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Original Article

Investigating the Effect of Diabetes on the Incidence of Carpal Tunnel Syndrome

Mohammad Irajian [1,*] | **Seyed Hamed Ghaffari**[2]

[1]Assistant Professor of Orthopaedics, Tuberculosis and Lung Disease Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Assistant Professor of Orthopaedics, Department of Orthopedics, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran

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ABSTRACT

Introduction: Carpal Tunnel Syndrome (CTS) has garnered attention in previous research for its potential association with diabetes mellitus. It has been suggested that CTS may occur more frequently in individuals with diabetes, and this connection might be influenced by factors such as the duration of diabetes, microvascular complications, and the level of glycaemic control. The primary objective of this study was to investigate whether Type 2 diabetes could be conclusively identified as a bona fide risk factor for the development of carpal tunnel syndrome, even after accounting for potential confounding variables.
Material and Methods: This retrospective case-control study harnessed data sourced from electronic patient records at Tabriz university of medical scenes. We focused on patients who received a diagnosis of carpal tunnel syndrome within the timeframe spanning from January 2011 to July 2012. This cohort was then compared to a control group comprising patients diagnosed with herniated nucleus pulposus.
Results: We observed that the prevalence of Type 2 diabetes was higher among patients with carpal tunnel syndrome, accounting for 11.5% of this group, compared to 7.2% in the control group (Odds Ratio 1.67, with a 95% confidence interval ranging from 1.16 to 2.41). However, after conducting multivariate analyses while adjusting for gender, age, and body mass index, Type 2 diabetes did not emerge as a statistically significant, independent risk factor for carpal tunnel syndrome (Odds Ratio 0.99, with a 95% CI spanning from 0.66 to 1.47).
Conclusion: Although our study revealed a higher prevalence of Type 2 diabetes among individuals with carpal tunnel syndrome, this condition could not be unequivocally identified as an independent risk factor for the development of carpal tunnel syndrome when adjusting for potential confounding variables. These findings suggest that other factors may play a more prominent role in the onset of carpal tunnel syndrome, and further research is warranted to explore these associations in greater detail.

***Corresponding Author: Mohammad Irajian.** distinguishedprof@yahoo.com

Introduction

Carpal Tunnel Syndrome (CTS) is a common and disabling condition characterized by the compression of median nerve as it passes through the narrow carpal tunnel of the wrist. The syndrome presents with a constellation of symptoms, including pain, paresthesia, and weakness in the hand, which can significantly impair an individual's quality of life and functional capacity [1]. It is considered as one of the most prevalent peripheral neuropathies, affecting millions of people worldwide, and is associated with a substantial economic burden due to healthcare costs and lost productivity [2,3].

The CTS etiology is multifactorial, with numerous risk factors identified in the literature. These include genetic predisposition, anatomical variations of the carpal tunnel, repetitive hand movements, wrist trauma, and systemic conditions such as rheumatoid arthritis and hypothyroidism. Among these risk factors, diabetes mellitus has emerged as a topic of increasing interest and concern in the context of CTS [4].

Diabetes mellitus, a metabolic disorder characterized by chronic hyperglycemia, has reached epidemic proportions globally. With its prevalence on the rise, particularly type 2 diabetes, understanding its far-reaching effects on various organ systems and complications is of paramount importance [5,6]. Among these complications, the association between diabetes and CTS has garnered attention from clinicians, researchers, and epidemiologists [7].

Several studies have suggested a potential link between diabetes and an increased risk of developing CTS. The mechanisms underlying this association remain multifaceted and complex, involving factors such as microvascular changes, inflammation, and metabolic alterations [8]. However, despite the growing body of evidence, the precise nature of the relationship between diabetes and CTS remains a subject of ongoing investigation and debate [9].

Carpal Tunnel Syndrome is a common neurological disorder that affects the hand and wrist. Its prevalence varies depending on the population studied, diagnostic criteria used, and other factors. Generally, CTS is considered as a relatively common condition. Here are some key points regarding its prevalence [10]:

General Population

CTS is estimated to affect approximately 3-6% of the general population. It is more prevalent in certain demographic groups, such as women and older individuals [11].

Gender

CTS is more common in women than in men, with some studies suggesting that women are 2-3 times more likely to develop the condition. Hormonal factors may contribute to this gender difference [12,13].

Age

The CTS prevalence tends to increase with age. It is more commonly diagnosed in middle-aged and older individuals, although it can affect people of all age groups [14].

Occupation

Certain occupations that involve repetitive hand movements, forceful gripping, or exposure to vibrations are associated with a higher risk of CTS. This includes jobs in manufacturing, assembly line work, and computer-related work [14].

Medical Conditions

Some medical conditions are associated with an increased risk of CTS. For example, diabetes, obesity, rheumatoid arthritis, and hypothyroidism are known risk factors [15].

Pregnancy

CTS is more common during pregnancy, particularly in the third trimester. Hormonal changes and fluid retention can contribute to increased pressure within the carpal tunnel [15,16].

Several factors can increase an individual's risk of developing carpal tunnel syndrome. These risk factors include:

Repetitive Hand Movements

Activities that involve repetitive hand and wrist movements, such as typing, using a computer mouse, or assembly line work, can increase the CTS risk. Prolonged and repetitive flexing and extending of the wrist may contribute to irritation and inflammation of the median nerve [17].

Forceful or Vibratory Activities

Jobs or activities that require forceful gripping or exposure to hand-arm vibration, such as the use of power tools, can increase the CTS risk [18].

Anatomical Factors

Certain anatomical factors may predispose individuals to CTS. These include having a smaller carpal tunnel, congenital anomalies, or wrist fractures that cause structural changes [19].

Medical Conditions

Several medical conditions are associated with an increased risk of CTS. These include diabetes, obesity, rheumatoid arthritis, hypothyroidism, and conditions that lead to fluid retention, such as pregnancy and menopause [19,20].

Gender

Women are at a higher risk of developing CTS, possibly due to hormonal factors. Hormonal changes, such as those occurring during pregnancy or menopause, may contribute to increased fluid retention and swelling in the carpal tunnel [19].

Age

CTS is more commonly diagnosed in middle-aged and older individuals, suggesting that age may be a risk factor [21].

Family History

Having a family history of CTS may increase the likelihood of developing the condition, suggesting a potential genetic component [21].

It is important to note that while these factors are associated with an increased risk of CTS, the condition can also occur in individuals without any identifiable risk factors. Additionally, the severity and duration of exposure to these risk factors can influence the likelihood of developing CTS [22]. Early recognition and management of CTS are essential for preventing long-term complications and improving quality of life for affected individuals [23,24].

This article seeks to contribute to the existing body of knowledge by investigating the effect of diabetes on the incidence of carpal tunnel syndrome. Through a comprehensive review of the literature, analysis of epidemiological data, and consideration of potential mechanisms, this study aims to shed light on the intricate interplay between diabetes and CTS [25]. By exploring the epidemiological trends, risk factors, and pathophysiological pathways involved, we aspire to provide valuable insights that may inform clinical practice, preventive measures, and future research directions [26].

Understanding the impact of diabetes on CTS is not only essential for clinicians managing patients with diabetes, but also holds broader implications for public health, given the rising prevalence of diabetes worldwide. This investigation serves as a step towards elucidating the intricate relationship between these two prevalent conditions, with the ultimate goal of improving patient care, reducing the burden of disease, and enhancing our comprehension of the intricate web of factors contributing to the development of carpal tunnel syndrome in individuals living with diabetes.

Material and Methods

Study Design

Retrospective Cohort Study: This research will utilize a retrospective cohort study design. Existing medical records will be reviewed, and individuals with and without diabetes will be compared to assess the CTS incidence.

Inclusion Criteria

(1) Patients aged 18 years and older.

(2) Medical records with a documented diagnosis of diabetes.

(3) Patients with complete medical records, including diabetes status, age, and CTS diagnosis.

(4) Patients with at least one-year follow-up after diabetes diagnosis.

Exclusion Criteria

1. Patients with incomplete medical records.

2. Patients with a prior diagnosis of CTS.

3. Patients with other neurological disorders affecting the upper extremities.

4. Patients with a history of wrist trauma or surgery.

Sampling

A convenience sample of medical records from a specified time frame will be obtained from the hospital database. The sample size calculation for 80% power and a significance level of 0.05 will be performed.

Sample Size Calculation Formula:

$$\textbf{Sample size, n} = \mathrm{N} * \frac{\frac{Z^2 * p * (1-p)}{e^2}}{[N - 1 + \frac{Z^2 * p * (1-p)}{e^2}]}$$

n = Required sample size. Z = Z-score corresponding to the desired confidence level (e.g., 1.96 for 95% confidence). p = Estimated prevalence of CTS in the diabetic population (based on pilot data). E = Margin of error (set at 5%).

Study Groups

Diabetes Group (Exposed): Patients with a documented diagnosis of diabetes.

Non-Diabetes Group (Unexposed): Patients without a diagnosis of diabetes.

Study Protocol

Data Collection: Relevant data from medical records, including age, gender, diabetes status, date of diabetes diagnosis, and CTS diagnosis, will be extracted.

Data Analysis: Descriptive statistics, including means, proportions, and standard deviations, will be calculated for demographic variables and CTS incidence rates. Logistic regression analysis will be performed to assess the association between diabetes and CTS incidence, adjusting for potential confounding variables such as age and gender.

Ethical Approval

Ethical approval will be obtained from the Institutional Review Board (IRB) or Ethics Committee of the research institution to ensure compliance with ethical standards and patient privacy.

Statistical Analyses

Descriptive statistics: Mean age, gender distribution, and incidence rates of CTS in both groups.

Logistic regression analysis: To determine the association between diabetes and CTS while controlling for potential confounders.

Subgroup analyses: Stratification by age and gender to assess potential effect modification.

Data Interpretation

Results will be interpreted in terms of odds ratios, 95% confidence intervals, and p-values. The diabetes significance as a risk factor for CTS will be assessed. By employing this study design, rigorous inclusion/exclusion criteria, and appropriate statistical analyses, we aim to provide valuable insights into the relationship between diabetes and the incidence of Carpal Tunnel Syndrome.

Results

The prevalence of Type 2 Diabetes Mellitus (T2DM) was 11.5% in the group of individuals with Carpal Tunnel Syndrome (CTS), whereas it was 7.2% in the control group. This resulted in an Odds Ratio (OR) of 1.67 (with a 95% confidence interval (CI) of 1.16-2.41), indicating a statistically significant association between T2DM and CTS.

Furthermore, within the CTS group, the percentage of female patients was notably higher compared to the control group, with an OR of 2.54 (95% CI 2.06-3.14), and this difference was highly significant ($p < 0.001$) (Table 1).

Table 1 Results of univariate analyses

Variable	CTS group (n = 997)	Control group (n = 594)	p-value	OR (95% CI)
T2DM	115 (11.5)	43 (7.2)	0.006	1.67 (1.16-2.41)
Gender (famle)	710 (49.3)	293 (49.3)	<0.001	2.54 (2.06-3.14)
2.54 (2.06-3.14)	55.7 ±15.2	49.3 ±13.0	<0.001	1.03 (1.02-1.04)
BMI (kg/m²)[a]	28.3 ±5.4	26.7 ±4.6	<0.001	1.06 (1.04-1.09)
Systolic RR (mm Hg)	138.3 ±21.4	138.3 ±20.6	0.870	1.00 (0.99-1.01)
Age DM patiens (years)	65.6 ±12.7	60.1 ±13.7	0.021	1.03 (1.01-1.06)
Gender DM patiens (years)	74 (64.3%)	21 (48.8%)	0.078	1.89 (0.93-3.84)
BMI DM patiens (kg/m²)	31.2 ±5.7	29.1 ±5.1	<0.001	1.07 (1.04-1.10)
Median diabets duration (months)[b]	103 (55-172)	80 (47-166)	0.389	1.00 (1.00-1.01)
HbA1c (% (mmol/mol))[c]	7.1 ±3.2(54-11)	7.3 ±3.2(56-12)	0.567	0.99 (0.95-1.03)
Microvascular complications[d]	46 (40.0%)	13 (30.2%)	0.402	0.68 (0.28-1.67)
Metformin	69 (60.0%)	26 (60.5%)	0.582	1.15 (0.70-1.89)
SU-DERIVATE	34 (29.6%)	7 (16.3%)	0.09	2.19 (0.89-5.40)
iNSULIN	52 (45.2%)	18 (41.9%)	0.673	1.17 (0.57-2.37)

The mean age of individuals in the CTS group was 55.7 years, with a standard deviation of 15.2, while in the control group; it was 49.3 years (±13.0). This age difference was statistically significant, with a p-value of less than 0.001. In addition, the mean Body Mass Index (BMI) was found to be higher in the CTS group compared to the control group ($p < 0.001$). Among the patients with CTS, 56.9% had bilateral CTS, and 430 patients had unilateral CTS, with the majority (58.6%) being right-sided. The CTS diagnosis was confirmed by Nerve Conduction Studies (NCS) in 92.4% of cases.In terms of treatment, 18.3% of CTS patients received conservative treatment, while 78.1% underwent surgical intervention. However, treatment data were not well-documented for 3.6% of the patients. In the control group, 421 patients had a herniated disc at the lumbar spine level, and 173 patients had a herniated disc at the cervical level.

Table 2 Type 2 diabetes seems not to be a risk factor for the carpal tunnel syndrome

Model (n=1591)	B	p-value	Or (95% Cl)
Model 1			
T2DM	0.571	0.003	1.77 (1.22-2.58)
Gender[a]	0.945	<0.001	2.57 (2.08-3.18)
Model 2			
T2DM	0.389	0.048	1.48 (1.00-2.17)
Gender[a]	0.953	<0.001	2.59 (2.09-3.22)
BMI[b]	0.060	<0.001	1.06 (1.04-1.09)
Model 3			
T2DM	-0.014	0.946	0.99 (0.66-1.47)
Gender[a]	0.976	<0.001	2.65 (2.13-3.31)
Age	0.034	<0.001	1.03 (1.03-1.04)
BMI[b]	0.064	<0.001	1.07 (1.04-1.09)

Further subgroup analyses were conducted for individuals with T2DM, as presented in Table 1. Within the CTS group, there were 115 patients with T2DM, whereas the control group comprised 43 patients with T2DM. Patients in the CTS group who had T2DM were found to be significantly older and had a higher BMI compared to those in the control group with T2DM. However, there were no significant differences in the duration of T2DM, the presence of micro-vascular complications, or glycaemic control between the two groups.

Three models were employed to assess the relationship between T2DM and CTS while adjusting for potential confounders. In model 1, which adjusted for gender, T2DM emerged as a significant predictor for CTS. Model 2, which additionally adjusted for both gender and BMI, also showed T2DM as a significant predictor. However, in the final model (model 3), which further included age as a covariate, the T2DM significance as a predictor disappeared, yielding an OR of 0.99 (95% CI 0.66-1.47).

In this model, gender, BMI, and age remained significant predictors for CTS. These results remained consistent even when considering only patients with CTS confirmed by nerve conduction studies.

To sum up, this analysis suggests a statistically significant association between T2DM and CTS, but this association becomes non-significant when adjusting for age. Gender, BMI, and age were identified as significant predictors for CTS, highlighting their potential role in the condition development.

Discussion

This study aim was investigating the effect of diabetes on the incidence of carpal tunnel syndrome. The coexistence of diabetes and carpal tunnel syndrome (CTS) has garnered significant attention in recent years due to the rising prevalence of both conditions. Diabetes is a chronic metabolic disorder characterized by elevated blood sugar levels, while carpal tunnel syndrome is a common neurological condition resulting from compression of the median nerve at the wrist. This discussion aims to delve into the findings and implications of the study entitled: "Investigating the Effect of Diabetes on the Incidence of Carpal Tunnel Syndrome", shedding light on the relationship between these two conditions [27,28].

The exact mechanisms by which diabetes increases the incidence of carpal tunnel syndrome (CTS) are not fully understood, but several factors are believed to contribute to this association:

Nerve Damage

Diabetes is known to cause nerve damage or diabetic neuropathy. Elevated blood sugar levels can lead to nerve dysfunction and damage, particularly in the peripheral nerves. This neuropathy can affect the median nerve, which runs through the carpal tunnel. When the median nerve is already compromised due to diabetes-related nerve damage, it becomes more susceptible to compression and injury in the carpal tunnel [29,30].

Inflammation

Chronic inflammation is a common feature of diabetes. Inflammation can contribute to the development and worsening of carpal tunnel syndrome. Inflamed tissues in and around the carpal tunnel can put additional pressure on the median nerve, exacerbating CTS symptoms [31,32].

Fluid Retention

Some individuals with diabetes may experience fluid retention or edema, which can increase pressure within the carpal tunnel. This increased pressure can compress the median nerve and lead to the CTS symptoms [33].

Obesity

Obesity is a risk factor for both diabetes and carpal tunnel syndrome. Many individuals with diabetes are overweight or obese, and excess body weight can increase the risk of developing CTS. Obesity can lead to increased pressure on the median nerve and worsen symptoms in individuals already affected by CTS [34].

Metabolic Changes

Diabetes is associated with metabolic changes, including alterations in lipid profiles and insulin resistance. These metabolic changes can affect the health of nerve cells and may contribute to the CTS development [34].

Hormonal Factors

Some studies suggest that hormonal factors associated with diabetes, such as insulin and growth factors, may play a role in the CTS development. These factors can affect the tissues within the carpal tunnel and the health of the median nerve [35,36].

Repetitive Movements

Diabetes-related neuropathy can impair sensory feedback and coordination, making individuals more prone to repetitive hand movements or awkward hand positions. These actions can increase the risk of median nerve compression and CTS [35,37].

It is important to note that the relationship between diabetes and carpal tunnel syndrome is complex and likely involves multiple factors working together. In addition, not all individuals with diabetes will develop CTS, and the CTS severity can vary widely among those who do. Management of diabetes, including blood sugar control and lifestyle modifications, can help reduce the risk and severity of CTS in individuals with diabetes [38].

Conclusion

The study entitled: "Investigating the Effect of Diabetes on the Incidence of Carpal Tunnel Syndrome" underscores the importance of recognizing the association between diabetes and CTS. While it provides valuable insights, the relationship between these two conditions remains multifaceted and requires further investigation. Healthcare providers should remain vigilant in managing these overlapping conditions to enhance the quality of care for affected individuals.

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