The Effect of Night Splinting and Hand Exercise on Reducing the Symptoms in Patients with Carpal Tunnel Syndrome

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ABSTRACT

Carpal tunnel syndrome is one of the most common peripheral neuropathies. It happens because of a pressure on the median nerve, which runs the length of the arm, goes through a passage in the wrist called the carpal tunnel, and ends in the hand. **Aim:** Determine the effect of night splinting and hand exercise on reducing the symptoms in patients with carpal tunnel syndrome. **Design:** A quasi-experimental research design was utilized. **Subjects**: A convenience sample of 60 adult patients admitted to the above-mentioned settings and diagnosed with carpal tunnel syndrome were recruited in this study. The present study was conducted at the Rass Al-Teen General Hospital, at Alexandria. **Tools**: Two tools were used. Tool I. Socio-demographic and Clinical Data Interview Schedule. Functional Status and Symptoms Severity in patients with carpal tunnel syndrome assessment questionnaire. Boston Carpal Tunnel Syndrome Questionnaire. **Results:** The majority of patients were in age group 50-60 year, and female had moderate difficult in functional status before program, there were a statistical significance difference in hand pain severity and hand pain description in the period before and after hand exercises program. **Conclusion:** Patients with carpal tunnel syndrome who receive night splinting and hand exercise exhibit reducing the symptoms. **Recommendations.** Educate patients about necessary hand and finger exercises and neural mobilization and night splinting stabilization instructions regarding their conditions and self-care activities using the booklet and illustrated pamphlets for each patient especially those who cannot read and write

Keywords: Splinting, Hand, Exercise, Carpal Tunnel Syndrome

Introduction

Carpal tunnel syndrome (CTS) occurs when the median nerve, which runs from the forearm into the palm, becomes pressed or squeezed at the wrist. The carpal tunnel a narrow, rigid passageway of ligament and bones at the base of the hand houses the median nerve and the tendons that bend the fingers. The median nerve provides feeling to the palm side of the thumb and the index, middle, and part of the ring fingers (although not the little finger). It also controls some small muscles at the base of the thumb. Sometimes, thickening from the lining of irritated tendons or other swelling narrows the tunnel and compresses the median nerve. The result may be numbness, weakness, or sometimes pain in the hand and wrist some people may feel pain in the forearm and arm). CTS is the most common and widely known of the entrapment neuropathies, in which one of the body's peripheral nerves is pressed on or squeezed **[Shechtman, Gestewitz, & Kimble, 2019]**.

Symptoms usually start gradually, with frequent numbness or tingling in the fingers, especially the thumb and the index and middle fingers. Some people with CTS say their fingers feel useless and swollen, even though little or no swelling is apparent. The symptoms often first appear in one or both hands during the night. The dominant hand is usually affected first and produces the most severe symptoms. A person with CTS may wake up feeling the need to "shake out" the hand or wrist. As symptoms worsen, people might feel tingling during the day **[Seradge, Bear, & Bithell, 2020]**. Women are three times more likely than men to develop carpal tunnel syndrome. People with diabetes or other metabolic disorders that directly affect the

body's nerves and make them more susceptible to compression are also at high risk. CTS usually occurs only in adults. Workplace factors may contribute to existing pressure on or damage to the median nerve. The risk of developing CTS is not confined to people in a single industry or job, but may be more reported in those performing assembly line work such as manufacturing, sewing, finishing, cleaning, and meatpacking than it is among data-entry personnel **[Randolph, 2018]**.

Early diagnosis and treatment are important to avoid permanent damage to the median nerve. A physical examination of the hands, arms, shoulders, and neck can help determine if the person's complaints are related to daily activities or an underlying disorder. A physician can rule out other conditions that mimic carpal tunnel syndrome **[Michlovitz, 2016]**. The wrist is examined for tenderness, swelling, warmth, and discoloration. Each finger should be tested for sensation and the muscles at the base of the hand should be examined for strength and signs of atrophy. Routine laboratory tests and X-rays can reveal fractures, arthritis, and nerve-damaging diseases such as diabetes. Specific tests may produce the symptoms of CTS. In the Tinel test, the doctor taps on or presses on the median nerve in the person's wrist **[McArdle, Katch, & Katch, 2016]**. The test is positive when tingling in the fingers or a resultant shock-like sensation occurs. The Phalen, or wrist-flexion, test involves having the person hold his or her forearms upright by pointing the fingers down and pressing the backs of the hands together **[Madenci, Altindag, Koca, Yilmaz, & Gur, 2019]**.

Carpal tunnel syndrome is suggested if one or more symptoms, such as tingling or increasing numbness, is felt in the fingers within 1 minute. Doctors may also ask individuals to try to make a movement that brings on symptoms **[MacDermid, & Wessel, 2014]**. Electrodiagnostic tests may help confirm the diagnosis of CTS. In a nerve conduction study, electrodes are placed on the hand and wrist. Small electric shocks are applied and the speed with which nerves transmit impulses is measured. In electromyography, a fine needle is inserted into a muscle; electrical activity viewed on a screen can determine the severity of damage to the median nerve **[Legg, 2018]**. Ultrasound imaging can show the abnormal size of the median nerve. Magnetic resonance imaging (MRI) can show the anatomy of the wrist but to date has not been especially useful in diagnosing carpal tunnel syndrome **[Kang, Koh, Lee, Choi, & Hahn, 2019]**.

Treatments for carpal tunnel syndrome should begin as early as possible, under a doctor's direction. Underlying causes such as diabetes or arthritis should be treated first. **Non-surgical treatments.** Splinting. Initial treatment is usually a splint worn at night. Avoiding daytime activities that may provoke symptoms. Some people with slight discomfort may wish to take frequent breaks from tasks, to rest the hand. If the wrist is red, warm, and swollen, applying cool packs can help. Over-the-counter drugs. In special circumstances, various medications can ease the pain and swelling associated with carpal tunnel syndrome. Nonsteroidal anti-inflammatory drugs (NSAIDs), such as aspirin, ibuprofen, and other nonprescription pain relievers, may provide some short-term relief from discomfort but haven't been shown to treat CTS **[Akalin, Peker, Senocak, Tamci, Gülbahar, & Once, 2018]**.

Corticosteroids such as prednisone or the drug lidocaine can be injected directly into the wrist or taken by mouth (in the case of prednisone) to relieve pressure on the median nerve in people with mild or intermittent symptoms. Caution that individuals with diabetes and those who may be predisposed to diabetes should note that prolonged use of corticosteroids can make it difficult to regulate insulin levels. Alternative therapies. Acupuncture and chiropractic care have benefited some individuals but their effectiveness remains unproved. An exception is yoga, which has been shown to reduce pain and improve grip strength among those with CTS **[Alfonso, Jann, Massa, & Torreggiani, 2018]**.

Carpal tunnel release is one of the most common surgical procedures in the United States. Generally, surgery involves severing a ligament around the wrist to reduce pressure on the median nerve. Surgery is usually done

under local or regional anesthesia (involving some sedation) and does not require an overnight hospital stay. Many people require surgery on both hands. While all carpal tunnel surgery involves cutting the ligament to relieve the pressure on the nerve, there are two different methods used by surgeons to accomplish this. *Open release surgery*, the traditional procedure used to correct carpal tunnel syndrome, consists of making an incision up to 2 inches in the wrist and then cutting the carpal ligament to enlarge the carpal tunnel. The procedure is generally done under local anesthesia on an outpatient basis, unless there are unusual medical conditions **[Atroshi, Larsson, Ornstein, Hofer, Johnsson, & Ranstam, 2019]**.

Endoscopic surgery may allow somewhat faster functional recovery and less postoperative discomfort than traditional open release surgery but it may also have a higher risk of complications and the need for additional surgery. The surgeon makes one or two incisions (about ½ inch each) in the wrist and palm, inserts a camera attached to a tube, observes the nerve, ligament, and tendons on a monitor, and cuts the carpal ligament as the tissue that holds joints together with a small knife that is inserted through the tube **[Carlson, Colbert, Frydl, Arnall, Elliot, & Carlson, 2020]**.

Following the surgery, the ligaments usually grow back together and allow more space than before. Although symptoms may be relieved immediately after surgery, full recovery from carpal tunnel surgery can take months. Some individuals may have infections, nerve damage, stiffness, and pain at the scar. Almost always there is a decrease in grip strength, which improves over time. Most people need to modify work activity for several weeks following surgery, and some people may need to adjust job duties or even change jobs after recovery from surgery. Recurrence of carpal tunnel syndrome following treatment is rare. Less than half of individuals report their hand(s) feeling completely normal following surgery. Some residual numbness or weakness is common **[Atroshi, Larsson, Ornstein, Hofer, Johnsson, & Ranstam, 2019]**.

At the workplace, workers can do on-the-job conditioning, perform stretching exercises, take frequent rest breaks, and use correct posture and wrist position. Wearing fingerless gloves can help keep hands warm and flexible. Workstations, tools, and tool handle, and tasks can be redesigned to enable the worker's wrist to maintain a natural position during work. Jobs can be rotated among workers. Employers can develop programs in ergonomics, the process of adapting workplace conditions and job demands to the capabilities of workers. However, research has not conclusively shown that these workplace changes prevent the occurrence of carpal tunnel syndrome **[Jablecki, Andary, Floeter, Miller, Quartly, Vennix, & Wilson, 2018]**.

The present study aimed to:

Determine the effect of night splinting and hand exercise on reducing the symptoms in patients with carpal tunnel syndrome.

Hypothesis:

To fulfill the aim of this study the following hypothesis was formulated:

Patients with carpal tunnel syndrome who receive night splinting and hand exercise will exhibit reducing the symptoms than those patients who receive routine nursing interventions

Materials And Method

Materials

Research design:

A quasi-experimental research design was utilized.

Settings:

The present study was conducted at the physiotherapy unit of Rass Al-Teen General Hospital at Alexandria.

Subjects:

A convenience sample of 60 adult patients admitted to the above-mentioned settings and diagnosed with carpal tunnel syndrome was recruited in this study. The selected group was assess before and after night splinting and hand exercise.

- The study sample will be estimated based on the Epi-info-7 program using the following parameters;

1- Population size: 157

2- Expected frequency: 50%

3- Acceptable error: 10%

4- Confidence coefficient: 95%

5- Minimum sample size: 60

Patients' inclusion criteria:

Patients were considered eligible to participate in the study if they meet the following criteria:

- Age: 21-60 years.
- The patient confirmed a diagnosis of carpal tunnel syndrome based on signs and physical symptoms, as well as by nerve conduction.
- Able to communicate verbally, and able to follow the instructions.
- Didn't participate in regular exercise activities in the last two months.

Patients' exclusion criteria:

- General disorder/physical disability
- Diabetes Mellitus
- Hypothyroidism
- Hand/wrist deformity
- Previous CTS surgery
- Cervical disc hernia
- Rheumatoid arthritis

Study Tools:

Two tools were used by the researcher to collect the necessary data based on the review of relevant literature.

Tool I.

Socio-demographic and Clinical Data Interview Schedule

This tool was developed by the researchers and it was included:

- **Part I. Socio-demographic data:** It was used to measure demographic characteristics of carpal tunnel syndrome patients. It was included: age, gender, level of education, marital status, occupation, and residence.
- **Part II. Patient's Clinical Data:** ***Clinical data were collected from medical records, and was included:***
  - Previous hospitalization, past and present medical history such as the presence of cardiovascular disease, epilepsy, psychological disease, visual impairment, orthopedic disease, diabetes mellitus, Parkinson's, and Alzheimer's disease, and date of discharge.
  - Prescribed medications and over-the-counter medications.

Tool II.

Functional Status and Symptoms Severity in patients with carpal tunnel syndrome assessment questionnaire. Boston Carpal Tunnel Syndrome Questionnaire (BCTQ). **[Beaton, Bombardier, Guillemin, 2018]**. The questionnaire is self-administered and assesses the severity of symptoms and functional status in patients with CTS. The symptoms severity scale (SSS) assesses the symptoms for severity, frequency, time, and type. The scale consists of 11 questions with multiple-choice responses, scored from 1 point (mildest) to 5 points (most severe). The overall symptom severity score is calculated as the mean of the scores the eleven individual items. The functional status scale (FSS) assesses the effect of the CTS on daily living. The scale consists of 8 questions with multiple-choice responses, scored from 1 point (no difficulty with the activity) to 5 points (cannot perform the activity at all). The overall score for the functional status was calculated as the mean of all eight. Thus, higher symptom severity or functional status score indicates worse symptoms or dysfunction. Assessment of the symptom severity and the functional status in patients with carpal tunnel syndrome.

Method

1. Official letter permission was obtained from the Faculty of Nursing in Alexandria University to be directed to the hospital directors and head nurses of the departments for conducting the study after explanation of the aims of the study.
2. The developed tool I adopted tool II was tested for content validity by a jury of 5 experts in the fields of medical-surgical nursing and necessary modification was done accordingly.

3. **A Pilot study** was conducted on 10% out of the sample patients for testing (6 patients), clarity, feasibility, and applicability of the tools, and any modifications were done. Patients included in the pilot study were excluded from the study.
4. .**Sociodemographic and clinical data** were obtained from all patients were participate in this study on the first day of contact with researchers.
5. Night splinting and hand exercise was carried out in four phases as the following:

a. Phase I: Assessment phase:

After selection of the studied patient group according to inclusion criteria, an initial assessment to all patients was carried out before implementing the night splinting and hand exercise. It was aimed to collect baseline patients' data, health history, assess the functional status and symptoms severity using tool II.

The symptoms of carpal tunnel syndrome include:

- An ache or pain in your fingers, hand, or arm
- Hand numbness
- Tingling or pins and needles
- A weak thumb or difficulty gripping
- Numbness, stiffness in the fingers and hand.

These symptoms often start slowly and come and go. They're usually worse at night.

- Each patient was interviewed by the researchers using tool I within approximately 20 minutes, according to patients' response, after explaining the purpose of the study and by using tool II within approximately 30-45 minutes to collect the necessary data.

b. Phase II: Planning phase:

- Based on the assessment phase, the program contents, expected outcome, priorities, and media in the form of the educational booklet were prepared by the researchers for patients under the study based on the review of related literature.
- The researchers prepare a suitable room at the hospital for meeting the patients and perform the rehabilitation program after dealing with hospital administration staff and before starting the program.

c. Phase III: Developmental and implementation phase:

- The hand exercise was developed by the researchers on carpal tunnel syndrome patients and it included 2 parts: didactic and practicum parts.

1. Didactic part:

- It consisted of verbal instructions about the types of exercises, the importance of each exercise, and precautions during the exercises for a period of 20 to 30 minutes.
- A booklet containing the contents of the guidelines was distributed to the patients. It was written in a simple Arabic language and supplemented by photos and illustrations to help the patient's understanding of the contents.

2. Practicum part:(Patients Exercise Training)

- A Patient's hand night splinting and exercise hand exercise program were include a group of exercises that were

formulated using demonstration and re-demonstration in a period of (20 to 40 minutes) according to the type of each exercise used. The exercises were organized according to a feasible learning sequence (from easy to difficult) to enhance patients' understanding. Patients were asked to re-demonstrate the exercises until the researcher will confirm that the patient matched the required skills. A wrist splint can be worn to support the wrist while holding it firm and still immobilize it.

A good wrist splint should:

- Be comfortable, washable, durable, and easy to remove.
- Keep the wrist in a neutral position. The wrist is generally in a neutral position when you are holding a glass of water, with the thumb in line with the forearm.
- Restrict wrist movements while allowing fine hand movements.

Splints are available without a prescription from a drugstore, or with a prescription from an orthopedic or medical supply house. Physical and occupational therapists can custom-fit splints made from lightweight materials. This often reduces the clumsiness of wearing a splint.

- The hand exercise sessions were implemented for exercise treatment, a hand and finger exercise ball that consists of two parts: a foam body were used. Patients placed squeezed it for 1 second. Patients repeated this exercise for 30 seconds to 1 minute per day.

3. 1st session (initial session):

Exercise protocol

This hand and finger exercise treatment was a home program in which patients were instructed to perform with a ball. This ball is a hand exercise therapy device that strengths nine muscles that close the hand and nine muscles that open and spread the hand. This therapy improves the balance between the muscles and increases the strength, balance, and blood flow to the hand, wrist, and elbow. According to the user instructions, the neck and shoulder are kept in a neutral position, and the elbow remains at 90° of flexion, (Step 1).

During the exercise, the patients squeezed the ball for 1 s (Step 2) and then opened their fingers (Step 3). The exercise was performed actively for 30 seconds to 1 min, and patients were instructed to continue with the exercise program at home two times/day for a 3-month period. Exercise steps are shown in Flowchart 2. An educational brochure about exercise was given to patients, and they were informed to stop performing the exercises if they felt pain or fatigue. Patients recorded the time they performed the exercises every day on the monthly follow-up schedule. This schedule was given to them at the beginning of the treatment, and they received instructions for filling out the schedule.

Figure 1: Hand exercise with ball

d. Phase IV: Evaluation Phase:

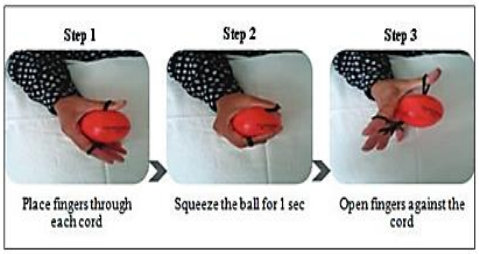
- Carpal tunnel syndrome patients were re-assessed by the researchers using tools II, after the implementation of the carpal tunnel syndrome night splinting and hand exercise

to determine the effectiveness of the program on reducing the Symptoms Evaluation will be done in three phases as follow:

i. **Zero phase:** This phase was used during the assessment phase pretest for all group (pretest)

ii. **Phase I:** Immediately after implementation of the night splinting and hand exercise-based exercise program after three weeks of starting exercise sessions. The post-test questionnaire (the same as the pre-test) was completed.

iii. **Phase II:** Patients will be followed after three months for evaluation of the degree of implementing night splinting and hand exercise program, improvement using tool II, then effective comparison was done before and after the program to identify the effect of the implementation of night splinting and hand exercise. Phone contact was maintained between researchers and patients to ensure follow-up visits in outpatient clinics and program application answer quires.



Flowchart 2: Exercise steps

Outcome assessments

Phalen and Tinel tests

Phalen test was performed with full flexion of the patients' wrists for 60 s, and Tinel test was performed with percussion on the median nerve at the wrist. These tests were recorded as positive if the patient experienced paresthesia in at least one of three radial digits.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation. The significance of the obtained results was judged at the 5% level.

Statistical analysis of the data:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation. The significance of the obtained results was judged at the 5% level.

1 - Paired t-test: For normally distributed quantitative variables, to compare between two periods

2 - Student t-test: For normally distributed quantitative variables.+

3 - F-test (ANOVA): For normally distributed quantitative variables, to compare between more than two groups

4 - Pearson coefficient: To correlate between two normally distributed quantitative variables

Ethical considerations:-

- Written informed consent was obtained from each patient after explanation of the purpose of the study.
- Privacy and confidentiality of the collected data for each patient were assured.
  Patients right to withdraw at any time of research participation was considered and respected.

Results:

Table (1): Frequency distribution of the studied patients according to their socio-demographic characteristics.

As regards **age**, it was observed that the highest percentages (43.3%) of the patients were in the age group of (50-60), while the lowest percentages (18.3%) of the study group was in the age group of (30-40). Regarding **gender**, more than half of the study group (58.3%) was females. As regards the **marital status** the majority of the studied patients (85%) were married. Concerning the **educational level** the highest percentages of studied patients were (45%) were secondary education. Furthermore, the majority of studied patients were housewives.

Table (1): Show Distribution of the studied patients according to Sociodemographic data (n = 60)

Demographic data	No.	%
Age in years:		
30<40	11	18.3
40<50	23	38.3
50≤60	26	43.3
Median (Min. – Max.)	48.50 (30.0 –60.0)	
Mean ± SD	47.55 ± 8.42	
Gender:		
Male	25	41.7
Female	35	58.3
Marital status:		
Single	5	8.3
Married	51	85.0
Divorced	3	5.0
Widow	1	1.7
Educational level		
Illiterate	10	16.7
Read and write	6	10.0
Primary	4	6.7
Secondary	27	45.0
University	13	21.7
Occupation		
Laborer	9	15.0
Clerical	10	16.7
Professional	11	18.3
Housewife	19	31.7
Retired	11	18.3
Area of residence		
Urban	41	68.3
Rural	19	31.7

Table (2): Frequency distribution of the studied patients according to their clinical data

This table showed that the total percent of studied patients (100%) were diagnosed with CT. the majority of the studied patients (58.3%) had a medical history of endocrine diseases, (50.0%) of the studied patients don't know the presence of any nerve compression in the body. The majority of the studied patients had don't know any family history of nerve compression, and no previous hand operation. Regarding the symptoms the highest percentage of studied patients were complained of hand pain, swelling, and wrist stiffness (71.7%, 58.3%, 46.7%) respectively, while the minority of patients (33.3%) were complained of irregular wrist movement. As regards the onset of disease (56.7%) of studied patients started from months, and (46.7%) of them getting doctor visit when symptoms increased. (31.7%) of studied patients had no disease progression. the highest percentage of patients (56.7%) had no history of physiotherapy, while (43.3%, 50%, 56.7%) respectively had a

history of physiotherapy, with irregular duration, and not feeling well after it. The majority of the studied patients (56.7%) had administered medication, (48.3%) with irregular durations.

Table (2): Frequency Distribution of the Studied Patients according to their Clinical Data (n = 60)

Clinical data	No.	%
Associated Medical Diseases*		
None	5	8.3
Endocrine diseases	35	58.3
Cardiovascular disease	34	56.7
Gastric disease	12	20.0
Nerve compression		
Yes	7	11.7
No	23	38.3
Don't know	30	50.0
Family compression		
No	24	40.0
Don't know	36	60.0
Previous Hand Operation		
Yes	8	13.3
No	52	86.7
If the result yes, which hand		
Right hand	2	3.3
Left hand	3	5.0
Both	3	5.0
No	52	86.7
Symptoms*		
Hand pain	43	71.7
Swelling	35	58.3
Wrist stiffness	28	46.7
Difficult movement	23	38.3
Irregular wrist movement	20	33.3
Onset		
Days	12	20.0
Months	34	56.7
Years	14	23.3
Doctor visit		
With starting of symptom	8	13.3
When symptoms increase	28	46.7
When symptom not tolerated	24	40.0
Progress		
Rapid progress	11	18.3
Slow progress	8	13.3
Constant	12	20.0
Rapid detoriated	6	10.0
Slow detoriated	4	6.7
Don't know	19	31.7
History of Physiotherapy		
Yes	26	43.3
No	34	56.7
Physiotherapy duration		
Days	10	16.7
Months	14	23.3
Years	6	10.0
Irregular	30	50.0
feeling well after Physiotherapy		
Yes	26	43.3
No	34	56.7
Medication		
Yes	34	56.7
No	26	43.3
Medication duration		
Days	7	11.7
Months	12	20.0
Years	12	20.0
Irregular	29	48.3

Table (3): Distribution of the studied patients according to Boston carpal tunnel syndrome questionnaire (BCTQ) symptom severity scale items in pre and post period (n = 60)

This table illustrated that the majority of the studied patients (43.3%) had very serious hand and wrist pain that occur at night in the pre-program period, while this severity is decreased to medium level (43.3%) in the post program period. As regards hand or wrist pain that wake up during a typical night in the past two weeks there is decreased from (28.3%) 2 to 3 times in the pre-program period, to (56.7%) once in the post-program period. In relation to typical pain in the hand or wrist during the day time there are improvement in level of pain from (41.7%) 4 -5 times in the pre-program period to (45%) 2 to 3 times in the post program period. Regarding number of hand or wrist pain during daytime there were decreased from (36.7%) More than 5 times in the pre-program period to (63.3%) 1-2 times / day in the post program period. Furthermore, episode of pain last during the daytime, there were (35%) of the studied patient 0~60 Continued in the pre- progm period, while (55%) ＜10 minutes in the post program period.

Regarding numbness, weakness in the hand and wrist, tingling there were improvement from (43.3%, 31.7%, 33.3%, 26.7) 0-60 continued in the pre-program period to (55%) 0-60 Continued and (58.3%, 36.7%, 36.7%) normal in the post-program period. In relation to hand numbness or tingling wake you up during a typical night during the past two weeks there were improvement from (33.3%) 2 to 3 times in the pre-program period to (35%) once in the post-program period. regarding difficulty with the grasping and use of small objects such as keys or pens there were improvement from (38.3%) Moderately difficulty in the pre-program period to (48.3%) Little difficulty in the post-program period.

Table (3): Show Distribution of the studied patients according to Boston carpal tunnel syndrome questionnaire (BCTQ) symptom severity scale items in pre and post period (n = 60)

Boston carpal tunnel syndrome questionnaire (BCTQ) symptom severity scale	Pre										Post									
	Normal		Slight		Medium		Severe		Very serious		Normal		Slight		Medium		Severe		Very serious	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1. How severe is the hand or wrist pain that you have at night?	0	0.0	3	5.0	12	20.0	19	31.7	26	43.3	2	3.3	5	8.3	26	43.3	19	31.7	8	13.3
	Normal		**Once**		**2 to 3 times**		**4 to 5 times**		**More than 5 times**		**Normal**		**Once**		**2 to 3 times**		**4 to 5 times**		**More than 5 times**	
2. How often did hand or wrist pain wake you up during a typical night in the past two weeks?	2	3.3	12	20.0	17	28.3	14	23.3	15	25.0	7	11.7	34	56.7	16	26.7	3	5.0	0	0.0
3. Do you typically have pain in your hand or wrist during the daytime?	0	0.0	4	6.7	6	10.0	25	41.7	25	41.7	2	3.3	5	8.3	27	45.0	20	33.3	6	10.0
	Normal		**1-2 times / day**		**3-5 times**		**More than 5 times**		**Continued**		**Normal**		**1-2 times / day**		**3-5 times**		**More than 5 times**		**Continued**	
4. How often do you have hand or wrist pain during daytime?	2	3.3	11	18.3	12	20.0	22	36.7	13	21.7	6	10.0	38	63.3	12	20.0	4	6.7	0	0.0
	Normal		**＜10 minutes**		**0~60 Continued**		**＞60 minutes**		**Continued**		**Normal**		**＜10 minutes**		**0~60 Continued**		**＞60 minutes**		**Continued**	
5. How long on average does an episode of pain last during the daytime?	3	5.0	11	18.3	21	35.0	14	23.3	11	18.3	17	28.3	33	55.0	7	11.7	0	0.0	3	5.0
6. Do you have numbness (loss of sensation) in your hand?	4	6.7	7	11.7	26	43.3	13	21.7	10	16.7	11	18.3	16	26.7	33	55.0	0	0.0	0	0.0
7. Do you have weakness in your hand or wrist?	4	6.7	15	25.0	19	31.7	18	30.0	4	6.7	35	58.3	25	41.7	0	0.0	0	0.0	0	0.0
8. Do you have tingling sensations in your hand?	2	3.3	13	21.7	20	33.3	14	23.3	11	18.3	22	36.7	18	30.0	7	11.7	6	10.0	7	11.7
9. How severe is numbness (loss of sensation) or tingling at night?	0	0.0	15	25.0	16	26.7	14	23.3	15	25.0	22	36.7	18	30.0	9	15.0	6	10.0	5	8.3
	Normal		**Once**		**2 to 3 times**		**4 to 5 times**		**More than 5 times**		**Normal**		**Once**		**2 to 3 times**		**4 to 5 times**		**More than 5 times**	
10. How often did hand numbness or tingling wake you up during a typical night during the past two weeks?	3	5.0	8	13.3	20	33.3	18	30.0	11	18.3	16	26.7	21	35.0	14	23.3	5	8.3	4	6.7
	Without difficulty		**Little difficulty**		**Moderately difficulty**		**Very difficult**		**Very difficult**		**Without difficulty**		**Little difficulty**		**Moderately difficulty**		**Very difficult**		**Very difficult**	
11. Do you have difficulty with the grasping and use of small objects such as keys or pens?	0	0.0	7	11.7	23	38.3	17	28.3	13	21.7	19	31.7	29	48.3	9	15.0	3	5.0	0	0.0

Table (4): Distribution of the studied patients according to functional status scale items in pre and post period (n = 60):

This table illustrated that the highest percentage of patients (38.3%, 33.3%, 48.3% 40%, 36.7%, 31.7%) had moderately difficulty in Writing, Buttoning of clothes, Holding a book while reading, Gripping of a telephone handle, Opening of jars, Household chores, Carrying of grocery basket, Bathing and dressing respectively in the pre-program period, while (43.3%) of patients had little difficulty in all items of functional status in the post-program period

Table (4): The Frequency Distribution of the Studied Patients according to Functional Status Scale Items in Pre and Post Period (n = 60)

Functional status scale	Pre										Post									
	No difficulty		Little difficulty		Moderate difficulty		Intense difficulty		Cannot perform the activity at all due to hands and wrists symptoms		No difficulty		Little difficulty		Moderate difficulty		Intense difficulty		Cannot perform the activity at all due to hands and wrists symptoms	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1. Writing	0	0.0	10	16.7	23	38.3	20	33.3	7	11.7	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
2. Buttoning of clothes	0	0.0	20	33.3	20	33.3	12	20.0	8	13.3	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
3. Holding a book while reading	0	0.0	12	20.0	29	48.3	15	25.0	4	6.7	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
4. Gripping of a telephone handle	0	0.0	13	21.7	24	40.0	15	25.0	8	13.3	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
5. Opening of jars	0	0.0	12	20.0	26	43.3	17	28.3	5	8.3	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
6. Household chores	0	0.0	11	18.3	24	40.0	19	31.7	6	10.0	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
7. Carrying of grocery basket	0	0.0	14	23.3	22	36.7	14	23.3	10	16.7	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0
8. Bathing and dressing	0	0.0	16	26.7	19	31.7	14	23.3	11	18.3	15	25.0	26	43.3	13	21.7	6	10.0	0	0.0

Figure (1): Distribution of the studied patients according pain scale: (visual analogue scale) items in pre and post period (n = 60)

Regarding hand pain severity the highest percentage of studied patients in the pre-program period had (43.3%) complain of very severe hand pain in the 1st week , and (35%,48.3%) in the 3rd week, and 5th week respectively, while in the post program period there were improvement in the level of hand pain which (56.7%) moderate hand pain in the 1st week ,and (63.%,85%)mild hand in the 3rd week, and 5th week respectively. As regards pain description in the 1st week the majority of studied patients(76.7%,70%,63.3%) had tingling ,aching ,and numbness respectively in the pre-program period, while in the post-program period there were improvement to be (16.7%,23.3%,40%) had tingling ,aching ,and numbness respectively in the post-program period. In the 3rd week the majority of studied patients had aching, numbness, tingling (15.7%, 70%, 65%) respectively in the pre- program period, and it was decreased to be (16.7%, 38.3%, 21.7%) respectively in the post program period. In the 5th week the majority of studied patients had aching, numbness, tingling (60%, 63.3%, 50%) respectively in the pre- program period, and it was decreased to be (31.7%, 8.3%, 0.0%) respectively in the post program period.

Figure (1): Show distribution of the studied patients according pain scale: (visual analogue scale) items in pre and post period (n = 60)

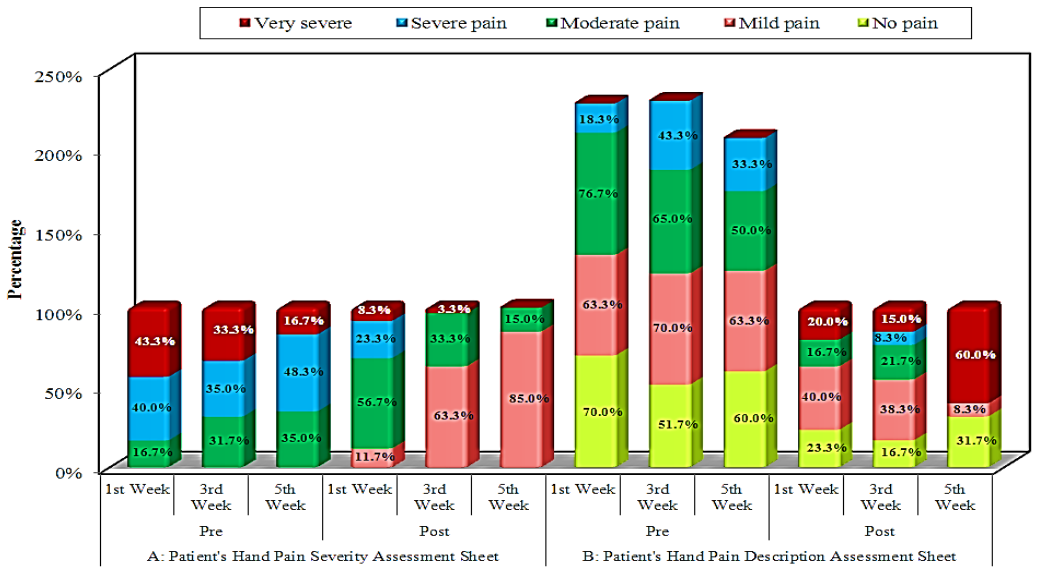


Table (5): Comparison between pre and post period according to Boston carpal tunnel syndrome, functional status and pain scales (n = 60)

This table shows the variation in the pain severity score, functional status scale, hand pain severity and description among the studied group, and also after the program than before. As evident from the table, statistically significant difference in pain severity score, functional status scale ,hand pain severity and description among the studied group, were elicited in the study group post program than before for; pain severity score, functional status scale ,hand pain severity and description among the studied group, where p= <0.0001*

Table (5): Show comparison between pre and post period according to Boston carpal tunnel syndrome, functional status and pain scales (n = 60).

	Pre	Post	t	p
Boston carpal tunnel syndrome questionnaire (BCTQ) symptom severity scale				
Total Score			30.985*	<0.001*
Min. – Max.	30.0 – 49.0	18.0 – 36.0		
Mean ± SD.	38.83 ± 4.43	25.87 ± 4.95		
Mean Score				
Min. – Max.	2.73 – 4.45	1.64 – 3.27		
Mean ± SD.	3.53 ± 0.40	2.35 ± 0.45		
% Score				
Min. – Max.	43.18 – 86.36	15.91 – 56.82		
Mean ± SD.	63.26 ± 10.06	33.79 ± 11.25		
Functional status scale				
Total Score			18.772*	<0.001*
Min. – Max.	16.0 – 38.0	8.0 – 32.0		
Mean ± SD.	26.27 ± 5.73	17.33 ± 7.39		
Mean Score				
Min. – Max.	2.0 – 4.75	1.0 – 4.0		
Mean ± SD.	3.28 ± 0.72	2.17 ± 0.92		
% Score				
Min. – Max.	25.0 – 93.75	0.0 – 75.0		
Mean ± SD.	57.08 ± 17.91	29.17 ± 23.09		
Pain scale: (Visual Analogue Scale)				
A: Patient's Hand Pain Severity Assessment Sheet				
Total Score			16.234*	<0.001*
Min. – Max.	6.0 – 12.0	3.0 – 9.0		
Mean ± SD.	9.10 ± 1.70	4.87 ± 1.23		
Mean Score				
Min. – Max.	2.0 – 4.0	1.0 – 3.0		
Mean ± SD.	3.03 ± 0.57	1.62 ± 0.41		
% Score				
Min. – Max.	50.0 – 100.0	25.0 – 75.0		
Mean ± SD.	75.83 ± 14.20	40.56 ± 10.23		
B: Patient's Hand Pain Description Assessment Sheet				
Total Score			4.955*	<0.001*
Min. – Max.	10.0 – 20.0	3.0 – 15.0		
Mean ± SD.	15.30 ± 2.15	8.68 ± 2.61		
Mean Score				
Min. – Max.	2.0 – 3.0	1.0 – 5.0		
Mean ± SD.	2.32 ± 0.27	2.89 ± 0.87		
% Score				
Min. – Max.	25.0 – 50.0	0.0 – 100.0		
Mean ± SD.	33.07 ± 6.78	47.36 ± 21.78		

t: Paired t-test

P: p value for comparing between **Pre** and **Post**

*: Statistically significant at $p \leq 0.05$

Table (6a): Correlation matrix between Boston carpal tunnel syndrome, functional status and pain scales in pre period (n=60)

		Boston carpal tunnel syndrome	Functional status scale	A: Patient's Hand Pain Severity Assessment Sheet	B: Patient's Hand Pain Description Assessment Sheet
Boston carpal tunnel syndrome	**r**		0.100	-0.103	-0.455*
	p		0.447	0.432	<0.001*
Functional status scale	**r**			-0.105	-0.122
	p			0.424	0.351
A: Patient's Hand Pain Severity Assessment Sheet	**r**				-0.094
	p				0.475
B: Patient's Hand Pain Description Assessment Sheet	**r**				
	p				

r: Pearson coefficient

*: Statistically significant at $p \leq 0.05$

Table (6b): Illustrates the correlation matrix between Boston carpal tunnel syndrome, functional status and pain scales in post-period (n=60)

The Boston carpal tunnel syndrome was significantly correlated with the total score of Functional status scale where P=<0.001*

Table (6b): The Correlation Matrix between Boston Carpal Tunnel Syndrome, Functional Status and Pain Scales in post-period

		Boston carpal tunnel syndrome	Functional status scale	A: Patient's Hand Pain Severity Assessment Sheet	B: Patient's Hand Pain Description Assessment Sheet
Boston carpal tunnel syndrome	r		0.472*	-0.059	0.125
	p		<0.001*	0.656	0.341
Functional status scale	r			-0.219	0.212
	p			0.092	0.104
A: Patient's Hand Pain Severity Assessment Sheet	r				0.050
	p				0.704
B: Patient's Hand Pain Description Assessment Sheet	r				
	p				

r: Pearson coefficient

*: Statistically significant at $p \leq 0.05$

Discussion

Carpal tunnel syndrome is a hand disorder which indicates the presence of symptoms such as pain, numbness, and muscle weakness among the patient. CTS is an occupational related disorder which can occur in any profession. However, it can be prevented and managed. The prevalence of CTS highest in the age group of 50-59 years followed by the age group of 41-49 years for the females, and for the males, CTS in women was higher than in men due in part to differences in carpal tunnel volume between men and women. The present study aimed to determine the effect of night splinting and hand exercise on reducing the symptoms in patients with carpal tunnel syndrome. **[Aygül, Ulvi, Kotan, Kuyucu, & Demir, 2019; Beaton, Bombardier, Guillemin, & Ferraz, 2018; Bahar-Moni, Abdullah, Fauzi, Chee-Yuen, Abdul-Razak, & Sapuan, 2019]**.

The findings of the present study observed that the highest percentages of patients were in the **age group** of (50-60), this result come on line with **[Pinar, Enhos, Ada, & Güngör, 2015]**, who stated that CTS ranges between 1.3% and 2.0% in the general population among individuals aged ≥25 years, and its incidence ranges between 0.3 and 3.3 per 1,000 person-year), and in middle-aged patients (40-49 years) and in patients aged >70 years is 2.8 and 1.4 per 1,000 person-year.

Regarding gender, more than half of the study group were females, this results were supported by **[Pourmemari, 2020]**, who stated that the prevalence of CTS is twice in female than for male and **[Cazares-Manríquez, Wilson, Vardasca, García-Alcaraz, Olguín-Tiznado, et al., 2020],** who found that CTS is occurs in 3.4% in women than 0.6% in men.

As regards **marital status** the majority of the studied patients were married, this result is in line with **[Mattioli, Baldasseroni, Curti, Cooke, Bena, De Giacomi, et al., 2018]**, who attributed that CTS increased in married female related to parity, high body mass index after marriage. Regards **occupation** the majority of studied patients were housewives, this findings is in line with **[Mattioli, Baldasseroni, Curti, Cooke, Bena, De Giacomi, et al., 2018]**, who stated that CTS is more likely occur in housewife with manual work which involves taxing hand-wrist activities, such as prolonged, highly repetitive wrist flexion/extension, forceful grip in awkward postures, and use of hand-held vibratory tools. Regards **area of residence** more than half of the study patients come from urban area, this finding is similar to **[Tsai, Kuo, Muo, Chou, & Lu, 2019]**, who found that the majority of patients were had in urban cities.

As regards **medical history** the majority of the studied patients had of endocrine diseases, this result is in line with **[Otsubo, Kimata, Okutsu, Oshikawa, Ueda, Sugimoto, & Akiba, 2019]**, who stated that the most risk factor for CTS is repetitive maneuver, obesity, hypothyroidism, sarcoidosis, multiple myeloma, and leukemia. In relation to **symptoms** of the disease the majority of the patients suffer from hand pain, swelling, wrist stiffness, and difficult movement this result is in line with **[Zamborsky, Kokavec, Simko, & Bohac, 2017]**, who stated that mild CTS, the patient experiences numbness in the fingers, un pleasant sensation during thumb movements, writer's cramp/fatigue and pain in the forearm or shoulder. While contradicted with **[Schoenhuber, Capone, Gentile, & Pentore, 2017]**, who found that patients with mild to moderate CTS had mild functional limitations, whereas patients with more severe disease may report less severe symptoms, but have more severe functional limitations of the hand.

Regarding **onset of symptoms** the majority of the patients had gradual onset of the symptoms over months, this result is accordance with **[Sucher, & Schreiber, 2014]**, who found that symptoms may be quite variable, thus it requiring clinical examination and electro-diagnostic testing to confirm. As regards **physiotherapy** more than half of the studied patients had not stated physiotherapy and 48.3% had irregular physiotherapy. This result is contradicted with **[Zaralieva, Georgiev, Karabinov, Iliev, & Aleksiev, 2020],** who found that the functionality of the affected hand can be restored by appropriate physiotherapy rehabilitation programs. It has been revealed that the majority of the studied patients had irregular **administration medications**, this findings were reported by **[Abdel-Moneim, & Said, 2016]**, who stated that conservative treatment is effective in the mild-moderate forms, unless progressive motor deficit, severe sensory deficit or serious electrophysiologic anomalies occur, in addition acetyl-carnitine combines a potentially neuroprotective is effective pain control .

According to **Boston carpal tunnel syndrome questionnaire (BCTQ)** symptom severity scale items in pre and post program period, it has been showed that the severity of hand or wrist pain, pain wake up during a typical night, episode of pain, numbness tingling, and difficulty with the grasping it decreased after exercise program. This findings is accordance with **[Beaton, Bombardier, Guillemin, 2018]** who stated that gliding exercises improve symptoms by preventing, or stretching, the adhesions among the tendons and median nerve, decreasing tenosynovial edema, improving venous return and reducing pressure inside the carpal tunnel.

In relation to **functional status** the highest percentage of patients had moderately difficulty in Writing, Buttoning of clothes, Holding a book while reading, etc. in the pre-program period, and it improved after program , and there was significantly correlated with the total score of functional status scale ,this finding is accordance with **[Ünver & Akyolcu, 2018]** who found that efficacy of

hand and fingers exercises performed with a ball in decreasing the symptoms of CTS and improvement in functional status of patients

Conclusion:

This study evaluated the efficacy of hand and finger exercises performed with a ball in decreasing the symptoms of CTS in patients who used the ball for 30 s to 1 min two times/day. This exercise treatment demonstrated no absolute contraindications, significant decrease in CTS symptoms, and improvement in functional status of patients. The strengths of this study were reliable and valid outcome measures. The proposed protocol, focusing on neural mobilization and night splinting stabilization, for patients undergoing conservative treatment for CTS, exhibits better results in reducing pain, and improve function status, increased strength, sensitivity, and improved hand functions.

Recommendations:

Educate patients about necessary hand and finger exercises and neural mobilization and night splinting stabilization instructions regarding their conditions and self-care activities using booklet and illustrated pamphlets for each patient especially those who cannot read and write

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