

Efficacy of Manual Therapy Interventions on Symptoms Severity and Functional Status in Patients with Carpal Tunnel Syndrome

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Abstract:

Carpal Tunnel Syndrome (CTS) represents the most common compressive mono-neuropathy of the upper limbs and leads to significant disability. **Aim:** This study aimed to evaluate the efficacy of manual therapy interventions on symptoms severity and functional status in patients with CT. **Design:** A pretest and post-test quasi-experimental research design was used. **Setting:** This study was conducted in Outpatient Clinic of Neurology, allied to Zagazig University Hospitals. **Sample:** A Purposive sample of 50 adult patients with diagnosis of mild to moderate CTS. **Tools:** A Structured Interview Questionnaire for Patients with Carpel Tunnel Syndrome, Boston Carpal Tunnel Questionnaire (BCTQ), and Patient-Rated Wrist Evaluation (PRWE) Questionnaire. **Results:** There was significant improvement in symptoms severity and functional status post-manual therapy interventions with mean scores 58.18 ± 15.0 & 33.9 ± 10.21 respectively at p- value <0.001 . There was a highly statistically significant difference regarding patient-rated wrist evaluation at pre- and post-manual therapy interventions with mean scores 70.17 ± 11.97 & 30.92 ± 9.13 respectively at p- value < 0.001 . **Conclusion:** According to the study findings, it can be concluded that application of manual therapy interventions for patients with CTS had a statistically significant effect on enlightening symptoms severity, improving functional status, wrist pain, and functional disability in activities of daily living, which supported the proposed hypotheses. **Recommendations:** c Additional research on larger probability sample is recommended to compare different combinations of manual therapy interventions in management of CTS.

Keywords: *Carpal Tunnel Syndrome, Functional status, Manual Therapy interventions, & Symptoms severity.*

Introduction:

Carpal Tunnel Syndrome (CTS) is the most mutual syndrome of peripheral nerve entrapment of the upper limb and involves compression of the median nerve as it passes through the carpal tunnel (Lytras et al., 2020). The incidence of the syndrome in the general population reaches 99/100.000 people. Global prevalence rates range between 7% and 19%. People over the age of 40 are more susceptible while women make up 65-75% of cases (Kazantzidou et al., 2021). Carpal tunnel syndrome is described by tenderness and paresthesia in the allocations of the median nerve, as well as the palmar wall of the first finger, the second and third finger and the radial part of the fourth finger; it also implies a failure of feeling, manual acuity, and functionality. Though, the signs and symptoms differ and do not compare with the level of severity (Hernández-Secorún et al., 2021, Anwar et al., 2019, & Erickson et al., 2019).

The syndrome leads to weakness and atrophy of the thenar muscle in advanced stages, decreased sensation, reduced muscle strength, and positive irritation tests leading to hand disability (Salehi et al.,

2019). CTS restricts functionality and physical activity levels and causes problems in daily living activities (Tanriverdi et al., 2019).

Recurrent movements of the wrist and fingers or sustaining persistent uncomfortable positions of the wrists are the widespread professional risk factors in CTS. Other non-working factors integrate tendosynovitis of flexors of fingers, thickened diagonal carpal ligament, fracture or dislocation of the distal radius or lunate, rheumatoid arthritis, lipoma, diabetes, hyperthyroidism, and pregnancy (Osiak et al., 2021 & Ünver, & Akyolcu, 2018).

Conventional therapies have to be respected as the first care approach for patients with mild to moderate CTS. Additionally, several CTS patients attempt to stay away from surgical intervention and would like to find other remedies (Talebi et al., 2020). Non-surgical usual treatments, such as splinting, corticosteroid infusion, and physiotherapy involving manual therapy techniques, such as massage, nerve glide workouts and expanding, have been shown to be efficient in treating CTS (Multanen et al., 2021).

Manual therapy procedure is defined as the set of nimble movements practical with hands to lessen inflammation, soft tissues distension and pain, assemble or operate the soft tissues and the joints, advance the elasticity of the tissues, increase the range of motion of the joints, realize relaxation, progress muscle function, and restore normal movement (**Kazantzidou et al., 2021**). Massage involves systematic manipulations over the soft tissues of the body such as muscles, connective tissues, tendons, ligaments, and joints, aiming to aid blood circulation, muscle relaxation or creating physical stimulations, and is divided into various types of touching, pressing, or continuous movements on the skin and underlying tissues, which are used to relieve muscle tension and pain and to promote health (**Rezaei & Mahdavinejad, 2020**). Application of gliding exercises are known to stretch the adhesions and increase the gap between the transverse carpal ligament and the median nerve, enabling the venous return from the nerve bundle and reducing the carpal tunnel pressure (**Nakandala, 2019**).

Significance of the study:

Carpel tunnel syndrome signifies the most important occupational health problem with high social and commercial consequences. Patients with CTS often experienced pain which troubled daily activities functioning and deteriorated quality of sleep. The patients also were presented with serious difficulties in doing professional work. The restricting symptoms connected with CTS result in extremely high costs in both medical and non-medical costs. CTS has been recognized as the most common reason of sick leave, decreased efficiency, and personal fiscal losses among the different types of compressive neuropathies.

Aim of the study:

This study aimed to evaluate the efficacy of manual therapy interventions on symptoms severity and functional status in patients with carpal tunnel syndrome.

Through the following specific objectives:

- Assess severity of symptoms for patients with carpal tunnel syndrome.
- Evaluate functional status of the affected hand of patients with carpal tunnel syndrome.
- Assess wrist pain and functional disability in patients' activities of daily living.
- Design, implement, and evaluate effect of manual therapy interventions on symptoms severity and functional status in patients with carpal tunnel syndrome.

Hypotheses:

To accomplish the purpose of this study, the subsequent research hypotheses were formulated:

H1: Symptoms severity and functional status of patients with carpal tunnel syndrome will prove statistically significant improvements after performance of manual therapy interventions.

H2: Wrist pain and functional disability in activities of daily living of patients with carpal tunnel syndrome will demonstrate statistically significant improvements after application of manual therapy interventions.

Operational definitions:

Manual therapy interventions have been defined as "Structured approaches to manage symptoms and loss of function of patients with mild to moderate carpal tunnel syndrome to lessen tissue adhesion, increase range of motion of joints, increase wrist mobility, and reinstate normal movement through patients' acquisition of knowledge and application a blend of techniques of exercises (tendon and nerve gliding exercises) as well as massage technique".

Symptoms severity refers to the magnitude or severity of a group of complains related to wrist and hand experienced by patient which resulting from compression of the median nerve at the wrist such as numbness, weakness, and tingling. It was measured by symptoms severity scale.

Functional status is a patient's capability to carry out normal daily activities necessary to meet essential needs, achieve usual roles, and preserve health and well-being. Functional status may alter from maximum ability of doing daily activities to severe disability. It was measured by functional status scale.

Materials and Methods:

Research Design:

A pretest and post-test quasi-experimental research design was utilized to conduct the study. A quasi-experimental research designs examine whether there is a fundamental relationship between independent and dependent variables. Simply defined, the independent variable is expected to bring about some variation or change in the dependent variable (**Rogers & Révész, 2019**). In both experimental and quasi-experimental designs, the program or policy is considered as an 'intervention' in which a treatment – including the elements of the program/policy being evaluated – is tested for how well it accomplishes its objectives (**White & Sabarwal, 2014**).

Research Setting:

The current study was conducted in Outpatient Clinic of Neurology, which located on the fourth floor of Outpatients Clinics Hospital, consisted of 5 rooms "one room for new cases, one room for epileptic patients, one room for patients' follow up, and two rooms for taking sessions equipped with computer, data show projector, and projector's screen", affiliated

to Zagazig University Hospitals which was located at Sharkia Governorate, Egypt.

Subjects:

A purposive sample of 50 adult patients with diagnosis of mild to moderate CTS were recruited in this study. The sample was computed by power and sample size estimation program to provide power of 80% at confidence level 95%. The estimated sample size turned to be 50 patients with CTS who had received the manual therapy interventions. Formula of calculating sample size was

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{(N-1) \cdot e^2 + Z^2 \cdot p \cdot (1-p)}$$

Inclusion criteria: adults aged ≥ 18 years, both sexes, a positive diagnosis of mild or moderate CTS as diagnosed by a neurologist based on signs, physical symptoms, as well as by nerve conduction studies, and able to communicate verbally and follow instructions. **Exclusion Criteria:** physical disability, previous CTS surgery, participated in regular exercise activities or physical therapy program within the previous six months, took oral steroid within previous three month, medical problems contraindicated for massage therapy such as cuts, bruising, abrasions, skin infection, or open wounds of affected hand, steroid injection into the wrist, recent fracture, deformity, or tumor of hand /wrist, diabetes mellitus, renal/hepatic diseases, thyroid disorders, gout, fibromyalgia, rheumatoid arthritis, osteoarthritis, cervical disc hernia, epilepsy, or post stroke conditions.

Tools of data collection:

Tool I: A Structured Interview Questionnaire for Patients with Carpel Tunnel Syndrome: It was developed by the researchers based on reviewing related literature and opinions of experts for content validity. The questionnaire covered two main parts as the following:

Part I: Patient's Demographic Data: It included 8 items of demographic data of patients such as age, gender, marital status, level of education, occupation, residence, living status, and lifestyle job post disease.

Part II: Patient's Medical History: It involved 5 questions about the medical history of the patients related to duration of hand symptoms, incidence of disease, methods of management, other health problems, and associated manifestations.

Tool II: Boston Carpal Tunnel Questionnaire (BCTQ): (Pre/Posttest)

This questionnaire was applied to assess the severity of symptoms of carpal tunnel syndrome and functional status of the affected hand. It was adopted

from **Levine et al., (1993)**. It comprised of two subscales including:

First subscale: Symptoms Severity Scale: It was utilized to estimate nature, occurrence, and extent of wrist and hand symptoms. It contained 11 questions which included strictness of nocturnal pain, frequency of nighttime awakening due to pain, severity of daytime pain, incidence of daytime pain, duration of daytime pain, harshness of numbness, severity of weakness, sternness of tingling, severity of nocturnal numbness or tingling, rate of night awakening due to numbness or tingling, and struggle in grasping small objects

Second subscale: Functional Status Scale: It was utilized to assess effect of carpal tunnel syndrome on patients' normal daily activities. It composed of 8 items of daily activities: writing, buttoning clothes, holding, gripping, opening jars, household chores, carrying, as well as bathing and dressing.

Scoring system of Boston Carpal Tunnel Questionnaire (BCTQ):

Symptoms severity scale was on a 5-point rating scale, which ranged from 1 (normal) to 5 (very serious). The overall result of this scale was calculated as the mean of all 11 items based on statistical analysis. Thus, a higher symptoms severity score indicated worse symptoms. Functional status scale was a 5-point rating scale where there was five-level responses set scored from 1 to 5 (1= no difficulty; 2=mild; 3=moderate; 4=severe; and 5=very severe). The overall score of this scale was calculated as the mean of all 8 daily activities items based on statistical analysis. Thus, a higher functional status score implied worse dysfunction.

The overall score for Boston Carpal Tunnel Questionnaire was calculated as the mean of all 19 items based on statistical analysis. Thus, a higher Boston Carpal Tunnel Questionnaire score indicated worse symptoms and worse dysfunction.

Tool III: Patient-Rated Wrist Evaluation (PRWE) Questionnaire: (Pre/Posttest)

This tool was used to evaluate wrist pain and functional disability in patients' activities of daily living. It was adopted from **Kleinlugtenbelt et al., (2018)**. It comprised of 15 items divided in to 3 subscales including:

First subscale: Pain Scale: It was utilized to assess severity of patients' wrist pain at rest, when doing a repeated wrist movement, when lifting a heavy object, time of its worst, and its frequency. It included 5 items on a 10-point rating scale, where the patient had the option to verbally rate pain severity on a scale from 0 to 10; (0) indicated absence of pain, while (10) represented the worst pain he had ever experienced.

Second subscale: Function-Specific Activities Scale: It was used to evaluate functional disability in

patients' specific activities of daily living. It contained 6 items which included using affected hand for turning a doorknob, cutting meat, fastening buttons, pushing up from a chair, carrying objects, and using bathroom tissues, on a 10-point rating scale ranged from 0 (no difficulty) to 10 (unable to do).

Third subscale: Function-Usual Activities Scale: It was utilized to assess functional disability in patients' usual activities of daily living. It consisted of 4 items which included personal care activities, household work, work, and recreational activities, on a 10-point rating scale which was ranged from 0 (no difficulty) to 10 (unable to do).

Scoring system of PRWE Questionnaire:

The overall result of pain scale was the calculated sum of all 5 items (out of 50). The maximum score in this section was 50 and minimum 0. The overall result of function-specific activities was the calculated sum of all 6 items and further divided by 2 (out of 30). The maximum score in this section was 30 and minimum 0. The overall result of function-usual activities was the calculated sum of all 4 items and further divided by 2 (out of 20). The maximum score in this section was 20 and minimum 0.

The overall score for PRWE Questionnaire was calculated as the mean of all 15 items which was 100 where "0" was the best score while "100" was the worst score based on (Wietlisbach, 2020). Thus, the higher score the poorer outcome.

Content validity and Reliability: of the planned tools by utilizing face and content validity. Face validity aimed at reviewing the elements to decide whether the tools measured what supposed to measure. Content validity was conducted to ascertain whether the subject of the tools covered the aim of the study. Tools were revised by five experts in each specialty and academic position "three of them were professors and two of them were assistant professors of medical surgical nursing from Faculty of Nursing at Zagazig University and Neurology staff from Faculty of Medicine at Zagazig University "who reviewed the content of tools for clarity, relevance, comprehensiveness, understanding, and ease for implementation". According to their opinions, minor modifications were done, and the final form was developed.

The reliability of the tools was tested using the internal consistency method. It was found that Cronbach's alpha reliability coefficient was 0.863 for Boston Carpal Tunnel Questionnaire while Patient-Rated Wrist Evaluation Questionnaire was reliable at 0.856. Content validity and reliability tests were done before starting of data collection.

Ethical considerations:

Before the initial interview, an oral consent was secured from each subject after being notified about

the character, objective, and advantages of the study. Subjects were also knowledgeable that membership was voluntary and about their right to abandon at any time devoid of giving excuses. Privacy of any attained data was ensuring through coding of all data. The researchers confident patients that the data would be used for only the research objective.

Pilot study:

A pilot study was conducted on 10% of the overall study subjects (5 patients) to measure the precision and feasibility of the tools and to approximate the required time to fill in each document. Basic modifications were done according to the pilot study findings. Pilot subjects were later excluded from the main study sample.

Field work:

Official permissions to conduct the proposed study were obtained by the researchers from general director of Zagazig University Hospitals, and head of Outpatient Clinic of Neurology to carry out the study. Letters were issued to them from Faculty of Nursing, Zagazig University explaining the aim of the study to obtain their permission and help. Informed consents were secured from subjects in this study after explaining the nature, purpose, and benefits of the study. The researchers interviewed patients at Outpatient Clinic of Neurology three days a week on Sunday, Tuesday, and Thursday. Patients were assigned to receive manual therapy interventions provided by the researchers.

The study was conducted through preparatory, assessment, planning, implementation, and evaluation phases. These stages were conducted over a time of six months from the starting of January 2022 to the end of June 2022.

Preparatory phase:

This phase was pertaining to construction of the study tools and production of manual therapy interventions by the researchers based on extensive review of current, related literature; (American Academy of Orthopedic Surgeons, 2010, American Academy of Orthopedic Surgeons, 2018, & Talebi et al., 2020), which were written by simple Arabic language and contained illustrative pictures for more illustrations to facilitate patients' understanding.

Assessment phase:

The researchers interviewed patients who gave their consents and fulfilled the eligibility criteria, explained to them nature and purposes of the study. The researchers introduced themselves to patients to set a line of communication. The researchers interviewed patients individually at Outpatient Clinic of Neurology utilizing the data collection tools as a pre-test. Tool, I & II took about 15-20 minutes and tool III took about 15 minutes to be filled from each patient to collect the necessary data. The obtained

data served as baseline data and guided the researchers in the formulation of manual therapy interventions.

Planning phase:

During this phase, the researchers designed manual therapy interventions based on patients' needs which identified in the assessment phase and review of the most recent and relevant literature.

Training methods were chosen to outfit teaching of small groups in the form of lectures, group discussion, demonstration, and re-demonstration. Teaching media were arranged as PowerPoint presentation, video-films, colored posters, and illustrative pictures. Also, manual therapy interventions schedule was prepared. Additionally, the researchers prepared an illustrative leaflet in easy Arabic language to help patients assimilate and invigorate the provided information to attain aim of the study.

Implementation phase:

The manual therapy interventions were implemented in the form of sessions which was carried out in study setting. The researchers distributed patients into small groups including 5 patients in each group. The content of the manual therapy interventions was distributed over 6 consecutive sessions, including theoretical and practical part.

The first session was for orientation to clarify aim and contents of the manual therapy interventions, general objectives, intended learning outcomes, teaching methods, teaching media, learner's activities, and evaluation methods.

This was followed by two sessions for the theoretical part. One session covered definition of CTS, its causes, clinical manifestations, and methods of treatment. The other session included the necessary information related to types of exercises, importance of each exercise, precautions during exercises, as well as importance and precautions of massage technique. Three sessions covered practical part regarding manual therapy interventions which included the combination of techniques of exercises (tendon and nerve gliding exercises) as well as massage technique. Manual therapy interventions primarily depended on the principal of patient's learning how to work out home exercises and self-massage under the researchers' guidance.

Two sessions for tendon and nerve gliding exercises techniques demonstration and re-demonstration. Tendon and nerve gliding exercises were taught to patients practically by the researchers then patients were asked to re-demonstrate the exercises by themselves under researchers' supervision until the researchers made sure that participants acquired the required skills. They were promptly intervened to correct their missteps, if any.

Exercises involved wrist flexion exercise for 15 seconds repeated 5 times per day, wrist extension exercise for 15 seconds repeated 5 times per day, and shoulder turn exercise 10 times for 5 sessions per day. Tendon gliding exercises was performed in the way that the fingers would be in five positions: straight, hook, fist, tabletop, and straight fist for 20 second repeated 5 times per day. Nerve gliding exercises was performed in the way that hand and wrist would be in six positions For 20 seconds repeated 5 times per day; First, wrist in neutral position, fingers and thumb are in flexion; second, wrist in neutral position, fingers and thumb are in extension; Third, wrist and fingers are in extension, thumb is in neutral position; Fourth, wrist, fingers and thumb are in extension; Fifth, the same as in fourth position but forearm is in supination; and Sixth, The same as in fifth position but gently stretching thumb with the other hand. Tendon and nerve gliding exercises are followed by 5 minutes for video-films showed exercises techniques.

One session for massage technique demonstration and re-demonstration. Hand massage began with 30-s effleurage, remained with 60-s friction, 30-s petrissage, 30-s shaking, and culminated with 30-s effleurage. It totally took 3 minutes. This method provided a rapid and effective approach to hand and forearm tissues. Massage technique was followed by 5 minutes for video-films showed massage technique. Participants were advised to carry out their allocated exercises and massage technique autonomously at home, completed one session a day on at least 5 days a week, for 4 weeks. Patients recorded the time they performed exercises and massage technique every day on follow up schedule. This schedule was given them at the beginning of the manual therapy interventions, and they received instructions for filling out the schedule. Also, they were instructed to fulfill with medications recommended by their physicians and wear splint at evening.

Furthermore, in case participants forgot, to remember tendon and nerve exercises and massage technique, a compact disk (CD) including video-films showing exercises and massage techniques were given to patients.

An educational booklet about tendon and nerve gliding exercises and massage technique was provided to patients, and they were notified to end acting the exercises or massage if they felt pain or exhaustion. Also, patients were instructed to drink water after receiving a massage to eliminate toxin and lactic acids developed during massage process. Period of every session was 30–45 minutes.

The patients were phoned by the researchers for follow up and encouraged to do exercises and massage technique completely and regularly at home.

Evaluation phase:

It was the last phase which was carried out one month after manual therapy interventions implementation to evaluate their effect by the using of the same pre-test tools as A Structured Interview Questionnaire, Boston Carpel Tunnel Questionnaire, and Patient-Rated wrist evaluation Questionnaire.

Statistical Design:

The collected data organized, tabulated, and statistically analyzed using Statistical Package for Social Science (SPSS) version 25 for windows, running on IBM compatible computer. Descriptive statistics were applied (e.g., frequency, percentages,

mean and standard deviation). Dependent (t) test was utilized to compare mean scores. Pearson correlation coefficient test (r) was used to test the correlation between studied variables. Multivariable logistic regression was done to determine the presence of statistical association between independent variables and the outcome variable and its strength with direction. Reliability of the study tools was done using Cronbach's Alpha. A significant level value was considered when $p < 0.05$ and a highly significant level value was considered when $p < 0.01$. No statistical significance difference was considered when $p > 0.05$.

Results

Table (1): Percentage and Frequency Distribution of The Studied Patients According to Their Demographic Data (n=50).

Demographic data	No.	%
Age (Year)		
30-<40	18	36.0
40-<50	22	44.0
50-60	10	20.0
\bar{x} S.D	44.91±8.25	
Gender		
Male	7	14.0
Female	43	86.0
Marital Status		
Married	48	96.0
Not married	2	4.0
Educational level		
Educated	48	96.0
Not educated	2	4.0
Occupation:		
Working	20	40.0
Not working	30	60.0
Residence		
Rural	35	70.0
Urban	15	30.0
Living status		
With family	50	100.0
Without family	0	0.0
Life style regarding their job post-disease		
No change in job	20	40.0
Work part time.	0	0.0
Leave work.	0	0.0
Have new job.	0	0.0
Not work	30	60.0

Table (2): Percentage and Frequency Distribution of the Studied Patients According to Their Medical History (n=50).

Items	No.	%
Duration of hand symptoms (months)		
<12	25	50.0
12-<24	4	8.0
24-<36	6	12.0
≥ 36	15	30.0
\bar{x} S.D	26.4 ± 10.71	
Incidence of disease		
Unilateral	5	10.0
Bilateral	45	90.0
*Method of management		
Medications	29	58.0
Splinting	37	74.0
Physiotherapy	10	20.0
Duration of Physiotherapy (n=10)		
<36 months	3	30.0
36-<48 months	5	50.0
≥ 48 months	2	20.0
\bar{x} S.D	40.5 ± 12.15	
*Other health problems		
Hypertension	25	50.0
Cancer	0	0.0
Bone Fracture	0	0.0
Respiratory diseases	17	34.0
Gastric disease	28	56.0
Cardiovascular diseases	5	10.0
Visual Impairment	14	28.0
*Associated manifestations		
Pain	50	100.0
Numbness and tingling in hand and shoulder	50	100.0
Paresthesia	28	56.0
Atrophy of muscles	0	0.0
Weakness in hands	34	68.0
Burning in palm of hand and thumb	29	58.0
Itching in palm of hand and thumb	17	34.0

Table (3): Distribution of Mean Scores Reported by Patients Regarding Boston Carpal Tunnel Subscales at Pre- and Post-Intervention (n=50).

Items	No. of items	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	t	P-value
Symptoms Severity Scale	11	31.77 ± 9.18	20.34 ± 6.08	19.67	0.000**
Functional Status Scale	8	26.41 ± 5.91	13.56 ± 4.13	15.63	0.000**
Total	19	58.18 ± 15.06	33.9 ± 10.21	21.67	0.000**

t = t.test.

** Highly statically significant at $p < 0.01$.**Table (4): Distribution of Mean Scores Reported by Patients Regarding Patient-Rated Wrist Evaluation at Pre- and Post-Intervention (n=50).**

Items	No. of items	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	t	P-value
Pain	5	38.21 ± 5.88	17.74 ± 4.75	11.27	0.000**
Function—Specific activities	6	19.2 ± 3.25	7.250 ± 2.31	15.30	0.000**
Function—Usual activities	4	12.76 ± 2.84	5.93 ± 2.07	11.96	0.000**
Total	15	70.17 ± 11.97	30.92 ± 9.13	18.73	0.000**

t = t.test.

** Highly statically significant at $p < 0.01$.

Table (5): Correlation Between Boston Carpal Tunnel Subscales and Patient-Rated Wrist Evaluation Subscales Among the Studied Patients at Pre- and Post-Intervention (n=50).

Variables		Symptoms Severity Scale		Functional Status Scale		Pain		Function-Specific activities	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Functional Status Scale	r	0.471	0.532						
	p	0.000**	0.000**						
Pain	r	0.435	0.555	0.408	0.479				
	p	0.000**	0.000**	0.001**	0.000**				
Function-Specific activities	r	0.463	0.527	0.301	0.444	0.524	0.627		
	p	0.000**	0.000**	0.001**	0.000**	0.000**	0.000**		
Function-Usual activities	r	0.451	0.503	0.299	0.415	0.548	0.615	0.508	0.620
	p	0.000**	0.000**	0.004**	0.001**	0.000**	0.000**	0.000**	0.000**

r = correlation coefficient test. * Significant at $p < 0.05$. ** Highly significant at $p < 0.01$.

Table (6): Multiple Linear Regression Model Predisposing Factors for Boston Carpal Tunnel Among the Studied Patients at Post-Intervention.

Items	Unstandardized Coefficients		Standardized Coefficients	t	P. Value
	B	Std. Error	B		
Constant	11.99	.315		4.873	.000
Age	.134	.091	.205	1.521	.009
Educational level	.281	.078	.379	2.552	.000
Occupation	.121	.067	.143	1.965	.007
Duration of hand symptoms	.305	.052	.352	3.319	.000
Incidence of disease	.294	.060	.310	3.008	.000
Patient-rated wrist evaluation	.678	.128	.559	5.831	.000
Model summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	
	0.717	0.696	0.682	0.26937	
ANOVA					
Model	Sum of Squares	df	Mean Square	F	P. Value
Regression	14.61	6	1.999	14.91	0.000**

Highly significant at $P < 0.01$ T: t-test value. F: ANOVA df: degree of freedom

A. **Dependent Variable:** Total Boston carpal tunnel.

B. **Predictors: (constant):** Age, Educational level, Occupation, Duration of hand symptoms, Incidence of disease and Patient-rated wrist evaluation.

Table (7): Multiple Linear Regression Model of Predisposing Factors for Patient-Rated Wrist Evaluation among the Studied Patients at Post-Intervention.

Items	Unstandardized Coefficients		Standardized Coefficients	t	P. Value
	B	Std. Error	B		
Constant	8.621	.708		4.097	.000
Age	.113	.052	.191	2.009	.000
Educational level	.273	.097	.313	3.027	.000
Occupation	.233	.053	.221	2.701	.000
Duration of hand symptoms	.542	.127	.384	4.036	.000
Incidence of disease	.405	.101	.414	3.501	.000
Boston carpal tunnel	.686	.132	.559	5.831	.000
Model summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	
	0.781	0.705	0.697	0.29371	
ANOVA					
Model	Sum of Squares	df	Mean Square	F	P. Value
Regression	15.82	6	2.083	15.80	0.000**

Highly significant at $P < 0.01$. T: t-test value. F: ANOVA df: degree of freedom

A. **Dependent Variable:** Total Patient-rated wrist evaluation.

B. **Predictors: (constant):** Age, Educational level, Occupation, Duration of hand symptoms, Incidence of disease and Boston carpal tunnel.

Table (1): Shows that the age of 44.0 % of studied patients was 40-<50 years with the mean age 44.91 ± 8.25 , as majority of them (86.0 %) were females, the most of them (96.0 %) were educated, and 60.0 % were not on the job because they were housewives. All the study sample (100.0%) live with family. More than two thirds (70.0%) of studied patients live in rural.

Table (2): Reveals that the duration of hand symptoms for half (50.0 %) of studied patients was <12 months. 90.0 % of studied sample had bilateral incidence of disease, 74.0 % of studied patients used splinting, while only 20.0 % used physiotherapy as methods of management. All studied sample (100.0 %) suffered from pain, numbness, and tingling in hand and shoulder and 68.0 % had Weakness in hands.

Table (3): Points that there was a highly statistically significant difference concerning Boston carpal tunnel subscales at pre- and post-intervention with mean scores 58.18 ± 15.0 & 33.9 ± 10.21 respectively at p- value ≤ 0.001 .

Table (4): Indicates that there was a highly statistically significant difference regarding patient-rated wrist evaluation at pre- and post-intervention with mean scores 70.17 ± 11.97 & 30.92 ± 9.13 correspondingly at p- value ≤ 0.001

Table (5): Reveals that there was a positive correlation coefficient between Boston carpal tunnel subscales and patient-rated wrist evaluation subscales among the studied patients at pre- and post-intervention at p- value = 0.001.

Table (6): Shows the model for predisposing factors for Boston carpal tunnel score among the studied patients at post-intervention. The table explores the significant positive predictors of this score throughout post phase were age, educational level, occupation, duration of hand symptoms, incidence of disease and patient-rated wrist evaluation. As r- square indicates, 69.0 % of the variance of Boston carpal tunnel score.

Table (7): Indicates the model for predisposing factors for patient-rated wrist evaluation score among the studied patients at post-intervention. The table points that the significant positive predictors of this score throughout post phase were age, educational level, occupation, duration of hand symptoms, incidence of disease and Boston carpal tunnel. As r- square indicates, 70.0 % of the variance of patient-rated wrist evaluation score.

Discussion

Manual therapy includes a set of influences and practices that affect the biological processes in the body. Their activity diminishes pain, promotes rebuilding methods, improves range of motion (ROM), motivates immune system, and enhances biochemical performance. Compared to other

remedies the manual therapy is commonly used, inexpensive, non-invasive, and easy to apply it is also used in the treatment of patients with (CTS). This syndrome signifies the most common compressive mononeuropathy of the upper limb and leads to significant disability. (Zaralieva et al, 2021)

As regarding symptom severity and functional status, the present study pointed to there was a highly statistically significant difference at pre- and post-intervention. Where, there was an improvement in symptom severity and functional status post intervention compared to pre-intervention. According to the point of view of the researchers, this difference in symptom severity and functional status related to the manual therapy interventions (gliding exercises and massage). This result was in harmony with Talebi et al, (2018) & Ünver & Akyolcu, (2018) who stated that Significant improvement was initiated in wholly outcome events (visual analogue scale (VAS), Symptoms Severity Scale (SSS), Functional Status Scale (FSS), and Median neurodynamic test (MNT) in the manual remedy group than modality group. Soyuer, (2021) mentioned that gliding exercises relief symptoms by preventing, or extending, the adhesions among the tendons and median nerve, decreasing tenosynovial oedema, improving venous return and, thus, reducing pressure inside the carpal tunnel

According to patient-rated wrist evaluation, the current study revealed that there was a highly statistically significant difference at pre- and post-intervention. This finding was supported with Balletero-Pérez et al, (2017) who stated that studies evaluated the nerve gliding exercises as an isolated therapy stated that significant pain alleviation in all patients and between three quarters and most of patients get better function. Also, Hafez et al, (2014) who showed that there was a significant enhancement of pain, ROM of wrist flexion and extension, and hand grip in stretching group due to use exercise program that includes, nerve and tendon gliding exercise (stretching exercise), ultrasonic therapy, wrist splint, and strengthening exercises. This result was in contrast with Martins & Siqueira, (2017) who mentioned that nerve and tendon gliding exercises were less effective than splint immobilization in relieving pain and enhancing hand function.

The current study findings revealed that there was a positive correlation coefficient between symptom severity, functional status, pain, and functional of usual and specific activity among the studied patients at pre- and post-intervention. All items had high score (the worst result) before intervention and post intervention the score was decreased (the better result). According to the researchers' point of view

this result reflected the effect of the manual therapy interventions (exercises and massage) on enhancing functional status and reducing symptoms severity. These results were agreed with **Anwar et al, (2019)** who revealed that mean values for symptom severity in the study was diminished from moderate to mild symptoms category. As far as functional severity mean was too decreased in mild.

The present study pointed to that there were significant positive predictors of predisposing factors for Boston carpal tunnel score and patient-rated wrist evaluation score at post-intervention involved; age, educational level, occupation, duration of hand symptoms, incidence of disease and patient-rated wrist evaluation. These findings were supported by **Alsharif et al, (2017)** who stated that CTS is most common in patients aged 40- 60 years old. In the population of working age, the possibility of having CTS rises by 30% per decade. This supports that the median nerve is compromised by deteriorating events resulting from increased activity of the hands.

Moreover, Guan et al, (2018) added that, the effect of learning on the CTS is more showed in the low educational level. On the other hand, the low education degree for the recognition and understanding defects in the progress of health education, further diminished the ability of self-protection of their wrist in the process of work, which increased the risk of survival.

Conclusion

Corresponding to the study findings, it can be concluded that application of manual therapy interventions for patients with CTS had a statistically significant effect on enlightening symptoms severity, functional status, wrist pain, and functional disability in activities of daily living. There was a positive correlation between symptoms severity, functional status, pain, function-usual activities, and function-specific activities among the studied patients after manual therapy interventions, which supported the proposed hypotheses.

Recommendation

Based on results of the present study it can be recommended that:

1. More research on bigger probability sample is recommended to compare different patterns of manual therapy interventions in CTS.
2. Arabic booklet with simple language and different easy pictures should be accessible and presented for high-probability groups, involving guidelines for therapeutic exercises, massage, and lifestyle modification.
3. A rehabilitation program should be designed for every patient, corresponding to the clinical

pictures, the results of the clinical studies, the accompanying disorders, and in view of the professional history.

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