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Evaluation of the Effect of Kinesio Taping on the Plantar Arch Index of Children with Spastic Diplegic Cerebral Palsy

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ABSTRACT

Background & Objective: Cerebral palsy is a non-progressive disorder of posture and motor status caused by various factors and can cause childhood disabilities and abnormalities like flat foot deformity. Kinesio Taping is a typical technique that helps relieve pain, relax muscles, and increase proprioception. The purpose of this study was to evaluate the effectiveness of Kinesio Taping on the plantar arch index in children with diplegic cerebral palsy.

Materials & Methods: This randomized clinical trial study was performed on 20 children with spastic diplegic cerebral palsy aged 2 to 6 years in Zanjan-Iran rehabilitation centers. The children were examined in separate intervention and control groups. In the control group, common flat foot exercises were performed. In contrast, in the intervention group, the Kinesio Taping method was used in addition to the mentioned exercises, and finally, the data were analyzed. Paired samples T-Test and Independent T-Test were used to determine the effect of Kinesio Taping in reducing flat feet.

Results: After statistical analysis, it was found that, although both groups showed significant results in their plantar arch indexes, the intervention group's results seemed more effective ($p<0.05$).

Conclusion: Kinesio taping can be a safe, inexpensive, and accessible method to manage flat feet complications in children with diplegic cerebral palsy.

Keywords: Flatfoot, Kinesio Taping, Cerebral palsy

Introduction

Cerebral palsy (CP) is a non-progressive disorder of posture and motor status, a common cause of childhood disability (1). CP is caused by various factors attributed to early brain damage, resulting in permanently impaired motor control, marked by weakness and muscle stiffness (2). Children with physical disabilities, such as CP, usually experience multiple changes in the structure and function of muscles and bones, especially in the lower extremities. These skeletal muscles defect in children with CP are associated with low muscle strength and increased fractures in the lower extremities (3). Walking is considered a primary goal for CP children to promote their functional abilities and lifestyles. Therefore, rehabilitation specialists try to manage every issue that affects the quality of walking ability during the rehabilitation process (4).

One deformity, which can affect the walking ability of CP children negatively, is pes planus or flat foot deformity. This deformity is a condition in which the medial longitudinal arch of the foot disappears chronically and abnormally. In addition, there are two types of flat feet: flexible and rigid. In the flexible type, the medial longitudinal arch collapses in the weight-bearing foot during a loading response in the stance phase but reappears when no weight bearing is done (5). A flatfoot deformity is commonly caused by an incomplete or incorrect pathological imbalance of the joints in the lower limbs, abnormal muscle activity, and cartilage damage with or without knee pain (6). Problems associated with flatfoot deformity have been reported as a common concern. There are varieties of complications associated with this deformity, including foot pain, hallux valgus,

knee problems, impairment of the range of motion, weakening of muscle strength trigger compensatory mechanisms that aggravate the dysfunctions. The pain negatively impacts activities of daily living, gait, balance, and quality of life and increases the risk of falling (7-10). This deformity must be managed properly as it will lead to increased muscle spasticity, fatigue, and cramping in the muscles of the lower limbs and legs due to overuse (6). There are different conservative and surgical treatments to manage this problem. Conservative methods such as exercise, arch supports, orthopedic shoes, some braces, and even Botulinum Neurotoxin injection and surgical methods are commonly utilized to manage flat foot deformity.

Nevertheless, the effectiveness of these therapies remains uncertain for pediatric flexible pes planus. On the other hand, surgical procedures include soft tissue surgeries, and bone surgeries are usual surgeries to manage rigid flat feet. However, there is no unified conclusion on surgical treatment either (11-13).

Kinesio Taping (KT) is a typical technique that helps relieve pain, relax muscles, and increase proprioception. In addition, this technique significantly affects the rehabilitation treatment of various soft tissue disorders (14). KT is a natural, complementary, and inexpensive treatment designed to facilitate the body's natural healing process by providing support and stability to muscles and joints without restricting the range of motion. It also provides sensory feedback and fast movement related to functional abilities (1, 6). This method was first introduced in Japan as a treatment method. In recent years its use has become very popular, and the lasting therapeutic effects of its use have become apparent (15).

KT has been used in orthopedic therapy, such as sports injuries, but recently has been used in children's rehabilitation as a sensory method to support joint function by affecting muscle function, increasing lymphatic system activity, pain suppression mechanism, and improving blood circulation (1). Some studies have used trunk or lower limb KT for spastic CP children to investigate its effect on the balance and functional mobility of these children. Finally, most of them have concluded that KT is an effective method to improve the balance and functional mobility of spastic CP children (16, 17). As a result, in connection with other therapeutic interventions, KT has improved the integration of the rehabilitation process and increased the daily independent activities and social participation or the quality of these activities. It has also been able to modify small and large motion functions (18).

Few studies have been conducted on the effects of KT on foot complications of children with spastic CP, and the results are conflicting. In general, it can be said that few randomized controlled trials have been conducted to show the effects of the process on the upper and lower limbs, and more studies are needed, which we have examined in this study.

Materials and Methods

Design

The Ethics Committee of Zanjan University of Medical Sciences (IR.ZUMS.REC.1396.312) and the Iranian Registry of Clinical Trials (IRCT20190214042710N1) approved this randomized clinical trial study.

Participants

This study was an unblinded randomized clinical controlled trial from 2018 to 2019. We used simple randomization. The study population was selected from 52 children who were diagnosed with SCDP. According to inclusion and exclusion criteria, 21 children with SDCP aged 2 to 6 years in Zanjan occupational therapy centers were randomly selected. One participant left the study, and finally, 20 children remained until the end.

The inclusion criteria consisted of ages between 2-6 years, flexible flat feet deformity, not receiving any other therapeutic methods except exercise therapy in the occupational therapy center, and categorized in level III and above of the Gross Motor Function Classification System (GMFCS). In these levels of GMFCS, CP children at least poses the ability to walk using a hand-held mobility device (19). On the other hand, those children who showed skin problems such as irritations or rushes related to the KT, experienced neurological conditions such as seizures during the study time, experienced orthopedic problems like fractures, or were absent for more than three sessions for any reasons during the study period were considered to be excluded from the study. Then, written consent was obtained from the parents of the children, and in the first session, the amount of the arch index of the children's feet was measured and recorded using the Staheli method (20).

Staheli Method

Talc powder was used to measure the medial longitudinal arch through the Staheli method due to its softness and high adhesion strength. To perform this, the children were asked to place their feet in a box containing talcum powder and then placed their feet on a screen covered with black ink on which the print of the feet was visible. Afterward, according to the Staheli calculation method of the arch index (21), as shown in the following image, first the narrowest part of the arch (A) and then the widest part of the heel (B) were measured using a caliper three times separately and consecutively by the researcher. In the end, the average numbers were considered as the results. The results, then, were recorded in millimeters. Finally, according to the. Staheli formula (AI= A/B), the size of the narrowest part of the arch (A) was divided by the widest part of the heel (B) (22) (Figure 1).

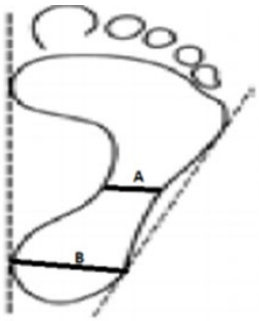

Figure 1. **Stalehi formula**

Groups and Intervention

After recording the information mentioned above, our intervention began. The children were divided into two groups: A) Intervention group, the mean age of this group was 4.7. In this group, treatment was performed by applying Kinesio Taping method. It should be noted that before the KT of the children's feet, a photo was taken of the mediolateral, and at the end of the design, a photo was taken for comparison. B) Control group, common flat feet exercises were performed. The mean age of the control group in this group was 4.1.

For the Intervention group, the tape tip was initially connected by creating a Y-shaped incision in the upper part of the fascia insertion of the dorsum of the foot anterior to the calcaneus without applying traction. Then, the foot was placed in a dorsiflexion position. While holding the base of the tape with one hand, we pulled the second strip of Y with the other hand with a maximum stretch of 75% and connected it to the first metatarsophalangeal joint along the first metatarsus. After attaching the end of the inner edge, we performed the taping to the outer edge, which is located along the fifth metatarsus. To connect the metatarsal arc section, we took the foot back to the dorsiflexion position, started from the edge of the strip along the fifth metatarsus, and placed the base of the tape in the proximal part. At this time, the child was asked to relax his leg in a neutral position. It was then connected to the navicular area by applying a 50% stretch from the fifth metatarsus. At this point, the child was again asked to perform dorsiflexion, and the end tip of the tape was attached without stretching. Finally, the extra parts were cut **(23, 24)**.

It should be noted that an experienced occupational therapist performed this method, and the tapes were replaced every two days. This procedure continued for 4 months for the children of the intervention group. It is also worth mentioning that the type of tapes used for this group was the same. Finally, after 4 months, the children were re-examined as in the first session, and new information was recorded.

Statistical Analysis

The Kolmogorov-Smirnov test was used to check the normality of the data. Paired samples T-Test and Independent T-Test were used to determine the effect of KT in reducing flat feet in children with SDCP and investigate the relationship between primary and secondary arch index in the control group. All data were analyzed by SPSS version 25.0 ($P \leq 0.05$).

Results

Having the initial data from the two groups and comparing them with the new data and comparing the two control and intervention groups, we realized the effectiveness of the KT method.

Based on the results of data analysis and the use of the Kolmogorov-Smirnov test, it has been shown that the primary and secondary arch of the right and left foot in both control and treatment groups have a normal distribution.

The use of KT is effective in reducing flat feet in children with SDCP:

According to Table 1, the test statistics is 8.71, and the significance level is zero ($P<0.05$), meaning a significant difference exists between the treatment group's primary and secondary arch index of the left feet. Therefore, the KT method has been effective.

Table 1. **Primary and secondary arch index of the left foot in the treatment group**

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Arch Index	.10836	.05558	.01243	.08234	.13437	8.719	19	.000

According to Table 2, the test statistics is 7.71, and the significance level is zero ($P<0.05$), meaning a significant difference exists between the right foot's primary and secondary arc index in the treatment group. Therefore, the KT method has been effective.

Table 2. **Primary and secondary arch index of the right foot in the treatment group**

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Arch Index	.11983	.06948	.01554	.08731	.15234	7.713	19	.000

According to Table 3, the test statistics is 6.564and the significance level is 0.030, which means a significant difference between the primary and secondary arc index of the right foot in the control group.

Table 3. **Primary and secondary arch index of the right foot in the control group**

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Arch Index	0.0489	.01056	.00236	-.00294	.00694	6.564	19	0.030

According to Table 4, the test statistics is 4.025and the significance level is 0.040, which means a significant difference between the primary and secondary arc index of the left foot in the control group.

Table 4. **Primary and secondary arch index of the left foot in the control group**

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Arch Index	0.0517	.01268	.00284	.007	.004	4.025	19	0.040

There is a significant difference between the secondary arc index in the control group and the treatment group.

The treatment group's secondary arch index mean of the left and the right foot is 0.84 and 0.82, respectively. The standard deviation is also 0.09 and 0.11, respectively. The secondary arch index average of the left and right foot in the control group is 0.91. The standard deviation is also 0.10 and 0.09, respectively.

The t-test rate for the secondary left arch index is 0.16, and the significance level is 0.69 (P>0.05), so there is equality of variance. The t-test rate is also 2.16, and the significance level is 0.03 (P>0.05). Therefore, the secondary left arch index of the treatment group and control group is different. As a result, the secondary left arch index of the treatment group is less than the control group.

The t-test rate for the secondary right arch index is 0.26, and the significance level is 0.60 (P>0.05), so there is equality of variance. The t-test rate is also -2.75, and the significance level is 0.0 (P<0.05). Therefore, the secondary right arch index of the treatment group and control group is different. Hence, the secondary right arch index of the treatment group is less than the control group.

Discussion

The data analysis results showed a significant difference between the primary and secondary arch indexes of the right and left feet in the intervention group. This indicated the effect of KT on reducing flat foot conditions in children with SDCP. In addition to other common interventions to reduce children's flat feet with SDCP, KT can also be used as part of an intervention plan. However, there were some limitations to mention, like the length of the study that the children had to get the KT for four months frequently. In the beginning, several parents asked us to teach them the KT technique so they could do it themselves. We tried to visit the KT during their

occupational therapy sessions because we wanted the same person to do it for the duration of the study. However, no one asks them to participate in extra sessions. We also provided the tapes ourselves. Besides, we knew that not all the children could participate in all the sessions. Therefore, we did not exclude anyone unless they were absent for more than three sessions. Only one child was excluded based on the above criteria.

The results of this study were consistent with the findings of Prtoazar et al. **(16)** and Ahmadizadeh et al. **(17)**. Who examined the efficacy of KT on balance skills of CP children. Also, the results were consistent with Joong-San Wang et al. **(25)**. who examined the rapid effects of KT on lower limb muscle tone and flexible flat feet. Because in both studies, the positive effects of KT on improving plantar fasciitis had been proven.

The results of this study were also consistent with the research of Zeinab A.Hussein et al. **(1)**. who examined the cumulative effect of KT intervention on the ankle and the control of the posture with hemiparesis of CP because, in both studies, the use of KT in the treatment of structural foot disorders was found to be useful.

According to the data collection and analysis results, there were significant differences between the primary and secondary arch indexes in both legs of the child with SDCP in the control group. This indicates that to improve structural and anatomical disorders and reduce deformity and its effects, such as flat feet, the necessary measures and interventions must be done to minimize damage and limit its side effects. In other words, not only does the passage of time not lead to recovery, it is also more likely to cause injury.

The results of this part of the study were inconsistent with Joong-San Wang et al. **(25)**. In the control group, he used sham adhesive tape instead of KT glue; the results of that study also showed that there was no significant difference between the primary and secondary scores of the lower limb muscles and the rigidity of the flexible flat feet in the control group.

The statistical analysis results showed a significant difference between the quantity of the secondary arch index of the control group and the intervention group. Subsequently, the results of this study indicated the importance of using KT in managing flat feet in children with SDCP. The results of this part of the study were consistent with Joong-San Wang et al. **(25)**. who evaluated the positive effects of KT on the treatment of flexible flat feet. The results of this study were also consistent with a study conducted by Ozgun kaya Kara et al. **(18)**. One of their study's results was the effect of using KT on increasing proprioceptive feedback. To explain this alignment, it can be pointed out that increasing the proprioceptive feedback improves the child's body scheme and body awareness, which ultimately helps to correct structural problems such as flat feet.

Conclusion

Cerebral palsy is one of the most common neurological disorders in children. It is divided into different types due to its great diversity; among these divisions, we can mention its types based on the location of brain damage, motor level skills, and so on. One type of CP based on the prevalence of conflict is SDCP. SDCP is associated with further involvement of the lower limbs and has arm involvement of lesser severity than leg involvement. These involvements consist primarily of motor function and are often accompanied by sensational, perceptional, cognitional, communicational, behavioral, and musculoskeletal problems. Because of their spasticity, these children experience significant standing, sitting, or walking difficulties, muscle weakness, joint abnormalities, and reduced postural control. One of the most common structural problems in the clinical view of these children in the foot area is flat foot deformity. Flat Foot in these children causes serious long-term effects for the patient due to the specific biomechanics of the body.

In summary, the findings of this study showed that KT could be used to improve flat foot deformity in SDCP children. We recommend choosing a larger population for further studies. Since the flatfoot deformity causes gait and balance difficulties, assessing functional factors such as gait and balance skills is also advisable.

Acknowledgments

None.

Conflict of Interest

The authors declared that they had no conflicts of interest.

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