ORIGINAL ARTICLE

Effectiveness of home exercise in pregnant women with carpal tunnel syndrome: Randomized Control Trial

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Abstract

Objective: To evaluate the effectiveness of a home exercise programme in pregnant patients with carpal tunnel syndrome.

Methods: The randomised, single-blind, controlled clinical study was conducted at Vakif University School of Medicine, Istanbul, Turkey, From December 2017 to June 2018 and comprised pregnant women with carpal tunnel syndrome (CTS) . Clinical evaluation of each patient was performed by a blind researcher and (EMG) Electromyography measurements were performed by another blind researcher. Patients were divided into two groups with normal and (mild or moderate) CTS based on EMG results and clinical examination. Patients with symptoms, clinical signs and CTS in EMG were included in group 1, while patients whose symptoms and clinical evaluation (such as Tinel, Phalen, Reverse Phalen and Durkan's test) were positive but not CTS in EMG were included in group 2. Exercise forms were given to both groups and they were asked to perform the exercises stated in the form in 3 sets each day and 10 repetitions in each set. The Sick Boston Carpal Tunnel Syndrome Questionnaire was administered face-to-face to collect data which was analysed using SPSS 22

Results: Of the 33 subjects, 19(57.6%) were in patient group 1 and 14(42.4%) in control group 2. The overall mean age of the sample was 28.84±3.62 years. There were no significant differences between the groups in terms of symptoms and clinical tests ($p>0.05$). The symptom severity scale between the groups was significantly high in group 1 ($p<0.05$). Patients receiving treatment showed a decrease in symptom severity and functional capacity, but only the former showed a significant decrease in group 2 ($p>0.05$).

Conclusion: Nerve and tendon slip exercises for patients with mild to moderate carpal tunnel syndrome symptoms were found to be simple and reliable methods that could be applied to patients to increase their functionality and to reduce the severity of the disease.

Keywords: Carpal tunnel syndrome, Home exercise, Pregnant women. (JPMA 70: 202; 2020) **https://doi.org/10.5455/JPMA.1846**

Introduction

Carpal tunnel syndrome (CTS) is one of the most common upper limb compression neuropathies.[1] It has a prevalence of 3.7% to 5.8% when diagnosed clinically and neuro-physiologically in the general population.[2] Risk factors commonly known for CTS include repeated use of the hand and wrist, aging, obesity, pregnancy, acromegaly, amyloidosis, diabetes mellitus, kidney diseases, trauma, osteoarthritis and thyroid diseases.[3]

Women, especially middle-aged women, are more susceptible to CTS with a 70% incidence rate, and it is a common problem during pregnancy.[4] CTS in pregnancy is reportedly 63% in the third trimester, and about 47% have bilateral CTS.[5]

The earliest symptom of CTS is hand numbness and / or tingling[6]. These symptoms occur especially on the palmar face of the second finger and on the palmar face of the thumb and the radial face of the middle finger, the ring finger, and the index finger. These symptoms do not occur in palm. The reason for this is that the branches of the median nerve innervating the palms are separated before entering the tunnel.

In CTS, paraesthesia develops early in the sleeping period, but develops later in the day. During the day, hand-made activations (dishwashing, knitting) trigger paraesthesia and pain symptoms.[7]

In patients with CTS, the result of median nerve compression in one or both wrists usually results in pain, tingling sensation, numbness and weakness that worsen at night, especially in the first three fingers.[8]

The aetiology of CTS due to pregnancy is not fully

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understood. In general, hormonal changes and pressure-enhancing oedema in the carpal tunnel have been suggested as contributing factors to the development of CTS.[9]

The diagnosis of CTS is made by anamnesis, clinical symptoms, physical examination findings and support of these findings with electro-rheological tests. In order to diagnose CTS and to detect the severity of the disease, it is suggested to use electro-diagnostic tests.[10]

For the clinical diagnosis of CTS, provocative tests, such as Tinel test, Phalen's test, Reverse Phalen's and Durkan's Carpal Compression test, are used which are some of the special clinical examination methods. The purpose of the provocative tests is to detect symptoms by increasing inter-carpal pressure. In Tinel test, paralysis of the median nerve distribution with applied percussion on the wrist distal limb is considered positive. However, when percussion is applied, it should be done gently. The reason is that symptoms may occur with severe percussion on the normal median nerve. The average sensitivity of this test varies 23-60% and the specificity varies 64-80%.[11] In Phalen's test, the presence of symptoms in the median nerve dermatome with the wrist active in the full flex for one minute is considered positive.[11] In the Reverse Phalen's test, hand, wrist and palms are placed in 90-degree extension to look at each other. As in the Phalen's test, the appearance of symptoms in the median nerve dermatome is considered positive.[11] In Durkan's Carpal Compression test, the examiner's thumb is pressed on the median nerve with the thumbs of both hands for 30 seconds. Evaluation is like in the Phalen's test. The mean sensitivity and specificity of the test for CTS were 64% and 83%, respectively.[12]

There are various treatment options for patients with CTS, depending on various factors, such as the stage of the disease, the severity of the symptoms and the preferences of the patient. Conservative treatment options are used as first-line treatment in mild-to-moderate CTS cases because of the high likelihood of improvement in postpartum period. These include physical therapy (PT) interventions, splint, nerve and tendon slip exercises, acupuncture, low-level laser. Surgical treatment is performed in patients with severe CTS and in patients with conservative treatment failures. However, surgical treatment should not be used for postpartum patients.[13]

There is very little study of the efficacy of nerve and tendon-shifting exercises on pregnancies.

The current study was planned to evaluate the effectiveness of the home exercise programme in pregnant women with CTS.

Patients and Methods

The randomised, single-blind, controlled clinical study was conducted at Vakif University School of Medicine, Istanbul, Turkey, From December 2017 to June 2018 and comprised pregnant women with CTS.

Permission was obtained from the institutional ethics committee decision was taken from the clinical research ethics committee with the document number 9671 and NCT03718598. Informed consents were obtained from each patient. Those included had symptoms of numbness, tingling, weakness and pain in the hands for at least 1 month, assessed through provocation tests and physical examination to match the median nerve distribution. Clinical evaluation of each patient was performed by a blind researcher and EMG measurements were performed by another blind researcher. Before the patients were included in the study, it was not known which group they would be included in. Patients were divided into two groups according to EMG results after inclusion. Patients were divided into two groups with normal and (mild or moderate) CTS based on EMG results and clinical examination. Patients with symptoms, clinical signs and CTS in EMG were included in group 1, while patients whose symptoms and clinical evaluation (such as Tinel, Phalen, Reverse Phalen and Durkan's test) were positive but not CTS in EMG were included in group 2. Exercise forms were given to both groups and they were asked to perform the exercises stated in the form in 3 sets each day and 10 repetitions in each set.

Those excluded were patients who had previously undergone carpal tunnel surgery, or had a history of gestational diabetes mellitus (GDM), eclampsia, preeclampsia, thyroid disorders, arthropathies, hand or wrist trauma, bilateral fractures, severe CTS with atrial fibrillation (AF), cervical radiculopathy or peripheral neuropathy, other aetiological causes, thoracic outlet syndrome, diabetes mellitus, hypothyroidism, hyperthyroidism, rheumatological diseases.

Patients who had pain and numbness problems at the hands reporting to the Bezmiâlem Vakif University Polyclinic for Women and Obstetrics were directed to the Bezmiâlem Vakif University Physical Therapy

Rehabilitation Polyclinic. After the examination and clinical testing of each patient through Tinel, Phalen's, Reverse Phalen's and Durkan's Carpal Compression tests, the patients were directed to Bezmiâlem Vakif University Neurology Polyclinic. Based on EMG results and clinical examination, those with mild and moderate CTS were placed in group 1, while normal subjects were placed in group 2. A disease exercise form was distributed among all the patients to do exercises.

All electro-diagnostic tests were performed using an electro-neuromyography device (Medtronic, Skovlunde, Denmark) at 25°C room temperature while the patient was lying in supine position. Motor and sensory nerve conduction studies were performed in the median nerve. The measurements of the median nerve sensory distal latency, sensory amplitude, sensory nerve conduction velocity, motor latency, motor amplitude and motor nerve conduction velocity were performed using standard techniques. Composite muscle action potentials were recorded from the abductor pollicis brevis muscle induced by supramaximal electrical stimulation of the median nerve at 8cm on the recording electrode. Antidromic sensory latency and sensory nerve conduction studies were performed at a distance of 14cm from the second step wrist point.[14] In line with the American electro-diagnostic medical diagnostic criteria, and assessed using the Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ), those with median nerve motor distal latency (MDL) normal and sensory nerve conduction rate (SNCR) slowed (<42m/sec) were considered mild. SNCR slowed and \with MDL prolongation (>4.2ms) were considered moderate CTS. Patients with MDL >6ms were excluded.

The intervention comprised tendon and nerve gliding exercises. The tendon slip exercises were performed in five different positions; flexion, flat, hook, punch, table-top and flat-punch. Nerve-gliding exercises were performed by moving the fingers and wrists in six different positions, focussing on the median nerve consisting of the disease grip, finger lengthening, wrist extension, thumb extension, forearm supination and gentle gait. Written and verbal instructions were given to make 10 sets of exercises in 3 sets in order to have exercises for all patient's tendons and nerve-shifting exercises. In the exercise set recommended 3 times a day, each exercise was asked to do 10 repetitions. In the tendon shift exercises, to make wrist extension when the fingers are in the hook holding position, to make wrist flexion when the fingers are loose, to make a full punch, to make a half-punch when the distal interphalangeal (DIF) joints are in extension, to make the table top position (MKP joints flexed, interfalangeal joints in extension), distal, proximal and MKP is made to flex the joint as isolated. The hand is held in the position for 5 seconds. In median nerve shifting exercises, also called neural mobilization, the fingers are extended to the wrist in neutral position and the wrist and fingers to the extension in the neutral position. In the forearm supination, the thumb is stretched with the wrist extended. Brochures were also provided explaining the exercises.

During routine pregnancy examination, patients were asked whether they had exercised at home or not. Patients without exercise compliance were excluded.

The BCTSQ form was administered face-to-face, and the patients were evaluated before the intervention and 1 month after having given birth.

The BCTSQ consists of two parts; Boston Symptom Severity Scale (BSSS) and the Boston Functional Capacity Scale (BFCS). BSSS consists of 11 questions for symptoms. In each question there are five different answers with scores between 1 and 5. The average score was obtained by dividing the total score by the number of questions. High score indicates severe symptom. BFCS consists of 8 questions for functional capacity. Again, there are five different answers in each question, ranging from 1 to 5. The average score was obtained by dividing the total score by the number of questions. High score indicates decrease in functional capacity. The questionnaire has been validated and tested for Turkish society.[15,16]

Data was analysed using SPSS 22. The sample size was calculated with type 1 error and power of the test set at 90%. Power analysis was done on the basis of literature.[17] Normal distribution of continuous numerical variables was investigated by Shapiro Wilk test. The results of the numerical variables were expressed as mean±standard deviation (SD). Non-parametric tests were used because the intergroup comparisons did not show normal distribution. Mann-Whitney U test for continuous variables, and Chi-square test or Fisher's exact test for categorical variables was used to compare the data to determine the significance between the groups. The Wilcoxon test was used to analyse the significant association between pre-treatment and post-treatment values within the group. The significance limit for all statistics

was determined as p<0.05.

Results

Of the 33 subjects, 19(57.6%) were in patient group 1 and 14(42.4%) in control group 2. The overall mean age of the sample was 28.4±3.62 years. In group 1, 16(84%) subjects were in the third trimester (p<0.05). There was no significant difference between the groups with regards to age, body mass index (BMI), number of pregnancies, education, socio-economic status and smoking Table-1).

Group 1 had 16(84%) patients with indole pain and 18(95%) with indole paraesthesia. There were no significant differences between the groups in terms of symptoms such as pain, paraesthesia, weakness and incompetence, and with respect to all the clinical tests (p>0.05 each). The BSSS score was significantly high in group 1 (p=0.009). BFCS was high in group 1, but there were no statistical differences between the groups (Table-2).

All the cases completed the exercise programme and their BSSS and BFCS scores were significant (p<0,001 and p=0.001). In group 2, statistically significant decrease was seen in BSSS score only (p=0,013). There was no statistically significant difference between the groups in terms of scores after the intervention (Table-3).

Table-2: Significance levels of the difference between symptoms of participants with and without carpal tunnel syndrome (CTS).

	Group 1 (n:19) n(%)	Group 2 (n:14) n(%)	p
Ache*			0,12
Yes	16(84)	8(57)	
No	3(16)	6(43)	
Paraesthesia **			0,29
Yes	18(95)	11(79)	
No	1(5)	3(21)	
Weakness**			1.00
Yes	13(68)	9(64)	
No	6(32)	5(36)	
Incompetence*			0,33
Yes	10(53)	5(36)	
No	9(47)	9(64)	

*Pearson Chi-Square, **Fisher's Exact Test.

Table-1: Significance levels of the difference between the demographic data of participants with and without carpal tunnel syndrome (CTS).

	Group 1 (n:19)		Group 2 (n:14)		p
	n(%)	mean±SD	n(%)	mean±SD	
Age*		28,4±3.62		28,8±4.67	0,680
BMI *		28,9±3,2		28,7±4,2	0,716
Number of pregnancies *		1,9±1,2		2,1±1,4	0,815
Pregnancy week **					0,004
2.TM	3(16)		9(64)		
3.TM	16(84)		5(36)		
Education					0,357
Primary school	10(53)		4(29)		
High school	7(37)		7(50)		
High education	2(11)		3(21)		
Socio-economic level **					0,665
Low	8(42)		5(36)		
Moderate	10(53)		7(50)		
High	1(5)		2(14)		
Cigarette***					0,698
Yes	6(32)		3(21)		
No	13(68)		11(79)		
Alcohol					
Yes	-		1(7)		
No	-		13(93)		
Which asset to acquire					
Single	10(53)		-		
Bilateral	9(47)		-		
BSSS *		2,8±0,9		2±0,7	0,009
BFCS *		2,5±1,1		2±1	0,235

* Mann-Whitney U test, ** Pearson Chi-Square, *** Fisher's Exact Test, BSSS: Boston Symptom Severity Scale score, BFCS: Boston Functional Capacity Scale score, SD: Standard deviation, TM: Trimester.

Table-3: Comparison of symptom severity and functional capacity scores before and after exercise therapy in groups.

	Group 1 (n:19)			Group 2 (n:14)			Pre-treatment of group 1 vs. group 2
	Pre-treatment mean±SD	One month after delivery mean±SD	p*	Pre-treatment mean±SD	One month after delivery mean±SD	p*	p**
BSSS	2,8±0,9	1,7±1,2	<0,001	2±0,7	1,4±0,8	0,013	0,292
BFCS	2,5±1,1	1,7±1,1	0,001	2±1	1,7±1,3	0,328	0,788

* Wilcoxon Signed Ranks Test, ** Mann-Whitney U Test, BSSS: Boston Symptom Severity Scale score BFCS: Boston Functional Capacity Scale score, SD: Standard deviation.

Discussion

The study investigated the efficacy of tendon and nerve-shifting exercises in pregnancies, and comprised 33 pregnant women in the 2nd and 3rd trimesters. CTS patients were found to be significantly higher in the 3rd trimester. Patients put on exercise treatment were found to have fallen in BSSS and BFCS. Especially, in the BFCS, there was a significant decrease in the CTS group.

During the course of the CTS surveys, various studies have advocated the conservative treatment of mild-moderate CTS cases.[18] The current study had mild and moderate CTS patients. Patients with advanced CTS usually do not respond to conservative treatment. And, generally, surgical intervention is needed for these patients.

After childbirth, there was a marked improvement in the symptoms of the hand which is a finding similar to other studies.[19] However, the functional improvement in the study was more prominent in CTS patients.

The BCTSQ administered to the patients is a highly reliable and responsive questionnaire for CTS. It is also an easy-to-use tool for evaluating CTS formation that occurs during pregnancy.[20] BCTSQ assesses not only the presence of self-evident CTS symptoms, but also the severity and possible disability of hand function. It has been extensively tested and proven to have similar qualities as neurotransmission studies.[21] Jarvik et al. reported an average of 2.81 points on the BSSS and 2.32 points on the BFSS.[22] In the current study, it was similarly found to be 2.8 on BSSS and 2.5 on BFSS.

Liquid retention increases during pregnancy in all women and is consistent with normal physiological pattern during pregnancy. The weight-gain between 20th and 30th week of pregnancy is largely attributed to the increase in maternal fat deposits. After 30 weeks, an increase in extravascular fluid also leads to weight-gain.[23] In the current study, CTS was found higher in the third trimester.

Regarding the efficacy of nerve and tendon-slip exercises, the identification of the specific pathogenesis of CTS may be important in determining the actual efficacy of these exercises. Current evidence suggests that patients with CTS due to mechanical compression of the median nerve are more likely to benefit from such exercise.[24] Nerve and tendon-slip exercises can relieve ischemic pain by contributing to the median transmission of oxygenated blood to the distal region of the wrist and the hand. For this reason, slip exercises are recommended in the conservative management of CTS.[25]

A recent systematic review showed that treatment effect changes according to mobilisation techniques. It has also been shown that tendon and nerve-slip exercises alone have the same treatment effect as wrist orthosis. Previous research suggests that different approaches to median nerve mobilisation lead to different degrees of nerve activity.[26] In the current study, after the exercise programme which was given to the patients, both the severity scales of the patients and the functional scales were clearly improved.

Conclusion

Nerve and tendon-slip exercises for patients with mild-moderate CTS symptoms in the second and third trimester of pregnancy were found to be simple and reliable methods that can be applied to patients in order to increase the function of the patients and reduce the severity of the disease.

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References

1. Katz JN, Simmons BP. Clinical practice. Carpal tunnel syndrome. New Eng J Med. 2002; 346:1807-12.
2. Pyun SB, Song W, Yoo SD. Slowed conduction velocity of the median sensory nerve across the carpal tunnel in normal adults. Am J Phys Med Rehabil. 2005; 84:598-603.
3. Stevens JC, Beard CM, O'fallon WM, Kurland LT. Conditions associated with carpal tunnel syndrome. Mayo Clin Proc. 1992; 67:541-8.
4. Bahrami M, Rayegani S, Fereidouni M, Baghbani M. Prevalence and severity of carpal tunnel syndrome (CTS) during pregnancy. Electromyogr Clin Neurophysiol. 2005; 45:123-5.
5. Rozali ZI, Noorman FM, De Cruz PK, Feng YK, Razab HW, Sapuan J, et al. Impact of carpal tunnel syndrome on the expectant woman's life. Asia Pac Fam Med. 2012; 11:1.

6. Nadler S, Nadler J. Cumulative trauma disorders. Physical medicine and rehabilitation: principles and practice 4th ed. Philadelphia: Lippincott Williams & Wilkins, 2005; pp-615-30.
7. Kohara N. Clinical and electrophysiological findings in carpal tunnel syndrome. Brain nerve = Shinkei kenkyu no shinpo. 2007; 59:1229-38.
8. You H, Simmons Z, Freivalds A, Kothari MJ, Naidu SH. Relationships between clinical symptom severity scales and nerve conduction measures in carpal tunnel syndrome. Muscle Nerve. 1999; 22:497-501.
9. Sax TW, Rosenbaum RB. Neuromuscular disorders in pregnancy. Muscle nerve. 2006; 34:559-71.
10. Ghasemi-rad M, Nosair E, Vegh A, Mohammadi A, Akkad A, Lesha E, et al. A handy review of carpal tunnel syndrome: From anatomy to diagnosis and treatment. World J Radiol. 2014; 6:284-300.
11. Skirven TM, Osterman AL, Fedorczyk J, Amadio PC. Rehabilitation of the hand and upper extremity, 2-Volume Set E-Book: Expert. Philadelphia: Elsevier Health Sciences, 2011.
12. MacDermid JC, Wessel J. Clinical diagnosis of carpal tunnel syndrome: a systematic review. J Hand Ther. 2004;17:309-19.
13. Hashempur MH, Naseri M, Ashraf A. Carpal tunnel syndrome in lactation: a challenging issue. Women's Health Bulletin. 2015;2: :e31414.
14. Jackson DA, Clifford J. Electrodiagnosis of mild carpal tunnel syndrome. Arch Physical Med Rehab. 1989; 70:199-204.
15. Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, Fossel A, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. JBJS. 1993; 75:1585-92.
16. Sezgin M, Incel NA, Serhan S, Camdeviren H, As I, Erdoğan C. Assessment of symptom severity and functional status in patients with carpal tunnel syndrome: reliability and validity of the Turkish version of the Boston Questionnaire. Disabil Rehabil. 2006; 28:1281-5.
17. Dimitrios S, Stasinopoulos L. Treatment of Carpal Tunnel Syndrome in pregnancy with Polarized Polychromatic Non-coherent Light (Bioptron Light): A Preliminary, Prospective, Open Clinical Trial. Laser Ther. 2017; 26:289-95.
18. Bardak AN, Alp M, Erhan B, Paker N, Kaya B, Onal AE. Evaluation of the clinical efficacy of conservative treatment in the management of carpal tunnel syndrome. Adv Ther. 2009; 26:107-16.
19. Padua L, Aprile I, Caliandro P, Mondelli M, Pasqualetti P, Tonali P. Carpal tunnel syndrome in pregnancy Multiperspective follow-up of untreated cases. Neurology. 2002; 59:1643-6.
20. Bakhsh H, Ibrahim I, Khan W, Smitham P, Goddard N. Assessment of validity, reliability, responsiveness and bias of three commonly used patient-reported outcome measures in carpal tunnel syndrome. Ortop Traumatol Rehabil. 2012;14:335-40.
21. Ortiz-Corredor F, Calambas N, Mendoza-Pulido C, Galeano J, Díaz-Ruíz J, Delgado O. Factor analysis of carpal tunnel syndrome questionnaire in relation to nerve conduction studies. Clin Neurophysiol. 2011;122:2067-70.
22. Jarvik JG, Comstock BA, Kliot M, Turner JA, Chan L, Heagerty PJ, et al. Surgery versus non-surgical therapy for carpal tunnel syndrome: a randomised parallel-group trial. Lancet. 2009; 374:1074-81.
23. Cunningham FG, Leveno KJ, Bloom SL, Spong CY, Dashe JS, Hoffman BL, et al. Obstetricia de Williams. Brazil: McGraw Hill Brasil, 2016.
24. Heebner ML, Roddey TS. The effects of neural mobilization in addition to standard care in persons with carpal tunnel syndrome from a community hospital. J Hand Ther. 2008; 21:229-40.
25. Rozmaryn LM, Dovelle S, Rothman ER, Gorman K, Olvey KM, Bartko JJ. Nerve and tendon gliding exercises and the conservative management of carpal tunnel syndrome. J Hand Ther. 1998; 11:171-9.
26. Lim YH, Chee DY, Girdler S, Lee HC. Median nerve mobilization techniques in the treatment of carpal tunnel syndrome: A systematic review. J Hand Ther. 2017; 30:397-406.