



## RESEARCH

# Effects of kinesio taping on pain, balance, and disability after kyphoplasty in patients with osteoporotic vertebral fractures

Osteoporotik vertebral kırığı olan hastalarda kifoplasti sonrası kinezyo bantlamanın ağrı, denge ve engellilik üzerine etkileri

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### Abstract

**Purpose:** This study aimed to evaluate the effects of Kinesio taping on pain, balance, and disability in patients with osteoporotic vertebral fractures who underwent kyphoplasty.

**Materials and Methods:** Fifty-five patients who underwent kyphoplasty were randomized into active (n = 26) and sham (n = 29) Kinesio taping groups. After discontinuations, 40 participants completed the study. Pain, balance, and disability were assessed using the Visual Analog Scale (VAS), the Berg Balance Scale (BBS), and the Quebec Low Back Pain Disability Scale (QLBPDS), respectively. Assessments were performed at baseline, immediately after treatment, and at the end of week 6.

**Results:** Pain, balance, and disability scores changed over time in both groups. Significant pain reduction was observed only in the active Kinesio taping group, while balance improved significantly in both groups. Disability scores decreased more in the active Kinesio taping group, with a mean reduction of 18.1 points, compared with an 8.3-point reduction in the sham group at the end of week 6. No differences were found between groups in pain or balance changes over time.

**Conclusion:** Kinesio taping may improve functional disability in the short term after kyphoplasty. However, its effects on pain and balance do not appear to be superior to placebo.

**Keywords:** Osteoporosis, kyphoplasty, athletic tape, osteoporotic fractures

### Öz

**Amaç:** Bu çalışmanın amacı, kifoplasti uygulanan osteoporotik vertebral kırıklı hastalarda kinezyo bantlamanın ağrı, denge ve engellilik üzerindeki etkilerini değerlendirmektir.

**Gereç ve Yöntem:** Kifoplasti uygulanan elli beş hasta aktif (n = 26) ve sham (n = 29) kinezyo bantlama gruplarına randomize edilmiştir. Çalışmadan ayrılanlar sonrasında, 40 katılımcı çalışmayı tamamlamıştır. Ağrı, denge ve engellilik sırasıyla Görsel Analog Skala (VAS), Berg Denge Ölçeği (BBS) ve Quebec Bel Ağrısı Engellilik Ölçeği (QLBPDS) kullanılarak değerlendirilmiştir. Değerlendirmeler başlangıçta, tedavi bitiminde ve 6. Haftanın sonunda yapılmıştır.

**Bulgular:** Her iki grupta da zaman içinde ağrı, denge ve engellilik skorlarında değişiklik gözlenmiştir. Ağrı skorunda anlamlı azalma yalnızca aktif kinezyo bantlama grubunda görülürken, denge her iki grupta da anlamlı şekilde iyileşmiştir. Engellilik skorları aktif kinezyo bantlama grubunda sham gruba kıyasla daha fazla azalmış; 6. Haftanın sonunda ortalama azalma aktif grupta 18,1 puan, sham grupta ise 8,3 puan olarak saptanmıştır. Ağrı ve denge açısından gruplar arasında zamana bağlı değişim farkı bulunmamıştır.

**Sonuç:** Kinezyo bantlama, kifoplasti sonrası kısa dönemde fonksiyonel engelliliği iyileştirebilir. Ancak ağrı ve denge üzerindeki etkilerinin plasebodan üstün olmadığı görülmektedir.

**Anahtar kelimeler:** Osteoporoz, kifoplasti, atletik bant, osteoporotik kırıklar

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## INTRODUCTION

Osteoporosis is a condition affecting the entire skeletal system, marked by reduced bone quantity and compromised bone architecture, resulting in greater fracture risk<sup>1</sup>. Osteoporotic vertebral fractures (OVFs) are a common consequence of osteoporosis and are associated with reduced quality of life, disability, depression, and persistent pain that may last for up to two years after fracture<sup>2</sup>.

Kyphoplasty is a minimally invasive vertebral augmentation procedure commonly used in the treatment of acute or subacute OVFs. The technique involves balloon inflation within the vertebral body followed by cement injection<sup>3</sup>. Although kyphoplasty has shown good efficacy in the treatment of OVF, it has been reported that 10-51% of OVF patients may continue to experience mild to moderate back pain after successful surgery, and another study reported that 7.3% of patients with OVF had postoperative residual back pain 7 days after surgery<sup>4,5</sup>.

Kinesio taping (KT) is a treatment method based on the application of kinesthetic tapes to the skin using special techniques. It is intended to reduce pain, facilitate muscle activity, provide musculoskeletal support, and enhance proprioception and functional performance<sup>6</sup>.

Non-surgical approaches such as bracing, physiotherapy, and medical treatments have been investigated to improve pain and functional outcomes in patients with OVFs. While KT has been extensively studied in populations with low back pain<sup>7-9</sup>, evidence supporting its use in patients with OVFs remains limited. To date, only one randomized controlled trial has examined postural taping in this population, without specifically evaluating KT or its application in the post-kyphoplasty period<sup>10</sup>.

Recent meta-analyses assessing non-surgical interventions, including bracing and taping, in patients with OVFs suggest potential benefits of external support strategies<sup>11,12</sup>. However, these analyses also highlight substantial heterogeneity and uncertainty in the available evidence. In particular, sham-controlled randomized trials investigating KT after kyphoplasty are lacking.

The present study was designed to evaluate the effects of KT as an adjunctive intervention following kyphoplasty in patients with OVFs who continued to experience pain after the procedure. By comparing

active and sham KT, this study aimed to examine its impact on pain, balance, and functional disability. It was hypothesized that patients receiving active KT would demonstrate greater improvements in functional outcomes, with potential benefits in pain and balance, compared with those receiving sham taping.

## MATERIALS AND METHODS

### Study design

This single-center, prospective, double-blind randomized controlled trial was conducted at the Neurosurgery and Physical Medicine and Rehabilitation Outpatient Clinics of Izmir Katip Celebi University Ataturk Research and Training Hospital. Ethical approval was obtained from the institutional clinical research ethics committee (approval date: December 15, 2022; approval number: 72). The study was conducted in accordance with the Declaration of Helsinki.

All study procedures, outcome measures, and statistical analyses were predefined before patient enrollment. Kyphoplasty procedures were performed by experienced neurosurgeons, while KT interventions and exercise instructions were administered by a physiatrist. Outcome assessments were conducted by a different physiatrist who was blinded to group allocation. Data were collected prospectively and monitored throughout the study period.

### Sample

Patients admitted to the Neurosurgery Outpatient Clinics with acute OVF who underwent kyphoplasty were clinically evaluated for eligibility. Inclusion criteria were patients aged 45–75 years with acute thoracic or lumbar osteoporotic fractures. Participants were required to have a Visual Analogue Scale (VAS) score  $\geq 4$  for low back pain within the last 48 hours, assessed at one week after kyphoplasty. Eligible patients were able to walk independently and agreed not to use analgesics during the study period. Exclusion criteria were multiple vertebral fractures, fractures due to different causes (cancer metastases, trauma, etc.), history of any other spinal intervention, any additional neurological, rheumatologic, musculoskeletal, severe cardiovascular or vestibular disease that may affect balance and muscle strength, use of medications that may affect the central

nervous system and/or muscle strength or medications for pain, contraindications for KT (serious skin injury, open wounds, etc.), previous experience of KT.

### Procedure

In the first week after kyphoplasty, the participants who were eligible to participate in the study and gave written consent were clinically evaluated again. After clinical assessment, a baseline assessment was performed out and then final eligible participants were assigned to one of the treatment groups.

### Allocation concealment, randomization, and blinding

Final eligible participants giving their written informed consent were randomized into two groups (active KT group versus sham KT group) by the sealed envelope selection method. These sealed envelopes were prepared by a person who was not a member of the study. The information regarding group allocation was revealed only when one physiatrist opened the sealed envelope prior to the KT application. Outcome assessments were conducted by a different physiatrist who was blinded to group allocation. The same blinded assessor evaluated all participants at predetermined time points. Thus, both participants and the outcome assessor were blinded to the treatment allocation.

### Interventions

Both taping (active and sham) methods were applied once a week total of 3 weeks and participants were asked to remove the tapes 5 days after application and the remaining 2 days were untaped (1 cycle of KT). The interventions were performed by the same study member throughout the study period blinded to the outcome assessments. All interventions were applied according to a predefined and standardized protocol to ensure consistency across participants and reproducibility of the procedures.

### Kinesio taping

Five cm wide Kinesio tape (Medwelt Kinesio Tape ® 5cm x 5m, Capelle aan den IJssel, Netherlands) was applied to the patients in the intervention group. The functional correction technique was used for posture correction<sup>13</sup>. The Kinesio tape was applied diagonally starting from both acromioclavicular joints, without stretching at the first 5 cm and the last adhesion point, but with the highest level of stretching in the middle, ending under the contralateral costa, while

the patient kept the shoulders in protraction. In addition, for the painful lumbar areas, two 'I' or strip-shaped Kinesio tapes were applied bilaterally to the paravertebral muscles using a space correction technique by 25% stretching at the middle 1/3 and without stretching at the first and last parts<sup>14</sup> (Figure 1 here).



Figure 1. The method of Kinesio taping

### Sham kinesio taping

The sham KT was applied without tension as an active placebo, using the same placement as the active taping, consistent with previous sham taping studies, to maintain blinding while limiting mechanical effects<sup>9,15</sup>. Each of the tapes was administered a total of 3 times, staying on for 5 days and going without tape for the remaining 2 days of the week.

### Exercises

Both groups were prescribed a home exercise program following kyphoplasty, including spinal extension exercises (prone back and shoulder extension), deep abdominal exercises (arm and leg extension in the quadruped position), pelvic tilt exercises, and strengthening and balance exercises (squat exercise; upper extremity strengthening exercises using a medium-resistance TheraBand; tandem stance and tandem walking; single-leg stance; heel raise; and heel standing). Each exercise was performed with a 10-second hold followed by a 5-second relaxation period, for 10 repetitions, twice daily, over a 6-week period, which corresponded to the total duration of the study. At the first interview, all patients were shown the exercises and performed them under supervision and afterward, their commitment to exercises was confirmed at every visit. All patients were informed to avoid bending forward and heavy lifting.

## Outcome measures

In total, participants were assessed three times with outcome measures by the same study member blinded to randomization and interventions. After the first assessment at 1 week after kyphoplasty (baseline – T0), the second assessment was performed immediately after the last KT cycle (T1). Taping was not applied for the next 3 weeks, but patients were asked to continue with the exercises given. The final assessment was performed at the end of the third week after the KT was terminated (T2).

The outcome measures used were the Visual Analogue Scale (VAS) for pain, the Berg Balance Scale (BBS) for balance, and The Quebec Low Back Pain Disability Scale (QLBPDS) for disability.

Pain intensity was assessed using the Visual Analogue Scale (VAS). Participants marked their current pain level on a 10-cm horizontal line, with higher scores indicating greater pain intensity<sup>16</sup>. The VAS is widely used and has demonstrated validity and reliability<sup>17,18</sup>.

Static balance and fall risk were evaluated using the Berg Balance Scale (BBS). The scale includes 14 tasks, each rated on a scale from 0 to 4, resulting in a total score between 0 and 56, where higher scores reflect better balance performance<sup>19</sup>. The reliability of the scale has been reported with intra- and inter-rater ICC values of 0.98 and 0.99, respectively, and a Cronbach's alpha of 0.96<sup>20</sup>. The Turkish version has also demonstrated high reliability and internal consistency<sup>21</sup>.

The QLBPDS measures functional disability in conditions such as acute/chronic low back pain, sacroiliac joint dysfunction, and previous lumbar surgery. This scale was originally developed by Kopec et al. and has been shown to be valid and reliable, with a test retest reliability of 0.92 and a Cronbach's alpha coefficient of 0.96<sup>22</sup>. Participants were asked to evaluate the level of difficulty they experienced when performing 20 daily activities related to low back pain, covering six functional domains: bed rest, sitting or standing, ambulation, movement, bending, and lifting or carrying heavy objects. Responses were scored on a 6-point scale ranging from 0 (no difficulty) to 5 (unable to perform). The total score ranges from 0 (no disability) to 100 (maximum disability). A higher score indicates significant disability<sup>23</sup>. The Turkish version of the QLBPDS has demonstrated high test–retest reliability (ICC = 0.92) and internal consistency (Cronbach's alpha = 0.94–0.95)<sup>24</sup>.

## Statistical analysis

Sample size estimation was based on a previous study by Bulut et al<sup>13</sup>. A minimum of 36 participants was required, assuming an alpha level of 0.05 and a beta level of 0.20. The calculation was based on the difference between baseline and final measurements (T2–T0) using an independent samples t-test. A priori sample size estimation was performed using G\*Power software (version 3.1.9.6; Universität Kiel, Germany).

Data were analyzed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as numbers (n) and percentages (%), and continuous variables as mean  $\pm$  standard deviation. Data normality was assessed using the Shapiro–Wilk test.

Baseline demographic and clinical characteristics were compared between groups using the independent samples t-test for continuous variables and Fisher's exact test for categorical variables. Mixed ANOVA was used to examine changes over time and differences between groups for pain (VAS), balance (BBS), and disability (QLBPDS). This analysis evaluated the main effects of Group and Time, as well as the Group  $\times$  Time (interaction effect).

The assumption of sphericity was assessed using Mauchly's test, and homogeneity of variances was examined using Levene's test. Residual normality was evaluated visually with Q–Q plots and statistically with the Shapiro–Wilk test. Post hoc pairwise comparisons were adjusted using the Bonferroni correction. The interaction effect (patterns of change over time) was illustrated graphically. Mean change scores (difference from baseline) were compared between groups using the independent samples t-test. Statistical significance was set at  $p < 0.05$ , while  $p < 0.10$  was considered for interaction effects.

## RESULTS

When patients undergoing kyphoplasty were screened on a weekly basis, a total of 204 patients were assessed for eligibility. Of these, 63 patients declined participation, 37 patients did not meet the age criteria, 11 patients were excluded due to additional comorbidities, 22 patients reported no residual pain at one week after kyphoplasty, and 16 patients had vertebral fractures due to causes other than osteoporosis, such as trauma or metastasis, and

had undergone surgery. The remaining 55 patients who met the inclusion criteria were

randomized into two groups: the intervention and control groups. Seven patients withdrew from the study due to unwillingness to continue participation related to long travel distance to the hospital, two patients were excluded because of allergic reactions to KT, five patients required additional treatment due to the development of pain other than residual pain,

and one patient was unable to continue the study due to hospitalization following gastrointestinal bleeding. Consequently, 40 participants (35 women, 5 men) with a mean (SD) age of 67.9 (8.0) years were included in the per-protocol analysis. Figure 2 shows the flow chart. Although the participants were evenly distributed between the groups in terms of numbers, the groups were not exactly similar in terms of gender and use of anti-osteoporotic medication

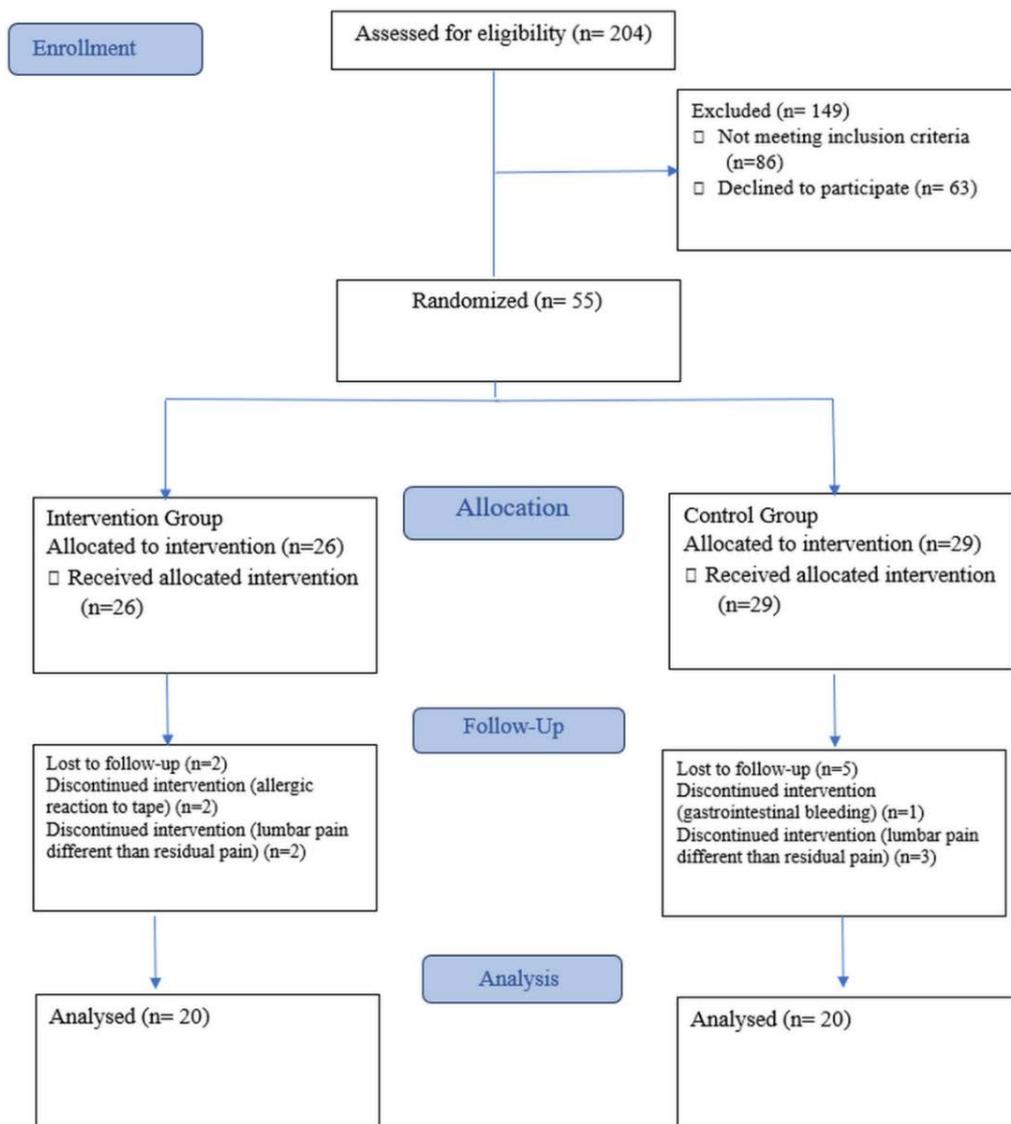


Figure 2. CONSORT diagram

**Table 1. Demographic and baseline clinical characteristics of the participants across the groups**

Variable	Active KT (n=20)	Sham KT (n=20)	P*
Age, year (Mean ±SD)	67.1±8.49	68.75±7.50	0.519
Sex (female), n	15	20	0.047
BMI, kg/m <sup>2</sup> , (Mean ±SD)	28.27±8.09	28.27±3.62	>0.05
Anti-osteoporotic medicine, yes	19	13	0.044
Level of Kyphoplasty			0.176
Lower thoracal (T10-T12)	9	4	
Upper lumbar (L1-L3)	11	16	
Falls in the last one year, yes	13	13	>0.05
VAS for pain, cm	6.2±2.0	6.0±1.9	0.810
BBS	41.2±13.8	41.2±10.2	>0.05
QLBPDS	55.6±22.5	53.2±22.7	0.739

SD: Standard Deviation; KT: Kinesio taping; n: Number; BMI: Body mass index; VAS: Visual analogue scale; BBS: Berg balance scale; QLBPDS: Quebec low back pain disability scale

For BBS, mixed ANOVA revealed a significant effect of time ( $F=18.837$ ,  $p<0.001$ ). Within-group comparisons showed that BBS scores at T1 and T2 were significantly different from baseline in both groups (adjusted  $p<0.05$ ). No significant main effect

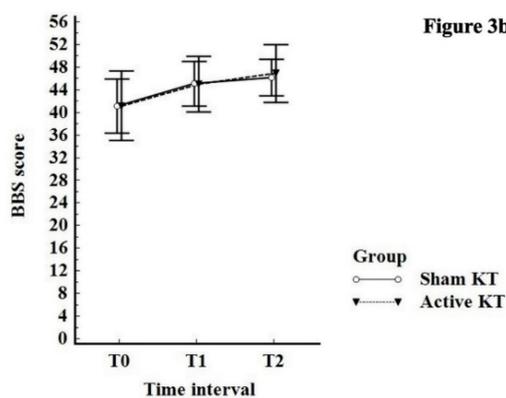
of group or interaction effect was found ( $F=0.04$ ,  $p=0.948$ ;  $F=0.115$ ,  $p=0.828$ , respectively). Changes and patterns of change in in BBS scores over time by group are shown in Table 3 here and Figure 3b here.

**Table 3. Comparison of the treatment group over time in terms of balance**

BBS	T0	T1	T2	T1-T0 (95% CI)	T2-T0 (95% CI)
Sham KT	41.2±10.2	45.1±8.4	46.2±6.9	4.0 (0.3 to 7.6) <sup>a</sup>	5.1 (1.0 to 9.1) <sup>b</sup>
Active KT	41.2±13.8	45.0±10.6	46.9±10.9	3.9 (0.04 to 7.7) <sup>c</sup>	5.8 (1.9 to 9.6) <sup>d</sup>
p*				0.961	0.744

CI: Confidence Interval; KT: Kinesio taping; BBS: Berg balance scale; T0: Assessment at baseline; T1: Assessment at the end of treatment; T2: Assessment at the end of week 6; T1-T0: change from baseline to end of treatment; T2-T0: change from baseline to end of week 6. <sup>a</sup>, Within-group pairwise comparison (adjusted  $p=0.033$ ); <sup>b</sup>, Within-group pairwise comparison (adjusted  $p=0.012$ ); <sup>c</sup>, Within-group pairwise comparison (adjusted  $p=0.047$ ); <sup>d</sup>, Within-group pairwise comparison (adjusted  $p=0.003$ )

\* p values based on the independent groups t-test (comparison of the change)

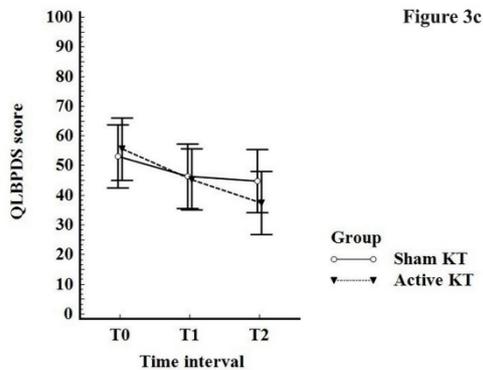
**Figure 3b. Changes in the Berg Balance Scale (BBS) scores over time. KT: Kinesio taping.**

For QLBPDS, mixed ANOVA demonstrated a significant effect of time ( $F=22.638$ ,  $p<0.001$ ). Within-group analyses indicated that QLBPDS scores at T1 and T2 differed significantly from baseline only in the active KT group (adjusted  $p=0.005$  and  $p<0.001$ , respectively). The main effect of group was not significant ( $F=0.089$ ,  $p=0.767$ ). The Group × Time (interaction) effect reached the predefined significance threshold ( $F=3.089$ ,  $p=0.051$ ). Comparison of change scores showed a greater reduction in disability in the active KT group compared with the sham group (mean difference  $-9.8$ ; 95% CI  $-18.8$  to  $-0.7$ ;  $p=0.035$ ). Changes patterns of change in in QLBPDS scores over time by group are shown in Table 4 here and Figure 3c here.

**Table 4. Comparison of the treatment group over time in terms of disability**

	T0	T1	T2	T1-T0 (95% CI)	T2-T0 (95% CI)
<b>QLBPDS</b>					
Sham KT	53.2±22.7	46.5±23.0	44.9±22.6	-6.7 (-14.8 to 1.4)	-8.3 (-16.6 to 0.03)
Active KT	55.6±22.5	45.4±22.0	37.5±22.7	-10.2 (-17.4 to -3.0) a	-18.1 (-26.3 to -9.8) b
p*				0.403	0.035

CI: Confidence Interval; KT: Kinesio taping; QLBPDS: Quebec low back pain disability scale; T0: Assessment at baseline; T1: Assessment at the end of treatment; T2: Assessment at the end of week 6; T1-T0: change from baseline to end of treatment; T2-T0: change from baseline to end of week 6. <sup>a</sup>, Within-group pairwise comparison (adjusted p= 0.005); <sup>b</sup>, Within-group pairwise comparison (adjusted p<0.001); \* p values based on the independent groups t-test (comparison of the change)



**Figure 3c. Changes in the Quebec Low Back Pain Disability Scale (QLBPDS) scores over time. KT: Kinesio taping.**

**DISCUSSION**

The results of this study indicate that KT was associated with clinically meaningful improvements in functional outcomes and demonstrated observable effects on pain and balance. However, there was no clear evidence that these effects were superior to those of placebo.

Vertebroplasty and kyphoplasty are invasive treatment options used for pain relief and fracture stabilization in patients with osteoporotic vertebral fractures who do not respond adequately to conservative treatment. A meta-analysis published in 2016 reported that both procedures led to significant improvements in pain, function, and quality of life, although the effect of kyphoplasty on pain was not superior to conservative management<sup>25</sup>. Similarly, a 2018 meta-analysis found no significant differences between vertebroplasty and sham procedures in terms of pain, function, quality of life, or treatment

success in patients with acute or subacute osteoporotic vertebral fractures<sup>26</sup>. To address uncertainty arising from inconsistent findings, a cross-sectional analysis of meta-analyses reported that vertebroplasty and kyphoplasty were equally effective in reducing pain and improving function in patients with OVF<sup>27</sup>. Beyond methodological and population-related differences, these findings suggest that not all patients derive the same level of benefit from invasive interventions. In this context, the present study examined whether KT, as an adjunctive non-invasive intervention, could provide additional benefits in pain reduction and functional recovery in patients who remained symptomatic one week after kyphoplasty.

KT is commonly used in musculoskeletal medicine for pain and posture management<sup>28,29</sup>. It has been suggested to improve muscle function, posture, and pain perception by enhancing proprioceptive input<sup>30</sup>. A small case series involving women with chronic low back pain reported improvements in pain and functional outcomes following KT, accompanied by changes in somatosensory cortical activity, which may indicate a neuromodulatory mechanism<sup>31</sup>. However, KT does not directly influence bone healing or structural stability in vertebral fractures.

Although KT has been widely applied in populations with non-specific low back pain<sup>7,32,33</sup>, evidence supporting its effectiveness in patients with OVF undergoing kyphoplasty remains limited. A feasibility randomized controlled study evaluating postural taping using an X-shaped adhesive plaster in patients with OVF reported improvements in pain during movement and function-related quality of life, while the effect on pain at rest was modest<sup>10</sup>. To date, studies specifically examining KT as an adjunctive intervention in patients who remain symptomatic after kyphoplasty are scarce. In this context, the

present study contributes additional evidence regarding its potential role. A randomized controlled study investigating the acute effects of KT on balance, back muscle endurance, and lumbar flexibility in sedentary individuals reported improved static balance compared with an education-only control group<sup>34</sup>. While these findings suggest a possible short-term effect of KT on balance, treatment responses may vary depending on the population and clinical setting.

In the present study, KT was not superior to sham treatment in terms of short-term pain and balance outcomes. Nevertheless, statistically and clinically meaningful improvements in functional disability were observed in the active KT group. Improvements in pain and balance may be more plausibly explained by the combined effects of natural healing, structured exercise, and placebo-related factors rather than a specific therapeutic effect of KT. In contrast, the observed improvement in functional outcomes may reflect a treatment-related contribution.

Several factors should be considered when interpreting these findings. Although fracture levels were statistically similar between groups at baseline; lumbar vertebral fractures were less frequent in the active KT group. As lumbar fractures involve more mobile spinal segments, functional improvement may have been relatively limited in the sham group. Furthermore, differences in anti-osteoporotic medication use and sex distribution between groups may have influenced the results. Additionally, the absence of pre-kypoplasty data on pain intensity and functional status limits the ability to fully assess treatment-related changes. Taken together, these factors warrant cautious interpretation of the findings.

This study has other limitations. The lack of a standardized method and duration for KT may have influenced the results. In addition, the ongoing effects of kypoplasty and the natural healing process cannot be excluded. Initiating KT in the first week after kypoplasty may have limited the ability to distinguish its specific effects from natural recovery. Delaying the intervention until a later stage, such as four weeks after the procedure, might have provided clearer results.

In conclusion, KT may contribute to short-term improvement in functional disability after kypoplasty. However, its effects on pain and balance

do not appear to be superior to placebo. KT may still be considered as an adjunctive supportive therapy for patients with persistent pain after kypoplasty, particularly when analgesic use is not appropriate. Future studies with larger sample sizes and longer follow-up periods are needed to better define the role of KT within multimodal rehabilitation programs. Stratification by fracture level, baseline functional status, and comparisons with other conservative interventions may help identify patients most likely to benefit.

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**Ethical Approval:** Ethical approval was obtained from the Ethics Committee for Clinical Research at Izmir Katip Çelebi University with decision number 72 dated 15.12.2022. Written informed consent was obtained from all participants prior to their inclusion in the study.

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