Turkish Journal of Thoracic and Cardiovascular Surgery 2023;31(4):507-516

ORIGINAL ARTICLE / ÖZGÜN MAKALE

The effect of kinesio taping on pain, respiratory function, and muscle strength after thoracotomy

Torakotomi sonrası kinezyo bantlamanın ağrı, solunum fonksiyonu ve kas gücü üzerine etkisi

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ABSTRACT

Background: This study aims to investigate the effectiveness of kinesio taping on pain, respiratory function, and respiratory muscle strength in patients after posterolateral thoracotomy.

Methods: Between June 2019 and May 2020, a total of 88 patients (48 males, 40 females; mean age: 56.1±9.0 years; range, 28 to 69 years) following posterolateral thoracotomy were randomly allocated to the therapeutic kinesio taping group (n=44) or the control group (n=33). Kinesio taping was applied to the kinesio taping group for seven days. Pain, respiratory functions, respiratory muscle strength, amount of analgesic drug use, and quality of life were evaluated preoperatively, on postoperative Day 0, before tape application, postoperative Days 1, 2, and 7, and at postoperative first month.

Results: There was no significant difference between the groups in terms of demographic and clinical characteristics. The results of respiratory functions and respiratory muscle strength were all improved in both groups, while there were more significant improvements in the kinesio taping group. There was a statistically significant difference in the mean Visual Analog Scale scores on postoperative Days 2 and 7 between the two groups. The amount of tramadol use of the patients in the kinesio taping group was significantly lower on postoperative Days 2 and 7 than in the control group.

Conclusion: Kinesio taping is an effective method to reduce pain and improve respiratory function after posterolateral thoracotomy. Therefore, it is thought that kinesio taping should be applied as a part of the pulmonary rehabilitation program after thoracotomy.

Keywords: Kinesio tape, pain, pulmonary function, pulmonary muscle strength, thoracotomy.

ÖZ

Amaç: Bu çalışmada posterolateral torakotomi sonrası hastalarda kinezyo bantlamanın ağrı, solunum fonksiyonu ve solunum kas gücü üzerindeki etkinliği araştırıldı.

Çalışma planı: Haziran 2019 - Mayıs 2020 tarihleri arasında posterolateral torakotomiyi takiben toplam 88 hasta (48 erkek, 40 kadın; ort. yaş: 56.1±9.0 yıl; dağılım, 28-69 yıl), terapötik kinezyo bantlama grubuna (n=44) veya kontrol grubuna (n=33) randomize edildi. Kinezyo bantlama grubuna yedi gün süreyle kinezyo bantlama uygulandı. Ameliyat öncesi, ameliyat sonrası 0. gün, bant uygulaması öncesi, ameliyat sonrası bir, iki ve yedinci gün ve ameliyat sonrası birinci ay ağrı, solunum fonksiyonları, solunum kas kuvveti, analjezik ilaç kullanım miktarı ve yaşam kalitesi değerlendirildi.

Bulgular: Demografik ve klinik özellikler açısından gruplar arasında anlamlı bir fark yoktu. Çalışmanın sonunda her iki grupta da solunum fonksiyonları ve solunum kas gücünün tümünde iyileşme gözlenirken, kinezyo bantlama grubunda daha belirgin iyileşmeler vardı. İki grup arasında ameliyat sonrası 2 ve 7. günlerde ortalama Görsel Analog Ölçeği açısından istatistiksel olarak anlamlı fark vardı. Kinezyo bantlama grubundaki hastaların tramadol kullanım miktarı ameliyat sonrası iki ve yedinci günde kontrol grubuna kıyasla anlamlı düzeyde düşük idi.

Sonuç: Posterolateral torakotomi sonrası kinezyo bantlama ağrıyı azaltmak ve solunum fonksiyonlarını iyileştirmek için etkili bir yöntemdir. Bu nedenle, torakotomi sonrası pulmoner rehabilitasyon programının bir parçası olarak kinezyo bantlamanın uygulanması gerektiği düşünülmektedir.

Anahtar sözcükler: Kinezyo bant, ağrı, solunum fonksiyonu, solunum kas gücü, torakotomi.

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Doi: 10.5606/tgkdc.dergisi.2023.24407

Received: November 10, 2022
Accepted: January 15, 2023
Published online: October 19, 2023

Cite this article as: Temel Aksu N, Erdoğan M, Erdoğan A. The effect of kinesio taping on pain, respiratory function, and muscle strength after thoracotomy. Turk Gogus Kalp Dama 2023;31(4):507-516. doi: 10.5606/tgkdc.dergisi.2023.24407.

After thoracotomy, there is a decrease in lung volume and expansion due to incisional pain. Decreased lung volume and expansion causes retained bronchopulmonary secretions, atelectasis, and respiratory tract infections, leading to a significant decrease in respiratory function and respiratory muscle strength. Effective pain control is of utmost importance to prevent retained secretion, atelectasis, infection, and hypoxemia.[1]

The inadequacy of postoperative pain management has led to the development of alternative treatments.[2] More than one alternative treatment method can be used to manage pain and reduce functional impairment after thoracotomy.[3,4] Kinesio taping technique, which is one of these alternative treatment applications, was developed by a Japanese acupuncturist, Dr. Kenzo Kase, and presented as an alternative to traditional taping techniques. It can increase the effects of rehabilitation and is one of the ways to support postoperative physiotherapy.[5,6]

Kinesio taping applied after cardiopulmonary surgery reduces postoperative pain and analgesic drug use and improves inspiratory muscle strength and respiratory function.[7-10]

In the literature, the effects of kinesio taping on pain and respiratory functions after thoracotomy have been investigated. However, there is no study to evaluate its effects on respiratory muscle strength. In the present study, we, therefore, aimed to examine the effects of kinesio taping on respiratory muscle strength in addition to pain and respiratory function after posterolateral thoracotomy.

PATIENTS AND METHODS

This single-center, unblinded, prospective, randomized-controlled study was conducted at Akdeniz University Faculty of Medicine, Department of Thoracic Surgery, between June 2019 and May 2020. Thoracotomy was performed in all patients by the same surgical team. Patients who underwent thoracotomy with a posterolateral thoracotomy incision, agreed to participate in the study, were aged between 20 and 75 years, had no known cerebrovascular disease, had no morbid obesity and heart disease that would hinder the study, had no cognitive and cognitive impairments, and had no previous paralysis and related effects were included in the study. Patients with hemodynamic instability, previous chest trauma, thoracotomy or tube thoracostomy, not complying with the pulmonary function test, allergic to the applied band, cancer patients receiving neoadjuvant therapy (i.e., chemotherapy, chemoradiotherapy or radiotherapy) were excluded from the study. Finally, a total of 88 patients (48 males, 40 females; mean age: 56.1±9.0 years; range, 28 to 69 years) who met the inclusion criteria were enrolled. The study flowchart is shown in Figure 1.

The patients were followed under mechanical ventilation support, until spontaneous breathing started and extubated in the intensive care unit (ICU).

All patients were randomly (1:1) assigned to kinesio taping group (n=44) or control group (n=44) using a computerized random number generator (GraphPad Software, San Diego, CA, USA) on postoperative Day 0.[11]

The first group of the study consisted of patients in the kinesio taping group who underwent kinesio taping in addition to postoperative pulmonary rehabilitation and standard pain medication applications, and the second group consisted of patients in the control group who underwent postoperative pulmonary rehabilitation and standard pain medication applications. After surgery, the patients were administered diclofenac sodium 75 mg tablet (Voltaren; Novartis Pharmaceuticals, Istanbul, Türkiye) once a day; intravenous tramadol hydrochloride 30 mg (Contromal; Abdi İbrahim Pharmaceuticals, Istanbul, Türkiye) before breathing exercises and mobilization; paracetamol (Parol; Atabay Pharmaceuticals, Istanbul, Türkiye) and morphine for additional pain control. The postoperative pulmonary rehabilitation program included breathing exercises, airway clearance techniques, and progressive ambulation exercises.

On postoperative Day 0, kinesio taping was applied to the patients in the Kinesio taping group whose hemodynamic status was stable after extubation by an expert physiotherapist. The material we used for kinesio taping was Kinesio® Tex Gold™ (Kinesio Holding Corp., NM, USA), a 100% cotton, latex-free, 5-cm wide elastic band. All tapes were applied by a single physiotherapist. We applied kinesio taping as described below:

1. To stimulate the facilitation of the diaphragmatic function, a 5-cm wide kinesio tape was applied on the skin.
2. Taping was applied to the latissimus dorsi and serratus anterior muscles which were cut during thoracotomy.
3. In addition, kinesio taping can be performed on the trigger pain point of the patient (usually above the pectoralis major).

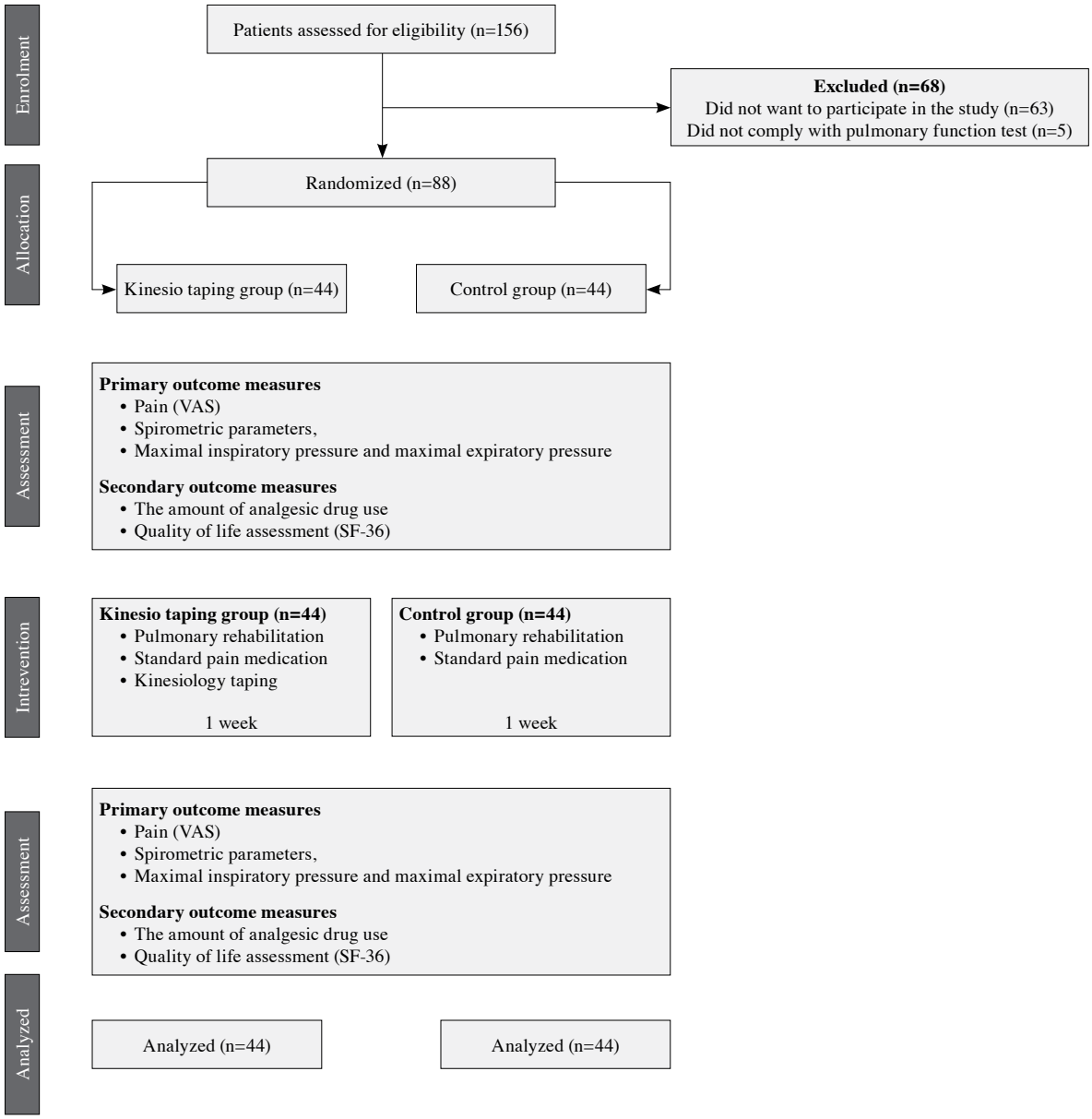

Figure 1. CONSORT diagram of study population.
VAS: Visual Analog Scale; SF-36: Short-Form-36.

The kinesio tape can stay for three to four days, if the patient does not develop any discomfort. Then, the tape was renewed. The bands were removed at one week postoperatively.

The patients were followed from the preoperative period until discharge. For each patient, age, sex, weight and height measurements, body mass index (BMI) educational status, type of surgery, whether there was any additional systemic disease, smoking, alcohol habits, concomitant medications, previous operations, postoperative complications, surgical procedure, duration of operation, duration of anesthesia, chest tube stay, and length of hospital stay were recorded.

Outcome measurement

The Visual Analog Scale (VAS) was used as a one-dimensional scale for pain assessment. It is a self-administered, one-dimensional measure of pain intensity widely used in various adult populations. The VAS is a 10-cm long line in which participants

mark the point they believe best represents the severity of pain. "0" indicates no pain, while "10" indicates excruciating pain. When asked, patients touch a point corresponding to their degree of pain, and this mark indicates the degree of pain on the scale. Higher scores indicate greater pain severity.[12,13] Preoperative, on postoperative Day 0 after kinesio taping, postoperative Days 1, 2, and 7 and at postoperative first month were evaluated.

Pulmonary function testing was performed using a digital spirometer (Pony FX, COSMED Inc., Rome, Italy). This test was repeated three times for each patient and the best value was recorded. Forced expiratory volume in 1 sec (FEV1), forced vital capacity (FVC), FEV1/FVC, peak expiratory flow (PEF), 25 to 75% forced expiratory flow (FEF25-75%) were recorded as described in the literature.[14,15] The tests were performed preoperatively, on postoperative Day 0 after kinesio taping, postoperative Days 1, 2, and 7, and at postoperative first month.

Respiratory muscle strength was evaluated by measuring maximal inspiratory and maximal expiratory pressures with a portable intraoral pressure measuring device (Pony FX, COSMED Inc., Rome, Italy). Maximal voluntary inspiratory pressure (MIP) or maximal expiratory pressures (MEP) are the most frequently reported technique to evaluate respiratory muscle strength non-invasively. The technique was reported by Black and Hyatt[16] as a non-invasive technique in the late 1960s. The maneuvers were repeated at least five times at intervals of at least 30 sec, and the best among the measurements with a 5 to 10% difference was selected for analysis. The tests were performed preoperatively, on postoperative Day 0 after kinesio taping, postoperative Days 1, 2, and 7, and at postoperative first month.

In addition, the Short Form-36 (SF-36) quality of life scoring was used to evaluate the quality of life of the patients. It is a questionnaire with eight subscales that gives information about the health status and quality of life of the person. It was translated into Turkish in 1999 and validation and reliability studies were conducted in different patient groups.[17,18] The SF-36 was applied in the preoperative period and at the postoperative first month.

Statistical analysis

The G*power sample size calculator (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used to identify the sample size of the study. A sample size of 35 subjects for each group was estimated with 0.05 type I error rate (α) and 90% power (1-α). A total of 88 patients were included to avoid possible dropouts.

Statistical analysis was performed using the SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). In the comparisons between the two groups, the Student t-test or Mann-Whitney U test was used. The chi-square test (Fisher exact test, two-tailed) was used to compare categorical variables. Two-way analysis of variance (ANOVA) was performed for repeated measures to evaluate the change over time of the measured variables of the treatment and control groups and the group-time interactions. A p value of <0.05 was considered statistically significant.

RESULTS

Demographic and clinical information of the patients are shown in Table 1. There was no significant difference between the groups in terms of age, sex, type of surgery, weight, height, BMI, smoking status, and length of chest tube and hospital stay ($p>0.05$). In addition, there was no significant difference between the groups in terms of the preoperative respiratory function, respiratory muscle strength, quality of life and pain results ($p>0.05$).

The changes in respiratory function and respiratory muscle strength results between and within the groups after kinesio taping on postoperative Days 0, 1, 2, 7, and at postoperative first month are shown in Table 2. Accordingly, there was a statistically significant difference in the results of respiratory function and respiratory muscle strength between the two groups in the days after surgery. In the analysis of changes within the group performed in the kinesio taping group and control group, the results of respiratory function and respiratory muscle strength statistically significantly decreased in the postoperative period over time ($p<0.001$).

Table 3 shows the results of the statistical analysis of the amount of analgesia drug use and mean VAS scores, the change between the groups and the time-dependent changes within the group in the postoperative periods of the patients in the kinesio taping and control groups. Accordingly, there was a statistically significant difference between the mean amount of diclofenac use on the postoperative Day 2 and Day 7 between the kinesio taping group and control group. In the intra-group change analyses performed in the kinesio taping group and control group, the amount of tramadol and diclofenac use statistically significantly decreased over time in the postoperative period ($p<0.001$).

Table 1. Demographic and clinical characteristics of patients

	Kinesio taping group (n=44)			Control group (n=44)			
Variables	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			54.3±6.4			57.3±7.2	0.064
Sex							0.323
Male	23	52.27		25	56.82		
Female	21	47.73		19	43.18		0.234
Resection type							
Wedge resection	17	38.64		16	36.36		
Segmentectomy	13	29.55		13	29.55		
Lobectomy	11	25.00		13	29.55		
Pneumonectomy	3	6.82		2	4.55		
Weight (kg)			69.0±10.5			69.7±11.2	0.435
Height (m)			168.1±5.9			164.4±3.5	0.265
Body mass index (kg/m^2)			29.0±5.9			26.1±4.3	0.165
Visual Analog Scale			0.1±0.9			0.1±1.0	0.265
Preoperative pulmonary function test							
FVC (L)			3.2±0.8			3.1±0.6	0.482
FVC (%)			87.2±18.3			85.5±19.2	0.560
FEV1 (L)			2.7±0.8			2.3±0.8	0.523
FEV1 (%)			81.0±18.8			78.5±19.3	0.654
FEV1/FVC (%)			84.2±15.1			82.2±14.5	0.231
PEF (L/s)			6.3±1.9			5.9±2.5	0.093
FEF25-75 (L/s)			1.8±0.8			1.2±1.9	0.843
Preoperative pulmonary muscle test							
MIP (cmH_2O)			62.5±31.7			61.0±32.6	0.368
MEP (cmH_2O)			89.9±39.1			88.2±38.7	0.456
Smoking							0.215
Yes	40	90.91		38	86.36		
No	4	9.09		6	13.64		
Duration of chest drain (days)			3.8±1.1			4.8±1.1	0.165
Hospitalization time (days)			7.1±3.5			8.8±4.7	0.269
SF-36							
Physical functioning			68.5±11.3			70.8±9.3	0.235
Role limitations-physical problems			61.6±8.7			65.4±5.1	0.179
Pain			65.8±9.3			67.2±12.4	0.542
General health			71.2±11.7			68.4±6.7	0.589
Energy			63.3±7.3			65.5±4.3	0.239
Social functioning			69.1±9.0			64.4±7.4	0.067
Role limitations-emotional problems			64.4±6.5			69.1±9.7	0.075
Mental health			62.1±10.8			60.2±5.3	0.347

SD: Standard deviation; FVC: Forced vital capacity; FEV1: Forced expiratory volume in 1 sec; PEF: Peak expiratory flow; FEF25-75%: 25 to 75% forced expiratory flow; MIP: Maximal voluntary inspiratory pressure; MEP: Maximal expiratory pressure; SF-36: Short Form-36.

Table 4 presents the pre- and postoperative statistical analysis results of eight sub-dimensions of the SF-36. In the analysis of change within the group in the kinesio taping group, there was a statistically significant worsening in Role Limitations-Physical Problems ($p<0.05$). However, there was no statistically significant change in Physical Functioning, Pain, General Health, Energy, Social Functioning, Role Limitations-Emotional Problems, Mental Health in the kinesio taping group compared to baseline.

Table 2. Pulmonary function test and pulmonary muscle test averages of the patients in the kinesio taping and control groups in the postoperative period and intra- and inter-group time-dependent changes

	Kinesio taping group	Control group	Inter-group changes	Intra-group changes	
				Kinesio taping group	Control group
	Mean±SD	Mean±SD	*p*	*p*	*p*
FVC (L)				<0.001	<0.001
Postop day 0	1.6±0.8	1.57±0.64	0.083		
Postop day 1	1.8±0.4	1.13±0.54	**0.023**		
Postop day 2	2.8±1.3	1.75±0.12	**0.037**		
Postop day 7	3.6±2.5	2.94±1.65	**0.024**		
Postop month 1	3.8±0.5	3.46±1.23	0.193		
FVC (%)				<0.001	<0.001
Postop day 0	57.2±18.3	55.5±19.2	0.160		
Postop day 1	56.5±16.0	55.3±18.3	0.234		
Postop day 2	60.5±24.3	57.3±26.2	**0.043**		
Postop day 7	65.2±17.8	57.2±19.3	**0.038**		
Postop month 1	75.3±25.1	73.4±25.4	0.120		
FEV1 (L)				<0.001	<0.001
Postop day 0	1.4±0.8	1.3±0.8	0.523		
Postop day 1	1.4±1.2	1.4±0.4	0.093		
Postop day 2	1.4±0.7	1.1±2.8	0.052		
Postop day 7	2.3±2.6	2.0±2.0	**0.041**		
Postop month 1	2.8±1.1	2.0±1.2	**0.024**		
FEV1 (%)				<0.001	<0.001
Postop day 0	61.0±18.8	59.5±19.3	0.174		
Postop day 1	60.9±27.2	54.3±19.2	**0.021**		
Postop day 2	62.1±10.2	55.7±18.5	**0.034**		
Postop day 7	71.9±16.2	63.1±27.2	**0.029**		
Postop month 1	78.3±27.1	71.2±18.0	**0.035**		
FEV1/FVC (%)				>0.001	>0.001
Postop day 0	84.2±15.1	82.2±14.5	0.231		
Postop day 1	85.7±24.2	83.3±22.6	0.134		
Postop day 2	82.4±18.4	80.9±25.0	0.078		
Postop day 7	78.2±16.1	80.5±23.2	0.237		
Postop month 1	82.3±23.3	79.9±22.1	0.107		
PEF (L/s)				<0.001	<0.001
Postop day 0	3.2±1.9	3.0±2.5	0.243		
Postop day 1	3.2±0.4	3.1±2.3	0.087		
Postop day 2	4.5±1.1	3.4±2.6	**0.022**		
Postop day 7	4.5±2.5	4.0±1.4	0.050		
Postop month 1	6.0±0.7	5.3±2.0	0.215		
FEF25-75 (L)				<0.001	<0.001
Postop day 0	1.14±0.78	1.1±1.9	0.243		
Postop day 1	1.09±0.34	1.1±1.7	0.743		
Postop day 2	1.76±1.02	1.5±1.4	**0.048**		
Postop day 7	2.21±0.36	1.9±0.5	**0.034**		
Postop month 1	2.85±0.17	2.7±0.6	0.102		
MIP (cmH_2O)				<0.001	<0.001
Postop day 0	40.5±31.7	41.0±32.6	0.368		
Postop day 1	40.7±25.7	41.2±30.1	0.254		
Postop day 2	43.1±32.7	42.2±28.8	0.456		
Postop day 7	51.1±29.0	43.2±31.3	**0.021**		
Postop month 1	69.9±33.5	65.2±36.2	**0.042**		
MEP (cmH_2O)				<0.001	<0.001
Postop day 0	39.9±29.1	38.2±28.7	0.456		
Postop day 1	42.3±22.4	44.0±25.5	0.267		
Postop day 2	46.3±20.6	45.2±22.0	0.421		
Postop day 7	50.3±21.1	45.4±28.1	**0.023**		
Postop month 1	89.3±34.2	82.4±20.2	**0.039**		

SD: Standard deviation; FVC: Forced vital capacity; FEV1: Forced expiratory volume in 1 sec; PEF: Peak expiratory flow; FEF25-75%: 25 to 75% forced expiratory flow; MIP: Maximal voluntary inspiratory pressure; MEP: Maximal expiratory pressure; SF-36: Short Form-36.

Table 3. The amount of analgesic drug use and VAS score averages of the patients in the kinesio taping and control groups in the postoperative period and intra- and inter-group time-dependent changes

	Kinesio taping group			Control group			Inter-group changes	Intra-group changes	
								Kinesio taping group	Control group
Applied analgesic amounts (mg)	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*	*p*	*p*
Tramadol								<0.001	<0.001
Postop day 0	290.4±29.2			295.5±18.3			0.945		
Postop day 1	172.9±12.7			265.3±27.0			0.234		
Postop day 2	60.3±37.5			79.6±32.9			**0.018**		
Postop day 7	2.5±29.1			65.9±14.4			**0.008**		
Postop month 1	0.0±0.0			0.0±0.0			1.000		
Diclofenac								<0.001	<0.001
Postop day 0	137.9±39.2			138.9±40.0			0.805		
Postop day 1	124.5±62.5			133.9±56.5			0.256		
Postop day 2	58.9±52.3			135.7±35.7			**0.026**		
Postop day 7	27.3±48.9			106.9±26.6			**0.005**		
Postop month 1	0.0±0.0			0.0±0.0			1.000		
VAS								<0.001	<0.001
Preoperative		0.00	0.00-0.00		0.00	0.00-0.00	1.000		
Postop day 0		0.87	0.55-0.89		0.89	0.72-0.90	0.074		
Postop day 1		0.80	0.42-0.87		0.79	0.52-0.89	0.067		
Postop day 2		0.44	0.32-0.61		0.58	0.30-0.74	**0.030**		
Postop day 7		0.29	0.18-0.38		0.32	0.19-0.49	**0.042**		
Postop month 1		0.09	0.00-0.10		0.12	0.00-0.32	**0.017**		

VAS: Visual Analog Scale; SD: Standard deviation.

Table 4. The results of the SF-36 mean scores of the patients in the Kinesio taping and control groups before and after the operation

	Kinesio taping group			Control Group			Inter-group changes	
	Preop	Postop 1. month	Intra-group changes	Preop	Postop 1. month	Intra-group changes	Before treatment	After treatment
SF-36	Mean±SD	Mean±SD	*p*	Mean±SD	Mean±SD	*p*	*p*	*p*
Physical functioning	68.5±11.3	55.5±7.2	0.267	70.8±9.3	43.1±6.3	0.004	0.235	0.043
Role limitations-physical problems	61.6±8.7	48.7±5.9	0.026	65.4±5.1	45.9±9.3	0.013	0.179	0.151
Pain	65.8±9.3	62.3±12.6	0.352	67.2±12.4	42.2±11.3	0.025	0.542	0.006
General health	71.2±11.7	67.8±11.3	0.251	68.4±6.7	65.2±9.4	0.156	0.589	0.127
Energy	63.3±7.3	57.2±6.3	0.102	65.5±4.3	55.2±8.6	0.092	0.239	0.312
Social functioning	69.1±9.0	65.1±8.8	0.287	64.4±7.4	62.3±9.2	0.305	0.067	0.245
Role limitations-emotional problems	64.4±6.5	62.3±10.0	0.124	69.1±9.7	48.9±12.7	0.005	0.075	0.007
Mental health	62.1±10.8	55.6±10.5	0.251	60.2±5.3	54.7±11.3	0.115	0.347	0.365

SF-36: Short Form-36; SD: Standard deviation.

Intergroup analysis showed that patients in the kinesio taping group had significantly better Physical Functioning, Pain and Role Limitations-Emotional Problems scores at one month after the operation compared to the control group.

DISCUSSION

Severe pain occurs in approximately 70% of patients in the postoperative period after thoracotomy. Effective analgesia and physiotherapy practices help patients to actively participate in respiratory rehabilitation after surgery and prevent complications.[19]

A study performed after laparoscopic cholecystectomy showed that tape applications had a significant effect on postoperative pain perception and analgesic consumption.[20] Adding kinesio taping to the post-cesarean physiotherapy program increases abdominal muscle strength and endurance, reduces pain severity and low back injury level, and improves the quality and efficiency of health care.[21] Kinesio taping is used in patients after cardiac surgery to reduce pain, stabilize muscle tone, support respiratory muscles, prevent pectoralis muscle contracture, accelerate wound healing process after surgery, and improve the respiratory functions of patients.[7]

Kinesio tape application can be applied for early pain control after thoracotomy, thereby preventing the development of postoperative complications. Kinesio taping after lobectomy reduces pain, stabilizes muscle tone, accelerates the wound healing process and increases wound elasticity.[7] It has been reported that kinesio taping performed after discharge is effective in long-term pain control.[8,10]

In another study, the results of kinesio taping on pain reduction and quality of life were evaluated in patients receiving non-steroidal anti-inflammatory drug therapy for post-thoracotomy pain syndrome. As a result of the study, there was no additional benefit of kinesio taping in the treatment of post-thoracotomy pain syndrome.[22]

In this study, we found that the VAS scores of the patients in the kinesio taping group were significantly lower on postoperative Days 2 and 7 compared to the control group. However, it was not significantly different in both groups on postoperative Day 0 and at postoperative first month. This can be explained by intensive analgesic administration in the ICU on postoperative Day 0. The main finding of this study is a significant reduction in thoracic pain intensity in the kinesio taping group.

Kinesio taping applied to the thorax causes significant improvements in expiratory tidal volume and mechanical efficiency. Inspiratory muscle training and kinesio tape application improve minute volume.[23,24] Kinesio taping applied after lobectomy can also significantly improve early postoperative inspiratory volume loss.[10] The changes in pain, dyspnea perception, and respiratory functions were evaluated by applying kinesio tape in the postoperative period in patients after thoracotomy.[25] The kinesio tape application in patients who underwent thoracotomy was found to be a safe and simple method for pain control in the postoperative period. However, it had no significant effect on FVC, FEV1, FEV1/FVC, and PEF values.

In our study, respiratory muscle strength was also evaluated after thoracotomy. Decreased MIP and MEP values after surgery, with kinesio taping applied from postoperative Day 0, increased more in the kinesio taping group compared to the control group over time. This increase was found to be higher and significant, particularly on postoperative Day 7 and at postoperative first month. This finding confirms that kinesio taping provides an increase in respiratory muscle strength and this increase contributes to the increase in respiratory muscle strength due to pulmonary rehabilitation applied in the future.

In addition, we found a decrease in the values of FVC, FVC%, FEV1, FEV1%, PEF, FEF25-75% measured in both groups. This decrease was less in the patients in the kinesio taping group compared to the patients in the control group. After taping, the patients were able to inhale more deeply and cough more effectively.

Patients with less pain can breathe and cough more normally. Therefore, better breathing of patients can be explained by lower pain levels. If taping reduces the incidence of postoperative pneumonia by providing better respiratory functions, tape application in the early postoperative period is critical.

Nonetheless, this study has some limitations. First, it has a relatively small sample size. Second, there is no placebo group. Third, there are no data regarding long-term efficacy. In addition, physiotherapists who applied kinesio taping were not blind which is inevitable due to the nature of the intervention.

In conclusion, our study results demonstrate that kinesio taping is a cost-effective and simple method to safely and effectively reduce pain, improve respiratory function and respiratory muscle strength after posterolateral thoracotomy without side effects. Based on these findings, we believe that kinesio taping should be applied as a part of the pulmonary rehabilitation program after thoracotomy.

Ethics Committee Approval: The study protocol was approved by the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee (date: 06.11.2017, no: 70904504/362). The written informed consent was signed by every participant. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Were involved in conceptualization, reviewing and editing the manuscript: N.T.A., M.E.; Were involved in data curation, formal analysis, investigation, methodology, project administration, resources, software, validation, visualization, and writing the original draft: N.T.A., M.E., A.E.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: This research was supported by University Scientific Research Projects.

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