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Pregnancy-related carpal tunnel syndrome; non-invasive early diagnosis and postpartum evaluation

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Abstract

The diagnosis of pregnancy-related carpal tunnel syndrome (PRCTS) was made with noninvasive methods and evaluated the effect of PRCTS on quality of life, its treatment and prognosis. Third-trimester pregnant women between the ages of 18-45 and diagnosed with PRCTS were included. For diagnosis; the presence of pain, positive motor and sensory tests, Carpal Tunnel Symptoms Scale-6 (CTS-6), and Boston Carpal Tunnel Questionnaire (BCTQ) were evaluated. The criteria used to determine improvement were the regression of complaints and symptoms based on a VAS score of 0 and a CTS-6 score of less than 5. According to these criteria, patients whose complaints regressed in the postpartum eighth week were called group A, whose complaints regressed in the postpartum sixth month were called group B, and women who still did not meet the criteria were called group C. The study included 102 wrists of 94 women. When the type of delivery, gestational age at birth, gravida, and parity were compared according to the continuity of complaints and symptoms, no differences were found. When the first trimester body mass index (BMI) measurements were compared between groups A and B, it was observed that group B had higher first trimester BMI values; this difference was statistically significant. The mean age was 29.2 years in group A, was 32.6 years in group B and the difference was significant. Conclusions: We recommend that pregnant women over 30 years old with a high BMI should be screened for PRCTS using non-invasive diagnostic tools, CTS-6, and VAS.

Keywords: Carpal tunnel syndrome, CTS-6, BCTQ, VAS, diagnosis, pregnancy

Introduction

It has been suggested that women are more prone to carpal tunnel syndrome (CTS) due to morphology [1,2]. In 1957, pregnancy-related CTS (PRCTS) was directly defined in two cases, and it was noted that the symptoms increased, especially in the advanced weeks of pregnancy [3]. Studies examining the prevalence of PRCTS (7–62%) report a range of rates because they use different methods for diagnosis [4-11].

Various factors, such as an increase in body mass index (BMI), hormones (relaxin), fluid redistribution, and maternal age, are involved in the etiology of PRCTS [4-7]. In terms of prognosis, although it has been reported that PRCTS generally regresses completely spontaneously or with conservative treatment methods after birth, residual symptoms and neurophysiological findings that require surgical decompression up to a year after birth have also been reported [3,4,6,8-13]. Considering that CTS is seen more often in women and most women get pregnant more than once in their lives, it would be valuable to perform PRCTS screening during antenatal pregnancy follow-ups when there are risk factors such as advanced maternal age and increased BMI [2,5,7].

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Objectives

In this study, the diagnosis of PRCTS in the third trimester was made with noninvasive methods, and these women were followed up with conservative treatment. In addition, the effect of PRCTS on quality of life, its prognosis, and the need for surgical treatment were evaluated.

Material and Methods

This was a prospective study. A pre-study power analysis based on previous data determined a sample size of at least 89 pregnant to reach the desired power of >0.8. The prevalence of CTS was the primary outcome measure for proportional power analysis [4,9,14].

Third trimester pregnant women between the ages of 18-45 and diagnosed with CTS were included in the study. The following were the exclusion criteria: previously diagnosed with CTS with a treatment history, conditions considered to be secondary causes of CTS, women who did not breastfeed for the first six months or stopped breastfeeding, and women who had a stillbirth. Certain professions (such as tailor, hairdresser, musician, secretary, dishwasher, cook, ironer, and dry cleaner) that require repetitive or strong wrist effort were not included in the study. The study included one hundred and two wrists of 94 women (bilateral in eight) diagnosed with CTS who fulfilled the inclusion criteria by completing their follow-ups. The pregnant who agreed to participate in the study were screened for CTS by an obstetrician and diagnosed by an orthopedic and traumatology specialist.

Diagnosis and evaluation criteria

Age, gestational age at birth, gravida, parity, BMI, and delivery type were evaluated and recorded. The criteria for diagnosis were the presence of pain, positive sensory and motor tests [grip, palmar-key-tip pinch, Semmes-Weinstein Monofilament Test (SWMT)], Carpal Tunnel Symptoms Scale-6 (CTS-6), and Boston Carpal Tunnel Questionnaire (BCTQ) [15-17]. Electrodiagnostic tests (EMG) was requested to further examine women whose symptoms and complaints did not resolve during postpartum follow-up.

Pain was evaluated with a Visual analog scale (VAS). Weakness, numbness, nocturnal numbness, thenar atrophy, and Tinel's and Phalen's tests were evaluated with the CTS-6 evaluation tool modified by Graham [16]. The CTS-6 is a scale that evaluates six essential criteria based on history, symptoms, and physical examination findings over 26 points. According to the CTS-6 scoring results, it is possible to diagnose CTS with a probability of >12=0.80 and a probability of >5=0.25. The BCTQ, on the other hand, was used as a questionnaire evaluating the severity of symptoms and functional status [17]. Handgrip strength was evaluated using a hand dynamometer (Jamar, Model SH 5001, Saehan Corporation, Masan, South Korea) in kilograms. The grip strength (key, tip, palmar) of the thumb, second, and third fingers was evaluated with a pinchmeter (Lafayette Instrument Company Inc., Lafayette, IN, USA) in kilograms. Sensory function was evaluated using the SWMT separately in the first three fingers [18].

Outcome measures

Evaluations of women in the third trimester were called measurement I, and postpartum evaluations at the eighth week were called measurement II. The women whose complaints and symptoms continued in measurement II were called for follow-up again at the sixth month, and this evaluation was named measurement III. Sensory and motor tests, BMI, VAS, CTS-6, and BCTQ were evaluated all measurement. In addition, BMI was evaluated in the first trimester. The criteria used to determine improvement were the regression of complaints and symptoms based on a VAS score of 0 and a CTS-6 score of less than 5. According to these criteria, the women whose complaints regressed in measurement II were called group A, and those who regressed in measurement III were called group B. As a result of measurement III, EMG was applied to women who still did not meet the regression criteria (group C). Finally, all women were called by telephone at 12 months postpartum, their complaints and symptoms were reexamined, and the study was terminated.

Treatment

Pregnant who were diagnosed in the third trimester were given training on movements, sleep position, and activity modification to decrease symptoms and complaints. Tendon and nerve gliding exercises and neutral volar wrist splints were recommended in combination. Splint therapy was used all day (removal recommended only during exercising and hand washing). Patients were asked to do 5–10 repetitions of each exercise five times a day until measurement II to decrease symptoms. At the end of measurement II, the same treatment modalities were given for the patients whose complaints and symptoms continued until measurement III. Patients with clinically significant findings based on EMG were operated on after being offered surgical decompression of the median nerve. Continuation of conservative treatment modalities was recommended for patients who did not choose to be operated on.

Statistical analysis

The data obtained were evaluated using the SPSS version 23.0 (IBM Corp., Armonk, NY, USA) software program. The Kolmogorov-Smirnov test was used to evaluate the distribution of the data. Normally distributed data were presented as mean ± SD; non-normally distributed data were presented as median (IQR). Student's t-test was used to compare normally distributed data, and the Mann-Whitney U test was used to compare non-normally distributed data. Normally distributed data were evaluated with the paired sample t-test for dependent groups, and data that were not normally distributed were evaluated with the Wilcoxon test. The chi-square test, Fisher's exact test, and the Fisher-Freeman-Halton test were used to evaluate categorical variables. A p-value

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of <0.05 was considered statistically significant for all tests.

Results

The mean age was 30.6 years old (range: 19–44). The dominant hand was right in 85.3% of the women. The average gestational week was 38.5 weeks (range: 32–41). The delivery method was spontaneous vaginal delivery in 42.2% of the pregnant and cesarean section in 57.8%. Gravida and parity averages were 2 (range: 1–5) and 1 (range: 0–3), respectively. Fourty-one pregnancies were primiparous and 53 pregnancies were multiparous. In terms of occupational distribution, almost two-thirds (66%) were housewives, while the others were civil servants, lawyers, nurses, teachers, sales personel, cleaners, and agricultural workers

At measurement II, the complaints and symptoms of 59 women (60 wrists) had regressed (group A). Thirty-five women (42 wrists) were evaluated at measurement III, and the complaints and symptoms of 23 women (27 wrists) had regressed (group B). While 12 women (15 wrists) underwent EMG due to their ongoing complaints and symptoms (group C). However, the evaluation criteria and life scales had improved, and the diagnosis of CTS was confirmed in all of them. Mild CTS was determined in six wrists, moderate in eight wrists, and severe in one wrist. Surgical decompression was recommended to 12 (14.6%) women (group C), as there were clinically significant electrophysiological changes. Four women (five wrists: three mild/two moderate) chose to for go surgical treatment. The symptoms and complaints of the eight women who underwent surgical treatment regressed, and no additional perioperative or postoperative complications were detected. Ninety women did not have any additional complaints or symptoms at 12 months postpartum. The complaints and symptoms of four women (five wrists) who were not operated on persisted. Four women were not followed to the end of the study; two women did not attend follow-ups because they did not accept surgical treatment, and two women moved to another city.

In Table 1, the first and second measurements of all women, and in Table 2, women with ongoing complaints, were compared. There was a significant improvement in all measurements in all parameters except group C (p<0.001). When the type of delivery, gestational age at birth, gravida, and parity were compared according to the continuity of complaints and symptoms, no statistically significant differences were found (p=0.593, p=0.089, p=0.770, and p=0.273, respectively). Although it was not statistically significant, the symptoms and complaints regressed earlier in primiparous (p=0.153). When the first trimester BMI (23.8±3.3) measurements (at the beginning of the pregnancy follow-ups) were compared between group A and B, it was observed that group B had higher first trimester BMI values; this difference was statistically significant (p=0.030). In addition, although it was not statistically significant, it was determined that the symptoms and complaints of women with higher BMI values in the first and second measurements continued longer (p=0.071, p=0.086, respectively). The mean age of group A was 29.2 years, group B was 32.6 years; this difference was statistically significant (p=0.01). The mean age of group C was 36.7 years.

Table 1. Comparison between the measurements I and II

	Measurement I (n=94)	Measurement II (n=94)	p
BMI (kg/m²)	28.0 ± 3.8	27.0 ± 4.0	< 0.001
VAS*	3 (1-5)	0 (0-2)	< 0.001
CTS-6	14.6 ± 2.2	3.8 ± 4.6	< 0.001
BCTQ	39.6 ± 8.1	26.2 ± 9.5	< 0.001
Grip (kg)	24.2 ± 4.0	26.1 ± 4.5	< 0.001
Palmar Pinch (kg)	5.6 ± 1.2	5.8 ± 1.1	< 0.001
Key Pinch (kg)	4.4 ± 1.0	4.6 ± 1.0	< 0.001
Tip Pinch (kg)	3.4 ± 0.9	3.6 ± 0.9	< 0.001
SWMT*	2.83 (2.44-3.22)	2.36 (2.36-2.44)	< 0.001

Values presented as mean ± SD *Values presented as median (IQR) BCTQ: Boston Carpal Tunnel Questionnaire, BMI: body mass index, CTS-6: Carpal Tunnel Symptoms Scale-6, kg: Kilograms, m: Meters, SWMT: Semmes-Weinstein Monofilament Test, VAS: Visual analog scale

Table 2. Comparison between all measurements of group B

	Measurement I (n=42)	Measurement II (n=42)	Measurement III (n=42)	p**
BMI (kg/m²)	28.7±4.5	27.8±4.7	25.6±4.1	<0.001
VAS*	5(4-6)	2(1-3)	1(0-3)	<0.001
CTS-6	15.4±2.6	7.2±5.2	3.8±6.0	<0.001
BCTQ	44.8±8.0	33.3±11.1	21.4±16.4	<0.001
Grip (kg)	22.0±4.3	23.4±5.3	24.9±6.3	<0.001
Palmar Pinch (kg)	5.0±1.5	5.4±1.5	6.1±1.7	<0.001
Key Pinch (kg)	4.0±1.2	4.2±1.2	4.7±1.4	<0.001
Tip Pinch (kg)	3.0±1.0	3.2±1.0	3.4±1.2	<0.001
SWMT *	2.83(2.44-3.84)	2.44(2.36-3.22)	2.36(1.65-2.44)	<0.001

Values presented as mean ± SD *Values presented as median (IQR) **Statistical significance between the second and third measurements was evaluated. BCTQ: Boston Carpal Tunnel Questionnaire, BMI: body mass index, CTS-6: Carpal Tunnel Symptoms Scale-6, kg: Kilograms, m: Meters, SWMT: Semmes-Weinstein Monofilament Test, VAS: Visual analog scale

Table 3 provides comparisons of all the measurements of the women whose complaints did not resolve who were offered surgery (group C). When considering the motor strength of the group C, there was no significant improvement, except for palmar pinch and no statistically significant difference was found including handgrip (p<0.001) (Table 2) . In the measurements made with the SWMT test, the thumb showed the most sensitive evaluator size, followed by the second, and finally the third finger (thumb > index > middle).

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Table 3. Comparison of group C for all measurements

	Measurement I (n=15)	Measurement II (n=15)	Measurement III (n=15)	p**
BMI (kg/m²)	30.5±3.4	30.1±3.7	27.0±3.0	<0.001
VAS*	7(5-8)	4(3-7)	4(2-7)	0.581
CTS-6	17.3±2.7	13.0±4.9	9.4±7.2	0.010
BCTQ	50.6±8.1	43.8±12.6	39.5±15.2	0.023
Grip (kg)	18.1±2.8	17.8±4.2	17.9±4.4	0.781
Palmar Pinch (kg)	3.6±1.2	4.1±1.6	4.4±1.4	0.250
Key Pinch (kg)	2.9±1.1	3.3±1.3	3.3±1.2	0.206
Tip Pinch (kg)	2.1±0.7	2.4±1.0	2.2±1.0	0.257
Thumb SWMT*	3.84(3.61-4.08)	3.61(3.22-4.08)	2.83(2.44-3.61)	0.007
SWMT*	3.84(3.61-4.08)	3.22(3.22-4.08)	2.83(2.36-3.22)	0.003

Values presented as mean ± SD *Values presented as median (IQR) **Statistical significance between the second and third measurements was evaluated.BCTQ: Boston Carpal Tunnel Questionnaire, BMI: body mass index, CTS-6: Carpal Tunnel Symptoms Scale-6, Kg: Kilograms, m: Meters, SWMT: Semmes-Weinstein Monofilament Test, VAS: Visual analog scale.

Discussion

It has been reported that the severity of PRCTS symptoms may increase in the last trimester; these symptoms can range from pain, numbness, weakness to sleep disorders and depression [11]. Voitk et al. found that only 46% of symptomatic pregnant consulted a doctor for hand symptoms, and only 35% of these women received treatment [19]. It is thought that the most important reason for this is that pregnant doesn't disclose their symptoms, or physicians do not question these women about their symptoms.

Since the electrodiagnostic changes that diagnose CTS may be physiological during pregnancy, the importance of determining the optimum diagnostic test in pregnant women has emerged. Electrophysiological tests may result in false-positivity at a higher rate than other diagnostic tools. It may also lead to an increase in the rates of false estimation and, accordingly, unnecessary treatment [20]. Especially in a sensitive population such as pregnant women, using non-invasive diagnostic methods based on clinical evaluations instead of EMG is less expensive [4,6,8,11,13,15,21]. When a patient clinically shows signs of CTS but there are no positive findings on EMG, it is still possible for this patient to be offered treatment for CTS and to benefit from surgical decompression [21]. Conversely, when a clinically asymptomatic volunteer is diagnosed with CTS electrodiagnostically, it will be much more difficult for this volunteer to accept treatment methods because they have no clinical complaints or symptoms [10,12,15].

We think that the CTS-6 test, in which symptoms, complaints, and clinical examination can be evaluated together, is the most useful non-invasive scale for making a diagnosis. Another criterion we used to determine improvement in PRCTS was a CTS-6 score of less than 5. The correlation between the pretest probability established with the CTS-6 and the posttest probability calculated from the EMG results is very high [16]. As a result of the third measurement, when EMG was applied to the wrists of women whose complaints still had not resolved according to our improvement criteria, our CTS diagnosis was confirmed to be 100% compatible with the EMG. Like the CTS-6, the use of the BCTQ has been shown to offer similar sensitivity, specificity, and positive predictive value to EMG [17]. Meems et al. [11] reported that the BCTQ was compatible with the symptoms and gave even higher scores in the advancing weeks of pregnancy, especially in the third trimester. In our study, we used the BCTQ scale to better compare the severity of symptoms and the dysfunction assessed by the CTS-6 in follow-ups. Our BCTQ results were similar to the literature. It was observed that while they were high at the time of diagnosis, they decreased significantly in the second measurement at the end of the puerperium [11,14]. In the present study, the mean VAS for pain at the time of diagnosis was 3.2. At the sixth month postpartum, the VAS score was 0 for all women except those who were offered surgery. The absence of pain was a criterion for recovery in this study.

The SWMT cut-off value has been defined as 2.83 size monofilament for diagnosing CTS by many authors [18,22]. It has even been reported that the SWMT and the 3.22 size can be a valuable quantitative method to detect moderate and severe CTS [23]. Our study evaluated the first three fingers separately, including size 4.31, which is accepted as the final evaluation size for the SWMT and diminished protective sensation. The median of the first measurement was the 2.83 size monofilament, which is compatible with the literature [18,22]. In particular, in the 15 wrists for which surgery was recommended, the median of the first measurement was the size of the 3.84. This value is accepted as the size at which diminished protective sense begins to be identified. The thumb was determined as the 3.84 size median for the SWMT in the first measurement, and the diminished protective sense due to PRCTS in the third trimester was determined as that size. It has been suggested that for the diagnosis and evaluation of CTS (EMG or SWMT), the thumb is the most sensitive finger. With the SWMT, the sense of the thumb and the total sense of the entire hand correlate with each other, and it has been suggested that testing only the thumb can be used instead of testing the other fingers in the median nerve sensory test [18,24]. In our study, the order of the sensory difference between the SWMT and the fingers was the same (thumb > index > middle). There was a correlation between the SWMT and the thumb and third finger total sense in all measurements, especially in patients recommended for surgery.

It has been reported that primiparity is a risk factor for CTS in the puerperal period [6,25-27]. In other studies, it was stated that there was no relationship between parity and CTS [10,11]. Another study reported that there might be a relationship between increased parity and PRCTS [7]. Although our study showed no

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statistically significant difference in terms of parity, it showed that symptoms and complaints in primiparous pregnancies regressed earlier after pregnancy. It has been reported that advanced maternal age is a risk factor for CTS detected during pregnancy and the puerperium [7,25-27]. In our study, women whose symptoms and complaints resolved early were under 30 years of age, while the average age of the women who resolved late was 32.6 years. The mean age of the women who were offered surgical decompression was 36.7 years, which is even higher.

Studies have shown that BMI is an independent risk factor for PRCTS as well as the rest of the population [2,5,7]. It has even been reported that higher weight gains during pregnancy compared to pre-pregnancy are associated with a lower probability of recovery from PRCTS during follow-up [5,12,13]. Our study revealed that women whose complaints persisted had higher first trimester BMI values. Although it was not statistically significant, the symptoms and complaints of the women with higher BMI values persisted longer in the measurements made at the end of the third trimester and puerperium. Other studies have indicated that breastfeeding is especially a significant risk factor for CTS during the puerperium, and complaints and symptoms improve after breastfeeding is stopped [25,26]. Other studies have determined that certain working conditions and people working in jobs that require repetitive hand movements are at higher risk for CTS [2,28]. Therefore, our study excluded women who had jobs that require repetitive or strong wrist effort and women who did not breastfeed, considering that these risk factors may affect the results.

Since many other studies are retrospective and focus on diagnosis with scans made with national data, sufficient information has not been presented in terms of treatment [6,7,10,11,14]. In our study, immediately after the diagnosis was made, the women were educated about sleep position and activity modification. This education was combined with treatment using tendon and nerve gliding exercises and neutral volar wrist splints [29]. Splinting in the neutral position decreases the pressure on the median nerve by increasing the carpal tunnel volume [13,29,30]. All-day use of neutral splints has been found to cause regression in CTS symptoms, improvement in functional status, and improvement in sensory and motor latencies on EMG [29, 30]. In the treatment of CTS, exercise with a neutral wrist splint reduces pain and provides a significant increase in grip and pinch strength, even if it is used for a short time, such as four to six weeks [30]. In our study, with conservative treatment modalities, complaints and symptoms completely resolved in 59% of the women at the postpartum second month and in 86.4% of the women at the sixth month. However, if symptoms persist or worsen despite conservative therapy, surgical treatment should be recommended [13,15]. In our study, 14.6% of the women were offered surgery, and surgical decompression was performed for the 9.8% who accepted it. In other studies in the literature, this rate was found to be 5.1–15–16.3% [6,8,13].

The strengths of this study are that it was prospective, and repeated measurements were made during pregnancy, the puerperium, and later. Despite the broad exclusion criteria, we still had a sufficiently large sample size to be directly diagnosed with CTS. However, it was impossible to fully determine the prevalence of CTS during pregnancy because all pregnant could not be screened, and some pregnant chose not to participate in the study. Another limitation is that there was no control group. Because healthy pregnant without a diagnosis of CTS will not show clinical signs and symptoms, clinical evaluation scales and tests can not be used.

Conclusions

This study supports that pregnant women over 30 years old with a high BMI be screened for PRCTS using non-invasive diagnostic tools (thumb SWMT), CTS-6, and VAS scales. Thus, by taking early precautions with conservative treatment methods, it will be possible to prevent additional costs to the health system by improving the mother's health, whose provides care during pregnancy and postpartum follow-up.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments. It was approved by the ethics committee of Tokat Gaziosmanpasa University of Medicine Faculty Ethics Committee, Turkey (21-KAEK-129). Written informed consent was gained from all patients; all participants were informed that they could withdraw at any point during the study.

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