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Original Article

Effectiveness of Adding Kinesiotape to Rehabilitation program on pain and functional performance in patients with Carpal Tunnel Syndrome

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Abstract:

Objectives: to investigate the effect of adding Kinesiotape to the physiotherapy rehabilitation program on pain, function, wrist ROM, hand grip strength and hand skills in individuals with carpal tunnel syndrome. **Methods**: Thirty-six patients suffering from chronic carpal tunnel syndrome were recruited. They range in age from thirty to forty-five years. They were divided into Group A [control]: received the physiotherapy rehabilitation program only. Group B [experimental]: received Kinesiotaping added to the physiotherapy rehabilitation program. VAS was used for assessment of pain, a universal goniometer for ROM of wrist, a hand dynamometer for hand grip strength, and Moberg Pick-Up Test [MPUT] for hand skills. The Boston Carpal Tunnel Questionnaire [BCTQ] is used to evaluate hand function. **Results**: There was significant improvement in all clinical measures in both groups [$p < 0.05$]. The experimental group showed a statistically significant improvement in wrist flexion ROM, wrist functional impairment, hand grip power, and pain intensity compared to the control group. There was a significant improvement in wrist extension ROM, wrist ulnar and radial deviation ROM and hand skills that were equivalent to the control group. **Conclusion**: This study found that an effective way to improve wrist functional impairments, hand grip power, wrist flexion ROM, and pain intensity is to combine rehabilitation with Kinesiotaping.

Keywords: Carpal tunnel syndrome, Kinesiotaping, Boston Carpal tunnel Questionaire, function, pain.

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1. Introduction:

Carpal tunnel syndrome [CTS] is a frequent medical condition that makes a patient's hand and arm hurt, tingle, and feel numb. The median nerve is affected by CTS when it is restricted or compressed as it travels through the carpal Tunnel **[1]**. Multiple risk factors increase the incidence of CTS, including monotonous wrist activities, obesity, pregnancy, rheumatoid arthritis, and heredity. A wide range of symptoms could be connected to CTS. They are categorized as mild, moderate, and severe. Numbness, tingling, and pain in the median nerve distribution identify the condition. These sensations may be felt in the radial side of the ring finger, thumb, middle finger, and index finger **[2].**

Physical therapy programs are an effective alternative to the surgical release of carpal tunnel in terms of higher speed in reducing the serious manifestations of carpal tunnel syndrome. Several open and percutaneous surgical procedures have been promoted for the treatment of CTS upon failure of conservative intervention. Effective treatment for carpal tunnel syndrome, whether conservative or surgical, should decrease symptoms and nerve degeneration by reducing pressure inside the carpal tunnel, increasing the vascular supply to the nerve as a result, and promoting the tendon and nerve to glide with one another **[3].**

Kinesiotape [KT] is one of the most prominent adhesive therapeutic tapes for performance improvement, rehabilitation, and injury prevention. It was found to be effective therapeutically in joint movement facilitation **[4],** muscle activity enhancement, muscle peak torque enhancement **[5],** and functional performance improvement **[6], [7], [8].**

The lymphatic system is affected due to the narrowing of the space between the tendons and skin which in turn causes soft tissue inflammation. This compression and the resultant restricted lymph outflow activate the skin's pain receptors, causing localized discomfort. If the skin in the affected area is stretched before KT is applied, the skin and the tape together form wave-like convolutions when the skin is returned to its normal condition. The distance between the skin and subcutaneous tissue increases as a result of this elevation of the skin. The fluid may flow more easily from this area into the lymphatic system, relieving pressure on pain receptors and enhancing the body's capacity for self-healing. The tissue is continuously raised and lowered by the movement of the body at the same time like a pump motion therefore, lymphatic drainage and blood circulation are encouraged. Furthermore, mobility ensures that the skin will keep moving and hence adhesion will be reduced. The mechanoreceptors are stimulated by this motion, which further reduces pain **[4], [5].**

A particular tendon or ligament may encounter reduced pulling force during KT treatment to avoid further injury and encourage tissue recovery [6]. The applied force was parallel to the anatomical directions of the tendons. The flexors' pulling force may be reduced by applying KT parallel to their tendons. The reduced force of the flexor tendons that are exposed to negative tension from the tape is presumably what causes the reduction in pain intensity. Furthermore, the improvement in blood flow would be responsible for pain reduction **[9].**

The neuromobilization technique has been used to treat nerve entrapment syndromes **[10] [11].** Shacklock revealed that neurodynamic mobilization helps restore the capability of the nervous tissue itself to withstand stress and strain. Furthermore, it encourages the repair of normal physiological activity of nerve cells together with pain reduction and functional enhancement **[12].** Tendon gliding exercises were developed to facilitate the digital flexors and median nerve movement inside the carpal tunnel. Exercises that promote the mobility of tendons and nerves in the tunnel are hypothesized to decrease nerve adhesion, disperse excess fluid, and enhance neural vascularity **[13].**

Hamzeh et al. [2021] investigated the effect of neurodynamics vs exercise therapy on pain and function in people with carpal tunnel syndrome and found that the application of neurodynamics-based therapy was more effective in decreasing pain and improving function and strength and avoiding surgery in patients with CTS. These improvements were maintained after 6 months of therapy **[14].**

Horng et al. [2011] found that to improve the functional status and quality of life of CTS patients, the combination of tendon gliding exercises, paraffin therapy, and splinting might be more effective than the combination of nerve gliding exercises, paraffin therapy, and splinting **[13].**

According to a systematic review of the literature made by Bobowik [2019], that was based on articles concerned with the physiotherapy of people with carpal tunnel syndrome [CTS]. The review presented a summary of the effectiveness of various types of physiotherapeutic interventions in the conservative treatment of carpal tunnel syndrome [CTS]. On their basis, significant benefits and improvement of CTS symptoms are visible. This increases the chance of avoiding or delaying surgical intervention **[15].**

Wolny and Linek [2018] made a comparison study of the effectiveness of neuro-mobilization and placebo therapy in the treatment of CTS. The use of neuromobilization has an effective therapeutic effect in the treatment of mild and moderate forms of CTS **[16].**

Wolny et al. [2017] Compared the effectiveness of manual therapy [MT], neuro-mobilization and other manual techniques [functional massage of trapezius muscle] with Electric modality [EM] in the form of low-level laser therapy and ultrasounds in the treatment of CTS. They found that both low-level laser therapy and ultrasound therapy as well as manual therapy combined with other techniques were effective in the treatment of CTS. The techniques used in the manual therapy group showed a slightly higher therapeutic efficacy of CTS. The combination of MT and EM methods may bring increased efficacy in the treatment of CTS **[17].**

Oskouei et al. [2014] compared the effectiveness of neuromobilization with routine physiotherapeutic treatment [immobilization, TENS currents and ultrasounds] in CTS therapy. They found that Neuromuscular neuro-mobilization, as well as standard therapeutic procedures [immobilization, TENS, US], are effective in the treatment of CTS. The techniques used in the treatment group showed a slightly higher therapeutic efficacy of CTS. The combination of research group and control group methods may bring increased efficacy in the treatment of CTS **[18].**

Maddali Bongi et al. [2013] evaluated the effectiveness of manual therapy in the treatment of CTS symptoms. They found that manual therapy is an effective conservative way of treating symptoms in patients with CTS. It is worth mentioning that only the articles of Pratelli et al. and Mordalii Bongi et al. evaluated the condition of patients several weeks after the completion of therapeutic procedures. They were able to confirm that treatments in the field of manual therapy and fascial manipulation demonstrate long-term effectiveness, and the health effects achieved last long **[19],[20].** Pratelli et al. in his work also showed that in the case of laser therapy [LLLT], after 3 months from the end of the intervention, the obtained therapeutic effect was withdrawn **[20].**

The effectiveness of physiotherapy rehabilitation programs alone and Kinesotaping alone have been reported in several studies therefore, the purpose of this research is to investigate the effect of adding Kinesiotape to the physiotherapy rehabilitation program on pain, function, wrist ROM, hand grip strength and hand skills in individuals with carpal tunnel syndrome.

2. Materials and Methods:

Study design:

This is two-armed randomized controlled clinical research with pre-test and post-test design.

Participants:

Thirty-six patients, both male and female, with persistent carpal tunnel syndrome were recruited. They range in age from thirty to forty-five. They were divided into two equal groups at random using a simple random technique. Group A [control]: received the physiotherapy rehabilitation program only. Group B [experimental]: received Kinesiotaping added to the physiotherapy rehabilitation program.

Patients were included if their age were between 30 to 45 years old, they were clinically diagnosed with mild or moderate CTS by orthopedists and then referred to us. Patients experienced nocturnal paresthesia that woke them up; and discomfort associated with holding something in the hand or applying pressure over the palmar aspect of the wrist. Sensory problems with the first, second, third, and portion of the fourth digit paresthesia; pain for twelve weeks or more; positive Tinel's sign and Phalen's test; and the need to shake, or use deceptive hand motions to reduce symptoms.

Patients were excluded if their age was less than 30 or more than 45 years old, they got a severe CTS diagnosis from an orthopedist, were treated with physical therapy for CTS over the past three months, had a local corticosteroid injection, thenar atrophy, or peripheral nerve damage at more proximal levels in the upper limb, cervical disc hernia

[radiculopathy which can affect symptoms], carpal tunnel release surgery, negative Tinel's sign or Phalen's test, history of wrist fracture, cognitive impairment, or pregnant woman. Additional systemic diseases such as diabetes mellitus, hypothyroidism, and rheumatoid arthritis were further excluded.

This examination involved thirty-six wrists. Every patient was affected by unilateral CTS. Patients were randomly assigned to one of the two groups using a safe method that involved opaque, unopened envelopes with the numbers 1-2 on them. The first group received a physiotherapy rehabilitation program alone in the form of ultrasound therapy, nerve and tendon gliding exercises, and strengthening exercises for the hand. The second group received Kinesiotaping added to the physiotherapy rehabilitation program. The physiotherapy rehabilitation program was performed three times per week for 3 weeks. Kinesiotaping was changed twice per week.

All patients were asked to participate in this research and signed an informed consent upon their approval. This study was carried out according to the ethical guidelines of the 1964 Declaration of Helsinki and was approved by the Ethical Committee for Human Research at the Faculty of Physical Therapy, Cairo University, Egypt [Approval no: P.T.REC/012/004772]. Assessment was done before and after the rehabilitation program and the outcome measures are listed below.

Assessment Procedures:

A) **Pain intensity:**

The intensity of pain was measured using the visual analogue scale [VAS]. The VAS instrument consists of a horizontal line that is 100 mm long and has anchor points at 0 for no pain and 10 for the most painful sensation, it has high validity and reliability **[21].** Patients were asked to make a mark on the line that best represents his/her pain level.

B) Wrist ROM:

A universal goniometer was used to assess wrist ROM [flexion, extension, ulnar deviation, and radial deviation], it has high validity and reliability for measurement of wrist ROM **[22].**

C] Hand grip strength [HGS]:

A Hydraulic Smedley spring hand-held dynamometer [Baseline] [**Figure: 1**] was used to assess HGS. It is a reliable and valid tool for the measurement of hand grip strength **[23], [24], [25].** The testing position was performed while the elbow was at 90 degrees of flexion, the forearm and wrist were in neutral, and each patient was asked to tightly squeeze his hand at maximal strength and hold for 3 seconds [recording position]. After that, patients were asked to rest for 60 seconds. The average was calculated after the measurements were made three times. The person relaxed and sat up straight, not resting or hanging onto anything. All repetitive measurements were taken from the same position.

Figure 1: Hydraulic Smedley spring hand-held dynamometer for assessment of HGS.

D] Hand skills

Hand skills were evaluated by the Moberg pick-up test **[Figure:2].** The MPUT was measured in terms of the time was took to pick up each object with the dominant hand, one at a time, in seconds. Twelve tiny items were placed on a table before the participants were seated, and they were instructed to pick them up into a box as quickly as possible. According to several studies, the MPUT is an excellent test for assessment of the functional performance of the upper limbs in rheumatology **[26],** carpal tunnel syndrome **[27],** and in those who don't have upper limb illness **[28].** Amirjani discovered that the MPUT's inter-rater reliability and internal consistency [test-retest] are both good to excellent **[27].**

There were two phases of the MPUT: one with the eyes open and the other with the eyes closed. For each phase of the test, the dominant hand is assessed first. We used a plastic desk blotter, a plastic box, 12 little metallic things [screws, clips for paper, a diameter ring, a security pin, small nuts, coins, and a key], and a timer. On a table, the desk blotter was spread out. The self-identified dominant hand of each patient was on the table close to the desk blotter while they sat in a chair facing it. Patients were asked to pick the little object on the table; the spontaneously chosen hand was judged dominant. The box was placed on the desk blotter, and the 12 things were arranged randomly next to the box on the side of the dominant hand. Patients were told to pick up each item separately and place it in the box as fast as they could without dropping them. Time in seconds was calculated from the beginning of the process till the last object fell off.

Figure 2: The Moberg Pick-Up Test.

E] Functional Assessment:

The functional disability of patients with CTS was assessed by the Boston Carpal Tunnel Questionnaire [BCTQ]. The BCTQ is a valid, and reliable assessment tool for wrist function **[29].** The Arabic version of the Boston Questionnaire for the measurement of functional impairment has higher validity and reliability **[30].** The self-administered questionnaire analyzes the severity of symptoms and functional levels in CTS patients. The functional status scale [FSS] and the symptom severity scale [SSS] are the two scales that make up the BCTQ. The SSS consists of 11 items that are grouped into 6 categories [pain, paralysis, paresthesia, nocturnal symptoms, weakness, and overall functional condition], and each item is evaluated on a scale of 1 to 5, with 1 being the least severe. The FSS consists of eight functional activities that are typically compromised by CTS and are rated on a scale of 1 to 5, with 1 being the easiest to accomplish and 5 being the most difficult. The BCTQ score analyzes the severity of CTS across a typical 24-hour period in the two weeks before completing the questionnaire. The symptom severity scale [SSS] measures the symptoms based on their type, frequency, and severity. The scale consists of 11 questions with multiple-choice responses, with the scores ranging from 1 [the least severe] to 5 [the most severe]. The average of the results for each of the eleven unique items was used to generate the overall symptom severity score. The functional status scale [FSS] assesses how the CTS impacts day-to-day functioning. The mean of all eight parameters created the functional status overall score. Consequently, a higher functional status score or symptom intensity indicated more severe symptoms or disabilities **[31], [32].**

Treatment procedures:

A) Ultrasound

For three weeks, ultrasound therapy was administered three times per week for a total of five minutes per session. The ultrasound machine was adjusted to a pulsed mode of 1:4, a frequency of 1 MHz, and an intensity of 1 W/cm^2. A coupling medium of aqua sonic gel and a 5 cm^2 transducer were used. The transducer was placed over the affected wrist and directed towards the carpal tunnel region, which extends from the wrist crease to the palmar area **[33],** as shown in **Figure 3.**

Figure 3: Ultrasound for CTS

B) Nerve gliding exercises

Nerve gliding exercises were done three times per week, each consisting of 10 repetitions, and each session comprised about 8 minutes of treatment. A sliding technique was used in the first approach. This procedure included two active movements that were done simultaneously, the first of which [elbow extension] to mobilize the median nerve distantly and the second of which mobilized it proximally [ipsilateral cervical flexion]. The patient was in-

structed to assume the starting position with the neck neutral, shoulder abducted 90 degrees, elbow flexed 90 degrees, wrist neutral, MCP, PIP, and DIP extended. Then, the patient was trained to extend the elbow and lateral flex the cervical spine ipsilaterally in a synchronized manner. The second technique, which included movements at the elbow and neck, was used as a model for a tensioning approach since it lengthened the nerve bed. In this exercise, cervical contralateral lateral flexion and elbow extension were performed simultaneously. The patient was asked to start in a posture where the neck was neutral, the MCP, PIP, and DIP were extended, the shoulder joint was abducted 90 degrees, the elbow was flexed 90 degrees, and the wrist was neutral. Consequently, the patient was taught to extend the elbow and lateral flex the neck contralaterally in a synchronized manner **[34].**

C] Tendon gliding exercises

Tendon gliding exercises were performed three times a week for three weeks, averaging 10 repetitions per session. Wehbe and Hunter's approach was used which includes five finger motions. The patient was asked to extend all fingers [MCPJs, PIPJs, and DIPJs] in the first position. The fingers in the second position [full fist] were completely flexed [MCPJs, PIPJs, and DIPJs]. The patient was instructed to extend the distal interphalangeal joints [DIPJs] while the metacarpophalangeal joints [MCPJs] and proximal interphalangeal joints [PIPJs] remained completely flexed in the third position [the claw hand position]. The patient was asked to extend all of the PIPJs while the MCPJs were in flexion and the DIPJs were in extension in the fourth position [tabletop]. All PIPJs and DIPJs were fully flexed [hooked] at the fifth position, while all MCPJs were extended **[35],** as shown in **Figure 4.**

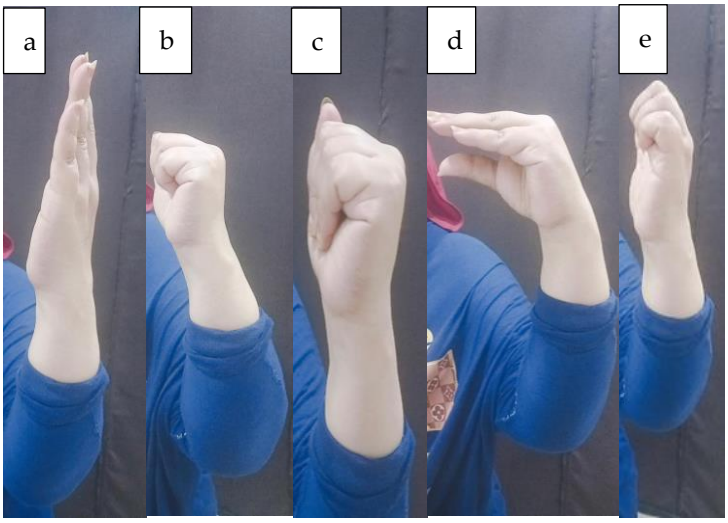

Figure 4: Tendon gliding exercises a] straight b] full fist c] claw hand d] tabletop e] hook

D] Strengthening exercises of hand

Strengthening exercises of the hand with a hand gripper, rubber grip ring, rubber handball, and finger resistance band were done three times per week for ten repetitions each session for three weeks. The exercise program was to be followed at home by the patients for three weeks, twice daily. The patients were told to maintain a neutral neck and shoulder posture with the elbow flexed 90 degrees.

E] Kinesiotaping

For three weeks, Kinesiotaping was changed twice a week. A combination of ligament and muscle treatment was used to relax the muscles and median nerve, which are located below the flexor retinaculum. The forearm and wrist are first cleansed with cotton and alcohol. An I tape was applied by cutting it in both muscle and ligament applications. In muscle application, a tonus-decreasing application was used from muscle insertion to muscle origin and the application was fixed in the opposite direction. The base was attached to the forearm, while the patient was seated in a comfortable position Anchor the base with skin displacement and apply the tape strips with the other hand along

the course of the forearm flexors with 10% stretch. Finally, gentile rubbed was essential to fix the tape strips in place **[36],** as shown in **Figure 5.**

Figure 5: Kinesiotaping for CTS

Statistical analysis:

SPSS for Windows, version 28, was used for the statistical analysis [SPSS, Inc., Chicago, IL]. For all dependent variables as well as the basic demographic information of the patients [sex, age, height, weight, and body mass index], descriptive statistics were presented in mean and standard deviation. The Kolmogorov-Smirnov test and the Shapiro-Wilk test were used to establish the normality of all dependent variables across the control and experimental groups, respectively. The *p*-value was established at 0.05. To find the significant differences between the two groups during both pre- and post-testing periods, the mean values of the relevant parameters were compared between the two groups using a repeated measure MANOVA test.

3. Results:

Forty-eight of the sixty-four people with mild or moderate CTS were found to satisfy the study's inclusion criteria. Figure 6 represents a flow chart of screened, excluded, included and randomized number of patients. The 48 patients were randomized into 2 groups: the control group (A) received a physiotherapy rehabilitation program only (n = 24), and the experimental group (B) received Kinesiotaping added to the physiotherapy rehabilitation program (n = 24). From this, 4 patients dropped out during the first week, 5 patients during the second week, and 3 patients during the third week therefore, the follow-up assessment was performed for 18 patients for each group.

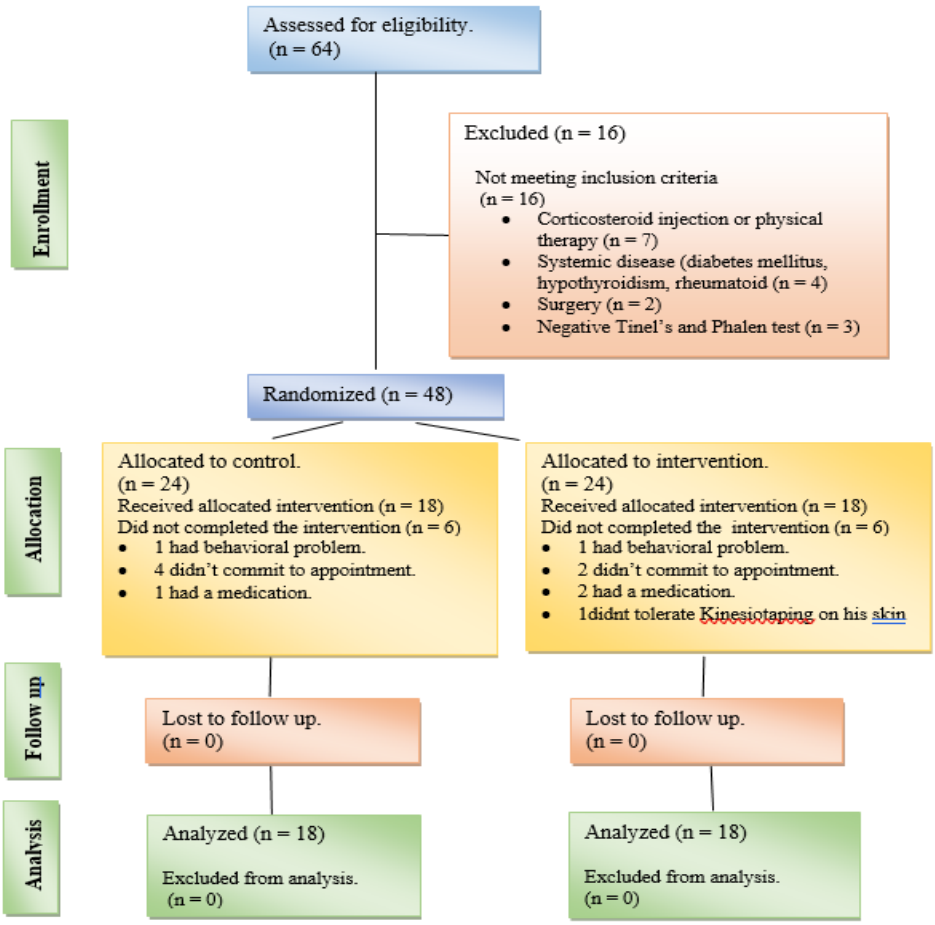

Figure 6: Flow chart

The mean ± standard deviation (SD) of all demographic data is presented in **Table 1**. Comparing the mean values of age, weight, height, and BMI for all patients in both groups using the independent sample t-test revealed that there were no significant differences between them in age (p = 0.287), weight (p = 0.180), and BMI (p = 0.087), while a significant difference had been observed in height (p = 0.001), as shown in **Table 1.**

The distribution of males and females in the control group was 55.6 % (10) and 44.4 % (8) respectively, while in the experimental group, it was 94.4 % (17) and 5.6 % (1) respectively. Comparing the sex distribution for all patients in the control and experimental groups using the Chi-square test revealed that there were significant differences between groups (p = 0.003). The distribution of affected side, right and left sides in the control group was 55.6 % (10) and 44.4 % (8) respectively, while in the experimental group, it was 77.8 % (14) and 22.2 % (4) respectively. Comparing the affected side distribution for all patients in the control and experimental groups using the Chi-square test revealed that there were significant differences between groups (p = 0.046), as shown in **Table 2.**

Table 1: Evaluation of demographic data in both groups.

Variable	Mean ± SD		t-value	P-value	Sig.
	Group A N = 18	Group B N = 18			
Age (years)	39.44 ± 3.568	40.11 ± 3.496	-.566	0.287	NS
Weight (kg)	78.89 ± 12.252	75.72 ± 7.760	.926	0.180	NS
Height (cm)	171.94 ± 8.299	163.78 ± 6.264	3.332	0.001	Sig
m2)/BMI (kg	26.70 ± 3.88	28.27 ± 2.86	-1.386	0.087	NS

*SD = Standard deviation, *t-value = t-statistic, *P-value= probability, *Sig. =Significance, *NS=non-significant.

Table 2: The frequency and the chi-squared test for comparison of sex and affected side distribution between groups.

	Group A N = 18	Group B N = 18	$\chi 2$ value	p-value	Sig
Females	10 (55.6 %)	17 (94.4 %)	9.00	0.003	Sig
Males	8 (44.4 %)	1 (5.6 %)			
Right	10 (55.6 %)	14 (77.8 %)	4.00	0.046	Sig
Left	8 (44.4 %)	4 (22.2 %)			

MANOVA:

Repeated measure ANOVA was conducted to study the effect of rehabilitation timing on VAS, Wrist ROM (flexion, extension, radial and ulnar deviation), functional disability (Boston Carpal Tunnel Questionnaire symptom and function), hand grip power (dynamometer) and hand skills (Moberg pick up test open and close) in both groups, as shown in **Table 3.** Mean values and individual assessments of between-group significant difference in adding dependent variable was assessed by independent sample t-test and presented in **Table 4.**

Table 3: Repeated measure ANOVA testing between group A (Control) and B (experimental).

Repeated measure ANOVA		
Interaction effect (Group * time)		
VAS	F = 7.766	*p* < 0.001*
Wrist Flexion ROM	F = 39.617	*p* < 0.001*
Wrist Extension ROM	F = 9.749	*p* = 0.004*
Wrist Ulnar deviation ROM	F = 6.399	*p = 0.016**
Wrist Radial deviation ROM	F = 1.464	*p = 0.235*
Boston Carpal Tunnel Questionnaire Symptom	F = 9.918	*p = 0.003**
Boston Carpal Tunnel Questionnaire Function	F = 3.022	*p = 0.091*
Dynamometer	F = 13.973	*p < 0.001**
Moberg pick up test open	F = 0.025	*p = 0.876*
Moberg pick up test close	F = 0.009	p = 0.923
Effect of time		
VAS	F = 329.347	*p* = 0.009*
Wrist Flexion ROM	F = 514.079	*p* < 0.001*
Wrist Extension ROM	F = 464.729	*p* < 0.001*
Wrist Ulnar deviation ROM	F = 356.243	*p* < 0.001*
Wrist Radial deviation ROM	F = 260.287	*p* < 0.001*
Boston Carpal Tunnel Questionnaire Symptom	F = 157.781	*p* < 0.001*
Boston Carpal Tunnel Questionnaire Function	F = 112.139	*p < 0.001**
Dynamometer	F = 95.300	*p < 0.001**
Moberg pick up test open	F = 163.315	*p < 0.001**
Moberg pick up test close	F = 206.968	*p < 0.001**

Table 4: Mean values of all dependent variables in group A (Control) and B (experimental) comparisons.

Variable	Group A N=18 $\bar{x}$ ± SD	Group B N=18 $\bar{x}$ ± SD	MD	p-value	Sig
VAS (mm)	48 ±12.12	39.11±11.82	7.766	<0.001*	Sig
Wrist Flexion ROM (degrees)	51.33 ±4.92	53.78±3.73	39.617	0.051	NS
Wrist Extension ROM (degrees)	48.22±4. 65	48.89±3.86	9.749	0.321	NS
Wrist Ulnar deviation ROM (degrees)	19.44±1.62	20.17±2.18	6.399	0.133	NS
Wrist Radial deviation ROM (degrees)	15.28 ±1.18	15.39±1.65	1.464	0.409	NS
BCTQ Symptom	2.39±0.62	1.98±0.46	9.918	<0.001*	Sig
BCTQ Function	2.25±0.64	1.81±0.60	3.022	<0.001*	Sig
Dynamometer (%)	4.89 ±0.79	5.65±0.81	13.973	<0.001*	Sig
MPUT open (seconds)	13.25 ±1.88	12.22±2.05	0.025	0.062	NS
MPUT close (seconds)	17.64 ±1.53	16.53±1.48	0.009	<0.001*	Sig

SD = Standard deviation, *t-value = t-statistic, *P-value= probability, *Sig. =Significance, *NS=non-significant

4. Discussion:

Results of this study revealed that adding Kinesiotaping to physiotherapy rehabilitation programs reduces pain intensity, increases wrist range of motion, and improves hand grip strength, as well as hand skills in chronic carpal tunnel syndrome patients.

The recorded improvement in pain intensity levels among carpal tunnel syndrome participants could be explained based on the previously reported positive effects of rehabilitation on the improvement in blood and lymphatic circulation **[37].** Furthermore, it may be attributed to the selective proprioceptive stimulation as well as mechanoreceptors stimulation, due to feedback from large-diameter afferent nerve fibers and reduction in the excitability of small-diameter nerve fibers, all of which makes it easier to modulate and reduce the intensity of pain **[38].** The current study's findings are consistent with earlier research showing that Kinesiotaping included in the rehabilitation program reduced pain severity, only for a short term **[39].**

Our results revealed no significant difference in the wrist ROM (flexion, extension, ulnar and radial deviation) between groups at the end of the program. This finding may be explained that Kinesio taping didn't interfere with daily activities because it just maintains the wrist in a neutral position which in turn increases the carpal tunnel volume, reduces the pressure on the median nerve and further reduces the inflammation and facilitates symptom reduction and the technique of application of taping cannot improve wrist motion therefore, both groups demonstrated improvement in wrist ROM without significant differences in between **[40].**

On the other hand, recent clinical trials have reported that although Kinesiotaping is safe and a widely tolerable therapeutic approach, certain restrictions have been reported, such as decreased abilities in placing the affected wrist joint to optimize space in the carpal tunnel. This lowers the capacity to regulate force output, which does not preclude the usage of powerful hand movements that are significantly related to chronic carpal tunnel syndrome **[41].**

The current study results revealed that the functional disability was significantly reduced after rehabilitation in both groups. This comes in agreement with some evidence stated in recent research that Kinesiotaping improved the clinical outcomes in CTS patients in the form of a reduction of symptom severity and improvement in wrist function and ROM **[42].**

On the other hand, a recent clinical trial reported that adding Kinesiotaping to a physiotherapy rehabilitation program might activate and speed up the healing and repair process. The reported success of Kinesiotaping in the reduction of symptoms severity was expressed in the form of improvement of clinical outcomes especially pain among chronic carpal tunnel syndrome patients although the actual mechanism of action is still unknown, mainly the prime complaints that focus on pain intensity which leads to functional limitations **[43].**

The significant differences between groups in hand grip strength observed in this study come in agreement with a previous one which studied the effect of Kinesiotaping combined with TENS. The beneficial effect of this combination was explained by the anti-inflammatory effect of that treatment in addition to the tactile stimulation which was reflected in the observed improvement in the clinical outcomes of CTS **[44].**

On the other hand, according to a recent clinical trial, Kinesiotaping may activate mechanoreceptors, which in turn stimulate the sense of retraining and maintaining motor abilities. This, in turn, stimulates additional circulatory supply and lymphatic drainage, which in turn results in profound improvements in muscle strength **[45].**

However, a recent clinical trial found that while Kinesiotaping may activate mechanoreceptors, there is no significant difference in maximal grip strength measured under three different conditions (without taping, with placebo tape, and KT) in 21 healthy undergraduate athletes **[6].**

Our results revealed no significant improvement in hand skill (MPUT open) between groups. However, there was a significant improvement in hand skill (MPUT close) of group A compared with that of group B post-treatment.

As per the results of the present investigation, there is evidence to suggest that the addition of Kinesiotaping as a therapeutic technique could have significant anti-inflammatory effects. One probable explanation for the effectiveness of taping could be its ability to stimulate neuromuscular circuits through increased afferent stimulation, providing patients with persistent carpal tunnel syndrome with clinical relief **[46].**

Furthermore, Graf et al. (2022) ensured that the application of the Kinesiotaping muscle facilitation technique in healthy individuals, as well it might be used to facilitate small immediate increases in muscle strength by producing a concentric pull on the fascia, which may stimulate increased muscle contraction **[47, 9].**

The current study's main limitation was that it did not examine the long-term effect of adding Kinesiotaping to a physiotherapy rehabilitation program on pain severity, wrist range of motion, hand grip strength, or hand skill in patients with chronic carpal tunnel syndrome. This is because there is a dearth of literature on similar interventional clinical trials, which could guarantee the immediate effectiveness of adding Kinesiotaping to the physiotherapy rehabilitation program on outcome measures. Moreover, clinical evidence suggests that Kinesiotaping may be a better treatment option for chronic carpal tunnel syndrome in both men and women over a longer period of time.

Kinesiotaping and the physical therapy rehabilitation program are suggested therapies for carpal tunnel syndrome patients because they reduce pain intensity, increase wrist flexion range of motion, reduce wrist functional impairment (symptoms and functional scores), and improve hand grip power. The effects of different exercise and intervention kinds on wrist extension range of motion (ROM), wrist ulnar deviation range of motion (ROM), wrist radial deviation range of motion (ROM), and hand skills (open and closed eyes) are areas that require further research for people with CTS.

More research is needed to determine how Kinesiotaping affects persons with CTS's pain and function when wearing orthoses and splints. To definitively demonstrate the efficacy of this therapeutic method, larger trials with longer follow-up and comparison studies may be conducted. We believe that more research is necessary to compare different taping approaches, as this could yield more information.

5. Conclusion:

The current study found that an effective way to improve wrist functional impairments (symptoms and functional scores), hand grip power, wrist flexion range of motion, and pain intensity is to combine treatment with Kinesiotaping and physical therapy rehabilitation programs. On the other hand, Kinesiotaping did not affect hand skills (open and closed eyes), wrist radial deviation ROM, wrist ulnar deviation ROM, or wrist extension ROM.

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