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Original Article

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Assessment of sonographic measurement of the median nerve cross-sectional area in pregnant women with hypertensive disorders

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Abstract

Objective: To investigate the prevalence of carpal tunnel syndrome symptoms and assessed the median nerve cross-sectional area measurement by ultrasound in pregnant women in the second and third trimester with hypertensive disorders.

Methods: This study presented four groups that were included in the cross-sectional study: one group of healthy pregnant women (control group) and three groups of pregnant women with hypertensive disorders (gestational hypertension, chronic hypertension , and preeclampsia).

Results: Carpal tunnel syndrome symptoms such as hand numbness and hand pain were significantly higher in the hypertensive group than in the control group (p=.013, p= .002, respectively). We found that the right and left median nerves' cross-sectional area was significantly higher in the hypertensive group than in the control group (p<.001). Also, participants had a positive low correlation and statistically significant difference between body mass index, gestational weight gain, and median nerve cross-sectional area (r= .347, p<.001; r=.414, p<.001). We showed excellent reliability for intraclass correlation coefficients of right and left median nerve cross-sectional area measurements (Intra observer Intraclass correlation coefficients= 0.926 and 0.955, respectively).

Conclusion: Obstetricians should be aware of the increased prevalence of carpal tunnel syndrome in pregnant women with hypertensive disorders and increased carpal tunnel syndrome symptoms in the second and third trimesters. Because of its convenience and low cost, ultrasonography may be preferred for diagnosing carpal tunnel syndrome symptoms in pregnant women. In addition, pregnant women should be referred for early diagnosis and treatment of carpal tunnel syndrome.

Keywords: Carpal tunnel syndrome, hypertensive disorders, median nerve, pregnancy

Introduction

The physiological changes during pregnancy can lead to musculoskeletal complaints. Carpal tunnel syndrome (CTS) is a common cause of numbness and pain in the hand during pregnancy.[1] In the third trimester, most pregnant women present with bilateral symptoms. The prevalence of CTS ranges from 31% to 62% during pregnancy compared with 0.7% to 9.2% in the general population.[1,2] Symptoms such as numbness, burning, and tingling in the radial half of the hand occurs when the median nerve is compressed in the carpal tunnel. In addition, these patients show atrophy of the thenar muscles, weakness, and decreased palmar grip strength and hand dexterity.[3] CTS symptoms often occur at night and affect sleep quality. This situation can cause pregnant women to suffer from anxiety and depression.[4] Fluid retention increased weight gain, and hormonal changes during pregnancy predispose patients to CTS.[5] Swelling in the carpal tunnel compresses the median nerve, causing increased symptoms.[6]

The diagnosis of CTS should include a clinical assessment based on motor and sensory symptoms and the patient's medical history. However, the sensitivity and specificity of clinical diagnostic tests are controversial.[7] Confirmatory tests include electromyography (EMG), nerve conduction studies, and nerve ultrasonography (USG). EMG is very sensitive to median nerve dysfunction and can determine the degree of demyelination and

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axonal loss, but it is expensive, lengthy, and uncomfortable.[8] The prevalence of CTS is increased in pregnant women; USG may be used as an alternative diagnostic method to EMG.[9] CTS can be diagnosed with high-resolution USG, which is painless, non-invasive, and can be performed in a short time. Ultrasonography can show an increased median nerve cross-sectional area (MNCSA) in the carpal tunnel before compressing the median nerve. It has a high correlation with electrodiagnostic results and high diagnostic accuracy.[10] This study aimed to determine the prevalence of CTS symptoms and evaluate the measurement of the MNCSA by ultrasound in pregnant women in third-trimester pregnant women with hypertension. We aimed to facilitate early diagnosis and treatment of CTS.

Methods

Our presented cross-sectional study was conducted in the Perinatology unit between March 2021 to December 2021. All participants have given written informed consent. The Ministry approved the study of the Health of the Republic of Turkey and the Medical Research Ethics Department of the hospital and adhered to the tenets of the Declaration of Helsinki (E2-21-249). Multiple pregnancy, previously diagnosed endocrine (diabetes mellitus, thyroid diseases, etc.), neuromuscular and rheumatological diseases, its treatment before pregnancy, and known cases of CTS were the criteria for exclusion.

Hypertensive disorders in pregnant women were separated according to the diagnostic criteria of previously defined guidelines.[11,12] The present study included four groups (n=196): one group of healthy pregnant women (control group (n=110)), three groups of pregnant women with hypertensive disorders (gestational HT (n=41), chronic HT (n=20), and preeclampsia (n=25)). Pregnant women diagnosed with gestational HT were on antihypertensive treatment during pregnancy, and pregnant women diagnosed with chronic HT were on antihypertensive treatment before pregnancy. In addition, pregnant women diagnosed with pre-eclampsia also used antihypertensive treatment because they had early-onset pre-eclampsia. Age, gravidity, parity, gestational weight gain (GWG), body mass index (BMI), and symptoms of the CTS were recorded. The blood pressure of all pregnant women was measured. Then they were referred for sonographic examination.

Skin and subcutaneous tissues, the superficial and deep tendons of flexor digitalis muscle, the tendon of flexor pollicis longus muscle, and the median nerve in the palms of each patient were examined with ultrasound. Patients were examined using the 9-L 8-MHz linear array probe of the Voluson E10 (GE Medical Systems, Zipf, Austria). It was held at 90 degrees to the long axis of the nerve to ensure that the measured area overlapped the MNCSA at the level of the distal wrist crease. The MNCSA measurements were taken at the level of the carpal tunnel entrance. Area calculations (to the nearest mm²) were measured only on the inside of the echogenic surface of the median nerve (Figure-1).[13] Crasto et al. found that after 5 minutes of the teaching period, the measurement of MNCSA by inexperienced ultrasound operators was consistent with that of an experienced operator.[14] The same physician (trained by EA, Associate Professor, a hand surgeon who regularly uses USG daily) did all the exams and was not informed of the pregnant women's symptoms and diagnoses. Another physician questioned the symptoms and diagnoses of pregnant women.

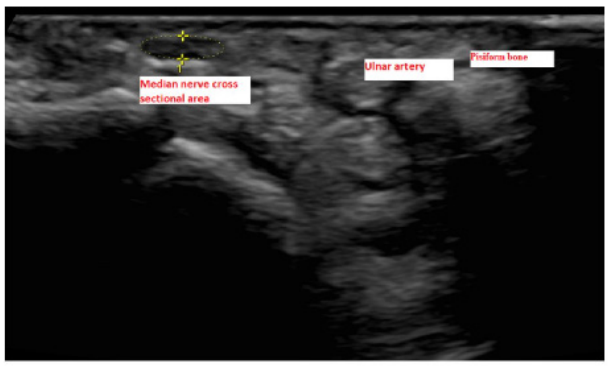

Fig 1. The measurement of the median nerve cross-sectional area

Sample size was calculated using G Power software (version 3.1; Franz Faul, University of Kiel, Kiel, Germany).[15] A p-value of 0.01 and a power of 95% for the sample size resulted in an effect size of 1.69. In each group, n=13 cases were planned to be included. It was planned to include at least 52 patients, 39 in the case group (gestational hypertension, chronic hypertension and pre-eclampsia) and 13 in the control group. The data was analysed using IBM SPSS Statistics for Windows. Continuous values were presented as the median (interquartile range) and as the mean ± standard deviation. Categorical values were expressed as the numbers (percentages). The Kolmogorov-Smirnov test was used to assess the normal distribution of variables. We compared the normally distributed data in more than two groups with the one-way analysis of variance (ANOVA) test. The Mann-Whitney U test and the Kruskal-Wallis test were used to compare the independent groups. The Chi-Squared test was performed to compare categorical variables. Correlations between continuous variables were tested using Spearman's test. Forty pregnant women randomly

selected from the control group were examined a second time on the same day by the same observer (DO) to demonstrate the reproducibility and feasibility of MNCSA measurements. Intraclass correlation coefficients (ICC) were calculated for the MNCSA measurements and presented by means of a Bland-Altman plot analysis (mean difference and 95% limits of agreement were marked). All p-values in the analysis were two-tailed, and values less than 0.05 were considered to be significant.

Results

In the present study, 196 pregnant women were recruited. The demographic data, sonographic measurements, and clinical features are shown in Table 1. Age, gravidity, parity, GWG, BMI, and gestational week of the hypertensive disorders and control groups were similar. CSA of the median nerve and symptoms associated with CTS were compared between the hypertensive disorder groups (Table 2). CSA of the median nerve and symptoms related to CTS were compared between the hypertensive disorders group and the control group (Table 3). In this study of 196 pregnant women, a statistically significant difference and a low positive correlation were observed between BMI, GWG, and MNCSA (r= .347, p<.001; r=.414, p<.001). Intra observer ICC was 0.926 and 0.955 for right and left MNCSA measurements, respectively, as shown in Figure-2 and 3. We showed excellent reliability for ICC of right and left MNCSA measurements.

Table 1. Demographics and clinical characteristics

	Gestational HT (n: 41)	Chronic HT (n: 20)	Preeclampsia (n: 25)	Control (n: 110)	p value
Age (years)	30±8	30±7	31±7	29±7	.241*
Gravidity	3±2	3±2	2±1	3±1	.165*
Parity	1±0	1±1	1±1	1±1	.578*
BMI (kg/m²)	33±7	32±5	30±5	29±4	.137*
GWG (kg)	11±5	10±5	10±4	7±3	.069*
Gestational Week	35±5	33±6	32±5	31±6	.107*
Systolic blood pressure (mmHg)	129±14	133±16	136±18	101±11	.002*
Diastolic blood pressure (mmHg)	85±9	92±11	89±14	68±7	.004*

Body mass index (BMI), gestational weight gain (GWG), hypertension (HT)
Variables are presented mean ± standard deviation
*ANOVA test

Table 2. MNCSA in the hypertensive disorder groups

	Gestational HT (n: 41)	Chronic HT (n: 20)	Preeclampsia (n: 25)	p value
Right MNCSA (mm²)	8 (7;10)	8 (8;10)	9 (8;9)	.636†
Left MNCSA (mm²)	8 (7;9)	8 (7;10)	8 (7;8)	.878†
Hand numbness	9 (22%)	7 (35%)	8 (32%)	.489 ‡
Hand pain	6 (14.6%)	3 (15%)	2 (8%)	.695 ‡

Hypertension (HT), median nerve cross-sectional area (MNCSA), SQUARE MILLIMETER (mm²)

Variables are presented (median (IQRs)) or counts (percentage)
† The Kruskal-Wallis Test ‡ Chi Square Test

Table 3. MNCSA in the hypertensive and control groups

	Hypertensive group (n: 86)	Control group (n: 110)	p value
Right MNCSA (mm²)	8 (8;10)	7 (6;8)	<.001§
Left MNCSA (mm²)	8 (7;9)	7 (6;8)	<.001§
Hand numbness	24 (27.9%)	15 (13.6%)	.013 ‡
Hand pain	11 (12.8%)	2 (1.8%)	.002 ‡

Median nerve cross-sectional area (MNCSA), SQUARE MILLIMETER (mm²)

Variables are presented (median (IQRs)) or counts (percentage)
§ The Mann Whitney U Test ‡ Chi Square Test

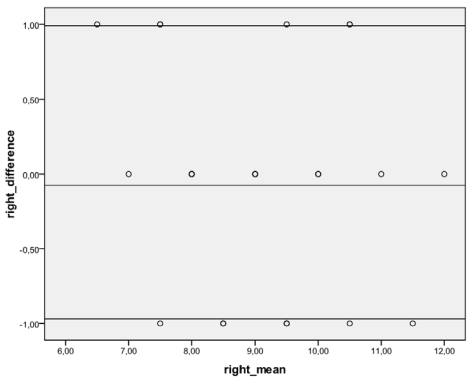

Fig 2. The Bland–Altman plot for the right MNCSA

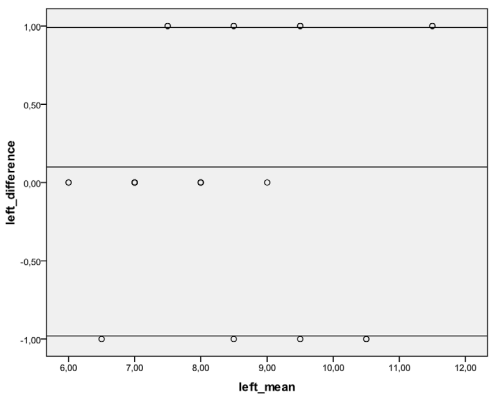

Fig 3. The Bland–Altman plot for the left MNCSA

Discussion

The direct effects of hypertension on CTS are still unclear. There is a close association between generalized edema caused by the increased volume load during pregnancy and the development of CTS.[16,17] According to Edwards et al., hypertension may affect sensory nerve conduction, increasing cutaneous sensory thresholds and decreasing sensory action potential amplitudes, but this situation is unclear.[18] Although it has been suggested that treatment of hypertension may affect the natural history of CTS, there is no evidence to date that this is the case.[19]

When the median nerve is compressed in the carpal tunnel, it destroys the blood-nerve barrier, leading to endoneurial edema and the development of neuropathy.[20] Symptoms of CTS include tingling or pain and numbness in a distribution that consists of the median nerve zone and typically worsens at night, usually awakening from sleep. We found that CTS symptoms such as pain and numbness in hand were significantly higher in the hypertensive group than in the control group. We compared the presence of CTS symptoms between hypertensive disorder groups and found no difference. However, numbness and pain in the hands occurred more frequently in pregnant women with chronic HT than in women diagnosed with preeclampsia and gestational HT. In a recent study, 111 out of 482 pregnant women with CTS experienced symptoms, and the prevalence of CTS symptoms was approximately 23%.[21] Moreover, other studies have found prevalence values between 25-34% of pregnant women, comparable to our study.[4,7] Especially in the last period of pregnancy, numbness and pain in hand, the CTS -related symptoms, should be questioned in pregnant women diagnosed with hypertensive disorders.

Due to weight gain during pregnancy, blood flow to the median nerve decreases, venous blood flow decreases due to fluid retention, and the risk of CTS increases.[22] Studies have shown increased CTS-related symptoms due to increased GWG in the third trimester.[23,24] We found a positive low correlation and statistically significant difference between BMI, GWG, and MNCSA in 196 pregnant women. Increased BMI is a possible risk factor for CTS. Wright et al. found that pregnant women diagnosed with CTS had high rates of overweight, obesity, and excessive GWG.[14] GWG should be maintained at an optimal level, and weight control should be supported in pregnant women with CTS -related symptoms.

Ultrasonography can detect morphological changes resulting from compression of the median nerve. It may be useful in the diagnosis and differential diagnosis of CTS. It may show increased CSA in the carpal tunnel before median nerve compression. We found that the right and left median nerves' CSA was statistically significantly higher in the hypertensive group than in control (8 vs. 7; 8 vs. 7, $p<0.001$, respectively). We also compared the CSA of the right and left median nerves between groups with hypertensive disorders and found no difference. In one study, the MNCSA was most predictive of the diagnosis of CTS, and the optimal cutoff value was 9 9.8 mm^2, 82% sensitivity, and 87.5% specificity.[25] In a systematic review evaluating four studies, cutoff values of 8.5 to 10 mm^2 for diagnosis, specificities ranged from 73 to 98%, and sensitivities ranged from 65 to 97%.[8] Measurement of the MNCSA should be standardized for the CTS diagnosis, and further studies are needed to establish specific diagnostic thresholds. EMG is the gold standard diagnostic modality for CTS. However, it is not recommended for pregnant women due to its high cost and painful electrical stimulation. Instead, USG may be preferred to EMG for diagnosing CTS because of its high prevalence in the pregnant population. USG is superior to EMG in diagnosing CTS as it also evaluates possible pathologies in the carpal tunnel and the anatomical structure of the median nerve.

Limitation in this study, more extensive population-based studies should be planned to define the CTS diagnosis better and management practices in pregnancy. However, there was no information about CTS treatment and its outcome in our study population.

Conclusion

To date, this is the first study to demonstrate the prevalence of CTS symptoms and also to evaluate ultrasound measurement of MNCSA in the group of second and third trimester pregnant women with hypertension. MNCSA can be easily assessed with USG since CTS symptoms increase during pregnancy. Because of its convenience and low cost, USG can be used to screen for CTS symptoms. If CTS can be diagnosed early, it would be possible to treat conservatively. The high prevalence of CTS in pregnant women with hypertension and the increase in symptoms of CTS in the third trimester should be noted by obstetricians.

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