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Physical Management of Children with Cerebral Palsy

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1. Introduction

Cerebral palsy (CP) refers to a group of permanent disorders of the development of movement and posture, causing activity limitations, which are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. Damage to the central nervous system cause disorders in neuromuscular, musculoskeletal and sensorial systems. These disorders result in posture and movement deficiencies. The causes of motor disorders are developmental retardation, abnormal muscle tone, muscle weakness, postural control deficiencies, sensorial problems, behavioral problems, orthopedic problems, abnormal movement patterns and reflex, activity, asymmetry and deformities. Within the scope of the assessment to be performed in terms of motor, besides the changes in the muscle tone, co-contraction capacities of the muscles, involuntary extremity and body movements, stabilization of the extremities, correction, balance and protective reactions, sitting balance, upper extremity and hand functions and sensory-perception problems; orthotics, need of mobilization tools and other aid tools, cooperation of the family and their knowledge on the disease also needs to be assessed. Modern therapy methods in CP rehabilitation aim to develop the maximum functionality and independence possible for the child by using the present neuromotor potential. The dynamic motor control approach based on changing the motor patterns and configuration of the tasks rather than the hierarchical modeling of the neurological motor development is used for rehabilitation.

2. Cerebral palsy

2.1. Definition

Cerebral palsy (CP) was first described by William Little in 1862 and initially was called Little's disease. It was described as a disorder that appeared to strike children in the first year of life, affected developmental skill progression, and did not improve over time. Little related the disorder as a lack of oxygen at the birth. After that, Sigmund Freud suggested that CP might be rooted in the brain's development in the womb and related aberrant development to factors influencing the developing fetus (Accardo, 1982). Asphyxia at the birth was thought to be the cause of CP until the 1980s, but today researches have shown that this etiology to be less likely and only one of many with potential to result in CP (Nelson & Ellenberg 1986, Moster et al., 2001). Recently, the most widely accepted consensus definition utilized for both clinical and research purposes is the one put forward by Rosenbaum et al, "cerebral palsy describes a group of permanent disorders of movement and posture, causing activity limitations, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. Beside the motor impairments, sensation, perception, cognition, communication, behavior, epilepsy and musculo-skeletal problems are also accompany to cerebral palsy" (Rosenbaum et al., 2007).

2.2. Incidence and etiology

Although, the exact prevalence of CP is variable and depends on definitions and case ascertainment, today, studies has shown that, CP prevalence is around 2 per 1000 live births in both developed and developing countries (even very different reasons). Conversely to perinatal mortality, the birth prevalence of CP has not declined since the 1950s, The proportion of children with CP that are born very preterm has increased with the advent of neonatal intensive care and improvements of neonatal intensive care may be necessary before its benefits can be fully realized (Blair & Stanley, 1997). CP prevalence is 1 per 1000 live births, for term children The prevalence of CP decreases significantly with increasing gestational age category: 14.6% at 22–27 weeks' gestation, 6.2% at 28–31 weeks, 0.7% at 32–36 weeks, and 0.1% in term infants. The type of CP is also changed by gestational age; in preterm infants, spastic CP is predominant and in term infants, the nonspastic form of CP is more prevalent than in preterm infants (Cans et al., 2000). For moderately preterm children (32–36 weeks' gestation) estimates are 6–10 times higher and for very preterm children (less than 32 weeks' gestation) prevalence is 10 times higher than in moderately preterm children. The birth weight changes the CP prevalence and it the highest in children weighing 1000 to 1499g (59.18 per 1000 live births), and the lowest in children weighing over 2500g (1.33 per 1000 live births). CP rates for live births show a lower prevalence for babies of birth weight less than 1000g than for those with a birth weight of 1000–1499g. Because the high numbers of babies do not live long enough to develop CP, it disappears when estimating prevalence for neonatal survivors (Cans et al., 2000). Changes in perinatal and neonatal mortality accelerated in from the 1960s, with a huge decrease up until the late 1980s, when there was an increase in the absolute number of children with CP. From

1990 there has been a plateauing of mortality rates but a downward trend in CP rate mainly in moderate and very low birth weight children (Cans et al., 2000).

There are a lot of conditions or risk factors associated with CP can be broken down into those occurring in the prenatal, perinatal or postnatal time periods. CP may result from one or more etiologies and can occur at any stage from before conception to infancy, with the actual cause difficult to determine in all cases (Taft, 1999, Rosembaum, 2003, Jones et al., 2007). Currently, problems occurring during intrauterine development, congenital disorders, asphyxia occurring in any gestational age and preterm birth are thought to account for the majority of cases (Naeye, et al., 1989, Moster et al., 2001). Neuroimaging studies support the current thought that prenatal causes of CP, like brain malformations intrauterine vascular malformations, and Infection are more common than birth asphyxia (Truwit et al., 1992). Although intrapartum asphyxia originally was thought to be a major contributor to CP, it accounts for only 10% to 20% of cases (Nelson & Ellenberg, 1986). The most frequent perinatal/neonatal etiologies in low-birth-weight infants are periventricular leukomalacia, periventricular hemorrhage and cerebral infarction, but in infants of normal birth weight, the most often reason is hypoxic-ischemic encephalopathy. Postnatal causes are generally result in spastic CP and represent only about 10% to 18% of cases (Pharoah et al., 1989). More than 30% of children, there are no risk factors or known etiology (Taft, 1999, Rosembaum, 2003). The 30-year survival rate is approximately 87% (Glader & Tilton. 2009).

Risk Factors Associated With Cerebral Palsy		
Prenatal	**Perinatal**	**Postnatal**
Hypoxia		
Intrauterine infections		
Consanguinity		Asphyxia
Iodine deficiency		Infantil spasms
Genetic influences	Asphyxia	Hyperbilirubinemia
Metabolic disorders	Premature birth<32 weeks	Cerebral Infarction
Plecental malformations	Low birth weight	Exposure toxins
Feotal malformation syndormes	Abnormal fetal presentation	Pulmonary problems
Toxicity	Instrument delivery	Meningitis
Multipl pregnancy	Blood incompatibility	Intraventricular hemorrhage
Intrauterin growth restriction	Infection	Neoplasmas
Thrombophilic disorders	Plecental abruption	Head trauma
Periventricular leukomalacia		Cerebral infection
Vascular accidents		
Abdominal trauma		

Table 1. Data from: Nelson & Ellenberg, 1986, Naeye et al., 1989; Nelson, 1989, Kuban & Leviton, 1994, Han, et al., 2002, Gibson et al., 2003; Jones et al., 2007, Pountney 2007.

2.3. Classification

Classification of CP is based on pathology, etiology or clinical description. Because pathology and etiology are unclear in so many cases, universal classification is currently possible only for clinical description, but reliability is elusive, partly since the term covers such a variety of clinical presentations. Classifications could include different types, distribution and severity of motor impairments and associated impairments. Because the characteristics of each factor vary widely, the combination of characteristics found in a person with CP may often be unique. Classification systems but what is important is subjective and depend on the purpose of classification (Blair, 1997). The most of the classification systems have poor reliability, since that they use terminology which is understood differently by clinicians trained in different disciplines. Using simple and everyday language and avoiding from technical terms or even pictorial representations are more beneficial to understand the classification. An early attempt to avoid technical language was followed by one that sought only to decrease reliance on it and is the subject's development (Evans, 1989, Blair, 1997, SCPE Collaborative Group, 2000).

One method to classify CP, divides CP into two major physiologic classifications, as pyramidal (spastic) and extra pyramidal (nonspastic) which are indicating the area of the brain lesion resulting predominant motor disorder. Results from defects or damage occurring in the brain's corticospinal pathways, also described as upper motor neuron damage. Spastic CP accounts for nearly 70% to 80% of all cases of CP. In pyramidal/spastic CP cognitive impairments seen in approximately 30% (Taft, 1995, Jones, 2007). Increased muscle tone is the predominant feature and hyperreflexia, clonus, extensor Babinski response, and persistent primitive reflexes are commonly accompany. Extrapyramidal (nonspastic) CP is caused by damage to outside of the pyramidal tracts in the basal ganglia or the cerebellum. It could divide into two subtypes, dyskinetic and ataxic (Jones, 2007). Dyskinetic and ataxic forms account for 15% to 20% of all cases of CP, with dyskinetic accounting for 10% to 15% and ataxic nearly 5% (Taft, 1995; Sanger, et al., 2003, Jones, 2007). These forms result with disabilities with abnormal tone regulation, postural control and coordination (Dormans & Pelligrino, 1998).

An another method is to describe the predominant motor characteristics, which include spastic, hypotonic, dyskinetic and ataxic, as well as the topographical pattern of limb involvement, such as monoplegia, diplegia, triplegia, hemiplegia or quadriplegia (Bobath, 1980, Jones, 2007, Pountney, 2007).

2.3.1. Spastic CP

The spastic child shows hypertonus of a permanent character, even at rest. The level of spasticity varies with the child's general condition, that is, child's excitability and strength of stimulation to which child is forced at any moment. If the degree of spasticity is high, the child will fix in a few typical patterns due to the severe level of co-contraction of the involved parts, especially around the proximal joints like shoulders and hips. As a result of tonic respirocal inhibition, some of the muscles may appear weak by their spastic antagonists: for example, the quadriceps by spastic hamstring and the dorsiflexors of the ankles by spastic triceps surae. But the real weakness may develop in some muscle groups because of disuse in case of long standing or prolonged immobilization. Sapasticity is of typical distribution and changes at first

in a predictable manner, owing to tonic reflex activity. Movements are restricted in range and require huge effort (Bobath, 1980).

2.3.2. Dyskinetic CP

The term of dystonic is now generally preferred to athetiod CP. Dystonic CP has few signs in the early months of life except possibly some variations of muscle tone, but abnormal postures and movements begin to occur in the second half of the first year. There are involuntary movements around the mouth and of the arms and legs and these become particularly prominent when attempting fine or gross motor movements. There are varied patterns of the abnormal movements and swallowing difficulties are common. Many of the children make grimacing movements of their face, which are often associated with attempted movements in other part of the body (Scrutton, 2004). Because both have dystonic phase, it may be difficult to distinguish between the child who is later going to be dystonic and child with cerebral diplegia early on in first year of life. In dyskinetic child the fluctuating tone persists, and tendon reflexes tend to be normal and may be increased in the lower extremities. The child has abnormal postures with increased tone depending on position in space, relation of head to body, contact with a surface or stimulation of the oral region. Initiating activity itself is clumsy and uncoordinated and involuntary movements may make effective voluntary activity difficult. In this type of CP bulbar problems are common, swallowing difficulties are frequent and may affect nutrition. Additionally, drooling may be important problem. Speech is usually impaired with dysarthria because of involment of the muscles (Scrutton, 2004).

Chorea: Sudden, quick, aimless, dancing movements of the head, neck and extremities. *Athetosis:* Involuntary, slow and snake-like movements. The plane, direction and timing of movements of the proximal articulars have mostly been defected. Chorea and athetosis sometimes occur at once, this is called choreoathetosis.

Ballismus: Involuntary thrusts like explosions. It is rare.

Tremor: Involuntary, rhythmic reciprocal, movements that occur due to the contraction of agonists and antagonists. These movements are generally more prominent in small articulars and extremity distal. It is rarely seen alone and is frequently accompanied by athetosis or ataxia.

Rigidity: Increase of tonus that includes both gravity and antigravity muscles (lead pipe and cogwheel indication).

Dystonia: Movements that are mostly characterized by constant muscle contractions in the trunk, neck and extremity proximal, causes contortions, repetitive movements or abnormal posture.

Diskinetic movements may occur in different ways. As it can occur as *intermittent spasms* characterised by increase in the flexor or extensor tonus due to tonic labyrinth and reflexes that affect the neck, it can also occur as *mobile spasms* that include the alternative flexion of extremities, extension, pronation and supination. Exaggerated movements, called *momentary localized contractions*, may occur with the muscle or muscle groups of anywhere in the body

also being affected. Facial grimacing, exaggerated and asymmetric activation of the mimic muscles, rotating, bending movements of the hand and fingers, etc (Kerem Gunel, 2011).

2.3.3. Ataxia CP

The child does not have involuntary movements; however volitional movements are affected usually all over the body. In classical neurology there is an unstable, gait with wide based of support and often gross tremor in the arms and hands. The infant with ataxic CP presents as a low toned baby with tonic paresis, the opposite to spasticity. There are increased ranges of movement at all joints and postural development is delayed, as is walking. Physiological ataxia is prolonged, and speech is usually slow and of developmental patterns rather the dysarthria of acquired ataxias. Hand skills are disrupted in regulating speed, distance and power, and since the cerebellum is involved in motor learning the child may appear dysraxic (Bobath, 1980, Scrutton, 2004).

2.3.4. Hypotonic CP

Hypotonic CP often is included in classifications of CP because of the resulting motor delays observed. This form also is referred to as central hypotonia. To classify hypotonia as CP, myopathy or neuropathy must be excluded as potential causes. These infants are low toned, exhibit a marked reduce in overall muscle tone and will have significant delays in motor milestones. Hypotonic CP has persistent primitive reflex patterns and hyperreflexia, so it distinguishes from lower motor neuron problems which causes of hypotonia (Taft, 1999, Jones, 2007).

It is possible to see different combinations of forms of CP depending on the area of brain lesion; this can be confusing to parents when different professionals call their child's CP "mixed". However, when the types overlap on each other, it can be difficult to classify definitely the resulting disability within the typical subtypes (Kuban& Leviton, 1994, Taft, 1999, Jones, 2007)

Another classification is done according to the extremities that are affected.

Diplegia is defined as involvement of the whole body; the lower half but, is more affected then the upper half. Head control and control of the upper limbs are usually little affected and speech is nearly normal (Bobath, 1980). The child with classical diplegic CP has slightly flexed and internally rotated hips and femoral anteversion, semi-flexed knees, extended planter flexed ankles and depending on the extent of involvement and effectiveness of management, some fixed contractures potentially at all hip, knee and ankle joints. Additionally, there are some associated posturing in the upper extemities like internally rotated shoulders, flexed elbows, wrist and fingers and adducted/opposed thumbs. This pattern is often seen after 2 years of age and may be completely apparent after 3 or 4 years. Commonly, before the age of year, there will be dystonic phase when the child will have accompanying hypertonia and diagnosis of CP may be quite difficult (Scrutton, 2004). When the child gets older, usually toward the end of the first year and during the second year, spasticity becomes more clear. The most of these groups of children walk independently and these deformities develop as a result of the crouch gait which seen in many of spastic diplegic children because of spasticity in the hip adductors and flexors, hamstring and calf muscles. To compensate for tight tendo

Achilles, children in this group may develop hyperextension of the knee and kyphosis may develop as a sequel to tight hamstring or hyperlordosis as a compensatory balance mechanism (Pountney, 2007).

Quadriplegia is also defined as involment of the whole body, however upper parts being more involved than, or at least as equally involved as, the lower parts. Spasticity dominates in all four extremities. The children develop very minimal functional movements and they are at great risk of contractures and deformities. Distribution is usually asymmetrical. Due to the greater involvement of the upper body, head control and eye coordination poor. In general, children with quadriplegic distribution have severe CP, frequently associated with seizure and severe cognitive impairment. These children usually have feeding problems, and some involvement of speech and articulation (Bobath, 1980). If their care is not good, they have tendency to develop both scoliotic and kyptotic problems in adult life. Beside these deformities, may develop dislocation of their hip joints and spinal curvature. The subluxation or dislocation of hip joint may cause significant morbidity in terms of pain and difficulty with postural control, creating limitations in sitting, standing and walking, and personal care problems which include hygiene (Bobath, 1980, Scrutton, 2004, Pountney, 2007). Children who do not walk independently, approximately 60% of this group will have hip dislocation by age 5 years (Scrutton & Baird, 1997, Scrutton et al., 2001). It is recognized that dislocation continues to occur well into adolescence offered a protocol for the surveillance of hips in young children, which recommends a baseline X ray at 30 months to determine risk (Scrutton & Baird, 1997, Miller & Bagg, 1992). The association between hip dislocation and spinal curvature is well known and children with a windswept deformity of the hip are subluxated or present as a precursor to spinal curvature. Spinal curvature occurs in up to 70% of children with bilateral cerebral palsy but it is most prevalent in those with quadriplegia. As a result of weakness of sitting stability, pain, pressure and respiration problems will occur. Scolisis is the most common curve seen; however kyphosis and hyperlordosis are also common. In many of spinal curves, rotatory elements are present and combinations of curve a and combinations of curve patterns, such as kypho-scoliosis, are present. Spinal problems explained above can occur from very young age and continue to progress well into adulthood, with individuals with the spastic form of CP at greatest risk (Lonstein, 1995, Satio et al, 1998 Pountney, 2007).

Hemiplegia is involment of upper and lower extremity on one side (Bobath, 1980). The upper limb appears to be much more involved than the lower limb, although this is partly because the less affected proximal part of body makes walking look relatively 'normal'. The lack of fine movements of the hand are very pronounced, but fine movements of the toes are equally impaired. The typical postures are similar to diplegia but affect only half the body. Bony undergrowth of the affected extremity, when present, occurs in the first two years of life and if not well managed may play a part in the development of a contracture of the tendo Achilles. What is so apparent in a unilateral disorder points to the fact that many diplegic children will have some bony undergrowth in both extremities. Although their onset of walking may be delayed, nearly all hemiplegic children walk, but they often experience underdevelopment of the affected side, which results in smaller extremities and can result shortening in the leg (Scrutton, 2004). Equines of the foot and ankle, flexion of the elbow, wrist and fingers and adducted thumb are classical deformities of the hemiplegic child. For hemiplegic children, one hand functions well, however the other has some degree of dysfunction (Uvebrant, 1988,

Scrutton, 2000). Impairment of the upper extremity results with complications in almost all forms of human activity like self-care, school or work, and engagement in play or daily life activities (Exner, 2001, Sköld et al., 2004). The hemiplegic hand can be described as slow and weak, with uncoordinated movements, incomplete finger fractionation, spasticity and commonly, impaired tactile sensibility (Uvebrant 1988, Brown & Walsh 2000, Krumlinde-Sundholm & Eliasson, 2002) additionally, Impairments in fingertip force control and timing during object manipulation and inadvertent mirror movements are also described (Gordon et al., 1999, Kuhtz-Buschbeck et al., 2000).

Recently, the clinical type of CP of children with CP is classified based on the most frequent neurologic indications. SCPE's (Surveillance CP Europe) classification system is progressing on creating an international language. The system adopted by SCPE provides a decision flow chart to aid classification into neurological and topographical categories including spastic (unilateral or bilateral), ataxic, dyskinetic (dystonic or choreoathetotic), or not classifiable. Despite careful planning of the system, there has been little work to demonstrate the validity and reliability of classification. The lack of any defined criteria for recording functional limitation in the SCPE definition was noted by lenksi et al (2001). Subsequently, SCPE, along with other research groups, demonstrated that the inclusion of a description of functional ability markedly improved the reliability of diagnosing children with CP. Consistent applica-tion of the diagnosis is of paramount importance when the prevalence of CP from different sources and places is being compared.

According to the record system that SCPE suggests, CP;

Spastic type CP is characterised by at least two:

- Abnormal posture and/or movement.

- Increased tonus (not required to be constant).

- Pathological reflexes (increase in reflexes: hyperreflexia and/or pyramidal indications, i.e. Babinski response).

Spastic CP can be bilateral or unilateral.

Spastic Bilateral CP is diagnosed if it includes extremities on both sides of the body.Spastic Unilateral CP is diagnosed if it includes extremities on one side of the body.

Ataxic type CP is characterised both of the below:

- Abnormal posture and/or movement.

- Loss of muscle control so that movements are performed with abnormal force, rhythm and accuracy

Both of the below are dominant in dyskinetic type of CP:

- Abnormal posture and/or movement.

- Involuntary, incontrollable, repetitive and sometimes stereotype movements.

Dyskinetic CP however, can by dystonic or choreo-athetoic:

- *Dystonic CP is active in both situations:*

- *Hypokinesis (decrease in activity, i.e. difficult movement).*

Hypertonia (tonus generally increased).Choreo-athetodic CP is active in both situations:

- *Hypokinesis (decrease in activity, i.e. severe movements).*

- *Hypertonia (tonus generally increased)* (Krägeloh-Mann, 2009, Garne, et al. 2008).

2.4. Commonly associated conditions

Because of the abnormal tone or movement associated with the disorder, nearly all children with CP have orthopedic concerns. These orthopedic concerns may be the extent of the effect of CP for some children. Many are at risk, but, for associated medical concerns as well. The most children with CP have at least one additional disability. For many children, the associated disabilities may be more significant from a functional or quality-of-life perspective than the neuromotor impairments that define the condition. It is important to be aware of potential associated disabilities and medical complications so that the child can be monitored in a proactive manner (Glader & Tilton, 2009).

2.4.1. Primary effects: Neurologic Sequel

From a neurologic view, some primary issues may arise as a result of the underlying injury causing the CP. Major manifestations include seizures disorders, intellectual and learning disabilities, neurobehavioral concerns, sensory impairment, and effects of bulbar palsy (Glader & Tilton, 2009).

2.4.1.1. Seizure disorders

The rate of epilepsy in children with cerebral palsy is, ranging from 15% to more than 60%, depending on the type of cerebral palsy and the origin of the series. In these children, epilepsy is an index of the severity of cerebral palsy. Associated disabilities like mental problems are much more common in patients with CP with epilepsy than in those without seizures. The presence of seizure seems to be a more predictive factor of mental development than the extent of the brain damage. Epilepsy associated with CP is difficult to control, although remission, even in the presence of brain damage, can occur. But, there is still controversy concerning the optimal seizure-free period needed before discontinuing antiepileptic drugs (Glader & Tilton, 2009).

2.4.1.2. Intellectual disability and learning disabilities

Nearly 65% of children with CP meet criteria for intellectual disability (Miller, 1998). There is a correlation between intellectual disability and the subtype of CP. Children with spastic quadriplegia have the highest tendency of having an intellectual disability, additionally there is some indication that the presence of epilepsy correlates more strongly with intellectual disability (Glader & Tilton, 2009).

Learning disabilities occur in children with CP, and seem to correlate with general cognitive function. There is a discussion about children with a right-sided hemiplegia have increased prevalence of language disorders based on a left-sided injury (Trauner et al., 1996). Additionally, low-birth-weight infants with CP have increased risk for educational impairments (Fennell & Dikel, 2001).

2.4.1.3. Neurobehavioral concerns

There are a lot of neurobehavioral concerns arise in children with CP. Typical problems include inattention, internalizing behavioral problems, immature adaptive skills, and undesirable behaviors. Consistent with the attention-deficit/hyperactivity disorder, inattention may be primarily neurologic. Neurobehavioral issues may indicate subclinical seizures, depression, discomfort, anxiety or fatigue. The interaction between a numerous of medical realities can result with these maladaptive behaviors such that they are of a secondary rather than primary etiology. This condition demands a different approach to treatment and knowledge of the potential associated medical concerns. It can be challenging to explain the etiology of neuro-behavioral symptoms in a child with CP, particularly if communication impairment exists. The diagnosis of neurobehavioral origin is generally one of exclusion, after other explanations, like discomfort and fatigue, have been excluded (Glader & Tilton, 2009).

2.4.1.4. Hearing impairment

Hearing loss occurs in 12% of children with CP in different degrees. Most commonly, hearing loss relates to a kernicterus, very low birth weight, meningitis, or it is very important to obtain a hearing evaluation in any child suspected to have CP (Carey 2009, Glader & Tilton, 2009).

2.4.1.5. Vision problems

More than 25% of children with CP have different kinds of visual problems, and some studies place the prevalence at closer to 40%. Children with a periventricular leukomalacia seem to be particularly tend to vision problems. The range of visual impairment encountered includes retinopathy of prematurity, nystagmus, amblyopia, refractive errors, optic nerve atrophy and cerebral visual impairment (Rudank et al., 2003). All children diagnosed with CP must be evaluated by an eye specialist. A functional vision or cerebral visual impairment assessment looks for the presence of visual field cuts and behaviors, like the use of peripheral vision and gaze preference. All of these can affect a child socially and academically in term participation (Glader & Tilton, 2009).

2.4.1.6. Gastrointestinal problems

Different gastrointestinal problems are present in a child with CP. Delay in growth and malnutrition are common (Sullivan et al, 2000) and the sequel of malnutrition are important to recognize. As a result of that, endurance or ability of a child can be affected. Postoperative wounds may cause Infection.

Decreased oral intake may reflect underlying gastrointestinal problems, especially conditions relating to lack of motility. The child with uncontrolled gastroesophageal reflux or constipation may feel uncomfortable. Treatment of these underlying disorders can have an important effect on nutrition. Caloric enhancement and work with a dietitian to optimize caloric intake can be central to helping a child to overcome the malnutrition. The most common reason for decreased oral intake is oromotor dysfunction. Oromotor problems can be exaggerated by challenges with overall tone and poor positioning. Treatments to gain oromotor control and safety include different modifications of food textures, feeding techniques and seating. A therapist specialize in feeding can play an important role for a child challenge with oral feeding. In more severe cases, oral feeding cannot be managed safely, and assessment for direct enteral feeds (e.g, placement of a gastrostomy tube) must occur (Glader & Tilton, 2009).

Many children with CP challenge with difficulties gaining weight; on the other hand, on occasion, obesity is a problem and when it occurs, the child faces increased challenges to overall motor activity and coordination (Carey 2009, Glader & Tilton, 2009).

2.4.1.7. Sleep problems

Sleep problems are common in children with CP. There are different etiologies, include, among others, primary obstructive sleep apnea; discomfort, which requires thorough evaluation for a wide range of medical issues; and a primary neurologic complication of sleep-wake cycle abnormality or even seizures (Glader & Tilton, 2009).

3. Motor assessment

CP refers to a group of permanent disorders of the development of movement and posture, causing activity limitations, which are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain (Bax et al., 2005). Damage to the central nervous system causes disorders in neuromuscular, musculoskeletal and sensorial systems (Butler et al., 1999). These disorders result in posture and movement deficiencies. The causes of motor disorders are developmental retardation, abnormal muscle tone, muscle weakness, postural control deficiencies, sensorial problems, behavioral problems, orthopedic problems, abnormal movement patterns and reflex, activity, asymmetry and deformities (Rosembaum et al., 2007). Modern therapy methods in CP rehabilitation aim to develop the maximum functionality and independence possible for the child by using the present neuromotor potential (Hamamci & Dursun, 1995). Evaluation is very important in understanding and efficiently treating motor function problems that are the major factor influencing functional independence in CP (Livanelioğlu & Kerem Günel, 2009).

In an assessment of a child with CP, whose physiotherapy and rehabilitation needs were determined, the physiotherapist should be search the functional status, active neurophysiologic and biomechanical mechanisms and accompanying problems effect the situation. The clinical type, severity of the disease, chronologic age, age of initiating physiotherapy, existence and severity of abnormal reflexes, cognitive problems appearing together, hearing disorders,

visual impairment, sensory-perception problems, general state of health and the socio-cultural and economic status of the family should be considered while deciding on suitable physiotherapy methods (Stranger & Oresic, 2003).

The actual question that needs to be answered within scope of the information obtained, as a result of the assessment, is what is important in the child's life. What needs to be provided is not only motor development abilities such as sitting, crawling, walking, muscle tonus regulation, balance and coordination training. The acquisitions shall be ensured to be able to be used in daily life (Bower & McLellan, 1992).

While clinical observation is one of the most important parts of the assessment, it completes standardized tests and contributes information which carries at least the same significance. By assessing the child, according to the parameters listed below, the physiotherapist shall present a general table of the child. The child must be calm and trust the physiotherapist during the observations conducted in terms of motor, sensory, cognitive, emotional and social/family. The parent or the guardian undertaking the care of the child shall be with the physiotherapist during the observation. The child must not be hungry, nor should be observed right after eating. The room where the observation will be done should be quiet, at an agreeable temperature and not contain unnecessary toys and equipment; if possible it should be a room covered with material that is appropriate for the child to move on the ground, with walls painted in warm colours and should not be too small. Firstly, what the child can do on his/her own should be observed while examining the functional movements, fine and gross motor skills during the observation (Mayston, 2008).

Within the scope of the assessment to be performed in terms of motor, besides the changes in the muscle tonus, co-contraction capacities of the muscles, involuntary extremity and body movements, stabilization of the extremities, correction, balance and protective reactions, sitting balance, upper extremity and hand functions and sensory-perception problems; orthotics, need of mobilization tools and other aid tools, cooperation of the family and their knowledge on the disease also needs to be assessed. The assessment of the motor function should be based on the normal process of a normal motor function development but it should also be sensitive towards special problems. For motor development reflex development, proper posture, sufficient extremity movements, appropriate muscle tonus, sensory development and cognitive functions within an integral neurologic and musculoskeletal system is required. Full completion of the motor development is required for the functional independence and social and emotional development of the child. Therefore it is required to know the normal development of a child. By knowing the normal development, the developmental problems that may occur in the child due to any reason can be better understood (Tsorlakis et al., 2004).

3.1. Muscle tone assessment

The methods used for assessing spasticity take place within a wide range that extends from clinical scales to more complex systems based on Electromyographic Analysis (EMG). Collecting comprehensive history and observations are very important in assessing the effect of spasticity on functions. The muscle groups, in which the spasticity exists, and their inter-

action with postural reactions' effect on functions should be researched. Although assessing functional activities and daily-life activities does not directly determine the severity of spasticity, it could present an idea on the reflection of the changes of the spasticity on the functional condition (Kerem Günel, 2011). One method of assessing spasticity in the clinic is to determine the amount of resistance that the spastic muscle presents during a passive movement of the relevant extremity. Ashworth has, accordingly, defined a 5–point scale. This scale evaluates the resistance that occurs during the passive movements of the extremities with points between 0-4. Although the Modified Ashworth Scale (MAS) is a subjective method in our day, it is widely used as an easily applied method that does not require any tool in assessing spasticity (Bohannon & Smith, 1987, Clopton et al., 2005).

Modified Ashworth Scale for Grading Spasticity	
Grade	Description
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 of the range of motion when the affected part(s) is moved in flexion or extension
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 affected part(s) easily moved
3	considerable increase in muscle tone, passive movement difficult
4	affected part(s) rigid in flexion or extension

The Tardieu Scale is another scale that assesses spasticity with passive movements, as does the AS and MAS. This scale presents spasticity's nature that depends on speed. Passive straining is performed at the speed of the extremity segments falling with gravity and slower and faster than this speed. The Modified Tardieu Scale (MTS) has added the assessment positions and spasticity angles of the extremities to the original scale (Boyd & Graham, 1999, Gracies et al., 2010). The MAS, Pendulum test and MTS for measuring the spasticity of children with CP was compared and MTS was determined to be most appropriate measurement method (Mutlu et al., 2007).

Spastic muscles limit articular movements in antagonist directions. Therefore, in addition to assessing the movement of the articular with a goniometre can also be used as an objective method although it presents conflicting results in terms of reliability. Assessments, which are not widely used in the clinic and are used more in assessments researches, are methods such as the dynamic flexometre, pendulum test, electrophysiologically assessing the H reflex and M response and the biomechanical analysis of response of the spastic muscle to angular and speed differences, etc. (Mutlu et al., 2008, Akbayrak et al., 2005).

The Barry Albright Dystonia Scale is a highly reliable rating scale developed in order to asses the dystonia in children with CP and traumatic brain injuries. The scoring is "none"; 0, "slight"; 1, "mild"; 2, "moderate"; 3, and "severe";4. Each region has specific descrip-

tors for a scoring. Generally if dystonia is present less than 10% of the time it is "slight", if it does not interfere with function or care it is "mild", if it makes functional movements harder it is "moderate", and if it prevents function it is "severe" (Albright, 1996).

3.2. Assessment of functional level and gross motor functions

The most widely-used test battery that measures the functional motor level in order to determine the motor development level of children with CP is the Gross Motor Function Measurement (GMFM). With GMFM, physiotherapists can define the motor function level of the child; obtain aid in specifying the targets of the treatment, follow-up the post- treatment development and present objective information regarding the child to relevant colleagues, other inter-discipliner professionals and families. It was developed in 1989 by Russell et al. by considering the motor function level of a 5-year old child with normal motor development. The GMFM measures how much of the action is achieved rather than measure the quality of the motor performance. The purpose is to determine the capacity and change. It is comprised of sections of supine-facedown positions and turning, sitting, crawling and standing on knees, standing on feet, walking and running and jumping (Russel et al., 1989, Russel et al., 2000).

The Gross Motor Function Classification System (GMFCS) is a classification system developed for children with CP. The GMFCS has been developed by Palisano et al. based on the actions the child can perform from sitting to walking. It is a practical system that can be used in clinics for the rehabilitation team to classify a child with CP, observe the efficiency of the applications and follow-up on the patient in inter-intra discipliner applications. Initially, children with CP aged below 12 were divided into five levels by considering their independency in gross motor functions such as sitting, walking, mobilization and transfer activities and the tools-equipment, tools that assist in walking that they use. As motor functions of children differ according to age, functions have been defined as under 2-years old, between 2-4 years old, between 4-6 years old and between 6-12 years old for each level. This system was extended in order to include the age ranges of between 12-15 and 15-18 years old in 2007 (Palisano et al., 1997, Palisano et al., 2007).

Commonly Used Tests:

Gross Motor Function Classification System –GMFCS (Palisano et al, 1997,2007)

Gross Motor Function Measure- GMFM 88 or 66 (Russel et al, 2003)

The Functional Indepence Measure for Children- WeeFIM (Mshall et al., 1993)

Pediatric Evaluation Disability Inventory- PEDI (Vos-Vromans et al., 2005).

The Neurological, Sensory, Motor Developmental Assessment –NSMDA (Burns et al., 1989)

Bayley Scales of Infant Development (Bayley 1983)

Trunk Control Measurement Scale –TCMS (Heyrman et al., 2011)

Gait Analysis

Table 3. Data from: Palisano et al. 1997,2007, Russel et al 2003, Mshall et al. 1993, Vos-Vromans et al. 2005, Burns et al. 1989, Heyrman et al. 2011.

Trunk Control can evaluate by Trunk Control Measurement Scale (TCMS). This scale consists of 15 items measuring two main components of trunk control: (a) a stable base of support (static sitting balance), and (b) an actively moving body segment (dynamic sitting balance). The subscale static sitting balance (items 1–5) evaluates the ability of the child to maintain a stable trunk posture during movements of upper and lower limbs. The section dynamic sitting balance is further divided into two subscales: selective movement control and dynamic reaching. The subscale selective movement control (items 6–12) measures selective trunk movements in the sagittal (flexion/extension), frontal (lateral flexion) and transverse (rotation) plane within the base of support. The subscale dynamic reaching (items 13–15) evaluates the performance of three reaching tasks, requiring active trunk movements beyond the base of support. All items are scored on a two-, three- or four-point ordinal scale and administered bilaterally in case of clinical relevance. Maximum scores on the three subscales are 20, 28 and 10, respectively, resulting in a total score from 0 to 58. A higher score indicates a better performance (Heyrman et al., 2011).

3.3. Functional level assessment related by motor performance

The Functional Independence Measure for Children (WeeFIM) has been developed by using the Functional Independence Measure (FIM) developed for adults by "Uniform Data System" in 2003. It is a useful, short, comprehensive measurement method that determines the devel‐ opment, educational and social functional limitations of children that have CP and other development disorders. WeeFIM contains a total of 18 articles in 6 fields; self-care, sphincter control, transfers, locomotion, communication and social and cognitive. Whether or not the child is aided, performs on time or if they required an aiding device while performing the function in each article of these fields is scored from 1 to 7. 1 point is given if they perform the mission with aid, 2 for independently performing and 7 if they perform on the right time and safely. Accordingly, the child can score 18 the least (fully dependant) and 126 the most (fully independent) (Mshall et al., 1993, Ottenbacher et al., 1999)

Also The Pediatric Evaluation Disability Inventory (PEDI), is a comprehensive clinical assessment tool that assesses the functional ability and performance of disabled children. It has been developed especially to assess the function of small children and is a distinguishing measurement method that can be used for children below 7,5 years old and also older children. PEDI is comprised of three main sub-sections; functional abilities, help of caretakers and modifications. Each of these sections assesses self-care, mobility and social function areas. The functional abilities part comprises of 197 articles and measures the functional abilities of the child. In this section the "self-care" sub-section comprises of 73, the "mobility" sub-section comprises of 59 and the "social functions" sub-section comprises of 65 articles. The section regarding help of the caretakers comprises of 20 articles and measures the disability condition of the child according to the amount of aid required in order to perform the functional activity. The modifications section also comprises of 20 articles and shows the environmental modifi‐ cations and tools that the child uses during his/her daily life. Each sub-section of PEDI can be used independently (Vos-Vromans et al., 2005).

3.4. Developmental evaluations

The Bayley Infant and Child Development Assessment Scale was developed by Nancy Bayley. It was revised in 1993 and the Bayley Infant and Child Development Evaluation Scale-version 2 (Bayley-II) was published. It evaluates the developmental condition of the child according to age in general. Bayley-II is used to evaluate children aged 1-42 months and to follow their development in the USA. Its standardization has been done on 1700 children in the USA and it has been used in studies and clinical applications for over 40 years (Bayley, 1993). It is one of the best tests for evaluating child development. The test is valid and reliable for determining the child's development (Blauw-Hospers & Hadders – Algra, 2005).

The Bayley and Bayley-II evaluation scales are the mental development scale (MDS) and psychomotor development scale (PDS). MDS evaluates the cognitive and language develop-ment while PDS evaluates gross and fine motor development. The MDS and PDS scales are the basic limitations of Bayley and Bayley-II (Johnson & Marlow, 2006). This limitation has been revised in Bayley-III. Thus, the composite scores of cognitive, language and motor parameters can be calculated separately. The structure of Bayley-III, the new version of Bayley-II, provides more useful information in understanding the development in the early stage, increases our capacity to identify early developmental problems and ensures focusing on special areas specific to the weakness with early intervention programs. In terms of research, it provides a better understanding of early development in the high-risk group and provides more sensitive results for clinical studies (Anderson et al., 2010). The primary purpose of Bayley-III is to identify children with a developmental delay and provide information for an intervention plan. It identifies the developmental delay risks of children aged between 1 and 42 months, and helps professionals in the identification of future applications (Bayley, 2006).

The test has been divided into 5 subgroups: cognitive, language, motor, social-emotional and adaptation. It has been created for the evaluation of the separate parts of the total development for each child. The marking system of the subtests produce scores that can be used to define an end point for each subtest in different age groups. It includes a registry form; cognitive, receptive language, expressive language subtests; and fine and gross motor subtests. The cognitive scale evaluates the sensory-perceptual sensitivity, discrimination and the resultant abilities; early period object recognition-memory retention, learning, problem-solving skills, initiation of verbal communication and vocalization, and generalized evidence of early ability and classification (Burns, 1992).

The neurological, sensory, motor developmental assessment (NSMDA) has been designed to examine the characteristics of motor development in the early childhood period and is a standard motor development test used to evaluate infants or children between the ages of 1 and 6 years (Burns et al., 1989). It is preferred for characterizing the motor development and identifying any problematic motor development areas during long-term follow-up of of premature children. It is also used in the prediction of general developmental results such as to help in the diagnosis of CP, compare motor results in different problems, and predict the motor development and cognitive performance of premature children (Burns et al., 1989, Spittle et al., 2008, Burns et al., 2009, MacDonald & Burns, 2005).

NSMDA evaluates the development of the motor performance of the child especially in certain periods and defines normal or abnormal features, motor performance, and abnormal or dysfunctional motion components at various ages. The test shows whether the motor development and mobility components of the infants and children are within normal limits, suspect or abnormal. Test parameters evaluate the age-appropriate motor skills, muscle tone, deep tendon reflexes, movement patterns, postural reactions and balance, and the tactile, proprioceptive, visual and vestibular sensory systems (Burns et al., 1989). NSMDA has been shown to be valid and reliable from birth until the age of 2 years. NSMDA was mentioned as an adequate and differentiating set of tests in a review on the clinometric characteristics of various test sets evaluating neuromotor development in first year of life (Spittle et al., 2008).

3.5. The evaluation of gait

Various methods such as observation, measurement of time-distance characteristics, video recording systems and kinetic and kinematic analysis performed with computer-aided systems are used in the evaluation of gait in children with SP (Livanelioğlu & Kerem Günel, 2009). While gait can be evaluated by observation in the clinical environment, it is digitally evaluated in gait analysis laboratories. Functional observational gait evaluation can be performed with the Gilette Functional Evaluation Survey (Novacheck et al., 2000), Physician Rating Scale (Maathuis, 2005,) and Functional Mobility Scale (Graham et al., 2004). The gait substep of GMFM can also be used in the functional evaluation of the gait (Ross & Engsberg, 2007). Although many gait problems can be understood by the visual examinations performed by experienced clinicians or analysis performed with video records, gait analysis technology is necessary to interpret the problem numerically, to record and reevaluate later, and objectively reveal the effectiveness of the treatment is necessary in complex walking problems (Kawamura et al., 2007).

Gait analysis is a systematic measurement used to identify and evaluate human movement. The numerical evaluation, identification and interpretation of gait is possible with gait analysis. Modern gait analysis laboratories are based on four disciplines: Visual inspection, quantitative analysis, biomechanical analysis and electromyography (EMG). While visual examination evaluates the body motions in repetitive gait, quantitative analysis provides the kinematic parameters, time and distance characteristics of the joints during the gait. Biomechanical analysis and EMI provide information about the muscle activity during gait and its effect on gait. A detailed gait analysis includes all of these methods (Kawamura et al., 2007). Gait is evaluated in each of the three planes as sagittal, coronal and transverse with 3D gait analysis (Deluca, 1991, Patric et al., 2001). The pelvic tilt, flexion-extension of the hip and knee, and the plantar flexion and dorsiflexion of the ankle are commonly evaluated in the sagittal plane while pelvic obliqueness, abduction-adduction of the hip, knee varus-valgus, foot inversion-eversion are evaluated on the coronal plane with 3D gait analysis. The internal and external rotations of the pelvis, femur, knee, tibia, and ankle are evaluated in the transverse plane. Kinetic (strength, pressure, moment and torque) and kinematic (changing place, linear velocity, acceleration) analyses and the analysis of the time-distance characteristics are

performed with 3D gait analysis. Angular sizes are recorded in kinematic analysis (Schwartz, 2009).

4. Therapy approaches

The dynamic motor control approach based on changing motor patterns and configuration of the tasks rather than the hierarchical modeling of the neurological motor development is used for the rehabilitation. This approach allows looking at the child from the functional aspect in environments such as the home and school and performing a realistic evaluation. The aim of CP rehabilitation should be the development of current abilities of the child and to keep these abilities at an optimal level. It is important to minimalize the effects of functional limitations and disorders and protect the patient from the disability to prevent secondary disorders and maximize the motor functions to the extent permitted by the existing deficit. Therefore, the type of treatment where the optimal functions can be gained should be determined. The main goal of treatment should be reaching maximum functional capacity. However, correction of abnormal posture and patterns, prevention of the deformities that may develop, mobilization, development of existing skills, and teaching new skills are also among the targets of treatment (Miller, 2007, Camper et al., 2000).

The rehabilitation program of children with CP is determined according to the age and functional condition of the child and the general treatment approach shows significant changes according to the age (Camper et al., 2000). Combinations of different approaches may be used in each age group. The environment where the therapy will be conducted can be the home of the child as well as clinics and hospital departments, inpatient rehabilitation hospitals, rehabilitation centers or school-based therapy environments. The therapy plan should be consistent with the patient's age as well and have a specific purpose and relevant measurable short-term targets. These short-term targets allow the therapist, family and the child to be informed about the process. Another aspect of the treatment is family training. The exercise plan should be taught to the child and family, the functionality of the child in the home environment should be evaluated, and the long-term expectations of the family should be taken into account (Miller, 2007, Camper et al., 2000). It is important that the rehabilitation process be started as early as possible due to the plasticity characteristics of the central nervous system (Bluw-hospers & Hadders-Alga).

The current function of the child and prognosis for acquiring new skills should be taken into account when deciding on the effectiveness of the physiotherapy. While the treatment program is planned, the growth spurts of the child and procedures such as surgery should be taken into account. Whatever the functional level of the child, the family should also be included in the process through home programs. Deciding on the intensity of the treatment is important in the management of the process. The use of intensified therapy after orthopedic interventions and neurosurgery, during growth spurts that can affect the motion biomechanics of the child, and when a specific task is being focused on has critical importance. Physiotherapy in adolescents and adults with CP should be supported with recreational activities. Thus, motivation can be provided for the acquisition of new skills (Styer- Acevedo, 1999).

An extensive framework of methods is included within the concept of physiotherapy and rehabilitation in CP. Some of the approaches based on neurophysiological grounds have been developed over time and remain valid while some are no longer preferred (Damiano, 2004). In addition to neurophysiological approaches, there are also strength training, hydrotherapy, restrictive obligatory motion treatment, electrotherapy applications, hippotherapy and alternative-complementary therapy approaches that are used together with such approaches or independently.

4.1. Neurodevelopmental therapy

Today, the Bobath approach, initially, aims to observe the existing performance of the child with CP, analyses it, interpret it and then enable the child to reach the maximum level of independency within the limitations of the child's potential assessment and result (DeGangi & Royeen, 1994). Neurodevelopmental therapy (NDT) was developed by Bertha Bobath, physiotherapist, Karel Bobath, neuropsychiatrist. Bobath's approach was shaped in order to involve scientific theories that were and empirical experiments that were developed and has a structure that is open to development and is dynamic. Thus, it has been developed until our day since its first application and has undergone some changes. According to the Bobath's, the motor problem is one of the most important problems and delay or disorder of normal motor development or not being able to establish postural control against gravity due to function problems in the central nervous system is the most significant factor that causes motor problems (Tsorlakis, 2004, Bly, 1991). The NDT method, which regards all problems occurring in the child as a result of the injury in the central nervous system, has focused on working on memory, perception, sense, postural control and abnormal patterns, reflexes and sensory motor components in the muscle tonus. It is used to facilitate special gripping techniques movement patterns, balance responses and normal muscle tonus and also to decrease abnormal movement patterns, reflexes and spasticity. During the years when the NDT was first developed, the child was more passive in this approach; however, as it has received the name of "living concept" it is observed that the child is more active now (Kerem Günel, 2009).

The effect of the family is very important and the family must act like a part of the rehabilitation team within the scope of NDT (Butler & Darrah, 2001). There have been debates on whether NDT principles affect motor development in terms of reflex and hierarchic model of motor control is focused on only neural explanation. For instance, in the motor control model, the central nervous system is regarded as one of the systems that affect only motor behavior. Motor control is also affected by cognitive and environmental factors. However, physiological components and environmental contents are accepted as non-neural explanations in the child's progress (Fetters & Kluzik, 1996).

Implementing clinical practices with applications based on evidence is increasingly becoming more important today. Although NDT is the most commonly used method in child rehabilitation by physiotherapists all over the world, research that presents its effects are deemed to be insufficient. There are many reasons for this. Research presenting NDT's effect was organized by AACPDM (American Cerebral Palsy Association) and as a result the difficulties and the evidence encountered were studied (Butler & Darrah, 2001)

The most prominent difficulty is that all problems, diagnosed on research that includes low incidence and high heterogeneity conditions, become complex with the change of children along with their growth and development process. Despite these obstacles, due to different practices and understandings in applying NDT and its ongoing and wide effect in CP treatment, it is important to collect information on NDT. Researchers indicate that NDT is clinically significant but that no statistical assessment can exactly present its result, partially due to the difficulties mentioned above. In researches where the NDT's clinical effect is attempted to be presented by practice, the NDT structure changes with time and in these researches NDT practices are usually performed with other therapy techniques and medical treatments (Law et al., 1997).

The primary target of NDT is to change the central nervous system's neural based motor responses. Various aspects of the motor response have been assessed with measurement methods used in conducted researches. These are qualitative movement or physiological motor function (i.e. involuntary muscle tonus changes, spasticity, etc), reflex activity, weight transfer, postural control, trunk rotation, combined reactions, upper extremity movements and walking parameters. As a result of these researches, generally, it has been indicated that a better motor response occurred and that there were positive changes in terms of physiological motor function, movement time, step length for walking, speed and foot angle after the NDT practices (Bobath, 1971). Nonetheless, the evidence of this development in physiological motor functions and qualitative movement is not consistent. One other very important target of NDT is to prevent or slow down deformities. The measurements of articular movement width, orthosis or surgical suggestions after the NDT practice are used for researching the degree of contractures. It has been indicated that NDT provides advantages in protecting the dynamic articular movement width in the ankle and knee (Kluziket al., 1990). In other words, when the articular limitation was repetitively and immediately assessed after 20-25 minute NDT sessions, it decreased further. To decrease spasticity, provide normal movement experience, support functional independence during daily activities and thus indirectly support motor learning, physiotherapists use special grips and positioning within the scope of NDT. Dynamic articular movements and the child's active participation during the movement can be clinically descriptive. When considering principles of evidence-based practices in studies, it is possible to mention that the studies were conducted with groups that have low-level work force and insufficient number of cases and are heterogeneous. When the results are considered, it can be emphasized that NDT practices have positive results on postural tonus, functional independency and dynamic articular movements; however, NDT cannot be proved to be superior to other practices and further studies are strongly required. These efforts should involve randomized studies in more comprehensive groups whereby only NDT is applied in homogeneous groups by making use of reliable and valid evaluation analyses where age, sex, severity and type of disease, socio-economic and cultural structure of family are kept under control and which indicate long-term effects (Mayston, 2008, Butler & Darrah, 2001, Herndon et al., 1987).

4.2. Strength training

Disorders affecting muscle strength and motor control in children with CP are indicated among the main reasons of the motor performance disorder (Giuliani, 1991, Damiano & Abel, 1998, Engsberg et al., 2000). Muscle weakness is a common disorder in children with CP and is associated with insufficient or reduced motor unit discharge, inadequate coactivation of antagonist muscles, secondary myopathy and impaired muscle physiology. Studies have shown the usefulness of strength training in children with CP and revealed the relationship of muscle strength with activity (Scianni et al., 2009). Strength exercises increase muscle strength, flexibility, posture and balance in CP. They also increase the level of activity in daily life and develop functional activities such as walking and running (McBurney et al., 2003).

Isotonic, isometric and isokinetic exercises can be used to increase muscle strength and motor function recovery. Strengthening methods commonly used in all age groups are functional activities, gravity and body weight (Finlay et al., 2012, Berry et al., 2004, Damiano et al., 1995, Fowler et al., 2001). A sufficient level of loading is necessary to increase the strength of the muscles when choosing among different strengthening methods. Strength training requires effort against progressive resistance. Progressive resistance exercises that develop muscle performance and motor skills by increasing the force production capacity are important for individuals with CP. Increase in muscle strength and joint range of motion are provided with resistance exercise training (Mockford & Caulton, 2008). Damiano concluded that resistance exercises that involve the lower and upper extremities in children with spastic diplegia increase the strength capacity (Damiano et al., 2010). An increase in the spasticity was not observed with resistance exercise training (Dodd et al., 2002). Training conducted with manual resistance, fitness equipment, free weights, Gymball, theraband, running band, static bike, leg press and isokinetic devices are examples of resistance exercises (Finlay, 2012).

Studies reveal the presence of weakness compared to their peers in the affected extremities of children with CP even if they have a high functional level, and this weakness increases with neurological involvement (Damiano et al., 1995, Wiley & Damiano 1998). In addition, Thompson reported that children with CP show lower strength-generating capacity in all lower extremity muscle groups, except for the hip extensors, compared to their healthy peers. When the gross motor function classification system (GMFCS) levels are taken into account, the muscle strengthening trainings are most commonly used in levels I-III. Children at this level have better selective control and less coactivation and are therefore considered to tolerate the specific progressive exercise training better. Muscle strengthening in children on level IV and V is controversial due to the problems with motor control. Hydrotherapy is the most popular muscle-strengthening method in children at this level (Finlay, 2012).

Previous reviews provide contradictory results about the effect of muscle strengthening interventions. Although the investigators have proven that strength training in children with CP increases their motor abilities, it has not been proven to create a positive change in their functional capacities. The transfer of gains obtained with increased strength to functional activities requires time. It is stated that changes in muscle power should be associated with functional results. The increase in function is not parallel to the increase in isometric muscle strength in studies conducted in children. Strength training in studies includes open chain or

isokinetic exercises without weights and isotonic exercises with weights (Damiano et al., 1995, Damiano et al., 1995). The strengthening effect is specific to the mode of exercise. The transfer of exercises without weights to conditions with weights is quite limited as activities with weights involve different and more complex muscle activity patterns. When strength exercises involve close kinetic chain exercises that are more associated with function, the transfer of the strength to functional motor performance improves. The person puts weight on his feet and the body mass rises and falls with the concentric and eccentric activation of the lower extremity muscles in these exercises. These movement characteristics are used in many activities that involve the lower extremity, such as standing up and walking (Blundell, 2003).

Functional strengthening training, increase the power of the weak antagonist and responsible spastic agonist and aim to provide functional benefits in children with CP (Damiano, et al., 1995). Functional exercises are a combination of aerobic and anaerobic capacity and strength training; they develop the physical fitness, activity intensity and quality of life in ambulatory children (MacPhail, et al., 1995).

A treadmill can provide functional exercise and is a dynamic approach that can be used to support the motor development of individuals with CP. The normal walking rate and distance of individuals with CP increase with treadmill exercises (Cheng, et al., 2007, Dodd & Foley, 2007). Treadmills that support the body weight can be an option in individuals with CP who have no gait ability (DiBiasio & Lewis, 2012).

Strength training is significant only when the aim is the development of a specific motor skill or function. The functional gains of children without voluntary muscle control capacity from a strength training program are therefore restricted. Surgical interventions such as muscle-tendon lengthening, selective dorsal rhizotomy, botulinum toxin injection, and intrathecal baclofen pump implantation can increase the muscle length or improve muscle control in these children. Thus, strength training can be more effective and longer lasting effects can be ensured (Miller, 2007).

Training the same muscle groups on different days is appropriate in children. Strength training should be modified in the presence of muscle pain or when muscle pain and tension develops with exercise. The child should be able to comprehend and consistently produce maximum or almost maximum effort for strength training. Although strength training can be implemented for children aged 3 years or older, it is therefore more realistic for children aged 4-5 years (Miller, 2007). Despite the lack of an evidence regarding the harm of strength training, it should not be forgotten that excessive physical effort may trigger seizures in children with a relevant history.

4.3. Constrained Induced movement therapy

Constrained Induced movement therapy (CIMT) is a treatment approach based on restraining the uninvolved upper extremity and exercising the involved upper extremity intensively. The treatment protocol is based on the principle of the limitation of the nonaffected extremity and forcing the patient to use the affected extremity during the day (Taub et al., 1999).

Children with hemiplegic CP develop strategies and techniques during their growth and development to perform their daily tasks with one hand. They discover that performing tasks with the unaffected extremity is more effective and efficient even when there is only a mild disorder in the affected extremity (Kuhtz et al., 2000). DeLuca introduced the term developmental disregard to describe a child with hemiplegia who may disregard, or learn not to use, the affected limb during the development of motor function. Although the behavior mechanism in children with CP is similar to the consolidation of the unaffected extremity and not using the affected extremity seen in adults, Eliasson has reported that learned disuse could be a different condition in these children. As development in children continues, the term "learned disuse" is replaced with "developmental disuse". A hemiplegic child cannot experience normal motor function of the extremity, and the opportunity, experience and environment that allows the child to learn how to use the affected extremity must therefore be created during therapy. CIMT makes this possible (DeLuca, 2002). Studies that started with adults have spread to the pediatric field. The frequency and intensity of the application were decreased and applications modified for pediatric use in most of the studies (Charles et al., 2009, Pierce, 2002). A limited number of controlled studies have been performed on CIMT and obligatory use in hemiplegic CP (Hoare et al., 2007, Masciento et al., 2009). The restriction was ensured with various gloves, splints or material in these studies and the duration of using the splints varied greatly. Although studies vary regarding the restriction duration within the day, the concentrated repetitive training of the involved extremity 3-6 hours a day with the aim of shaping motor behavior has been shown to be effective (Masciento et al., 2009, Charles et al., 2006, Sakzewski et al., 2001). CIMT involves providing verbal feedback for small progresses in accomplishment of the task choosing specific tasks in order to address the motor deficiencies of the child, helping the child in case he cannot complete the motion alone and during the realization of the motion stages, and systematically increasing the degree of difficulty of the performed task (Hoare et al., 2007).

The increased use of the affected extremities with CIMT is suggested to be due to an expansion in the contralateral cortical area that controls this extremity's motion and the development of new ipsilateral areas. This is reported to form the neural basis for the continuation of the use of the affected extremity after the treatment (Morris & Taub, 2001).

Charles et al. reported improvement of hand function and two-point differentiation with CIMT (Charles & Gordon, 2005, Charles et al., 2001), De Luca reported CIMT to increase dependent reaching, grabbing, weight transferring in both upper extremities and the quality of the involved upper extremity (DeLuca et al., 2003). Charles reported that modified CIMT increases the efficiency of the movement in the affected extremity in a study with decreased intensity and they described the method as "child friendly" (Charles et al., 2006). Gordon et al emphasized that both younger and older children benefited from CIMT in the same way and CIMT was useful at any age (Gordon et al., 2006). Taub et al reported very good progress in the functional use of the involved extremity in patients with the use of CIMT (Taub et al., 2007, Taub et al., 2004). Cope et al showed evidence of cortical reorganization in hemiplegic children in a pilot study (Cope et al., 2008). Although all these studies provide important data showing

that CIMT is useful for the hemiplegic upper extremity, the advantages and disadvantages of the method are still being discussed.

Disadvantages such as reduction in children's self-confidence along with decreased motivation when the child finds the method difficult have been suggested with CIMT use in some studies. Although it is said there are no medical complications related to the use of splints, there are also studies indicating friction by the splint on the healthy side and mild contractures in the joints of the long-term restricted extremity. An attempt is made to eliminate these negative factors by decreasing the splint use duration, opening the splints at certain intervals and checking the skin integrity, and getting the children do play games, get involved in outside activities or join social activities such as trips or camps during CIMT. Charles, Ries, Naylor, Eliason and Brandao emphasized in their studies conducted with young children that this problem can be overcome by decreasing the restriction duration, extending the application duration, and including more games and entertaining activities in the treatment program (Charles et al., 2005, Cope et al., 2008, Ries & Leonard, 2006, Naylor & Bower, 2005, Eliason et al., 2005, Brandao et al., 2009).

4.4. Electrical stimulation

Electrotherapy is the name given to any treatment or evaluation applied to the body from outside by using electrophysical agents. Electrical stimulations within a wide range from low-level stimulations such as to decrease pain, TENS or threshold electrical stimulation where there is no muscle activation to neuromuscular electrical stimulation where active muscle contraction is observed can be used (Wright et al., 2012). The rehabilitation of the pediatric group is different than the adult group. The communication and cooperation skills as well as the histological and physiological features of this group are different. Electrotherapy applications in children therefore have basic differences than those in adults and have special applications (Palisano et al., 2006).

The main electrical stimulations used to increase muscle strength in children with CP are neuromuscular electric stimulation (NMES) and threshold electrical stimulation (Kerr et al., 2004). NMES is the application an electrical current intensive enough to cause muscle contraction. Electrodes are placed on the skin over the targeted muscles in order to reveal the contraction. Two strengthening mechanisms are aimed for. The first of these is the loading principle; muscle strength increase is ensured with an increase in the cross-sectional area of the muscle. The selective development of type II fibers ensures the development of synaptic efficiency in the muscle in the second mechanism (Reed, 1997).

NMES is used to help physiotherapy in order to increase strength, normal joint motion, motor control and co-contraction and also to temporarily decrease spasticity. The results of studies on the effect of NMES on spasticity and function vary. Although NMES is most commonly used to create reciprocal relaxation in the antagonists of the spastic muscle, it can be used for the same purpose by tiring the spastic muscles (Arya et al., 2012).

The use of NMES on children with spastic CP in order to develop gait parameters and functional results has recently increased and it has become a popular technique in physio-

therapy and rehabilitation. However, it has not been completely proven on which muscle NMES is effective on in CP. The use of non-invasive NMES in CP has significant advantages such as not being a surgical procedure and having relatively mild side effects (Arya et al., 2012).

Studies on the use of electrical stimulation in CP are limited and have provided various results. According to the result of a meta-analysis by Cauraugh et al., electrical stimulation minimizes activity limitation during the disturbance and the gait (Cauraught et al., 2011). Although NMES is used for the treatment of many clinical problems, the contraction required by the activity the patient is participating in during stimulation is not task-specific (Kerr et al., 2004).

The use of neuromuscular stimulation for a functional target is also known as functional electrical stimulation (FES) (Reed, 1997). FES can be defined as the stimulation of the nerve and muscle electrically in order to produce the requested joint motion. FES can be used to develop underlying motor control by increasing repetition of the specific task movement (Kapadia et al., 2013). FES can develop motor control and decrease spasticity in hemiparetic patients. FES is accepted to increase afferent input and activate neuronal plasticity (Pierber et al., 2011).

Threshold electrical stimulation is defined as the application of low-level, subcontraction electrical stimulation in the home environment during sleep. It is thought that the increased blood flow will result in increased muscle mass as long as trophic hormone secretion is high (Dali et al., 2002).

Another type of current used in physiotherapy is high-voltage pulsed galvanic stimulation. This weak current has an extremely short pulse duration and causes minor electrochemical pain during the stimulation (Noreau et al., 2008).

The use of electrical stimulation is recommended for muscle disuse atrophy, following cast use, long-term orthosis use and postoperatively in children with CP. The use of electrical stimulation in children younger than the age of two and in obese patients has been reported to be contraindicated.

4.5. Hippotherapy

Horse-assisted rehabilitation practices are ancillary treatment methods that use the repetitive rhythmic movement of the horse as their basis. The motivation of the child with CP and his participation in the treatment in these applications, performed mostly in a natural environment, are usually positive as he is in continuous interaction with a living creature. The method positively contributes to the physical, emotional, cognitive and social aspects of the children. Horse-assisted rehabilitation practices can be divided into two as Recreational Horse Riding Treatment (RHRT) and hippotherapy (Şik et al., 2012).

RHRT is performed with trained horses and a horse trainer and focuses on the progressive protection of balance and posture, only using the slow and rhythmic gait of the horse. The success of defeating the emotional fear and anxiety and going through the riding phases enable the child to notice his own value and increases self-respect. The method provides motivation to teach something new to the child in the cognitive sense (Şik et al., 2012). Hippotherapy

consists of a physiotherapist or occupational therapist using the movements of the horse as a therapy tool or method. Hippotherapy is an individual therapy that uses an interdisciplinary team approach. The basis of the method is the horse gait providing a marked, soft, rhythmic and repetitive movement model similar to the mechanics of the human gait (Winchester et al., 2002). The movements of the horse have a dynamic effect on the body of the child. Pelvic movements of the horse during the walk enable the pelvis and body of the child to move close to a normal gait. There are also views that when this rhythmic movement is combined with the neutral body temperature of the horse of 38 degrees, it decreases the hypertonicity in the child with CP and provides comfort. Adapting to the movements of the horse activates the muscles and joints and this can increase strength and provide a range of motion within time. The movement of the horse generally provides various inputs and these help to develop joint stability, weight transfer and postural balance responses in children with CP (Zadnikar & Kastrin, 2011, Bertoti, 1988, Quint & Toomey, 1998).

Hippotherapy mainly aims to provide balance and proper body posture in various positions, develop the child's sensory-motor and cognitive-motor skills, and gradually increase the stretching and movement capacity of the child while the horse is moving at a slow pace. When applied together with the neurodevelopmental treatment approach, it helps development of rough motor functions regarding balance, posture and mobility and brings muscle tone to a normal level in children with CP (Miller, 2007, Zadnikar & Kastrin, 2011).

There is a limited number of studies in the literature investigating the effectiveness of RHRT or hippotherapy on rough motor functions and postural control in children with CP. Hippo-therapy is reported to develop rough motor functions and improve postural control, and contribute to balance, strength, coordination, muscle tone, joint range of motion, weight transfer and body posture in children with CP in the majority of these studies. Hippotherapy is also reported to have a positive effect on providing symmetry and functional motor skills in children with cerebral palsy. Besides, it contributes to psychological self-confidence, self-esteem, motivation, attention span, spatial awareness, concentration, and ability to speak (Miller, 2007, Şik et al., 2012, Zadnikar & Kastrin, 2011, Quint & Toomey, 1998).

4.6. Aquatherapy

Aquatherapy is one of the physiotherapy methods used for children with CP (Blohm, 2011). Aquatherapy can decrease spasticity, develop the tolerance to multisensor stimulators and increase the circulation due to the effect of hydrostatic pressure. The purpose of this therapy is to develop the ability of performing daily activities. Compared with the motions performed on land, water facilitates positioning by decreasing the gravity effect, decreases the pressure force applied to the joints, and therefore helps the children who cannot perform certain activities on land to move more fluently and actively. Additionally, the viscosity and flow characteristics of water increase body stabilization and help increase strength with the resistance they provide (Dumas & Francesconi, 2001, Thorpe, 2005, Hillier, et al., 2010). Aquatherapy also contains many elements of physiotherapy performed on land such as resistance exercise, aerobic exercise, endurance and motor skills. It also involves adapting to the water, functional independence, movement control in water, rotation, swimming and

breathing activities. It is considered to provide psychosocial benefits (Ennis, 2011, Bumin, et al., 2003).

The aquatherapy techniques used today are the Halliwick, Bad Ragaz and Watsu methods. The Halliwick method commonly used in children with CP is divided into four stages: (1) adapting to water, (2) rotation, (3) control of movement in water, (4) movement in water. The essence of this method consists of 10 points focusing on postural control while learning how to swim. The disabled individual first learns how to ensure balance in a supine stable position and then how to maintain balance in an unstable position. In other words, the Halliwick method is a motor learning program where the individual learns how to secure his balance (Bumin et al., 2003).

Watsu shiatsu is an aquatherapy method that combines stretching, joint mobilization and dancing. The movements of the individual are continuously supported during the session (http://www.watsu.org.nz/.). Another therapy method is Bad Ragaz where the individual is supported with floating devices and the therapist provides manual resistance to the individual's active movements. The therapist also applies facilitation that will provide proprioceptive input in order to activate the weak muscles. The Bad Ragaz method uses the principles of proprioceptive neuromuscular facilitation (PNF) (www.wcpt.org/apti/terminology).

5. Adulthood and cerebral palsy

Today, survival in childhood and adulthood CP continues to improve. The largest epidemiological database is a series of 47 000 people registered as using services in the State of California between 1983 and 2002 (Strauss et al., 2004). According to studies, survival has increased in the last 20 years by 3.4% per year, even in the most disabled group. There are different factors playing a role like improvement in nutrition, increased quality of care, and improvement of society's attitude to people with CP with a consequent provision of high quality medical care (Kent, 2013). Individuals with mild CP have nearly normal life expectancy (Hutton & Pharoah, 2006). In a study, (Strauss et al., 2004) there was a mild decline in ambulation in late adulthood and few who walked well initially maintained the skill over the following 15 years. Additionally, there was also some evidence of a reduction in the abilities of upper extremity functions, possibly related to upper limb contractures. Speech, self-feeding and the communication in the wider community were all well continuous. Disabled people may suffer from intercurrent illness that is suboptimally managed resulted by communication difficulties, discrimination, or poor access to services compared to able-bodied peers, and this is more evident in younger age groups (Cannell et al., 2011, Kent, 2013).

5.1. Survival in adults with cerebral palsy

Survival in childhood and adulthood CP continues to improve although adverse prognostic factors include immobility, reduced upper limb function, and gastrostomy feeding. The largest epidemiological database is a series of 47 000 people registered as using services in the State of California between 1983 and 2002 (Strauss et al., 2004, Kent, 2013). Even in the most disabled

group, survival has increased in the last 20 years by 3.4% per year. Improvement in nutrition, increased quality of care, and improvement of society's attitude to people with CP with a consequent provision of high quality medical care all appear to be playing a role (Kent, 2013). Individuals with mild CP have an almost normal life expectancy (Hutton and Pharoah, 2006). The management of aging in individuals with physical impairment is a new medical challenge. In a study of patients over 60 (Strauss et al., 2004) there was a mild decline in ambulation in late adulthood and few who walked well initially maintained the skill over the following 15 years. There was also some evidence of a reduction in the ability to self-dress, possibly related to upper limb contractures. Speech, self-feeding and the ability to communicate in the wider community were all well preserved. People with disabilities may suffer from intercurrent illness that is suboptimally managed because of communication difficulties, discrimination, or poor access to services compared to able-bodied peers, and this is more evident in younger age groups (Cannell et al., 2011, Kent, 2013).

5.2. Medical complications of cerebral palsy in adulthood

Medical problems in CP include those directly associated with the condition which may be present on a lifelong basis; these can be anticipated and will need monitoring. Second are the predictable complications of the condition such as worsening spasticity, where the main aim of treatment is to prevent deformity, improve nursing care, facilitate therapy, and increase tolerance of bracing (Kent., 2013).

Mechanisms of deterioration may include physical growth and weight gain, spasticity, and deformity leading to biomechanical disadvantage and muscle weakness. Abnormal compensations may break down with a loss of energy or fitness, for instance hip hitching for foot clearance, use of hip adductors to pull through in the presence of hip flexor weakness, or excessive use of lateral trunk flexion for gait progression. Spasticity is also a possible mechanism for accelerating problems with osteoarthritis. The onset of osteoarthritis is common in the general population and their various predisposing factors. In people with cerebral palsy, including abnormal gait and congenital joint malalignment, it may be anticipated that the effect of arthritis will manifest more rapidly and have a greater impact; people with mobility impairments use more energy to mobilize, have skeletal malalignment, deformity, contracture may contribute to pain and joint changes, and there is evidence of onset of musculoskeletal alteration in performance at an earlier age in people with CP (Kent 2013).

Deterioration in ambulation is a frequent presenting complaint. Most individuals remain in the same functional class of ambulation through adolescence and early adulthood. A large longitudinal study of 7550 children at 10 years and 5721 adults at 25 years (Wu et al., 2004, Day et al., 2007) showed that, although most improved their ambulatory capacity, 25% of those who walk at 10 years lose the ability by the age of 25. Of those using a wheelchair on an occasional basis, a third will be expected to lose their ability to walk by the age of 25, while the rest will remain ambulant for the next 15 years. In aging in the able-bodied, physical work capacity reduces, muscle strength generally is maintained into middle age, and complex performance activities can show a grade change because of coordination and integration of multiple functions, and these can be anticipated in those with a disability.

Other risks of deterioration include physiological burnout (Pimm, 1992) as a result of fatigue, reduced muscle power, dexterity, and mobility, intercurrent illness, and injury. Long bone fractures and prolonged immobilization and cognitive and depressive factors may also be important, although these can be interrelated (Ando & Ueda, 2000, Jahnsen et al., 2003; Strauss et al., 2004, Opheim et al., 2009). How individuals perceive their body influences how they manage everyday life and use coping mechanisms. In spite of this, life satisfaction in CP is similar to that in the general population, certainly in the Swedish and German populations (Sandstrom, 2007; Hergenr€oder & Blank, 2009). Pain and loss of function are more distressing than the overall level of functioning (Andren & Grimby, 2004) and should be treated appropriately.

The most common cause of death in CP is respiratory related (Reddihough et al., 2001). If people survive into their 40s and 50s cardiovascular disease (Krigger, 2006) and neoplastic disorders become more significant (Poulos et al., 2006). It is thought that there is an increase in mortality from cancer, stroke, and heart disease, partly due to lack of early detection and poor surveillance; breast cancer mortality is around three times the national rate. The incidence of cardiovascular and cerebral vascular conditions is two to six times higher than in the general population. The prevalence of poor health in patients with CP is not known as many do not present to health services. In a widely quoted study it was found that individuals had problems with kyphoscoliosis (26%), lower extremity contractures (71%), poor nutrition, i.e., underweight (60%), skin/hair problems (31%), bladder (56%) and bowel dysfunction (53%), and overall health problems that would warrant health service intervention (59%) (Thomas et al., 1989). The exact incidence of complications reflects the type, distribution, and age of subjects within the studies. The literature tends to support the view that individuals with CP "adjust to their own normality." In one study of the health of a group of women with a mean age of 37.5 years, around 68% were able to walk and 50% were independent in activities of daily living despite over a third of them having some degree of learning disability and 40% a seizure history.

Eighty-four percent complained of any sort of pain, 59% of hip and back deformities, 56% had bowel problems, 49% bladder problems, 43% had poor dental health, and 28% gastro-oesophageal reflux (Turk et al., 1997). In a similar vein, in a Swedish study 84% lived in their own home, 24% worked full time, and 64% could walk with or without aids. As many as 35% reported deterioration in walking ability and 9% had stopped completely. The prevalence of specific problems was 77% with spasticity, 80% with some contractures, and 18% with daily pain. In spite of this 60% regarded themselves as active and 54% were unlimited in their community mobility (Andersson & Mattsson, 2001).

Pain is an important underreported symptom. Common causes include osteoarthritis, soft tissue rheumatism, overuse injuries, fractures, and postural deformity. In one study 27% of the adults with CP had chronic pain compared with 15% in the general population (Loge & Kaasa, 1998; Jahnsen et al., 2004a, b). In adults with CP, however, pain did not increase with age, which is different from the general population (Gajdosik & Cicirello, 2001). The most frequent site was back pain, both in adults with CP and in the general population. Pain in different body parts was associated with those exposed to special strain in the different types

of CP, for example a high prevalence of neck and shoulder pain in persons with dyskinesia. More pain was significantly associated with being female, having a high fatigue score, low life satisfaction, and low and deteriorated physical function. Pain was associated with both overuse and inactivity. In a systematic review of studies including those that included adults with CP, psychosocial factors were shown to be significantly associated with pain and dysfunction in all disability groups. The psychosocial factors most closely associated with pain and dysfunction across the samples included: (1) catastrophizing cognitions; (2) task persistence, guarding, and resting coping responses; and (3) perceived social support and solicitous responding social factors. Psychosocial factors are significant predictors of pain and functioning in persons with physical disabilities. It is probable that psychosocial interventions are as helpful in patients with CP as in the general population, but this needs further research (Jensen et al., 2011).

In one series 76% of community-living adults self identified more than one muscular skeletal complaint and 55% of these had sustained fractures (Murphy et al., 1995). Pain limits activity (Turk et al., 1997), and two-thirds can anticipate having moderate to severe, 24% constant, and 56% daily pain. In another study 32% reported dissatisfaction with pain management (Engel et al., 2006). Other causes of chronic pain in musculoskeletal disorders include hip dysplasia (Hodgkinson et al., 2001) leading to postural problems and back pain. A wide variety of chronic pain syndromes include back pain, spinal stenosis, and degenerative disk disease. Individuals coped well with pain considering its duration and persistence (Castle et al., 2007). Joint pain may be related to primary or secondary osteoarthritis, as well as spasticity, contractures, or co-contraction leading to gait disturbance, for example spastic equinus and hyperextension of the knee.

Gait analysis and appropriate use of focal treatment of spasticity orthotics can be helpful in management. In one study 64% of ambulators and 91% of nonambulators had contractures, 27% had pain in weight-bearing joints, and 21% had muscle pain and spasm (Murphy et al., 1995). Similar findings were pain (59%) and joint deformities (19_57%) which were observed in a cohort of 25–36-year-olds, many of whom had lost contact with follow-up services (Hilberink et al., 2007).

Cervical myelopathy is an important reversible cause of deterioration, particularly in those with dyskinetic CP. It has been postulated that cervical instability, disk herniation, spondylosis, osteophytes, and stenosis of the spinal canal may all lead to this condition (Fletcher & Marsden, 1996; Amess et al., 1998).

Metabolic bone disease is more prevalent in institutional environments and vitamin D supplements may need to be considered in such groups. Osteoporosis is also common in people who are immobile, have never been mobile, those with neuroendocrine abnormalities, and those who have used anticonvulsants (King et al., 2003). Osteoporosis can give rise to low impact fractures of either the vertebrae or long bones such as the femur.

Falls risk can also increase the prevalence of fractures. One series gave 30% as having suffered from a fracture (Murphy et al., 1995). Soft tissue rheumatism includes tenosynovitis and elbow or hip bursitis. Some of this is related to problems associated with abnormal forces across joints

worsened by spasticity and deformity. The use of crutches can be associated with ulnar neuropathies, and self-propulsion of wheelchairs can also lead to shoulder and elbow problems.

In hemiplegia,musculoskeletal overuse injuries may affect the unaffected side. One study reported that 10% of a mixed CP sample and 20% of people with dyskinesia had carpal tunnel symptoms (Murphy et al., 1995).

6. Conclusion

The main problem in CP is locomotion. Problems in muscle tone, muscle strength, balance, and reflex development affect the motor development and the muscle contracture, joint limitation, postural disorders added in later years decrease motor performance. The evaluation of these problems in detail and the use of the appropriate approaches are of vital importance.

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References

[1] Accardo P J, Freud on Diplegia: Commentary and Translation. American Journal of Diseases of Children. 1982;136:452–456

[2] Akbayrak T, Armutlu K, Kerem Gunel M, Nurlu G. Assessment Of The Short-Term Effect Of Antispastic Positioning On Spasticity. Pediatrics International 2005;47(4): 440–445.

[3] Albright A. Spasticity And Movement Disorders In Cerebral Palsy. J Child Neurol 1996;11(1):1-4.

[4] Anderson PJ, De Luca CR, Hutchinson E, Roberts G, Doyle LW. Underestimation Of Developmental Delay By The New Bayley-III Scale. Archives of pediatrics & adolescent medicine 2010; 164 (4): 352-356.

[5] Andersson C, Mattsson E . Adults with cerebral palsy: a survey describing problems, needs, and resources, with special emphasis on locomotion. Dev Med Child Neurol. 2001; 43: 76–82.

[6]   Ando N, Ueda S. Functional deterioration in adults with cerebral palsy. Clin Rehabil. 2000; 14: 300–306.

[7]   Andren E, Grimby G. Dependence in daily activities and life satisfaction in adult subjects with cerebral palsy or spina bifida: a follow-up study. Disabil Rehabil.2004; 26: 528–536.

[8]   Aquatic Bodywork Association New Zealand. What is Watsu? Available at: http://www.watsu.org.nz/. Accessed July. 2013

[9]   Arya B K, Subramanya K, Mahadevappa M, Kumar R. Electrical Stimulation Devices For Cerebral Palsy: Design Considerations, Therapeutic Effects And Future Directions. In:Yue W., Chattopadhyay S, Lim T C, Acharya U R, (Ed). Advances in Therapeutic Engineering. Boca Raton, FL: CRC Press, Taylor & Francis. 2012.

[10] Bax M, Goldstein M, Rosenbaum P, Leviton A, Paneth N, Jacobsson B, Damiano DL. Proposed Definition And Classification Of Cerebral Palsy. Dev Med Child Neurol 2005; 47(8):571-576

[11] Bayley N. Bayley Scales Of İnfant Development. II Manual. San Antonio 1993: Harcourt Brace.

[12] Bayley N. Bayley Scales of Infant and Toddler Development-Third Edition. San Antonio 2006, TX, USA: Harcourt Assessment.

[13] Berry ET, Giuliani CA, Damiano DL. Intrasession and Intersession Reliability of Handheld Dynamometry in Children with Cerebral Palsy. Pediatric Physical Therapy 2004;16:191- 198.

[14] Bertoti D B. Effect Of Therapeutic Horseback Riding On Posture In Children With Cerebral Palsy. Phys Ther 1988; 68: 1505–12.

[15] Blair E, Stanley F J. Mental Retardation and Developmental Disabilities Research Reviews. Special Issue: Cerebral Palsy. 1997; 3(2):184–193

[16] Blauw-Hospers CH, Hadders-Algra M. A Systematic Review Of The Effects Of Early İntervention On Motor Development. Developmental Medicine and Child Neurology 2005; 47 (6): 421-432.

[17] Blohm D. Effectiveness Of Aquatic İnterventions For Children With Cerebral Palsy: Systematic Review Of Current Literature. J Aquatic Phys Ther 2011;19(1): 19-29.

[18] Blundell S W, Shephard R B, Dean C M, Adams R D. Functional Strength Training In Cerebral Palsy: A Pilot Study Of A Group Circuit Training Class For Children Aged 4–8 Years. Clinical Rehabilitation 2003;17: 48-57

[19] Bly L. A Historical And Current View Of The Basis Of NDT. Pediatric Physical Therapy 1991;3(3):131-135.

[20] Bobath K. The Normal Postural Reflect Mechanism And İts Deviation In Children With Cerebral Palsy. Physiotherapy 1971;57(11):526–532.

[21] Bobath K. A Neurophysiological Basis For Treatment Of Cerebral Palsy. Second edition.1980

[22] Bohannon RW. Smith MB. Interrater Reability Of A Modified Ashworth Scale Of Muscle Spasticity. Phys ther 1987;67(2): 206-207

[23] Bower E, McLellan DL. Effect Of Increased Exposure To Physiotherapy On Skill Acquisition Of Children With Cerebral Palsy. Dev Med Child Neurol 1992;34(1):25–39

[24] Boyd RN, Graham HK. Objective Measurement of Clinical Findings In The Use of Botulinum Toxin Type A for The Management of Children with Cerebral Palsy. European Journul of Neurology 1999; 6: 23-35.

[25] Brandäo M B., Mancini M C, Vaz D V, Bueno A M, Furtado S R C, Coelho Z A C. Effects Of Constraint-Induced Movement Therapy In Children With Hemiplegia: A Single Case Experimental Study. Revista Brasileira de Fisioterapia 2009; 13(6): 527-534.

[26] Brown J K. Walsh E G. Neurology of the upper limb. In: Neville B, Goodman R, editors. Congenital Hemiplegia. Clinics in Developmental Medicine No. 150. London: Mac Keith Press. 2000; p 113–149.

[27] Bumin G, Uyanik M, Yilmaz I, Kayihan H, Topçu M. Hydrotherapy for Rett Syndrome. J Rehabil Med 2003; 35(1): 44-45.

[28] Burns Y, Ensbey R, Norrie M. The Neurosensory Motor Developmental Assessment Part I & Part II. The Australian Journal of Physiotherapy 1989; 35: 141-157.

[29] Burns Y. NSMDA: Physiotherapy Assessment For Infants And Young Children. Brisbane 1992, Australia: Copyright Publishing Co Pty Ltd.

[30] Burns Y R, Danks M, O'Callaghan MJ, Gray PH, Cooper D, Poulsen L, et al Motor Coordination Difficulties And Physical Fitness Of Extremely-Low-Birthweight Children. Developmental medicine and child neurology 2009; 51 (2): 136-142.

[31] Butler C, Chambers H, Goldstein M. Evaluating Research In Developmental Disabilities: A Conceptual Framework For Reviewing Treatment Outcomes. Dev Med Child Neurol 1999; 41(1):55–59

[32] Butler C, Darrah J. AACPDM Evidence Report: Effects Of Neurodevelopmental Treatment (NDT) For Cerebral Palsy. Dev Med Child Neurol 2001;.43(11):778–790.

[33] Camper KS, Linden DWV, Palisano R J. Physical Therapy for Children. 2. ed. Philadelphia 2000: WB Saunders Company. p.: 534.

[34]   Cannell MB, Brumback BA, Bouldin E D et al. Age Group Differences In Healthcare Access For People With Disabilities: Are Young Adults At Increased Risk? JAdolescHealth. 2011; 49: 219–221.

[35]   Cans C, De-la-Cruz J, Mermet M A. Epidemiology of Cerebral Palsy. Paediatrics And Child Health, 2008; 18(9): 393-398

[36]   Carey W. Crocker A. Elias E. Feldman H. Coleman W. Developmental-Behavioral Pediatrics, 4th Edition, Saunders, Philadephia, 2009; 658-660

[37]   Castle K, Imms C, Howie L. Being In Pain: A Phenomenological Study Of Young People With Cerebral Palsy. Dev Med Child Neurol.2007; 49: 445–449.

[38]   Cauraugh J H, Naik S K, Wen Hao H, Coombes S A, Hol KG. Children With Cerebral Palsy: A Systematic Review And Metaanalysis On Gait And Electrical Stimulation. Clinical Rehabilitation 2011; 24: 963-978

[39]   Charles J R, Gordon A M. A Critical Review Of Constraint-Induced Movement Therapy And Forced Use In Children With Hemiplegia. Neural Plasticity 2005; 12(2-3): 245-61.

[40]   Charles J R, Wolf S L, Schneider JA, Gordon A M. Efficacy Of A Childfriendly Form Of Constraint-Induced Movement Therapy In Hemiplegic Cerebral Palsy: A Randomized Control Trial. Developmental Medicine and Child Neurology 2006; 48(8): 635-642.

[41]   Charles J R, Wolf S L. Invited Commentary. CIMT in Children with Cerebral Palsy. Physical Therapy 2009; 89:1142-1143.

[42]   Charles J R, Lavinder G, Gordon, A M. Effects Of Constraint-Induced Therapy On Hand Function In Children With Hemiplegic Cerebral Palsy. Pediatric Physical Therapy 2001; 13(2): 68-76.

[43]   Cheng R J, Liu C F, Lau T W, Hong R B. Effect of Treadmill Training with Body Weight Support on Gait and Gross Motor Function in Children with Spastic Cerebral Palsy. American Journal of Physical Medicine & Rehabilitation 2007; 86(7):548-555

[44]   Clopton N, Dutton J, Featherston T, Grisby A, Mobley J, Melvin J. Interrater And İntrarater Reliability Of The Modified Ashworth Scale In Children With Hypertonia. Pediatr. Phys. Ther 2005;17: 268-274.

[45]   Cope S M, Forst H C, Bibis D, Liu X C. Modified Constraint-Induced Movement Therapy For A 12-Month-Old Child With Hemiplegia: A Case Report. American Journal of Occupational Therapy 2008; 62(4):430-7.

[46]   Dali C, Hansen F J, Pedersen S A, Skov L, Hilden J, Bjørnskov I, Strandberg C, Christensen J, Haugsted U, Herbst G. Threshold Electrical Stimulation (TES) In Ambulant Children With CP: A Randomized Double-Blind Placebocontrolled Clinical Trial. Dev Med Child Neurol 2002; 44: 364–369.

[47] Damiano DL, Kelly LE, Vaughn CLB. Effects of Quadriceps Femoris Muscle Strengthening on Crouch Gait in Children With Spastic Diplegia. Physical Tehrapy 1995;75(8): 658-671.

[48] Damiano D L, Kelly L E, Vaughan C L. Effects Of A Quadriceps Femoris Strengthening Programme On Crouch Gait In Children With Cerebral Palsy. Phys Ther 1995; 75(8): 658-667.

[49] Damiano D. Physiotherapy Management In Cerebral Palsy:Moving Beyond Philosophies. In: Scrutton D, Damiano D, Myston M (Ed). Management Of The Motor Disorders Of Children With Cerebral Palsy. Mac Ketith Pres. London 2004; 161-169 .

[50] Damiano DL, Abel MF. Functional Outcomes Of Strength Training In Spastic Cerebral Palsy. Arch Phys Med Rehabil 1998; 79: 119–25.

[51] Damiano DL, Arnold SA, Steeled KM, Delp SL. Can Strength Training Predictably Improve Gait Kinematics? A Pilot Study on the Effects of Hip and Knee Extensor Strengthening on Lower- Extremity Alignment in Cerebral Palsy. Physical Therapy 2010; 90(2):269-279

[52] Damiano DL, Vaughan CL, Abel MF. Muscle Response To Heavy Resistance Exercise In Children With Spastic Cerebral Palsy. Dev Med Child Neurol 1995; 37: 732-739

[53] Day SM, Wu WV, Strauss DJ et al. Change In Ambulatory Ability Of Adolescents And Young Adults With Cerebral Palsy. Dev Med Child Neurol 49:2007; 647–653.

[54] DeGangi G, Royeen C. Current Practice Among Neurodevelopmental Treatment Association Members. Am J Occup Ther 1994;.48(9):803-809.

[55] Deluca PA. Gait Analysis In The Treatment Of Ambulatory Child With Cerebral Palsy. Clin. Orthop. Relat. Res 1991; 264:65-75.

[56] DeLuca S C, Echols K, Ramey S, Taub E. Pediatric Constraint Induced Movement Therapy For A Young Child With Cerebral Palsy: Two Episodes Of Care. Physical Therapy 2003; 83: 1003-1013.

[57] DeLuca S. Intensive movement therapy with casting for children with hemiparetic cerebral palsy: a randomised controlled trial. Dissertation, The University of Alabama at Birmingham, 2002.

[58] DiBiasio P, Lewis C. Exercise Training Utilizing Body Weight Supperted Treadmill Walking With Young Adult With Cerebral Palsy Who Was Non-Ambulatory. Physiotherapy Theory and Pract 2012; 28(8): 641-652.

[59] Dodd J K, Foley S. Partial Body-Weight-Supported Treadmill Training Can Improve Walking In Children With Cerebral Palsy: A Clinical Controlled Trial. Developmental Medicine & Child Neurology 2007;49(2): 101-105.

[60] Dodd KJ, Taylor, NF, Damiano DL. A Systematic Review Of The Effectiveness Of The Strength-Training Programs In People With Cerebral Palsy. Arch Phys Med Rehabil 2002, 83, 1157–64.

[61] Dormans J P. Pellegrino L. Caring For Children With Cerebral Palsy .. Baltimore: Brooks Publishing. 1998; 8-21

[62] Dormans J P. Pellegrino L. Caring For Children With Cerebral Palsy .. Baltimore: Brooks Publishing. 1998; 8-21

[63] Dumas H, Francesconi S. Aquatic Therapy In Pediatrics: Annotated Bibliography. Phys Occup Ther Pediatr 2001;20(4): 63-78.

[64] Eliasson A C, Krumlinde-sundholm L, Shaw K, Wang C. Effects Of Constraint Induced Movement Therapy In Young Children With Hemiplegic Cerebral Palsy: An Adapted Model. Developmental Medicine and Child Neurology 2005; 47(4):266-75.

[65] Engel JM, Jensen MP, Schwartz L (2006). Coping With Chronic Pain Associated With Cerebral Palsy. Occup Ther Int 13: 224–233.

[66] Engsberg JR, Ross SA, Hollander KW et al. Hip Spasticity And Strength In Children With Spastic Diplegia Cerebral Palsy. J Appl Biomech 2000; 16: 221–33.

[67] Ennis E. The Effects Of A Physical Therapy-Directed Aquatic Program On Children With Autism Spectrum Disorders. J Aquatic Phys Ther 2011; 19(1): 4-10.

[68] Evans P. Johnson A. Mutch L. Alberman E A. Standard Form For Reporting Clinical Findings in Children With A Motor Deficit of Central Origin. Dev Med Child Neurol 1989; 31(1):119-27.

[69] Exner C E. Development Of Hand Skills. In: Case-Smith J, editor. Occupational Therapy for Children. 4th Ed. St. Louis: Mosby. 2001; p 289–327.

[70] Fennell E B, Dikel TN: Cognitive And Neuropsychological Functioning In Children With Cerebral Palsy. J Child Neurol 2001; 16:58-63

[71] Fetters L, Kluzik J. The Effects Of Neurodevelopmental Treatment Versus Practice On The Reaching Of Children With Spastic Cerebral Palsy. Phys Ther 1996;.76(4): 346-358.

[72] Finlay H, Ainscough J, Craig J. et al. Current Clinical Practice In The Use Of Muscle Strengthening In Children And Young People With Cerebral Palsy - A Regional Survey Of Paediatric Physiotherapists. APCP Journal 2012; 3(1): 27-41

[73] Fletcher NA, Marsden CD. Dyskinetic Cerebral Palsy: A Clinical And Genetic Study. DevMed Child Neurol.1996; 38: 873–880.

[74] Fowler EG, Ho TW, Nwigwe AI, Dorey FJ. The Effect of Quadríceps Femoris Muscle Strengthening Exercises On Spasticity in Children With Cerebral Palsy. Physical Therapy2001; 81(1): 1215-1223

[75] Gajdosik CG, Cicirello N. Secondary conditions of the musculoskeletal system in adolescents and adults with cerebral palsy. Phys Occup Ther Pediatr. 2001; 21: 49–68.

[76] Garne E. Dolk H. Krägeloh-Mann I. Holst Ravn S. Cans C. SCPE Collaborative Group. Cerebral Palsy And Congenital Malformations. Eur J Paediatr Neurol. 2008; 12(2): 82-88

[77] Gibson C S. MacLennan A H. Goldwater P N. Dekker G A. Antenatal Cause Of Cerebral Palsy: Associations Between Inherited Thrombophilias, Viral And Bacterial Infection, And Inherited Susceptibility To Infection. 2003; 58(3):209-20.

[78] Giuliani CA. Dorsal Rhizotomy For Children With Cerebral Palsy: Support For Concepts Of Motor Control. Phys Ther 1991; 71: 248–59.

[79] Gordon A M, Charles J, Wolf S L. Efficacy Of Constraint-Induced Movement Therapy On İnvolved Upper-Extremity Use In Children With Hemiplegic Cerebral Palsy Is Not Age-Dependent. Pediatrics 2006; 117(3): 363-73.

[80] Gordon AM. Charles J. Duff S V. Fingertip Forces In Children With Hemiplegic Cerebral Palsy. II: Bilateral Coordination. Dev Med Child Neurol 1999; 41:176–185.

[81] Gracies JM, Burke K, Clegg NJ, Browne R, Rushing C, Fehlings D, et al. Reliability of the Tardieu Scale for Assessing Spasticity in Children With Cerebral Palsy. Arch Phys Med Rehabilitation 2010; 91:421-428.

[82] Graham HK, Harvey A, et al.The Functional Mobility Scale FMS.J Pediatre Orthop 2004; 24:514-520.

[83] Hamamci N, Dursun E. Serebral Palsi Rehabilitasyonu ve Guillain Barré Rehabilitasyonu. In: Oğuz h. (ed). Tibbi Rehabilitasyon. İstanbul: Nobel Tip Kitabevleri; 1995. p633-652

[84] Han T R. Bang M S. Lim J Y. Yoon B H. Kim I W. Risk Factors Of Cerebral Palsy In Preterm Infants. American Journal of Physical Medicine and Rehabilitation. 2005; 81: 297-303.

[85] Hergenröder H, Blank R. Subjective Well-Being And Satisfaction With Life In Adults With Spastic Cerebral Palsy: A Pilot Study Of A Randomized. Dev Med Child Neurol. 2009 May;51(5):389-96

[86] Herndon WA, Troup P, Yngve DA, Sullivan JA. Effects Of Neurodevelopmental Treatment On Movement Patterns Of Children With Cerebral Palsy. J Pediatr Orthop 1987;7(4):395-400.

[87] Heyrman L Molenaers G, Desloovere K, Verheyden G, De Cat J, Monbaliu E. Feys H. A Clinical Tool To Measure Trunk Control In Children With Cerebral Palsy: The Trunk Control Measurement Scale. Research in developmental Disabilities 2011;32(6): 2624–2635.

[88]   Hilberink SR, Roebroeck ME, Nieuwstraten W et al. Health Issues In Young Adults With Cerebral Palsy: Towards A Life-Span Perspective. J Rehabil Med.2007; 39: 605–611.

[89]   Hillier S, McIntyre A, Plummer L. Aquatic Physical Therapy For Children With Developmental Coordination Disorder: A Pilot Randomized Controlled Trial. Phys Occup Ther Pedi 2010; 30(2): 111-124.

[90]   Hoare B, Imms C, Carey L, Wasiak J. Constraint-Induced Movement Therapy In The Treatment Of The Upper Limb In Children With Hemiplegic Cerebral Palsy: A Cochrane Systematic Review.Clinical Rehabilitation 2007; 21: 675–685

[91]   Hodgkinson I, Jindrich ML, Duhaut P et al. Hip pain in 234 non-ambulatory adolescents and young adults with cerebral palsy: a cross-sectional multicentre study. Dev Med Child Neurol .2001; 43: 806–808.

[92]   Hutton JL, Pharoah PO. Life Expectancy In Severe Cerebral Palsy. Arch Dis Child. 2006; 91: 254–258.

[93]   Jahnsen R, Villien L, Aamodt G et al. Musculoskeletal Pain In Adults With Cerebral Palsy Compared With The General Population. J Rehabil Med. 2004b; 36: 78–84.

[94]   Jahnsen R, Villien L, Egeland T et al. Locomotion Skills In Adults With Cerebral Palsy. Clin Rehabil 2004a; 18: 309–316.

[95]   Jahnsen R, Villien L, Stanghelle JK et al. Fatigue In Adults With Cerebral Palsy In Norway Compared With The General Population. Dev Med Child Neurol 2003;45: 296–303.

[96]   Jensen MP, Moore MR, Bockow TB et al. Psychosocial Factors And Adjustment To Chronic Pain In Persons With Physical Disabilities: A Systematic Review. Arch Phys Med Rehabil.2011; 92: 146–160.

[97]   Johnson S, Marlow N. Developmental Screen Or Developmental Testing? Early human development 2006;82 (3): 173-183.

[98]   Jones M W, Morgan E, Shelton C E, Thorogood C, Cerebral Palsy: Introduction and Diagnosis (Part I). J Pediatr Health Care. 2007; 21: 146-152.

[99]   Kapadia N M, Nagai M K, Zivanovic V, Bernstein J, Woodhouse J, Rumney P, Popovic MR. Functional Electrical Stimulation Therapy for Recovery of Reaching and Grasping In Severe Chronic Pediatric Stroke Patients. Journal of Child Neurology 2013; 0: 1-7.

[100]   Kawamura C, Filh MCM, Barreto M M, Asa SKP, Juliano Y, Novo NF. Comparsion Between Visual And Three-Dimensional Gait Analysis In Patiens With Spastic Diplegic Cerebral Palsy. Gait Posture 2007; 25: 18-24.

[101]   Kent R. M. Cerebral palsy. Handbook of Clinical Neurology, 2013; 110 (3rd series. Neurological Rehabilitation M.P. Barnes and D.C. Good, Editors, Elsevier B.V.

[102] Kerem Gunel M. Physiotherapy For Children With Cerebral Palsy. In: Zeljka Petelin Gadze.(Ed).Epilepsy In Children-Clinical And Social Aspects. Rijeka:Intech; 2011.p213-134

[103] Kerem Gunel M. Rehabilitation Of Children With Cerebral Palsy From A Physio-therapist's Perspective. Acta Orthop Traumatol Turc 2009;43(2):173-181.

[104] Kerr C, McDowell B, McDonough S. Electrical Stimulation In Cerebral Palsy: A Re-view Of Effects On Strength And Motor Function. Dev Med Child Neurol 2004; 46: 205–213.

[105] King W, Levin R, Schmidt R et al. Prevalence Of Reduced Bone Mass In Children And Adults With Spastic Quadriplegia. Dev Med Child Neurol.2003; 45: 12–16.

[106] Kluzik J, Fetters L, Coryell J. Quantification Of Control: A Preliminary Study Of Ef-fects Of Neurodevelopmental Treatment On Reaching In Children With Spastic Cere-bral Palsy. Physical Therapy 1990; 70(2):65-76

[107] Krägeloh-Mann I. Cans C. Cerebral Palsy Update. Brain Dev, 2009; 31(7): 537-544

[108] Krigger KW (2006). Cerebral Palsy: An Overview. Am Fam Physician 73: 91–100.

[109] Krumlinde-Sundholm L. Eliasson A C. Development Of The Assisting Hand Assess-ment: A Rasch-Built Measure Intended For Children With Unilateral Upper Limb Impairments. Scan J Occup Ther. 2003; 10: 16–26.

[110] Kuban K. Leviton A. Cerebral Palsy. The New England Journal of Medicine. 1994; 330: 188-195.

[111] Kuhtz-Buschbeck J P. Krumlinde-Sundholm L. Eliasson A C. Forssberg H. Quantita-tive Evaluation Of Mirror Movements In Children With Hemiplegic Cerebral Palsy. Dev Med Child Neurol. 2000; 42: 728–736.

[112] Glader L, Tilton A. Cerebral Palsy. In: Carey W. Crocker A. Elias E. Feldman H. Cole-man W. (ed.) Developmental-Behavioral Pediatrics, 4th Edition, Saunders, Philade-phia, 2009; 658-662

[113] Law M, Russell D, Pollock N, Rosenbaum P, Walter S, King G. A Comparison Of İn-tensive Neurodevelopmental Therapy Plus Casting And A Regular Occupational Therapy Program For Children With Cerebral Palsy. Dev Med Child Neurol 1997;39(1):664- 670.

[114] Livanelioğlu A, Kerem Gunel M. Serebral Palside Fizyoterapi. Ankara: Yeni Özbek: 2009

[115] Loge JH, Kaasa S. Short Form 36 (Sf36) Health Survey: Normative Data From The General Norwegian population. Scand J Social Med.1998; 26: 250–258.

[116] Lonstein JE. The Spine In Cerebral Palsy. Current Orthopaedics 1995; 9:164-177

[117] Maathuis KBB, Van der Shans CP, Van iperen A, Riedman HS, Geertzen JHB. Gait In Children With Cerebral Palsy Observer Reliability Of Physcian Raiting Scale And

Edinburgh Vizual Gait Analysis Interval Testing Scale. J Pediatre Orthop 2005; 25:268-272

[118] MacDOnald J, Burns Y. Performance On The NSMDA During First And Second Year Of Life To Predict Functional Ability At The Age Of 4 In Children With Cerebral Palsy. Hong Kong Physiotherapy Journal 2005; 23: 40-45.

[119] MacPhail H E A, Kramer J F. Effect Of Isokinetic Strengthtraining On Functional Ability And Walking Efficiency In Adolescents With Cerebral Palsy. Dev Med Child Neurol 1995; 37(9):763–775.

[120] Masciento L R, Gloria A E, Habip E S. Effects Of Constraint-Induced Movement Therapy As A Rehabilitation Strategy For The Affected Upper Limb Of Children With Hemiparesis:Systematic Rewiev Of The Literature. Revista Brasileira de Fisioterapia 2009;13(2): 97-102.

[121] Mayston M. Bobath Concept: Bobath@50: Mid-Life Crisis--What Of The Future? Physiother Res Int 2008;13(3):131-136

[122] McBurney H, Taylor NF, Dodd KJ, Graham HK. A Qualitative Analysis Of The Benefits Of Strength Training For Young People With Cerebral Palsy. Dev Med Child Neurol 2003; 45: 658–63

[123] Miller, F. Physical Therapy of Cerebral Palsy.Wilmington 2007: Springer. 354-391.

[124] Miller F., Bagg M R. Age And Migration Percentage As Risk Factors For Progression In Spastic Hip Disease. Developmental medicine and child neurology. 1992; 37: 449-455

[125] Miller G. Cerebral Palsies: An Overview. In Miller G, Clark GD (eds): The Cerebral Palsies: Causes, Consequences, and Management, Boston, Butterworth-Heinemann, 1998; 1-35.

[126] Mockford M. Caulton JM. Systematic Review of Progressive Strength Training in Children and Adolescents with Cerebral Palsy Who Are Ambulatory. Pediatr Phys Ther 2008; 20(4):318-3

[127] Morris D M, Taub E. Constraint-Induced Therapy Approach To Restoring Function After Neurological Injury. Top Stroke Rehabil 2001; 8: 16–30.

[128] Moster D, Lie R T. Irgens L. Bjerkedal T, Markestad T. The Association Of Apgar Score With Subsequent Death And Cerebral Palsy: A Population-Based Study In Term Infants. Journal of Pediatrics. 2001; 138: 798-803.

[129] Msall M E, Digaudio K M, Duffy L C. Use Of Functional Assessment In Children With Developmental Disabilities. Phys Med Rehabi. Clin North Am 1993; 4: 517- 27.

[130] Murphy K P, Molnar G E, Lankasky K (1995). Medical And Functional Status Of Adults With Cerebral Palsy. Dev Med Child Neurol 37: 1075–1084.

[131] Mutlu A, Livanelioglu A, Kerem Gunel M. Reliability Of Ashworth And Modified Ashworth Scales In Children With Spastic Cerebral Palsy. BMC Musculoskeletal Disorders 2008;9:1471-2474.

[132] Mutlu A, Livanelioglu A, Kerem Gunel M. Reliability Of Goniometric Measurements In Children With Spastic Cerebral Palsy. Med Sci Monit 2007;13(7):323-329.

[133] Naeye R L. Peters E. Bartholomew M. Landis R. Origins Of Cerebral Palsy. American Journal of Disease of Children. 1989; 143: 1154-1161

[134] Naylor C E. Bower E. Modified Constraint Induced Movement Therapy For Young Children With Hemiplegic Cerebral Palsy: A Pilot Study. Developmental Medicine and Child Neurology 2005; 47: 365-369.

[135] Nelson K B, Ellenberg J H. Antecedents Of Cerebral Palsy-Multivariant Analysis. N Engl J Med. 1986; 315:81-86

[136] Nelson K B. Causes of Cerebral Palsy. Current Opinions in Pediatrics.1989; 11: 487-491.

[137] Nelson K B, Ellenberg J H. Antecedents Of Cerebral Palsy: Multivariate Analysis Of Risk. New England Journal of Medicine.1986; 315: 81–86

[138] Noreau L, Lepage C, Bernard P M. Recent Modality In Physical Therapy In Treatment Of Cerebral Palsy. Phys. Ther 2008; 78(5): 458- 469.

[139] Novacheck T, Stout J, Tervo R. Reliability And Validity Of The Gilette Functional Asessment Questioner As An Outcome Measure In Children With Walkinh Diasbilities. Journal of pediatric orthopaedics 2000; 20(1): 75 -81

[140] Opheim A, Jahnsen R, Olsson E et al. Walking Function, Pain, And Fatigue In Adults With Cerebral Palsy: A 7-Year Follow-Up Study. Dev Med Child Neurol.2009;51: 381–388.

[141] Ottenbacher KJ, Msall ME, Lyon N, Duffy LC, Granger CV, Braun S. Measuring Developmental And Functional Status In Children With Disabilities. Dev Med Child Neurol 1999;.41(3):186-194.

[142] Palisano R, Rosenbaum P, Walter S, Russell D, et al. Development And Reliability Of A System To Classify Gross Motor Function In Children With Cerebral Palsy. Dev Med Child Neurol 1997;39(4):214-223.

[143] Palisano R J, Campbell S K, Harris S R. Evidence- Based Decision Making In Pediatric Physical Therapy. In: Campbell SK, Vander Linden D W Palisano R J (ed). Physical therapy for children. 3rd ed. Missouri: Saunders Elsevier, 2006: 0-32

[144] Palisano R, Rosenbaum P, Backett P, Livingston M. Gross Motor Function Classification System Expended And Revised. Dev Med Child Neurol 2007;39 : 214-223.

[145] Patrick JH, Roberts P, Cole GF.Therapeutic Choise In Locomotor Management Of The Child With Cerebral Palsy- More Luck Than Judgement?. Arch. Dis. Chil 2001; 85: 275-279.

[146] Pharoah P, Cooke T, Rosenbloom L. Acquired Cerebral Palsy. Arch Dis Child. 1989; 64: 1013-1016

[147] Pieber K, Herceg M, Wick F, Grim-Stieger M, Bernert G, Paternostro-Sluga T. Functional Electrical Stimulation Combined With Botulinum Toxin Type A To Improve Hand Function In Children With Spastic Hemiparesis – A Pilot Study. Wien Klin Wochenschr 2011; 123: 100–105.

[148] Pierce S, Daly K, Gallagher K. Constraint Induced Therapy For A Child With Hemiplegic Cerebral Palsy: A Case Report. Archive of Physical Medicine and Rehabilitation 2002;83:1462-1463.

[149] Pimm P (1992). The Progression Of Cerebral Palsy In Adulthood. Educational and Child Psychology 9: 3–4.

[150] Poulos AE, Balandin S, Llewellyn G et al. Women With Cerebral Palsy And Breast Cancer Screening By Mammography. Arch Phys Med Rehabil . 2006;87: 304–307.

[151] Quint C, Toomey M. Powered Saddle And Pelvic Mobility: An Investigation Into The Effects On Pelvic Mobility Of Children With Cerebral Palsy Of A Powered Saddle Which Imitates The Movements Of A Walking Horse. Physiotherapy 1998; 84: 376–84.

[152] Reddihough DS, Baikie G, Walstab JE. Cerebral palsy in Victoria, Australia: Mortality And Causes Of Death.J Paediatr Child Health.2001; 37: 183–186.

[153] Reed B. The Physiology Of Neuromuscular Electrical Stimulation. Pediatr Phys Ther. 1997; 9: 96–102.

[154] Ries J D. Leonard R. Is There Evidence To Support The Use Of Constraint-Induced Therapy To Improve The Quality Or Quantity Of Upper Extremity Function Of A 2 1/2-Year-Old Girl With Congenital Hemiparesis? If So, What Are The Optimal Parameters Of This İntervention? Phyical Therapy 2006; 86: 746-752.

[155] Rosembaum P, Panet N, Leviton A, Goldstein M, Bax M. A Report: The Definiation And Classification Of Cerebral Palsy. Dev Med Child Neurol 2007 49: 7-14

[156] Rosembaum P. Cerebral Palsy: What Parents and Doctors Want to Know. British Medical Journal. 2003; 326, 970-974.

[157] Rosenbaum P, Paneth N, Leviton A, et al. A Report: The Definition And Classification Of Cerebral Palsy. Dev Med Child Neurol. 2007; 109:8-14

[158] Ross S A, Engsberg JR. Relitionship Between Spasticity, Strenght, Gait And The GMFM -66 İmpersons With Spastic Diplegia Cerebral Palsy. Arch Phys Med Rehabil 2007; 88(9): 1114-1120

[159]   Rudank S L. Fellman V. Laatikainen L. Visual Impairment In Children Born Prema-
turely From 1972-1989. Ophthalmology 2003; 110:1639-1645

[160]   Russell D J, Rosenbaum P L, Cadman D T, Gowland C, et al. The Gross Motor Func-
tion Measure: A Means To Evaluate The Effects Of Physical Therapy. Dev Med Child
Neurlo 1989;32(3):341-352.

[161]   Russell D J, Avery L M, Rosenbaum P L, Raina P S, Walter S D, Palisano R J. Im-
proved Scaling Of The Gross Motor Function Measure For Children With Cerebral
Palsy: Evidence Of Reliability And Validity. Phys Ther 2000;80(9):873-885.

[162]   Rutherford O M. Muscular Coordination And Strength Training: Implications For In-
jury Rehabilitation. Sports Med 1988; 5: 196–202

[163]   Saito N. Ebara S, Ohotsuka K et al. Natural History Of Scolipsis In Spastic Cerebral
Palsy, Lancet. 1998; 351: 1687-1692

[164]   Sakzewski L, Ziviani J, Abbott D F, Macdonell R A, Jackson G D, Boyd R N. Partici-
pation Outcomes In A Randomized Trial Of 2 Models Of Upper-Limb Rehabilitation
For Children With Congenital Hemiplegia. Archives of Physical Medicine and Reha-
bilitation 2001;92 (4): 531-9.

[165]   Sandstrom K. The lived body _ experiences from adults with cerebral palsy. Clin Re-
habil. 2007; 21: 432–441.

[166]   Sanger T D. Delgado M R. Gaebler- Spira D. Hallett M. Mind J W. Classification And
Definition Of Disorders Causing Hypertonia In Childhood. Pediatrics. 2003; 111:
89-97.

[167]   Schwartz M. Kinamatics of Normal Gait. In: GAGE, J. (Ed). The Indentification And
The Treatment Of Gait Problems In Cerebral Palsy. London. Mac Keith Pres. 2009; p.:
99-133.

[168]   Scianni A, Butler JM, Ada L, Teixeira- Salmela LF. Muscle Strengthining Is Not Effec-
tive In Children And Adolescents With Cerebral Palsy: A Systematic Review. Aus-
tralian Journal of Physiotheraphy 2009. 55: 81-87.

[169]   SCPE Collaborative Group. Surveillance Of Cerebral Palsy In Europe: A Collabora-
tion Of Cerebral Palsy Surveys And Registers. Dev Med Child Neurol 2000;
42:816-24.

[170]   Scrutton D, Baird G, Smeeton N. Hip Dsyplasia In Bilateral Crebral Palsy: Indidence
And Natural History in Children Aged 18 Months To 5 Years. Developmental medi-
cine and child Neurology. 2001; 43: 586-600.

[171]   Scrutton D. Baird G. Surveillance Measures Of The Hips Of Children With Bilateraly
Cerebral Palsy. Archives of disease in childhood. 1997; 56: 381-384

[172]   Scrutton D. Damiano D. Myston M. Management Of The Motor Disorders Of Chil-
dren With Cerebral Palsy. Mac Keith Pres. 2004; p 12-14

[173] Scrutton D. Physical Assessment And Aims Of Treatment. In: Neville B, Goodman R, Editors. Congenital Hemiplegia. Clinics in Developmental Medicine No.150. London: Mac Keith Press. 2000; 65–80.

[174] Sköld A. Josephsson S. Eliasson A C. Performing Bimanual Activities – The Experiences Of Young Persons With Hemiplegic Cerebral Palsy. Am J Occup Ther. 2004; 58: 416–425.

[175] Spittle AJ, Brown NC, Doyle LW, Boyd RN, Hunt RW, Bear M et al. Quality Of General Movements Is Related To White Matter Pathology In Very Preterm Infants. Pediatrics 2008; 121 (5):184-1189.

[176] Spittle AJ, Doyle LW, Boyd RN. A Systematic Review Of The Clinimetric Properties Of Neuromotor Assessments For Preterm Infants During The First Year Of Life. Developmental medicine and child neurology 2008; 50 (4): 254-266.

[177] Stanger M. Oresic S. Rehabilitation Approaches For Children With Cerebral Palsy: Overview. J Child Neurol 2003;18(1):79-88

[178] Strauss D, Ojdana K, Shavelle R et al. Decline In Function And Life Expectancy Of Older Persons With Cerebral Palsy. Neurorehabilitation.2004; 19: 69–78.

[179] Styer-Acevedo J. Physical Therapy For The Child With Cerebral Palsy. In: Tecklin JS.Pediatric Physical Therapy (3rd ed). Lippincott Williams&Wilkins. Philadelphia 1999:107-162.

[180] Sullivan P. Lambert B. Rose M. Et al. Prevalence And Severity Of Feeding And Nutritional Problems In Children With Neurological Impairment: Oxford Feeding Study. Dev Med Child Neurol. 2000; 42: 674-680

[181] Şik B Y, Çekmece Ç, Dursun N, Dursun E, Balikçi E, Altunkanat Z, Gülcü MA. Hippoterapi Serebral Palsili Çocuklarin Rehabilitasyonunda Yararli mıdır? .Turkiye Klinikleri J Med Sci 2012; 32(3): 601-8.

[182] Taft L T. Cerebral Palsy. Pediatrics in Review. 1995; 16: 411-418.

[183] Taft, L. T. Accentuating The Positive For Children With Cerebral Palsy. Exceptional Parent, 1999; 29: 64-66.

[184] Taub E, Griffin A, Nick J, Gammons K, Uswatte G, Law C R. Pediatric CI Therapy For Stroke-Induced Hemiparesis In Young Children. Developmental neurorehabilitation 2007; 10 (1): 3-18.

[185] Taub E, Ramey S L, DeLuca S C, Echols K. Efficacy Of Constraint-Induced Movement Therapy For Children With Cerebral Palsy With Asymmetric Motor Impairment. Pediatrics 2004; 113(2): 305-12.

[186] Taub E, Uswatte G, Pidikiti R. Constraint Induced-Movement Therapy: A New Family Of Techniques With Broad Application To Physical Rehabilitation - A Clinical Review. Journal of Rehabilitation Research and Development 1999; 36: 237-251.

[187] Pountney T. Cerebral Palsy. In , Pountney T (ed). Physical therapy For Children.Butterworth Heinemann Elsevier. USA. 2007: 90-108

[188] Thomas A, BaxM, Smyth D. The Health and Social Needs of Young Adults With Physical Disabilities. 1989. MacKeith Press, Blackwell Scientific Publications Ltd, Oxford.

[189] Thorpe D, Reilly M, Case L. The Effects Of An Aquatic Resistive Exercise Program On Ambulatory Children With Cerebral Palsy. J Aquatic Phys Ther 2005;13(2):21-24

[190] Trauner D A. Ballantyne A. Friedland S. Et al. Disorders Of Affective And Linguistic Prosody In Children After Early Unilateral Brain Damage. Ann Neurol. 1996; 39:361-367

[191] Truwit C L. Barkovich A J. Koch T K. Ferriero D M. Cerebral Palsy: MR Findings In 40 Patients. American Journal of Neuroradiology 1992; 13: 67-78.

[192] Tsorlakis N, Evaggelinou C, Grouios G, Tsorbatzoudis C. Effect Of Intensive Neurodevelopmental Treatment In Gross Motor Function Of Children With Cerebral Palsy. Dev Med Child Neurol 2004;46(11):740–745

[193] Turk M, Geremski C, Rosenbaum P (1997). The Health Status Of Women With Cerebral Palsy. Arch Dis Child 78: S10–S17.

[194] Uvebrant P. Hemiplegic Cerebral Palsy Aetiology And Outcome. Acta Paedtr Suppl. 1988; 34: 1–100.

[195] Vos-Vromans D C, Ketelaar M, Gorter JW. Responsiveness Of Evaluative Measures For Children With Cerebral Palsy: The Gross Motor Function Measure And The Pediatric Evaluation Of Disability Inventory. Disabil Rehabil 2005;27(20):1245-1252.

[196] Wiley ME., Damiano DL. Lowe-Extremity Strength Profiles In Spastic Cerebral Palsy. Dev Med Child Neurol 1998; 40: 100-107

[197] Winchester P, Kendall K, Peters H, Sears N, Winkley T. The Effect Of Therapeutic Horseback Riding On Gross Motor Function And Gait Speed In Children Who Are Developmentally Delayed. Phys Occup Ther Pediatr 2002; 22: 37–50.

[198] World Confederation for Physical Therapy. Terminology In Aquatic Physical Therapy. Available at: http://www.wcpt.org/apti/terminology. Accessed july. 2013.

[199] Wright A P. Durham S, Ewins D J, Swain IS. Neuromuscular Electrical Stimulation For Children With Cerebral Palsy: A Review. Arch Dis Child 2012; 97:364–371.

[200] Wu YW, Day SM, Strauss DJ et al. (2004). Prognosis for ambulation in cerebral palsy: a population-based study. Pediatrics 114: 1264–1271.

[201] Zadnikar M, Kastrin A. Effects Of Hippotherapy And Therapeutic Horseback Riding On Postural Control Or Balance In Children With Cerebral Palsy: A Meta-Analysis. Dev Med Child Neurol 2011; 53(8): 684-91.