ISSN: 2651-4451 • e-ISSN: 2651-446X

**Turkish Journal of Physiotherapy and Rehabilitation**

*2023 34(1)93-101*

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# A COMPARISON OF MANUAL THERAPY AND EXTRACORPOREAL SHOCKWAVE THERAPY IN PATIENTS WITH CARPAL TUNNEL SYNDROME

**ORIGINAL ARTICLE**

## ABSTRACT

**Purpose:** To investigate the effects on pain, symptom severity, and functionality of different physiotherapy methods applied to patients with carpal tunnel syndrome and to evaluate the advantages of these over each other.

**Methods:** A total of 75 patients (69 females, 6 males) aged 25-60 years were separated into 3 groups. The patients in Group 1 were given a home exercise program (HP), including median nerve and tendon gliding exercises. Group 2 received the same HP plus manual therapy (MT), including soft tissue and joint mobilisation. Group 3 received the same HP plus extracorporeal shockwave therapy (ESWT). Pain severity was evaluated with a Visual Analog Scale. Symptom severity and levels of functionality were evaluated with the Boston Carpal Tunnel Syndrome Questionnaire and the Cochin Hand Function Questionnaire. All the patients were evaluated before and after treatment.

**Results:** While there was a significant decrease in the resting and activity pain levels of each 3 groups after the treatment ($p<0,05$), no significant difference was found between MT and ESWT groups ($p> 0.05$). However, the pain values of these two groups were significantly decreased compared to the EP group ($p <0.05$). The pain values of both groups were significantly lower than those of the HP control group ($p <0.05$). A statistically significant increase was determined in the level of functionality in all the groups after treatment ($p<0.05$). The decrease in symptom severity and the increase in functionality were significantly greater in the MT and ESWT groups compared to the HP group ($p<0.05$). After the treatment, there were no superiorities with respect to the pain, symptom severity, and functionality values of the MT and ESWT groups ($p>0.05$).

**Conclusion:** In our study, the MT and ESWT applications we used in patients with CTS patients provided significant improvement compared to HP exercises only. We speculate that some differences that are not seen in the early period can be seen in long-term follow-up. Further studies should be performed to assess the long-term results.

**Keywords:** Carpal Tunnel Syndrome, Nerve Gliding, Tendon Gliding, Manual Therapy, Extracorporeal Shockwave Therapy

# KARPAL TÜNEL SENDROMLU HASTALARDA MANUEL TEDAVİ VE EKSTRAKORPOREAL ŞOK DALGA TEDAVİSİNİN ETKİLERİNİN KARŞILAŞTIRILMASI

**ARAŞTIRMA MAKALESİ**

## ÖZ

**Amaç:** Karpal tünel sendromlu hastalarda farklı fizyoterapi yöntemlerinin ağrı, semptom şiddeti, fonksiyonellik düzeyleri üzerindeki erken dönem etkilerini araştırmak ve birbirlerine üstünlüğünü değerlendirmektir.

**Yöntem:** Çalışmamıza 25-60 yaş aralığında 75 hasta (69: K, 6: E) dahil edildi. Hastalar 3 gruba ayrıldı. Birinci gruba median sinir ve tendon kaydırma egzersizlerini içeren ev programı (EP) verildi. İkinci gruba aynı ev programına ilaveten yumuşak doku ve eklem mobilizasyonu içeren manuel tedavi (MT) uygulandı. Üçüncü gruba da aynı ev programına ilaveten ekstrakorporeal şok dalga tedavisi (ESWT) uygulandı. Ağrı şiddeti Vizuel Ağrı Skalası ile, semptom şiddeti ve fonksiyonellik düzeyleri Boston Karpal Tünel Sendromu Anketi ve Cochin El Fonksiyon Anketi ile değerlendirildi. Hastaların ölçümleri tedaviden önce ve sonra yapıldı.

**Sonuçlar:** Tedaviden sonraki değerlendirmelerde her 3 grubun istirahat ve aktivite ağrılarında anlamlı düşüş bulunurken ($p<0,05$), MT ve ESWT grupları arası fark bulunmadı ($p>0,05$). Ancak iki grubun ağrı değerlerinde EP grubuna göre anlamlı azalma görüldü ($p<0,05$). Tüm gruplarda fonksiyonellik düzeylerinde anlamlı artış bulundu ($p<0,05$). Semptom şiddetinde azalma ve fonksiyonellik düzeylerindeki artış, MT ile ESWT gruplarında EP grubuna göre anlamlı bulunurken ($p<0,05$), MT ile ESWT grupları arasında fark bulunmadı ($p>0,05$). Tedaviden sonra MT ve ESWT gruplarının ağrı, semptom şiddeti ve fonksiyonellik değerleri karşılaştırmasında grupların birbirlerine üstünlükleri bulunmadı.

**Tartışma:** Çalışmamızda KTS hastalarında kullandığımız MT ve ESWT uygulamasının yalnızca EP egzersizlerine göre anlamlı iyileşme sağladığı görüldü. Erken dönemde görülmeyen bazı farkların, uzun dönem takiplerde görülebileceğini düşünüyoruz. Uzun dönem sonuçları değerlendirmek için ileri çalışmalar yapılmalıdır.

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***Received:*** *08.12.2021 (Geliş Tarihi)*
***Accepted:*** *23.11.2022 (Kabul Tarihi)*

## INTRODUCTION

Carpal tunnel syndrome (CTS) is a median neuropathy trap caused by paresthesia, pain, numbness, and other symptoms. It is one of the most common neuropathies, having a negative effect on the quality of life (1,2). Diagnosis of CTS is made from a detailed history, electrophysiological examinations, and clinical examination. Clinical findings are important parameters in diagnosis. There are some specific tests for CTS diagnosis, and while positivity in the tests strengthens the diagnosis, negativity does not affect the diagnosis (3).

The general principle in CTS treatment is to eliminate pain for the patient and accelerate the process of returning to daily living functions. Treatment methods applied to patients, most of whom recover with conservative treatment, include exercises to improve daily activities, various electrotherapeutic applications, manual therapy approaches, orthoses, banding, deep friction, ESWT, anti-inflammatory drug use, and surgical approaches (4). In the literature on CTS, flexor tendon and nerve gliding exercises have been reported to reduce synovial edema, provide feeding of the tissues by the nerve bundles through the provision of venous return, and accelerate the rate of axonal transmission (4,5).

Tendon gliding exercises are thought to increase nerve transmission through the support of tissue feeding and axonal transmission (4-6). Neural mobilisation, in which the nerve glides, is also a neurodynamic treatment method used to treat the peripheral nerve system and the surrounding tissues. Thus, it contributes to neural tissues regaining flexion capability and allows the re-stimulation of the normal physiological function of neural structures (7). In studies that have examined the effect of neural mobilisation techniques in addition to conservative treatment, there has been observed to be a more significant improvement in the functionality levels of the neural mobilisation group (6-8).

Manual therapy increases joint mobility by stimulating mechanoreceptors. Increased joint mobility increases tissue strength and flexibility in the surrounding structures (9). Deep friction and myofascial release, which are soft tissue manual therapy techniques are used for the benefit of the analgesic effect (10). An increase in intra-articular movement and surrounding soft tissues stimulates synovial fluid movement and accelerates circulation. In a study by Fernandez et al. of females with CTS, it was concluded that MT and surgery were similarly effective in improving functionality in the symptomatic hand, symptom severity, and fingertip grip strength (11). By forming potential treatment with myofascial release of the flexor retinaculum, an improvement is provided in flexion in the carpal ligament and the impaired nerve functions. Thus, pain and protective muscle spasms are reduced.

ESWT is a shock wave treatment that has an analgesic effect with accelerated tissue repair and cell growth by focusing on the affected area in CTS treatment (12,13). ESWT is thought to increase the inhibitory control of the dorsal radical brain through serotonergic activation and provides hyperstimulation analgesia. The anti-inflammatory effect of ESWT has been investigated and proved (13). In recent years, ESWT has become a non-invasive treatment method used in soft tissue diseases (14,15).

Physiotherapists should prefer efficient, safe, and easily appliable treatment modalities due to serious econonic losses of CTS, commonly observed disease. In the literature, CTS research studies on treatment modalities including exercise therapy alone as well as combined with nerve and tendon gliding (6-8, 16), MT approaches (10-18), and ESWT applications (15,19,20) reported successful results. However, we did not come across a study comparing these different applications in the literature. Therefore, we believe our study will have an important contribution to the literature as well as to the physiotherapists who may consider working in this field.

The aim of this study was to investigate the effects on pain, symptom severity, and levels of functionality of exercise, MT, and ESWT approaches applied to CTS patients and to evaluate the superiority of these to each other. The hypothesis of the study was that there would be a difference in respect of pain and functionality between the results of the CTS patients who applied tendon and nerve gliding exercises, MT, and ESWT methods.

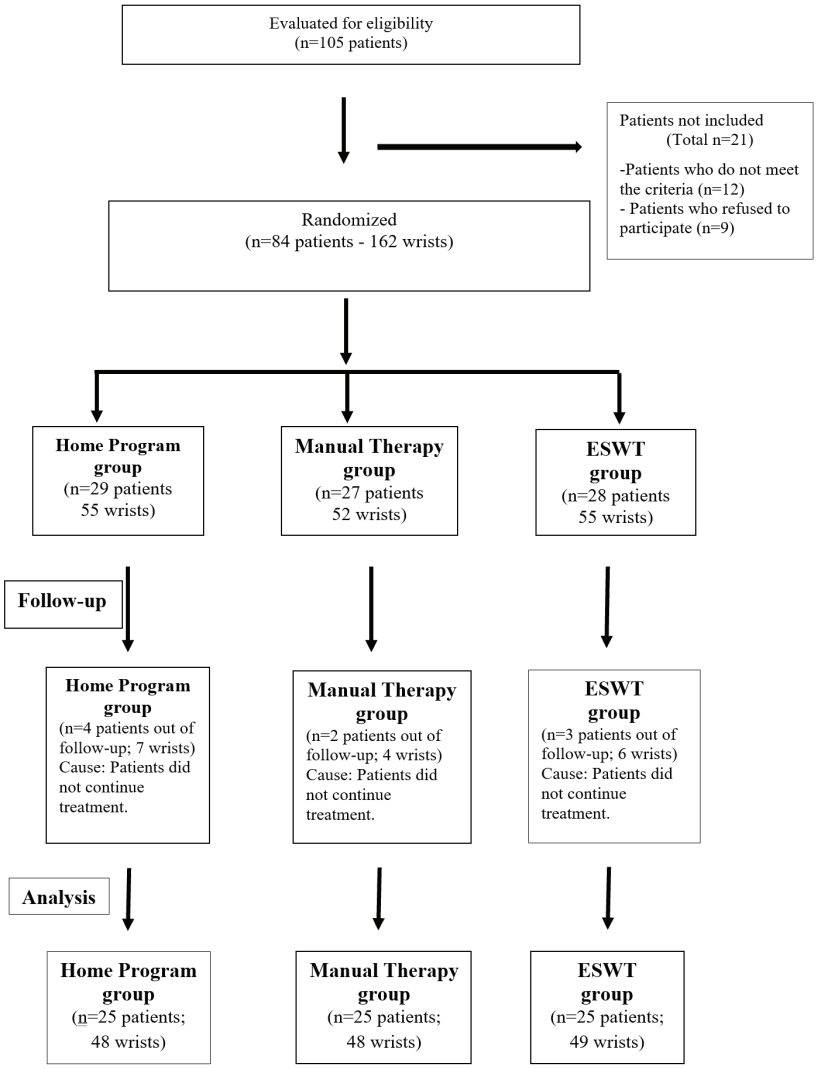


**Figure 1.** Flow-Chart

## METHODS

Approval for the study was granted by the Non-Interventional Research Ethics Committee of Hasan Kalyoncu University Health Sciences Faculty (decision no:2018/04, dated:02.05.2018). The study included patients aged 25-60 years diagnosed with CTS by their physician who agreed to participate in the study. Exclusion criteria were defined as pregnancy, the presence of a malignant tumour, cardiac pacemaker, a history of surgery in the wrist region, the use of analgesics in the treatment process, those who had received physical therapy for the wrist region within the last 6 months, and those who did not wish to participate in the study. This single center, randomized, controlled study was conducted in the Physical Medicine and Rehabilitation General Polyclinic of 25 Aralık Public Hospital. A total of 75 patients who met the study criteria were separated into 3 groups with a list randomization method, taking the order of presentation as reference (Figure 1). The patients in Group 1 were given a home exercise program (HP), including neurodynamic median nerve mobilisation and tendon gliding exercises. Group 2 received the HP plus manual therapy (MT), including soft tissue and joint mobilisation. Group 3 received the HP plus extracorporeal shockwave therapy (ESWT). Informed consent for voluntary participation in the study was obtained from all the patients.

In the evaluation of the pain of patients at rest and during activity, a Visual Analog Scale (VAS) was used. Patients were instructed to mark the level of

**Figure 2.** Carpal Joints Ventral Mobilisation

pain felt on a line 10 cm in length, marked from 0= no pain to 10 = intolerable pain (21).

Patients with CTS received Tinel, Phalen, and carpal compression tests, provocative tests of special clinical examination bilaterally applied by the physiotherapist (NT). The purpose of these tests is to detect symptoms by increasing the intercarpal pressure. For example, the Tinel test is positive when a tingling or pricking sensation is felt in the median nerve distribution with gentle percussion applied to the distal wrist (2). The Phalen test was applied by keeping both wrists in full flexion position for 30-60 seconds. The emergence of or increase in pain, numbness, and paresthesia during the test was evaluated as positivity (3). In the carpal compression test, the pressure was applied with two fingers over the median nerve in the wrist. Positivity in the test was defined as pain, numbness, and paresthesia in the area affected by the nerve (3).

The Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ) was used to evaluate the functional level and symptom severity. The questionnaire comprises two sections of symptom severity and functional capacity, and the total points obtained in each section are divided by the number of questions to provide an average score for each section. Higher scores indicate decreased functional capacity and increased symptom severity (22). In addition, Cochin Hand Function Scale was used (CHFS) to evaluate functional performance and activity limitations related to the hand (23). The scale includes 18 activities in daily functions, and the performance of the subject for each parameter is scored from 0 (no difficulty) to 5 (I cannot do this).

All the patients in the study received general training about the mechanism of CTS, progression, and preventative measures. Furthermore, patients were taught how to apply home exercises comprising neurodynamic median nerve mobilisation and tendon gliding exercises.

During the application the neurodynamic median nerve mobilisation, it was instructed that the shoulder was in depression, abduction, and external rotation; the elbow was in extension, the forearm in supination, and the wrist and fingers in extension. Following the head in lateral flexion at the end of these movements, tension was applied to the median nerve (16). Nerve gliding was applied as the head was brought into lateral flexion, the wrist and fingers were brought into flexion, the head was returned to a neutral position, and by moving the hand and fingers into extension (23). Lastly, as part of the tendon glide exercises, fingers were held in five positions, straight, hook, fist, tabletop, and long fist, respectively (2,3). These home exercises were performed as 10 repetitions in each session, 5 days a week for 4 weeks. A reminder message was sent to all the patients once a week.

For the MT group, in addition to the HP, MT techniques were applied by the physiotherapist (NT). As part of soft tissue mobilisation, the myofascial release was applied to the anterior, mid, and posterior scalene, the pectoralis major and minor, the biceps brachii muscles, and the flexor retinaculum. For joint mobilisation, cervical tractions and mobilisation were applied to the distal and proximal radio-ulnar, radiocarpal (Figure 2), and intercarpal joints (6-8,9). While the patient was in supine position, general, and segmental traction to the cervical region was applied by the physiotherapist taking the patient's head in one hand and applying traction to all the cervical vertebrae, first as general than as segmental to each cervical segment starting from caudal to cranial. Furthermore, the myofascial release was applied to the anterior, medial and posterior scalene muscles, then to the pectoralis major and minor and the biceps brachii muscles. Joint gliding was applied as anterior and posterior mobilisations to the distal and proximal

radioulnar joints and towards dorsal and volar to the radiocarpal and intercarpal joints. Later, mobilisation with traction was applied to the metacarpophalangeal joints. Last, during the deep friction and myofascial release techniques of the flexor reticulum, while the wrist was in dorsiflexion, the thumb of the physiotherapist was positioned on the lateral edges of the flexor reticulum. This was applied until release was obtained in the flexor reticulum. In patients with an increase in CTS symptoms with the wrist in dorsiflexion, the application was made without bringing the wrist into dorsiflexion. MT interventions were applied for a total of 12 sessions 3 days a week, 10 repetitions for 4 weeks by the physiotherapist (NT).

For the ESWT group, in addition to the HP, a total of 12 ESWT sessions were applied 3 days a week for 4 weeks by the physiotherapist (NT). The ESWT therapy was applied with a Vibrolith ESWT device (Elmed Medical Systems, Orlando, FL, USA) at 1.5 bar pressure, 2000 shots, and 10 Hz. frequency, with the ESWT probe, placed perpendicular to the median nerve. As the area of application was narrow, the median nerve did not have a deep course in the carpal tunnel, therefore, low pressure was preferred to minimize complications (12). The patients were followed up until the end of the study, and no local tissue effect was reported.

### Statistical Analysis

Data obtained in the study were analyzed by IBM® SPSS© 21.0 software (SPSS Inc., Chicago, IL, USA) (24). The conformity of the variables to normal distribution was examined with the Kolmogorov-Smirnov test. Descriptive statistical methods were used, and results were stated as mean±standard deviation values, number(n), and percentage (%). Paired t-test was used to assess VAS (resting and activity), Boston symptom intensity, Boston functional status, and Cochin hand function scores within the groups. One-way Anova test was used in comparisons between the groups. The results are presented using the standard deviations. Tukey Post-hoc test was used to compare the pain, symptom severity, and functionality values the groups after the treatment. Considering the evaluation of Tinel, Phalen, and Carpal compression test values before and after the treatment, Wilcoxon sign test was used within the groups; chi-square test was used between the groups. 95% confidence interval, and statistical significance level of $p<0.05$ were considered. Power analysis was applied to calculate the sample size using G-power 3.19 software (25). A moderate effect size (effect size = 0.5) was set based on Cohen's d, and the significance level was assigned to a = 0.05 and power = 0.8, resulting in a minimum of 22 subjects per group required. Considering a drop-out rate of 20%, the minimum number per group was set at 25.

## RESULTS

The mean age of the patients was 49.12 years (range, 25-60 years), and the mean body weight was 81.14 kg. The groups were similar in respect of age, gender, affected wrists, and body weight ($p>0.05$) (Table 1).

In the comparison of the pre-treatment pain values, no difference was determined between the groups

**Table 1.** Comparison of Demographic Characteristics of the Groups

| | | HP (n=25) X±SD | MT (n=25) X±SD | ESWT (n=25) X±SD | p |
|---|---|---|---|---|---|
| **Age (year)** | | 46.84±9.46 | 50.68±9.84 | 49.84±8.63 | 0.316[a] |
| **Body weight (kg)** | | 82.80±13.40 | 79.00±20.77 | 81.64±13.03 | 0.746[a] |
| **Gender** | Female | 23 (%92) | 23 (%92) | 23 (%92) | 0.349[b] |
| | Male | 2 (%8) | 2 (%8) | 2 (%8) | |
| **Affected wrist** | R- Hand | 2 (%8) | 2 (%8) | 1 (%4) | 0.807[b] |
| | L-Hand | 0 (%0) | 0 (%0) | 0 (%0) | |
| | Both Hands | 23 (%92) | 23(%92) | 24(%96) | |

*$p<0.05$, p[a]: One-way ANOVA test, p[b]: Pearson Chi-Square, X: Arithmetic Mean, SD: Standard Deviation, HP: Home Program, MT: Manual Therapy, ESWT: Extracorporeal Shock Wave Therapy, R: Right, L: Left

**Table 2.** Comparison of pain and functionality values before and after treatment within and between groups

| | | HP (n=25) X±SD | MT (n=25) X±SD | ESWT (n=25) X±SD | p[b] |
|---|---|---|---|---|---|
| **Resting VAS (cm)** | Before treatment | 6.96±1.98 | 6.88±1.76 | 6.52±1.47 | 0.642 |
| | After treatment | 3.80±1.75 | 2.48±1.71 | 2.52±1.89 | 0.016* |
| | **p[a]** | <0.001* | <0.001* | <0.001* | |
| **Activity VAS (cm)** | Before treatment | 7.08±1.63 | 7.28±1.30 | 7.56±1.50 | 0.521 |
| | After treatment | 3.48±1.47 | 2.80±1.44 | 3.00±1.93 | 0.324 |
| | **p[a]** | <0.001* | <0.001* | <0.001* | |
| **Boston Symptom Severity Score** | Before treatment | 3.21±0.49 | 3.18±0.44 | 3.21±0.39 | 0.980 |
| | After treatment | 1.96±0.49 | 1.62±0.28 | 1.61±0.53 | 0.010* |
| | **p[a]** | <0.001* | <0.001* | <0.001* | |
| **Boston Functional Status Score** | Before treatment | 3.23±0.43 | 3.10±0.51 | 3.04±0.46 | 0.333 |
| | After treatment | 1.80±0.39 | 1.47±0.34 | 1.45±0.54 | 0.010* |
| | **p[a]** | <0.001* | <0.001* | <0.001* | |
| **Cochin Hand Function Questionnaire** | Before treatment | 1.98±0.65 | 1.90±0.51 | 1.96±0.54 | 0.888 |
| | After treatment | 0.75±0.52 | 0.43±0.36 | 0.47±0.52 | 0.040* |
| | **p[a]** | <0.001* | <0.001* | <0.001* | |

*p<0.05, p[a]: Within-group comparison Paired T-test, p[b]: Between-group comparison One-way ANOVA test, X: Arithmetic Mean, SD: Standard Deviation, VAS: Visual Analog Scale, HP: Home Program, MT: Manual Therapy, ESWT: Extracorporeal Shock Wave Therapy

(p>0.05). The greatest reduction in the difference between the pre and post-treatment mean values was in the MT group for the resting pain values and in the ESWT group for the activity pain values. No statistically significant difference was determined between the groups in the pre-treatment evaluations of symptom severity and function. In the post-treatment evaluations, a statistically significant difference was determined in all the test mean values (p<0.05) (Table 2).

When the groups were compared in respect of post-treatment resting and activity pain values, a statistically significant difference was determined in the MT and ESWT groups compared to the HP group (p<0.05). No difference was seen between the MT and ESWT groups (p>0.05). In the comparison of the functionality results, a statistically significant difference was seen in the MT group compared to the home exercise program group (p<0.05), and no significant difference was determined between the MT and ESWT groups (p>0.05). In the comparison of the BCTSQ values between the home exercise program group and the ESWT group, the values were found to be significantly better in the ESWT group (p<0.05) (Table 3).

The results of the Tinel, Phalen, and carpal compression specific tests showed no significant differences between the groups in the comparisons made

**Table 3.** Comparison of Pain, Symptom Severity, and Functionality Values of the Groups After Treatment

| | | HP- MT | HP- ESWT | ESWT- MT |
|---|---|---|---|---|
| **Resting VAS** | **p** | 0.029* | 0.036* | 0.997 |
| **Activity VAS** | **p** | 0.311 | 0.555 | 0.902 |
| **Boston Symptom Severity Score** | **p** | 0.025* | 0.019* | 0.993 |
| **Boston Functional Status Score** | **p** | 0.026* | 0.019* | 0.992 |
| **Cochin Hand Function Questionnaire** | **p** | 0.050* | 0.102 | 0.947 |

*p<0.05, p: Tukey Post-hoc test, VAS: Visual Analog Scale, HP: Home Program, MT: Manual Therapy, ESWT: Extracorporeal Shock Wave Therapy

**Table 4.** Comparison of Tinel, Phalen, and Carpal Compression Test Values Before and After Treatment within and between Groups

| Tests | | HP N (%) | MT N (%) | ESWT N (%) | $p^b$ |
|---|---|---|---|---|---|
| **Tinel Test** | Before treatment | 24 (%96) | 24 (%96) | 24 (%96) | 1.000 |
| | After treatment | 5 (%20) | 1 (%4) | 3 (%12) | 0.220 |
| | **$p^a$** | <0.001* | <0.001* | <0.001* | |
| **Phalen Test** | Before treatment | 22 (%88) | 24 (%96) | 24 (%96) | 0.424 |
| | After treatment | 3 (%12) | 1 (%4) | 3 (%12) | 0.532 |
| | **$p^a$** | <0.001* | <0.001* | <0.001* | |
| **Carpal Compression Test** | Before treatment | 24 (%96) | 24 (%96) | 24 (%96) | 1.000 |
| | After treatment | 4 (%16) | 1 (%4) | 2 (%8) | 0.332 |
| | **$p^a$** | <0.001* | <0.001* | <0.001* | |

*p<0.05, $p^a$: Within-group evaluation Wilcoxon sign test, $p^b$: Between-group evaluation Chi-square test, HP: Home Program, MT: Manual Therapy, ESWT: Extracorporeal Shock Wave Therapy

pre- and post-treatment. In the comparisons within the groups, a statistically significant difference was determined between the pre-and post-treatment test results in all the groups (p<0.05) (Table 4).

## DISCUSSION

The aim of this study was to investigate the effects on pain, symptom severity, and levels of functionality of ESWT and MT approaches applied to patients with CTS and to evaluate the advantages of either method over the other. The hypothesis that there would be a difference between the results of the home exercise program applied as tendon and nerve gliding exercises and the MT and ESWT methods in respect of pain and functionality was partly confirmed. No difference was determined between the MT and ESWT groups in the improvements obtained in pain and functionality, whereas the results of the MT and ESWT groups were better than those of the group applied with the home exercise program alone. This study can be considered of value in respect of showing the 4-weeks term efficacy of these treatment methods applied for CTS.

CTS is a frequently seen peripheral entrapment neuropathy. Several different techniques and applications have been used in treatment, but very few studies in the literature have compared physiotherapy approaches. In a systematic review that investigated the efficacy of tendon and nerve gliding exercises for CTS, it was reported that when these exercises are combined with traditional treatments, there can be a positive effect for CTS patients, but it was also emphasized that there is a need for further, randomized controlled studies designed to evaluate the effect of tendon and nerve gliding exercises alone (6). In a recent, randomized controlled study of 80 patients, the study group was applied with tendon and gliding exercises together with a wrist splint, and the control group was treated with a wrist splint only. A certain amount of improvement was seen in symptom severity and the functional status scores in both groups, and it was reported that the exercises provided no extra benefit to the wrist splint treatment (8). In contrast, Hamzet et al. reported that the combination of neuromobilisation techniques with exercises compare to only home exercises was more effective in improving clinical findings (26). In the current study, median nerve mobilisations and tendon sliding exercises were applied as a home exercise program to all 3 groups. The support with active tendon and nerve gliding exercises was effective on the pain, symptom severity, and functionality levels of the CTS patients and was thought to be supported by the other treatment approaches.

In a study by Miranda-Medina et al., a significant therapeutic benefit of neurodynamic techniques as conservative treatment was reported in the pres-

ence of light and moderate CTS (27). İn another study, 189 patients with CTS have been separated randomly into the manual therapy group (including neurodynamic techniques) or the control group (without therapy). At the end of the treatment, they found significant differences in the MT group which also included neurodynamic techniques, but no differences in the control group. It is stated that MT had a positive effect on the overall health status of people with CTS (28). In our study, a significant difference was determined in respect of resting and activity pain values, symptom severity, and levels of functionality between the group applied with the home exercise program of nerve mobilisations and the group that received joint and soft tissue mobilisation applied by a physiotherapist in addition to the home exercise program. This difference was thought to have been created by the support to the home exercise program of the MT approach applied in person to the patient 3 times a week (26,28).

ESWT applications have increased significantly in recent years in patients with CTS and positive results of the efficacy of ESWT have been documented (15,19,20,29,30). In a study by Kocak Ulucakoy et al., ESWT alone was seen to be as effective as splint treatment, and it was reported that ESWT should not be ignored in the conservative treatment of CTS (15). To date, there are no standard guidelines about the frequency of application and the total number of doses for the use of ESWT in CTS patients. A short-term effect has been shown in a single session of ESWT, and most studies have applied 3 sessions (30). The results of our study demonstrated a significant difference in the resting and activity pain values, symptom severity, and levels of functionality in the ESWT group. However, when compared with MT, no superiority was determined between the applications of ESWT and MT. Both applications were seen to provide a greater improvement in pain and symptom severity than the nerve and tendon gliding exercises applied as the home exercise program alone. Similarly, in the functionality level results, the positive improvements in symptom severity and functionality level were seen to be greater in the MT and ESWT groups than in the HP group, with no difference between the MT and ESWT techniques. Our results were found to be consistent with findings in the literature. Studies have supported the application of MT techniques together with classical physiotherapy and have reported that combined treatments are more effective in improving symptoms and clinical findings (17,18,26,28).

The results of our study showed that all methods in the three groups reduced pain and symptom severity and increased functionality in 4-weeks treatment program. It was found that education and applied exercises and reminder text messages per week in the home exercises group alone had a positive effect on the patients. We emphasize the importance of home exercises to support CTS patients. On the other hand, direct application of ESWT to the wrist; local and central effects of joint and soft tissue MT techniques might improve the positive outcomes of our study results (16,26,28). MT and ESWT approeaches reduced the symptoms and significantly increased the functionality compared to the home program exercise after the treatment.

There were some limitations to this study, primarily that only the 4-weeks term efficacy was examined, and there were no long-term comparisons. There is a need for further larger, longer-term studies to confirm these results. Another limitation was that although a reminder was sent to the patients, adherence, and compliance with the exercises is an important problem in patients undertaking a home exercise program, which could have affected the results. Therefore, placebo-controlled studies are required to make long-term comparisons.

In conclusion, it can be said that nerve and tendon gliding exercises, soft tissue and joint mobilisations, and the application of ESWT provided an improvement in CTS patients, and these methods can be safely applied. At the end of the treatment period, the applications of MT and ESWT were found to be equally effective in reducing pain and increasing functionality in CTS patients. ESWT is a practical treatment method with no side effects. With the addition of MT approaches in patients with CTS degree, pain, neuropathic symptoms, and limitations will be reduced, and function increased. In addition, to encourage patients to be active during and after the treatment process, it can be considered important to teach nerve and tendon gliding exercises and give these as a home exercise program. Further studies should be performed to evaluate the long-term results.

***Source of Support:***The authors did not receive any financial support for this study.

***Conflict of Interest:*** The authors have no conflict of interests to declare.

***Author Contributions:*** NT: Concept, Design, Data Collection and Processing, Analysis and/or Interpretation, Literature Review, Article Writing. AT: Concept, Consulting, Analysis and/or Interpretation, Article Writing, Review

***Explanations:*** None.

***Acknowledgement:*** None

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