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The effects of additional kinesio taping over exercise in the treatment of patellofemoral pain syndrome

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Objective: The purpose of this prospective, randomized, controlled study was to determine the effects of kinesio taping in the treatment of patients with patellofemoral pain syndrome (PFPS).

Methods: Thirty-one women with PFPS (mean age: 44.88 years; range: 17 to 50 years) were randomly assigned to either a kinesio taping (KT) (n=15) or control (n=16) group. Both groups received the same muscle strengthening and soft tissue stretching exercises for six weeks and the KT group additionally received kinesio taping at four day intervals for six weeks. Visual analog scale was used to measure pain intensity. Tension of the iliotibial band/tensor fascia lata and hamstring muscles and the mediolateral location of the patella were measured before the treatment and at the end of the third and sixth week. The Anterior Knee Pain Scale / Kujala Scale was used for the analysis of functional performance.

Results: Comparing pretreatment and 6th week values, significant improvements were found in pain, soft tissue flexibility and functional performance of both groups ($p<0.05$). However, patellar shift was unchanged ($p>0.05$). The KT group had significantly better hamstring flexibility than the control group at the end of three weeks ($p<0.05$).

Conclusion: The addition of kinesio taping to the conventional exercise program does not improve the results in patients with PFPS, other than a faster improvement in hamstring muscle flexibility.

Key words: Exercise; flexibility; functional performance; kinesiotape; patellofemoral pain syndrome; physiotherapy.

Patellofemoral pain syndrome (PFPS) is one of the most common knee complaints, especially among females.[1,2] The incidence in the general population is 25% in adolescents and adults.[3] Patellofemoral pain is caused by numerous pathophysiological processes.[4] A tightness of the soft tissue around the knee joint and a quadriceps muscle imbalance have frequently been described as the contributing factors in patellofemoral pain. The abnormal relationship in the activation pattern of the vastus medialis obliquus (VMO) and vastus lateralis (VL) can alter the dynamics of the patellofemoral joint (PFJ).[5,6] This imbalance may lead to lateral tracking of the patella by the action of VL during knee extension.[7] Clinically, rehabilitation regimes for patients with PFPS often include VMO strengthening to promote active medial stabilization of the patella within the femoral trochlea and patellar realignment procedures, such as stretching, taping, and bracing.[8] Patellar taping has gained widespread acceptance as

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a viable treatment option for patients with PFPS and patellar instability.[9,10] The patella is taped specifically to address the individual's abnormal glide, rotation and tilt, and to maintain the patella correctly within the femoral trochlea during the full knee range of motion.[8,11]

Kinesiotape (KT), created by Kenzo Kase in 1996, is a thin, cotton, porous fabric with acrylic adhesive that is nonmediated and latex-free. It allows a partial to full range of motion for the applied muscles and joints with different pulling forces to the skin. It is proposed that the tapes lift the skin and increase the spaces between the skin and muscle, hence reducing the localized pressure and helping to promote circulation and lymphatic drainage.[12,13] As a result, it reduces pain, swelling and muscle spasm.[14] Although KT research is limited and the results are inconsistent, several studies have supported the efficacy of this treatment technique for acute injury inflammation, a faster return to activity, proprioception training pain, post-injury neurological function, and muscle imbalances.

No previous studies investigated the effectiveness of long-term application of kinesiotape on pain, soft tissue flexibility and functional performance in patients with PFPS, although some recent studies have investigated the immediate effect of KT on PFPS.[14-16] The purpose of this study was to determine the effects of kinesio taping in the treatment of patients with PFPS. We hypothesized that PFPS patients who received kinesiotape application, along with exercise therapy over six weeks, would have less pain, higher soft tissue flexibility and better functional performance, versus the patients who received exercise therapy alone.

Patients and methods

Thirty-one female subjects who were referred to physiotherapy by an orthopaedic consultant, with a diagnosis of unilateral PFPS participated in this study. To be included, participants had to be aged between 17 and 50 years and female. Exclusion criteria were tendonitis, Osgood-Schlatter syndrome, known articular cartilage, meniscus or ligament damage, history of patellar subluxation or dislocation and previous knee surgery.

Patients were randomly assigned to the kinesio taping (KT) (n=15) or the control (n=16) group, using a random number generator. Both groups received the same muscle strengthening and soft tissue stretching exercises for six weeks. The KT group additionally received kinesio taping at five days intervals for six weeks. Data were collected from July 2007 to June 2008 at Hacettepe University, Department of Orthopaedics and Traumatology. The demographic details of participants are shown in Table 1.

Table 1. Demographics and initial values of the sample.

	KT group (n=15) X±SS	Control group (n=16) X±SS	p
Age (years)	41.00±11.26	44.88±7.75	0.271
BMI (kg/m^2)	25.17±4.80	28.64±5.77	0.083
Pain duration (month)	11.80±10.84	14.75±16.32	0.561
ITB/TFL complex (cm)	-3.30±3.39	-4.63±5.33	0.721
Hamstring tension (°)	18.40±9.75	19.63±9.19	0.497

BMI: Body mass index

Patients' six-week home physiotherapy program was followed and new exercises were added as needed once a week. These exercises consisted of stretching iliotibial band/tensor fascia lata (ITB/TFL) complex, hamstring and quadriceps muscles and isometric and isotonic exercises for quadriceps, hip adductors, gluteus medius and maximus, open chain exercises like straight leg raise and leg raise with internal and external rotation and closed chain exercises like mini squat.

Taping protocol was individually designed. Kinesiotape was applied on the VMO and quadriceps femoris to provide proprioceptive stimulation for muscle weakness (origin to insertion/muscle technique) and the VL, ITB/TFL and hamstring muscles were taped to relieve tightness (origin to insertion/muscle technique) and to allow natural patella movement in the femoral groove (Fig. 1).

Visual analog scale (VAS) was used to measure the intensity of pain during nine activities; resting, prolonged sitting with knees flexed, kneeling, walking, squatting, ascending and descending stairs, going up and down hill.

Evaluations were performed by two experienced physiotherapists. Examiner 1 was blinded and positioned the patient. While taking the measurements, it was not possible for Examiner 2 to remain blinded. Measurements were repeated two additional times and the mean of the two results was recorded.

Fig 1. Kinesio taping to **(a)** the quadriceps, **(b)** the VMO, **(c)** the ITB/TFL, **(d)** the hamstring muscles. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

A modified Vernier caliper with one stable and three active jaws was used to evaluate the mediolateral position of the patella. The patient lay on the bed with the knee joint at 20° of flexion. The first and last jaws of the caliper were fixed on the lateral and medial femoral condyle and other two active jaws were fixed on the medial and lateral edges of patella. These four points were read and recorded as centimeters.

ITB/TFL length was assessed by a modified Ober's test.[17] Lying on their side, the patient's lower leg was flexed to 45° to maintain a neutral lumbar lordosis. The knee was flexed to 90° and the upper leg was passively brought into abduction and extension. The tester lowered the leg into adduction, attempting to control for any visually observed unwanted hip rotation.[18] The examiner measured and recorded the distance between the center of the patella and the bed as positive or negative.

The degree of hamstring tension was measured using a conventional goniometer. The patient lay in a supine position and Examiner 1 stabilized the hip at 90° flexion and then extended the knee passively to the point of firm resistance to movement. Examiner 2 placed the center of the goniometer over the lateral femoral condyle and recorded the popliteal angle.

All evaluations were done before treatment, at the end of the third week and at the end of the sixth week of the treatment period.

The Anterior Knee Pain Scale (AKPS) / Kujala Scale was used for the analysis of the functional results.[19]

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) for Windows (v11.5). Analysis consisted of the Friedman test, Wilcoxon signed-rank test, and McNemar's test. The Mann-Whitney U Test was used to analyze the differences between groups. The level of probability was set at $p<0.05$.

Results

The Mann-Whitney U Test revealed no statistically significant differences between the groups in terms of age, body mass index (BMI), pain duration, hamstring tension and ITB/TFL complex length before treatment ($p>0.05$).

The differences in pain in the nine positions were compared over the six week treatment and between the groups. In both the control and KT groups, pain significantly decreased for all positions ($p<0.05$). This difference was not significant between groups ($p>0.05$) (Table 2).

For both groups, hamstring tension significantly decreased after treatment ($p<0.05$). Analysis also revealed that this difference occurred in the first three weeks of the treatment for the KT group, while it gradually occurred over the course of treatment for the control group (Fig. 2).

ITB/TFL complex length increased significantly after treatment in all subjects ($p<0.05$). In the control group this difference occurred in the last three weeks of treatment (Fig. 3).

Data analysis of caliper measurements and patellar tilt test revealed that the mediolateral location of the patella did not change after the treatment in either group ($p>0.05$).

The Kujala score increased significantly after treatment in both the KT and control groups ($p<0.05$) (Table 3). Comparison of the groups revealed no significant difference between the performance increase of groups ($p>0.05$) (Table 4).

Discussion

We investigated the effects of long-term application of KT on pain, soft tissue flexibility, patella location and functional performance in patients with PFPS. The results indicated that exercise alone or KT with exercise was not enough to change the location and mobility of the patella, while both methods significantly decreased the pain and increased the flexibility of soft tissues at the end of the six week treatment program. Only the flexibility of the soft tissues around the knee joint increased earlier in the KT group than in the control group. The study also revealed a similar significant increase in functional performance after treatment in both groups.

Exercise therapy is a conventional treatment strategy for PFPS patients. Open and closed chain quadriceps exercises are mainly preferred in the treatment of PFPS.[20,21] In the present study, we used a home exercise program, consisting of both of open and closed chain exercises. Results showed that together, these exercises are effective in PFPS.

One method used in the treatment of PFPS is patellar taping to ensure an anatomical patellofemoral alignment.[22-24] Australian physiotherapist Jenny McConnell originally developed the patellar taping in the 1980s.[25] Her taping aimed to correct the patellar tracking and position to decrease pain and allow for more intensive quadriceps rehabilitation.[26,27] McConnell initially showed a 92% suc-

Table 2. Comparison of pain in nine different positions within and between the groups.

		Treatment time				
Position	**Groups**	**Pretreatment X±SD**	**3rd week X±SD**	**6rd week X±SD**	**x^2 p***	**t_1 p_1**
Resting	Control	3.16±3.98	1.26±1.37	0.81±1.16	x^2: 14.976; **p: 0.001**	-1.436
	KT	2.57±2.15	2.07±1.87	1.71±1.67	x^2: 2.577; p: 0.276	0.151
Sitting	Control	4.68±2.68	2.15±2.31	1.33±1.30	x^2: 16.618; **p: 0.000**	-0.040
	KT	6.12±3.48	4.27±2.28	3.16±2.71	x^2: 10.140; **p: 0.006**	0.968
Standing on knee	Control	6.11±2.43	3.73±3.05	3.37±2.72	x^2: 17.797; **p: 0.000**	-0.870
	KT	7.08±2.49*	5.17±2.18	3.69±2.14	x^2: 9.250; **p: 0.010**	0.384
Walking	Control	4.25±2.16	2.58±2.08	1.88±1.56	x^2: 14.456; **p: 0.001**	-0.574
	KT	5.78±2.54	4.39±2.29	2.88±2.32	x^2: 10.037; **p: 0.000**	0.566
Squatting	Control	5.76±2.75	4.10±2.58	3.12±2.73	x^2: 15.207; **p: 0.000**	-1.107
	KT	7.79±2.14	5.46±2.48	4.12±2.89	x^2: 16.793; **p: 0.000**	0.268
Ascending stairs	Control	5.04±3.16	3.20±2.63	1.85±1.81	x^2: 19.745; **p: 0.000**	-0.257
	KT	6.69±2.74	4.70±2.02	3.31±2.09	x^2: 17.088; **p: 0.000**	0.797
Descending stairs	Control	4.43±3.33	2.88±2.67	1.66±1.99	x^2: 15.164; **p: 0.001**	-0.119
	KT	5.85±3.29	4.29±2.60	3.41±2.89	x^2: 10.982; **p: 0.004**	0.906
Going up hill	Control	4.79±3.04	3.71±2.83	2.11±2.05	x^2: 14.286; **p: 0.001**	-0.692
	KT	5.67±2.96	4.01±2.15	2.60±1.69	x^2: 19.509; **p: 0.000**	0.489
Going down hill	Control	4.11±3.02	2.95±2.60	1.43±1.86	x^2: 20.679; **p: 0.000**	-0.792
	KT	4.76±3.10	4.01±2.74	2.82±2.64	x^2: 5.481; p: 0.065	0.428

t_1 / p_1: for the evaluations between 1st and 6th weeks
t_2 / p_2: for the evaluations between 1st and 3rd weeks
t_3 / p_3: for the evaluations between 3rd and 6th weeks

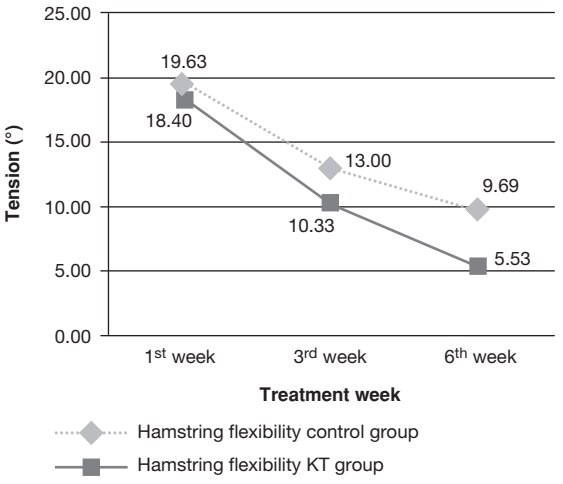

Fig 2. Flexibility of the hamstring muscles.

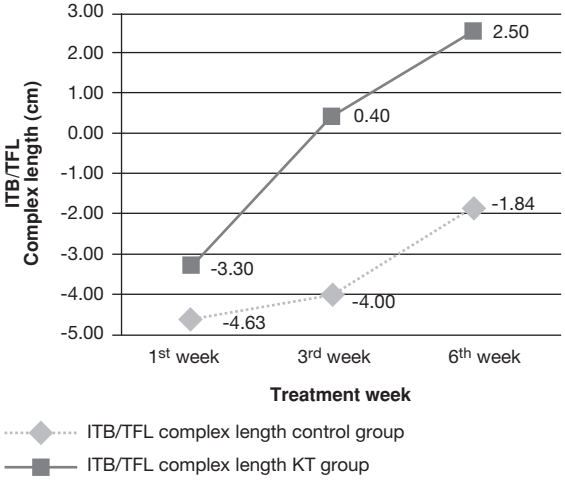

Fig 3. Length of the ITB/TFL complex.

cess rate in rehabilitation with the use of taping.[25] However, studies designed using rigid tapes cannot explain the mechanism of effectiveness of the very flexible KT. KT is unique, compared to other types of tapes, as it is approximately the same weight and the thickness of skin and its elasticity allows for elongation to 130%-140% of its resting state.[28,29] Thus, KT has been theorized to be an effective treatment to restore muscle function and decrease pain.[30-37] Kinesiotape improves a variety of physiological problems, including range of motion. KT is also believed to have several functions; restoring correct muscle function by supporting weakened muscles, reducing congestion by improving the flow of the blood and lymphatic fluid, decreasing pain by stimulating the neurological system and correcting malaligned joints, by relieving muscle spasm.[38] It is also pointed out that KT improves proprioception by the normalization of muscle tone, a reduction in pain, correction of inappropriate position and the stimulating effect on skin receptors.[39] Tunay et al. performed a study to determine the differences between the effects of kinesio- and McConnell patellar taping in patients with PFPS.[16] Fifteen female patients with the diagnosis of unilateral PFPS and 15 healthy females participated in the study. Kinesio- and McConnell patellar positioning techniques were applied to both groups and evaluations were repeated three times before taping and after each taping. Although positive effects of kinesio taping on functional performance in the healthy subjects was observed, no positive effect of taping was seen on the performance of patients with PFPS.

Yoshida et al. performed a study to determine the effects of kinesio taping on trunk flexion, extension, and lateral flexion.[38] Thirty healthy subjects with no history of lower trunk or back issues participated in the study. Subjects were performed two experimental measurements of range of motion (with and without the application of KT) in trunk flexion, extension, and right lateral flexion. Through evaluation of the sum of all scores, KT in flexion produced a gain of 17.8 cm compared to the control group. No significant difference was identified for extension or lateral flexion. Based on these findings, researchers determined that KT applied over the lower trunk

Table 3. Comparison of Kujala scores within groups.

	KT group (n=15)			Control group (n=16)		
Time	X±SD	t	p*	X±SD	t	p*
Pretreatment	67.91±12.22	-2.521	**0.012**	69.88±9.08	-3.115	**0.002**
Posttreatment	82.13±4.91			81.69±9.54		

*p=0.05, Wilcoxon signed-rank test.

may increase active lower trunk flexion range of motion. Proponents of kinesiotape state that tape convolution areas may increase the flow of blood and lymphatic fluids due to a lifting effect, which creates a wider space between the skin and the muscle and interstitial space. Kinesio taping on injured areas with major blood vessels is theorized to increase blood volume; and the possible increase in blood circulation to affect muscle functions. The application of kinesiotape is also believed to stimulate the cutaneous mechanoreceptors which activate nerve impulses when mechanical loads create deformation. The activation of the cutaneous mechanoreceptors by an adequate stimulus causes local depolarizations that trigger nerve impulses along the afferent fiber traveling toward the central nervous system. Previous studies to determine the effects of KT on the cutaneous mechanoreceptors have reported that KT used on select muscles and joints may improve muscle excitability.[28,30-37,40-43]

There may be a few possible reasons why KT improved the flexibility of soft tissues earlier than the control group in the present study. In the taped area, the KT increased blood circulation, which might affect the muscle and myofascia functions after kinesio taping. The application of KT might stretch the skin by applying pressure to the skin and this external load might stimulate cutaneous mechanoreceptors, causing physiological changes and increased flexibility of soft tissues in the taped area.

There are some limitations to this study. As in other researches in this area, the examiners were not blinded to the participants' group status. However, with the aim of reducing any bias this might cause, Examiner 1 was blinded. The subjects were measured without warm-up or pre-stretching, which may have affected flexibility. However, as this was standardized, any effect would be spread across all participants.

Since previous researches using KT have been conducted on healthy subjects, the results from these studies may not be applicable to individuals with pathology. No previous studies on PFPS patients have investigated the effectiveness over an extended period of kinesio taping on pain, soft tissue flexibility and functional performance in these patients, while some recent studies have investigated the immediate effects of KT in PFPS. The present study showed that kinesio taping with exercise does not exceed to only exercise therapy in patients with PFPS in a six-week therapy, except of earlier increase on the flexibility of the hamstring muscle. The addition of kinesio taping to the conventional exercise program does not improve the results in patients with PFPS, other than a faster improvement in hamstring muscle flexibility. Additional taping techniques, such as patellar correction techniques can be investigated in further studies to determine the clinical effectiveness of kinesio taping in patients with PFPS.

Conflicts of Interest: No conflicts declared.

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