**Türk Fizyoterapi ve Rehabilitasyon Dergisi**

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# EFFECT OF KINESIO TAPING ON GAIT PERFORMANCE AND BALANCE IN CHILDREN WITH HEMIPLEGIC CEREBRAL PALSY

**RESEARCH ARTICLE**

## ABSTRACT

**Purpose:** The objective of this study was to evaluate the effectiveness of kinesio taping (KT) on gait performance and balance in children with hemiplegic cerebral palsy (CP).

**Methods:** Nineteen ambulant children with spastic hemiplegic CP (mean age; 11.63±3.59 years, 8 boys, 11 girls) participated in this study. Passive dorsi flexion and plantar flexion range of motion (ROM) of ankle were measured with a goniometer in a supine position. Plantar flexor muscle tone and gait performance were evaluated by Modified Ashworth Scale and One-Minute Walk Test. Balance was evaluated with Pediatric Balance Scale (PBS) and Modified Timed Up Go (mTUG) Test. After pre-evaluation, kinesio tape was applied over the gastrocnemius and tibialis anterior muscles of hemiplegic side.

**Results:** The plantar flexor muscle tone and ankle ROM unchanged immediately and 48 h after KT application ($p>0.05$). However, there were significant differences in measurements of gait performance, PBS, mTUG test at 48 h after KT application ($p<0.05$), but not immediately ($p>0.05$).

**Discussion:** It is concluded that KT has not an effect on ankle plantar flexor muscle spasticity and ankle ROM, but improves gait performance and balance in children with hemiplegic CP at 48 h after application.

**Key words:** Cerebral palsy; gait; balance; kinesio tape.

# HEMİPLEJİK SEREBRAL PALSİLİ ÇOCUKLARDA KİNEZYO BANTLAMANIN YÜRÜYÜŞ PERFORMANSI VE DENGEYE ETKİSİ

**ARAŞTIRMA MAKALESİ**

## ÖZ

**Amaç:** Bu çalışmanın amacı, hemiplejik Serebral Palsili (SP) çocuklarda kinezyo bantlama (KB) uygulamasının yürüyüş performansı ve dengeye etkisini değerlendirmektir.

**Yöntemler:** Bu çalışmaya 19 yürüyebilen hemiplejik SP'li (ortalama yaş; 11.63±3.59 yıl, 8 erkek, 11 kız) çocuk katıldı. Ayak bileği dorsi ve plantar fleksiyon eklem hareket açıklığı (EHA) sırtüstü pozisyonda gonyometre ile ölçüldü. Plantar fleksör kas tonusu Modifiye Ashworth Ölçeği ile yürüyüş performansı 1 dk yürüme testi ile değerlendirildi. Denge, Pediatrik Denge Ölçeği (PDÖ) ve Zamanlı Kalk Yürü Testi ile değerlendirildi. İlk değerlendirme sonrası, hemiplejik taraf gastroknemius ve tibialis anterior kasları üzerine KB uygulandı.

**Sonuçlar:** Plantar flexor kas tonusu ve ayak bileği EHA, KB uygulamasından hemen sonra ve 48 saat sonra değişmedi ($p>0.05$). Yürüyüş performansı, PDÖ ve Zamanlı Kalk Yürü Testi ölçümlerinde KB uygulaması sonrası 48 saatte anlamlı farklılık bulundu ($p<0.05$). Fakat KB uygulaması sonrası hemen yapılan ölçümlerde değişmedi ($p>0.05$).

**Tartışma:** KB, uygulama sonrası 48 saatte hemiplejik SP'li çocuklarda plantar fleksör kas spastisitesi ve ayak bileği eklem hareket açıklığı üzerine bir etkiye sahip değildir, fakat yürüyüş performansı ve dengeyi geliştirir.

**Anahtar kelimeler:** Serebral palsi; yürüyüş; denge; kinezyo bantlama

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## INTRODUCTION

Cerebral palsy (CP) is the most common childhood disability resulting from a non-progressive injury to the brain during intrauterine or early postnatal development. Musculoskeletal problems affecting development of movement and posture, such as reduced selective motor control, poor balance, decreased range of motion (ROM), dystonia, spasticity and muscle weakness in children with CP lead to difficulties in activites of daily living such as gait, climbing stairs (1-3).

Energy cost of gait in children with CP is more than two-fold compared with typically developing children (4). Equinus gait is defined as a decrease in the ROM of the ankle dorsiflexion during gait (5) and is caused by excessive activation (spasticitiy) of the ankle plantar flexors or contracture of the gastrocnemius muscle (6,7). Architecture studies demonstrated that the gastrocnemius muscle volume in children with hemiplegic CP was smaller (28%) than typically developing children (8). However, Bland et al. observed tibialis anterior muscle of affected extremity shorter and thinner compared unaffected extremity with ultrasound imaging and thickness. The cross-sectional area of tibialis anterior muscle was positively related to strength and gait velocity in children with hemiplegic CP (9).

In recent years, kinesio taping (KT) has been widely used in rehabilitation of children with CP by therapists and scientists (10-13). Kase et al. proposed that KT had corrected muscle function by strengthening weakened muscles, improving circulation of blood beneath the skin by moving the muscle, decreasing pain through neurological suppression, and repositioning subluxed joints by relieving abnormal muscle tension (14). Researchers reported that KT adjusted muscle activity through proprioception feedback stimulated cutaneous mechanoreceptors and relieved abnormal muscle tension in healthy subjects (15,16).

To our knowledge, there are limited studies discussing the immediate effects of KT in children with CP. Therefore, the aim of this study was investigated the effects of KT applied over the gastrocnemius and tibialis anterior muscles on gait performance and balance in children with hemiplegic CP.

## METHODS

### Participants

Nineteen ambulant children with spastic hemiplegic CP (mean age; 11.63±3.59 years, 8 boys, 11 girls) who were receiving regular rehabilitation in paediatric clinical settings participated in this study (n = 19) (Table 1). Inclusion criteria were (1) age between 6 and 18 years, (2) being rated as level I or II in gross motor functional classification system (GMFCS) (3) able to follow verbal instructions, (4) ability to walk independently without assistive device. The exclusion criteria were (1) any orthopaedic surgery or botulinum toxin injection including lower extremity in the past 6 months, and (2) children with allergic reactions to the adhesive compound of Kinesio tape. This study was approved by the Bulent Ecevit University Ethics Committee (2015-37-09/06) and written informed consent was obtained from each participant and/or guardian.

### Procedures

The participants were evaluated for ankle ROM, ankle plantar flexor muscle tone, gait performance, pediatric balance scale, timed up-go test before (T1), immediately after (T2) and 48 h (T3) after KT. The participants were instructed to not remove kinesio tape for 48h.

### Ankle ROM

Passive dorsi flexion and plantar flexion ROM of the ankle were measured with a goniometer while the participant was lying in supine (17).

### Spasticity

Ankle plantar flexor muscle tone was evaluated with Modified Ashworth Scale (MAS) (18).

### Gait Performance

The One-Minute Walk test (1MWT) is a valid measure of functional mobility and endurance in children with CP (19). The participants were instructed to walk barefoot and without orthosis around the track as fast as possible for 1 minute. The distance (in meters) walked was measured using a measuring wheel and recorded.

### Pediatric balance scale (PBS)

The PBS has good test-retest (ICC = 0.998) and inter-rater reliability (ICC = 0.997) in children with CP

aged 5-15 years (20). The PBS includes 14 items to assess functional skills. These are "sitting to standing", "standing to sitting", "transfers", "standing unsupported", "sitting unsupported", "standing with eyes closed", "standing with feet together", "standing with one foot in front", "standing on one foot", "turning 360 degrees", "turning to look behind", "retrieving object from floor", "placing alternate foot on stool", "reaching forward with outstretched arm". Each item was scored on 0-4 point scale. A higher score indicates better balance abilities.

### Modified Timed Up Go test (mTUG)

The mTUG is a reliable (ICC = 0.99) tool to measure basic functional mobility and balance in children (21). The test began with the participant sitting on a chair which was selected according to the height of participant barefoot and without orthosis. The participant was instructed to rise from sitting, walk 3m at a comfortable velocity, touch a point marked on the wall, turn around, walk back to the chair, and sit down again. The time was recorded.

### Taping Application

The skin was cleaned with alcohol prior to KT application. The kinesio tape was applied over the gastrocnemius and tibialis anterior muscles of hemiplegic side by a certified physiotherapist. The tape was applied in a Y shape with 25% of available tension to inhibit gastrocnemius muscle the when participants were lay in prone position with knee extended and the ankle joint in neutral position on examination table. The functional correction technique was applied in an I shape over the tibialis anterior muscle to facilitate dorsiflexion while the participants were supine on table (22).

### Data analysis

Statistical Package for the Social Sciences (SPSS) for Windows 16.0 statistical package was used to analyse the obtained data. Normality of the dependent variables was checked using the Kolmogorov Smirnov test. A repeated measures one-way ANOVA with post-hoc t-test. Statistical significance was set at $p < .0167$ after Bonferroni correction.

## RESULTS

Means and standard deviations (Mean ± SD) of the participants' pre and post test scores are presented in Table 2. There were no significant differences in spasticity and ankle ROM scores immediately after and 48 h after KT ($p>0.05$). There were significant improvement in mTUG (7%)($p=0.008$) immediately after KT application. There were significant improvements in mTUG (11%)($p=0.005$), PBS (1%) ($p=0.003$) and gait performance (4%)($p=0.009$) 48 h after KT application.

## DISCUSSION

In the present study, we hypothesized that KT application over the gastrocnemius muscle to inhibit spasticity and tibialis anterior muscle to facilitate dorsiflexion might contribute to correct equinus gait and improve gait performance and balance. Our findings showed that the mTUG performance increased immediately after the KT application over the gastrocnemius and tibialis anterior muscles in children with spastic hemiplegic CP. In addition, the balance and gait performance improved at 48 h after taping. The kinesio tape provides proprioceptive feedback by stimulating cutaneous mechanoreceptors, relieves abnormal muscle tension, helps to improve postural alignment, corrects joint position, increases or inhibits muscle recruitment (12,15,16,23-25). To our knowledge, KT application may support foot and increase stability of the ankle such as the use of an ankle foot orthosis during stepping. There are limited studies investigating the effect of the KT on lower extremity performance during activities in children with CP. Similar to our results, Da Costa et al. observed significant improvements in the PBS dynamic score, TUG and sit to stand performance immediately after KT application over the quadriceps femoris and

**Table 1:** Descriptive characteristics of the participants (n = 19)

| Variables | Mean | SD |
|---|---|---|
| **Age (yrs)** | 11.63 | 3.59 |
| **Height (cm)** | 142.63 | 18.73 |
| **Weight (kg)** | 44.00 | 13.30 |

**Table 2:** Pre and Post Test scores of participants

| Test | T1 | T2 | T3 |
|---|---|---|---|
| **Spasticity** | 1.53±0.69 | 1.53±0.69<br>p=1[a] | 1.53±0.69<br>p=1[b]<br>p=1[c] |
| **Ankle dorsi flexion ROM (degree)** | 13.11±7.27 | 13.26±7.26<br>p=0.560[a] | 13.32±7.25<br>p=0.992[b]<br>p=0.311[c] |
| **Ankle plantar flexion ROM (degree)** | 41.68±3.72 | 41.89±3.78<br>p=0.644[a] | 41.95±3.77<br>p=0.992[b]<br>p=0.515[c] |
| **mTUG (s)** | 7.83±2.34 | 7.23±2.28<br>p=0.008[a] | 6.91±2.18<br>p=0.538[b]<br>p=0.005[c] |
| **PBS** | 49.26±5.18 | 49.52±5.11<br>p=0.062[a] | 50.00±5.05<br>p=0.074[b]<br>p=0.003[c] |
| **Gait performance (m)** | 50.42±8.16 | 52.42±7.83<br>p=0.043[a] | 52.94±8.46<br>p=0.946[b]<br>p=0.009[c] |

ROM: Range of motion, mTUG: Modified Timed Up Go test, PBS: Pediatric balance scale
a The difference between before KT application and immediately after KT application.
b The difference between immediately after and 48h after KT application.
c The difference between before KT application and 48h after KT application.

tibialis anterior muscles in four children with hemiplegic CP (26). They compared with a control group without taping. There was no control group in the present study, but our sample size was bigger than that of Da Costa et al.

Kaya Kara et al. observed the long term effects of taping and reported that KT application improved functional muscle strength, gross motor function, and independent activities in the daily life of children with unilateral spastic CP after 12 weeks (11). Kim et al. concluded that KT application of the tibialis anterior and gastrocnemius muscles increased proprioception and improved balance and gait abilities of stroke patients at eight weeks. They interpreted that KT application increased gait ability by improving proprioceptive feedback mechanisms and by reducing the time needed to recruit the dynamic ankle joint stabilizer muscles by limiting excessive joint movements (27). Cortesi et al. applied the kinesio tape over the gastrocnemius muscle of patients with multiple sclerosis and observed significant reduction in oscillation and total displacement of the center of pressure on the base of support (28).

Another result of the present study was that the taping did not contribute to decrease in spasticity of the gastrocnemius muscle. The MAS was used to evaluate the spasticity of the plantar flexor muscles. The MAS is applied manually to determine the resistance of muscle to passive stretching by therapists and this measurement includes a six-point scale, ranging from 0 to 4 (0, normal muscle tone; 4, fixed muscle contracture) (18). Mutlu et al. reported that the MAS was not very reliable measurement in the assessment of spasticity in children with CP (18). In the present study, the scores of spasticity of the children according to MAS were at low level for the majority of children. To our knowledge, complete loss of spasticity can not be expected at short term such as 48 h in children with CP. Karadag Saygi et al. demonstrated that combined use of botulinum toxin A injection and KT resulted in no significant improvement compared sham group on muscle tone, but passive ankle dorsiflexion increased significantly in twenty patients with stroke at 2 weeks (29). On the other hand, Tamburella et al. reported that KT application on gastrocnemius muscle reduced spasticity and improved passive ankle dorsiflexion ROM, balance and gait at 48h in eleven patients with chronic spinal cord injury (25). The scores of the MAS of the patients with chronic spinal cord injury (mean: 2.9±1.04) were higher than those of our

participants. Tamburella et al. applied Y-strip tape over the gastrocnemius muscle using a decompressive muscle technique, with 0% stretch. We applied kinesio tape on the gastrocnemius muscle with 25% tension at the same position. According to Kase et al., the muscle should be taped from insertion to origin to inhibit muscle function with 15-25% tension, or paperoff tension (14).

Gait abnormalities and balance disorder caused by the loss of selective motor control and abnormal muscle tone influence negatively the level of physical activity in children with CP. Kinesio tape may contribute to gait performance and balance in rehabilitation of children with CP. Limitation of this study, there was no control group for comparison. We evaluated short term effects of KT on children with hemiplegic CP. However, this study included a homogeneous group of children with CP.

## CONCLUSIONS

KT has no immediate effects on ankle plantar flexor muscle spasticity and ankle ROM, but improves gait performance and balance in children with hemiplegic CP 48 h after application. Future randomized controlled studies should investigate the effects of long-term KT applications on spastic muscles in children with CP.

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