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ORIGINAL ARTICLE

An investigation into the effects of kinesiotaping for posture correction on kyphosis angle, pain, and balance in patients with postmenopausal osteoporosis-associated thoracic kyphosis

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Abstract

Summary Although positive effect of kinesiotaping in reducing back pain in addition to exercise was observed in 6-week follow-up, no additional contribution to exercise was demonstrated in kyphosis angle and balance assessment. Instantaneous positive effect of taping was observed in kyphosis angle and static balance measurement using a SportKAT device measurements 30 min after taping.

Objective The present study aims to investigate whether kinesiotaping for posture correction in patients with osteoporosis-related increased kyphosis provides additional benefits to routine osteoporosis and balance exercises in reducing dorsal kyphosis angle, pain, and balance.

Method A single-center, parallel-group randomized controlled trial with unblinded assessments at baseline, week 3, and week 6 and additional measures 30 min immediately after taping in intervention group only. Forty-two female osteoporotic patients with hyperkyphosis were enrolled and randomized into 2 groups. The intervention group received an exercise program plus 3 sessions of kinesiotaping over the upper back; the control group received only an exercise program. The primary outcome measure was dorsal kyphosis angle, measured using a digital inclinometer. Secondary outcome measures were pain assessed on a visual analog scale (VAS 0–10 cm) and balance assessed with the Berg Balance Scale and SportKAT device.

Results The study was conducted on 22 patients with an average age of 64 ± 7.08 in the control group and 20 patients with an average age of 63.1 ± 8.8 in the treatment group. There was not a significant difference when dorsal kyphosis angle of the two groups was compared in terms of the change between the baseline and week 6. The mean change in the control group was 0.86 ± 2 while it was 0.70 ± 1.75 in the intervention group. No significant difference was detected between the groups in terms of balance measurements. Significant differences were seen in favor of the intervention group when the VAS pain scores of the two groups were compared in terms of the change between the baseline and week 3 ($p < 0.001$) and the baseline and week 6 ($p < 0.001$), while no such difference was identified when the changes between weeks 3 and 6 were compared between the two groups. A significant effect on dorsal kyphosis angle and balance was also shown in the treatment group 30 min after taping.

Conclusion Application of kinesiotaping may have short-term positive effects on pain, but is unlikely to have significant effects on kyphosis angle or balance for women with osteoporosis. Positive changes seen in kyphosis angle and balance 30 min after taping are short-lived.

Keywords Kyphosis angle · Balance · Berg Balance Scale · Kinesiotaping

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Introduction

Osteoporosis is a systemic musculoskeletal condition characterized by low bone mass, and with an increased probability of bone fragility and fracture as a result of impaired bone microstructure. There are several factors that may reduce bone mineral density, such as the bone turnover, bone shape, and bone microstructure [1].

Of all the bone fractures occurring in adults aged 45 years and above, 70% are reported to be associated with osteoporosis, and vertebra fractures are detected in one-third of women aged 65 years and above [2]. Patients with vertebral osteoporotic fractures have been found to have an impaired quality of life and functional status [2], and vertebral fractures also increase the risk of mortality [3].

Age-related hyperkyphosis is an exaggerated anterior curvature in the thoracic spine that occurs commonly with advanced age. This condition is associated with low bone mass, vertebral compression fractures, and degenerative disc disease, and contributes to difficulty performing activities of daily living and decline in physical performance [4].

Postural kyphosis caused by vertebral fractures is one of the leading consequences of osteoporosis, associated with physical impairment and psychological damage [5]. Hyperkyphotic posture not only increases postural back pain but also increases the risk of falls and consequent bone fractures [5, 6].

Methods such as postural training, exercise, spinal orthosis, and postural taping have been used to correct posture and resolve the pain associated with thoracic kyphosis secondary to osteoporosis [7]. There are a variety of external support devices available including rigid thoracolumbar spinal orthoses (TLSO) or hyperextension braces that are often used in the management of osteoporotic vertebral fracture (OVF). However, they are not recommended in the American Academy of Orthopaedic Surgeons clinical practice guideline [8]. Overall, there is limited evidence for the use of orthotics or taping either in the acute or long-term management of those with OVF. Further studies using high-quality methods and reporting are required to determine whether taping or orthotics are effective [9].

The present study aims to investigate whether the use of kinesiotaping to correct posture in osteoporosis-associated thoracic kyphosis patients provides additional benefits to routine osteoporosis and balance exercises in terms of pain, reduction of dorsal kyphosis angle, and balance.

Materials and method

This was a single-center, parallel-group, randomized controlled trial. The present study was conducted on patients diagnosed with osteoporosis presenting to Dokuz Eylül University, Faculty of Medicine, Department of Physical Therapy and Rehabilitation polyclinic between September 2015 and December 2016.

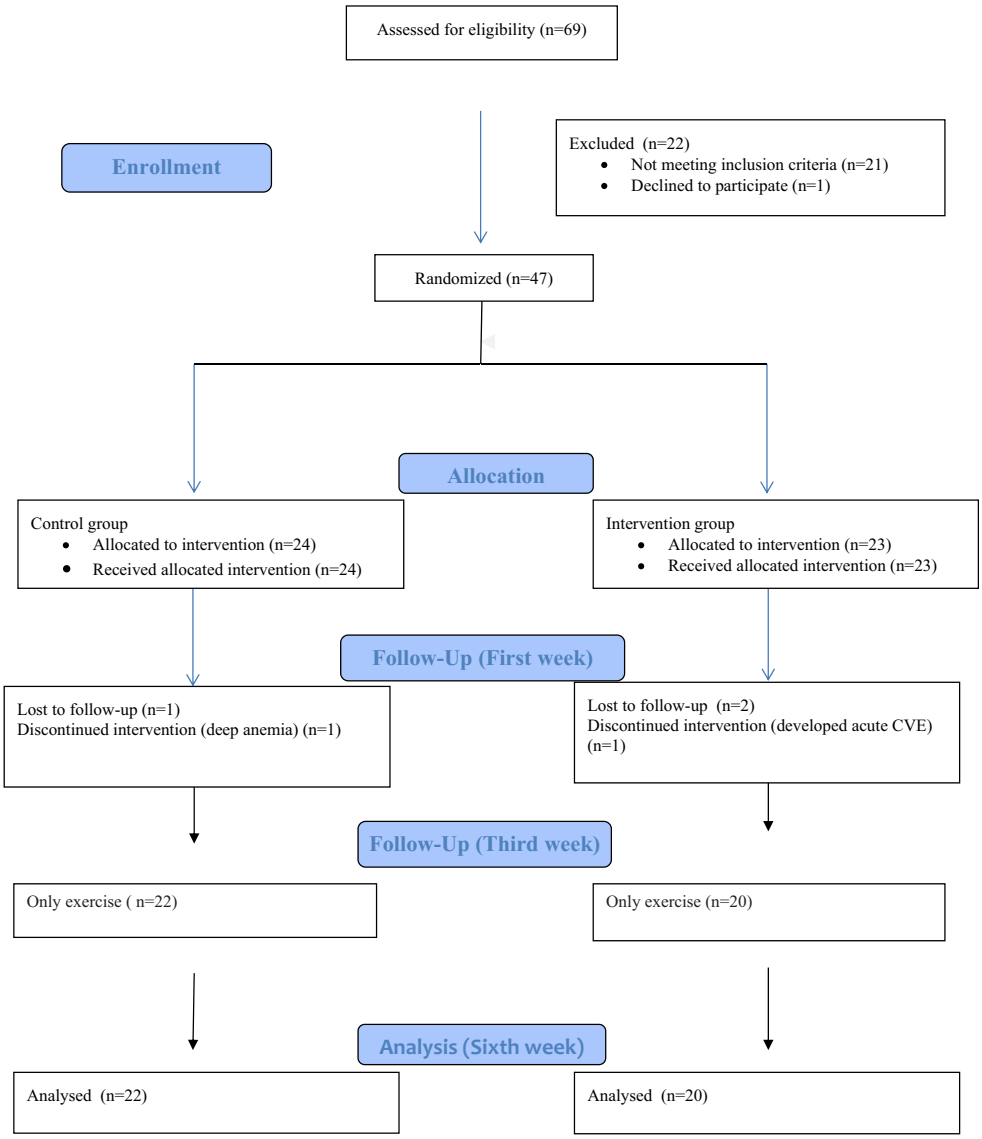
After the approval of the ethics committee, according to inclusion and exclusion criteria, 47 patients eligible for the study were divided into two groups using random number table according to block randomization method (Fig. 1). Demographic data of the patients in both groups including age, sex, profession, marital status, and body mass index as well as the age of menopause and menarche, medications used, chronic diseases, vertebral and nonvertebral osteoporotic fractures, and the history of falling within the last year were recorded.

The patients both in the control group and intervention group were shown routine osteoporosis and balance exercises by the research physician and they performed such exercises for the first time under physician supervision in the hospital. The patients were given conventional osteoporosis home exercises including strengthening and stretching exercises two times a day (a total of 84 sessions). The patients were recommended to repeat each exercise ten times. Balance exercises included tandem walk, standing on one foot, sit to stand exercise on a chair with arms in front, and toe stand and heel stand exercises. During each exercise, they were recommended to perform 40 steps of tandem walk, standing on one foot for 10 s (minimal hand support if required), and toe stand and heel stand for 10 s. In order to evaluate whether the patient complies with the exercises or not, each patient was given an exercise schedule.

The treatment group additionally received kinesiotaping for posture correction (Fig. 2). Functional correction technique, recommended by the Turkish Society of Physical Medicine and Rehabilitation for posture correction, was used as the kinesiotaping technique. It is applied at acromioclavicular joint level when the patient is in front flexion and the shoulders are protracted, the first 5 cm without stretch and then applying maximum stretch, advancing crosswise and terminating at the lower boundary of the rib, with the adhesion ends being applied zero stretch. The kinesiotape was applied at the opposite shoulder with the same technique such that a cross sign will be obtained. The cross point was adjusted in a way to correspond to the lower 1/3 portion of the scapula medial border. Kinesiotaping was applied by another physician involved in the study who was in the hospital. The patients were asked to remove the tape at home 5 days after the first taping application. In order to minimize taping-related complications, taping was not applied for the next 2 days. Afterwards, the second taping was also applied at the hospital by a physician. In this way, 3 taping applications in 3 weeks were performed.

The measurements were carried out by the physician before treatment (at baseline), 3 weeks (tape removed), and 6 weeks (3 weeks after completion of taping intervention). Outcome

Fig. 1 Flowchart



assessment was unblinded and it was not possible to mask the treatment group from participants.

Static balance assessment was performed using SportKAT device while Berg Balance Scale (BBS) was used for functional balance assessment. "Kinesthetic Ability Trainer" (SportKAT 1700, ASHCROFT®) device, the reliability of which was proven, was used for numerical assessment of static balance. The test was performed on two legs. The patient was asked to hold his arms crossed on his shoulders. The patient was told to try to keep the red X sign on the screen at a fixed position for 30 s by moving back, front, right, and left. Each patient tried the test first, and then, the test was repeated 3 times. Thirty-second breaks were taken between the tests. At the end, the mean value of the three measurements was calculated. The results were scored with balance index during the measurement. Balance index is inversely proportional to the balance ability. A lower score indicates a better balance ability; i.e., "0" score represents excellent balance.

The Smarter Inclinometer Dualer IQ device, which was available in our clinic, was used for measuring the thoracic kyphosis angle. The digital inclinometer device is equipped with two sensors. First, both sensors are placed in upright position on a flat surface and the device is reset pushing the start button. Later, the first sensor was positioned on the T1 vertebral spinous process and the second sensor on T12 vertebral spinous process, and the measurement was thus performed.

Back pain assessment was conducted using visual analog scale (VAS 0–10 cm)

Moreover, in the intervention group, balance measurement using SportKAT and dorsal kyphosis angle measurement using digital inclinometer were performed again by the researcher performing the other measurements only 30 min after first taping was applied to the patient. The other taping applications were not followed by instantaneous measurements.

Fig. 2 Method of kinesiotaping

G*Power 3.08 analysis was used to perform calculations on sample size, effect size, and statistical power. The minimal significance (a) and statistical power ($1 - b$) were set at 0.05 and 0.80 respectively. Primary outcome was dorsal kyphosis angle and MCID of angle is not defined. As far as we know, no similar studies have been found in the literature; the minimum number of patients required to be included into each study group was estimated to be 26 to achieve an 80% power with a 95% confidence interval. Due to the limited study period, one group was completed with 20 patients while the other group was completed with 22 patients.

Statistical analyses were performed by using the SPSS 15.0 for Windows program. Means were presented along with standard deviations, and median values were shown in the min-max range. Numeric variables were compared with chi-square and Fisher's exact tests, and the Mann-Whitney U test was used to investigate any significant differences in the measured variables between the study groups. The data was evaluated with the Kolmogorov-Smirnov test to check for normal distribution; however, as the number of patients in each group was lower than 30, the Friedman test was used to compare the baseline, 3rd-week, and 6th-week measurements within each group. For measurements with a significant difference, the Wilcoxon test was performed to identify which group caused the difference, and binary comparisons within the groups were also made with the Wilcoxon test. p values < 0.05 were considered statistically significant.

Findings

The primary outcome measure was dorsal kyphosis angle and the study was conducted on 22 patients with an average age of 64 ± 7.08 in the control group and 20 patients with an average age of 63.1 ± 8.8 in the treatment group.

Per protocol

Characteristics of the study groups are shown in Table 1.

The patients were recommended to repeat each exercise ten times and this was considered as 1 session. During 6 weeks, the patients were recommended to do two seasons per day and the total number of sessions was 84. Exercise compliance demonstrated that the average exercise session was 78.81 ± 8.3 in the control group while it was 75.65 ± 14.2 in the intervention group ($p = 0.380$).

The mean baseline VAS value was noted to be significantly higher in the intervention group but significant differences were seen in favor of the intervention group when the VAS pain scores of the two groups were compared in terms of the change between the baseline and week 3 ($p < 0.001$) and between the baseline and week 6 ($p < 0.001$), while no such difference was identified when the changes between weeks 3 and 6 were compared between the two groups ($p = 0.937$) (Table 2). The mean change in control group difference between initial measurement and week 3 was 0.54 ± 1.05 while it was 2.15 ± 1.08 in the intervention group.

The mean change in control group difference between initial measurement and week 6 was 1 ± 1.34 while it was 2.45 ± 1.53 in the intervention group) (Table 2).

There were no significant differences between the groups in terms of the values recorded at weeks 3 and 6 ($p > 0.05$). When the VAS scores were compared within each group, significant differences were noted between the baseline and the week 6 values in both groups ($p < 0.05$) (Table 2).

The dorsal kyphosis angle measurements obtained at the baseline and at the third and sixth weeks were not significantly different between the two groups ($p > 0.05$). When the values were compared within the groups, a significant difference was noted between the baseline and the sixth-week measurements in the intervention group ($p < 0.05$), while no such difference was observed in the control group ($p > 0.05$). (Table 3). The changes in the dorsal kyphosis angle values were not significantly different between the two groups ($p > 0.05$). (The mean change in the control group was 0.86 ± 2 while it was 0.70 ± 1.75 in the intervention group.) (Table 4)

Table 1 Characteristics of the study groups

Characteristic	Control group (mean ± SD) $n = 22$	Intervention group (mean ± SD) $n = 20$
Mean age (years)	64 ± 7.08	63.1 ± 8.8
Height (cm)	157.4 ± 5.62	156.3 ± 6.23
Body mass index (kg/m^2)	24.14 ± 3.74	26.85 ± 3.11
Marital status (married/single)	15/7	16/4
Occupation (housewife/other)	10/12	12/8
Age at menopause	45.09 ± 8.64	42.8 ± 10.8
Age ate menarche	14.8 ± 7.7	17.6 ± 11.3
History of chronic disorders (yes/no)	19/3	14/6
History of a fall within the last 1 year (yes/no)	5/17	4/16
Presence of fractures (yes/no)	9/13	7/13
Baseline VAS	4.90 ± 1.06	6.0 ± 1.48
Baseline dorsal kyphosis angle	55.95 ± 9.25	57.10 ± 10.30
Baseline static balance measurement	377.2 ± 315.5	434.03 ± 223.08
Baseline Berg Balance Scale	49.5 ± 4.83	47.3 ± 6.1

The baseline, week 3, and week 6 measurements obtained using a SportKAT 1700 device were not significantly different between the groups ($p > 0.05$). When the values recorded at baseline and week 6 were compared within the groups, significant differences were noted in the values in both groups ($p < 0.05$) (Table 3). Static balance measurements values were not significantly different between the two groups ($p > 0.05$) (mean change; control group 163.7 ± 282.47, intervention group 181.8 ± 219.73) (Table 4).

The Berg Balance Scale evaluations performed at the baseline and at weeks 3 and 6 were not significantly different between the two groups ($p > 0.05$), although there were significant differences between the baseline and week 6 assessments within each group ($p < 0.05$) (Table 3). BMD values were not significantly different between the two groups ($p > 0.05$) (mean change in the control group was − 2.81 ± 2.83 while it was − 4.10 ± 3.37 in the intervention group) (Table 4).

In the intervention group, the dorsal kyphosis angle measured by the digital inclinometer before and 30 min after kinesiotaping ($p < 0.001$) and the balance measurement scores estimated using the SportKAT device ($p = 0.015$) were found to be significantly different (initial kyphosis angle 57.10 ± 10.30, after taping 55.15 ± 9.90; static balance measurements: initial 434.03 ± 223.08, after taping 336.22 ± 119.2).

Intention-to-treat analysis

In intention-to-treat analysis, all results did not differ from the per-protocol analysis for the primary and secondary outcomes (Tables 2 and 3).

Table 2 Comparison of VAS (0–10 cm) values and intergroup comparison of the changes in visual analog scale

Visual analog scale	Control group (mean ± SD)	Intervention group (mean ± SD)	pb/p-int
Baseline	4.90 ± 1.06	6.0 ± 1.48	0.008*/0.009*
Week 3	4.36 ± 1.43	3.85 ± 1.69	0.270/0.126
Week 6	3.90 ± 1.60	3.55 ± 1.93	0.268/0.104
pa/p-int	0.001*/0.001*	< 0.001*/< 0.001*	–
dVAS1	0.54 ± 1.05	2.15 ± 1.08	< 0.001*/< 0.001*
dVAS2	0.45 ± 1.18	0.3 ± 0.86	0.937/0.940
dVAS3	1.0 ± 1.34	2.45 ± 1.53	0.002*/0.016*

pa, the difference between baseline and 6th-week measurements within each group (Friedman test, $p < 0.05$ significant value); *pb*, comparison of the groups ($p < 0.05$ significant value); *p-int*, intention-to-treat analysis; *dVAS1*, difference between initial measurement and week 3; *dVAS2*, difference between week 3 and week 6; *dVAS3*, difference between initial measurement and week 6

* In the Pa, Pb and Pint groups, $p < 0.05$ significant value

Table 3 Comparison of dorsal kyphosis angle, static balance measurement, and Berg Balance Scale evaluation

	Control group (mean ± SD)	Intervention group (mean ± SD)	pb/p-int
Dorsal kyphosis angle			
Baseline	55.95 ± 9.25	57.10 ± 10.30	0.762/0.706
Week 3	55.13 ± 9.88	55.85 ± 9.84	0.762/0.771
Week 6	55.09 ± 9.69	56.40 ± 10.07	0.659/0.651
pa/p-int	0.145/0.143	< 0.001*/< 0.001*	–
static balance measurement			
Baseline	377.2 ± 315.5	434.03 ± 223.08	0.144/0.143
Week 3	292.90 ± 154.24	268.70 ± 65.34	0.791/0.940
Week 6	214.0 ± 70.27	252.15 ± 92.47	0.212/0.569
pa/p-int	0.002*/0.002*	0.001*/0.001	–
Berg Balance Scale evaluation			
Baseline	49.5 ± 4.83	47.3 ± 6.1	0.230/ 0.394
Week 3	51.13 ± 3.44	50.6 ± 3.87	0.594/0.879
Week 6	52.31 ± 2.53	51.4 ± 3.87	0.621/0.787
pa/p-int	< 0.001*/< 0.001*	< 0.001*/0.001*	–

pa, the difference between baseline and 6th-week measurements within each group (Friedman test, $p < 0.05$ significant value); *pb*, comparison of the groups ($p < 0.05$ significant value); *p-int*, intention-to-treat analysis

* In the Pa, Pb and Pint groups, $p < 0.05$ significant value

Post hoc power analysis

In the post hoc power analysis, performed using sample sizes, means, and SD values for the significance level (alpha) of .05, the power was 30% for kyphosis angle, 9% for pain, and 32% for static balance, and 10% for balance at the 6th weeks.

Discussion

Our study found that kinesiotaping for posture correction resulted in a considerable decrease in back pain. However, no additional contribution of kinesiotaping for posture correction on the impact of conventional exercise on balance and kyphosis angle was shown.

Previous studies investigating balance using the SportKAT device in patients with osteoporosis have reported improvements in balance parameters after an exercise program [10, 11]. In this study, the SportKAT device was used also to evaluate balance in patients. Posture-correcting kinesiotaping resulted in a significant difference in the balance parameters measured using a SportKAT device 30 min after taping. When the changes were analyzed within each group, significant improvements were noted in the balance parameters of

Table 4 Intergroup comparison of the changes

	Control group (mean ± SD)	Intervention group (mean ± SD)	pd
dkyphosis1	0.8182 ± 1.70	1.25 ± 1.55	0.365
dkyphosis2	0.45 ± 0.99	− 0.55 ± 1.43	0.055
dkyphosis3	0.86 ± 2	0.70 ± 1.75	0.794
dsport1	84.2 ± 221.3	165.3 ± 206.6	0.158
dsport2	78.9 ± 127.7	16.5 ± 77.8	0.124
dsport3	163.7 ± 282.47	181.8 ± 219.73	0.513
dberg1	− 1.63 ± 1.7	− 3.3 ± 3.2	0.071
dberg2	− 1.18 ± 1.59	− 0.8 ± 1.98	0.467
dberg3	− 2.81 ± 2.83	− 4.10 ± 3.37	0.179
dvas1	0.54 ± 1.05	2.15 ± 1.08	< 0.001*
dvas2	0.45 ± 1.18	0.3 ± 0.86	0.937
dvas3	1.0 ± 1.34	2.45 ± 1.53	0.002*

d1, difference between initial measurement and week 3; *d2*, difference between week 3 and week 6; *d3*, difference between initial measurement and week 6; *pd*, difference between intergroup changes ($p < 0.05$ significant value)

* In the Pa, Pb and Pint groups, $p < 0.05$ significant value

both groups based on measurements obtained at the baseline and at weeks 3 and 6. However, no statistically significant differences were noted between the two groups.

Several studies in literature have investigated the effects of exercise on balance in patients with osteoporosis. In a study performed by Günendi et al., improvements were noted in both static and dynamic balance parameters after 4 weeks of an aerobic exercise program in patients with osteoporosis when compared with the controls [10]. The authors in that study evaluated static balance using a SportKAT device, and dynamic balance was evaluated by way of a Time Up and Go Test and Berg Balance Test, all of which indicated significant improvements. Similarly, assessments performed using a Berg Balance Scale and measurements obtained using a SportKAT device in the present study pointed to significant improvements in both groups.

There have been a limited number of studies in literature addressing the postural taping methods used in osteoporosis [7]. In clinical practice, the kinesiotaping method is recommended for pain control in patients with osteoporosis-associated kyphotic posture, although there have been no studies to date investigating the efficacy of this taping method.

Greig et al. classified 15 patients with osteoporotic vertebral fractures into three groups, as postural taping, placebo taping, and no taping. Thoracic kyphosis angle measurements were obtained before and after application, and the electromyographical activity of the body muscles was measured during three different static posture positions and balance parameters obtained from a strength platform were analyzed. Significant effects of postural taping on thoracic kyphosis were demonstrated, while no effects were seen on the electromyography measurements or balance parameters. The authors attributed this to the fact that muscle activity had not changed, despite the decreased thoracic kyphosis to the mechanical support by taping [7]. In our study, when intragroup assessments in dorsal kyphosis angle measurements are considered, the control group showed no significant difference while the treatment group showed a significant difference when initial values and sixth-week values in both groups were compared; however, in contrast to this study, there was no significant difference between the groups in terms of changes. (The mean change in dorsal kyphosis in the control group was 0.86 ± 2 while it was 0.70 ± 1.75 in the intervention group.) This may be due to the small number of patients and the short follow-up period. In our study, we could not evaluate the placebo effects of banding since there was no band of placebo banding in this study. However, there is a need for further research in order to determine the effect of kinesiotaping on dorsal kyphosis angle.

A previous study divided 20 patients with Parkinson's disease and incorrect posture into two groups; one group (13 patients) performed stretching and posture exercises along with proprioceptive tactile stimulation, while the other group (7 patients) were evaluated as controls. Of the 13 patients in the first group, six were additionally applied with kinesiotape following a posture-correcting technique for a period of 1 month. The patients were evaluated by the Berg Balance Scale, a Time Up and Go Test, and thoracic range of motion measurements in the sagittal and coronal planes before the therapy and at the end of the first and second months. While significant improvements were noted in all measurements of the rehabilitation group at the end of the first month, no significant differences were seen between the patients with or without kinesiotaping, and these effects were seen to continue at the end of the second month [12]. Similar to the described study, we used the Berg Balance Scale to evaluate balance in the present study, and in the balance measurements, we found improvement in both groups in the 3rd and 6th weeks. Furthermore, we could not detect additional contribution of kinesiotaping as in this study. (The mean change in Berg Balance Scale in the control group was -2.81 ± 2.83 while it was -4.10 ± 3.37 in the intervention group.)

In our study, kinesiotaping was applied three times, each remaining for 5 days. One study applied kinesiotaping for 1 month, while in another study, postural kinesiotaping was applied in patients with osteoporotic vertebra fractures for 4 weeks [12, 13]. In our study, kinesiotaping was applied for 3 weeks, too.

The limitations of our study include the relatively short period of taping, the small number of patients, a non-blind researcher performing the measurements, and balance measures with the SportKAT device not being a practical measurement method to be applied in every clinic of patients with osteoporosis. In addition to these, the minimum number of patients required to be included into each study group was estimated to be 26; due to the limited study period, one group was completed with 20 patients while the other group was completed with 22 patients. Furthermore, there was no placebo banding group in our study and the effects of other treatments before the study were not evaluated. The kinesiotaping-related side effects were not examined in our study; the patients did not report any side effects, either.

Different to previous studies, we carried out balance measurements using a SportKAT device in the present study and obtained thoracic kyphosis angle measurements using a digital inclinometer at baseline and 30 min after kinesiotaping. The measurements obtained 30 min after kinesiotaping indicated statistically significant improvements in both parameters.

In conclusion, no additional contribution of kinesiotaping for posture correction on the impact of conventional exercise on balance and thoracic kyphosis angle was shown. It was noted in the study, however, that posture-correcting kinesiotaping provided a more pronounced decrease in back pain. The back pain assessments made using VAS demonstrated significant differences in favor of the kinesiotape group when comparing baseline–week 3 and baseline–week 6, while the comparison between week 3 and week 6 was not significantly different. Based on the results of our study, we are of

the opinion that kinesiotaping may be one of the preferable treatment options since it reduces back pain related to increased thoracic kyphosis.

The patients with kyphotic posture suffering from back pain and diagnosed with osteoporosis must be given an exercise program and the balance training program must be a part of the conventional rehabilitation programs. Furthermore, these patients should be evaluated in terms of kinesiotaping for posture correction. In selected cases, kinesiotaping for reducing back pain can be applied; there seems, however, a need for studies with longer follow-up periods and more patients in order to determine the effect of kinesiotaping on balance and dorsal kyphosis angle.

Compliance with ethical standards

Conflicts of interest None.

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