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Scientific/Clinical Article

Comparison of the effectiveness of orthotic intervention, kinesiotaping, and paraffin treatments in patients with carpal tunnel syndrome: A single-blind and randomized controlled study

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ABSTRACT

Purpose: The aim of the study was to compare different conservative treatments in patients with carpal tunnel syndrome (CTS).
Study Design: A single-blind randomized controlled study.
Methods: Patients ($n = 169$) diagnosed with mild or moderate CTS were screened; 110 met study requirements. The patients were randomized into 3 groups. The control (CON) comparison provided to all patients was a fabricated night orthotic which held the wrist in a neutral position. The second group received adjunctive kinesiotaping (KIN) and the third group received paraffin (PARA). All patients were evaluated clinically, electrophysiologically, and ultrasonographically before treatment and at 3 weeks, 3 months, and 6 months.
Results: There were 36 patients in CON, 37 in KIN, and 37 in PARA. Pain reduction in KIN was better than the other groups at 3 weeks (mean difference [MD] in CON 2.4 ± 2.5, KIN 3.7 ± 2.0, PARA 2.7 ± 2.3; $P < .01$) and 6 months (MD in CON 3.4 ± 3.0, KIN 4.9 ± 3.1, PARA 3.7 ± 2.9; $P < .05$). KIN pain reduction was better than CON at 3 months (MD in CON 3.8 ± 2.8, KIN 5.0 ± 2.5; $P < .05$). Reduction of the cross-sectional area of median nerve at the level of radioulnar joint was greater for KIN than CON at 3 weeks (MD in CON 0.0 ± 0.5, KIN 0.3 ± 0.7; $P < .01$) than PARA at 3 months (MD in KIN 0.3 ± 0.8, PARA 0.0 ± 0.8; $P < .05$) and both groups at 6 months (MD in CON 0.1 ± 0.8, KIN 0.5 ± 0.9, PARA 0.0 ± 1.0 $P < .05$).
Conclusion: Adding KIN to night use of an orthotic was more effective in achieving symptomatic and structural improvements than either the orthotic alone or adjunctive use of paraffin in patients with mild and moderate CTS.

Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in general population.[1] Diagnosis of CTS depends on clinical symptoms, physical examination, and electrophysiological findings.[2] Ultrasonography (USG) and magnetic resonance imaging show cross-sectional area and echogenicity of median nerve, and give information about the surrounding structures around the median nerve.[3] In mild and moderate CTS, successful results have been reported with conservative treatment methods such as orthotics, oral medication, therapeutic exercise, ultrasound therapy, paraffin treatment, local steroid injection, and thus, these methods are all used as treatment methods.[4-6] Orthotics are recommended as the first choice after daily activity modifications.[7] Only 1 study regarding paraffin treatment in CTS was found. In this study, paraffin treatment was shown to reduce the carpal tunnel symptom severity score (SSS), but not a pain score, functional capacity score (FCS), or nerve conduction study (NCS) findings.[8] Kinesiotaping (KIN) has been developed to support muscle structure and help stability of the damaged area in many conditions including postural disorders, sports injuries, tendinitis, bursitis, feet deformities, lymphedema, and entrapment neuropathies.[9] A single study on the treatment of CTS with kinesiotaping treatment (KT) suggested that the group treated with orthotic plus KT showed clinical and electrophysiological improvement.[10] There was no study evaluating the

Conflict of interest: All named authors hereby declare that they have no conflicts of interest to disclose.

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effectiveness of either paraffin or KT treatments in CTS using USG. The aim of this study was to evaluate the effects on CTS symptoms and structure of the median nerve comparing orthotic intervention when it is used alone or in combination with paraffin or kinesiotaping.

Material and method

Subjects

A sample of 169 female patients (average age: 25-65 years) who were diagnosed with mild and moderate CTS were screened for the study during March 2013 and February 2014. The study was designed as a prospective, controlled trial. The study was approved by University Ethics Committee. Patients who completed the inclusion criteria and signed the informed consent form were included in the study. Exclusion criteria are shown in Table 1. The patients were randomized following simple randomization procedures (computerized random numbers) into 3 groups by a blind physician. Randomization sequence was created using Excel 2007 (Microsoft, Redmond, WA). There were 3 treatment groups which were orthotic intervention alone as a control (CON) group (36 patients/64 hands), orthotic plus KT (37 patients/64 hands), and orthotic plus paraffin (PARA) treatment (37 patients/63 hands). The study flowchart was shown in Figure 1.

Physical examinations

All patients' demographic data including gender, age, occupation, level of education, comorbidities, surgery history, and previous treatments for CTS were recorded. Systemic physical, musculoskeletal, neurological examination, and Tinel and Phalen tests were done to all 3 groups. Hand grip and finger pinch muscle strength measurements were assessed using a Jamar dynamometer and pinchmeter while the patient was in sitting position with the forearm neutral and the elbow flexed 90° beside trunk.[11] Three measurements were taken in this position and the mean value was used for report. Pain was evaluated using visual analog scale (VAS); CTS-specific symptoms were measured using the Boston Carpal Tunnel Syndrome Questionnaire (symptom severity and function).[12] A validity and reliability study of this questionnaire was done in Turkish as well.[13] A high score indicates symptom severity and low functional capacity.

Nerve conduction studies

Medtronic-Keypoint (Denmark, 2007) was used for the electrophysiological evaluation. Room temperature was set at 25°C, whereas hand temperature was maintained at min 32°C. Median motor NCS was recorded with surface electrodes from abductor pollicis brevis muscle. The standard distance between stimulation at wrist and recording electrode was 8 cm. Median and ulnar motor nerve proximal and distal latencies, motor nerve conduction velocities, compound muscle action potential amplitudes were measured. Median sensory NCS was recorded from the third digit antidromically with standard distance of 14 cm. Palmar segment was included in median sensory NCS. The recording was done orthoromically with an electrode on second finger and the stimulator on second and third metacarpal bone with a distance of 7 cm. Ulnar sensory NCS was recorded from fifth digit with standard distance of 14 cm. For all sensory NCSs, distal latency, sensory nerve action potential amplitude, and sensory nerve conduction velocity were measured. The latencies were marked at the onset of first negative peak, and the amplitudes were determined from peak to peak. Median and ulnar motor NCSs were recorded with cup electrodes from second lumbrical-interosseous muscle. The stimulation points were over the carpal tunnel for the median nerve and Guyon canal for the ulnar nerve with standard distance of 8 cm. The severity of CTS was defined as mild, moderate, or severe CTS electrophysiogically according to American Association of Neuromuscular & Electrodiagnostic Medicine guideline.[14]

Table 1
Exclusion criteria

Symptom duration more than 1 y
Previous CTS operation
Previous steroid injection into the carpal tunnel
Physical therapy targeted for CTS in the past 6 mo
Trauma history involving wrist and its surroundings
Having any systematic disease that can be the etiology of CTS such as diabetes mellitus, renal insufficiency, thyroid disease, and rheumatoid arthritis
Median nerve variations such as bifid or trifid median nerve, persistent median artery, or a space-occupying lesion detected by the carpal tunnel USG

CTS = carpal tunnel syndrome; USG = ultrasonography.

Ultrasonography

Median nerve USG was performed with a 6-18 MHz linear array probe (Esaote Mylab 60, Italy) in supine position. The nerves were viewed in axial plane. The transducer was kept perpendicular to median nerve. Nerve cross-sectional areas were measured at the hook of hamate, pisiform bone, and radioulnar joint. The cross-sectional area was measured by tracing the nerve just inside its hyperechoic rim. Three different measurements were obtained, and the average one was used for each level.

Each clinical (S.K.), electrophysiological (G.A.), and ultrasonographical (I.Y.) assessments were done by a blind physician before the treatment, third week (at the end of kinesiotaping and paraffin treatments), third month (at the end of orthotic intervention), and sixth month after the treatment. Another physician (B.M.K.) randomized the patients in groups and managed the treatments.

Orthotic intervention

An orthotic was fabricated with the wrist in a neutral position with volar support. Patients were instructed to wear it at night for 3 months. The patients' adherence for usage of the orthotic was reported at the third-week control and at the second month via phone call.

Kinesiotaping

Kinesiotaping was applied 2 times a week for a 3-week period with a total of 6 sessions. Taping was performed with "neural technique" for median and ulnar nerves and "area correction technique" for releasing the carpal tunnel. The skin was cleaned before taping. The upper extremity was positioned with a 30° extension on the wrist, full extension, and supination on the elbow. For the neural technique, 2 I bands were used. The first I band was pasted on the median nerve from second and third metacarpophalengeal joints to 5 cm below the medial epicondyle. The second I band was also pasted on the ulnar nerve from fifth metacarpophalengeal joint to 5 cm below the medial epicondyle while stretching with mild force (10%-15%). For the area correction technique, the I band that is half the length of the wrist circumference was taped on the volar side of the wrist. The band was stretched heavily at the middle part of one-third of its length, and the remaining parts of the I band were pasted on without stretching. The patient was asked not to use any crème or similar materials before taping and not to contact with detergents or bleaches after taping.

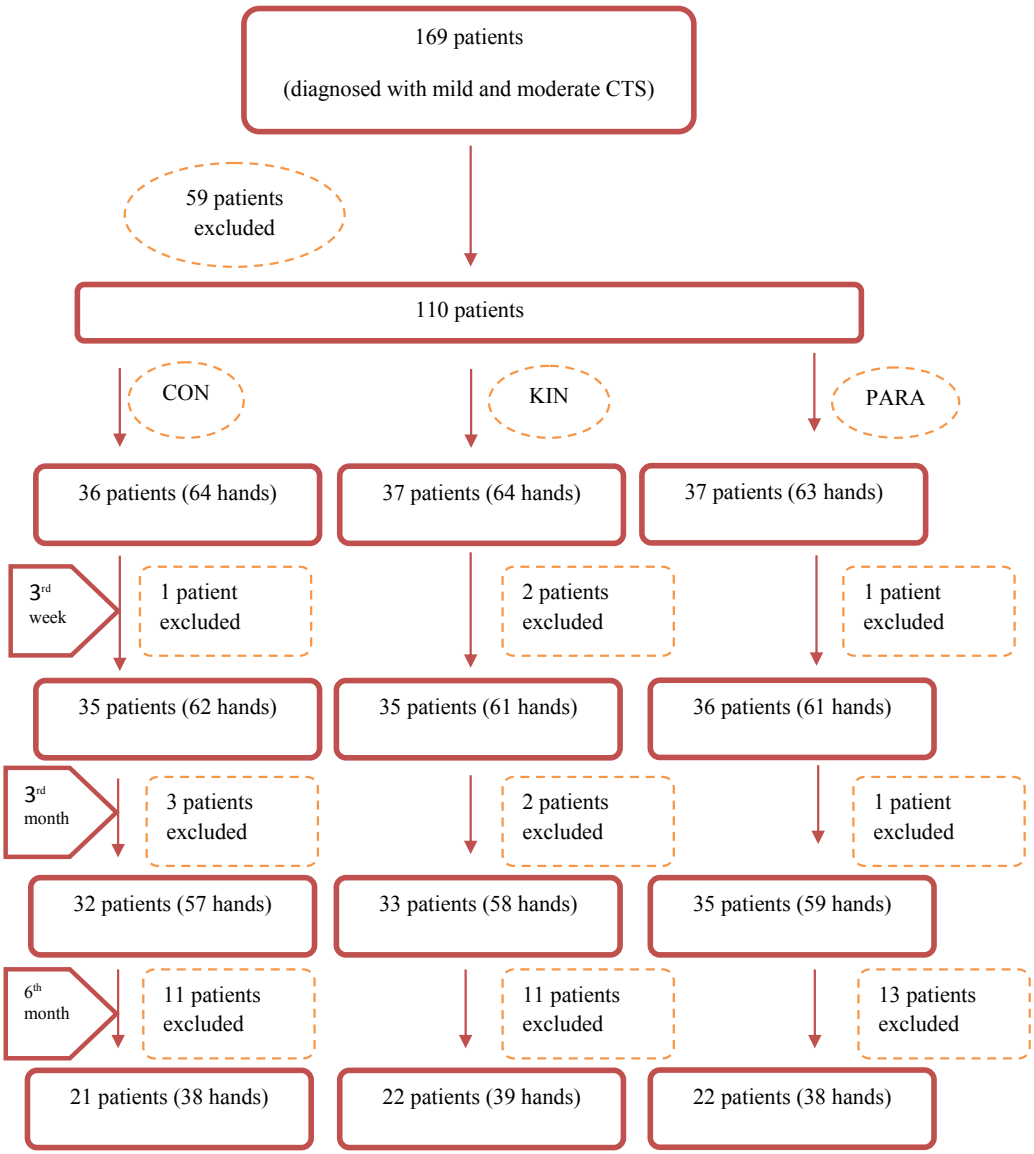

Fig. 1. The study flowchart. CTS = carpal tunnel syndrome; CON = control; KIN = kinesiotaping; PARA = paraffin.

Paraffin treatment

Paraffin treatment was applied for 3 weeks, 3 days in a week with a total of 9 sessions. Patient's hands were immerged into paraffin 10 times a session. After their hands were coated in a layer of paraffin, the patients put them on a plastic bag and strapped with a towel. The hands were kept in this position for 20 minutes.

Statistical analysis

For the statistical analysis, NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (Kaysville,UT) program were used. The data were analyzed using descriptive statistics. One-way analysis of variance test was applied for the quantitative data for the comparison of 3 or more groups, which showed normal distribution, and the group that caused difference was detected by Tukey honest significant difference test and Tamhane Test. Kruskal-Wallis test was also used in the comparison of 3 or more groups without normal distribution. In-group follow-up of the variables with normal distribution was done using repeated-measures test, and the paired evaluation was done using Bonferroni test and paired samples test. In-group follow-up of the variables without normal distribution was done using the Friedman test, and Wilcoxon signed rank test was used for their paired comparisons. Pearson chi-square test was used to test differences in proportions. Statistical significance was evaluated at $P < .01$ and $P < .05$ levels.

Results

From the 169 patients, those who were diagnosed with mild or moderate CTS were screened; 110 patients fit the study criteria. Reasons for exclusion of the 59 patients are listed in Table 2. The 110 patients were randomized into 3 groups: the CON group received only the orthotic and had ($n = 36$ patients), whereas orthotic + KT group (KIN) had 37 and orthotic + PARA group had 37 patients. From this, 4 patients dropped out at the third week controls, 6 patients at the third month and 35 patients at the sixth month controls. The study flowchart was shown in Figure 1.

Table 2
Reasons of exclusion

Surgery: 7 patients
Injection/physical therapy: 3 patients
Trauma: 1 patient
Additional systemic disease: 30 patients (diabetes mellitus: 16, hypothyroidism: 11, rheumatoid arthritis: 2, pregnancy: 1)
Ultrasonographical evaluation: 18 patients (bifid median: 17, persistent median artery: 1)

The mean age of the patients was 42.6 ± 9.3 years (min-max: 25-65). No statistically significant difference was found between the age, level of education, and occupation distributions of the 3 groups ($P > .05$) (Table 3).

Clinical data

No statistically significant difference was detected in pretreatment hand grip and finger pinch muscle strengths, VAS, SSS and FCS between the groups ($P > .05$). The improvement of finger pinch muscle strength, SSS, and FCS at the third week and third month was statistically significant in all 3 groups ($P < .05$). No statistically significant difference was found between groups ($P > .05$). Although there was no statistically significant difference between pretreatment, third week, and third month hand grip muscle strength within CON and PARA ($P > .05$), the difference between pretreatment and third month hand grip muscle strength was statistically significant in KIN group ($P < .01$). When the hand grip muscle strength improvement from pretreatment to the third month was compared between the groups, KIN had a notable superiority to PARA ($P < .05$). The decrease in VAS values in third week and third month was found to be statistically significant within groups ($P < .01$). In addition, when the VAS differences between the groups were compared, it was also statistically significant. Third week VAS value decrease in KIN was statistically significant when compared to the decrease in the other 2 groups ($P = .001$). In the third month assessment, VAS was found to be significantly decreased in KIN when compared to the orthotic group ($P < .05$) (Table 4).

When the mild CTS patients were evaluated separately, there was no difference in the number of hands between the groups ($n = 27$ in CON, $n = 28$ in KIN, $n = 30$ in PARA). In third week, VAS value differences between groups were statistically significant. In KIN, decrease in VAS was found significantly higher than the other 2 groups statistically ($P < .01$). This difference was not found in moderate CTS patients.

Table 3
Evaluation of demographics according to groups

	CON ($n = 32$)	KIN ($n = 33$)	PARA ($n = 35$)	[a]P	Post hoc
	Mean ± SD	Mean ± SD	Mean ± SD		
Age (y)	42.3 ± 9.8	43.1 ± 9.2	42.5 ± 9.2	.940	-
	n (%)	n (%)	n (%)	[b]P	
Level of education					
Middle school and lower	28 (87.5)	27 (81.8)	28 (80.0)	.699	
High school and above	4 (12.5)	6 (18.2)	7 (20.0)		
Occupation					
Housewife	24 (75.0)	28 (84.8)	27 (77.1)	.588	
Other	8 (25.0)	5 (15.2)	8 (22.9)		

ANOVA = analysis of variance; SD = standard deviation; CON = control; KIN = kinesiotaping; PARA = paraffin.
[a] One-way ANOVA test (1-sided variance analysis).
[b] Pearson chi-square test.

Electrodiagnostic data

There was no valid difference between pretreatment median nerve motor latency, sensory latency, and sensory conduction velocity values of the groups ($P > .05$). In CON, third week and third month improvement on motor latency, sensory latency, and sensory conduction velocity were statistically significant ($P < .05$). In KIN, third week and third month improvement on sensory latency and sensory conduction velocity and third month improvement on motor latency were found statistically significant ($P < .05$). In the PARA, third week improvement on sensory conduction velocity and third month improvement on motor latency, sensory latency, and sensory conduction velocity values were found to be statistically significant ($P < .05$). No statistically significant difference was found between the 3 groups' third week and third month improvement on motor latency, sensory latency, and sensory conduction velocity values ($P > .05$).

The number of patients with normal median motor and sensory nerve conduction was 17 (5 in CON, 9 in KIN, and 3 in PARA) at third week, 18 (7 in CON, 6 in KIN, and 5 in PARA) at third and sixth months.

Ultrasonographic data

No statistically significant difference was found between the pretreatment USG measurements of median nerve CSA at the level of radioulnar joint, pisiform, and hook of hamate between the 3 groups ($P > .05$). There was no significant decrease at the third week and third month measurements of median nerve CSA at the level of radioulnar joint within CON and PARA ($P > .05$). On the other hand, in the KIN, compared to pretreatment measurements, the decrease in third week and third month measurements of median nerve CSA at the level of radioulnar joint was statistically significant ($P < .01$). The decrease in third week measurements of median nerve CSA at the level of radioulnar joint was higher than CON, which is statistically significant ($P < .05$), and in third month, measurements of median nerve CSA at the level of radioulnar joint were reduced in comparison to PARA ($P < .05$) (Table 5). When the data were evaluated separately as mild and moderate CTS patients, in KIN, the decrease in measurements of median nerve CSA at the level of radioulnar joint was statistically significant at the third week, when compared to the other groups in mild CTS patients ($P = .007$). In all groups, the decrease in third week and third month measurements of median nerve CSA at the level of pisiform and hook of hamate was statistically significant ($P < .05$). There was no statistically significant difference between the groups when their third week and third month measurements of median nerve CSA at the level of pisiform and hook of hamate were compared to pretreatment measurements ($P > .05$).

There was correlation between VAS and median CSA at the level of pisiform at the third week ($P < .05$). VAS was also correlated with median CSA at all levels at the sixth month ($P < .01$).

Sixth month data

Since the number of patients was small at the sixth month, the data were compared separately. When the pretreatment values were compared within the groups; in CON, SSS ($P < .05$), VAS ($P < .01$), motor latency ($P < .01$), sensory conduction velocity ($P < .05$), measurements of median nerve CSA at the level of pisiform and hook of hamate ($P < .01$) improvements were stable at the sixth month. In KIN, the improvement on SSS ($P < .01$), VAS ($P < .01$), motor latency ($P < .01$), sensory latency ($P < .01$), and sensory conduction velocity ($P < .01$) measurements of median nerve CSA at the level of radioulnar joint, pisiform, and hook of

Table 4
Evaluations of VAS

	CON	KIN	PARA	P^a	Post hoc
	Mean ± SD (median)	Mean ± SD (median)	Mean ± SD (median)		
VAS					
PT ($N = 174$)	6.6 ± 2.1 (7.0)	7.1 ± 2.5 (8.0)	6.8 ± 2.1 (7.0)	.442	-
Third wk ($N = 174$)	4.2 ± 2.9 (4.0)	3.4 ± 2.7 (3.0)	4.1 ± 2.9 (4.0)	.328	-
Third mo ($N = 174$)	2.8 ± 2.7 (2.0)	2.1 ± 2.6 (1.0)	2.7 ± 2.8 (2.0)	.199	-
P^b	.001**	.001**	.001**		
Post hoc analysis[c]					
PT-3rd wk	0.001**	0.001**	0.001**		
PT-3rd mo	0.001**	0.001**	0.001**		
3rd wk-3rd mo	0.003**	0.001**	0.001**		
Difference measurements	Mean ± SD (median)	Mean ± SD (median)	Mean ± SD (median)		
PT-3rd wk	2.4 ± 2.4 (2.0)	3.6 ± 1.9 (4.0)	2.6 ± 2.2 (2.0)	.003**	2 > 1 2 > 3
PT-3rd mo	3.7 ± 2.7 (4.0)	4.9 ± 2.5 (5.0)	4.0 ± 2.9 (4.0)	.040*	2 > 1

VAS = visual analog scale; PT = pretreatment; SD = standard deviation; CON = control; KIN = kinesiotaping; PARA = paraffin.
*$P < .05$, **$P < .01$.
[a] Kruskal-Wallis test.
[b] Friedman test.
[c] Wilcoxon signed ranks test.

hamate ($P < .01$) were also stabile at sixth month. In PARA, the improvement on SSS ($P < .01$), FCS ($P < .01$), VAS ($P < .01$), motor latency ($P < .01$), sensory latency ($P < .01$), sensory conduction velocity ($P < .01$), and measurements of median nerve CSA at the level of pisiform and hook of hamate ($P < .01$) were the same at sixth month. In KIN, VAS and measurements of median nerve CSA at the level of radioulnar joint differences between pretreatment and sixth month were statistically higher than the other 2 groups ($P < .05$). No statistically significant difference was found in other clinical, electrophysiological, and ultrasonographical data between the 3 groups in sixth month ($P > .05$).

No side effects due to treatment were observed in this study.

Discussion

This study has shown that clinical, electrophysiological, and ultrasonographical improvement was observed in CTS after orthotic, orthotic + KT, and orthotic + paraffin therapies up to 6 months. In orthotic + KT group, median nerve CSA at the level of radioulnar joint reduced significantly and measurement of median nerve CSA at this level, and VAS decrease was found to be superior compared to other groups. This superiority was more pronounced in mild CTS cases.

Many studies support that orthotic intervention is effective clinically and electrophysiologically within the conservative treatment options in the patients with CTS.[15] In some studies, clinical and electrophysiological improvement was obtained in the CTS patients who used an orthotic device regularly unlike the patients who received no treatment.[16,17] Our study shows that clinical and electrophysiological improvement lasts up to 6 months. One study showed decrease of median nerve cross-sectional area, measured by USG, with orthotic intervention, but this decrease was not statistically significant. Only measurement of median nerve CSA at the level of pisiform was measured with USG, and the last evaluation was at third month in this study. The authors found no statistically significant improvement in electrophysiological tests, and they found no ultrasonographical improvement statistically.[18] On the other hand, we found that besides the improvement on motor

Table 5
Evaluations on median CSA at the radioulnar joint level measurements

	CON	KIN	PARA	P^a	Post hoc
	Mean ± SD	Mean ± SD	Mean ± SD		
CSA-RUJ					
PT ($N = 174$)	9.3 ± 2.4	9.6 ± 1.6	9.4 ± 1.8	.720	-
3rd wk ($N = 174$)	9.3 ± 2.4	9.2 ± 1.4	9.2 ± 1.6	.943	-
3rd mo ($N = 174$)	9.2 ± 2.2	9.2 ± 1.5	9.3 ± 1.5	.887	-
P^b	.144	.001**	.192		
Post hoc analysis[c]					
PT-3rd wk	1.000	0.001**	0.147		
PT-3rd mo	0.454	0.004**	1.000		
3rd wk-3rd mo	0.250	1.000	0.490		
Difference measurements	Mean ± SD (median)	Mean ± SD (median)	Mean ± SD (median)	[d]P	[e]P
PT-3rd wk	0.0 ± 0.5 (0)	0.3 ± 0.7 (0)	0.1 ± 0.6 (0)	.010*	2 > 1
PT-3rd mo	0.1 ± 0.8 (0)	0.3 ± 0.8 (0)	0.0 ± 0.8 (0)	.045*	2 > 3

ANOVA = analysis of variance test; CSA-RUJ = median cross-sectional area at the radioulnar joint level; PT = pretreatment; SD = standard deviation; KIN = kinesiotaping; CON = control; PARA = paraffin.
*$P < .05$, **$P < .01$.
[a] One-way ANOVA test.
[b] Repeated-measures test.
[c] Bonferroni test.
[d] Kruskal-Wallis test.
[e] Mann-Whitney U test.

latency, sensory latency, and sensory conduction velocity, there was a decrease in median nerve cross-sectional area in all 3 levels of measurement after orthotic intervention. One of these reasons can be explained by our study's larger sample size. Although this decrease is not statistically significant at the radioulnar level, the decrease at pisiform and hook of hamate levels were found statistically significant at third week, third month, and sixth month. In the diagnosis of CTS, it is expected for all 3 levels to show median nerve cross-sectional area increase, but the most sensitive level is known as the pisiform level.[19] For that reason, this statistically significant decrease in these 2 levels supports ultrasonographical improvement. There is only 1 study in the literature that involves CTS patients receiving KT treatment. In this study, the first group received KT and exercise; second group received orthotic and exercise; third group received KT, orthotics, and exercise; and CON group received only exercise. Compare to CON group, clinical parameters including SSS, FCS, hand grip, and finger pinch muscle strength and NCS findings were improved significantly in all groups at third month. Receiving orthotic and KT treatment together were also found to be superior to all other groups.[10] Unlike this study, our study has included large sample size and ultrasonographic assessment, and our final evaluation was in the 6th month. Along with clinical and electrophysiological improvement, ultrasonographical improvement was also shown on 3 levels in the group who received orthotic + KT treatment. However, there was no prior study found that observed the effect of paraffin treatment in patients with CTS. In our knowledge, there were 2 studies in the literature, in which both orthotic device and paraffin treatment were applied. Improvement in symptoms and some physical examination components were shown.[8,20] Chang et al reported no significant changes in PARA group in distal motor and sensory latencies of median nerve after treatment at eighth week.[8] In our study, there were no significant improvements in distal motor and sensory latencies of median nerve after paraffin treatment at third week, but at third and sixth months, all median NCS parameters were improved significantly. In addition to NCSs, we also observed statistically significant decrease of median nerve cross-sectional areas by USG. But these improvements were similar to orthotic group.

When the groups were compared, some parameters showed statistically significant differences. In the third month, improvement in hand grip strength in the KIN was superior to the other 2 groups. Similar to our results, previous study also showed increase in hand grip strength using this method.[10] This increase in muscle strength may be due to KT's stimulation on surrounding muscles. One meta-analysis shows that KT has a positive effect on activity of muscles.[21] The decrease in VAS values and median nerve cross-sectional area at the radioulnar level were superior in KIN when compared to the other 2 groups at third week, third month, and sixth month, and the decrease at third week (at the time when the KT treatment ended) was more prominent in mild CTS patients. The decrease in median nerve cross-sectional area may be due to the decrease in endoneural edema, and this decrease is concordant with the decrease in VAS value. It is known that at the early stages of disease, endoneural edema due to carpal tunnel's pressure increase is the main pathology, but in the chronic stage, fibrosis is the main condition.[22] Sensory fibers are affected before the motor fibers, and by the time fibrosis and adhesion increases, abnormalities in motor NCSs are seen.[23] This helps explain the statistically significant difference in improvement in mild CTS patients. Therefore, we can say that KT reduces endoneural edema. Indeed, the aim of KT treatment in CTS was to decrease the pressure by enlarging the carpal tunnel with correctional technique. The other effect may be that KT allowed to slightly limit the movements during day time, combined with the effects of orthotic device. Even though not as much as an orthotic does, KT limits repetitive flexion and extension movements. In addition, the patient always having a tape in hand may have caused constant visual stimulus and caused the patient to avoid from stringent movements.

The fact that the decrease in median nerve cross-sectional area and VAS value is not accompanied by electrophysiological findings shows a possibility that KT may affect nonmyelinated C fibers more. As we already know, if the C fibers are affected in a neuropathy, this cannot be detected with classical NCSs.[24] Pain is carried with A delta and nonmyelinated C fibers. The burning sensation in neuropathic pain is due to the damage to nociceptive pathway.[25] Microneurographical studies point nonmyelinated C fibers as the cause of burning sensation.[26] It is thought that this sensation is related to abnormal spontaneous discharge of damaged fibers. Abnormal spontaneous discharge is axon sourced; it affects the central nervous system in the long term and results in central sensitization.[27] Although there is no definitive proof showing peripheral and central sensitization in CTS, there are many studies supporting this idea.[28] Central sensitization may play a role as a prognostic factor in CTS. There are studies concluding that continuing symptoms after successful releasing operations in CTS may be due to this phenomenon.[29] Treatment targeted at nonmyelinated C fibers before central sensitization occurs may prevent progression to chronic CTS. Its superiority on mild CTS and reducing effect on edema shows that KT, in addition to orthotic intervention, is effective in the early stages of disease. It might be suggested that KT could prevent progression to chronic CTS if it shows these effects by affecting the nonmyelinated C fibers. The decrease in median nerve cross-sectional area at the radioulnar joint level and VAS value at sixth month in KT group when compared to other groups was statistically significant, which has supported this idea. Further studies are needed to explain this situation.

In patients who received KT in addition to orthotic device, ultrasonographic measurement revealed that the median nerve cross-sectional area decreased at proximal, entrance, and distal part of carpal tunnel. This decrease at the radioulnar joint level (proximal part of carpal tunnel) was found to be statistically significant compared to the other 2 groups. In our opinion, this difference may be due to the taping technique. In our study, the tape was pasted to the proximal part of the carpal tunnel with correctional technique. If the tape was pasted on entire area of the carpal tunnel, the other 2 levels could have shown statistically significant decrease in median nerve cross-sectional area. In our opinion, studies comparing different taping techniques will give us more information.

Our study had a limitation that there were many dropouts at sixth month control. It is challenging to keep patients engaged in research studies as their symptoms resolve and they return to more normal activities. We tried to minimize the risk of bias by evaluating sixth month data separately from the others. However, the potential for bias is high in this later follow-up data.

Conclusion

Our results indicate that 3-month usage of an orthotic at night provides clinical, electrophysiological, and ultrasonographical recovery in CTS patients, and this improvement can be preserved for up to 6 months. However, orthotic plus KT treatment provides better results on reducing pain and endoneural edema compared to single orthotic intervention, especially in mild CTS patients, and this superiority can last for up to 6 months. Additional paraffin treatment provides no superior results to orthoses in CTS patients. We suggest that KT and orthotic intervention can be used together in the treatment of mild CTS patients.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jht.2017.12.006.

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Quiz: # 615

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1. The study design was
   a. double blind RCTs
   b. single blind RTCs
   c. case series
   d. retrospective cohort
2. The subject population was
   a. actual patients displaying moderate to severe CTS
   b. college students with intermittent median parasthesias
   c. post op CTS patients
   d. actual patients diagnosed with mild to moderate CTS
3. All subjects received
   a. kinesiotaping
   b. paraffin baths
   c. a night orthotic devise with the wrist held in neutral
   d. dry needling
4. In addition to traditional assessment tools the authors evaluated the subjects using
   a. qualitative techniques
   b. ultrasonography
   c. manual therapy techniques
   d. MRI
5. The authors concluded that kinesiotaping was an effective adjunctive intervention to the control group
   a. true
   b. false

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