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Case Report

Radiographic Characteristics of the Distal Radius in Patients With Carpal Tunnel Syndrome: A Case-Control Study

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a common disorder with several known risk factors. However, the role of radiographic characteristics of the distal radius and risk factors of CTS has been overlooked.

Objectives: To identify radiographic characteristics of the distal radius as the risk factors of CTS.

Methods: In a case-control study, 60 patients with CTS who underwent surgical treatment (case group) and 60 people who underwent radiographic evaluation for reasons other than CTS (control group) were included. The case and control participants were matched for age and sex. Radiographic records of the patients were reviewed in the picture archiving and communication system, and the distal radius characteristics, including volar tilt, radius slope, radius height, and ulnar variance, were investigated.

Results: The Mean±SD volar tilt was 10.49±6.42° in the case group and 16.65±5.31° in the control group (P <0.001). The Mean±SD radius inclination angle was 19.58±4.72° in the case group and 17.88±4.88° in the control group (P=0.049). The Mean±SD height of radius was 10.30±3.21 mm in the case group and 12.24±5.33 mm in the control group (P=0.017). The Mean±SD ulnar variance was 1.36±1.43 mm in the case group and 0.75±0.27 mm in the control groups (P=0.002).

Conclusion: Radiological characteristics of the distal radius are significantly different between the CTS and non-CTS patients and could be regarded as the inherent risk factors of CTS development.

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1. Introduction

Carpal tunnel syndrome (CTS) is the most common form of focal mononeuropathy caused by nerve compression. This syndrome is identified by a set of signs and symptoms resulting from the pressure on the median nerve as it passes through the carpal tunnel [1, 2]. CTS prevalence is 1%-16% in the general population, with a female-to-male ratio of almost 3 to 1 [3].

Most cases of CTS are idiopathic. However, daily activities that require excessive use of the wrist joint are suggested as the underlying factor in patients with idiopathic CTS. Systemic diseases such as endocrine disorders (diabetes, hypothyroidism, acromegaly), infiltrative disorders (amyloidosis), pregnancy, distal radius fracture, lunate bone dislocation, connective tissue diseases (rheumatoid arthritis), and infectious diseases (sarcoidosis, tuberculosis, and Lyme disease) have also been associated with increased susceptibility to CTS [4, 5].

Considering the role of the distal radius in wrist movements, radial characteristics could also affect the development of CTS [4]. However, anatomical characteristics of the distal radius, including the radius height and inclination, have been less investigated as the risk factors of CTS [6].

Objectives

In this study, we aimed to compare the radiographic characteristics of the distal radius between patients with and without CTS to determine how these characteristics affect the incidence of this disorder.

2. Materials

This case-control study was approved by the Review Board of our institute. The medical records of the CTS patients who underwent surgical treatment in the Shafa Orthopedic Hospital, Tehran, Iran, were retrospectively reviewed between 2020 and 2021. Patients with a history of CTS surgery, the ipsilateral wrist or distal radius fracture, and congenital disorders affecting the bone anatomy were excluded from the study. Patients with inadequate medical records were excluded from the study, as well. In patients with bilateral CTS, one side was randomly selected and entered into the study. The control group was selected from patients who underwent wrist radiography for reasons other than CTS (such as patients with forearm fractures or traffic accidents) and matched with the case group in terms of age (±3 years) and sex.

Demographic information such as age, sex, and underlying disorders (diabetes, hypothyroidism) was extracted from the patients' medical records. For the anatomic evaluation of distal radius, wrist radiographs of the patients were achieved from the hospital picture archiving and communication system, and radiographic characteristics, including radius height, radius slope, volar tilt, and ulnar variance, were measured.

Sample size calculation and statistical analysis

The sample size was determined according to the mean and standard deviation of ulnar variance provided in the study of Ikeda et al., which was 1.7(1.8) mm in the case group and 0.8(1.5) mm in the control group [6]. According to these data, at a power of 80% and a significance level of 5%, 59 patients in each group were enough to detect a significant difference using a 2-sided independent t-test.

The data were analyzed in SPSS for Windows v. 16. Statistical tests used in this study included the independent t test to compare quantitative data between two groups, the Chi-squared test to compare the categorical variables between the two groups, and a logistic regression test to evaluate the research variables in increasing or decreasing the probability of CTS while controlling for confounding variables. All tests were applied at the significant level of $P<0.05$.

3. Results

Table 1 shows the distribution of demographic variables and clinical information in the two study groups. No significant difference was found between the characteristics of the patients in the two study groups.

Radiological evaluations of distal radius showed that all four distal radius indices were significantly different between the case and control groups, so that the volar tilt and radius height were higher in the control group, while the radius inclination and ulnar variance were lower in the control group (Table 2).

Figures 1-4 show the median, range, and 25-75 percentile of the distal radius in both groups with and without CTS. According to the mentioned results, 25% to 75% of the distal radiological findings of the distal radius in the case and control groups were as follows: the volar tilt was 7.25° to 17° in the case group and 14.75° to 18° in the control group,

Table 1. Distribution of demographic variables and clinical information in the two groups (n=60)

Variables		Mean±SD/No. (%)		P
		Control	Case	
Age		52.37±9.7	53.88±10.58	0.42
Age distribution, y	>50	14(23.3)	18(30)	0.41
	≤ 50	46(76.7)	42(70)	
Sex	Male	11(19.3)	11(19.3)	1
	Female	49(81.6)	49(81.6)	
Underlying diseases	Rheumatoid arthritis	1(1.7)	2(3.4)	0.55
	Diabetes	3(5)	8(13.3)	0.11
	Hypertension	4(6.7)	6(10)	0.51
	Hypothyroidism	3(5)	6(10)	0.298

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the radius inclination was 23° to 60º in the case group and 21° to 15º in the group control, the radius height was 9 to 12 mm in the case group and 7.45 to 16.03 mm in the control group, and the ulnar variance was 0.25 to 2 mm in the case group and 0.5 to 0.9 mm in the control group.

Data analysis by logistic regression test in the crude model revealed a significant effect of the volar tilt, radius inclination, radius height, and ulnar variance on the likelihood of CTS development. The same effects were identified in the adjusted model. In addition, diabetes has a significant impact on increasing the chances of developing CTS, so the presence of diabetes increased the likelihood of developing CTS by 6.55 times (P=0.027) (Table 3).

4. Discussion

In the present study, we compared the radiographic criteria of the distal radius in patients with and without CTS. The mean values for all evaluated indices were significantly different between the case and control groups. In this respect, volar tilt and radius height were significantly lower in the case group. The radius inclination and ulnar variance were significantly higher in the case group. Besides these four parameters, diabetes was a significant risk factor of CTS in multivariate analysis.

Distal radius fracture has been frequently associated with an increased risk of CTS development [7-9]. For example, Bienek et al. reported the development of CTS in 12 out of 16 patients with unilateral distal radius fractures that were presented at a mean period of 10 months after the injury [7]. These observations led to the conception that the distorted anatomy of the distal radius might predispose CTS development. Anatomical characteristics of the distal radius could also be regarded as the inherent risk factors of CTS.

A small number of studies have investigated the effect of radius characteristics in CTS development. Ikeda et

Table 2. Distal radius characteristics in the case and control groups (n=60)

Variables	Mean±SD		P
	Control	Case	
Volar tilt (degree)	16.65±5.31	10.49±6.42	<0.001
Volar inclination	17.88±4.65	19.58±4.72	0.049
Radius height	12.24±5.33	10.30±3.21	0.017
Ulnar variance	0.75±0.27	1.36±1.43	0.002

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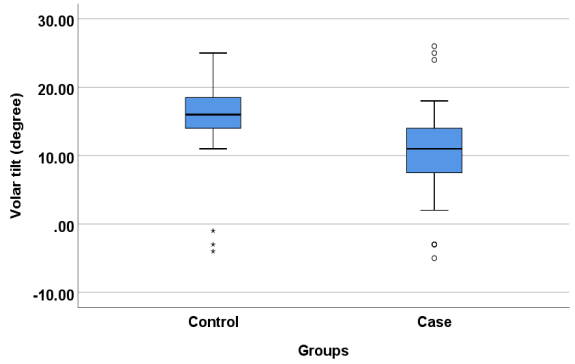

Figure 1. Median, range and 25-75 percentile of volar tilt in the case and control groups

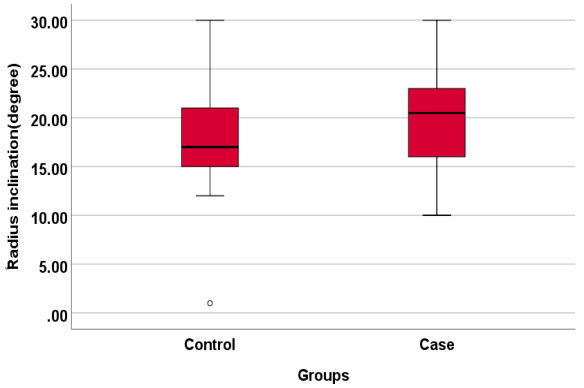

Figure 2. Median, range, and 25-75 percentile of radius inclination in the case and control groups

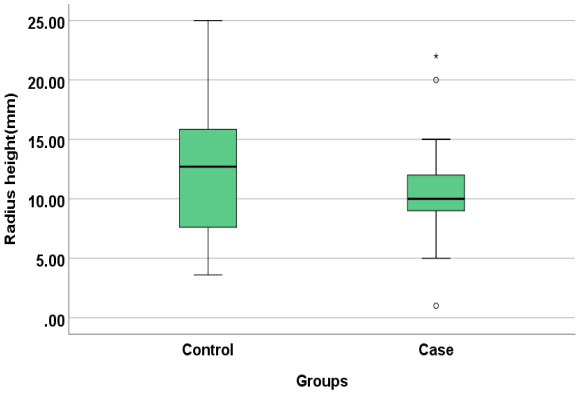

Figure 3. Median, range, and 25-75 percentile of radius height in the case and control groups

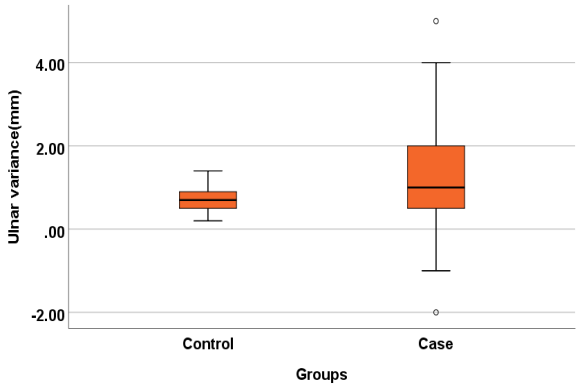

Figure 4. Median, range, and 25-75 percentile of ulnar variance in the case and control groups

Table 3. The effect of the demographic and distal radius characteristics on the incidence of carpal tunnel syndrome

Variables	Crude Model			Adjusted Model		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Age	0.81	0.35- 3.8	0.81			
Rheumatoid arthritis	1.002	0.067 – 14.89	0.99			
Diabetes Mellitus	4.15	0.64 – 25.66	0.13	6.55	1.24 – 34.7	0.027
Hypothyroidism	1.7	0.25 – 11.45	0.58			
Volar tilt	0.84	0.77 – 0.92	0.001	0.84	0.77 – 0.92	<0.001
Radius inclination	1.11	1.003 – 1.23	0.044	1.12	1.007 – 1.24	0.037
Radius height	0.83	0.73 – 0.95	0.005	0.83	0.73 – 0.94	0.004`
Ulnar variance	2.1	1.22 – 3.6	0.007	1.99	1.17 - 3.38	0.011

al. evaluated the radiological features radius in 94 patients with idiopathic CTS and 94 healthy individuals without CTS. Radiographic indices, including the radial inclination, volar tilt, ulnar variance, and transverse and anteroposterior diameters of the wrists, were measured and compared between the carpal tunnel syndrome patients and the controls. According to their results, the Mean±SD ulnar variance was 1.7(1.9) mm and 0.8(1.01) mm, in the case and control groups, respectively. This difference was statistically significant. Other evaluated parameters were not significantly different between these groups [6]. Similar to the study of Ikeda et al. the ulnar variance was significantly higher in the case group of the present study. In addition, radial inclination angle and volar tilt were significantly different between the case and control group of the present study, while they were not significantly different between the case and control group of the study of Ikeda and associates.

In a case-control study conducted by Watanabe et al., radiological characteristics were reviewed in 40 patients with Colles fracture, 30 of whom had CTS. According to their results, the mean radiocapitate distance was significantly more in the CTS patients (-12.8) 4.1(mm vs. -8.4 (4) mm). Volar prominence height (1.7 [3.6] mm vs 5.3 [2.2] mm) and volar tilt (-20.5 [10]º vs -11.3 [8.3]°) were also significantly smaller in the CTS group. In addition, radiocapitate distance was significantly correlated with both volar prominence height and volar tilt [10]. Similarly, the volar title was significantly smaller in the CTS group of the present study.

Diabetes was identified as an independent risk factor of the CTS in the present study. The association between diabetes and CTS development has been investigated in several studies. Kim et al. found no significant association between the incidence of CTS and diabetes mellitus [11]. According to the study of Hendriks, although diabetes mellitus was more frequently diagnosed in CTS patients, it could not be identified as an independent CTS risk factor [12]. According to the study of Moon et al. patients with diabetic polyneuropathy had an increased risk of CTS [13].

Altogether, the current findings suggest that distal radius characteristics could be regarded as the CTS risk factor. However, the present study had some limitations. The main limitation of this study was its retrospective design. In addition, the ideal control group for this study would be the individuals with no wrist pathology. However, we were not ethically allowed to expose healthy individuals to x-ray radiation.

5. Conclusion

The present study findings show that the anatomical characteristics of the distal radius are different in CTS patients compared to the non-CTS individuals. Therefore, the indices of distal radius could be regarded as the inherent risk factors for CTS development. However, standard prospective studies with a larger sample size are required to shed more light on these associations.

Ethical Considerations

Compliance with ethical guidelines

The present article is the result of the dissertation of the hand surgery fellowship course, which has been approved and implemented with the code 400233 in the Research Department of the Medical School of Iran University of Medical Sciences.

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Authors' contributions

Study concept and design: Hooman Shariatzadeh; Data collection: Ali Dehghan Marvast; Reviewing the manuscript critically: Mohsen Barkam.

Conflict of interest

The authors have no conflict of interest to disclose.

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