



Short-term Effect of Elastic Taping on Balance and Postural Control in Patients with Early-stage Parkinson's Disease -a Non-controlled, Quasi-experimental Study

Erken-evre Parkinson Hastalarında Elastik Bantlamanın Denge ve Postüral Kontrol Üzerine Kısa Süreli Etkisi-kontrolsüz, Yarı Deneysel Bir Çalışma

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ABSTRACT

Objective: Normal postural control and balance is achieved by the integration of visual, proprioceptive and vestibular sensory information. The patients with Parkinson's disease (PD), on the other hand, experience postural control disorders due to the lack of integration of these senses. Elastic taping is effective in improving expected postural adjustments by increasing proprioception and trunk muscle activation. The aim of this study was to investigate the short term effect of single session elastic taping on balance and postural control in patients with early-stage PD.

Methods: Elastic tape was applied with posture correction techniques on the upper back of 23 patients with early-stage PD (18 men, 5 women) during "on" phase. The postural control and balance ability of patients was assessed with the limits of stability (LOS), Sit-to Stand, Walk Across and Tandem Walking Tests of NeuroCom Balance Master test device. The tests were repeated after elastic taping in all patients.

Results: The maximum excursions and endpoint scores of LOS test, the speed of tandem walking test significantly increased after taping (Wilcoxon test, respectively; $p=0.04$, $p=0.02$, $p<0.001$). There was no significant difference between Walk Across and Sit to Stand results before and after elastic taping (Wilcoxon test, $p>0.05$).

ÖZ

Amaç: Görsel, proprioseptif ve vestibüler duyu bilgilerin integrasyonu ile normal postüral kontrol ve denge sağlanır. Parkinson hastaları (PH) ise bu duyuların integrasyonu yetersizliği nedeniyle postüral kontrol bozuklukları yaşarlar. Elastik bantlama, proprioepsyonu ve gövde kaslarının aktivasyonunu artırarak beklenen postüral ayarlamaları iyileştirmede etkilidir. Bu çalışmanın amacı, erken evre PH'lerinde tek seans elastik bantlamanın denge ve postüral kontrol üzerindeki kısa süreli etkisini araştırmaktır.

Yöntemler: Erken evre 23 PH'nin (18 erkek, 5 kadın) "On" döneminde, üst sırt bölgesine postür düzeltme teknikleri ile elastik bant uygulandı. NeuroCom Balance Master test cihazının kararlılık sınırları (LOS), Otur Kalk, Normal Yürüme ve Topuk Parmak Ucu yürüme testleri ile hastaların postüral kontrol ve denge yetenekleri değerlendirildi. Tüm PH'de elastik bantlama sonrası testler tekrarlandı.

Bulgular: Bantlamadan sonra LOS testinin ulaşılan maksimum uzaklık ve ulaşılan son nokta puanları ve Topuk Parmak Ucu Yürüme testinin hızı anlamlı olarak arttı (Wilcoxon testi, sırasıyla; $p=0,04$, $p=0,02$, $p<0,001$). Elastik bantlama öncesi ve sonrası Normal Yürüme ve Otur Kalk testi sonuçları arasında anlamlı bir fark yoktu (Wilcoxon testi, $p>0,05$).

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ABSTRACT

Conclusion: Our study is the first to investigate the short-term effects of elastic taping on balance and postural control in PD. It was concluded that the application of elastic tape in patients with PD could enhance dynamic balance and postural control parameters for a short time under challenging and complex conditions.

Keywords: Parkinson's disease, tape, balance, postural control, short-term

ÖZ

Sonuç: Çalışmamız, PH'de elastik bantlamanın denge ve postüral kontrol üzerindeki kısa süreli etkilerini araştıran ilk çalışmadır. PH'de elastik bant uygulamasının zorlu karmaşık koşullar altında dinamik denge ve postüral kontrol parametrelerini kısa bir süre için iyileştirebileceği sonucuna varılmıştır.

Anahtar Sözcükler: Parkinson hastalığı, bant, denge, postüral kontrol, kısa süreli

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disease characterized with motor, cognitive, emotional, autonomic and sensory impairments (1). Postural instability and balance impairment, which become evident as the disease progresses, could also be seen in the early-stage (2). Song et al. (3) reported that balance and postural control deficiencies could be detected in patients with early-stage PD by the use of evaluations involving complex tasks that challenged the neuromuscular system.

It is thought that in patients with PD, changes in the perception of verticalization due to impaired proprioception and somatosensory integration disorders, which lead to static and dynamic postural instability (4,5). Therefore, therapeutic approaches including active posture correction and proprioceptive stimulation are thought to be effective on axial symptoms (6).

In patients with PD, the reduced spinal movements cause an effort to maintain the body gravity line within the limits of stability and are usually compensated by increased trunk flexion which results in imbalance (4,5). Increased trunk flexion and the change in scapular position cause prolonged stress on muscle and joint structures, resulting in proprioceptive loss (7). It is known that even if there are no clinical findings of postural instability, postural synergies and hence postural control decrease in patients with early-stage PD especially under active challenging conditions (2,3).

Elastic taping aims to activate the proprioceptive system by increasing sensory stimuli with cutaneous mechanoreceptors, to improve anticipatory postural adjustments and activate trunk muscles and joints without restricting body movements. In the literature, it was showed that application of elastic taping on low back in non-specific chronic low back pain patients improved postural control in a short time period and elastic taping for postural correction in osteoporosis-associated thoracic kyphosis patients immediately improved the balance parameters (8,9). Studies have shown that elastic taping improves postural control and balance not only by increasing proprioceptive sensation, but also by determining the correct joint position for a comfortable and non-burdening posture (7,10). In recent years, it has been utilized in musculoskeletal and neurological diseases with the aim of increasing or

inhibiting muscle activity, providing joint repositioning, preventing injuries and improving proprioception (11,12).

In the literature, within our knowledge, there are no studies examining the short-term effects of elastic taping on balance and postural control in patients with PD. Therefore, in this study, we aimed to investigate the short-term effects of single session elastic taping on balance and postural control in patients with early-stage PD. The hypothesis of the present study was that the application of single session elastic taping in patients with early-stage PD would improve balance and postural control in a short-term period.

Methods**Study Design****Participants**

This study was carried out between February 2017 and June 2018 in Dokuz Eylül University, Faculty of Physiotherapy and Rehabilitation in cooperation with the Faculty of Medicine, Department of Neurology at Dokuz Eylül University. Patients who were diagnosed as having PD according to criteria of United Kingdom PD Society Brain Bank, had a Mini-Mental test score of ≥ 24 , a modified Hoehn&Yahr scale score of ≤ 2 , were aged ≥ 18 years and who were able to stand independently for minimum 1 minute and walk for at least 10 meters without any support and had stable clinical status were included the study. The exclusion criteria were neurological, orthopedic or visual dysfunctions irrelevant of PD, affecting walking and balance ability.

Ethics Approval

This study was approved by the Ethics Committee of Dokuz Eylül University with the protocol number 3013-GOA and decision number 2016/29-19. The objectives and methods were read to the patients who met the inclusion criteria and agreed to participate in the study, and an informed consent form was signed. This study was conducted in accordance with the Declaration of Helsinki.

Sample Size

The sample size calculation was based on a similar study which examined the short term effects of elastic taping on balance in elderly with postural hyper kyphosis (for Limits of Stability outcomes) (13). The sample size was determined as 15 subjects using Epi Info TM 7 (7.1.1.14) program based on 95% confidence interval, 80% power rate and 0.05 Type 1 error.

Intervention

All patients were assessed before and after elastic taping application during the “on” phase. A physiotherapist who was trained and certified in taping, applied Kinesio Tex Gold FP elastic tape (5 cm) on the upper back of individuals with posture correction technique. The waterproof, porous, adhesive, 0.5 mm-thick tape was applied. This method was the application of a chemical-free elastic tape that mimicked the tissue and elasticity of human skin. Taping was applied starting from the acromioclavicular joint without stretching and went on with maximum stretching to the level of the thoracic 7th vertebra. Taping was terminated without stretching after 7 thoracic vertebrae levels. Two I-shaped elastic tapes were applied diagonally from the anterior of the right and left acromion towards the back (14). The subjects were re-assessed after a resting period for approximately 45 minutes. The application of elastic tape is shown in Figure 1.

Measurement Methods

The modified Hoehn & Yahr scale was used to evaluate the clinical characteristics of patients with PD. Stage 1 indicates the lowest level of disease severity, whereas stage 5 refers to the highest level (15,16). Participants with a Hoehn&Yahr score greater than 2 were excluded.

Objective Balance Assessment

The postural control and balance ability of patients were evaluated by using NeuroCom Balance Master device (NeuroCom System Version 8.1.0, B 100718, 1989-2004 NeuroCom® International Inc. USA) which measured the dynamic and static balance abilities (17). It has high test-retest reliability in assessing the postural stability and balance impairment of healthy individuals (18). It is a valid and reliable method to measure balance performance in patients with PD (19). The Balance Master consisted of 48.26x152.40 cm² force plate connected to a computer including a software program that calculated the center of pressure relative to the platform coordinates. Force data were sampled at a frequency of 100 Hz. The objective balance assessments took place in a room free from external distractions. Before the assessment, the patients were positioned at standardized foot position on the force plate (Medial malleolus in horizontal line, calcaneus in vertical line). Before the objective balance assessment, trial tests of all evaluation parameters were performed for each patient in order to help the patients get used to the Balance Master device and to reduce the learning effect.

Postural Control

Limits of Stability (LOS)

The patient was asked to move the center of gravity as quickly as possible to 8 different targets (anterior-posterior, right-left and other directions) displayed on the computer screen while standing stationary above the center point determined on the platform. The time spent by patients for body moves (reaction time, sec.), the movement velocity (%/sec.), the last point that the subject could reach the target point (endpoint excursions, %), the distance to the target point (maximum excursions, %),

and the linearity of the movement while moving towards the target point (directional control, %) were measured (20).

Balance

Tandem Walk Test

The patient was instructed to walk with tandem steps and stand stable at the end of the platform. The step width (cm), walking speed (cm/sec), and postural sways at the end of the pathway (deg/sec) were measured. Each test was repeated 3 times 20.

Walk Across Test

Step width (cm), step length (cm), and walking speed (cm/sec) were measured while the patient was walking on the platform at the speed which they felt comfortable and safe. Each test was repeated 3 times (20).

Sit-to-Stand Test

The patient stood up quickly from the 40.64 cm high platform he/she was sitting on without using her/his arms or hands and waited for 5 seconds for the sway of the center of gravity to be measured. The time from sitting to standing stable (sec), the index of body weight rising (%), the speed of the sway of center of gravity while standing stable (°/sec), and the body weight's symmetry to right or left (%) were measured. Each test was repeated 3 times (20).

Statistical Analysis

The statistical analysis in this study was performed using “Statistical Package for Social Sciences” (SPSS) Version 22.0 (SPSS inc. Chicago, IL, ABD) program. The results were



Figure 1. The application of elastic tape

presented as means and standard deviation. Wilcoxon test was performed to compare the difference between the results before and after the elastic taping application. $P < 0.05$ was accepted to be statistically significant (21).

Results

In total, 23 patients with PD (18 males and 5 females) participated in the study. There was no allergic reaction in the patients after the application of elastic taping. The mean age of the patients was 64.52 ± 6.28 years. Table 1 illustrates the demographic characteristics of the patients.

There was no significant difference between before and after taping outcomes of reaction time, movement speed and movement control parameters in terms of LOS test ($p > 0.05$). The maximum excursion and endpoint values increased significantly after taping in patients with PD ($p < 0.05$, Table 2).

There was no significant difference between before and after taping values of Walk Across and Sit to Stand Tests. The walking speed of tandem walk test decreased significantly after taping ($p < 0.05$, Table 3).

Discussion

The aim of this study was to determine the effects of single session elastic taping on dynamic balance and postural control parameters in patients with early-stage PD. The main result of our study was that the short-term effect of elastic taping on postural control and balance occurred in active and challenging conditions such as tandem walking and stability limits. The

walking speed in Tandem Walk test, maximum excursions and endpoint values in LOS test increased after elastic taping application.

Recognizing and evaluating impairment in balance and postural control are so important in the management of PD, as it directly affects walking, mobility, and falls (22). Since it is difficult to identify balance and postural control deficits in early-stage PD, it is thought that fall and balance disorders usually occur in the late stages of the disease (23-25). In the literature, it was reported that balance and postural control disorders occurred in early-stages of PD, but clinical tests were not sufficient to detect this, and advanced computerized static and dynamic postural stability assessments (like posturography or accelometer) provided more accurate parameters (24-26). Based on this information, we preferred to analyze the LOS test, Tandem Walk test, Walk Across test and Sit to Stand test data of the patients with the Balance Master System in our study. Based on this information, we preferred to analyze the LOS test, Tandem Walk test, Walk Across test and Sit to Stand test data of the patients with the Balance Master System in our study. Supportive approaches such as exercise and elastic taping to be applied after computerized balance and postural control evaluations in the early-stage of PD, may be effective in improving balance and postural control disorders and slowing the clinical course, by supporting the correct posture. It has been stated in recent studies that elastic taping can be used for postural correction and can be an effective form of cutaneous proprioceptive biofeedback (7). Therefore, in our study, we applied elastic tape with the postural correction technique

Table 1. Characteristics of patients

		n = 23
Gender n (%)	Male	18 (78.3)
	Female	5 (21.7)
Age (year)		65.0 (61.0-67.0)
Height (cm)		1.72 (1.65-1.78)
Weight (kg)		80.0 (75.0-92.0)
Duration of illness (months)		36.0 (11.0-48.0)
Modified Hoehn and Yahr		2.0 (2.0-2.0)
All data were given as median (interquartile range)		

Table 2. A comparison of postural control measurements before and after elastic taping application

	n=23 Median (interquartile range)		
	Before elastic taping	After elastic taping	P
LOS reaction time (sec)	0.37 (0.26-0.59)	0.33 (0.17-0.47)	0.19
LOS movement velocity (deg/sec)	2.7 (2.2-3.4)	2.9 (2.5-3.6)	0.19
LOS endpoint (%)	64 (59-75)	71 (63-81)	0.02*
LOS max excursions (ESM) (%)	82 (74-88)	85 (78-91)	0.04*
LOS direction control (%)	76 (66-79)	73 (66-79)	0.59
*Wilcoxon test, $p < 0.05$			

to the upper back of patients with early-stage PD in order to increase proprioceptive feedback and support correct posture.

Postural stabilization is provided by the passive support of the osteoligamentous system, active support of the musculotendinous system and neural control. In PD, it is assumed that postural disorders develop due to musculotendinous changes such as decreased muscle flexibility, muscle endurance and muscle weakness and deficiency in neural control, therefore applications on the upper back area for these changes are thought to help improve posture (27). It has been shown that the active musculotendinous system and the neural control components of spinal stabilization are improved with the application of elastic banding, which contributes to postural control and affects the proprioceptive system in neurological diseases, thus supporting the spine in a neutral position (28,29). Elastic taping stimulates proprioceptive receptors by increasing motor nerve excitability and regulating muscle activity, and provides feedback on posture, thus increasing postural awareness during daily activities. Elastic taping has been shown to improve postural control and balance not only by increasing the proprioceptive sensation but also by determining the correct joint position for a comfortable, no weight-bearing posture (7,10,11,28).

When studies evaluating the short-term effect of upper back elastic taping in different disease groups were examined, it was observed that the effect of taping on the angle of kyphosis was frequently examined (9,13,14). However, in our study, kyphosis assessment was not performed because balance and postural control were evaluated in patients with early-stage PD who did not develop postural deformities. Greig et al. (14) reported that the decrease in the kyphosis angle they detected after taping could be due to the passive support of the tape and the active support of muscle contraction. In another study, it was reported that elastic taping helped to correct posture and increased stability limits in kyphotic elderly individuals (13). On the contrary, Bulut et al. (9) reported that similar elastic taping application did not have a significant short-term effect on kyphosis angle and clinical

balance values in women with postmenopausal osteoporosis-associated thoracic kyphosis. Since there are few studies and conflicting results in the literature regarding the short-term effect of upper back elastic taping applied for postural correction, we think that our study can summarize and clarify the findings in the literature on this subject. As stated in other studies, it was found in our study that the application of upper back elastic taping did not have an influence on simple balance and postural control tasks, but improved the performance of challenging balance and postural control in such conditions as stability limits and tandem walking.

Elastic taping can improve poor proprioception by increasing sensory input via cutaneous mechanoreceptors. Therefore, patients with poor proprioception, such as PD, may benefit more than healthy individuals with good proprioception (30). It has been reported in studies that short-term elastic tape application on the lower back improves the trunk position sense and trunk postural control in healthy women (31). There are few studies emphasizing that elastic taping applied to the upper back can change balance and postural stability parameters in a short time in stroke, another neurological disease in which proprioception is reduced, but there are no studies examining this in PD (29,32,33). Therefore, in our study, we investigated the short-term effects of elastic taping on balance and postural control. In our study, the short-term effect of elastic taping, which we applied for a single session, emerged in active and challenging conditions such as tandem walking and stability limits. After the application, walking speed in the Tandem Walk test, maximum excursions and endpoint values in the LOS test increased.

The improvement in the values of the LOS test, which evaluates postural control by measuring the active stability limits of the individual, indicates better balance and postural control (19,34). As the disease stage progresses in PD, LOS parameters worsen (movement speed decreases, endpoint and maximum excursion values decrease significantly) and the risk of falling increases with the increase in trunk rigidity and decrease in trunk coordination

Table 3. A comparison of balance measurements before and after elastic taping application

	n=23 Median (interquartile range)		
	Before elastic taping	After elastic taping	P
Walk across step width (cm)	17 (14.4-19.2)	15.6 (13.5-19.3)	0.85
Walk across step length (cm)	49.9 (44.3-57.6)	54.3 (43.4-61.7)	1.00
Walk across speed (cm/sec)	64.3 (56.5-72.4)	61.2 (52.8-73.1)	0.74
Walk across symmetry (%)	13 (4-19)	13 (8-22)	0.35
Sit to stand weight transfer (sec)	0.41 (0.29-0.63)	0.41 (0.29-0.55)	0.50
Sit to stand sway velocity (deg/sec)	3.3 (2.5-4.2)	3.4 (2.9-4.3)	0.87
Sit to stand rising index (%)	22 (18-25)	20 (18-26)	0.77
Sit to stand symmetry (%)	10 (5-13)	8 (4-17)	0.85
TANDEM step width (cm)	8.9 (7.8-11.2)	9 (8.3-12.0)	0.63
TANDEM speed (cm/sec)	26.9 (22-30.6)	33.1 (27.3-35.8)	<0.001*
TANDEM end sway (deg/sec)	4.8 (3.5-5.9)	4.0 (3.0-5.0)	0.12

*Wilcoxon test, p<0.05

(19,34). The improvement in this test performance after some rehabilitation approaches used in PD reflects the improvement in postural strategy. All rehabilitation approaches that will improve the LOS parameters are important in order to increase the independence of the patients in daily life and to reduce the risk of falling. It is thought that elastic taping, which is one of these approaches, can improve the anticipatory postural adjustments and increase postural stability by increasing proprioceptive stimulation in neurological patients. When the studies investigating the short-term effect of elastic taping in neurological diseases were examined, it was stated that calf taping in patients with Multiple Sclerosis reduced postural instability by improving the standing balance. It has been reported that ankle taping increases stability limits in patients with stroke, and trunk taping improves dynamic balance and dynamic postural control (32,35,36). Unlike other studies, in our study, elastic taping was applied to the upper back and only the maximum excursions and the end point values were observed to significantly increase. Elastic taping may have provided a biomechanical advantage with increased proprioceptive input in challenging conditions such as reaching the end point of stability limits in patients. Poor performance of an individual with PD in the LOS test indicates that the individual's functionality decreases and the risk of falling increases. Since patients cannot move their trunks correctly within the limits of stability, they experience imbalance during activities of daily living in which body weight is displaced, such as walking and reaching for objects (19,37). We think that the elastic tape, which can stay on the skin up to 1 week after application, will provide proprioceptive support to the patients, especially in dynamic and challenging conditions such as reaching, walking, sitting and standing in daily life and will help them to perform these functions without experiencing imbalance.

In the only study in the literature in which elastic taping was applied in PD, it was stated that taping applied within the scope of postural rehabilitation program (stretching, postural training, proprioceptive discrimination exercises and elastic taping to the trunk) did not affect dynamic balance performances (measured with Timed Up and Go and Berg Balance scale) (38). In our study, in which we applied elastic taping to increase postural control and to give proprioceptive input to the trunk, taping had no effect on dynamic balance values such as STS and NWT, but a significant increase was observed in tandem gait speed. Elastic taping made a significant difference in dynamic balance values only in this test because the tasks in the TWT were more demanding than in other tests, and patients with early-stage PD showed imbalance, especially in active and challenging conditions (39). However, tandem walking is a determinant of general mobility and walking difficulties in PD. Difficulty in walking in tandem is more pronounced in advanced stages of PD, where overall mobility decreases and the risk of falling increases (40). For this reason, applications that can be made to improve this gait before the disease stage progresses are important. This increase in tandem walking speed in our study shows us that elastic taping may be beneficial on bradykinesia in PD.

Study Limitations

The lack of a control group is the most important limitation of this study. Follow-up studies involving a control group matched for age and disease stage are required to reduce placebo effects and bias. In these studies, it would be beneficial to make a sham application to blind the subjects to the treatment distribution and to reduce the risk of compliance.

Conclusion

Although there are many studies in the literature examining the short-term effect of elastic taping in different disease groups, our study is the first to investigate the short term effects of elastic taping on balance and postural control in PD. It is stated in the literature that the decrease in the LOS test endpoint and maximum excursion and TWT walking speed values typically indicate balance problems, poor postural control ability, and bradykinesia in patients with PD. In our study, we observed a short-term improvement in these parameters after taping. In the light of all this information, our study offers physiotherapists an alternative method, elastic taping, which can be effective in improving balance and postural control in the early-stage of PD. We think that our study will offer an insight into other studies that will investigate elastic taping in PD in the future.

Ethics

Ethics Committee Approval: This study was approved by the Ethics Committee of Dokuz Eylül University with the protocol number 3013-GOA and decision number 2016/29-19.

Informed Consent: The objectives and methods were read to the patients who met the inclusion criteria and agreed to participate in the study, and an informed consent form was signed.

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Authorship Contributions

Surgical and Medical Practices: E.G., B.D.Ç., R.Ç., B.B., Concept: E.G., B.D.Ç., R.Ç., B.B., Design: E.G., B.D.Ç., R.Ç., B.B., Data Collection or Processing: E.G., B.D.Ç., R.Ç., Analysis or Interpretation: E.G., B.D.Ç., Literature Search: E.G., B.D.Ç., Writing: E.G., B.D.Ç., R.Ç., B.B.

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