Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/4ds1zj83

CARPAL TUNNEL SYNDROME ASS0SIATION WITH PREGNANCY AND TYPE II DIABETES

Fazal Mahmood[1*], Tahsin Ullah[2], Muhammad Ismail[3], Riaz[4], Alamgir Khan[5]

[1*]Senior Registrar, Timergara Teaching Hospital Dir | Email: dr_fmahmood@yahoo.com
[2] Senior Registrar, Timergara Teaching Hospital Dir | Email: tahsinullah.77@gmail.com
[3]Orthopedic Spine, Khyber Teaching Hospitals Peshawar | Email: ismailm452@gmail.com
[4]Timergara Teaching Hospital Dir | Email: drriazpmc1@gmail.com
[5]Senior Registrar, Timergara Teaching Hospital Dir | Email: dr.hafizalamgir@gmail.com

***Corresponding Author:** Fazal Mahmood
*Senior Registrar, Timergara Teaching Hospital Dir | Email: dr_fmahmood@yahoo.com

Abstract
Carpal Tunnel Syndrome (CTS) is a common condition resulting from the compression of the median nerve at the wrist, often influenced by factors such as pregnancy and Type 2 diabetes. Pregnancy-related CTS is primarily caused by hormonal changes, fluid retention, and ligament laxity, while diabetes exacerbates CTS through nerve ischemia and tissue changes due to prolonged hyperglycemia. This study aimed to evaluate the prevalence and severity of CTS in multiparous women diagnosed with Type 2 diabetes. Conducted over a six-month period from 11-03-2023 to 31-07-2023, and approved by the Timergara Orthopedic Department on 11-02-2023, the study included 63 female participants, divided into two groups: those with pregnancy-related CTS and those with Type 2 diabetes-related CTS. The findings revealed that 47.62% of participants exhibited CTS, with 52.38% of those with CTS also diagnosed with Type 2 diabetes. The severity of CTS ranged from mild to moderate, with the majority of cases being relatively mild (23.81% mild, 19.05% moderate, and 4.76% severe). The study found a higher prevalence of CTS in women aged 32-35 years, highlighting the role of age and diabetes in CTS development. Despite the presence of CTS, 60.32% of women reported no significant impairment in activities of daily living (ADLs). The study concludes that early diagnosis and management of CTS are essential for improving outcomes, particularly in diabetic and multiparous populations. The findings suggest that future studies should focus on the long-term effects of CTS in Type 2 diabetic women and explore effective treatment protocols tailored for this group.

Keywords: Carpal Tunnel Syndrome (CTS), Diabetes, Pregnant women, Timergara Orthopedic Department.

Introduction

Carpal Tunnel Syndrome (CTS) is a clinical condition caused by the compression of the median nerve in the carpal tunnel at the wrist. The carpal tunnel is formed by the transverse carpal ligament, the longitudinal carpal ligament, and the surrounding muscles of the hand[1]. In many cases, the compression of the median nerve results from tendonitis, synovial thickening of ligaments, and tendon sheaths[2]. CTS is the most common mononeuropathy[3]. Physiological changes, including fluid retention, hormonal changes, and weight gain, make pregnancy a recognized risk factor for the

emergence or worsening of CTS[4]. The hormone relaxin is particularly important during pregnancy because it increases ligamentous laxity, which can cause changes in the anatomy of the carpal tunnel, leading to an increased risk of nerve compression[5]. Relaxin receptors present in the anterior oblique ligament may cause joint laxity, which could manifest as carpometacarpal arthritis[6]. Additionally, fluid retention, particularly in the later stages of pregnancy, may lead to edema, further compressing the median nerve, which results in CTS symptoms[7]. Ultrasonography and radiography imaging techniques have shown median nerve impingement and anatomical defects in patients with CTS, such as hypoplasia of the hamate bone[8]. Early diagnosis and treatment are crucial to providing effective and less invasive management options for CTS[9],[10]. CTS is the most frequently observed pregnancy-related disease, and in some studies, up to 62.0% of pregnant women have some form of CTS[11]. The increased prevalence during the third trimester is particularly linked to maximum fluid retention and weight gain seen during this time[12]. Typical symptoms of CTS include pain, numbness, and paraesthesia, which generally resolve after labor. However, some women experience symptoms that require treatment[13]. CTS is more prevalent in primigravida versus multigravida women, and severe cases are reflected in higher pain scales[14]. Studies have shown a significant correlation between recurrent pregnancy and the development of CTS, with some finding the highest prevalence of CTS symptoms in pregnant women, especially in the third trimester[15]. Additionally, studies have shown that the prevalence of CTS increases during the later months of pregnancy, particularly in the 9th month[16]. Besides pregnancy, another major contributor to CTS development is Diabetes Mellitus. Prolonged hyperglycemia, a well-known risk factor for CTS, alters nerve function. In diabetic patients, CTS pathophysiology involves alterations in the carpal tunnel's connective tissue and nerve ischemia due to microvascular injury[17]. Diabetic neuropathy makes the median nerve more prone to compression, exacerbating CTS[18]. The incidence of CTS is reported to be 3–4 times higher in diabetic patients compared to the general population[19]. A study by Zhao et al.[20] stated that the presence of diabetes is significantly associated with the development of CTS in males and females, but there is a substantially higher risk of severe nerve damage in diabetic patients compared to a control group. Furthermore, research has shown that CTS can persist longer in diabetic patients and may be less receptive to conservative approaches like splinting and physiotherapy[21].Pregnancy, diabetes, and CTS share a complex relationship, with both conditions contributing to median nerve compression in different ways. Pregnancy leads to CTS due to fluid retention, hormonal changes, and ligamentous laxity, while hyperglycemia in diabetes promotes tissue changes and nerve damage, leading to CTS. CTS is among the most common neuropathies during pregnancy, significantly impacting the quality of life of affected women. Multigravida pregnant women are at a heightened risk of CTS due to cumulative physiological changes from subsequent pregnancies, including increased fluid retention, weight gain, and hormonal changes, which exacerbate median nerve compression. Although common, there is limited local data exploring the outcomes of CTS in multigravida women. Understanding the burden of CTS in this population is critical for early recognition and management, as delayed intervention may result in persistent symptoms that hinder daily activities and postpartum recovery. Further research is necessary to explore the specific socioeconomic and cultural determinants shaping the presentation and treatment of CTS in this region.

METHODOLOGY

The study lasted for six months and was divided into two main phases. Data collection occurred over three months, from **11-March-2023 to 31-July-2023**, followed by three months for analysis and report writing. This structured approach allowed for the cumulative assessment of the data and results. The study included 63 patients, divided into two groups: those with Carpal Tunnel Syndrome (CTS) related to pregnancy and those with CTS related to Type II diabetes. This sample size was sufficiently powered to detect clinically relevant differences, with the opportunity to adjust for effect sizes and confidence levels. CTS was diagnosed clinically and through diagnostic tests at any stage of pregnancy, including post-pregnancy. Patients with a family history of CTS or Type II diabetes, diagnosed through medical records or blood tests, were included. Participants aged **30 to 65 years** were eligible, provided they were willing to give informed consent. Exclusion criteria included

previous surgical treatment for CTS, severe comorbidities (e.g., kidney disease or neuropathy), CTS resulting from trauma or identifiable external factors, gestational or Type I diabetes in pregnant patients, and mental health problems that might restrict engagement.

- **Age, gender, occupation, and medical history**
- **Study Ratings**: CTS severity, neurophysiological testing, pain severity, diabetes management (HbA1c).
- **Pregnancy Data**: Trimester, complications, and gestational age.

Ethical approval was obtained from the **IRB/Ethics Committee at Timergara Orthopedic Department** on **11-February-2023**. To ensure ethical compliance, patient confidentiality was strictly maintained, and informed consent was obtained from all participants before participation. The study's purpose, procedure, risks, and benefits were clearly explained, and consent forms were available in **Urdu** and **Pashto** to ensure clarity. During the study, patient identifiers were removed, and all data was securely stored in encrypted files. Access to this data was restricted to authorized personnel only, and results were reported in aggregate form to protect participants' privacy.

Statistical Analysis:

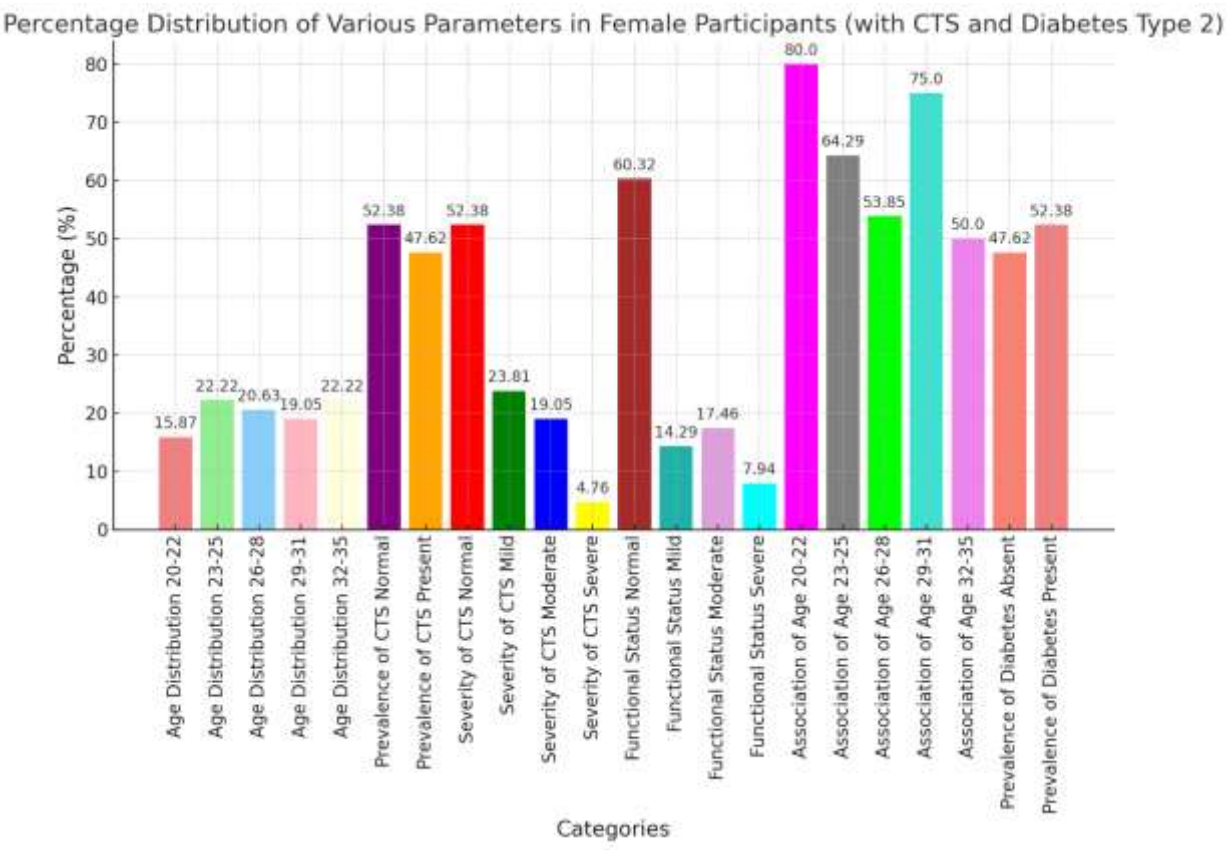
- **Group Comparisons**: Independent t-tests or Mann-Whitney U tests were used to compare CTS severity between pregnant women with CTS and diabetic patients with CTS.
- **Correlation and Multivariate Analysis**: Pearson or Spearman correlation coefficients were used to assess the relationship between CTS severity and diabetes control. Multivariate regression analysis was employed to identify optimal predictors and adjust for potential confounders. Statistical significance was defined as a p-value of <0.05 to ensure the reliability of the results.

Results

Age Distribution of Female Participants frequency of female participants in various age groups. (20-22, 23-25, etc.), and the y-axis would show the number of participants in each group. This can help visualize the age distribution and highlight any trends in the participation rates across age ranges. The age distribution shows an even spread across different age groups, with the highest participation coming from the 23-25 and 32-35 age ranges (both at 22.22%). The lowest participation is from the 29-31 group (19.05%). The slight variation may reflect the demographic preferences or trends in specific age brackets engaging in the study. Prevalence of Carpal Tunnel Syndrome (CTS) participants who have CTS compared to those who do not. The chart can have two sections: "Normal" (52.38%) and "Present" (47.62%). The prevalence of Carpal Tunnel Syndrome in the study population is nearly equal, with 52.38% of participants having a normal condition and 47.62% exhibiting signs of CTS. This suggests that CTS is quite common among the participants and may be an area of concern for further study, particularly regarding factors like age or functional status Severity of Carpal Tunnel Syndrome (CTS) levels (Normal, Mild, Moderate, Severe), and the number of participants. The "Normal" category should be highlighted separately, while the other categories can be stacked based on the severity levels of CTS. This will allow a quick comparison of the proportions. Out of the 30 participants with CTS, a majority (52.38%) report a normal condition, with 23.81% reporting mild severity, 19.05% moderate, and only 4.76% severe CTS. This indicates that while CTS is prevalent, most cases are relatively mild, and severe cases are rare in this sample. Prevalence of Diabetes Type 2 in CTS Group *Prevalence of Diabetes Type 2 in Participants with Carpal Tunnel Syndrome (CTS)* This displays the proportion of CTS participants with and without diabetes. One slice represents the "Absent" group (47.62%), and the other slice represents the "Present" group (52.38%). Over half (52.38%) of the participants with CTS also report having Type 2 diabetes. This is a noteworthy finding, as it suggests that there may be an association between diabetes and the presence of CTS. Given the link between diabetes and peripheral nerve damage, this could warrant further exploration into how these two conditions may influence one another.

Table 1: Female Participants with CTS and Diabetes Type 2 DHQ Hospital Dir Lower

Category	*Category*	*Frequency*	*P.%*
1. Age Distribution of Female Participants	20-22	10	*15.87%*
	23-25	14	*22.22%*
	26-28	13	*20.63%*
	29-31	12	*19.05%*
	32-35	14	*22.22%*
	Total	63	*100%*
2. Prevalence of Carpal Tunnel Syndrome (CTS)	Normal	33	*52.38%*
	Present	30	*47.62%*
3. Severity of Carpal Tunnel Syndrome (CTS)	Normal	33	*52.38%*
	Mild	15	*23.81%*
	Moderate	12	*19.05%*
	Severe	3	*4.76%*
4. Functional Status of ADL	Normal	38	*60.32%*
	Mild	9	*14.29%*
	Moderate	11	*17.46%*
	Severe	5	*7.94%*
5. Association of Age with CTS	20-22	8 (80%)	*20% CTS*
	23-25	9 (64.29%)	*35.71% CTS*
	26-28	7 (53.85%)	*46.15% CTS*
	29-31	9 (75%)	*25% CTS*
	32-35	7 (50%)	*50% CTS*
6. Prevalence of Diabetes Type 2 in CTS Group	Absent	30	*47.62%*
	Present	*33*	*52.38%*



Discussion

The purpose of this study was to determine the prevalence and severity of CTS in a cohort of female subjects with Type 2 diabetes, specifically multiparous women. Our work offers valuable insights into the role of diabetes in CTS, particularly in middle-aged women, and suggests, as others have done, that age and diabetes may be significant contributors to CTS development. The study included 63 women, grouped by five age categories. The overall prevalence of CTS in the sample was 47.62%, which is consistent with other studies on diabetic populations. CTS is more prevalent among Type 2 diabetic individuals, as nerve damage caused by increased blood sugar levels is a major diabetic complication that can exacerbate CTS[11]. In this study, the CTS group (47.62%) was almost equal to the non-CTS group (52.38%). In contrast, compared to Alahgholi et al. (2022), who found a high incidence of CTS during pregnancy, especially in primigravida women, our study found a lower incidence (41%)[21]. This difference can likely be explained by the populations studied (multiparous women in our study versus general pregnant women in their study), suggesting that CTS risk may be influenced by pregnancy history. Increased parity may also cause biomechanical adaptations that could weaken the association between parity and CTS in multiparous women compared to women in their first pregnancy.These results are consistent with Ajroud et al. (2020), who reported a CTS prevalence of 24.3% among pregnant women in Libya[22]. In their study, housewives represented the largest group of affected participants (51.3%), which aligns with our findings, where housewives formed the largest group in our sample. Nonetheless, our study identified a greater prevalence of CTS (41%) compared to Ajroud et al. (2020), implying that multiparous women with Type 2 diabetes may develop CTS at a higher rate than the general pregnant population. This suggests that diabetes worsens the incidence of CTS.Further, in a cohort study by Pari et al. (2021), the prevalence of CTS in the third trimester of pregnancy was noted to be 29.11% in 322 pregnant women with varying severity[23]. In our study, the prevalence was higher at 41%, with only 3.7% of participants reporting severe CTS, 16.1% reporting mild CTS, and nearly 1 in 5 multiparous women having mild CTS. This suggests that multiparity may increase the risk of CTS, but on the whole, multiparous women may experience less severe CTS compared to the general pregnant female population. This could be because multiparous women, who are more accustomed to the physical changes of pregnancy, may be less symptomatic. A major difference in findings comes from the study by Afshar et al. (2021), which found that 67.4% of pregnant women over 28 weeks of gestation reported CTS-related hand and wrist symptoms[24]. Our study, which assessed multiparous women with Type 2 diabetes, had a much lower prevalence of 41%. This difference may indicate the broader impact of pregnancy stage and gestational effects, which were not fully considered in our study, but it underscores the importance of gestational age and diabetes in explaining the severity and prevalence of CTS. The severity of CTS was mostly mild in our study: 52.38% had no CTS, 23.81% had mild CTS, 19.05% had moderate CTS, and 4.76% had severe CTS. These findings indicate that while CTS is common in women with Type 2 diabetes, its severity is generally mild to moderate, which is corroborated by other studies showing that CTS severity is often less extensive in diabetic populations compared to non-diabetic ones[25]. This is further supported by the study by Abd Elmoniem et al. (2018), which investigated the role of educational interventions on CTS knowledge and severity among pregnant women, noting that 70% of women had moderate to severe pain[26]. In contrast, our study found that the percentage of women with symptomatic CTS was significantly lower, possibly due to early treatment and limited awareness in the rural cohort we studied, where healthcare resources were more restricted.Despite having CTS and Type 2 diabetes, 60.32% of participants in our study reported no difficulties in performing Activities of Daily Living (ADLs). This suggests that although CTS is common, for most participants it does not significantly impair daily functioning. However, 7.94% of women reported severe impairment in their work, indicating that while CTS severity is generally mild in this cohort, some women require additional support. These findings agree with Mateen et al. (2023), who found that 46% of pregnant women developed CTS symptoms, with daytime numbness being more frequent[27]. Forty-four percent of women in our study experienced pain, highlighting the clinical importance of CTS-related sensory symptoms in pregnant and multiparous women. Nonetheless, the overall severity of CTS in our study was mild, suggesting that early diagnosis and treatment may be effective in preventing the progression of more severe stages of CTS. The older age

group (32-35 years) had the highest prevalence of CTS in our study (50%), which is consistent with known trends in the literature, as older age is a recognized risk factor for CTS due to age-related changes in connective tissue and nerve function[28].Moreover, the strong association between Type 2 diabetes and CTS in our study is notable, with 52.38% of CTS participants diagnosed with Type 2 diabetes. This finding is consistent with other studies indicating that diabetes is a major contributor to CTS due to the nerve-damaging effects of poorly controlled blood glucose levels[29].

Conclusion

Conclusion: This study revealed that the prevalence of Carpal Tunnel Syndrome (CTS) in multiparous women diagnosed with Type 2 Diabetes is probable, in addition, there is a significant association between age with the prevalence of CTS. The severity of CTS was mostly mild to moderate, and CTS had a negligible impact on the ADLs of most subjects. Older age (specifically 32-35 years) and Type 2 Diabetes were significant contributors to CTS development. Our results advocate early diagnosis and management of CTS in this population. However, prior studies have been limited because they did not target multiparous women with Type 2 diabetes and focused on short-term glycemic control outcomes. Therefore, more studies need to be carried out to extend those findings to see the long-lasting effect of CTS and its effectiveness in Type 2 diabetic women.

Author Contributions

Dr. Fazal Mahmood: Conceptualization, study design, data collection, analysis, and manuscript writing.
Dr. Tahsin Ullah: Data collection, analysis, and manuscript review.
Dr. Muhammad Ismail: Orthopedic consultation and expert review of findings.
Dr. Riaz: Statistical analysis, manuscript revision, and data interpretation.
Dr. Alamgir Khan: Clinical consultation, manuscript revision, and final review.

Conflict of Interest

The authors declare no conflict of interest related to this study.

Funding Sources

This study did not receive any funding from external sources.

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