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Effects of Pilates and Elastic Taping on Balance and Postural Control in Early Stage Parkinson's Disease Patients: A Pilot Randomised Controlled Trial

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ABSTRACT

Introduction: The purpose of this study is to investigate the effects of Pilates training and elastic taping on balance and postural control in patients with early stage Parkinson's Disease (PD).

Method: Patients were randomly divided into Pilates, elastic taping, and control (wait list) groups. Pilates training was performed for 6 weeks, twice a week and 60 minutes per session. In elastic taping group, in addition to Pilates training, elastic taping was applied to the upper back twice a week for 6 weeks with the aim of postural correction. In order to evaluate the postural control before and after the training, Berg Balance Scale, Trunk Impairment Scale, the tests of NeuroCom Balance Master performance test device as Limits of stability (LOS), Sit-to Stand, Walk Across and Tandem Walking Tests were performed.

Results: The data of 20 patients (6 male in Pilates group, 2 female and 6 male in elastic taping group, 3 female and 3 male in control group) were analyzed. Reaction times in LOS test decreased significantly and walking speed in Walk Across test increased significantly after 6 weeks in Pilates and elastic taping groups. In elastic taping group, the postural sways of Tandem Walk test were decreased significantly and, the rising index in Sit-to-Stand test increased significantly after 6 weeks (Wilcoxon Test, $p<0.05$).

Conclusion: We believe that Pilates is a feasible rehabilitation strategy for PD, and it has a remedial effect on the dynamic balance and postural control for these patients. We also think that elastic taping could be applied for supporting the right posture.

Keywords: Parkinson's disease, pilates, tape, balance, postural control

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INTRODUCTION

In Parkinson's Disease (PD), balance and postural dysfunctions are based on the inability of the postural muscles to respond the environmental demands and the emergence of inadequate postural reactions. In addition, rigidity, decrease in joint movements, weakness of extensor trunk muscles, and flexed posture of trunk involve to deterioration in postural reactions (1).

In PD, the proprioceptive defects lead to changes in the perception of verticalization and postural disturbances. The trunk movements necessary to keep the gravity center within the support surface are reduced and therefore compensation occurs with body flexion (2–4).

Postural instability is an indicator of the disease progressing from stage 2 to stage 3 on the Modified Hoehn&Yahr scale and is demonstrated by clinical withdrawal testing (5). Falaki et al. reported that postural synergies were reduced in stage 1 and 2 PD patients, even if not observed in daily life. Early detection of the decrease in postural synergies is very important for predicting progression of postural instability (6). Exercise program, which included low intensity and progressive trunk exercises and motor training can improve balance-related performance in patients with mild to moderate PD (7).

Pilates method aims to improve the balance and dynamic postural control by increasing endurance, strength and flexibility of "core" muscles (8). Pilates training in PD patients has been shown to improve postural stability, range of motion, movement quality, body alignment and quality of life (9, 10).

In recent years, it has been proposed that elastic taping lead to facilitate cutaneous stimuli through increased somatosensory inputs. Elastic taping can also stimulate the proprioception by activating the cutaneous mechanoreceptors (11–13). This method has been used in neurological (stroke, multiple sclerosis) and orthopedical diseases with the aim of improving muscle tone, range of motion, center of pressure balance parameters and analgesia (13).

In the literature, there are no studies examining the effect of elastic taping in combination with Pilates exercises on balance and postural control in PD. Thus, the aim of this study is to compare the effects of Pilates training and elastic taping on balance and postural control in early stage PD.

The hypothesis of this study was that PD patients who engaged in elastic taping treatment group would report more improvements in postural control parameters than Pilates exercise group and control group after this treatment period.

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METHOD

Study Design

Participants

This study, which has a randomized controlled design, was carried out between February 2017 and December 2017 in Dokuz Eylül University School of Physiotherapy and Rehabilitation in cooperation with Faculty of Medicine, Department of Neurology, Dokuz Eylül University. The idiopathic PD patients, who have been diagnosed for by a neurologist by using the diagnosing criteria of United Kingdom Parkinson's Disease Society Brain Bank and had Mini-Mental test score of ≥24 and modified Hoehn & Yahr scale score of ≤2, aged ≥18 year-old, and were able to stand independently for min. 1 minute and walk for at least 10 minutes without any support, were involved in the study.

The exclusion criteria were as follows; having neurological, orthopedical, cardiovascular diseases deteriorating the walking and functional abilities other than PD, having a surgery history related with PD (such as deep brain stimulation) and having participated in any physiotherapy program in last 6 months.

Ethics Approval

The study was approved by the Ethics Committee of Dokuz Eylül University (protocol number 3013-GOA and decision number 2016/29–19). The objectives and methods were read to/by the voluntary patients meeting the inclusion criteria of the study, and they signed the informed consents. This study was carried out in accordance with the Declaration of Helsinki.

Sample Size

The universe of the study consisted of the idiopathic PD patients followed by the Neurology Department of Faculty of Medicine, Dokuz Eylül University. The sample size calculation was based on similar studies which assessed step length in Walk across test in PD after balance training. The minimum size of sample was calculated to be 24 persons (8 in each group) by using G-Power (ver. 3.1) software (confidence level 95%, power 80% and 0.72 effect size). Considering the 20% drop out rate, it was planned that totally 30 people to be included in the study, with 10 in each group (14).

Procedure

The patient recruitment still continues. However, the data were analyzed as a pilot study. The patients accepting to participate in this study were randomly assigned to 2 treatment groups (Pilates exercise group, elastic taping group) and control (wait list) group using closed envelope method. A physiotherapist having experience in neurological physiotherapy generated the random allocation sequence, enrolled and assigned participants to interventions. The 2 treatment groups received Pilates exercise (Pilates Group-PG) or Pilates exercises plus elastic taping (Elastic taping Group-ET), while the control group received no treatment.

The study was initiated with totally 23 patients (7 in Pilates group, 9 in the elastic taping group, and 7 in the control group). One patient from Pilates group and 1 patient from control group quitted the study because of secondary health problems. One patient from elastic taping group quitted the study because of personal reason. The data of totally 20 patients (6 patients in Pilates group, 8 patients in elastic taping group, and 6 patients in control group) were analyzed (Figure 1). The routine medical treatments (dopaminergic) were maintained for all the patients during the follow-up period.

Interventions

Patients from both treatment groups underwent 12 Pilates exercise sessions (2 days/week for 6 weeks) lasting 60 minutes; the patients in the ET group received elastic taping in addition to Pilates exercises. Treatment was conducted by a physiotherapist having experience in neurological physiotherapy and certificate of Pilates training.

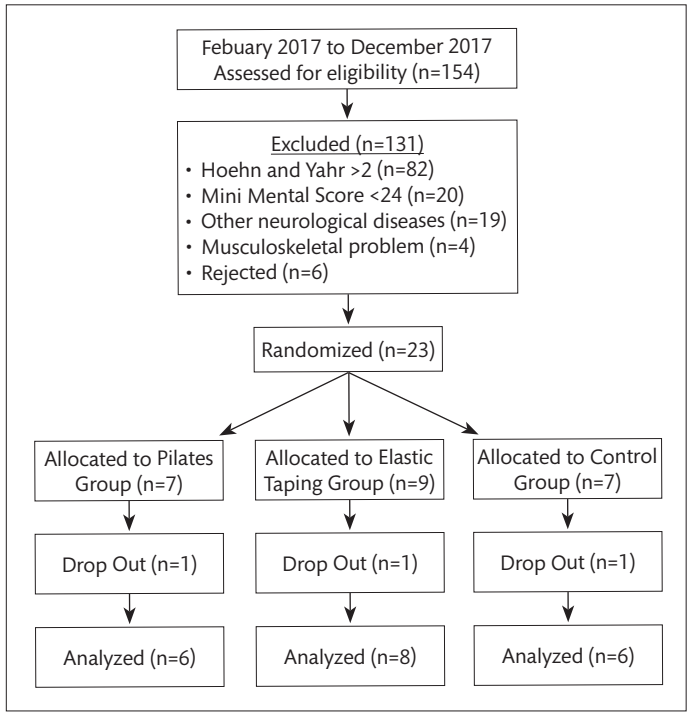

Figure 1. Flowchart of study process.

Pilates Group-PG

The Pilates exercise program was composed of warm-up exercise, the main exercise, and cool-down exercise. The details of the program are provided in Table 1. The sessions were conducted in 2–3 person groups. The exercise program developed for this intervention was based on the key Pilates' principals and was specifically designed for PD patients. Before the Pilates training, a special session was organized in order to inform the patients about the training principles and exercises. The fundamental principles including centering, concentration, control, breathing, precision and rhythm were taught. The individuals were asked

Table 1. Pilates exercise program

Warm up exercise 10 minutes	Breathing Centering Neck, trunk and extremity mobility exercises	
Main exercise 40 minutes	Shoulder drop Chest lift Hundred Single leg circles Single leg stretch Crisscross Side to side Shoulder bridge Book opening	Up/down side kicks Side lift Spine stretch forward Spine twist Press up Single leg kicks Modified scarecrow Modified swimming
Finishing exercise 10 minutes	Child's pose Modified mermaid Lunges Knee lifts Standing balance	

Total 60 minutes

for focusing on and trying to maintain these principles during sessions. Each movement was demonstrated in practice by a physiotherapist at first. The physiotherapist controlled the movements throughout the exercise and used as tactile, verbal, and imaginary cues in correcting when necessary. The difficulty level of Pilates training was carried out by changing the body positions during exercise, using of exercise balls and bands (Theraband Elastic Band Hygienic Corporation, Akron, Ohio) at 4th week according to the performance of the patients and the principles of Pilates (15).

Elastic Taping Group-ET

The Kinesio Tex Gold FP elastic tapes (5 cm-wide) were applied with postural correction method after each exercise session and replaced after each session. The tape, which is water-proof, adhesive and 0.5 mm thick, was applied to upper back in order to obtain the postural correction. The taping applied from the anterior aspect of the acromioclavicular joint, crossed over the muscle bulk of upper trapezius, and then diagonally towards 7th thoracic vertebra. In this method, 2 I-shaped elastic tapes were applied diagonally and no tension was applied on the point of initial and final contact (16).

Control Group

The patients were assigned to the wait list and their routine medical treatments were continued. The assessments were performed on 0th and 6th weeks also in this study. It was planned to involve them in the exercise program after completing the study.

Measurement Methods

The clinical and objective balance assessments were performed in all groups in the pre-treatment (0th week) and post-treatment period (6th week) during the "on" phase. The clinical characteristics of PD patients were examined in 5 main and 2 sub-stages according to Modified Hoehn & Yahr scale. Stage 1 indicates the lowest severity level, whereas Stage 5 refers to the highest severity level (17).

Objective Balance Assessment

The balance ability of patients was evaluated by using NeuroCom Balance Master balance and performance test device (NeuroCom System Version 8.1.0, B 100718, 1989–2004 NeuroCom® International Inc. USA). The system objectively measures the dynamic and static balance performances (18). It has high test-retest reliability in assessing the postural stability balance impairment of healthy individuals (19).

Limits of Stability: This test was used to record dynamic balance performance. The patient is directed to move the center of gravity as directly and quickly as possible to 8 different targets (anterior-posterior, medial-lateral, and other directions) on the display screen while standing on stable force plates. During this test, the time spent by individual in moving the body (reaction time, sec.), the movement velocity (°/sec.), the final point that the subject could reach towards the target point (endpoint excursions, %), the distance to target point (maximum excursions, %), and the linearity of the movement while moving towards the target point (directional control, %) are measured (18).

Tandem Walk Test: The individual is asked to walk with tandem steps and to stand still at the end of the platform. The step width (cm), walking speed (cm/sec), and postural sways (deg/sec) were measured at the end of walking (18).

Walk Across Test: The patient is asked to walk on the platform at a speed he/she feels comfortable and safe. The step width (cm), step length (cm), and walking speed (cm/sec) are examined (18).

Sit-to-Stand Test: The patient is asked to stand up from a platform with 40.64 cm height as fast as possible without any support and stand steady for 5 seconds in order to measure of body sways. The time from sitting to standing stable (sec.), the index of rising the body weight (%), the speed of the sway of center of gravity while standing stable (°/sec.), and the body weight's symmetry to right or left (%) are measured (18).

Clinical Balance Assessment

Trunk Impairment Scale (TIS): This scale consists of three subscales; static-dynamic sitting balance and trunk coordination The TIS score ranges from 0 to 23, with higher points indicating good trunk control (20).

Berg Balance Scale (BBS): This test assesses the static-dynamic balance with 14 functional item rated between 0 and 4 points. The maximal sum score is 56 points; the scores between 0 and 20 points indicate a balance impairment, those between 21 and 40 points indicate an acceptable balance ability, and those between 41 and 56 points indicate good balance (21).

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 normality of the variables' distribution was analyzed using Shapiro-Wilk Test. The descriptive analyses results were expressed as median minimum and maximum values for the non-normally distributed variables.

The categorical variables (gender) were expressed in percentages. The Chi-Square and Kruskal-Wallis tests were used in comparing the demographic and clinical characteristics of the patients. The pre-treatment (0th week) and post-treatment (6th week) measurements performed in 3 groups (Pilates Exercise group, Elastic taping group, and control group) were compared using the Wilcoxon Test. $p<0.05$ was accepted to be statistically significant (22).

RESULTS

There were no significant differences between treatment groups other in terms of age, height, body weight, disease period, and disease severity according to the modified Hoehn&Yahr scale (p>0.05) (Table 2).

The TIS scores did not showed significant improvements in 3 treatment groups after 6 weeks (p>0.05). The BBS scores increased in the PG and ET groups but decreased in control group without statistically significance after 6 weeks (p>0.05) (Table 3).

Reaction time parameter of the LOS test was decreased significantly after 6-weeks treatment in PG (p=0.046) and ET groups (p=0.05) (Table 3). The end-sway parameter of tandem walk test was decreased significantly in the ET group (p=0.04). This value decreased in the PG and increased in the control group without statistically significance (p>0.05) (Table 3).

The walking speed values of walk across test were increased significantly in PG and ET groups after 6 weeks (p<0.05). The step length values were increased in 3 groups but there was no statistically significance (p>0.05) (Table 3).

The rising index of sit to stand test was improved significantly in the ET group (p<0.05). The body sway performance was not changed significantly in 3 groups after 6 weeks (p>0.05) (Table 3).

Table 2. Characteristics of patients

		Pilates group n=6	Elastic taping group n=8	Control group n=6	p
Gender n (%)	Female Male	0 (0.0) 6 (100.0)	2 (25.0) 6 (75.0)	3 (50.0) 3 (50.0)	Not Assessed
Age (year)		64.0 (48.0–79.0)	65.0 (52.0–70.0)	61.0 (45.0–67.0)	0.63*
Height (cm)		1.73 (1.63–1.85)	1.71 (1.55–1.79)	1.62 (1.55–1.76)	0.17*
Weight (kg)		84.0 (73.0–90.0)	91.5 (65.0–118.0)	77.5 (60.0–84.0)	0.15*
Duration of illness (months)		42.0 (3.0–98.0)	27.0 (1.5–60.0)	27.0 (12.0–120.)	0.85*
Modified Hoehn and Yahr		2.0 (1.5–2.0)	2.0 (1.0–2.0)	2.0 (1.0–2.0)	0.57*

*Kruskal-Wallis test. All data were given as median (minimum-maximum).

Table 3. A comparison of previous and subsequent measurement of parameters for groups

	Pilates group n=6 Median (min.-max.)			Elastic taping group n=8 Median (min.-max)			Control group n=6 Median (min.-max)		
	WEEK 0	***WEEK 6***	***P***	***WEEK 0***	***WEEK 6***	***P***	***WEEK 0***	***WEEK 6***	***P***
TIS (score)	21 (17–23)	21 (20–23)	0.2	21 (18–23)	22 (19–23)	0.13	19.5 (15–23)	21 (17–23)	0.20
BBS (score)	55 (49–56)	56 (54–56)	0.2	55 (54–56)	56 (55–56)	0.06	56 (52–56)	55.5 (51–56)	0.70
LOS Reaction time (sec)	0.65 (0.13–1.73)	0.43 (0.17–0.49)	0.046*	0.49 (0.17–1.11)	0.32 (0.12–0.47)	0.05*	0.73 (0.49–1.19)	0.52 (0.18–0.97)	0.17
LOS Movement velocity (deg/sec)	2.15 (1.5–3.8)	2.5 (1.8–4.1)	0.78	2.3 (1.4–4)	2.75 (1.8–3.8)	0.83	1.95 (1.4–2.7)	2 (1.2–2.5)	0.15
LOS Endpoint (%)	59.5 (35–87)	68 (50–87)	0.04*	75 (58–82)	71.5 (59–88)	0.89	55.5 (44–69)	63 (50–73)	0.60
LOS Max excursions (ESM) (%)	73 (65–102)	86.5 (76–99)	0.12	85.5 (74–95)	90 (77–100)	0.21	77.5 (69–83)	81.5 (72–85)	0.11
LOS Direction control (%)	78.5 (52–88)	79 (69–80)	0.92	79.5 (54–85)	73 (60–79)	0.07	74 (66–83)	73 (61–68)	0.25
Tandem walk test Step width (cm)	8.0 (7.2–20.5)	7.8 (6.0–18.4)	0.92	8.6 (6.4–11.1)	9.55 (6–11.5)	0.44	7.9 (5.7–12)	7.35 (5.9–8.2)	0.46
Tandem walk test Speed (cm/sec)	22.2 (17.5–33.7)	23.75 (13.1–34.4)	0.92	25.45 (18.8–30.4)	26.15 (21.2–34.3)	0.58	25.8 (12.13–29.8)	26.2 (9.9–29.8)	0.60
Tandem walk test End sway (deg/sec)	4.9 (3.9–6.9)	4.15 (2.7–6.4)	0.25	5.1 (3.2–6.6)	3.35 (2.3–5.7)	0.04*	3.95 (1.5–5.2)	4.7 (2.9–6.6)	0.25
Walk across test Step width (cm)	15.5 (12.4–19.6)	14.45 (11.8–17.2)	0.46	16.4 (12.1–21.6)	17.3 (12.1–24.2)	0.67	14.25 (4.6–22.2)	14.6 (10.1–21.9)	0.92
Walk across test Step length (cm)	46.5 (40.5–59.1)	54.1 (33.1–70.3)	0.12	50.35 (25.9–63.7)	52.85 (39.5–97.8)	0.33	46.4 (39.2–62.30)	47.45 (36.1–59)	0.92
Walk across test Speed (cm/sec)	59 (53.4–75.5)	60.2 (53.9–93)	0.046*	66.15 (36–81.5)	76.35 (56.9–92.8)	0.02*	59.2 (50.9–87.2)	67.55 (45.9–74.2)	0.60
Walk across test Symmetry (%)	11 (3–23)	14 (3–30)	0.14	10 (3–30)	11.5 (2–39)	0.62	9.5 (3–74)	26 (15–45)	0.34
Sit to stand test Weight transfer (sec)	0.41 (0.12–0.89)	0.61 (0.4–0.89)	0.12	0.35 (0.16–0.65)	0.28 (0.19–0.79)	0.53	0.4 (0.25–1.43)	0.38 (0.2–1.06)	0.60
Sit to stand test Sway velocity (deg/sec)	3.25 (2.5–4.7)	2.75 (1.8–4.3)	0.09	4.95 (3–12)	4.35 (2.4–5.5)	0.40	3.75 (0.9–4.6)	3.45 (1.1–4.8)	0.75
Sit to stand test Rising index (%)	21 (15–42)	22 (13–30)	0.17	18.5 (2.5–29)	25 (13–38)	0.01*	19.5 (12–38)	21 (9–31)	0.20
Sit to stand test Symmetry (%)	3 (1–11)	8 (0–19)	0.25	7 (2–22)	10 (0–19)	0.94	7 (0–30)	9.5 (0–25)	0.6

*Wilcoxon test, *p<0.05.* TIS, trunk impairment scale; BBS, Berg balance scale; LOS, limits of stability.

DISCUSSION

We examined the effectiveness of two different methods on balance and postural control in the early stage PD patients. We hypothesized that the application of elastic taping additionaly to Pilates exercises would result more improvement in clinical and objective balance outcomes when compared to the Pilates training and control groups. Our findings showed that there was no difference between Pilates exercise and elastic taping groups in terms of treatment efficiency. The Pilates and elastic taping methods had remedial effects on dynamic balance parameters (reaction time and end point excursion values of LOS test, walking speed, end sway of tandem walk test, rising index of sit-to stand test) of these patients.

Pilates and Dynamic Balance

Pilates is an exercise method that aims to improve the flexibility and axial stability by strengthening the "core" muscle system of body. It provides postural stability with the activation of agonist and antagonist muscles, and increases balance and motor coordination, muscle strength, endurance, and flexibility (9, 23).

Given the studies examining the effects of Pilates training on the balance in literature, it can be seen that the treatment outcomes were not analyzed by using an objective balance assessment system as in our study. In previous studies, the dynamic balance was frequently evaluated with the Timed Up and Go test (TUG). The effectiveness of Pilates training were compared with conventional physiotherapy (24), gait training (25), calisthenic exercises (26) in different papers and reported significantly more improvements in TUG scores in early and middle-stage PD patients. In our study, Pilates training provided significant improvements in the reaction time and endpoint excursions values of LOS test, and the walking speed. We believe that the improvements of end sway values in tandem walk and the rising index in sit to stand test are due to the reformative effect on postural control with additional taping in the elastic taping group.

Johnson et al. reported that 6-week Pilates training had a curative effect on BBS values of early-and mid-stage Parkinson patients (9). In the present study, the mean reason for not observing a significant change in BBS values is thought to be that the early-stage patients constituting the universe of this study did not complain about the imbalance.

Pilates and Postural Control

When the studies investigating the effects of Pilates exercises on postural control were examined, it was seen that the Pilates training had no effect on the postural sways in healthy subjects (aged between 60 and 76 years) and early-mid stage PD patients. However, an improvement was determined in reaching to the target of LOS test (9, 27). In this study, we found that the reaction time was shortened in LOS test, and the dynamic postural control improved in 2 treatment groups.

We think that dynamic postural control is affected earlier than static control in PD patients and consequently, Pilates training improves the dynamic postural control rather than static in the early stages of the disease.

Pilates and Walking

Newell et al. found prominent improvements in walking speed and stride length parameters by computerized measurement method in healthy elderly subjects after 6-week Pilates training (27) and similarly, in our study, walking speed and stride length parameters were improved in both treatment groups. We think that the improvements in step length and walking speed improve the dynamic balance after Pilates training.

Elastic Taping

It is argued that the elastic taping applications on the upper back regarding the postural deformity and soft tissue changes in the PD patients improve the postural control and gait by increasing proprioceptive inputs (28). In a study examining the immediate effects of elastic taping on balance among the elderly subjects with increased thoracal kyphosis, it was reported that the taping can improve the balance ability by postural correction (29). Capecci et al. showed that the 4-weeks rehabilitation protocol including stretching, postural training, proprioceptive discriminating exercises and elastic taping reduced the trunk abnormalities due to sensorimotor disorder in moderate and advanced PD patients (30).

In the present study, the elastic taping was performed in order to improve the postural control and provide accurate proprioceptive inputs to the PD patients without postural anomalies. Finally, there was no significant difference between Pilates and elastic taping groups in terms of treatment effectiveness. We think that the elastic taping yielded no dramatic results for the postural control since the study sample consisted of early-stage Parkinson patients without significant postural deformity.

LIMITATIONS

The main limitation of the present study is that the sample size is limited to 20 individuals. However, as this is a pilot study, the number of cases is increasing day by day. It is planned to re-analyze and report the results when the research will be completed.

CONCLUSION

We believe that the Pilates training is a feasible rehabilitation approach for PD patients and that it is useful to improve the dynamic balance and postural control among these patients. We argue that the elastic taping applied in combination with Pilates training can also be applied to support the smooth posture.

Ethics Committee Approval: This study was carried out in accordance with the Declaration of Helsinki. The study was approved by the Ethics Committee of Dokuz Eylül University (protocol number 3013-GOA and decision number 2016/29–19).

Informed Consent: The objectives and methods were read to/by the voluntary patients meeting the inclusion criteria of the study, and they signed the informed consents.

Peer-review: Externally peer-reviewed.

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