Original article:

Case control study of various risk factors in clinically and electrophysiologically diagnosed patients of Carpal tunnel syndrome (CTS)

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Abstract:

Introduction: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in upper limbs**.** It is due to compression of the median nerve, as it passes beneath the transverse carpal ligament. Various risk factors are known for CTS- hypothyroidism, rheumatoid arthritis etc. Very little research work is available on the association of CTS with wrist to palm ratio and Body Mass Index (BMI).

Methods: For present study clinical examination and nerve conduction study was carried out to confirm the diagnosis of CTS. 60 patients and 60 age matched controls were studied. Wrist circumference and anteroposterior diameter (depth) at distal flexor wrist crease was measured .Palm length was measured from distal flexor wrist crease to the tip of the middle finger .Wrist palm ratio was calculated by dividing wrist depth by palm length. Body mass index was measured by using standard formula. All the parameters were compared with controls.

Observations & Results : In patients compared to controls BMI value, hand circumference and wrist to palm ratio values were significantly increased ($P < 0.001$).In patients compared to control palm length was significantly decreased ($P < 0.001$).

Conclusion: Increased BMI and increased wrist palm ratio is associated with increased prevalence of Carpal tunnel syndrome.

Key words: CTS (carpal tunnel syndrome), BMI (body mass index), wrist palm ratio, wrist circumference and anteroposterior diameter (depth).

Introduction

Carpal Tunnel Syndrome is most common entrapment neuropathy in upper limbs. The carpal tunnel is bounded by carpal bones and transverse ligaments. Diameter of carpal tunnel is 2-2.5 cm and the median nerve passes through it. The area in the wrist where the nerve enters the hand is called the carpal tunnel. This tunnel is normally narrow, so any swelling can pinch the nerve and cause pain, numbness, tingling or weakness and this is called as Carpal Tunnel Syndrome. The cause of CTS is various disorders like Hypothyroidism, Rheumatoid arthritis, Pregnancy, Diabetes Mellitus etc. The clinical features of CTS patients include

numbness, paraesthesia and pain in hand, which aggravate at night. These symptoms may extend proximally to elbow and even shoulder. There may be sensory loss in the first three digits, and radial half of fourth digit. Carpal tunnel Syndrome has been linked to jobs with strenuous & rapid repetitive hand activity. (1)

In Netherland, study showed that crude incidence rate of CTS was 1.5 times higher in female than to male and ratio was 3:1.(2)In Bureau of US, Department of labour evidence suggests that about 3 % women & 2% men were diagnosed with CTS during their lifetime, with peak prevalence in women older than 55 yrs.(3) In overall World Prevalence rates of carpel tunnel syndrome reported are 3.0-5.8 % in females and 0.6-2.1% in males. (4)

Obesity is one of the predisposing factors for carpel tunnel syndrome. The relation between BMI (Body mass index) and carpel tunnel syndrome is very strong. Greater body mass appears to reduce nerve flow speed into the hand. It is believed that other factors may be involved such as personal factors, unsafe actions and unhealthy lifestyles. Hormonal changes appear to play a major role in carpel tunnel syndrome. (3)

Poor nutrition, previous injuries and stress can increase risk for carpel tunnel syndrome. In addition high levels of so called 'bad' cholesterol (Low density lipoprotein or LDL) has also been linked to an increased risk for carpel tunnel syndrome. (5)

In 2004,BOZ Ozmenglu M, Altunayoglu V, Velioglu S, Aligoglu Z. aimed to identify the role of Body Mass Index (BMI),Wrist index, hand anthropometric measures as risk factors for CTS in both genders and CTS.(6) Some authors suggested that body mass index, stature and body weight are the risk factors. Others reported that the cross sectional area of Carpal Tunnel and even wrist dimensions are important factors in the development of idiopathic Carpal Tunnel Syndrome. (7)

However very little work is available regarding wrist ratio and wrist palm ratio and its association with CTS in Western Maharashtra .In this area such type of study was not done previously. So in present study association of gender, obesity, wrist ratio and wrist palm ratio was studied in clinically and electrophysiologically diagnosed patients of Carpal tunnel Syndrome.

Nerve conduction study is a very sensitive parameter for diagnosis of carpal tunnel syndrome. So nerve conduction studies of patients and controls were carried out to find out commonly observed nerve conduction abnormality in carpal tunnel syndrome patients. Nerve conduction study is also used to confirm the clinical diagnosis of carpal tunnel syndrome.

Study of association of various risk factors (gender, obesity, wrist ratio and wrist palm ratio) with clinically and electrophysiologically diagnosed patients of carpal tunnel syndrome.

Objectives

1) Study of nerve conduction of Median and Ulnar nerves of clinically diagnosed patients of carpal tunnel syndrome and of healthy individuals.

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a) Measurements of distal motor latency (DML), distal sensory latency (DSL), in median and ulnar nerves.
b) Calculation of difference between distal motor latency of median and ulnar nerve.
c) Calculation of difference between distal sensory latency of median and ulnar nerve.

2) Measurement of Body mass index, wrist ratio and wrist palm ratio and study association of these indices with CTS patients

Materials & methods

Sources of data: The study was conducted in the Electrophysiology Lab of Department of Physiology in Krishna Institute of Medical Sciences, Karad. The study was conducted on 60 clinically diagnosed patients of Carpal Tunnel Syndrome who were referred to the department for nerve conduction and on 60 age matched healthy individuals who were selected from staff of this institute. Approval from Institutional Ethical Committee (IAC) was taken before commencement of the study.

Study design:

Case-Control Study

Inclusion criteria**:**

Patients clinically and electrophysiologically diagnosed based on the symptoms and signs suggestive of Carpal Tunnel Syndrome were selected for the study. Apparently healthy staff members of Krishna Institute of Medical Sciences, Karad, without any signs or symptoms suggestive of any neurological abnormality were selected as controls.

Exclusion criteria**:**

Fractures, Skin graft, Skin diseases, Cardio-vascular diseases Pregnancy, Peripheral artery diseases, Diabetes, CTS patients with symptoms of polyneuropathy or radiculopathy, Any other marked systemic or local abnormality

Method of collection of data:

Electro-diagnostic study was conducted on these 60 healthy individuals and 60 Carpal Tunnel Syndrome patients, which includes Motor and Sensory conduction of Median and Ulnar nerves, of both hands of the subjects and the patients.

Body mass index: - Height and weight was measured of each participant including controls and body mass index was calculated by using standard formula.

Body mass index = Weight in kilo gram/ Height in meter ^{2}.

Wrist Ratio and Wrist palm ratio [5] - Wrist circumference, the anteroposterior diameter (depth in mm) the transverse diameter (width) at distal flexor wrists crease was measured of both hands in both groups (Patients and controls).

Wrists ratio was calculated by dividing depth by width.

Palm length was measured from distal flexor wrists crease to the tip of the middle finger.

Wrist palm ratio (WPR) was calculated by dividing wrist depth by palm length.

For measurement of circumference and palm length, measuring tape was used and measurement of the transverse diameter & anteroposterior diameter was done by using a standard Vernier calliper.

Standard nerve conduction studies were performed on carpel tunnel syndrome subjects and controls by using Octopus machine from Chandigarh (INDIA).

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The following parameters were studied during electro diagnostic test by using standard methodology of nerve conduction study. [1]

Motor conduction: Distal motor latencies of Median and Ulnar nerves, motor conduction velocity and difference between distal motor latencies of median and ulnar nerves.

Sensory conduction: Distal sensory latencies of Median and Ulnar nerves, sensory conduction velocity and difference between distal sensory latencies of median and ulnar nerves. For recording sensory and motor nerve conduction, surface metal electrodes were used.

Statistical methods used:

Data collected was entered and analysed using Microsoft excel and SPSS 20 software packages. Statistical analysis was done calculating mean and standard deviation .

Observations & results

Table No.1: Number of males & females in CTS patients and healthy controls.

Sex	Patient	Control
Male	9 15.00%	6 10.00%
Female	51 85.00%	54 90.00%
Total	60 100.00%	60 100.00%

The result shows that in CTS patient group females were 51 (85%) and males were 9 (15%), in healthy control group females were 54 (90%) and males were 6 (10%).

Table No-2: Values of Age, Height, weight and BMI (body mass index) of CTS patients and healthy controls

Parameters	Patients	Controls	P values
Age in Yrs	39.46±9.03 (23-61)	36.46±8.54 (23-56)	0.064•
Height in cms	157.25±7.52 (144-180)	158.10±7.53 (142-177)	0.538•
Weight in kgs	61.06±11.22 (45-100)	56.68±9.71 (36-85)	0.024•
BMI	24.44±3.74 (18.47-36.76)	22.63±2.99 (16.60-31.20)	0.004**

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•:-Non Significant, **:-Very significant,

The result showed that there was no significant difference in age, height, weight between CTS patients and controls. But there was significant difference in the BMI values of CTS patients and controls ($P < 0.01$).

Table No-3: Values of Wrist circumference, palm length, wrist anteroposterior diameter, wrist transverse diameter, wrist ratio and wrist palm ratio in right hand of CTS patients and controls.

Parameter	Side	Patient	Control	P value
Circumference in mm	Right	165.93 ± 10.13 (150-195)	159.85 ± 10.59 (140-185)	<0.002**
Palm length in mm	Right	167.65 ± 22.82 (100-210)	180.91 ± 10.31 (150-205)	<0.001***
Anteroposterior diameter in mm	Right	32.98 ± 4.55 (20-45)	32.40 ± 2.92 (25-43)	0.406•
Transverse diameter in mm	Right	53.40 ± 5.50 (45-70)	51.61 ± 3.92 (44-65)	0.047*
Wrist ratio	Right	0.61 ± 0.10 (0.32- 0.81)	0.62 ± 0.56 (0.38-0.78)	0.811•
Wrist palm ratio	Right	0.19 ± 0.52 (0.12-0.40)	0.17 ± 0.01 (0.14-0.22)	<0.001***

(•:-Non Significant, *:-Significant, **:-Very significant, ***:- Highly significant.)

In Right hand as compared to controls there was significant increase in wrist Circumference ($P < 0.05$), wrist transverse diameter ($P < 0.05$), and Wrist palm ratio ($P < 0.001$) observed in patients, while significant decrease in palm length ($P < 0.001$) observed in patients. There was no significant difference observed in wrist anteroposterior diameter and wrist ratio.

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Table No-4: Values of wrist circumference, palm length, wrist anteroposterior diameter, wrist transverse diameter in left hand of CTS patients and controls.

Parameter	Side	Patient	Control	P value
Circumference in mm	Left	164.90 ± 9.78 (148-195)	159.85 ± 0.59 (140-185)	0.008**
Palm length in mm	Left	167.56 ± 23.02 (100-210)	181.16 ± 10.31 (150-205)	<0.001***
Anteroposterior diameter in mm	Left	32.70 ± 4.40 (20-45)	32.25 ± 2.5 (25-40)	0.496•
Transverse diameter in mm	Left	53.00 ± 5.59 (43-70)	51.46 ± 3.92 (44-65)	0.085•
Wrist ratio	Left	0.62 ± 0.10 (0.32-0.81)	0.62 ± 0.56 (0.38-0.78)	0.873•
Wrist palm ratio	Left	0.19 ± 0.50 (0.12-0.38)	0.17 ± 0.01 (0.14-0.22)	<0.001***

(•:-Non Significant, *:-Significant, **:-Very significant, ***:- Highly significant.)

In left hand, as compared to controls there was significant increase in wrist circumference ($P < 0.05$), and wrist palm ratio observed in patients ($P < 0.001$) while significant decrease in palm length was observed in patients ($P < 0.001$). There was no significant difference observed in wrist anteroposterior diameter, wrist transverse diameter and wrist ratio.

Discussion

Carpal tunnel syndrome is a most common entrapment neuropathy. Prevalence of Carpal Tunnel Syndrome is increasing .Lot of research work is going on to find out etiopathogenesis of Carpal Tunnel Syndrome. Hypothyroidism, Rheumatoid Arthritis, Pregnancy, Acromegaly and obesity etc, are common and proved predisposing factors for Carpal tunnel syndrome.[1]

Now a days increased obesity (increased BMI), is also reported to be associated with Carpal Tunnel Syndrome. Some authors suggested that body mass index, stature and body weight are risk factors.[8]Others reported that the cross sectional area of Carpal Tunnel and even wrist dimensions are important factors in the development of idiopathic Carpal Tunnel Syndrome.[7] So in present study these risk factors like type of work, gender, BMI, wrist ratio and wrist palm ratio were studied in clinically and electrophysiologically diagnosed patients of carpal tunnel syndrome.

Our findings suggest that compared to males, in females Carpal Tunnel Syndrome is very common. In our study 85% were females and 15% were males. Our findings

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are consistent with findings of other workers (Table No.1).

In our study 68% were housewives. This could be because of jobs with strenuous and repetitive hand activity. Housewives required these movements while cleaning the pots and washing the clothes and while household work. [3]Women who have Carpal Tunnel Syndrome may also have smaller carpal tunnel.

In our study BMI value of controls was (24.44 ± 3.74) and BMI value of CTS patients was (22.63 ± 2.99).Compared to controls, in CTS patients BMI values were significantly increased ($P < 0.01$),(Table No.2).Increased BMI is associated with increased fat deposition and it may reduce nerve flow in the hand. [8]This could be the reason for increased obesity leading to the complaints of Carpal Tunnel Syndrome.

Type of hand, size of hand could be the factors responsible for CTS (Anthropometric parameters). As compared to controls there was significant increase in wrist circumference ($P < 0.05$), wrist transverse diameter ($P < 0.05$), and Wrist palm ratio ($P < 0.001$) observed in patients, while significant decrease in palm length ($P < 0.001$) was observed in patients.

No significant difference was observed in wrist anteroposterior diameter and wrist ratio. Thus the study shows that hands of CTS patients group were shorter than control group. So the type of hand and size of wrist are also important factors for development of Carpal Tunnel Syndrome (Table no.3 and 4).

The electrophysiological diagnosis of CTS is based on conduction abnormalities across carpal tunnel as median nerve gets compressed in carpal tunnel. [1] Characteristic findings in the electrophysiological diagnosis of CTS were-slowing sensory conduction of median nerve, decrease in SNAP amplitude, and increase in DSL and DML in median nerve. As ulnar nerve does not pass through carpal tunnel and passes lateral to tunnel its DML and DSL are expected to be normal. So difference between DML and DSL of median and ulnar nerve may be considered as very sensitive indicator of CTS. [9, 10&11]

The American Association of Electro diagnostic Medicine (AAEM) has concluded that median nerve sensory transmission is also more sensitive indicator for diagnosis of CTS .[12] In this study median nerve sensory velocity was reduced as it was measured across the carpal tunnel. There was significant decrease in SNCV of the patients, on both sides.

For electrodiagnosis of CTS, most sensitive indicators are 1) Decrease in sensory nerve conduction velocity of median nerve.

2) Increase in difference between distal motor latency of median and ulnar nerve > 1.1ms.

3) Increase in difference between distal sensory latency of median and ulnar nerve > 0.2 ms.

Our patients fulfilled all electrophysiological criteria for diagnosis of carpal tunnel syndrome.

In our study difference between distal motor latency of median and ulnar nerve in patient was 2.07 ± 1.36 while in control it was 0.66 ± 0.3 ($P < 0.01$), shows highly significant values in CTS patients. Mean values of difference between distal sensory latency of median and ulnar nerve in patient was 1.39 ± 0.93 while in controls 0.11 ± 0.07 ($P < 0.001$) shows statistically highly significant values in CTS patients. Sensory conduction velocity of median nerve (dominant hand) in patient was 39.81 ± 9.5 while in controls

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was 55.59 ± 7.55 ($P < 0.001$) shows statistically highly significant difference.

Conclusion

Prevalence of Carpal Tunnel syndrome is increasing because of increased obesity and more number of jobs concerned with repetitive wrist movements, like typing and computer work. Nerve conduction Study is very sensitive investigation for diagnosis of CTS. Short hand could be the reason for causation of CTS. This is a small scale study further research is required to find out etiopathogenesis of CTS and implement preventive measures to decrease prevalence of Carpal Tunnel syndrome.

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