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Kinesiotaping as an alternative treatment method for carpal tunnel syndrome

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Background/aim: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy. Conservative treatment choices are not always satisfactory. The aim of this study was to investigate the effect of kinesiotaping (KT) on pain level, grip strength, and functional status compared with that of placebo KT and orthotic device (OD) in patients with CTS.

Materials and methods: In this randomized, placebo-controlled study, participants were allocated into one of three groups: an experimental KT group (Group 1), a placebo KT group (Group 2), and an OD group (Group 3). Visual analogue scale (VAS) and Douleur Neuropathique 4 (DN4) scores, dynamometric grip strength measures, and the Boston CTS questionnaire (BQ) were the outcome measures.

Results: All groups significantly improved in terms of VAS scores ($P < 0.05$), DN4 scores ($P < 0.05$), and BQ scores ($P < 0.05$). Grip strength improved in Group 3 ($P = 0.001$). There was a significant difference among the groups with respect to BQ scores ($P < 0.05$).

Conclusion: KT application for the treatment of CTS should be an alternative treatment choice.

Key words: Kinesiotaping, carpal tunnel syndrome, pain, disability

1. Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy and is caused by compression of the median nerve at the wrist (1). The etiology of CTS can result from prolonged static postures and repeated wrist activities (2,3). The diagnosis of CTS is based on symptoms, provocative tests, and nerve conduction studies (NCSs). Various treatment approaches, individually or in combination, have been recommended in the literature for the conservative treatment of mild/moderate CTS, including wrist orthotic devices (ODs), steroid injections and nonsteroidal antiinflammatory drugs, vitamin B12 supplementation, physical therapy agents, activity modification, and tendon/nerve gliding exercises (4,5).

In recent years, kinesiotaping (KT) has become increasingly popular for various musculoskeletal conditions such as shoulder pain (6), patellofemoral pain syndrome

(7), subacromial impingement syndrome (8), plantar fasciitis (9), and spasticity (10).

However, there are not enough studies to show efficacy in these conditions. It provides dynamic support and protection to the injured/overused muscle, while allowing a functional and safe range of motion by either inhibition or facilitation, according to the underlying pathology. In addition to those concepts, Kase et al. (21) defined several corrective techniques (neural, mechanical, fascia, space, ligament/tendon, functional, circulatory/lymphatic corrections) for several diagnoses.

In clinical practice, wrist ODs placed in a neutral position are the first step of treatment. Local corticosteroid injections and physical therapy modalities are also preferred. However, physical therapy involves time commitment of physiotherapists and patients. Local injections may not be preferred by the patient because they are invasive and not an exact solution for CTS. It has been hypothesized that KT application, through neural technique and space correction, and recommended by Kase et al. (21) for CTS, should be an alternative treatment method. The aim of the present study was to analyze the effect of KT on pain, functional status, and grip strength in patients with mild to moderate CTS by comparing placebo KT and a well-known treatment method, a neutral positioned wrist OD. To the best of our knowledge, this is the first study to evaluate the efficacy of KT in patients with CTS.

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2. Materials and methods

2.1. Study design and participants

This was a prospective, randomized placebo-controlled trial. Patients with symptoms of CTS including nocturnal paresthesia, pain in the median nerve distribution during activity, or numbness in the median nerve distribution were examined. Patients with clinically suspected CTS were referred to the electromyography laboratory of the hospital. Mild and moderate CTS patients, according to NCSs, were asked to participate in the study. Mild CTS is defined as abnormal median nerve peak sensory conduction velocity (<42 m/s) and normal median nerve motor latency (<4 ms). Moderate CTS is defined as NCS abnormalities for median nerve peak sensory conduction velocity (<42 m/s) and abnormal median nerve motor distal latency (>4 ms) (11).

Patients older than 18 years who had symptoms for less than 1 year were included in the study. Patients were excluded if there were any secondary entrapment neuropathy (e.g., diabetes, inflammatory arthritis, hypothyroidism, previous wrist trauma), pregnancy, skin infection on the forearm, cervical radiculopathy, polyneuropathy, previous history of carpal tunnel decompression surgery, and corticosteroid injection into the carpal tunnel.

The local Ethics Committee approved the study, and all subjects gave written informed consent.

2.2. Patient allocation

Forty-five patients (65 wrists) were included in the study. Twenty patients had bilateral CTS. Occupation, age, sex, dominant hand, and affected side were recorded as demographic properties. Patients were randomly assigned to one of the three groups using a secure system of opaque closed envelopes numbered 1–3. Wrists of the patients with bilateral CTS were allocated to the same group according to the envelope number that the patient chose. The first group received KT, the second group received sham KT, and the third group received an OD, performed by a researcher not involved in the study. Thirteen patients (22 wrists) from Group 1, 13 patients (22 wrists) from Group 2, and 14 patients (21 wrists) from Group 3 completed the study. A flow diagram of the patients is presented in Figure 1.

2.3. Assessments

All patients were examined by the Phalen test and Tinel test. A manual muscle strength test and a sensorial examination were performed. Outcome measures are listed below. Patients with bilateral symptoms were asked to complete two questionnaires, one for each hand separately. Assessments were done before (T0) and after the treatments (T1).

2.4. Outcome measures

2.4.1. Pain level

The visual analogue scale (VAS) pain score is between 0 (no pain) and 10 (worst possible pain).

The DN4 questionnaire (12) consists of ten items. The first seven items are related to pain characteristics and sensations, and the remaining three items are related to the examination. For each item, a score of "1" is given if the answer is "yes", and a score of "0" is given if it is "no". The patient is defined to have neuropathic pain if the sum of all ten items is calculated to be 4 or greater. A Turkish version of DN4 was validated by Unal-Cevik et al. (13).

2.4.2. Functional status

The Boston questionnaire (BQ) (14) is self-administered and assesses the severity of symptoms and functional status in patients with CTS. The symptom severity scale (SSS) assesses the symptoms with respect to severity, frequency, time, and type. The scale consists of 11 questions with multiple-choice responses, scored from 1 point (mildest) to 5 points (most severe). The overall symptom severity score is calculated as the mean of the scores for the 11 individual items. The functional status scale (FSS) assesses the effect of CTS on daily living. The scale consists of eight questions with multiple-choice responses, scored from 1 point (no difficulty with the activity) to 5 points (cannot perform the activity at all). The overall score for functional status was calculated as the mean of all eight individual terms. Thus, a higher symptom severity or FSS score indicates worse symptoms or dysfunction; a Turkish version of the BQ was validated by Sezgin et al. (15).

2.4.3. Grip strength

Assessment of grip strength was evaluated with a Riester Dynatest hand dynamometer. Patients performed three consecutive tests while sitting with their shoulder abducted and neutrally rotated, elbow flexed at 90°, and forearm and wrist in a neutral position. The mean score of the three measurements was used in the statistical analysis.

2.5. Treatments

2.5.1. Group 1

Tape with a width of 5 cm and a thickness of 0.5 mm was used. Kinesio Tex I Strip was measured from elbow to fingertips and cut. It was folded approximately two blocks from the end and cut into two triangles on the fold. The third and fourth fingers were slipped through holes and Kinesio Tex was applied on the dorsum of the hand with no tension. The position of elbow extension, wrist extension, and radial deviation was provided, and Kinesio Tex was applied from hand to medial epicondyle with 15%–25% tension and ended at medial epicondyle with no tension. The second Kinesio Tex I Strip was measured for wrist size

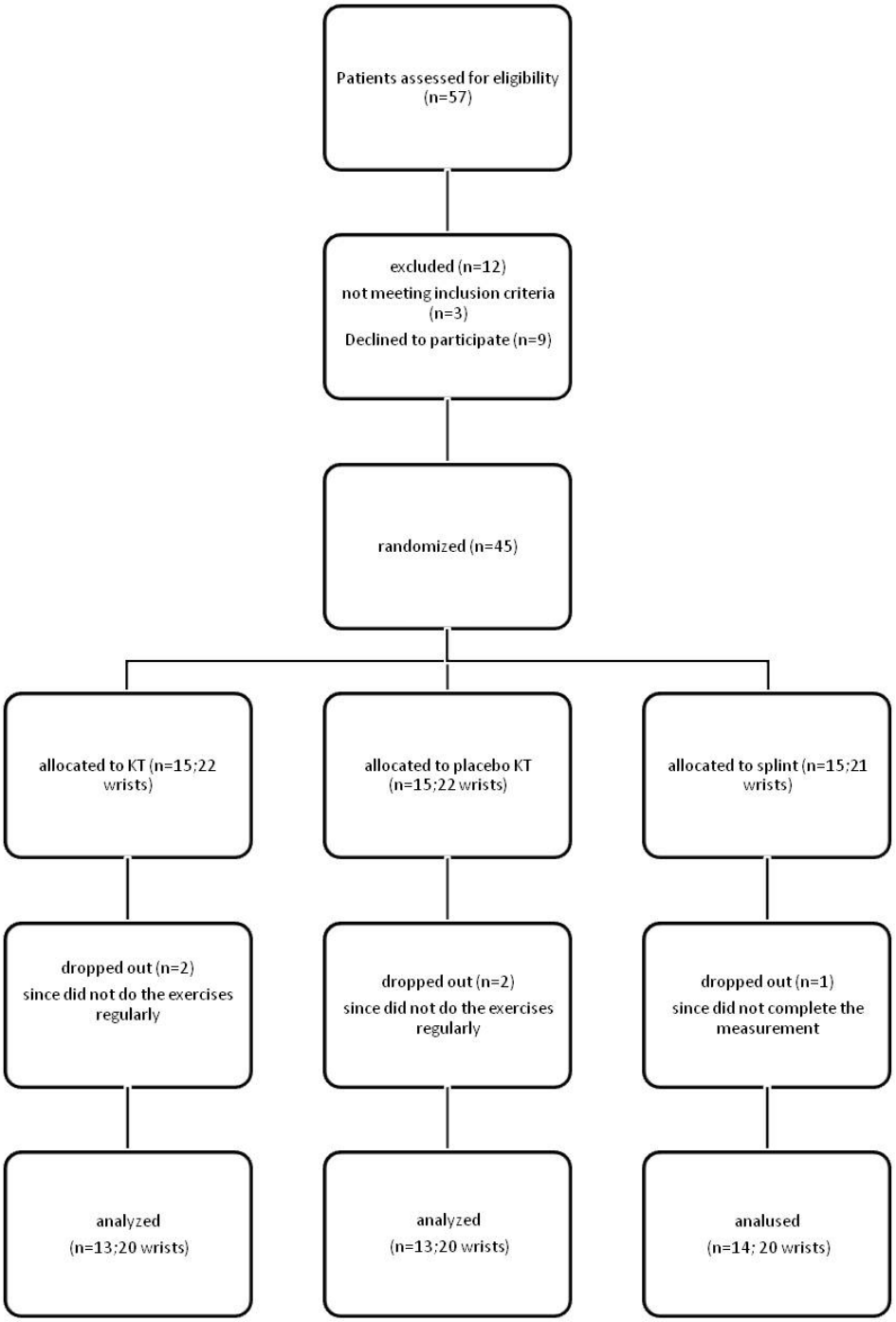

Figure 1. Flow diagram of the patients.

and cut. It was applied to the carpal tunnel region with 25%–35% tension (Figure 2a). This technique is a space correction and neural technique described by the Kase et al. (21). Applied tensions to KT were performed according to the visible pores on KT. Subjects were taped by a doctor certified to apply KT.

2.5.2. Group 2

Tape with a width of 5 cm and a thickness of 0.5 mm was used. Kinesio Tex I Strip was applied without having the proper position and with no tension (in a manner inconsistent with the technique, Figure 2b).

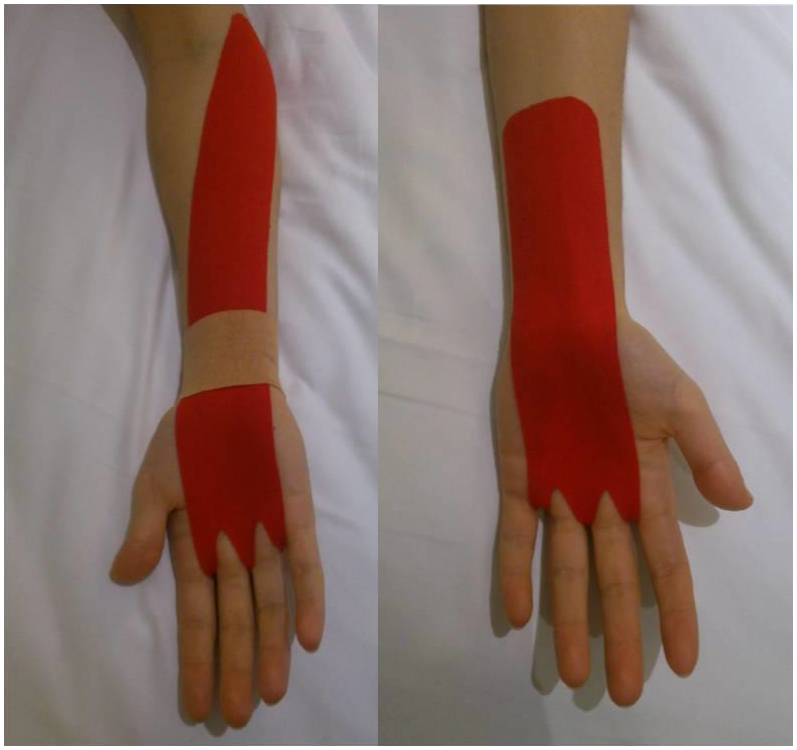

Figure 2. a) Kinesiotape application; b) Placebo kinesiotape application.

Kinesiotape was applied to both groups at the beginning of the week, to stay on for 5 days, with a 2-day rest, for a total of four times.

2.5.3. Group 3

In the OD group, patients applied custom-made volar thermoplastic wrist ODs in the neutral position. The patients were encouraged to use the ODs night and day, whenever possible, for 4 weeks. The rationale for the OD is supported by anatomic and clinical studies. Anatomic studies demonstrate that the pressure in the carpal tunnel is at its lowest when the wrist is placed in a neutral position and is at its highest when the wrist moves into flexion and extension (16,17). The investigator applying the treatments (CB) was different from the investigator evaluating the outcome measures (SB); the latter was blind to which series of treatments (experimental KT, placebo KT, or OD) each patient was about to receive or had just received. The patients in Group 1 and Group 2 were blind to the treatments. All three groups received home exercise programs during the 4 weeks, consisting of tendon-gliding exercises. To follow up and to improve patient compliance, each patient was asked to document what they did in a supplied diary. This diary contains how many times they did each exercise in a day. The diaries were checked every visit. Patients who did not do the exercises regularly were excluded from the study.

2.6. Sample size

In the initial study, a pilot study was conducted on 10 wrists from all three groups. In order to determine the sample size, power analysis was performed using the G * Power (v3.1.7) program. Seventeen wrists per group would provide 80% statistical power and a 5% significance level (effect size d = 1.0 to detect a 3 point difference in the VAS scores among groups). To compensate for the dropouts, we recruited 20 wrists per group.

2.7. Statistical analysis

The Number Cruncher Statistical System 2007 and Power Analysis and Sample Size 2008 programs were used. Descriptive statistics were given as means ± standard deviation and numbers. Parameter values before treatment (T0) and after treatment (T1) were compared using the Wilcoxon signed-ranks test. Kruskal–Wallis test with Bonferroni correction was used to compare the differences among the groups. The significance level was set at $P < 0.05$.

3. Results

The mean age of the patients was 50.1 ± 85 (20–65) years; 95% of the patients were female and 5% were male. The demographic properties of the groups are presented in Table 1. There were no significant differences in terms of demographic properties among the groups.

Table 1. Demographic features of the groups.

	Group 1 (KT [a]) (n = 20)	Group 2 (placebo KT) (n = 20)	Group 3 (orthotic device) (n = 20)	P
Age (year) mean, Min–max	49.8 ± 11.5 (20–62)	48.95 ± 6.0 (40–60)	51.3 ± 8.3 (40–65)	0.493
Sex (Female/male) (n)	12/1	13/0	13/1	0.355
Employment status	3 childminders (23%) 9 housewives (69%) 1 technician (8%)	2 retired (15%) 9 housewives (70%) 2 officials (15%)	3 retired (10%) 9 housewives (80%) 2 butchers (10%)	0.926
Dominant hand	Right 13 (100%)	Right 13 (100%)	Right 13 (92%) Left 1 (8%)	0.126
Affected side	Right 13 (59%) Left 9 (41%)	Right 12 (54%) Left 10 (46%)	Right 12 (50%) Left 12 (50%)	0.768
CTS [b] severity according to electrophysiological studies	12 mild (54%) 10 moderate (46%)	8 mild (36%) 14 moderate (64%)	11 mild (45%) 13 moderate (55%)	0.710

KT [a]: Kinesiotaping; CTS [b]: Carpal tunnel syndrome.

3.1. Pain

VAS scores decreased in Group 1 (P = 0.001), Group 2 (P = 0.009), and Group 3 (P = 0.030). There was no difference among the groups regarding VAS scores after treatment (P = 0.269).

DN4 scores significantly decreased in Group 1 (P = 0.005), Group 2 (P < 0.0001), and Group 3 (P = 0.024). There was no difference among groups regarding DN4 scores after treatment (P = 0.842).

3.2. Grip strength

Grip strength improved in Group 3 (P = 0.001), but not in Group 1 (P = 0.078) and Group 2 (P = 0.121). There was no significant difference among the groups regarding grip strength after treatment (P = 0.503). The results for pain assessment and grip strength are shown in Table 2.

3.3. Functional status

3.3.1. Symptom severity subscale scores

The SSS scores improved in all three groups (P < 0.0001, P < 0.0001, and P = 0.036, respectively). There was a significant difference among the groups with respect to SSS scores (P = 0.024); it was between Group 1 and Group 3, in favor of Group 1 (P = 0.009).

3.3.2. Functional status subscale scores

The FSS scores improved in Group 1 (P = 0.001), but did not improve in Group 2 (P = 0.077) or Group 3 (P = 0.090). There was a significant difference among the groups with respect to FSS scores (P = 0.017). The only significant difference was between Group 1 and Group 3 in favor of Group 1 (P = 0.006).

3.3.3. Boston CTS questionnaire total scores

All three groups improved in terms of BQ scores (P < 0.0001, P = 0.011, and P = 0.038, respectively). There was a significant difference among the groups with respect to BQ scores. The only significant difference was between Group 1 and Group 3, which was in favor of Group 1 (P = 0.008). The results are shown in Table 3.

4. Discussion

In the present study, the treatment of patients with CTS with KT, placebo KT, and splinting for 4 weeks provided pain relief and decreases in symptom severity. However, improvement in grip strength was observed only by splinting, and improvement in functional status was observed only by KT.

There are various studies that have investigated the effect of KT by comparing placebo application on pain relief in several musculoskeletal conditions such as shoulder diseases and patellofemoral pain syndrome (7–9). Similar to the results of the present study, Shakeri et al. (9) found that both experimental KT and placebo KT groups improved in terms of pain level and disability. Contrary to these results, Aytara et al. (8) and Thelen et al. (7) did not find any improvement in terms of pain level in either experimental KT or placebo KT groups. They concluded that this result is due to the low level of pain intensity at baseline.

The aim of applying an OD to one of the groups was to increase carpal tunnel volume and to decrease the pressure on the median nerve (16). The KT pulls up the skin and provides a space under the skin, directing connective tissue to the expected area (18,19). On the other hand, KT application can control the pulling force to a certain tendon or ligament to avoid further injury, so that tissue repair can be facilitated (9,20). In the present study, the direction of the force applied was parallel to the direction of the

Table 2. Pain and grip strength assessment of the groups.

	Group 1 (KT [c]) Mean ± sd (min–max) (n = 20)	Group 2 (placebo KT) Mean ± sd (min–max) (n = 20)	Group 3 (orthotic device) Mean ± sd (min–max) (n = 20)	P**
DN4 [a] - 1	5.5 ± 2.3 (1–9)	4.6 ± 2.6 (0–9)	4.5 ± 1.6 (1–8)	
DN4 - 2	3.7 ± 2.3 (0–8)	3.0 ± 2.4 (0–9)	3.7 ± 2.0 (0–7)	0.842
P *	**0.005**	**0.003**	**0.024**	
VAS [b] - 1	6.6 ± 2.1 (0–10)	5.8 ± 3.2 (0–10)	6.1 ± 2.9 (0–10)	
VAS - 2	4.1 ± 2.7 (0–8)	3.9 ± 2.8 (0–9)	5.7 ± 3.1 (0–10)	0.269
P *	**0.001**	**0.009**	**0.030**	
Grip strength - 1 (kg)	2.9 ± 1.4 (0.7–6)	3.3 ± 1.1 (1–5)	3.1 ± 1.4 (1–6)	
Grip strength - 2 (kg)	3.3 ± 1.5 (0.6–7)	3.7 ± 1.0 (2.1–5.6)	3.5 ± 1.6 (1.4–7.1)	0.503
P *	0.078	0.121	**0.001**	

*within group comparisons, **between group comparisons,
DN4 [a]: DN4 Questionnaire, VAS [b]: Visual Analogue Scale, KT [c]: kinesiotape.
Values in bold are significant.

Table 3. Boston Carpal Tunnel Syndrome Questionnaire (BQ) and subscale scores of the groups.

	Group 1 (KT [c]) Mean ± sd (min–max) (n = 20)	Group 2 (placebo KT) Mean ± sd (min–max) (n = 20)	Group 3 (orthotic device) Mean ± sd (min–max) (n = 20)	P **
SSS [a] - 1	32 ± 8.4 (11–47)	33 ± 10.7(11–50)	31.6 ± 8.4 (13–47)	
SSS - 2	20 ± 7.5 (11–35)	24.4 ± 8.0 (11–36)	28.7 ± 11.8 (14–51)	**0.024**
P *	**<0.0001**	**<0.0001**	**0.036**	
FCS [b] - 1	23.1 ± 6.0 (9–34)	19.7 ± 8.4 (8–36)	21.7 ± 7.0 (8–34)	
FCS - 2	16.2 ± 5.4 (8–26)	16.3 ± 5.8 (8–27)	19.7 ± 19.7 (8–32)	**0.017**
P *	**0.001**	0.077	0.090	
BQ - 1	54 ± 13.1 (20–72)	52.8 ± 17.6 (19–83)	53.4 ± 14.1 (21–77)	
BQ - 2	37.7 ± 11.9 (20–56)	41.3 ± 14.7 (21–67)	48.6 ± 19.0 (23–83)	0.057
P *	**<0.0001**	**0.011**	**0.038**	

*within group comparisons, ** between group comparisons
SSS [a]: Symptom severity scale, FCS [b]: Functional status scale, KT [c]: Kinesiotape.
Values in bold are significant.

tendons. By applying KT parallel to the flexor tendons, the pulling force of the flexors can be reduced. The reduction in pain intensity is probably because of the reduced pulling force to the flexor tendons that cause negative tension from taping. The improvement in focal circulation (21) might also be an important factor for pain relief. However, these theories do not explain why pain relief was observed in the placebo group. A possible explanation for this result could be the increased attention of patients and avoiding ergonomic mistakes and repetitive wrist movements.

Another explanation is that the placebo KT, which was applied improperly but in the same area, might cause pain relief by direct mechanical stimulation to the nociceptors or mechanoreceptors. Pain modulation through the gate control theory is one probable rationalization for the effectiveness of taping. It is speculated that tape stimulates neuromuscular pathways through increased afferent feedback (22). Increases in afferent stimulus to large-diameter nerve fibers can alleviate the input received from the small-diameter nerve fibers conducting nociception. If the placebo KT had been applied to another area away from the flexor retinaculum, pain relief might not have been seen in this group. However, such an application to the placebo KT group would avoid the blind component of the study. This result of the study raises the question: does the KT application technique matter at all? In order to answer this question, a tape with different characteristics (e.g., patches) should be applied to the same area in another group. Further studies should be designed in order to find the efficiency difference of several KT application techniques for the same disease.

In a meta-analysis by Williams et al. (18), KT had at least a small beneficial effect on strength. Hsu et al. (23) found significantly larger increases in strength in the lower trapezius muscle using a hand-held dynamometer, before and after taping application, compared to a placebo. Lee et al. (24) also found significantly higher hand grip strength in the KT application group compared with a no-taping condition group. Vithoulka et al. (25) investigated the effects of KT on quadriceps peak torque during eccentric assessment at the time of taping. Fu et al. (26) investigated the effect of KT on quadriceps muscle strength for the concentric contraction of the quadriceps at 180 °/s 12 h after taping, with the tape still in situ. Contrary to the results of those studies, Chang et al. (27) reported no significant difference in maximal grip strength measured under three conditions (without taping, with placebo taping, and KT) in 21 healthy collegiate athletes. Studies that found improvement in muscle strength by KT application differ from the present study. In those studies, KT was applied using the muscle facilitation technique in healthy subjects. Secondly, some of the studies measured the strength while the muscle was still taped.

KT is hypothesized to facilitate small immediate increases in muscle strength by producing a concentric pull on the fascia, which may stimulate increased muscle contraction (28). In this study, increased grip strength was found only in the OD group. However, the goal of taping the KT group was to inhibit wrist flexor muscles and correct carpal tunnel space in the present study. The aim of this taping technique is to inhibit the muscle activity, enlarge the carpal tunnel, and reduce the pressure of this space to decrease compression on the median nerve, besides decreasing the pain level. On the other hand, the patients did only gliding exercises and not strengthening exercises in the present study. The increase in grip strength in the OD group was not thought to be meaningful since there was a slight increase (12%), and there was no difference regarding grip strength among the groups. Further studies should be designed to evaluate the effect of KT on grip strength in patients with CTS by using a different KT technique.

In the present study, the functional status improved only in the KT group. Kinesiotape is a thin, porous cotton fabric with a medical grade acrylic adhesive. The tape can be stretched up to 140% of the original length. After taping, the mobility of the applied muscle or joint can still be maintained at full range. Thus, patients continue to perform their daily tasks; however, in the OD group there is a rigid restriction, so patients would not be able to continue daily work activities. To understand the functional capacity in the OD group, it would be better to evaluate these patients later after the treatments. A similar improvement was not observed in the placebo group. Therefore, the effect of KT should not only be due to the nonrestrictive structure of KT, but is probably also due to its space correction and neural technique effects. Other subscales, SSS scores and total BQ scores, improved in all three groups; however, posttreatment changes were significantly different among the groups for the SSS subscale and FSS subscale, in favor of the KT group.

In the present study, patients were evaluated soon after the 4-week treatment period. However, the patients were not followed up to evaluate how long the efficacy of the KT persists.

Another limitation of the study is the lack of exact equality of mildly and moderately affected patients among the groups as determined by EMG findings. The effect of applications may differ according to the severity of EMG findings. In order to investigate this matter, moderate and mild CTS patients should be compared in each group. However, larger sample sizes are needed for such analysis.

There is no evidence on the efficacy of KT treatment for CTS. This is the first study to investigate the effects of KT in CTS patients. Further clinical studies are needed to determine the long-term therapeutic benefits of KT on CTS patients.

In conclusion, KT application for the treatment of CTS is as useful as applying an OD regarding pain relief and superior to OD in functional status improvement. The KT should be used as an alternative treatment method for CTS without the disadvantage of restricting daily activities.

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