

Evaluation of Bilateral Foot Deformity in Patients with Hemiplegic Type Cerebral Palsy

Hemiplejik Tip Cerebral Palsyli Hastalarda Bilateral Ayak Deformite Değerlendirmesi

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Abstract

Aim	The aim of our study is to determine the potential degree of the deformity that may occur on the healthy foot, which is often neglected during treatment, in the case that the patient can walk independently, by evaluating the feet, the affected and healthy side of patients with hemiplegic type CP.
Methods	13 females and 15 males, aged between 3 and 19, diagnosed with hemiplegic type CP were included in the study. A foot examination was done with a feiss line to determine the patient's foot deformity. The midpoint of the patient's malleolus medialis and the midpoint of their first metatarsophalangeal joint were connected with a straight line. Tuberositas ossis navicularis in the os naviculare was also marked and detected, and its perpendicular distance to the straight line was approximately measured in centimeters with a soft tape measure. These measurements were repeated on both feet.
Results	13 of the participants in the study were females and 15 of them were males. 12 of the patients had right side hemiplegic type CP, while 16 of them had left side hemiplegic type CP. 17 of the patients could walk independently, 11 could walk with support or an assisting device or could only stand but not actively walk. The age average of the patients was 14.5; 42.9% of them were under the age of 10 and 57.1% of them were 10 years old and above. While a significant difference was not encountered between the left foot measurements when the patients' walking status and foot measurements were compared, there was a significant difference between the average measurements of the right foot. It was seen that as age increased, the measurement values of the right and left feet linearly increased as well.
Conclusion	It could be concluded that the existing deformities on the affected side can worsen over time, and a new deformity may ensue on the healthy side over time as well. We think that deformities can advance quicker especially in cases who can walk, due to the effectiveness of their muscle weaknesses, and that these situations must definitely be evaluated in the treatment program.
Keywords	Cerebral palsy, foot, deformity, rehabilitation, hemiplegia.

Özet

Amaç	Çalışmamızda hemiplejik tip CP'li hastaların tutulmuş ve sağlam taraftaki ayaklarını feiss çizgisi ile değerlendirilerek hastanın bağımsız yürüyör olma durumunda tedavide çoğunlukla ihmal edilen sağlam tarafta oluşabilecek deformitenin derecesini belirlemeyi amaçladık.
Çalışma planı	Çalışmaya hemiplejik tip CP tanısı almış 3 ile 19 yaş aralığında, 13 kız ve 15 erkek hasta dahil edildi. Hastanın ayak deformitesini belirlemek amacıyla feiss çizgisi ile ayak değerlendirildi. Bunun için hastanın malleolus medialis'inin orta noktası ile birinci metatarsophalangeal eklemi orta noktası düz bir çizgi ile birleştirildi. Os naviculare'de tuberositas ossis navicularis de işaretlenerek belirlendi ve düz çizgiye olan dik uzaklığı yaklaşık olarak santimetre cinsinden yumuşak mezura ile ölçüldü. Bu ölçümler her iki ayakta tekrarlandı.
Bulgular	Çalışmaya katılanların 13'i kız, 15'i erkekti. Hastaların 12'si sağ taraf hemiplejik tip CP iken 16'sı sol taraf hemiplejik tip CP idi. Hastaların 17'si bağımsız olarak yürüyebiliyordu, 11'i ise destekli veya yardımcı cihaz ile yürüyebiliyordu ya da sadece ayakta durabiliyor aktif olarak yürüyemiyordu. Hastaların yaş ortalaması 14,5 iken; %42,9'u 10 yaş altında iken %57,1'i 10 yaş ve üstündeydi. Hastaların yürüme durumu ile ayak ölçümleri kıyaslandığında sol ayak ölçümleri arasında anlamlı farka rastlanmazken, sağ ayaktaki ölçümlerinin ortalaması arasında anlamlı fark vardı. Yaş arttıkça sağ ve sol ayak ölçüm değerlerinin de doğrusal olarak arttığı görülmekteydi.
Sonuç	Tutulmuş tarafta var olan deformitelerin zamanla kötüleşebileceği, sağlam tarafta da zamanla yeni deformite oluşabileceği kanısına vardık. Özellikle yürüyebilen vakalarda kas zayıflıklarının etkili olmasından dolayı deformitelerin daha hızlı ilerleyebileceği ve tedavi programında bu durumların mutlaka değerlendirilmesi gerektiğini düşünmekteyiz.
Anahtar Kelimeler	Hemipleji, cerebral palsy, ayak deformitesi, feiss çizgisi

INTRODUCTION

Cerebral Palsy (CP) is a non-progressive, permanent central nervous system disorder that occurs as a result of the undeveloped brain being affected from different reasons during the prenatal, perinatal and postnatal periods (1). It is a static encephalopathy that can develop due to various etiological reasons and may also vary in clinical findings. Simultaneously, it is one of the most common disability reasons seen in childhood (2,3)

CP does not have special diagnosis tests and unfortunately it is quite difficult to detect in the motor development of babies younger than 6 months (4). In the early stages, symptoms such as the absence or weakness of head control, constant crying, convulsions, seriously high or low tonicity, exaggerated primitive reflexes, early hand preference, inability to crawl, delay in walking, developmental delay can be seen (5).

CP is a broad picture that affects the patient in motor, cognitive, sensory, social and emotional aspects in various degrees. In this disease, additional problems that negatively affect the patient's life, usually such as mental retardation and epilepsy, can also be seen (6).

The classification of the disease is mostly made according to the anatomical localization of the damage, movement type and the condition of the affected limb. The most commonly used is the classification defined by Phelps and Perlstain that is made according to tonicity dysfunction and affected limb (7).

In lesions of the pyramidal tract, spastic type cerebral palsy occurs. It is classified as monoplegia, diplegia, hemiplegia, triplegia, tetraplegia according to the places of damage in the body (8).

In extrapyramidal tract lesions, dyskinetic type cerebral palsy occurs. It is classified athetoid, choreic, choreoathetoid, dystonic according to the severity of the involuntary movement. Apart from these types, there are different types of cerebral palsy, including ataxic type, hypotonic type and mixed type (8).

As for the classification made according to the muscle tonicity and the dominant movement abnormality type

suggested by the Surveillance of Cerebral Palsy in Europe (SECP) in 2000, it is classified by; spastic (unilateral or bilateral), ataxic, dyskinetic (dystonic or choreoathetoid), mixed type (8).

In hemiplegic type CP, distinct plegia or paresis is dominant in the right or left half of the torso (9). The functions of the unaffected side of the body can also be affected in various levels or it may not have complete sufficiency if its existing mechanism dysfunctions over time (10). Although the upper limb is affected more compared to the lower limb in the affected side in hemiplegic type CP, the lower limb, which has an important role in weight and load bearing, is more prone to the deformities that can occur. The damage to the healthy side is inevitable due to the child being unable to use the affected side or using it less, preferring the healthy side in activities and weight bearing, wrong movement patterns and unsuitable positionings (11,12).

Hip, knee, foot and ankle problems are very commonly encountered issues in the lower limb (13). One of the commonly observed deformities in hemiplegic type CP is the talipes equinovarus deformity. This deformity is generally related to the spasticity of the m. tibialis posterior and the weakness of the m. peroneus longus and m. peroneus brevis (14). Although foot deformities start as a dynamic deformity, it can become a contracture during the process. Thus, foot deformities can cause permanent and more serious damages alongside having a very negative effect on walking and wearing shoes (15).

The foot deformities developed on the healthy side in hemiplegic type CP may increase due to wrong positioning and unbalanced weight transfer, especially when the child starts walking, and can be ignored most of the time. The healthy side is mostly neglected both in physiotherapy and in evaluations due to the focus being on the affected side foot deformity.

Hence, in our study we aimed to determine the degree of the deformity that can occur later, especially in the healthy side that is often neglected, particularly in patients that can walk, by conducting the bilateral foot evaluations of

patients with hemiplegic type CP with females a feiss line. Accordingly, we consider the treatment method that fits the patient may differ and the suggested medical orthosis and shoes should include these criteria

PATIENTS AND METHODS

Our study, after receiving the ethics committee that decision number 2020/936, started with the patient guardians signing the informed consent form.

13 females and 15 males between the ages 3 and 19, who were diagnosed with hemiplegic type CP, right or left dominant, who did not have a different neurological disorder were included in the study.

Patients who have rigid pes planus, who have had any type of surgical procedure related to the lower limbs, who had any orthopedic problem that could affect walking, who had a systemic disease related to the foot or neurological problem were not included in the study.

The age, gender, information on the affected side and walking status of the patients were recorded. Afterwards, the patients who could walk waited while standing up on a hard floor, in a comfortable standing position; the patients who could not walk stood up with support by transferring weight as much as possible and their measurements were taken. The patients were asked to be in the most comfortable position to understand the weight distribution in daily life activities better. No corrections were made for wrong postures.



Figure 1: Feiss line ⁽¹⁶⁾

The foot examination was performed with a feiss line to determine the foot deformity of the patient. For this, the midpoint

of the patient's malleolus medialis and the midpoint of the first metatarsophalangeal joint were connected with a straight line. The tuberositas ossis navicularis in the os naviculare was also marked and specified, and its perpendicular distance to the straight line was approximately measured in centimeters with a soft tape measure (Figure 1). These measurements were repeated on the affected and healthy side. The drawings were made with a hypoallergenic eye pencil to not hurt the patients (Figure 2, 3).



Figure 2a, 2b. Feiss line in the healthy side foot (patients who can walk)



Figure 3a,3b: Feiss line in the affected side foot (patient who can walk)

Table 1: Affected side distribution of patients by gender

Gender	Right Hemiplegic Type CP	Left Hemiplegic Type CP
Male	2	13
Females	10	3

The analysis of the data was done in the SPSS 22.0 package program. Statistically, the Shapiro-Wilk test, Mann-Whitney test and Spearman's Rho test were used. The Eta coefficient was used to investigate the relationship between the groups that consist of one numerical and one categorical variable.

RESULTS: 13 of the participants in the study were females and 15 of them were males. 12 of the patients had right side hemiplegic type CP, while 16 of them had left side hemiplegic type CP (Table 1). 17 of the patients could walk independently, 11 could walk with support or with an assisting device or could only stand but not actively walk. The age average of the patients was 14.5; 42.9% of them were under the age of 10 and 57.1% of them were 10 years old and above.

The average of the difference variable comprised of the measurement differences between the right foot and left foot is 0.6464, and its standard deviation is 0.4333 (Table 2).

A significant difference between the measurement averages in the right foot was not found when the patients' right and left foot measurements were statistically compared. The average measurements in the right foot of patients with right side hemiplegic was 0.9571 with a standard deviation 1.1167, while the average measurements in the right foot of patients with left side hemiplegic was 1.4394 with a standard deviation 1.9563.

A significant difference was not found between the average measurements in the left foot either. The average measurements in the left foot of patients with right side hemiplegic was 1.2490 with a standard deviation 1.7250, while the average measurements in the left foot of patients with left side hemiplegic was 1.1084 with a standard deviation 1.5063.

When the walking status of the patients and their foot me-

Table 2: Patients' right and left foot measurements

	N	Average (cm)	Standard Deviation (cm)	Maximum (cm)
Right Foot Measurement	28	1.5964	1.30511	4.80
Left Foot Measurement	28	1.6000	1.15342	4.20
Difference between Right Foot and Left Foot	28	0.6464	0.43332	2.00

asurements were compared, a significant difference between left foot measurements was not encountered, while there was a significant difference between the average of the measurements in the right foot. The average of the measurements in the right foot of patients who could walk was 0.6344 with a standard deviation 1.0588, while the average of measurements in the right foot of patients who could not walk was 1.6444 with a standard deviation 2.4273.

Although there was a difference in the average of the measurements in the right foot between male and females patients, there was not a significant difference between left foot measurements (Table 3).

A scatter plot for the right foot measurement value variable and the left foot measurement value variable can be found below. It can be seen that as the left foot measurement values increased, the right foot measurement values also linearly increased.

DISCUSSION AND CONCLUSION

Alongside frequently encountering foot and ankle issues in hemiplegic type CP, affectedening and worsening deformities can ensue over time (17). In almost all neurological types of CP, equinovarus-valgus deformities are observed, especially the hemiplegic type (18,19).

The correct evaluation and careful examination of foot and ankle issues in children with CP has serious significance in the early diagnosis of many problems, ensuring walking early and in the correct pattern and successful treatment (20,21).

In our study, we considered that the deformities might increase rapidly on the healthy side of walking patients

Table 3: Patients' right and left foot measurements by gender

	Right Foot		
	Mean ± Standard Deviation (cm)	MannWhitney U	p-value
Males	2.1533±1.38660	36.500	.005
Females	0.9538±0.86854		
	Left Foot		
	Mean ± Standard Deviation (cm)	MannWhitney U	p-value
Males	1.8600±1.26480	76.500	.333
Females	1.3000±0.97211		

by evaluating both sides of patients' feet. Previous studies were conducted by taking anthropometric measurements on both sides and comparing them to healthy children (22). In other studies, a comparison was made between the healthy side and affected side and it was reported that the affected side showed deficiencies in terms of musculoskeletal development (23). In another study, it was stated that the affected side skeleton age was less than the healthy side (24). In our study, parallel to these studies, we encountered musculoskeletal weaknesses and deformities on the affected side.

In a study conducted by Bennet et. al., it was indicated that as age increased, the deformity degree would increase (25). Similarly, it was observed that age negatively affected deformity development in our study. In this sense, although there are schools of thought that suggest peroneal extension to prevent foot deformity in CP in small ages, it is not a frequently used method due to insufficient studies. In cases such as this, it could be thought that the appropriate orthosis suggested to the patient can prevent deformities in early periods and maintain the existing situation despite increasing age (26).

In choosing orthosis, the healthy side foot must certainly be evaluated, even if there are no deformities, the possibility that it could increase with walking should not be overlooked.

In a study, it was stated that gender is negligibly low in terms of deformity in hemiplegic type CP (27). In our study, 13 females and 15 male patients were evaluated and a significant difference was not observed between their foot

deformities.

Foot deformity etiology can develop due to many reasons. Insufficient muscle strength, excessive and unbalanced loads in the stepping phase of walking, bone structure disorders, genetic proneness can be some of these reasons (28).

Art. subtalaris takes most of the load on the lower limb instead of the knee or ankle while walking or standing. Especially in children diagnosed with CP, the spasticity in m. gastrocnemius or contractures in the knee and m. soleus also cause art. subtalaris to be affected (29).

In children with CP, the tarsal bones, which are highly cartilaginous due to musculoskeletal problems, are quite prone to deformity due to abnormal loads (30).

In cases where the anatomic structure of the foot is impaired, as the load on it increases, the deformity will also increase, causing rigid deformities to occur over time (31).

In our study, we evaluated the foot deformities of the patients who were diagnosed with hemiplegic type CP and continue physical therapy and rehabilitation programs actively, patients who could walk and could not walk, with the feiss line, which every physiotherapist can easily apply.

We came to the conclusion that the deformities that exist on the affected side could worsen over time, and new deformities could ensue on the healthy side over time. Especially in cases who could walk, we consider that deformities can progress more rapidly due to the effectiveness of muscle weaknesses and that these situations must be evaluated in the treatment program. In later times, not ignoring these possibilities for the orthosis and shoe choices

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DISCLOSURES

There is no conflict of interest for all authors.

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References

1. Livanelioğlu A., Kerem G M. SEREBRAL PALSİDE FİZYO-TERAPİ. Ankara: Yeni Özbek Matbaası, 2009. s. 19-41.
2. Aisen ML, Kerkovich D, Mast J, et al. Cerebral palsy: clinical care and neurological rehabilitation. *Lancet Neurol*.2011;10(9):844-852.2. DOI:10.1016/S1474-4422(11)70176-4
3. Canbay Sevdâ. Serebral Palsili Çocuklarda Beyin Magnetik Rezonans Görüntüleme Bulgularının Klinik Değerlendirmesi. Yüksek Lisans Tezi, Selçuk Üniversitesi, Konya, 2013.
4. MacLenman AH, Thompson SC, Gecz J. Cerebral palsy: causes, pathways, and the role of genetic variants. *Am. J. Obstet. Gynecol*. 2015 Dec;213(6):779-88. DOI: 10.1016/j.ajog.2015.05.034
5. Nahm NJ, Graham HK, Gormley ME, Georgiadis AG. Management of hypertonia in cerebral palsy. *Curr. Opin. Pediatr*. 2018 Feb;30(1):57-64. doi: 10.1097/MOP.0000000000000567.
6. Jamika L. H.-C, William G. Cerebral palsy. *StatPearls. Treasure Island: July 18, 2019: 45-47*
7. Yalçın S., Özaras N. Dormans J.; Serebral Palsi Tedavi ve Rehabilitasyon, *Mas Matbaacılık*; 2000; 13-31, 51-56.
8. Cans C; Surveillance Of Cerebral Palsy in Europe (SCEP): A Collaboration Of Cerebral Palsy Surveys And Registers. *Dev Med Child Neurol*, 2000; 42: 816-24
9. Dormans J, Susman M, Özaras N, Yalçın S. Serebral palsi tedavî ve rehabilitasyon, 1. baskı. İstanbul: Mas Matbaacılık, 2000;13-93.
10. Özel S. Serebral palsi. In: Beyazova M, Gökçe Kutsal Y, eds. *Fiziksel tıp ve reabilitasyon Cilt-2. 2. baskı*. Ankara: Güneş Tıp Kitabevleri, 2011;2681-724.
11. İrdeseli J. Serebral palsi rehabilitasyonu. In: Özcan O, Arpacioğlu O, Turan B, eds. *Nörorehabilitasyon. 1.baskı*. Bursa: Motif Matbaa, 2000;137-58.
12. Elbasan B, Akaya KU, Akyuz M, Oskay D. Effects of neuromuscular electrical stimulation and Kinesio Taping applications in children with cerebral palsy on postural control and sitting balance. *J Back Musculoskelet Rehabil*. 2018;31(1):49-55. DOI: 10.3233/BMR-169656
13. Limpaphayom N, Chantarasongsuk B, Osateerakun P, Prasongchinn P. The split anterior tibialis tendon transfer procedure for spastic equinovarus foot in children with cerebral palsy: results and factors associated with a failed outcome. *Int Orthop* 2015; 39: 1593-8. doi: 10.1007/s00264-015-2793-8.
14. Berry J. Morphine Patient Controlled Analgesia (PCA), *Paediatric Analgesia Guidelines V5.2 2017 sept*. pp 9-10.
15. Thomas Dreher, MD and Wolfram Wenz, MD *Tendon Transfers for the Balancing of Hind and Mid-foot Deformities in Adults and Children Techniques in Foot & Ankle Surgery 2009 Dec; Vol 8,(4) DOI:10.1097/BTF.0b013e3181c264d5*
16. <https://doktordanhaberler.com/topuk-dikeni/>
17. Williams SA, Elliott C, Valentine J, Gubbay A, Shipman P, Reid S. Combining strength training and botulinum neurotoxin intervention in children with cerebral palsy: the impact on muscle morphology and strength. *Disabil Rehabil* 2013;35(7):596-605. doi: 10.3109/09638288.2012.711898.
18. Erken H, Yasmin D, Burç H. Serebral palsi'ye bağlı ayak varus deformitelerinde kombine tibialis anterior tendonu split transferi ve tibialis posterior tendonu'nun intramusküler uzatılması sonuçları S.D.Ü.Tıp Fak. Derg. 2014;21(1) /1-6
19. Carpenter DL, Batley RJ, Johnson EW. Developmental evaluation of infants and children. *Phys Med Rehab Clin North Am* 1996; 7: 361-82.
20. Dinçer Ü, Çakar E, Kırallı MZ, Dursun H. Diplejik serebral palsili hastalarda botulinum toksin uygulaması sonrasında fizyoterapi ve alt ekstremite ortezinin etkinliğinin karşılaştırılması. *Türk Fiz Tıp Rehab Derg* 2008; 54: 41-5.
21. Sade A, Otman AS. Serebral paralizide değerlendirme ve tedavi yöntemleri. 2. Baskı, Ankara: Hacettepe Üniversitesi Fizik Tedavi ve Rehabilitasyon Yüksekokulu Yayınları, 1997: 1-18.
22. Zonta MB, Agert F, Muzzolon SRB, et al. Growth and anthropometry in hemiplegic cerebral palsy patients. *Rev Paul Pediatr* 2009; 27: 416-23. doi: 10.1111/j.1469-8749.1984.tb04411.x.
23. Roberts CD, Vogtle L, Stevenson RD. Effect of hemiplegia on skeletal maturation. *J Pediatr* 1994; 125:824-8. DOI: 10.1016/s0022-3476(94)70086-9
24. Uvebrant P. Hemiplegic cerebral palsy. Aetiology and outcome. *Acta Paediatr Scand Suppl*. 1988; 345:1-100. doi: 10.1111/j.1651-2227.1988.tb14939.x.
25. Bennet GC, Rang M, Jones D. Varus and valgus deformities of the foot in cerebral palsy. *Dev Med Child Neurol* 1982;24(5):499-503. DOI: 10.1111/j.1469-8749.1982.tb13656.x
26. Şenaran H. Serebral palsi hastalarında ayak sorunları. *TO-TBİD Dergisi* 2018; 17 :516-522. <https://doi.org/10.14292/totbid.dergisi.2018.65>
27. Özer MK, Özer DS. Çocuklarda motor gelişim. 6. baskı. Ankara: Nobel Yayın Dağıtım, 2012: 76-7.
28. Sees JP, Miller F. Overview of foot deformity management in children with cerebral palsy. *J Child Orthop* 2013;7(5):373-7. doi: 10.1007/s11832-013-0509-4.
29. Ettl V, Wollmerstedt N, Kirschner S, Morrison R, Pasold E, Raab P. Calcaneal lengthening for planovalgus deformity in children with cerebral palsy. *Foot Ankle Int* 2009;30(5):398-404. doi: 10.1007/s11999-012-2709-5
30. Lee SJ, Sung IY, Jang DH, Yi JH, Lee JH, Ryu JS. The effect and complication of botulinum toxin type a injection with serial casting for the treatment of spastic equinus foot. *Ann Rehabil Med* 2011;35(3):344-53. doi: 10.5535/arm.2011.35.3.344.
31. Pin T, Dyke P, Chan M. The effectiveness of passive stretching in children with cerebral palsy. *Dev Med Child Neurol* 2007; 48(10):855-62. doi: 10.1017/S0012162206001836.