for correction of this deformity, soft tissue surgeries are not very effective and lateral column calcaneal lengthening procedures along with lengthening of tight muscles are required. In fixed moderate to severe equinovalgus deformities, a lateral opening osteotomy of calcaneum known as Evan's osteotomy is done at about 1.5 cm proximal to the calcaneocuboid joint. In some cases, a planter based closing osteotomy of medial cuneiform

is also required. If required, other mid foot osteotomies are also done.

For correction of severe deformities in children less than 12 year of age, Grice-Green extra-articular arthrodesis using fibular, tibial or iliac graft is a useful procedure. In cases of adolescent deformities, particularly in severe equinovalgus deformities, subtalar or triple arthodesis are also done along with lateral column lengthening using a bone graft.

If the valgus deformity is due to ankle, supramalleolar osteotomy or epiphysiodesis are the options.

Hallux valgus deformity

Hallux valgus in cerebral palsy develops in a foot with equinovalgus deformity. The fixed hallux valgus deformity is corrected with a combination of procedures. The procedures that can be combined include release of adductor muscles of the big toe, arthrodesis of 1st metatarsophalangeal joint, osteotomy of 1st metatarsal, lateral capsulotomy of 1st MP joint, medial capsule imbrication and proximal phalanx osteotomy. However out of all the procedures 1st carpometatarsal fusion has demonstrated the highest percent correction.[7]

Fig.9. Hallux valgus correction

Rotational deformities

Rotational deformities in cerebral palsy are common and are associated with in-toeing or out-toeing. In-toeing can be because of increased femoral anteversion, internal tibial torsion or metatarsus varus. Out-toeing, if present, can be because of femoral retroversion and external tibial torsion[8]. Soft tissue surgeries like lengthening of hamstrings, lengthening of adductors and lengthening of internal rotators of the hip are done to correct the rotational deformities at femoral level. But usually these procedures are not enough and osteotomies are required for the correction. Rotational deformities due to femoral anteversion are usually corrected by osteotomy of the femur at intra-trochanteric, subtrochanteric or supracondylar level. Supracondylar procedure is easier to be done and has the advantage that it can be done using a tourniquet. The deformities at tibial level are corrected by supramalleolar osteotomy. Along with the osteotomies the associated foot deformities are corrected as required.

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Members in Action – Part I

Dr. V.K Sreekala, *Professor & HOD of PMR, Sree Gokulam Medical College*, presented a paper on "Ergonomics in clinical Practice" on 31st July in the CME "OphthaTangents" by the Regional Institute of Ophthalmology, Thiruvananthapuram Alumni Association at the GMC Auditorium, Thiruvananthapuram.

സ്വാന്റെ പേബോ തിരുത്തിയെഴുതുന്ന സുവിശേഷങ്ങൾ

പരിണാമത്തെ മനസ്സിലാക്കിത്തരുക മാത്രമല്ല പാബോ ഗവേഷണങ്ങൾ ചെയ്തത്, നമ്മുടെ സവിശേഷതകളിൽ ചിലതിലേയ്ക്ക് വിരൽചൂണ്ടുക കൂടിയാണ്. ഭാവിയിൽ ആധുനിക മനുഷ്യരെ ബാധിക്കുന്ന പലതിനോടും നമ്മുടെ ജീനുകളിൽ രേഖപ്പെടുത്തിയ കാര്യങ്ങൾ ചർച്ച ചെയ്യപ്പെടും. ഈ വർഷത്തെ വൈദ്യശാസ്ത്ര നോബൽ ലഭിച്ച സ്വാന്റെ പാബോയുടെ ഗവേഷണാനുഭവങ്ങളെക്കുറിച്ച് ഡോ. യു. നന്ദകുമാർ എഴുതുന്നു.

11 Oct 2022, 05:25 PM

ഡോ. യു. നന്ദകുമാർ

Dr. U Nanadakumaran Nair, *Professor & HOD of PMR at Kollam Medicity*, wrote an article in the Webzine Truecopy Think, on Svaante Paabo, the Swedish scientist who won the Nobel Prize for Medicine/Physiology this year. The article discussed how Paabo using genetic studies showed how Neanderthal man migrated from Africa to Eaurasia, & the genes of the Neanderthal are still present in Eurasia, though Neanderthal man became extinct tens of thousands of years ago. This scientist's studies could pave the way for more genetic research & eventually better/newer treatments of genetic diseases which are transmitted from generation to generation.

Two disability assessment camps for Haemophilia, Thalassemia and Sickle Cell Disease were conducted at CRC Kozhikode, in July, by the PMR Department of Government Medical College, Kozhikode, along with Haematology, Pediatrics,& Orthopedics Departments.

10 SSK camps were conducted, by the PMR Department of Kozhikode, in July in various places of Kozhikode.

Dr. Sooraj Rajagopal, *Associate Professor, Department of PMR, Government Medical College, Kozhikode* prescribed preoperative rehabilitation measures & post operative rehabilitation for a Haemophilia patient who underwent TKR.

Kerala Inter ITI Sports Meet was conducted on 13 and 14 September,2022 at Olympian Rahman Stadium, Government Medical College, Kozhikode. The athletic events were on 13/9/2022 and football on 14/9/2022. A medical team from the Department of PMR gave medical assistance. 47 injuries were registered on the first day and 41 on the second. The common injuries were quadriceps and calf muscle sprain, muscle cramps, sole blisters and abrasions. There were a few cases of dehydration and hypotension. The participants were not wearing any protective gear while running on the synthetic track. Cases were managed with analgesic sprays, gels, ice packs and IV fluids. Two patients were referred to the MCH casualty. The medical team was headed by **Dr. Razy Hassan** *(SR PMR)* and included **Dr. Jijith P Sathyan, Dr. Vinni P, Dr. Farseena CK, Dr. Sajna Roy and Dr. Masna Majeed KP** *(Junior Residents, PMR),* **Dr. Prabhanand and Dr. Fameena***(Interns)* and **Mrs. Asma** *(Staff Nurse)*, **Mr. Sidhique** *(Nursing Assistant)* and **Mr.Siddhique** *(Attender).*

The medical team was assisted by two staff members from ITI (Industrial Training Institute, Kozhikode). They were very supportive. Analgesic sprays, gels, Betadine ointment, Band-Aids and oral glucose powder packets were provided by the organizers of the event to supplement our First Aid Kit.

The events ended on 14/09/2022 at 6pm. The medical team cover of the sports events afforded a rich academic and hands-on experience to the residents of PMR.

Bharatheeya Vidyanikethan, Kozhikode District Level Athletic Meet_was conducted on 16th September, 2022 at Olympian Rahman Stadium, Government Medical College, Kozhikode. There were around 100 athletes, both girls and boys, aged 10 to 15 years. A medical team from the Department of PMR gave medical assistance. 17 injuries were registered in 17 athletes. The common injuries were quadriceps muscle strain, muscle cramps, sole blisters and abrasions. There was 1 case of dehydration and hypotension. Unfortunately, the participants were not wearing any protective gear during the event. Most of them were barefoot runners. Cases were managed with analgesic sprays, gels, ice packs and ORS fluids. The medical team was headed by **Dr. Razy Hassan** *(SR, PMR)* and included **Dr. Jijith P Sathyan, Dr. Sajna Roy** *(Junior Residents, PMR)*, **Mrs. Nishamol** *(Staff Nurse)*, **Mr. Anil** *(Nursing Assistant)* and **Mr.Siddhique**

(Attender). The events ended on 16/09/2022 at 4pm. **Dr. Sajna Roy** and **Dr .Jijith P Sathyan** were delegated to give the prizes to some of the winners, by the organizing team! The medical team cover of the sports events was an opportunity for the residents to gain on- the- field experience in tackling common athletic injuries. It also strengthened team work.

Dr. Roy Ramachandran, *Associate Professor of PMR at Government Medical College, Kozhikode*, presented a talk in the JPEF ADA Global Convention on July 21st. The talk on 'Minimally Invasive Procedures in Diabetic Arthropathies' focused on these rare interventions & their benefits.

Dr. Roy also presented a seminar on management of life style disorders during the inauguration of Jeevathaalam project at Kozhikode . This is a novel project at Kozhikode district by the health department and NHM to screen, detect life style disorders and malignancy early, and prevent them....PMR is the main specialty deputed for this project..

Platinum jubilee convention of Govt. Medical College Trivandrum of which **Dr. Roy** is an alumnus was held in late August. He delivered a vivacious presentation on "Exercise and fitness". This talk was part of the Dr. CR Soman memorial session of "Healthy Medico, pride of the Nation"

Dr. Roy also delivered a talk on 'Exercises in Diabetes' at RSSDI State conference at Kottarakkara in Sept 2022.

Kerala Chapter of IAPMR conducted a special interactive session on 'Haemophilia Rehabilitation' on September 16th 2022, at Kozhikode. **Dr. Shigy Francis**, *Chief Consultant Physiatrist, at Lisie hospital* presented the topic & engaged the audience during this session.

Dr. Shigy also chaired sessions on Critical Illness Neuropathy & Cumulative Trauma Disease during IAPMR Midterm CME held at Nagpur.

അൽഷിമേഴ്സ് ദിന വാക്കത്തൺ

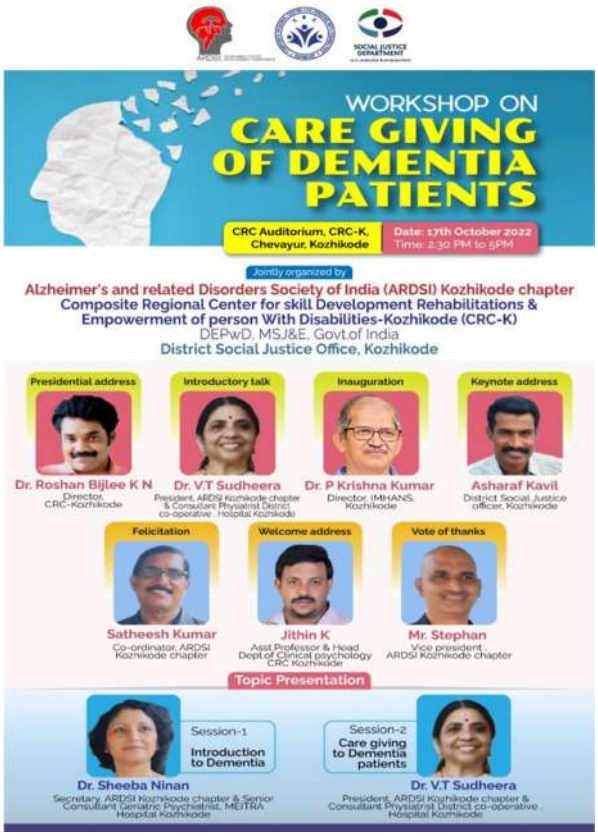
അൽഷിമേഴ്സ് ആൻഡ് റിലേറ്റഡ് ഡിസോഡേഴ്സ് സൊസൈറ്റി ഓഫ് ഇന്ത്യ കോഴിക്കോട് ചാപ്റ്റർ ലോക അൽഷിമേഴ്സ് ദിനത്തിന്റെ ഭാഗമായി കോഴിക്കോട് ബീച്ചിൽ നടത്തിയ വാക്കത്തൺ

കോഴിക്കോട്▸ ലോക അൽഷിമേഴ്സ് ദിനത്തിന്റെ ഭാഗമായി അൽഷിമേഴ്സ് ആൻഡ് റിലേറ്റഡ് ഡിസോഡേഴ്സ് സൊസൈറ്റി ഓഫ് ഇന്ത്യ കോഴിക്കോട് ചാപ്റ്റർ വിദ്യാർഥികളെ അണിനിരത്തി ബീച്ചിൽ വാക്കത്തൺ നടത്തി. എ.സി.പി. കുഞ്ഞിമൊയ്തീൻ ഫ്ലാഗ് ഓഫ് ചെയ്തു. വി.ടി. സുധീര, ഡോ. ഷീബ നൈനാൻ, അനി ജോൺ, സി.സതീൽ കുമാർ, ഇ.പി. സജീവ്കുമാർ, ബാബുതോമസ്, സ്റ്റീഫൻ, അനിചാലി, അൻസി, ഡോ.റോഷൻ ബിജ്ലി എന്നിവർ പങ്കെടുത്തു.

Dr. Sudheera V.T, *Consultant Physiatrist & President of ARDSI (Alzheimers & Related Disorders Society of India) Kozhikode Chapter*, organized & participated in a walkathon on World Alzheimers Day, which falls on September 21st.

In Association with Nursing College of Nirmala Hospital and JDT Islam Nursing college, **Dr. Sudheera**, conducted an awareness session on problems encountered in old age & nursing care that should be given.

Dr. Sudheera presented 4 talks on Osteoporosis on AIR which started on July 15th.



Alzheimer's & Related Disorders Society of

India Kozhikode Chapter organized a special workshop on Caregiving for Dementia Patients, on October 17th. **Dr. Sudheera** presented a talk titled – 'Caregiving to Dementia Patients' in this workshop.

Inauguration of CDC (Child Development Clinic) was done on Independence Day, August 15th organised by the PMR Department, at Believers Church Medical College Hospital (BCMCH). **Dr. Roshin Mary Varkey**, *Associate Professor, Department of PMR, Believers Church Medical College Hospital*, delivered the vote of thanks in this function.

On 6th of July, inauguration of the Believers Integrated Care Clinic for People with Parkinsons and other movement disorders was conducted. **Dr Roshin Mary Varkey** delivered a talk and explained how rehabilitation was integral in improving the condition of Parkinson's patients.

Onam was celebrated in the Department of PMR, at BCMCH with designing of Pookkalam & a grand Onasaddhya.

Artificial Intelligence…The Welcome Intrusion..

Dr. Ravi Sankaran MBBS, MD (Internal Medicine), MD (PMR) is the Professor & HOD of the Department of PMR, at Amrita Institute of Medical Sciences . He completed his MBBS from the Manipal Academy of Higher Education in 2005 & then did his MD Internal Medicine 2006- 2008, from the McLaren Regional Medical Center, Flint, Michigan, in the USA. He went on to do his MD in PMR 2008- 2010, Michigan State University, Lansing Michigan, USA. He also took MD in PMR from 2010- 2013, from Amrita Institute of Medical Sciences, Cochin, Kerala.

He completed Primary certification in Hyperbaric and Underwater Medicine in 2013, from National Baromedical services, Columbia, South Carolina, USA. He also completed his training in Spasticity Surgery and Rehabilitation in 2014, from Tokyo Women's University, Shinjiku, Tokyo, Japan.

He was the Chief Editor of the Kerala Journal of PMR from 2019 to 2022. His areas of interest include Spasticity, HBOT, Neurorehabilitation & Pain rehabilitation.

Artificial Intelligence (AI) is coming whether we like it nor not. It is predicted to be in 90% of hospitals and doing 80% of a doctor's work.[1] This sounds scary. How is this possible? AI excels in knowledge representation, planning, learning, problem-solving, adaptation, and interaction. Applied to healthcare AI assists with medical decision-based tasks, including diagnosis, therapy, prognosis, and monitoring based on medical and other types of information from different sources about the patient, other patients, and prior user's experience. These systems can manage uncertain, incomplete, or inconsistent information, and provide some level of supportive reasoning. In this article AI, Cerebral Palsy and Physiatry will be braided together to stimulate thought. If you haven't read my prior article on the same, I strongly suggest it as a primer.[2]

The goal of care in Cerebral Palsy is always two-fold: to get the family to accept they have a child with special needs, and maximize the patient's functional capacity so they can enjoy life. As there are no cures or great research potential involved most medical professionals have little interest in this population. Affected individuals are thrown to paramedicals and non-Modern Medicine practitioners for maintenance care. What ensues drives the healthcare industry but is not scientifically proven to deliver what the patient/ party wants. Treatment outcomes are rarely evaluated as few are proven to yield significant value (no p-value). Often once the diagnosis is made, Physiotherapy is ordered up and the last box in the checklist is ticked until a medical or surgical issue emerges. Physiatry is rarely included due to availability, accessibility, ignorance, or intentional exclusion.

A review of Pubmed done on 11.7.22 shows only one study detailing the utilization of AI in CP. The authors examined an EMR dataset of 1217 GMFM-66 assessments at a single time and 187 GMFM-66 assessments with reassessments after 1 year. Using Support Vector Machine, AI predicted the GMFM-66 scores accurately. (99.7% at a single time and

99.3% for the serial set). This showed an excellent agreement with the full GMFM-66 score.[3] Summarized, the study can look at data and accurately come to the same conclusion as a practitioner doing the same work. When we consider what GMFM-66 is, it is not more than a task performance checklist to assess patient capacity. The clinician rating this and the AI have similar tasks, hence the accuracy. The only way AI could outperform is if the clinician was unused to the scale. It can't replace the clinician as these patients need help to do the measured tasks. So what does all this mean?

AI has limitations. It requires data to be input into an electronic format before it can work. Data bytes accumulate and form data strings/ clusters. AI will help compare these and provide inferences. Bad data (incompletely entered, wrong information, etc) means weak algorithms whose output will be equally nonsense or harmful. Another cause for inaccurate data is inter-rater reliability. One Achilles tendon for AI is people who are: too lazy to enter data correctly, enter it in time, or do it at all. Using the above study, let's extrapolate and make an example for diagnostic AI gone wrong. Pretend the clinician entering the data can't read the handwriting on the chart, they will enter wrong values into the computer. If the patient is anxious and starts crying as the clinician enters data it can create the same effect. If the clinician wants to examine initially then enter information later, recall bias can come into play. Whatever the scenario the computer has non-representative data to work with and the information it provides will have that much value. The equivalent would be classifying apples as oranges because the data entered says so. When we look at therapeutic AI its goal is to provide information useful to guiding care.

AI can't take decisions, but it can offer the clinician enough to act in a more informed fashion. The problem is data entry biases are hard to pick up. An example in CP would be the scenario where clinicians involved in care report spectacular outcomes from their treatment when in fact the outcomes are mediocre. The algorithm formed would be biased towards those. If all the clinicians did this there would be no way to determine what treatment is best for a given patient. A specific example would be a PT who only knows Bobath PT but has access to the AI. They want to support their family, which means they can't lose their market share of the patients. This will influence their data entered. If their colleague who does Watsu sees his patients going to the Bobath guy, he will buy into AI and start entering spectacular results too. The only way to counter it would be a patient rating service to look for correlations hence validation. If the AI data owner or algorithm has a bias though, well all hope is lost.

The last limit of AI is its inability to detect ulterior motives. Chatbots are used to guide patients in need. If a patient/ party wants to declare that a clinician has damaged them, they can approach the AI chatbot and register multiple time-logged events. It is hard to defend against such allegations. The chatbot might be linked to a wearable sensor (smart-watch) which could provide limited objective data, but even that can be confounded by anxiety/ psychosis. The end results would be to have a patient come in for an evaluation. If they declined, an ambulance could be ordered to their doorstep but little more could be done. If a patient's 'pain' is being used by a relative to obtain narcotics, all they have to do is repeatedly approach the chatbot complaining of severe pain. The prescriber on the other end will have to either comply or ask the patient to come in for an evaluation. If they don't get the meds the patient party

can leave the clinician with a bad review then search for someone who will give them what they want. AI cannot detect motivation. The counter to this is using AI to document noncompliance with care.

What if a child has a serious complication and chatbot misguides as wrong information is given or the patient party is not tech/ language fluent/ presses the wrong button. Problems occur. Every system needs a scapegoat. Here it is the clinician. AI has limitations one should be aware of. While it can diagnose cancer in an MRI better than a clinician, there is a reason for it. AI is trained on datasets. Brain tumor in MRI datasets ubiquitously has dimensions marked out by a clinician. This is what AI learns to pick up as a diagnosis of cancer, not the cancer itself. If you remove the markings the accuracy is dismal. If it is given bad data, AI looks like a moron. Another example is a skin cancer detection app via a smartphone. It's better than a doctor in accuracy. If used on non-Caucasians its false-positive rate skyrockets and the app is useless.[5]

So what does the clinician do? Confirm or validate what AI says then advise what should be done. For our and the senior generations who've never seen such things we have an established workflow and this will be another tool on the proverbial work-belt. Perhaps it will be left to rust, used sparsely, or frequently. Regardless, future generations will be forced to work with these from day one and not see things the way we do. This means when they may get into trouble and not know how to get out of it. For example if the AI proposes a popular treatment regimen but the clinician foresees problems and the patient later has a bad outcome, who gets the blame? The doctor. If AI does something doctors already do well, it is declared the superior. This leaves a seminal question. If the doctor is right, AI is wrong, and the patient still has a bad outcome, who gets the blame? AI can't take responsibility for outcomes, but can say 'I told you so' if outcomes are suboptimal. As this culture takes off, the outcomes are limitless. Here's one. Patients will see doctors entering data into the computer and feel they can do the same. The Direct to Customer model will facilitate this for low risk issues.

Before we address specific applications we need to touch on parallel emerging technology: motion capture, AI telehealth, chat bot, wearables for activity monitoring, tele-venues for talent showcasing. I spent some time in Geneva last year with a Tamil engineer who had made software that would make a smartphone camera into a motion capture device. With the display a person could then get visual feedback and joint force vectors mapped. His six year old daughter enthusiastically showed me her Bharatnatyam moves as they were tracked in real time on his phone. People with impaired range of motion can be assessed remotely with this. With enough participants normative data can be made and related disease progression patterns mapped out. Telehealth progress speaks for itself. I always felt it was inferior to a face to face encounter, but if you've read my other articles, it yielded good results in particular patients. Wearables are everywhere, any smartphone has a pedometer linked to the cloud. A group of PTs showed us virtual therapy is as good as face to face care.[4] When we include deep fakes like the upcoming 'Finding Jack' movie things get wild. The star of the movie James Dean died in 1955 in an accident. AI is recreating everything about him for the movie though. The same can be done to provide remote rehab guidance so families can save costs and do things on their own.

Let's conjecture on how AI can help with regards to hot topics. As the literature for AI in CP is one article, we will consider a

Systematic Review and Meta Analysis topics of the past few years to discuss research options. Those are: Kinesiotaping, posture control, gait speed, functional gait training. I'd like all of you to first note the bias towards therapy topics. This is the chunk of services provided so it is expected. As PMR what options do we have? All the involved care providers have something to gain. We only gain if the patient benefits. This means being able to steer care in the right direction and be an impartial judge to treatment outcomes. It's time to take the captain's wheel. How? AI. To start we have to list the standard objective measures in CP: GMFCS, CFCS, MACS, and GMFM-66, MAS, topography, brain volume, imaging, EEG. If you are unfamiliar with these, what follows may not make sense. One last corollary, one third of patients respond to anything, one third to nothing, and one third go either way. Scientifically validated care is important to the last because this is where success is critical.

An SR on Kinesiotaping showed that in motor function there was no difference. The measures employed were WeeFIM, GMFM, Sitting Assessment Score. The limitations were short follow-up frame. Using wearables much of this data can be fed into an AI, the sample size increased and a more robust study done to see what changes.

They also looked at ptyalism. While wearables may not be able to track this, use of therapeutics and disposables may be indirect measures AI can track. Fine motor function did not change but improved posture was seen. AI can track these changes with Inertia Measuring Units (IMUs) in wearables, and the same is true for knee deformities.[6] An SR on Gait Speed considered the effect of gait training, resistance training, miscellaneous on gait speed. From the prior we know IMUs can greatly improve accuracy, and reproducibility of these tests and outcomes.[7]

What comes from all of this? Initially one can expect a slow buildup from early adapters followed by a splurge in data when a critical mass is reached. This is the point where it reaches the general market and becomes mandated by insurance companies. At its peak the data will lead to good, mediocre and lousy outcomes. How legally savvy the data owners are determines where this tool will stand at the end of all this. Then AI will join healthcare in its matured form like CT, MRI, NCS and lab tests. It wasn't long ago when people were getting X-rayed for anything, after which we realized there were problems with that much radiation. What does that mean for those with Cerebral Palsy. Some will improve, some may stop improving, and others might get better then worse. So what? As this comes into play we need to be on it. Bill Clinton the past US president when running for this first term promised to reduce drug error related deaths by bringing in the Electronic Medical Record. It was a radical success. When shown to doctors the response was less than cold. They had patients to take care of, not computers to stare at. By the time I started residency at MSU in 2008 the transition was in full effect. Now it's a standard in many hospitals. The problem comes from the response. Because we refused to use it initially, the insurance companies got hold of it, and made it mandatory for reimbursement. As we didn't pick it up, mid-level paramedicals were made to enter data. As they began doing more work, they became an interface between Dr and patient. Big Pharma got wind of the chance to generate more revenue and now midlevels prescribe instead of doctors in some countries. The same will happen with AI if we are inert. When the first Iphone came out I was quite content with my Motorola Razr. Lightweight, long battery

life, you know the type. I could never do all my work today without a smart phone. What I'm saying is change is inevitable.

Is there any good that can come from being an early adapter. One could be better informed to answer patient/ party questions. Initially they'll look different from those who don't have the info, but as time progresses we'll all speak the same. Only the quacks will be outliers and their games will be exposed. This technology allows for monitoring, tracking, recording of patient activity. All this can validate treatment efficacy. This means if a patient says they are better (so they don't have to pay for care), but actually are not the tech will show it. How will this integrate into existing care? A few ways: empower patient/ party to be informed and make better decisions, determine the scientific value of Ayurveda, Accupuncture, Homeo, Unnani, Sidha, or even Bobath vs Brunnstrom vs NDT vs Vojta etc.

When we discuss therapeutics in CP we frame them according to the three ages: mother, therapist, teacher. The age of mother is the most important time in a child's life but we don't have reproducible objective markers to track saying they are getting better. Next is the age of the therapist. Here our standard scales come into play and change can be measured. At best a biannual reassessment or interval reassessment is needed (pre-post treatment). AI can quantify changes with different care options and providers, data integrity and validity, and even track outliers who falsely report great outcomes versus the mean to market themselves. The last is the age of the teacher where we try to maximize functional capacity and turn it into an output a person can use to thrive. AI can help us categorize capacity to match to vocational options per SES, education and locale.

What research options exist with AI? The above sets the grounds, from there the sky are the limit. Keep in mind AI can tell us what happened; we have to figure out why. The bottom line is, this is an untouched area for publication, a chance to improve healthcare, and help people. Dig in now.

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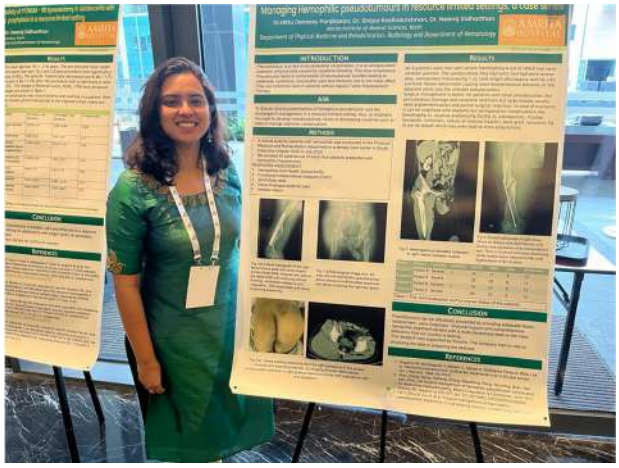
Members in Action – Part II

Dr Nittu Panjikaran, *Assistant Professor of PMR at Amrita Medical College*, recently published 2 articles in role of rehabilitation in JIA and mMASA in stroke patients.

Dr. Ravi Sankaran, *Professor & HOD of PMR at Amrita Medical College* has been working hard to set up the PMR department at the Amrita Hospital at Faridabad…



Dr. Nittu, also presented 2 posters in the national Hemophillia conference on Yttrium Synovectomy and Pseudotumours in Hemophillia.

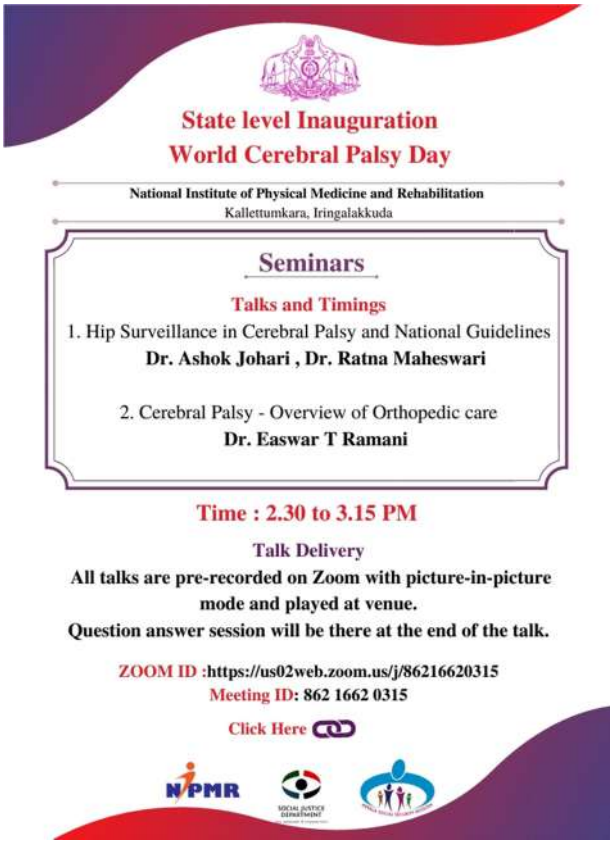
Dr. Ravi participated in the International Summit on Health Innovation at Amrita Hospital Faridabad, from August 22nd to 25th with **Dr. Allison Brashear** an expert on Spasticity, who has authored a book on this topic. **Dr. Ravi** also got a chance to interact with other health experts- **Dr. Deepak Yadav, Dr. Vivek Nambiar** to name a few…

The health summit concluded with Mata Amritanandamayi stressing the importance of research in health care.

A workshop on Prolotherapy – ARChon was conducted on October 1st & 2nd at Amrita Medical College. The Department of PMR at Amrita, under the aegis of **Dr. Ravi Sankaran**, arranged this workshop which included live demonstrations, dummy injections & interactive discussions on Prolotherapy. The workshop was led by **Dr. Sasikumar P. Menon, Dr. Ravi & Dr. Unnikrishnan Ramachandran.**

Dr. Anand Raja, *Consultant Physiatrist, at SUT Hospital & Research Centre*, conducted a medical camp in Kerala State Planning Board on August 11, 2022 . He also took an awareness class on ' Work related Musculoskeletal Disorders '

As part of the observance of World Spinal Cord Injury day, **Dr. Noufal Ali**, *Head of the Department of Physical Medicine & Rehabilitation, at Meitra Hospital, Kozhikode* featured in a video to create awareness on Spinal Cord Injury, its treatment & rehabilitation.



World Cerebral Palsy Day, October 6th, was observed at NIPMR, Irinjalakuda, with an informative Webinar.

Trivandrum Physiatrists' Club observed World Arthritis Day 2022 in association with

KGMOA Trivandrum and Dept of PMR, General Hospital Trivandrum on 12th October 2022. A Seminar was conducted by Dr Anil Kumar S, Former HOD & Chief Consultant on Physiatrists' Approach to Arthritis. Around forty delegates participated. **Dr. Arun A John**, *Secretary Trivandrum Physiatrists' Club* welcomed the delegates. **Dr. P B Meenakumari**, *HOD Dept of Medicine*, **Dr Sukesh Raj**, *Superintendent General Hospital Trivandrum* and **Dr. Sreejith R**, *Physiatrist* also expressed their views emphasizing the importance of creating public awareness on prevention, early detection and appropriate treatment of Arthritis.

The Department of PMR, in association with Department of Internal Medicine of Government Medical College, Thrissur, conducted an awareness session on World Arthritis Day at the Medical College. **Dr. Shiby T.G**, *Associate Professor & HOD of PMR at Government Medical College, Thrissur*, delivered a talk & co-ordinated this function.

Sexual Rehabilitation after Spinal Cord Injury

Dr. Fathima Haneena, *Consultant Physiatrist at KIMS Trivandrum* presented a talk on 'Sexual Rehabilitation in Spinal Cord Injury', which was aired on the Youtube channel of KIMS Trivandrum, on September 15th.

Dr. Masna Majeed, *Junior Resident in the Department of PMR at Government Medical College, Kozhikode*, bagged the First Prize for her paper titled- 'Current Ambulatory Status of Patients With Acute Limb Ischemia in COVID', in the National Midterm CME of IAPMR, held at Nagpur.

Assistive Technology for Cerebral Palsy Rehabilitation

Dr. Sindhu Vijayakumar is Associate Professor, Department of Physical Medicine and Rehabilitation (PMR), Amala Institute of Medical Sciences, Amalanagar, Thrissur.

MD, DNB, Certified Assistive Technology Professional.

Dr. Sindhu Vijayakumar graduated MBBS from JIPMER, Pondicherry, and MD in Physical Medicine and Rehabilitation (PMR) from the prestigious All India Institute of Medical Sciences (AIIMS), New Delhi. After obtaining MD and DNB degrees, she worked as faculty in PMR at AIIMS, New Delhi, Vardhman Mahavir Medical College (VMMC) and Safdarjang Hospital, New Delhi, and All India Institute of Physical Medicine and Rehabilitation (AIIPMR), Mumbai. She was selected for Residency in PMR at the University of Toronto in Canada and was trained at the Toronto Rehabilitation Institute in various aspects of Rehabilitation. For a brief period, she practiced in major private hospitals in Thrissur as Consultant Physiatrist and at the National Institute of Physical Medicine and Rehabilitation (NIPMR), Irinjalakuda. The passion towards practice of PMR and the endless possibilities prompted her to be the first doctor in India to be trained in the first-of-its kind Certificate Course on AT (Assistive Technology) Solutions.

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Assistive technology (AT) is the application of organized knowledge and skills related to assistive products, including systems and services. AT is a subset of health technology. An assistive product is any external product (including devices, equipment, instruments or software), especially produced or generally available, the primary purpose of which is to maintain or improve an individual's functioning and independence, and thereby promote their well-being (WHO definition). Assistive products are also used to prevent impairments and secondary health conditions.

Access to assistive technology is a human right and a prerequisite for equal participation and opportunities.

Cerebral palsy (CP), the most common motor disability of childhood, is disorder of the development of movement and posture, often associated with intellectual disability (ID), seizures, and/or problems with vision, hearing, feeding or speech. The primary focus of management should be early intervention with clear goals, both long and short term. Early intervention should focus on overcoming the motor synergy patterns and enhancing milestone development in all domains. Assistive Technology (AT) may be used as an adjunct to achieve the goals, alongside medications and therapies. Careful selection of appropriate AT device can enhance function.

Wherever possible, dynamic and lightweight systems should be used (especially orthoses) so that existing function may be facilitated. Energy efficiency, stability and functionality are important aspects, along with cosmesis, especially in case of children and teenagers. Adaptability in designs and colours to match

the school uniforms, awareness creation among school teachers and parents, etc are important steps to increase and improve acceptance rates. In common practice, especially in camps, there is a tendency to overprescribe assistive devices, which should be discouraged. Many of the commonly available children's toys as well as day-to-day objects could serve as assistive devices, if implemented in proper manner. Specific prescription devices like orthoses, seating or standing systems, ambulatory aids, etc. are required for specific indications.

Transition to adulthood is always a challenge, especially for persons with CP. For persons with severe involvement with maximum dependence, the AT requirement may not change. For those with mild and moderate disease, appropriate advancements need to be adapted in AT as well. More functional devices may be needed as age increases. Care must be taken from early rehabilitation phases to decrease abnormal joint forces and muscle power maintenance as much as possible, to reduce early onset of OA. Intellectual, scholastic and recreational activities must get as much attention as motor activities.

Classification of Assistive Technology:

- **Based on Current Practice and Branches**

Assistive Devices may be classified based on current practice and branches as

A. Prostheses and Orthoses – Wearable Technology

B. Other Assistive Aids

- Based on Technology Used

A. No or Low Technology

B. Moderate Technology

C. High Technology

- Based on Functional Limitation

a) AT for Vision Impairments

b) AT for Hearing Impairments

c) AT for Speech Language or Communication Impairments

d) AT for Motor Impairments

e) AT for Cognitive or Intellectual Impairments and Sensory Issues

An exclusive list of all AT used in CP is beyond the scope of this article. The basic principles and few examples are depicted for the practising Physiatrist. Appropriate and timely referral to the competent doctor and/or technologist is warranted with a mention of the deficit and the likely AT that we are considering.

For the purpose of this article, the Assistive Technology classification system basedon the functional limitations is used.

a) AT For Vision Impairments

Human faces, Vision stimulation charts (Fig 1, 2), bright coloured objects, etc. may be used right from the NICU. These objects, placed 8 – 12 inches away from the baby produces best results. Care should be taken to avoid extremely bright lights and to avoid over stimulation which may produce seizures. If vision impairment is diagnosed, it is best to involve a paediatric ophthalmologist in the team to guide visual stimulation therapies and strategies along with early and timely introduction of eye glasses and low vision aids as appropriate. If there is complete vision loss or blindness, early introduction of tactile strategies, counselling and introduction of braille should be offered to parents. Tactile and Braille toys (Fig 3, 4) are available in market. Use of visual guidance tiles, white canes, braille cards, etc. and blind- specific

education should be emphasized. All digital media has digital accessibility features which should be encouraged.

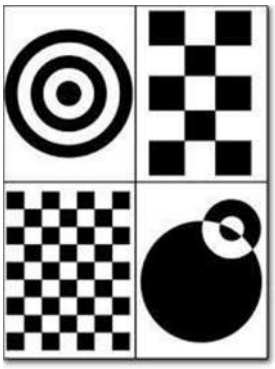

Fig 1, 2: Visual Stimulation Charts

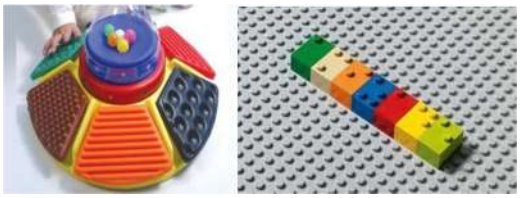

Fig 3: Tactile/textured toy Fig 4: Braille toy

b) <u>AT For Hearing Impairments</u>

If hearing impairment is suspected, early intervention, early use of hearing aids (Fig 5, 6) and in appropriate candidates, cochlear implants are done. Referral to a centre specialized in treating children with hearing impairment is often indicated. Soft rattles and auditory stimulation may be tried from an early stage, taking care not to do overstimulation. As a rule of thumb, babies should not be exposed to noise levels over 60 decibels. The noise level recommended for hospital nurseries is actually lower, at 50 dB. For reference, a quiet conversation is between 50 and 55 dB and an alarm clock is 80 dB. There are different types of hearing aids available in the market now and a clear understanding of how the hearing aid works is important to ensure adherence to its use. Most often, parents and treating team members do not realise the fact that most hearing aids amplify all sounds, including that of the fan or AC in the room and may be extremely disturbing to the child. Hence, it is important to understand what the child is trying to communicate and offer most appropriate solution. The hearing aid technology is very well advanced and sophisticated instruments are now available.

Fig, 5,6 Hearing Aids

c) <u>AT For Speech Language or Communication Impairments</u>

Non-verbal communication starts early in children, when they start recognising faces and smiling or crying appropriately. Although verbal communication or saying single word is anticipated only by 12 months, cooing by the 2nd month, babbling and copying sounds by the 4th month, etc are communication milestones that may be monitored. Many practitioners still provide wrong advice to parents, asking them to wait for two to three years, before starting therapy for speech delay. The key is not to wait and do detailed evaluation as early as possible. Adequate environmental stimulation is required for children to achieve speech, which is the reason many a times. Talking toys, games with repetition of names of objects, etc. are excellent for children to who have isolated speech delays. For children with associated hearing impairments, it will have to be corrected. If in detailed evaluation, speech

in not anticipated, parents and children should be offered Alternative and Augmentative Communication (AAC) as soon as possible. There are a variety of interventions available like Picture Exchange Communication System (PECS) (Fig 7), Symbol systems like gestures and sign language, Communication Devices like books, speech output devices (Fig 8, 9), computers, talking word processors, etc. Avaz (Fig 10) is a software application that is available in many Indian languages and can be easily installed. Children are advised to carry these AAC options with them to augment spontaneous communication and those who may not develop speech.

Fig 7: Easy to carry PECS

Fig 8, 9: Communication devices

Fig.10 Avaz App

d.) AT For Motor Impairment

Assistive devices for Motor Impairment are many. Further sub-classifications based on function will be helpful.

1. Orthoses
2. For Head control and Sitting
3. For Standing
4. For Walking
5. For Hand Function

d 1) Orthoses

Orthoses should be prescribed by the PMR Specilaist (Physiatrist) after detailed evaluation to ensure that the function is enhanced. There is evidence that the use of various types of AFOs, whether solid ankle, dynamic, floor/ground reaction orthoses (FRO) or posterior leaf spring, all improve at least some of the spatio-temporal gait parameters in children with CP. However, more detailed studies are warranted with better PEDro scales, especially in Indian conditions. Dynamic upper extremity splinting may prove to be effective in improving hand function. Conflicting evidence exists for the use of dynamic body suits in spastic and dyskinetic CP. The emerging technologies of robotics and exoskeletons are awaited but not yet available to the practising physiatrist.

Fig 11: AFO

Fig 12: WHO

d 2) AT For Assisting with Head control and Sitting

Nesting and positioning in the NICU is important to manage tone abnormalities andto facilitate neural recovery. In babies who have increased tone, preventing contractures is an integral part of this and could be started in the ICU itself with gentle passive movements and placing babies' trunk and extremities in particular positions, using soft pillows and cushions as far as possible, and avoiding hard splints. The positioning techniques are different for those who have reduced muscle tone and excessive passive movements should be avoided and causes other than CP should be carefully looked into. Carrying techniques (Fig 13, 14) have to be taught to caregivers that address the tonal abnormalities and synergy patterns.

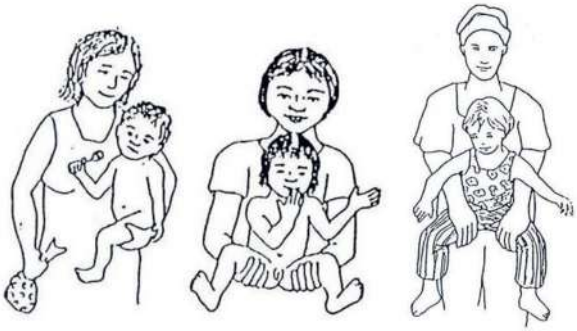

Fig 13, 14: Carrying and sitting options for children with hip adductor contractures

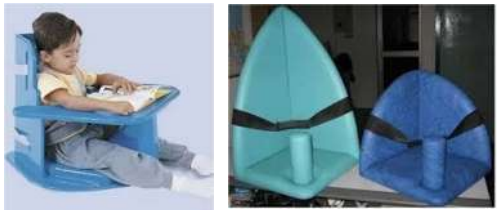

Fig 15, 16: Corner seats

Fig 17: CP Chair

d3) AT For Assisting with Standing

Early developmental therapy helps children to achieve the various motor developmental milestones. Assistive devices are only prescribed if there is great delay anticipated or in those with severe CP. Head bands or attachments to seats are given if children do not have head control. Corner seats (Fig 15, 16) facilitate sitting balance and CP Chairs (Fig 17) provide overall support including supporting the head in those children who do not develop head control.

Standing frames and devices are prescribed later on if needed (Fig 18, 19, 20).

Fig 18, 19, 20: Standing Frames

d4) AT For Assisting with Walking

Different varieties of paediatric sized canes, crutches (Fig 21) and walkers (Fig 22, 23) are available to support the ambulatory child, which is prescribed only as needed. Wheelchairs are only prescribed if the child does not attain walking by 6 years of age or the child is heavy for the parents to carry. However, sitting and positioning devices with wheels may be given according to the individual child and parents' involvement.

Fig 21: Forearm crutch Fig 22, 23: Paediatric Walkers

d 5) AT For Assisting with Hand Function

Built up handles, and other modifications based on individual needs may be custom made to enhance hand function (Fig 24, 25).

Fig 24: Swivel spoon and fork Fig 25: Adapted utensils for better grip

d) AT for Cognitive or Intellectual Impairments and Sensory Issues

Fig 26, 27, 28: Sensory and Educational Toys

Commercially available sensory toys, educational toys (Fig 26, 27, 28), etc. may effectively used by expert therapists as devices to overcome behavioural and sensory issues. Early learning toys are also available. If indicated puzzles, cards, etc. can be modified to suit the child. Each child needs individual education and learning plans and devices need to be made in a customized fashion.

Summary:

Appropriate use of Assistive devices is a useful adjunct to early intervention, habilitation and rehabilitation of children and adults with cerebral palsy. There are many myths and stigma associated with its use. These devices have to be prescribed by trained professionals, customized to the individual, trialled and modified from time to time to assess effectiveness and should enhance function. Gradation of services is important as the child attains specific goals.

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'Cerebral Palsy Management - An Occupational Therapist's Perspective '

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Cerebral palsy is a non progressive disorder of posture and movement which mainly occurs due to lesion in the developing brain (Faota & Faota,2009). This causes permanent disability in children. The incidence of CP is estimated to be 1.5 to 4 per 1000 live births or children (Chauhan et al.,2019). According to a national family health survey in 2015-16, 21%of child birth takes place at home by untrained attendants. The incidence has increased due to the high survival rates of very premature infants in both the very-low-birth-weight and extremely-low-birth-weight categories (Chauhan et al.,2019). Hence the rise of incidence is associated with prematurity and low birth weight. Motor and postural control, coordination of muscle action, Cognitive and sensory issues, seizures, feeding problems, behavioural problems and psychosocial delay, language and intellectual deficits, low vision and subsequent functioning are the common problems seen in children with cerebral palsy (Faota & Faota,2009).

Occupational therapy is one of the rehabilitation disciplines that works with clients with cerebral palsy. An occupational therapist focuses on Achieving health, well-being, and participation in life through engagement in occupation (AOTA 2014).Activities of daily living(ADL),Instrumental activities of daily living(IADL),Play, Work, Rest and Sleep, Leisure and social participation are the domains which an OT's addresses. The primary focus of intervention will be given to develop the skills necessary for self-care activities (ADLs-eating, grooming, bathing, dressing and toileting).Writing skills, cognitive skills, visual spatial skills, low vision ,adaptation of equipment and environment for better functioning are the other aspects of occupational therapy. Therapy in these areas increases quality of life and social participation in clients with

CP. International Classification of functioning is one such model which emphasizes participation and role of environment in participation restriction. Participation is one of the key elements to a child's development, health and well-being (Anaby D,2017) .Studies show that rehabilitation professionals focused more

on "body structure and components"(muscle tone,motor control),"activities"(gross motor skills,gait functioning) and less emphasis was placed for assessments and interventions specific to participation, leisure and play. Only a few number of therapist focused on participation related goals and its intervention (Anaby D,2017) .Majority of them focused on interventions related to primary impairments. Thus interventions should aim to improve client's functional activities, by identifying constraints in task or environment. Law et.al in 2015 found that therapy focused based on changing task or environments showed an effective change in the performance of younger children with CP.

Evaluation process

A holistic approach is used in the intervention process. Occupational therapy practitioners analyse the skills (range of motion, muscle power, muscle tone etc) required to do an activity or occupations. This gives a better understanding on body structure and functions, performance skills and performance patterns while doing the activity. Occupation based activity analysis is done for better understanding on clients abilities, their values and interests along with other demands of the activity(AOTA, 2014). For example the child is asked to eat a biscuit kept on the plate (activity). Now the therapist analyses each step and finds out the factors (range,hand functions,oral motor skills, posture,muscle power, vision, and sensory issues etc) which influence the clients performance. The identified factors are then evaluated using standardized and non standardized tools. The list of scales that are commonly used is given in table 1

Table 1:Standardized scales and its purpose

Sl No	Assessment tool /outcome measure	Purpose
1.	Canadian Occupational performance Model	Outcome measure to identifyclients self perception on performance
2.	Modified Ashworth Scale	Assess spasticity
3.	Bruininks-Oseretsky-Test-Motor-Proficiency	Performance measure -assess fine and gross motor skills in childrens,and young adults(21years)
4.	Pediatric Evaluation of Disability Inventory PEDI-CAT (Computer-Adaptive Test)	Assess self-care, mobility and social function
5.	Beery-Buktenica Developmental Test of Visual Motor Integration	Assess visual-motor skills
6.	Gross Motor Function Measures	Assess gross motor functions
7	School Function Assessment	Measures performance overall to the continuum
8.	Wee FIM/FIM/Barthel Index	Assess functional performance.
9.	Sensory Profile	Identify sensory processingissues

Intervention Process:

The treatment starts from the very beginning, which means their early stages of development.The intervention process mainly contains three steps-intervention plan, implementation and review(AOTA, 2014).In an intervention plan the practitioner sets goals based on client's priorities and uses a variety of approaches for the treatment of cerebral palsy. This

improves the chance of independence and quality of life. SI(sensory integration) and NDT (neuro developmental therapy)(Steultjens et al., 2004), Behavior modification and parental training (Rezaie & Kendi, 2020) are the most common approaches used during this process. While implementing the intervention plan practitioners use preparatory methods (stretching, using adjunct modalities, adaptive devices, splints and modify their home environment), preparatory Task(strengthening exercises, weight bearing activities, reach out activities, activities with clothespin etc),activities (practices components of the occupations) and occupations (dressing with help of adaptive aids and so on)to facilitate engagement in occupations(AOTA, 2014).Parental training and education is another key element of intervention. This helps them to reduce their stress and also to incorporate the plan into their routine.CIMT(constraint induced movement therapy),bilateral manual training (Beckers et al., 2020)and NDT are frequently used. Similarly, Peto's conductive method of education is widely used by occupational therapists. Children's learning behavior is to be improved with this program. A detailed reviewing and evaluation is done after implementation of the plan. A combined treatment approach including other rehabilitation professionals helps us to achieve the child's maximum level of independence. Thus interventions should aim to improve the client's functional activities, by identifying constraints in task or environment, rather than focusing on primary impairments(Anaby D,2017).A Top down approach will be more effective than targeting the body movement pattern (bottom up approach).

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Adverse Events After Serial POP Casting of Lower Limb in Cerebral Palsy Children

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Introduction

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain[1].

CP is the most common pediatric neuromuscular disorder in the world.

In India, prevalence is 1.5 to 2.5 per 1000 live births[2].

Based on muscle tone CP can be classified as Spastic, Athetoid, Ataxic, Hypotonic, Mixed[3]

Based on topography CP can be designated as Monoplegia, Hemiplegia, Tetraplegia, Diplegia, Triplegia

Serial casting is an intervention in CP children useful in increasing range of motion, spasticity reduction and improving functional ability. Plaster of Paris (POP) casting is associated with adverse events like pressure ulcers, swelling, pain etc[4].

Serial casting is a routine component of rehabilitation for spasticity reduction and ambulation in CP children at our centre. This study aims to quantify the complications of serial POP casting and describe the clinical factors related to these adverse events in cerebral palsy children.

Objectives

To measure the occurrence of adverse events in serial casting of lower limb for cerebral palsy children.

To describe the clinical factors related to these adverse events.

Methodology

Study Design: Descriptive, Observational retrospective study

Study Setting: CP Clinic, PMR Department, Govt. Medical College, Thiruvananthapuram.

Study Population: Patients attending CP clinic

Study Period: 4 months (November 2017 to February 2018)

Inclusion Criteria

- children with spastic CP who underwent serial casting (more than one session of casting) with complete records

Exclusion Criteria

- incomplete records

Sample Size: 17 patients, 92 casts

17 Children - 9 boys & 8 girls with CP who had undergone POP serial casting were included.

Study protocol - After informed consent details of clinical features and complications were collected from the previous records and substantiated wherever needed by history taking. The details were entered in a structured proforma.

Analysis: Data was entered in excel sheet and analysis done using SPSS

Study Variables

Clinical features

1. Sex
2. Type of spastic CP based on topography
3. GMFCS (gross motor functional classification system) level
4. Modified Ashworth Scale for spasticity
5. Standing balance
6. Past history of seizures
7. Cast type – below knee (BK), above knee (AK)
8. R3 TA (tendoachilles) angle – plantarflexion/dorsiflexion of ankle joint measured with patient supine and hip, knee flexed to 90 degrees with maximal passive dorsiflexion force by examiner

Adverse events

Pressure sore: - grade and site

Edema

Pain

Others- excessive crying, neurological deficit or vascular complications

Results

17 children (9 males and 8 females) with CP were included in the study. 92 occasions of cast applications for these children were considered for the analysis. When considering gender 67.4% of the cast were put for males and 32.6 % were put for females.

Considering the topography for which casts were put 38 (41.3%) were for diplegics, 20(21.7%) were for tetraplegics and 34 (37%) were for total body involvement, none for hemiplegia and monoplegia .

Considering the functional classification GMFCS level 2 was 28.3% GMFCS 3 was 4.3 % GMFCS 4 was 37% GMFCS 5 was 30.4 %. Regarding the spasticity Modified Ashworth Scale grade 1 was noted in 17.4 %, grade 2 in 58.7%, grade 3 in 17.4%, grade 4 in 6.5 % casts. Of the total casts put 50% had no standing balance, standing with support was in 47.8 % and standing without support in 2.2 %.

R3 angle of TA (tendo Achilles) was found to be 30^0 plantar flexion (PF) in 4.30 %, 10^0 PF and 5^0 PF in 13 % each, neutral and 5^0 DF each in 26.10%, DF 10^0 in 13%, DF 15^0 in 4.30%

Regarding the type of casts the study had 50 % each of above knee (AK) and below knee (BK) casts.

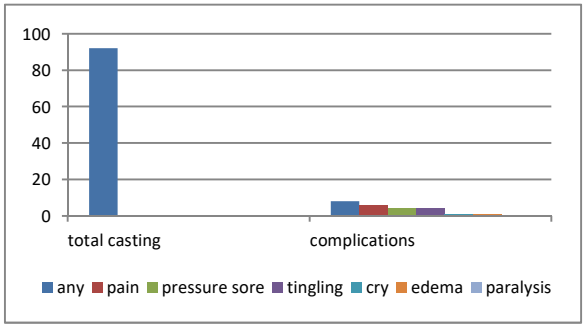
8 out of 17 children had history of seizure disorder. No seizure episodes occured during the casting period.

Regarding the incidence of complications, 8 out of the 92 casts (8.7%) developed the same.

Pain was the most common complication seen in 6 (6.5%) applications

It was followed by 4 incidences each of pressure sore (4.4%) and tingling (4.4%) and 2 incidences (2.1%) of excessive cry. There was one incidence of edema of the foot.

Complications incidence



Clinical features – association with complications

All 8 complications occurred in boys (p= 0.041)

10.5% of diplegic and 11.8% of Total Body Involvement patients developed complications; none seen in quadriplegic patients(p=0.504)

50% of complications(4 of 8) occurred in GMFCS 2 patients; followed by 25% in GMFCS 3 and 12.5% each for GMFCS 4& 5 (p=0.040)

Complications occurred only in patients with grade 2 spasticity (p=0.618)

75% of complications occurred in patients who can stand with support but association was not significant(p=0.240)

Incidence of pressure sore were seen equal (4.3% each) among Above Knee & Below Knee casts(p=0.063)

Pain (n=6) was present only in those with AK cast(p=0.003);And also edema(n=1)(p=0.237)

All complications (n=8) occurred in patients whose R3 at the ankle allowed dorsiflexion (p=0.003) but with grade 2 spasticity

Discussion

This study measured the occurrence of complications after serial POP casting of children with cerebral palsy and association of complications with various clinical factors.

Although serial casting is used frequently, there is, however, a lack of documented incidence of complications and side effects

In our study complications occurred in 8.7% of cast applications

Study by Marcus Pohl had shown complication rate of 19.8% [6]

Study by Shweta Jain etal showed 9.09% complication(pain & pressure sore)[7]

In our study, pain was the most common complication (6.5%) followed by pressure sore (4.4%) and tingling (4.4%)

Male gender had significant association with occurence of complication

GMFCS score also showed a significant association with occurrence of complications, especially pressure sore

Above Knee cast and R3 at the ankle allowed dorsiflexion had a significant association with occurrence of pain as a complication

Conclusion

Incidence of complication in serial plaster of paris casting of lower limb in children with spastic cerebral palsy was less than 10%. Hence we may infer that serial casting is a relatively safer procedure.

Most of the complications occurred in children with spastic diplegia and grade 2 spasticity who were able to stand.

Drawbacks

Retrospective, small sample size

Could not pick up drop out patients

Detailed method of casting not recorded.

Children may not report symptoms accurately.

NCS or vascular Doppler studies were not done for confirmation.

Suggestions

Further detailed large study should be taken up.

Cause of each complication to be ascertained.

Discussions with more experienced experts in this field held to improve methods of casting.

Casting care counselling and structured training for serial casting may help to reduce these adverse events.

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Spotlight……

The Midterm CME of the Kerala Chapter is just around the corner. Scheduled for November 5 & 6th, it's likely to be an academic feast. For details click the link given at the bottom of the page…

https://www.iapmrkerala.org/events/mid-term-cme-2022

Links….

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Musculoskeletal interventions and rehab. All joint injections, PRF therapy for ulcer. Prolotherapy.

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(Focusing on vocational possibilities and social integration)
Sport injury rehabilitation
Ultrasound guided Pain intervention (PM&R)

Journal Scan

Effectiveness of Rehabilitation Interventions to Improve Gait Speed in Children With Cerebral Palsy: Systematic Review and Meta-analysis

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Dr.Noufal completed his MBBS from Govt. Medical College, Kozhikode. He went on to do his MD in PMR from AIIMS, Delhi. After bagging a gold medal in DNB exam in 2018, he went on to work as Consultant Physiatrist at Baby Memorial Hospital, Calicut. His areas of interest include Neurorehabilitation & Interventional Physiatry.

Children with cerebral palsy (CP) have decreased gait speeds, which can negatively affect their community participation and quality of life. However, evidence for effective rehabilitation interventions to improve gait speed remains unclear.The purpose of this study was to determine the effectiveness of interventions for improving gait speed in ambulatory children with CP. MEDLINE/PubMed, CINAHL, ERIC, and PEDro were searched from inception through April 2014. The selected studies were randomized controlled trials or had experimental designs with a comparison group, included a physical therapy or rehabilitation intervention for children with CP, and reported gait speed as an outcome measure. Methodological quality was assessed by PEDro scores. Means, standard deviations, and change scores for gait speed were extracted. General study information and dosing parameters (frequency, duration, intensity, and volume) of the intervention were recorded. Twenty-four studies were included. Three categories of interventions were identified: gait training (n=8), resistance training (n=9), and miscellaneous (n=7).

Meta-analysis showed that gait training was effective in increasing gait speed, with a standardized effect size of 0.92 (95% confidence interval=0.19, 1.66; P=.01), whereas resistance training was shown to have a negligible effect (effect size=0.06; 95% confidence interval=-0.12, 0.25; P=.51). Effect sizes from negative to large were reported for studies in the miscellaneous category. Gait speed was the only outcome measure analyzed. Gait training was the most effective intervention in improving gait speed for ambulatory children with CP. Strength training, even if properly dosed, was not shown to be effective in improving gait speed. Velocity training, electromyographic biofeedback training, and whole-body vibration were effective in improving gait

speed in individual studies and warrant further investigation.

Phys Ther. 2016 Dec;96(12):1938-1954.

Selective Dorsal Rhizotomy in Cerebral Palsy: Selection Criteria and Postoperative Physical Therapy Protocols

Renata D'Agostini Nicolini-Panisson , Ana Paula Tedesco , Maira Rech Folle , Márcio Vinicius Fagundes Donadio

To identify selection criteria for selective dorsal rhizotomy (SDR) in cerebral palsy, to analyze the instruments used for evaluation, and to describe the characteristics of physical therapy in postoperative protocols. Integrative review performed in the following databases: SciELO, PEDro, Cochrane Library, and PubMed. The terms in both Portuguese and English for "cerebral palsy", "selective dorsal rhizotomy", and "physical therapy" were used in the search. Studies whose samples enrolled individuals with cerebral palsy who had attended physical therapy sessions for selective dorsal rhizotomy according to protocols and describing such protocols' characteristics were included. Literature reviews were excluded and there was no restriction as to period of publication. Eighteen papers were selected, most of them being prospective cohort studies with eight-month to ten-year follow-ups. In most studies, the instruments of assessment encompassed the domains of functions, body structure, and activity. The percentage of posterior root sections was close to 50%. Primary indications for SDR included ambulatory spastic diplegia, presence of spasticity that interfered with mobility, good strength of lower limbs and trunk muscles, no musculoskeletal deformities, dystonia, ataxia or athetosis, and good cognitive function. Postoperative physical therapy is part of SDR treatment protocols and should be intensive and specific, being given special emphasis in the first year. The studies underline the importance of appropriate patient selection to obatin success in the SDR. Postoperative physical therapy should be intensive and long-term, and must necessarily include strategies to modify the patient's former motor pattern.

Rev Paul Pediatr. 2018 Jan 15;36(1):9.

Nonimmersive Virtual Reality as Complementary Rehabilitation on Functional Mobility and Gait in Cerebral Palsy: A Randomized Controlled Clinical Trial

Joice Luiza Bruno Arnoni [1], Ana Francisca Rozin Kleiner [1], Camila Resende Gâmbaro Lima [1], Ana Carolina de Campos [1], Nelci Adriana Cicuto Ferreira Rocha [1]

This study aimed to investigate the effects of nonimmersive virtual reality (VR) as complementary rehabilitation on functional mobility and gait in children with mild unilateral cerebral palsy (CP). Prospective, randomized, controlled, clinical trial. Twenty-two children with unilateral CP were randomized into two groups: intervention group (IG) (n = 11) and control group (n = 11). After baseline assessments, the participants either started the VR intervention (IG) associated with conventional therapy, or continued conventional physical therapy (control group). Participants in the IG attended 45-minute training sessions twice a week for 8 weeks (total: 16 sessions and 12 hours of training). Participants in the control group underwent standard therapy for 50 minutes, twice a week. Timed Up and Go test (TUG), gait spatiotemporal variables, and pelvic angles were measured at baseline and after treatment sessions. When compared with the control group, the IG performed the following activities in decreased time: TUG, and stride time. Also, the IG increased the velocity of walking and the pelvis retroversion, and decreased the pelvis

interval/external rotations and amplitude of pelvis rotation while walking. A rehabilitative approach based on a nonimmersive VR as complementary rehabilitation may improve functional mobility and change joint mobility functions during gait of children with mild unilateral CP. The results of the study demonstrate that the insertion of a therapy based on VR may help in better strategies in the gait of children with CP. Thus, rehabilitation professionals can use this tool combined with conventional therapy.

Games Health J. 2021 Aug;10(4):254-263.

Impaired Voluntary Movement Control and Its Rehabilitation in Cerebral Palsy

Andrew M Gordon [1]

Cerebral palsy is caused by early damage to the developing brain, as the most common pediatric neurological disorder. Hemiplegia (unilateral spastic cerebral palsy) is the most common subtype, and the resulting impairments, lateralized to one body side, especially affect the upper extremity, limiting daily function. This chapter first describes the pathophysiology and mechanisms underlying impaired upper extremity control of cerebral palsy. It will be shown that the severity of impaired hand function closely relates to the integrity of the corticospinal tract innervating the affected hand. It will also shown that the developing corticospinal tract can reorganize its connectivity depending on the timing and location of CNS injury, which also has implications for the severity of hand impairments and rehabilitation. The mechanisms underlying impaired motor function will be highlighted, including deficits in movement execution and planning and sensorimotor integration. It will be shown that despite having unimanual hand impairments, bimanual movement control deficits and mirror movements also impact function. Evidence for motor learning-based therapies including Constraint-Induced Movement Therapy and Bimanual Training, and the possible pathophysiological predictors of treatment outcome and plasticity will be described. Finally, future directions for rehabilitations will be presented.

Adv Exp Med Biol. 2016;957:291-311

Constraint-induced movement therapy improves upper limb activity and participation in hemiplegic cerebral palsy: a systematic review

Hsiu-Ching Chiu [1], Louise Ada [2]

Does constraint-induced movement therapy improve activity and participation in children with hemiplegic cerebral palsy? Does it improve activity and participation more than the same dose of upper limb therapy without restraint? Is the effect of constraint-induced movement therapy related to the duration of intervention or the age of the children? Systematic review of randomised trials with meta-analysis. Children with hemiplegic cerebral palsy with any level of motor disability. The experimental group received constraint-induced movement therapy (defined as restraint of the less affected upper limb during supervised activity practice of the more affected upper limb). The control group received no intervention, sham intervention, or the same dose of upper limb therapy. Measures of upper limb activity and participation were used in the analysis. Constraint-induced movement therapy was more effective than no/sham intervention in terms of upper limb activity (SMD 0.63, 95% CI 0.20 to 1.06) and participation (SMD 1.21, 95% CI 0.41 to 2.02). However, constraint-induced movement therapy was no better than the same dose of upper limb therapy without restraint either in terms of upper limb activity (SMD 0.05, 95% CI -0.21 to 0.32) or participation (SMD -0.02, 95% CI -0.34 to 0.31). The effect of constraint-

induced movement therapy was not related to the duration of intervention or the age of the children. This review suggests that constraint-induced movement therapy is more effective than no intervention, but no more effective than the same dose of upper limb practice without restraint.

J Physiother. 2016 Jul;62(3):130-7.

Training postural control and sitting in children with cerebral palsy: Kinesio taping vs. neuromuscular electrical stimulation

İlkay Karabay [1], Asuman Doğan [1], Timur Ekiz [2], Belma Füsun Köseoğlu [1], Murat Ersöz [1]

To elucidate the effects of Kinesio Taping (KT) in addition to neurodevelopmental therapy (NDT) on posture and sitting, and to compare the effects of KT and neuromuscular electrical stimulation (NMES). Seventy-five children were randomized into control, KT, and NMES groups. NDT was applied to all children 4 times a week for 4 weeks. In addition, KT and NMES were applied to KT and NMES groups, respectively. Sitting subset of Gross Motor Function Measure (GMFM) and kyphosis levels of the groups were analyzed by two way mixed ANOVA. GMFM and kyphosis values improved significantly in all groups (all $p < 0.01$), yet change levels were more prominent in the KT and NMES groups than the control group. Moreover, NMES group showed better improvement. KT or NMES application for four weeks in addition to NDT is effective on improving kyphosis and sitting. Besides, NMES is more effective than KT.

Complement Ther Clin Pract. 2016 Aug;24:67-72.

Sit-to-stand training for self-care and mobility in children with cerebral palsy: a randomized controlled trial

Sirawee Chaovalit [1 2], Karen J Dodd [1 3], Nicholas F Taylor [1 4]

To investigate if a sit-to-stand exercise programme for children with cerebral palsy (CP) would improve self-care and mobility. Thirty-eight children with CP (19 males, 19 females; mean age 8y 0mo, SD 2y 4mo, age range 4y 0mo-12y 4mo) classified in Gross Motor Function Classification System (GMFCS) levels III and IV and their caregivers were randomly allocated to sit-to-stand training plus routine physiotherapy (balance and gait training) or routine physiotherapy only (controls). Task-specific sit-to-stand training was completed five times a week for 6 weeks under physiotherapist (twice weekly) and caregiver (three times weekly) supervision. Blinded outcome assessments at week 7 were the self-care and mobility domains of the Functional Independence Measure for Children, Five Times Sit-to-Stand Test (FTSST), and Modified Caregiver Strain Index (MCSI). The sit-to-stand group self-care increased by 2.2 units (95% confidence interval [CI] 1.3-3.1) and mobility increased by 2.2 units (95% CI 1.4-3.0) compared to the control group. In the sit-to-stand group, the FTSST was reduced by 4.0 seconds (95% CI -4.7 to -3.2) and the MCSI was reduced by 0.8 units (95% CI -1.2 to -0.4) compared to the control group. A sit-to-stand exercise programme for children with CP classified in GMFCS levels III and IV improved sit-to-stand performance and resulted in small improvements in self-care and mobility, while reducing caregiver strain. What this paper adds Sit-to-stand training improved independence in self-care and mobility for children with cerebral palsy (CP). Home-based sit-to-stand training programmes for children with CP can reduce the burden on supervising caregivers.

Dev Med Child Neurol . 2021 Dec;63(12):1476-1482.

In the News…

By Dr.Bineesh Balakrishnan

The BUDI Bracelet

Medical student Blynn Shideler arrived at Stanford with an award-winning health device – and every intention of improving it. The device addresses a need in the cerebral palsy community. Kids with cerebral palsy – a group of disorders that affect movement, balance, and posture – need daily sessions with a physical therapist to build strength and improve motor skills. As an undergraduate studying bioengineering at Columbia University, Shideler thought there must be a better way.

He collaborated with other students to design a device that would make it easier for these kids to perform their therapy exercises at home, or anywhere. The result was BUDI – the Biofeedback Upper-limb Device for Impairment – a bulky bracelet built with sensors that tracked motion and provided feedback on how the user might want to adjust how they are moving.

BUDI was named "Most Outstanding Design Project from Columbia Biomedical Engineering," and Columbia shared the news on social media. People in the cerebral palsy community noticed.

"A teenager in Ohio reached out and said, 'I have CP, saw your product and would love to try it,' " Shideler said.

But Shideler had no bracelets to give. His team had only built two prototypes. So, inspired by that message from someone he didn't know living across the country, Shideler set out to produce BUDI on a larger scale.

https://news.stanford.edu/report/2022/07/22/digital-solution-kids-cerebral-palsy/

Whole Body Vibration in Cerebral Palsy Rehabilitation

CP affects muscle quality, bone health, and motor skills. Roughly 75% of children with the condition experience spasticity, or muscle stiffness, making it difficult to move. It can also cause uncontrollable movements or loss of balance and coordination. Treatment options vary as much as the condition does, and the costs add up. Botox injections may help temporarily relax overactive muscles, and surgery can correct posture and misaligned joints. Physical therapy can also help, but more research is needed, Modlesky says.

"There are not nearly enough people who could recognize CP and recognize it early enough where children can get the support they need," he says. "And for those who get support, we don't know enough about what the most effective treatment strategies are."

This clinical trial is taking steps to change that. Forty-four children aged 5 to 11, visit the lab five times over a year. Researchers collect data to assess their movement, muscle strength, dexterity, balance, and other measures during sessions that last up to two days. But the study's primary focus is an alternative treatment: whole-body vibration therapy.

"There are preliminary studies suggesting that vibration has a positive effect on muscles and on balance," Modlesky says. "The focus of this study is to look at a mild vibration intervention and determine if it can improve muscle size and quality and if it can improve balance, ultimately increasing the child's participation in physical activity."

Participants stand on a small, square platform that looks like a scale. When activated, it emits almost imperceptible vibrations that travel from the feet to the head. Electromyography sensors track muscle responses as participants bend, jump, and balance, recording changes over time.

"Typical medical doctors have been pretty dismissive because his case is mild, and he doesn't deal with the common medical complications that come with CP," she says. "Having the people at UGA as a resource and knowing they are working to improve the lives of kids like [Noah] gives us so much hope. They understand at a scientific level what is going on in his body and have helped explain it to me when no one else has."

The study results could make alternative therapies like whole-body vibration more accessible and affordable. In the meantime, the lab is helping families learn more about how CP affects their children's daily lives.

https://news.uga.edu/getting-in-the-game/

Sensory Park in Southern Tamil Nadu

For the first time in southern Tamil Nadu, the district administration has created in Palayamkottai a 'sensory park' with play equipment -- a facility specially built for children who have physical and mental challenges to overcome.

This sensory park has been set up with the primary objective of improving the physical and mental health of intellectually challenged children through the play-way method, reports The Hindu.

This beautiful concept is the brainchild of the Tirunelveli District Collector V Vishnu, an IAS Officer of the 2012 batch (All India Rank 34).

Already some 20 children from Tirunelveli and Palayamkottai, all suffering from autism, Down's syndrome, hyperactivity, cerebral palsy and other intellectual disability are able to enjoy the facility.

The sensory park also has a vocational training and rehabilitation programme. Trainers at this facility impart speech therapy, physiotherapy, basic training like brushing the teeth, going to the toilet, bathing, eye-hand coordination, sensory activities and other occupational therapy to the children.

The equipment here is also specially selected while keeping the children's mental and physical health limitations and safety in mind.

https://www.timesnownews.com/health/world-cerebral-palsy-day-tirunelveli-has-a-sensory-park-with-play-equipment-for-children-with-intellectual-disabilities-article-94654941

Virtual Habilitation Gaming in Neurorehabilitation

Devesh S. often makes exaggerated and abrupt moves while trying to walk. The seven-year-old has athetoid cerebral palsy, a condition caused by abnormal brain development or damage when it is being formed. Devesh has trouble talking, understanding, learning and even walking straight. When he is in the VHAB (virtual habilitation) "game", though, the boy forgets these struggles. Created by TCS Rapid Labs, VHAB is a digital-assistive tool that

combines virtual reality with gesture analysis.

"Devesh started VHAB games just three months ago, but the change that happened in him is amazing," says Ambili Francis, a physiotherapist at the Adarsh Rehabilitation Centre (ARC) in Kochi, where Devesh studies. "The frequency of his falls decreased. He has become confident enough to complete complex operations that require good hand-leg coordination. He was impatient in the initial days; he used to be upset over small delays between two levels of the game. But he is more patient now; he pays attention to the instructions."

Tommy says the aim is also to retrain the brain of neurodivergent children. "The neurogenesis (forming of new neurons) and neuro-plasticity (a process by which the brain rewires to perform new functions) of their brain are enabled so that they will be able to do things they earlier could not. Also, the system knows to what extent a person can [stretch himself]. It is based on this that the system loads the games for each person."

Nirmal, who has cerebral palsy, has movement troubles and impaired hand-eye coordination. "He could not even feed himself because of tremors; his mother used to feed him at school," says Tommy. "She wanted him to be independent and self-sufficient. Parents of special children worry about a future where they won't be available to help. VHAB and our other assistive technologies are aimed at making neurodivergent individuals independent. Once VHAB was introduced, the children became more confident and independent, and the parents-especially mothers-could go to work."

Tommy is currently mentoring a Kerala-based startup called Punarjeeva Technology Solutions, which is researching game therapy for physical rehabilitation. Two of their tools—Hasth, a gamified system based on hand-tracking that improves fine motor movements; and Samatved, a gamified environment that offers balancing exercises—have shown promise in several cases, including in Nirmal's.

Dr Sasikumar Panicker, founder of Kumar Centre for Stroke and Neuro Rehabilitation, Kochi, uses both Hasth and Samatved at his clinic to help a wide range of patients, including those who had a stroke or have multiple sclerosis, cerebral palsy or brain injuries. "Depending on the areas affected in the brain because of a stroke, the kind of weakness that occurs may differ," says Panicker.

"We use only a small section of our brain," says Panicker. "A lot of neurons are dormant. In the case of a stroke or cerebral palsy, a section of neurons is damaged. But when we stimulate [neurons] with constant practise, it creates new engrams (memory trace) in the brain, which leads to new neural pathways. Through these new pathways, a patient will gain more ability and more strength. So, the idea is to awaken the dormant neurons via stimulation."

https://www.theweek.in/health/more/2022/09/20/how-a-virtual-reality-game-is-helping-neuro-divergent.html

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'Imagine Everybody' Living for Today…

Don't make assumptions about people with disabilities.

That's the message from Shoshana Goldberg and her 17-year-old daughter Yemina, who has cerebral palsy and has been a patient at Holland Bloorview Kids Rehabilitation Hospital for most of her life.

Yemina said that when people interact with her for the first time, they often assume she's "not smart" because she has a physical disability.

"People stare at me. They treat me like a baby."

Yemina is among four young people featured in Holland Bloorview's recently launched "Imagine Everybody" anti-stigma campaign, which urges Canadians to shape a future where disability is included.

Yemina has been coming to Holland Bloorview since she was a toddler, mostly as an outpatient, though she did have an in-patient stay following a surgery. She also participated in the hospital's summer camps and was a student in its kindergarten program.

"The (Imagine Everybody) campaign is fantastic. The world inside Holland Bloorview is so different from what you experience in the world outside Holland Bloorview in terms of inclusion and the attitude towards people with disabilities," Shoshana said. "It would be so nice if the whole world was fully accessible and fully inclusive, and that's what I think this campaign is trying to change."

https://www.toronto.com/news/north-york-teen-with-cerebral-palsy-helps-launch-holland-bloorviews-imagine-everybody-anti-stigma-campaign/article_fa90c065-3864-5dcc-99a7-62a2ea45454e.html

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Bionic Clothing..

Today, we have everything from smart canes that can monitor the number of steps taken to self-driving wheelchairs or ones that can be steered hands-free with simple head movements.

Just like the increasing use of robotic exoskeletons to assist individuals with spinal cord injury in both physical rehabilitation and real-world movements, CIONIC's device exists within the ecosystem of bionic wearable technologies designed to augment natural human movement, rather than simply replace it.

Housed within a highly wearable legging garment, the neural sleeve uses functional electrical stimulation (FES) technology to provide electrical stimulation to lower limb muscles in which the neural pathway from the brain has been damaged by conditions such as stroke, spinal cord injury and multiple sclerosis.

The use of multiple electrode arrays, unseen in traditional FES systems, allows for a real-time sequencing and firing of different muscle groups within the same gait cycle – offering fully orchestrated assistance and a more fluid step pattern than can be achieved by focusing on only one neural pathway, as traditional FES systems tend to do.

https://www.forbes.com/sites/gusalexiou/2022/09/28/bionic-clothing-startup-cionic-secures-125-million-funding-to-augment-mobility/?sh=2dbcc7ae2727

The Kozyavkin Method

Abu Dhabi & Al Ain branches of Cambridge Medical and Rehabilitation Center (CMRC) provide the Intensive Neuro Rehabilitation System (INRS), known as The Kozyavkin Method. The world-class rehabilitation program was created by Dr. Vladimir Kozyavkin over 30 years ago and is accredited by the European Medical Association (EMA.) The incredibly effective treatment targets CP patients and those with other consequences of trauma and organic lesions of the nervous system.

Najat was not the only success story for the Kozyavkin program in the UAE, but she also reminds us of her parents' dedication to helping their child and presenting her with real hope. "I might have enrolled my daughter a bit late after a year and 3 or 4 months, but, thank God, my daughter has

undergone the 'Kozyavkin Method.' The program has resulted in her being able to walk after a year and eight months." said Najat's Father.

The Kozyavkin method works as a multi-system program that rehabilitates nerve function in two phases – the intensive rehabilitation process and the consolidation phase. The active cycle takes place in the rehabilitation center and usually lasts from 15-21 days. Following this phase, the child returns to their usual routine while adhering to a daily home exercise program as guided by our specialized clinicians.

The intensive active cycles of therapy combine physical therapy with mental therapy and include restoring spinal and peripheral joint range of movement, enhancing muscle strength, coordination, and control, and reducing spasticity and increasing tone through movement. The program also involves Massage, Trigger Point Therapy, Joint Mobilization, Group Rhythmic Exercises, and even Rehabilitation Computer Games. Highly skilled physicians spearhead all sessions, physiotherapists, and massage professionals - each specifically trained and certified to perform the treatment.

Retrospective analysis of 12,256 patients who completed the program over 12 years has resulted in 47% of patients maintaining function between cycles and 45% of patients rapidly developing enhanced gross motor functions.

https://www.prnewswire.com/news-releases/a-success-story-for-the-kozyavkin-program-for-cerebral-palsy-at-cambridge-medical--rehabilitation-center-301607659.html

Questions

1. Maternal age older than ___ is a preconception risk factor for Cerebral Palsy…?
   (a) 20 yrs (b) 30 yrs (c) 35 yrs (d) 40 yrs
2. Hypertonia in CP is further subdivided into spastic, dystonic & _____ hypertonia..?
   (a) Athetoid (b) Choreifrom (c) Rigid (d) Myoclonic
3. With the infant supine, placing the index finger in the palm of the infant causes flexion of the fingers & fist making. The primitive reflex discussed in the question is..?
   (a) Pincer (b) Palmar grasp (c) Rossolimo (d) Galant
4. In the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) model, bio-psycho-social function is broken down into _____ categories..?
   (a) Five (b) Six (c) Eight (d) Twelve
5. The MACS level of a child who does not handle objects with severely limited ability to perform even simple actions is..?
   (a) IV (b) VI (c) V (d) III
6. According to Molnar et al., not being able to sit independently by __ yrs of age is a negative predictor of ambulation potential in Cerebral Palsy..?
   (a) 2 (b) 4 (c) 6 (d) 8
7. Weaning of seizure medications depends on the severity of the seizures and a time period of usually __ years elapsing during which the child has been seizure free..?
   (a) 2 (b) 3 (c) 4 (d) 5
8. _____ is a low-intensity, subthreshold electrical stimulus that has been theorized to increase blood flow and stimulate muscle growth when applied during sleep to take advantage of heightened trophic hormone secretion.
   (a) FES (b) NMES (c) TMS (d) TES
9. The Intrathecal Baclofen pump requires replacement every ____ years due to battery life.
   (a) 2 to 3 (b) 3 to 4 (c) 5 to 7 (d) 8 to 9
10. In Selective Dorsal Rhizotomy (SDR) the surgical technique involves single or multilevel laminectomies exposing the ____ nerve roots and selectively cutting a percentage of the dorsal rootlets with abnormal response with the aid of electrophysiologic monitoring.
    (a) C5 to T1 (b) L2 to S2 (c) T1 to T5 (d) T6 to T12

Reflexes…

Parachute & Land ow!!(Landau) Reflexes!!!

Developmental reflexes are very important in the assessment & rehabilitation of Cerebral Palsy…

Concept by Dr. Bineesh Balakrishnan

Art by Mr. Kalyan Kumar

Key

1. (d)
   Preconception: maternal seizures, intellectual disability, thyroid disease (hyper and hypo), history of stillbirth or neonatal death, maternal age older than 40 years, and low socioeconomic status.
   Antenatal: birth defects, small for gestational age, low birth weight, placental abnormalities, maternal disease during pregnancy (respiratory, heart, seizures, and incompetent cervix), abnormalities in fluid volume, maternal bleeding in the second and third trimesters, hypertension, preeclampsia, and chorioamnionitis.
   Intrapartum: birth hypoxia, meconium staining, meconium aspiration, abnormal duration of labor, and fetal presentation.
   Neonatal: seizures, respiratory distress, hypoglycemia, infections, and jaundice.
   Postnatal: stroke, abusive head trauma, bacterial meningitis, and motor vehicle crashes.
2. (c)
   The diagnosis can be further classified by the motor sign. Over the past 10 years, definitions for these motor signs have been detailed to provide reliable, valid terminology. Positive motor signs are defined as involuntary increases in frequency or magnitude of muscle activity. They include hypertonia ("examiner induced abnormally increased resistance to movement about a joint") and hyperkinesia ("unwanted, excess movement by the child"). Hypertonia is further subdivided into spastic, dystonic, and rigid hypertonia. Hyperkinetic movements are divided into dystonia, chorea, athetosis, myoclonus, tremor, tics, and stereotypies. Although positive motor signs are more recognizable, negative motor signs are described as "lack of muscle activity or control" and encompass weakness, reduced selective motor control, ataxia, and apraxia.
3. (b)

   The Palmar grasp reflex disappears by around 6 months.

4. (a)
   In this model, bio-psycho-social function is broken down into five categories: body function (b), body structure (s), activity and participation (d), environmental factors (e), and personal factors. Each domain has multiple levels associated with it.
5. (c)
   I- Handles objects easily and successfully
   II- Handles most objects but with somewhat reduced quality and/or speed of achievement.
   III- Handles objects with difficulty; needs help to prepare and/or modify activities
   IV- Handles a limited selection of easily managed objects in adapted situations
   V- Does not handle objects with severely limited ability to perform even simple actions

   CFCS (Communication Function Classification System)

   I- Sends and receives information with familiar and unfamiliar partners effectively and efficiently.
   II- Sends and receives information with familiar and unfamiliar partners but may need extra time.

III- Sends and receives information with familiar partners effectively, but not with unfamiliar partners.
IV- Inconsistently sends and/or receives information even with familiar partners.
V- Seldom effectively sends and receives information even with familiar partners.

6. (b)
Molnar's work in the 1970s laid the foundation for the future development of motor curves based on developmental milestone achievement, demonstrating that an individual being able to sit independently by the age of 2 years or having less than three primitive reflexes present by 18 to 24 months were positive predictors of ambulation, while not sitting independently by 4 years was a negative predictor. Their later work demonstrated that more than 50% of all children with CP will ambulate and further divided this by topographical classification (80% to 90% diplegia, 50% quadriplegia, 75% dyskinesia).

Rosenbaum published motor development curves based on an individual's GMFCS level in 2002 to support the prediction of longitudinal gross motor function of children. These curves, which were subsequently validated, had a large part in modifying the understanding of CP from a disease of childhood to a chronic disease. More recently, research has supported the understanding that children with GMFCS levels I and V tend to remain at these levels, whereas children with GMFCS levels II, III, and IV tend to need reclassification over time.

Most recently, the SCPE has been working to develop development curves for self-care capabilities, social participation, and health-related quality of life.

7. (a)
The CP population as a whole is at an increased risk for seizures (~30%). Seizures occur most frequently in children with a quadriparetic or hemiparetic clinical presentation. Medication use for epilepsy management may be associated with cognitive dulling or other side effects such as anorexia. Some children have hyperkinetic movement disorders that mimic seizure activity and may require prolonged video electroencephalogram (EEG) monitoring to delineate between the two conditions.

8. (d)
Neuromuscular electrical stimulation (NMES) is the application of an electrical current of sufficient intensity to elicit muscle contraction. When applied during a functional activity, it is referred to as functional electrical stimulation (FES). In contrast, threshold electrical stimulation (TES) is a low-intensity, subthreshold electrical stimulus that has been theorized to increase blood flow and stimulate muscle growth when applied during sleep to take advantage of heightened trophic hormone secretion. Evidence to support use of these modalities in children with CP is limited; however, there is more evidence to support NMES and FES than TES.

9. (c)
ITB is most often used to treat children with generalized spasticity or generalized moderate to severe dystonia. It is an FDAapproved method to treat spasticity of cerebral or spinal origin. Currently, indications for the use of ITB therapy include tone that is thought to interfere with function or the ability to provide care; modified Ashworth scores of greater than 3; and definable goals for spasticity reduction.

ITB is delivered through a programable pump placed subfascially in the abdominal wall and connected to a catheter that is tunneled from the side of the pump and inserted in the intrathecal space at a desired spinal level. This method allows the delivery of smaller doses of baclofen (micrograms) intrathecally, thus reducing the side effect profile seen with the oral form of baclofen (milligrams). The dose can be titrated to a desired therapeutic response. A screening lumbar bolus dose of baclofen can be used to evaluate medication responsiveness. The pump requires replacement every 5 to 7 years due to battery life.

Potential complications of ITB include infections, cerebrospinal fluid leaks, and catheter problems such as disconnection, migration, or kinking. Abrupt withdrawal is a medical emergency and may present as increased tone, spasms, diaphoresis, agitation, and pruritus. If untreated, it can progress to rhabdomyolysis and multisystem failure. Treatment includes high doses of oral baclofen, the use of benzodiazepines, and cyproheptadine. The latter alleviates the pruritus related to ITB withdrawal. ITB through a lumbar drain can also be used in treatment of severe withdrawal. Urinary retention can be seen acutely, whereas constipation and weight gain tend to be more chronic complications.

10. (b)

SDR is a surgical procedure used as a treatment for spasticity. The surgical technique involves single or multilevel laminectomies exposing the L2–S2 nerve roots and selectively cutting a percentage of the dorsal rootlets with abnormal response with the aid of electrophysiologic monitoring. The ideal candidate for an SDR is a child between the ages of 3 and 8 years of age with spastic diplegic CP, typically GMFCS levels I-III, little upper limb involvement, sufficient underlying strength, good selective motor control, and minimal contractures. Positive preoperative functional predictors for a good SDR outcome include the ability to rise from a squatted position with minimal support and a younger child's ability to crawl on hands and knees or tall kneel.

Questions

1. There are basically four major types of orthopedic surgeries in CP: muscle release and lengthening, tendon transfer, osteotomy, and _____?
   (a) Arthrodesis (b) Arthroplasty (c) Meniscectomy (d) Meniscoplasty
2. Power mobility can be pursued in children as young as ___ months old if they have fair motor control, no visual deficits, and good cognition.
   (a) 12 (b) 14 (c) 16 (d) 18
3. Ankle-foot orthoses have been demonstrated to decrease the energy cost of walking in children with CP, compared with barefoot walking, and to improve gait parameters of ____ and velocity.
   (a) Base of support (b) Arm swing (c) Stride length (d) Foot Progression Angle
4. Burke-Fahn-Marsden scale is used to assess _____ ?
   (a) Spasticity (b) Dystonia (c) Mobility (d) Feeding
5. Children with a migration percentage greater than 33%, or an acetabular index more than ___ degrees, are likely to need further treatment.
   (a) 10 (b) 15 (c) 20 (d) 30
6. Observation is warranted for flexible curves less than ___ degrees that do not compromise sitting balance.
   (a) 40 (b) 50 (c) 60 (d) 65
7. Mean half-life of oral Baclofen is ____?
   (a) 1.5 (b) 3.5 (c) 5.5 (d) 6.5
8. Maximum recommended daily dose of Tizanidine is ____ ?
   (a) 12mg (b) 24mg (c) 36mg (d) 48mg
9. The Neurodevelopmental treatment approach used in Cerebral Palsy is also called _____?
   (a) Doman-Delacato (b) Ayres (c) Rood (d) Bobaths
10. In the Sensory integration approach, the Primary sensory systems used to effect a motor response include all except..?
    (a) Kinesthetic (b) Proprioceptive (c) Tactile (d) Vestibular

Book Review….

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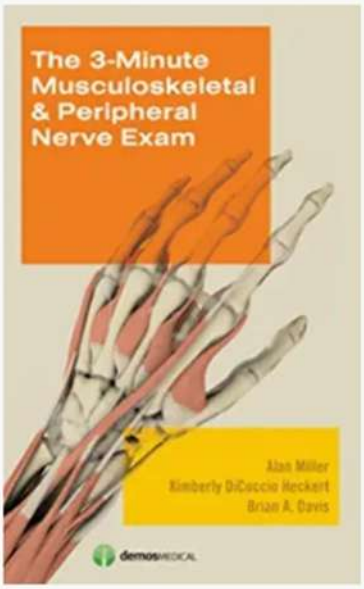
The 3 minute Musculoskeletal and peripheral nerve exam is the book I had the pleasure of reviewing. This is probably the best book on clinical examination tests I have ever read. The book has pictures to demonstrate techniques and easy to understand instructions. Clear, concise and well layed out. A great book for revision for clinicians & a must have for medical students.



The 3-Minute Musculoskeletal & Peripheral Nerve Exam

by Alan Miller MD | 13 August 2008 | 1st Edition

★★★★½ 53

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Key

1. (a)
   The timing of surgical intervention is determined by CNS maturation, ambulation potential, and the rate at which the deformity is developing. Graham has suggested delaying any orthopedic surgical intervention until ages 7 to 9 years due to a high risk of recurrence, unless there is evidence of hip subluxation. Prior to this age the focus should be therapies along with tone management.
   It is important to remember that orthopedic surgery in and of itself has no effect on motor control, strength, or muscle tone. The brief reduction in hypertonia is the direct result of the temporary decrease in muscle tension that involves the Golgi tendon apparatus and the muscle spindle. It is therefore of great importance to use a comprehensive team that addresses tone management presurgery and postsurgery.
2. (d)
   The goal in prescribing durable medical equipment (DME) for individuals with CP should focus on maximizing function, improving safety, and enabling independence using the ICF-CY model of health. Motor impairment is one of the top reasons for a mobility device in CP because exploration of the environment is imperative for cognitive development that leads to maximizing functional independence.
   Supportive or adaptive seating systems and standing frames can facilitate a developmentally appropriate upright posture, strengthening, flexibility across the lower extremities, weight bearing/bone density, upper limb function, communication, feeding by freeing the child's hands to perform bimanual tasks, improving breath support, and optimizing the head and trunk position to facilitate a safe swallow. Specialized seating devices are available for sitting on the floor, sitting on the toilet, feeding, and bathing, as well as for incorporation in a mobility device.
   Use of a wheelchair becomes applicable when a child either outgrows commercially available strollers or additional support is necessary. The goal of supportive seating is to provide an upright seated posture to facilitate interaction with the environment and minimize deforming forces secondary to postural abnormalities.
3. (c)
   Splinting and orthoses are commonly used in CP to manage spastic and flexible dynamic deformities of the extremities. There are a variety of passive and dynamic splints. Orthoses must be tailored to the child's age, deformity, motor control, and tolerance. With lower limb orthoses, the clinician should clearly identify the gait deviation and goals to be addressed, with special consideration of ankle-foot alignment, ROM, and tone. Ankle-foot orthoses have been demonstrated to decrease the energy cost of walking in children with CP, compared with barefoot walking, and to improve gait parameters of stride length and velocity.
4. (b)
5. (d)
   A systematic review by Gordon and Simkiss concluded that monitoring the acetabular index and migration percentage are the most effective parameters to determine timing of surgical intervention. A progression of the migration percentage by more than 7% per annum requires careful monitoring.
6. (a)

The reported incidence of scoliosis in CP has been estimated as 21% to 76%. The scoliotic severity directly correlates with the degree of the total body involvement and inversely correlates with functional and ambulatory status and GMFCS level. Scoliotic curves have been characterized and divided into two groups:-
Group 1: Curves are single thoracic or double thoracic and lumbar curves with level pelvis. This type of curve is typically associated with ambulatory patients (GMFCS levels II-II).
Group 2: Curves are long thoracolumbar or C-shape curves with associated pelvic obliquity, typically associated with nonambulatory patients.

The natural history of curve progression has shown that the onset occurs from 3 to 10 years of age with rapid progression during the adolescent growth spurt. Bracing traditionally has a very limited role in decreasing curve progression. A physical examination should be performed every 6 to 12 months and a radiograph obtained if a curve is detected. Standardizing the position of the child when follow-up radiographs are obtained will help to minimize errors in measurement of progression. Observation is warranted for flexible curves less than 40 degrees that do not compromise sitting balance. In most cases of scoliosis in CP, spinal instrumentation and fusion is considered due to significant curve progression, loss of sitting balance, and comfortable function. Ideally this can be delayed in children with flexible deformities until they approach skeletal maturity. It is important to note that surgical complications are high; therefore goal setting, patient selection, and preoperative preparation are of utmost importance.

7. (b)
Mechanism of action:- Binds to receptors (GABA) in the spinal cord to inhibit reflexes that lead to increased tone Also binds to receptors in the brain leading to sedation.

Pharmacology & dosing:- Rapidly absorbed after oral dosing, mean half-life of 3.5 hours Excreted mainly through the kidney Dose administration in children: start at 2.5–5 mg/day, increase to 30 mg/day (in children 2–7 years old) or 60 mg/day (in children 8 years and older)

Side effects & precautions:- Sedation, confusion, nausea, dizziness, muscle weakness, hypotonia, ataxia, and paresthesias Can cause loss of seizure control Withdrawal can produce seizures, rebound hypertonia, fever, and death.

8. (c)
Mechanism of action:- α2 -Agonist Acts in both the brain and spinal cord to enhance presynaptic inhibition of reflexes that lead to increased tone.

Pharmacology & dosing:- Well absorbed after oral dosing, half-life is 2.5 hours. Extensive first-pass metabolism in liver. Start with 2 mg at bedtime and increase until side effects limit tolerance. Maximum is 36 mg/day.

Side effects & precautions:- Dry mouth, sedation, dizziness, visual hallucinations, elevated liver enzymes, insomnia, and muscle weakness.

9. (d)

It is also called the Ayres approach.

Goals of treatment:-

- To normalize tone
- To inhibit primitive reflexes
- To facilitate automatic reactions and normal movement patterns

Primary sensory systems used to effect a motor response:-

- Kinesthetic
- Proprioceptive
- Tactile

Emphasis of treatment activities:-

- Positioning and handling to normalize sensory input
- Facilitation of active movement

Intended clinical population:-

- Children with cerebral palsy
- Adults post cerebrovascular accident (CVA)

This model emphasizes the treatment of infants.

It also emphasizes family involvement during treatment. Handling and positioning for activities of daily living.

10. (b)

Goals of treatment:-

- To improve efficiency of neural processing
- To better organize adaptive responses

Primary sensory systems used to effect a motor response:-

- Vestibular
- Tactile
- Kinesthetic

Emphasis of treatment activities:-

- Therapist guides but child controls sensory input to get adaptive purposeful response.

Intended clinical population:-

- Children with learning disabilities
- Children with autism

This model does not emphasize treatment of infants. It does not emphasize family involvement during treatment. Supportive role is encouraged.