Who develops carpal tunnel syndrome during pregnancy: An analysis of obesity, gestational weight gain, and parity

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Abstract

Purpose: To examine the prevalence, onset, and risk factors of carpal tunnel syndrome during pregnancy.

Methods: Maternal electronic medical records were linked to birth certificate records using social security number. The outcome of carpal tunnel syndrome during pregnancy was defined as ICD9 code 354.0 given at a prenatal visit. Chi-square, t-test, and adjusted logistic regression were performed.

Results: We analyzed 17,623 prenatal visits from the Hospital of the University of Pennsylvania from 1/2003–12/2007. Mean maternal age was 26.4 (6.5) years, with 21% white, 69% black, and 46% overweight or obese. Ninety-one (2.8%) mothers participated in 765 prenatal visits given a carpal tunnel syndrome diagnosis code. Compared to mothers without carpal tunnel syndrome, mothers with carpal tunnel syndrome were older (29.72 (5.42) versus 26.04 (6.37) years, $p = 0.005$), gained more weight during pregnancy (40.65 (10.13) pounds versus 34.2 (9.41) pounds, $p = 0.04$), and more likely to have college education (69.9% versus 44.5%, $p = 0.03$). Average onset (SD) of carpal tunnel syndrome was 18.1 (8.4) weeks' gestation.

Conclusion: Mothers with carpal tunnel syndrome had high rates of overweight, obesity, and excessive gestational weight gain. Diagnosis of carpal tunnel syndrome was rare but often occurred in the first and second trimesters, earlier than the frequently reported third trimester onset seen in literature. When looking at predictors of carpal tunnel syndrome, obese prepregnancy body mass index ($\text{BMI} \geq 30 \text{ kg/m}^2$) and excessive gestational weight gain, greater than two previous live births, higher level of maternal education and more prenatal care (>10 visits) were associated with increased risk of carpal tunnel syndrome. Higher maternal age was not associated with carpal tunnel syndrome diagnosis after adjusting for weight and parity, suggesting mediation by these covariates.

Keywords

Obesity, gestational weight gain, carpal tunnel syndrome

Background

The association of carpal tunnel syndrome (CTS) with pregnancy has been known for many years. First reported in 1945 by Walshe who described a population of pregnant women with “acroparaesthesias” in their hands and arms, Wallace and Cook also described two pregnant patients given the clinical diagnosis of CTS in 1957.^{1,2} Though the prevalence in the general population is around 10%,³ its prevalence in pregnant patients has a wide reported range of 2% to 62%.^{4,5} Anecdotally, up to 50% of pregnant women in the third trimester complain of waking in the middle of the night with paresthesia in one or both of their hands, which can be relieved by shaking the affected hand.² Difficulty in determining prevalence likely results from subclinical symptoms, the postpartum resolution of symptoms, and under-diagnosis by prenatal health care providers.^{5,6} Additionally, though some studies have shown that these symptoms typically arise during the third trimester due to the increased gestational weight gain (GWG), overall there is much discordance over the reported time of disease onset and the effect of prepregnant obesity and GWG.^{5,7–9}

GWG is the result of both maternal physiology and behavior including increased blood volume, uterine mass, interstitial fluid volume, developing fetus, and abdominal adiposity. At highest risk of excessive GWG are mothers with increased age, and those with low income due to a variety of environmental, socioeconomic, and educational barriers. The highest rates of excessive GWG are seen among Latina and African-American low-income mothers.^{10–14} Though GWG can be demonstrated with serial weights, the contribution of increasing blood volume, fluid retention, and resultant edema is less concrete and more difficult to assess. In the literature, many studies rely on clinical evidence such as the removal of rings during pregnancy due to swollen fingers as an indication of edema.⁹ Edema and overall adiposity are thought to lead to decreased blood flow to the median nerve at the transverse carpal ligament, as does the physiologic effects of shunting blood flow to the uterus and developing fetus.¹⁰

Systemic pregnancy complications that are a direct result of weight status like gestational hypertension and diabetes, also lead to decreased blood flow to the median nerve and increased risk of CTS.^{10–14} Additionally, when blood glucose levels are high, the proteins in the tendons of the carpal tunnel become glycosylated and inflamed, leading to further compression of the median nerve. There has not yet been a multivariate study of the relationship between socioeconomic indicators, GWG, diabetes, hypertension, parity, and CTS during pregnancy.⁷

Therefore, the purpose of this study is to examine the prevalence, onset, and association of these risk factors of CTS during pregnancy in an urban academic medical center by retrospectively studying a cohort of pregnant women with and without CTS. To the literature, we add an analysis of the largest number of pregnancies and CTS-related visits to our knowledge to date. We do have a unique study in that we have records from several office visits within the same pregnancy to quantify the timing of diagnosis as well as other corresponding characteristics of the pregnancy at the point of diagnosis. Our hypotheses are that (1) the onset of CTS in our urban, academic medical center will occur earlier

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than third trimester due to the high prevalence of prepregnant obesity and excessive GWG, and (2) prepregnant obesity and excessive GWG will be associated with increased risk of CTS during pregnancy in multivariable analysis.

Methods

The outpatient and inpatient electronic medical records (EMRs) of a cohort of pregnant women receiving prenatal care at a large obstetrics unit of an urban academic center between January 2001 and December 2007 ($n = 20,758$) were linked to state birth certificates using maternal social security number alone. We used records of office visits and delivery summaries, but did not use any billing data or records of visits to physical therapy or procedures. Prior to analysis, records without unique social security number were excluded from both the EMR and birth certificate records, as were records with births prior to 2003 when the birth certificate was revised to include more in-depth reporting of prenatal care utilization, pregnancy complications, and weight variables. Additional eligibility criteria included women with care at the medical center prior to pregnancy (conservatively defined as a visit in any department prior to the gestational age of the baby subtracted from the delivery date), at least one prenatal visit at the study center, and actual live delivery at the study center (as recorded on the birth certificate). Exclusion criteria included women with CTS diagnosis prior to pregnancy. The outcome of CTS during pregnancy was defined as ICD-9 code 354.0 identified in the EMR during any prenatal visit. We defined pregnancy as the gestational age of the baby subtracted from the delivery date and used the date of encounter attached to every ICD-9 code to confirm coding during pregnancy. If a woman had an ICD-9 code for CTS prior to her estimated start of pregnancy, she was coded as having CTS prior to pregnancy and excluded.

Our main exposure or independent variable was a constructed variable that by hypothesis was deemed to influence the likelihood of CTS diagnosis, containing information about a woman's prepregnancy body mass index (BMI) and her actual GWG. For this variable, women were separated into six clinically relevant groups. We separated women into BMI categories (normal $<25 \text{ kg/m}^2$, overweight $\geq 25 \text{ kg/m}^2$ – 30 kg/m^2 , and obese $\geq 30 \text{ kg/m}^2$). Then, within the BMI groups, women were further classified into GWG categories (adequate versus excessive) acquired from hospital records and based on the old Institute of Medicine (IOM) guidelines from 1990.¹⁵ We therefore had six clinically relevant groups: normal BMI with adequate and excessive GWG, overweight BMI with adequate and excessive GWG, and obese BMI with adequate and excessive GWG.

The EMR was linked to the birth certificate so that covariates could be drawn from both sources. We built our model in a step-wise fashion, first including covariates that could independently predict the outcome

of CTS as demonstrated by prior studies—maternal age, race/ethnicity, and education. Next we added the covariates associated with carpal tunnel diagnosis with significance $p < 0.1$ in our univariate analysis—self-reported smoking during pregnancy and number of live births prior to the current pregnancy as recorded by the mother on the birth certificate. Finally, we adjusted models for factors that might be in the pathway linking maternal clinical weight group (constructed variable containing information about a woman's prepregnancy BMI and GWG) with CTS, namely pregnancy complications like gestational diabetes and hypertension, and number prenatal care visits. If weight variables were missing from the gold standard EMR demonstrating actual measurement (15% subjects), we used the variables from the birth certificate which are collected through maternal self-report. Use of the birth certificate weight variables was limited in accuracy as women tend to under-report baseline weight as well as GWG especially if they gained excessive GWG.¹⁶ We calculated descriptive statistics for demographic and weight variables using chi-squared and *t*-tests. Multivariable logistic regression was used to determine the association of the maternal clinical weight category, covariates, and the outcome of presence of CTS diagnosis.

Results

After applying eligibility criteria, we included 17,623 prenatal visits in our study. Excluded women ($n = 3044$) were similar to those studied ($n = 3246$) with regard to education, mean gestational age of the delivered baby (38 weeks), and mean total number prenatal visits (9), but women excluded were slightly older (27 versus 26.6 years, $p = 0.001$) and more likely to report their race as "other" (16% versus 9%, $p = 0.001$). Of those women in the study, mean age of mothers was 26.4 (6.5) years, with 21% white, 69% black, and 22% without high-school completion (Table 1).

Ninety-one (2.8%) mothers participated in 765 prenatal visits given a CTS diagnosis code. Compared to mothers without CTS during pregnancy, mothers with CTS were older (29.72 (5.42) versus 26.04 (6.37) years, $p = 0.005$) and gained more weight during pregnancy (40.65 (10.13) pounds versus 34.2 (9.41) pounds, $p = 0.04$), with a trend towards larger BMI at the start of pregnancy (mean prepregnant BMI 27.51 (1.12) versus 26.02 (0.1) kg/m^2 , $p = 0.1$). A larger percent of women with CTS reported race as black when compared to those women without CTS (82.9 versus 70.2 ($p = 0.03$)). Finally, those with CTS were more likely to have college education (69.9% versus 44.5%, $p = 0.03$).

Of the study participants, average onset (SD) of CTS was 18.1 (8.4) weeks gestation (second trimester), with over half of women (55%) diagnosed during the first trimester with median weeks 10.4 (Table 2). In univariate analysis, maternal age over 30 years, black

Table 1. Maternal characteristics.

	Maternal CTS diagnosis		
	Yes N = 91	No N = 3155	<i>p</i>
Age, years: mean (SD)	29.72 (5.42)	26.04 (6.37)	0.005
Body mass index (BMI), kg/m^2 : mean (SD)	27.51 (1.12)	26.02 (0.10)	0.1
Gestational weight gain (GWG), lbs: mean (SD)	40.65 (10.13)	34.20 (9.41)	0.04
Race/ethnicity: (%)			
White	12.2	19.2	0.13
Black	82.9	70.2	0.03
College education: (%)	69.9	44.5	0.03

CTS: carpal tunnel syndrome.

Table 2. Time of CTS diagnosis among 91 pregnant women.

Trimester	Frequency (%)
1 (0–13 weeks)	55
2 (weeks 13–27)	42
3 (weeks 27–40)	3

CTS: carpal tunnel syndrome.

race, college education, previous live births >2 children, prenatal care visits >10, obese prepregnancy BMI, and excessive GWG were each significantly associated with the diagnosis of CTS (Table 3). In multivariate analysis, maternal age was no longer significantly associated with CTS risk after adjustment for maternal weight, signaling mediation by these covariates. In the final model, race was also no longer significant demonstrating that unmeasured racial and ethnic factors in part may explain the association seen between maternal weight and having CTS in previous population studies. Our final model had a maximized R^2 in the step-wise process and is therefore shown in Table 3.

Table 3. Univariate and multivariate logistic regression predicting CTS diagnosis.

Univariate analysis of:	Number (%) w/o CTS diagnosis (n = 3155)	Number (%) w/ CTS diagnosis (n = 91)	Unadjusted odds ratio (OR)	Adjusted odds ratio (OR) ^a	Adjusted p value
Age					
≤30 years	2340 (74)	60 (66)	1.00	1.00	0.9
>30 years	815 (26)	31 (34)	1.43 (1.0–2.3)	0.99 (0.59–1.69)	
Race					
White	606 (19.2)	11 (12.2)	1.00	1.00	0.5
Black	2215 (70.2)	75 (82.9)	1.86 (1.02–3.90)	1.2 (0.70–2.0)	
Other	334 (10.6)	4 (4.9)	0.90 (0.62–1.59)	Omitted ^b	
Maternal education					
Some high school	749 (23.7)	11 (12.2)	1.00	1.00	0.5
Finished high school	945 (29.9)	27 (29.2)	1.90 (0.67–5.49)	1.58 (0.40–9.94)	0.05
College or above	1405 (44.5)	51 (56.1)	2.68 (0.99–6.07)	10.4 (1.00–148)	
Smoker					
No	2494 (79)	84 (92.3)	1.00	1.00	0.7
Yes	661 (21)	7 (7.7)	0.62 (0.19–2.28)	1.32 (0.37–5.85)	
Live births					
First	1415 (45)	18 (19.8)	1.00	1.00	0.03
Second or third	1543 (49)	66 (72.5)	4.59 (1.91–11.07)	1.22 (1.05–1.75)	
Fourth or more	197 (6)	7 (7.7)	5.96 (1.82–19.85)	Omitted	
Prenatal care visits					
Low (<10)	1841 (58.4)	46 (50.5)	1.00	1.00	0.001
Adequate (≥10)	1293 (40.9)	45 (49.5)	1.29 (0.74–2.77)	2.95 (1.88–4.62)	
Hypertension					
No	3032 (96.1)	87 (95.6)	1.00	Omitted	
Yes	123 (3.9)	4 (4.4)	1.32 (0.33–5.28)		
Diabetes					
No	3095 (98.1)	89 (97.8)	1.00	Omitted	
Yes	60 (1.9)	2 (2.2)	1.35 (0.18–9.31)		
Clinical weight					
Normal BMI (BMI ≥ 18.5 kg/m ²), adequate GWG	1255 (39.8)	36 (39.6)	1.00	1.00	
Normal BMI, excessive GWG	745 (23.6)	18 (19.8)	0.99 (0.69–1.21)	1.33 (0.41–3.86)	0.6
Overweight BMI (≥25 and <30 kg/m ²), adequate GWG	147 (4.7)	0	Omitted	Omitted	
Overweight BMI, excessive GWG	518 (16.4)	12 (13.2)	1.29 (1.17–1.49)	1.75 (0.38–12.48)	0.4
Obese BMI (≥30 kg/m ²), normal GWG	167 (5.3)	14 (15.4)	2.34 (1.49–3.68)	2.99 (1.81–16.79)	0.01
Obese BMI, excessive GWG	457 (14.5)	11 (12.1)	1.38 (1.16–3.29)	1.27 (0.11–12.74)	0.2

^aAdjusted for age, race, education, smoking, parity, hypertension, diabetes, maternal weight category (constructed variable including information about maternal BMI and GWG), and number prenatal care visits.

^bOmission of variables is due to low cell count.

CTS: carpal tunnel syndrome; BMI: body mass index; GWG: gestational weight gain.

Discussion

Our study population is representative of those served by the urban academic center, with a large proportion of black patients. The high rates of overweight (BMI 25–30 kg/m²), obesity (BMI ≥ 30 kg/m²), and excessive GWG are also representative of the urban center, and demonstrate the maternal obesity epidemic which is growing in prevalence, and causing high rates of maternal and child morbidity and mortality. We believe our finding of an earlier onset of CTS to be a direct result of the poor weight status of mothers in Philadelphia both before and during pregnancy. Because of the difficulties both mother and child face if maternal weight status is unhealthy, the IOM recently updated their guidelines to be more restrictive on the amount of weight they recommend women gain during pregnancy.¹⁵ In addition to the increased risk of caesarean section, pregnancy complications like gestational diabetes and hypertension, fetal macrosomia, and possible childhood obesity, CTS during pregnancy is one additional indicator of the morbidity which results from maternal obesity.

Maternal obesity has been shown to increase the cost of pregnancy in part through increased utilization of health care.¹⁷ We note that the diagnosis of CTS was more likely if mothers had higher levels of prenatal care (>10 office visits). Increased exposure to diagnosticians like health care providers may be the reason for better diagnosis and coding. Similarly, higher levels of education also were associated with high CTS risk either because of maternal knowledge base leading to appropriate reported history, or higher prevalence of computer or office work.

Our study supports the previously reported link between increased age and CTS diagnosis during pregnancy, but we note that the effect of age is likely mediated through increased parity, and increased risk of unhealthy maternal weight. A new area of study is the association of parity, and the production of the hormone relaxin. Previous studies have shown a possible relationship of CTS with the polypeptide hormone relaxin, which is produced by the ovaries and corpus luteum in large amounts during pregnancy causing pelvic and cervical expansion, and blood vessel dilatation. Outside of causing pelvic girdle pain, relaxin may also induce inflammatory changes in the transverse carpal ligament, increasing its size causing impingement of the median nerve. Interestingly, those who have had more pregnancies may have higher relaxin production and therefore higher risk of CTS.^{18,19} Since relaxin is also a modulator of feeding and stress response when it interacts with a cognate receptor in the hypothalamus, the recent creation of a relaxin knockout mouse model may be the first step in novel therapies for obesity.²⁰ The hypothalamic hypophyseal overactivity that results from increased parity causing increased relaxin production during pregnancy may have the side effect of increasing both risk of obesity and CTS.

Though we believe this is the largest analysis of prenatal visits and CTS diagnoses to date, we still have small numbers of our outcome which certainly limit our multivariate analysis and performance of our statistical tests. This resulted in empty cells and the omission of some variables from the multivariate analysis, making interpretation of the results less reliable. The trends shown here are important, but further inquiry in a larger sample should be undertaken. The small number of CTS diagnoses likely results from unreported subclinical symptoms, under-diagnosis, or under-coding. The diagnosis of carpal tunnel was most often made by an obstetrician which could skew CTS rates either higher or lower based on the obstetrician's comfort with this diagnosis. Birth certificate records were also a limitation, as birth certificates are largely completed by maternal self-report which introduces recall bias. Finally, the high proportion of black women in our study may limit the generalizability of our results though representative of some urban centers.

In conclusion, along with the expanding waistline of America may come an expansion in the extent of CTS during pregnancy. Prenatal health care providers should be aware of the diagnosis, and the conservative treatment for mild disease including nighttime wrist bracing

and lifestyle modification. Since the use of most non-steroidal anti-inflammatory medications during pregnancy is not recommended, providers should consult specialists if women present with severe sensory deficit or weakness, or if conservative measures like night bracing and activity modification are ineffective after four weeks.^{19,21} Hand surgeons may expect more consults and perhaps longer duration and increased severity of CTS during pregnancy, especially among populations with high prevalence of obesity, excessive GWG, and high parity. Larger studies are needed to highlight this trend and to determine best practices for management of this disease in a pregnant population. An interdisciplinary focus will continue to be the best approach for managing potentially escalating diagnosis and treatment.

Declarations of conflicting interests

None declared.

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Ethical approval

The study was approved by the Institutional Review Board at the University of Pennsylvania School of Medicine. Written consent of individual patients was waived due to impracticality of collecting consent, and reality of no more than minimal risk to the privacy of individuals.

Guarantor

CW

Contributorship

BS and CW researched literature, conceived the study and wrote the draft. All authors reviewed, edited, and approved the final version of the manuscript.

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