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Analysing of Ankle-Foot Deformities in Cerebral Palsied Children: A Retrospective Study

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In this retrospective study, we aimed to describe the distribution of the number and its percentages of ankle foot deformities caused by Cerebral Palsy (CP) in disabled children who have attend in several special education and rehabilitation centers in Turkey so as to improve their quality of life. A total of 436 children with CP (205 female and 231 male) were aged between 10 and 468 months (mean±SD: 91.94±63.61), who have been treated in selected special education and rehabilitation centers for this study, were analyzed about ankle-foot deformities. During analyzing medical files belong to all subjects were detected to obtain the data. Deformity percentage in both sides (bilateral) demonstrated a grater value relative to the matched the only side, including right or left side. It was also found that equinovarus deformity in ankle-foot showed a high percentage (n= 146, 33.5%) much more than the other type of deformities in both female (31.3%) and male (35.5%) cerebral palsied children. In addition, the pes planus deformity was detected as the second high valued deformity (26.1%) among all subjects. On the other hand, talipes calcaneus deformity had the lowest percentage in the study. As expected, the high frequency of the deformities was found in the spastic cerebral palsied children (n= 243). Otherwise the low frequency about deformities was detected in the diskinetic cerebral palsied children (n=5). In the present study, both equinovarus and pes planus deformities of the ankle-foot in cerebral palsied children were found as high percentage deformities in both genders. Moreover, spastic type CP leads to ankle-foot deformities much more than other types of CP.

Key words: Cerebral palsy, ankle-foot, deformity

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INTRODUCTION

Cerebral Palsy (CP) is defined as a disorder of movement and posture due to a defect or lesion of the immature brain before second year of the lifespan CP is characterized by pathological changes especially in neuromuscoloskeletal system and is associated with incoordination movements abnormal postural defect and decreased perception and sense[1-3].

CP was described first time in 1862 by English Orthopedic Surgeon W.L. Little as a nonprogressive disorder of the immature brain[2]. Atered muscle tone is often one of the earliest signs of CP. An early hypotonia a few weeks or months to as long as one year after birth gives way to hypertonicity and abnormal postures, such as scissoring and extension of the lower extremities or persistent flexion and a fisted hand in the upper extremities CP is often manifest as spastic hemiplegia, spastic diplegia, or spastic quadriplegia in the athetoid form associated with basal ganglia involvement involuntary twisting movements of one or all extremities are observed. CP is described if infants have the potential to acquire developmental disabilities during childhood as a result of events that occurred prenatally, perinatally, or postnatally. Infants and children with CP have distinctly different physical therapy problems from those demonstrated by adults. Foremost infants and children rapidly develop[3-6].

In treatment of infants and children with CP, objective information is the cornerstone for defining the child's problem in biomechanical, neurological, motor developmental, or functional term. Deformity is commonly perceived and evaluated within a biomechanical perspective in physical therapy program. Health providers especially physical therapists who work with cerebral palsied children must also pay attention neurological and developmental aspects of deformities. Although deformity commonly presents in subjective assessment as a compliant about appearance, deformity may lead to delay or failure to achieve motor milestones and therefore represent the absence of functional ability that is normal for the child's age group. Fore these reasons, deformities should be required to analyze biomechanical, musculoskeletal, neurological and functional aspects of orthopedic problems must be evaluated when working with cerebral palsied children[7]. The aim of this study was to identify and to analyze ankle-foot deformities in children with CP.

MATERIALS AND METHODS

This present study was carried out in different cities in Turkey between 2002 and 2003 years under supervision-trained physical therapists from School of Physical Therapy and Rehabilitation at Pamukkale University in Denizli. Children with CP were included in the study from selected randomly special education and rehabilitation centers for cerebral palsied children in Denizli and its around region. The children who met the inclusion criteria were evaluated concerning ankle-foot deformities. The inclusion criteria were: children with a diagnosis of CP and children who had a medical file in the CP center. Cerebral palsied children were recruited from special education and rehabilitation centers for cerebral palsied children in Denizli region that selected randomly were studied. Four hundred and thirty six cerebral palsied children were included in the study; detecting his/her medical file with authorized and trained in cerebral palsy rehabilitation physical therapists who work in the selected CP centers. Preliminary data including the child's name and nickname, sex, date of birth and present age, gestational age and birth weight was recorded. Demographic data for the sample that completed the study (n=436) are shown in Table 1.

Delivery history: A description of the delivery history included factors such as type of labor, type of delivery, complications of delivery, presentation of infant, etc. The mother's pregnancy history was also recorded.

Cerebral palsy history: CP history included important factors such as type of CP, reason of CP, clinic type of CP, type of CP based on involved limbs.

Ankle-foot deformity data: The medical files of all children in the study were detected to obtain a complete data concerning ankle-foot deformities such as pes planus, pes cavus, pes planovalgus, talipes calcaneovalgus, talipes calcaneus, talipes valgus, talipes varus and equinovarus, so on. All preliminary descriptive information about the sample is shown in Table 2.

Statistical analysis: A total of 436 cerebral palsied children's results were given as number (n) and percentage (%). This is a retrospective study and results were given by gender. Therefore, no comparative statistical methods were used.

Table 1: Demographic data and physical features at study entry (N: 436)

Data	Mean±SD	
Age (months)	91.94±63.61	
Height (cm)	113.18±36.07	
Weight (kg)	23.69±12.80	
Gender	n	(%)
Female	205	47.0
Male	231	53.0

Table 2: Descriptive characteristics in patients with CP who were analyzed in the study

Variables		N	%
Type of labor	Normal birth	290	66.5
	Caesarcan section	131	30.0
	Other	15	3.4
Type of birth	Preterm	153	35.1
	Term	283	64.9
Reason	Prenatal	113	25.9
	Perinatal	248	56.9
	Postnatal	75	17.2
Clinic type	Spastic	341	78.2
	Dyskinetic	5	1.1
	Ataxic	19	4.4
	Athetoid	32	7.3
	Hypotonic	34	7.8
	Mix type	5	1.1
Involved limb	Monoplegia	9	2.1
	Paraplegia	47	10.8
	Hemiplegia	68	15.6
	Triplegia	4	0.9
	Quadriplegia	146	33.5
	Diplegia	86	19.7
	Both hemiplegia	4	0.9
Motordevelopmental stage	Apedal	109	25.0
	Quadripedal	133	30.5
	Bipedal	194	44.5
Operation history	yes	65	14.9
	no	371	85.1
Using orthesis	yes	228	52.3
	no	208	47.7

RESULTS

Four hundred and thirty six children with various types of CP were analyzed in order to identify the distribution of ankle-foot deformities according to gender, reason of CP, clinic type of CP, motor developmental stage, or sort of involved extremity. All results of this present study are given as number (n) and its percentage (%) for right ankle-foot, left ankle-foot and both sides, respectively. As expected, localization of the deformities was detected in both sides. And the percentage of equinovarus deformity in both sides was very high (n=146; 33.5%) relative to the matched other deformities, otherwise the percentage of talipes calcaneus deformity was the most lowest (n=1; 0.2%). The further information about other deformities percentages was given in Table 3.

Table 3: Number and percentage of the deformities in cerebral palsied children (N= 436) by right, left and both side ankle-feet

	Right ankle-foot		Left ankle-foot		Both sides	
Deformity	N	%	N	%	N	%
Pes planus	16	3.7	8	1.8	114	26.1
Pes cavus	-	-	1	0.2	8	1.8
Pes planovalgus	8	1.8	3	0.7	39	8.9
Talipes calcaneovalgus	2	0.5	3	0.7	15	3.4
Talipes calcaneus	1	0.2	-	-	1	0.2
Talipes valgus	5	1.1	1	0.2	19	4.4
Talipes varus	4	0.9	1	0.2	19	4.4
Equinovarus	21	4.8	20	4.5	146	33.5

A high percentage about equinovarus deformity was detected in both sides for females and males (females: n= 64, 31.3%; males: n= 82, 35.5%) (Table 4).

According to the reason of the CP such as prenatally, perinatally, or postnatally, the most highest percentage of the deformities was detected as equinovarus deformity in both side, too (prenatal: n: 40, 35.4%, perinatal: n=76, 34.7%, postnatal:n =20, 26.7%) (Table 5).

When we analyzed the number and its percentages of the deformities of the sample by clinic type of CP, including spastic, diskinetic, ataksik, athetoid, hypotonic, or mix, deformity frequency was greater in the spastic cerebral palsied children than the others. Otherwise the lowest deformity frequency was detected in the diskinetic cerebral palsied children relative to the matched other types of CP (Table 6).

A high percentage of the equinovarus deformity was detected for apedal (38.5%), quadripedal (41.3%) and bipedal (25.3%) motordevelopmental stage (Table 7).

We also analyzed the distribution of the percentages of the deformities according to type of involved limbs in the children with CP who were included in the study and then detected the hemiplegic or quadriplegic cerebral palsied children have had a high deformity percentage much more than the other types of CP (Table 8).

Table 4: Distribution of the number (N) and its percentage (%) of deformities in sample by gender

		Pes planus		Pes cavus		Pes planovalgus		Talipes calcaneovalgus		Talipes calcaneus		Talipes valgus		Talipes varus		Equinovarus	
Gender	Extremity	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Female	Right ankle-foot deformity	7	3.4	-	-	3	1.5	1	0.5	-	-	1	0.5	3	1.5	11	5.4
	Left ankle-foot deformity	3	1.5	-	-	1	0.5	2	1.0	-	-	1	0.5	1	0.5	7	3.4
	Both side deformity	54	26.3	3	1.5	21	10.2	8	3.9	-	-	8	3.9	10	4.9	64	31.3
Male	Right ankle-foot deformity	9	3.9	-	-	5	2.2	1	0.4	1	0.4	4	1.7	1	0.4	10	4.3
	Left ankle-foot deformity	5	2.2	1	0.4	2	0.9	2	0.9	-	-	-	-	-	-	13	5.6
	Both side deformity	60	26.0	5	2.2	18	7.8	7	3.0	1	0.4	11	4.8	9	3.9	82	35.5

Table 5: Distribution of the number (N) and percentages (%) of the deformities by prenatal, perinatal and postnatal reasons

Reason of CP	Extremity	Pes planus		Pes cavus		Pes planovalgus		Talipes calcaneovalgus		Talipes calcaneus		Talipes valgus		Talipes varus		Equinovarus	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Prenatal	Right ankle-foot deformity	6	5.3	-	-	1	0.9	1	0.9	-	-	3	2.7	1	0.9	4	3.6
	Left ankle-foot deformity	1	0.9	-	-	2	1.8	1	0.9	-	-	-	-	-	-	2	1.8
	Both side deformity	30	26.5	3	2.7	14	12.4	8	7.1	-	-	5	4.4	5	4.4	40	35.4
Perinatal	Right ankle-foot deformity	6	2.4	-	-	6	2.4	1	0.4	-	-	2	0.8	1	0.4	9	3.6
	Left ankle-foot deformity	5	2.0	-	-	-	-	2	0.8	-	-	1	0.4	-	-	14	5.6
	Both side deformity	62	25.0	3	1.2	21	8.5	5	2.0	1	0.4	11	4.4	10	4.0	76	34.7
Postnatal	Right ankle-foot deformity	4	5.3	-	-	1	1.3	-	-	1	1.3	-	-	2	2.7	8	10.6
	Left ankle-foot deformity	2	2.7	1	1.3	1	1.3	1	1.3	-	-	-	-	1	1.3	4	5.3
	Both side deformity	22	29.3	2	2.7	4	5.3	2	2.7	-	-	3	4.0	4	5.3	20	26.7

Table 6: Distribution of the deformities by clinic types of CP

Clinic type	Extremity	Pes planus		Pes cavus		Pes planovalgus		Talipes calcaneovalgus		Talipes calcaneus		Talipes valgus		Talipes varus		Equinovarus	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Spastic	Right ankle-foot deformity	16	4.7	-	-	6	1.8	2	0.6	-	-	5	1.5	4	1.2	3	0.9
	Left ankle-foot deformity	6	1.8	1	0.3	3	0.9	2	0.6	-	-	-	-	1	0.3	2	0.6
	Both side deformity	81	23.8	7	2.1	34	10.0	15	4.4	1	0.3	16	4.7	19	5.6	19	5.6
Dyskinetic	Right ankle-foot deformity	-	-	-	-	1	20.0	-	-	-	-	-	-	-	-	-	-
	Left ankle-foot deformity	1	20.0	-	-	-	-	-	-	-	-	-	-	-	-	1	20.0
	Both side deformity	2	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ataxic	Right ankle-foot deformity	-	-	-	-	-	-	-	-	1	5.3	-	-	-	-	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	7	36.8	-	-	1	5.3	-	-	-	-	2	10.5	-	-	1	5.3
Athetoid	Right ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3.1
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6.3
	Both side deformity	14	43.8	-	-	2	6.3	-	-	-	-	-	-	-	-	2	6.3
Hypotonic	Right ankle-foot deformity	-	-	-	-	1	2.9	-	-	-	-	-	-	-	-	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	1	2.9	-	-	1	2.9	-	-	-	-
	Both side deformity	9	26.5	1	2.9	2	5.9	-	-	-	-	-	-	-	-	3	8.8
Mix Type	Right ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Left ankle-foot deformity	1	20.0	-	-	-	-	1	20.0	-	-	-	-	-	-	-	-
	Both side deformity	1	20.0	-	-	-	-	-	-	-	-	1	20.0	-	-	1	20.0

Table 7: Distribution of the deformities by motordevelopmental stage in the sample

Motor develop-mental stage	Extremity	Pes planus		Pes cavus		Pes planovalgus		Talipes calcaneovalgus		Talipes calcaneus		Talipes valgus		Talipes varus		Equinovarus	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Apedal	Right ankle-foot deformity	3	2.8	-	-	2	1.8	-	-	-	-	-	-	-	-	2	1.8
	Left ankle- foot deformity	-	-	-	-	1	0.9	-	-	-	-	-	-	-	-	3	2.7
	Both side deformity	26	23.9	6	5.5	10	9.2	8	7.3	-	-	5	4.6	4	3.7	42	38.5
Quadripedal	Right ankle-foot deformity	5	3.8	-	-	2	1.5	1-	0.8	1	0.8	2	1.5	1	0.8	8	6.1
	Left ankle- foot deformity	2	1.5	-	-	-	-	-	-	-	-	1	0.8	-	-	6	4.6
	Both side deformity	39	29.3	1	0.8	7	5.3	2	1.5	1	0.8	7	5.3	6	4.5	54	41.3
Bipedal	Right ankle-foot deformity	8	4.1	-	-	4	2.1	1	0.5	-	-	3	1.5	3	1.5	11	5.7
	Left ankle- foot deformity	6	3.1	-	1	2	1.0	3	1.5	-	-			1	0.5	11	5.7
	Both side deformity	49	25.3	-	1	22	11.3	5	2.6	-	-	7	3.6	9	4.6	49	25.3

DISCUSSION

CP results from an injury in the developing brain, which can occur in utero during delivery, or during the first 2 years of life[1,2].

CP involves one or more limbs and frequently the trunk. It causes disturbances of voluntary motor function and produces a variety of symptoms, such as abnormal postures, loss of sense and perception, spinal and limbs deformities etc.[5]. Primary or secondary abnormalities within the spinal cord can increase spasticity and pain can also exacerbate it. Spasticity associated with CP can lead to musculoskeletal complications, including contractures, deformities, or subluxation so on[8,9].

Deformity to lower extremities decreases mobility and functional status resulting in reducing the standing, walking, running, climbing stairs of the cerebral palsied children[10]. CP cannot be cured. However most children who have CP receive multimodal therapy-for example, physical, occupational and speech therapies; orthopedic surgery; spasticity management and special educational support services. From infancy to adulthood, physical

Table 8: Distribution of the percentages of the deformities by involved limbs

Involved limb	Extremity	Pes planus		Pes cavus		Pes planovalgus		Talipes calcaneovalgus		Talipes calcaneus		Talipes valgus		Talipes varus		Equinovarus	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Monoplegia	Right ankle-foot deformity	-	-	-	-	-	-	-	-	1	11.1	-	-	1	11.1	-	-
	Left ankle-foot deformity	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	1	11.1	1	11.1		-	-	-	-	-	-	-	-	-	1	11.1
Paraplegia	Right ankle-foot deformity	1	2.1	-	-	-	-	1	2.1	-	-	-	-	1	2.1	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	13	27.7	-	-	12	25.5	1	2.1	-	-	1	2.1	4	8.5	2	4.3
Hemiplegia	Right ankle-foot deformity	12	17.6	-	-	6	8.8	1	1.5	-	-	4	5.9	2	2.9	1	1.5
	Left ankle-foot deformity	4	5.9	1	1.5	2	2.9	2	2.9	-	-	-	-	1	1.5	2	2.9
	Both side deformity	4	5.9	1	1.5	1	1.5	-	-	-	-	1	1.5	-	-	-	-
Triplegia	Right ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	2	50.0	-	-	1	25.5	1	25.0	-	-	-	-	-	-	1	25.0
Quadriplegia	Right ankle-foot deformity	3	2.1	-	-	-	-	-	-	-	-	-	-	-	-	2	1.4
	Left ankle-foot deformity	2	1.4	-	-	1	0.7	-	-	-	-	-	-	-	-	2	1.4
	Both side deformity	44	30.1	5	3.4	17	11.6	10	6.8	1	0.7	12	8.2	12	8.2	9	6.2
Diplegia	Right ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	1	1.2	-	-	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	26	30.2	1	1.2	5	5.8	3	3.5	-	-	3	3.5	3	3.5	7	8.1
Double-Hemipegia	Right ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Left ankle-foot deformity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Both side deformity	1	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

therapy for children with CP focuses on the prevention of disability by minimizing the effects of functional limitation and impairment, preventing or limiting secondary impairments and helping the child compensate for functions when necessary. Achieving these goals involves the promotion and maintenance of musculoskeletal integrity, the prevention of secondary deformity, the enhancement of optimal postures and movement to promote functional independence and optimal levels of quality of life. At all ages these children with hypoextensibility and spasticity are prone to developing contractures and deformities in spine or limbs. Contractures or deformities in ankle-foot can affect negatively the locomotor system especially standing and walking activities. Moreover in some causes, contractures or deformities prevent to wear their shoes or walking aids apparatus[5,7,10].

In a study of adult women with CP living in community, Turk *et al.*[1] found that a high prevalence of comorbid conditions such as seizures (40%) mental retardation (34%) and learning disabilities (26%), secondary conditions included significant musculoskeletal pain (49%) poor dental health (43%) and spinal and limb deformities (59%). There are several studies in the literature reporting that cerebral palsied children with severe lower extremities deformities resulting in impairment of standing and walking skills had the greatest risk of mobility during childhood. In Turk's study, deformities in spine and limbs are in the second line[11].

As understood adults with CP have a high rate of complications that may decrease their ability to achieve their potential in his/her treatment program[10,12].

Like children who don't have disabilities, cerebral palsied children want to walk, run, or climbing the stairs independently to have meaning full roles in society.

In this present study, greater numbers of deformities such as equinovarus, pes planus, pes cavus, pes planovalgus and talipes calcaneus were detected in cerebral palsied children who were studied. In the same time, the equinovarus deformity of the ankle-foot had a higher percentage more than the other deformities. And the pes planus deformity had a second higher percentage. Otherwise the pes planus deformities had a higher percentage than other deformities when we compared the result according to classification based on: involved limb such as monoplegia, paraplegia, hemiplegia, triplegia, quadriplegia, or diplegia. Foremost, in our study, the higher percentage of pes planus deformity was detected in triplegic cerebral palsied children. By DeLuca[3] and Galancy[13], it was found that the higher percentage for the equinovarus and pes planovalgus deformities were in quadriplegic cerebral palsied children .

In an other study by Banks[14], it was found that ankle and foot deformities in cerebral palsied children such as equines, equinovalgus, equinovarus, calcaneus and hallux valgus had higher percentages.

Acar *et al.*[15] detected a higher percentage of the postural changes associated with varus and valgus deformities in ankle-foot.

Bennet and Rang[16] observed that valgus and varus deformities of the ankle-foot in these children resulted from increased activity of the tibialis posterior muscle of the calf.

Butler and Engelbrecht[17] reported that to improve performance of children with CP health providers should know the characteristics and features of the locomotor system of the cerebral palsied children.

We also observed that equinovarus and pes planus deformities had similar percentage comparing by gender. On the other hand spastic cerebral palsied children have had a higher percentage of deformity than the other types of CP[18].

Otherwise children with diskinetic type have had a lower percentage of deformities in their ankle-feet.

According to classification based on motor developmental stage such as apedal, quadripedal, or bipedal, the result showed that eqiunovarus deformity had a higher and similar percentage in both sides.

The present study demonstrated that deformities of ankle-feet in cerebral palsied children should be detected earlier before planning the most suitable physical therapy program, orthopedic surgery, or spasticity management. Corrective procedures for the deformities of the ankle-feet can be used to improve ambulation, decreases pain, or facilitate mobility activities in children with CP. Appropriate combination of intervention must be consisted preventing and managing deformities to delay and prevent arthritis, pain, progressive deformity and contractures in order to facilitate ambulation, reduced pain and increase quality of gait in cerebral palsied children especially spastic type.

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