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ORIGINAL RESEARCH

Associations between hand anthropometric measurements, and degree of severity of carpal tunnel syndrome in Suez Canal area, Egypt

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is considered as the most commonly reported peripheral nerve entrapment syndrome resulting from compression of the median nerve at the wrist level. Many studies have investigated the association between anthropometric characteristics and the degree of severity of the disease. Most literature supports a causal association between overweight and CTS; moreover, there is strong evidence that anatomical characteristics of the hand-wrist system may change the risk, and perhaps the severity of CTS. The aim of this study was to investigate the association between hand anthropometric measurements in patients with CTS and severity of the disease.

Methodology: A cross-sectional study was conducted among patients with CTS (n = 600). For this purpose, a brief questionnaire and physical examination were done; hand dominance also was recorded. Body and hand anthropometric measurements were performed and recorded followed by electrodiagnostic testing at the same visit.

Results: Patients had significantly prolonged distal latency, prolonged peak latency, lower compound muscle action potential and sensory nerve action potential amplitudes, and slower sensory nerve conduction velocity. Patients had significantly higher wrist depth, higher wrist ratio (WR), shorter palm length, shorter hand length, and lower hand ratio. Correlations of WR and wrist depth were also found.

Conclusion: Anthropometric characteristics of the wrist and hand are significantly correlated with CTS. These measurements could be used in certain occupations to screen for those individuals who have increased liability to develop CTS.

Keywords: Carpal tunnel syndrome, hand anthropometric measurements, severity of CTS.

Introduction

Carpal tunnel syndrome (CTS) is considered as the most commonly reported peripheral nerve entrapment syndrome resulting from compression of the median nerve at the wrist level. Currently, CTS is typically diagnosed by history, physical examination, and by means of an electrodiagnostic study, these means of diagnosis have proved to be effective in localizing the site of pathology and estimating the degree of severity of the condition, and compared to magnetic resonance imaging and ultrasonography.

Many studies have investigated the association between anthropometric characteristics and the risk of CTS and the degree of severity. Most literature supports a causal association between overweight or obesity and CTS; moreover, there is strong evidence that anatomical characteristics of the hand-wrist system may change the risk, and perhaps the severity, of CTS [1–4].

The severity of CTS may be influenced by anthropometric measurements as observed in nerve conduction studies. Investigating these relationships can aid in improving the sensitivity and specificity in the diagnosis of CTS.

Subjects and Methods

This was a cross-sectional study that included 600 patients with CTS. The studied population were recruited as every adult (age ≥ 18 years) who are screened for the presence of one or more of the exclusion criteria as

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having a history of previous surgery of the upper limb, polyneuropathy for any cause, hand or wrist trauma with or without bone fracture; pregnant or lactation, intake of toxic medication to the peripheral nervous system.

The research was conducted at Department of Physical Medicine, Rheumatology and Rehabilitation, Suez Canal University Hospitals. All participants underwent a brief interview and physical examination, which included muscle strength testing, a sensory examination, and reflex testing of their upper limbs. Hand dominance was recorded. Height and weight were used to calculate the body mass index (BMI). Anthropometric measurements were performed and recorded followed by the electrodiagnostic testing at the same visit. Patients who suffered from diabetes mellitus, rheumatoid arthritis, hypothyroidism, who had a history of trauma or wrist fracture, or pregnant were excluded from the study.

All participants underwent the median nerve motor and sensory nerve conduction studies using standard techniques. Electrophysiological studies were conducted on a Nihon Kohden Neuropack MEB-7102 mobile unit with a two-channel evoked potential/EMG measuring system (Nihon Kohden Corporation, Tokyo, Japan). Skin temperature at the site of the recording electrode was maintained around 32–34 °C by means of hot packs. The ground electrode was placed between the recording electrodes distally and the stimulation site proximally. Conduction distances were measured by a measuring tape with the precision of 1 mm [5].

Motor nerve conduction study of the median nerve

An active recording surface disc electrode was attached to the abductor pollicis brevis muscle belly and the reference surface disc electrode over the first finger metacarpophalangeal joint. Electrical stimulation of the median nerve was done at 7 cm proximal to the active recording electrode at the wrist between the flexor carpi radialis tendon and palmaris longus tendon. Distal latency (DL) was obtained for the analysis [6].

Motor nerve conduction study of the ulnar nerve

An active recording surface disc electrode was attached to the abductor digiti minimi muscle belly and the reference surface disc electrode over the fifth finger metacarpophalangeal joint. Electrical stimulation of the ulnar nerve was done at 7 cm proximal to the active recording electrode at the wrist crease just lateral to the flexor carpi ulnaris tendon. DL was obtained for the analysis [7,8].

Anthropometric Measurements

Direct measurements were performed at the time of the electrodiagnostic study, included height, weight, waist, and hip circumference. In case of patients with bilateral symptoms, the hand with the worst symptoms was examined, or the dominant hand was chosen in case of inability to distinguish which one is worse [9]. Measurements of wrist shape, medio-lateral and dorso-volar diameter were performed as described by Johnson et al. [10]. Measurements of the hand were performed as described by Kouyoumdjian et al. [11] and Chroni et al. [12], width and depth of the wrist, length of the palm, length of the third digit and of the hand, and width of the palm, wrist ratio (WR), wrist depth/wrist width [13–15], hand ratio (HR), and hand length/palm width [16].

In case of patients with bilateral symptoms, the hand with the worst symptoms was examined, or the dominant hand was chosen in case of inability to distinguish which one is worse [9].

Results

Table 1 shows the demographic data of 600 patients with CTS; female gender had the higher percentage (70% of cases), mean age 45.3 ± 19.8 (18–53), weight 68.2 ± 11.5 (62–89), height 1.63 ± 0.08 (1.50–1.81), BMI 32.7 ± 3.33 (16.2–27.2). Median nerve parameters in CTS patients showed that patients had significantly prolonged DL, lower compound muscle action potential (CMAP) amplitude, prolonged peak latency (PL), lower sensory nerve action potential (SNAP) amplitude, and slower sensory nerve conduction velocity (SNCV) (Table 2). Table 3 shows anthropometric wrist and hand measurements; patients had significantly higher wrist depth, higher WR, shorter palm length, shorter hand length, and lower HR. Table 4 shows a correlation of wrist and hand measurements with median nerve electrophysiologic parameters of CTS group. Wrist depth was positively correlated with median motor DL and sensory PL, and negatively correlated with CMAP amplitude, SNAP amplitude, and SNCV. Similarly, WR was positively correlated with median motor DL and sensory PL, and negatively correlated with CMAP amplitude, SNAP amplitude, and SNCV.

Discussion

Hlebs et al., attempted to find an explanation that BMI and stature are risk factors, and they reported that the cross-sectional area of the carpal tunnel and even wrist dimensions are important factors in the development of CTS. It is also well known that nerve conduction parameters are affected by age, weight, and height. Our study aimed at assessing the relation of hand and wrist anthropometric measurements to median nerve conduction study parameters in CTS. It was observed that many individuals with CTS have square wrists. This observation led to correlating wrist dimensions with median sensory latencies [5].

Our study showed statistically significant results in CTS patients regarding hand measurements. Patients had more square-shaped wrist and shorter hand configuration. In addition, some of the wrist and hand anthropometric measurements showed a clear association with median nerve conduction study parameters across the carpal

Table 1. *Demographic data of the study group.*

Number (*n*)	600
Gender (women/men)	450/150
Age (years)	45.3 ± 19.8 (18–53)
Weight (kg)	68.2 ± 11.5 (62–89)
Height (m)	1.63 ± 0.08 (1.50–1.81)
BMI	32.7 ± 3.33 (16.2–27.2)

Table 2. *Median nerve electrophysiological parameters in carpal tunnel syndrome patients.*

Variables Test	Patients (*n* = 600)
Median motor DL (ms)	
Mean (SD)	6.62 (2.13)
Median	5.00
Median motor PL (ms)	
Mean (SD)	7.32 (2.13)
Median	5.00
Median CMAP amplitude (mV)	
Mean (SD)	7.92 (5.93)
Median	9.05
Median FMCV (m/s)	
Mean (SD)	41.70 (5.02)
Median	41.600
Median SNAP amplitude (μV)	
Mean (SD)	11.14 (15.38)
Median	9.00

FMCV, forearm median motor conduction; SD, standard deviation; *$P \leq 0.05$, significant.

Table 3. *Anthropometric wrist and hand measurements in carpal tunnel syndrome patients.*

Variables	Patients (*n* = 600)
Wrist width (cm)	
Mean (SD)	5.32 (0.55)
Median	4.00
Wrist depth (cm)	
Mean (SD)	3.83 (0.18)
Median	2.00
Wrist ratio	0.45 (0.07)
Mean (SD)	0.44
Median	
Palm length (cm)	
Mean (SD)	10.01 (0.70)
Median	10.00
Palm width (cm)	
Mean (SD)	6.035 (0.89)
Median	5.00
Third digit length (cm)	
Mean (SD)	8.430 (0.74)
Median	8.15
Hand length (cm)	
Mean (SD)	16.24 (0.77)
Median	14.50
HR	2.88 (0.13)
Mean (SD)	2.100
Median	

SD, standard deviation; $P \leq 0.05$, significant.

Table 4. *Correlation between wrist and hand measurements, and median nerve electrophysiological parameters.*

Variables	DL (ms)	PL	CMAP (mV)	FMCV (m/s)	SNAP (μV)	SNCV (m/s)
Wrist width (cm)						
r	−0.189	0.035	−0.071	−0.350	−0.005	0.143
p	0.135	0.634	0.321	0.048	0.857	0.076
Wrist depth (cm)						
r	0.405	−0.213	−0.214	0.551	−0.322	−0.532
p	0.000*	0.000*	0.000*	0.237	0.000*	0.000*
Wrist ratio						
r	0.504	−0.414	−0.134	0.651	−0.422	−0.642
p	0.000	0.000	0.000	0.000	0.000	0.000
Palm length (cm)						
r	−0.067	0.258	−0.140	−0.035	0.119	0.061
p	0.797	0.149	0.533	0.241	0.145	0.786
Palm width (cm)						
r	0.329	−0.134	−0.087	0.165	−0.176	−0.198
p	0.223	0.154	0.021	0.332	0.023*	0.231
Hand length(cm)						
r	−0.145	0.162	0.064	−0.051	0.115	0.093
p	0.487	0.328	0.706	0.614	0.166	0.242
HR						
r	−0.515	0.472	0.167	−0.432	0.338	0.631
p	0.001*	0.019*	0.021*	0.169	0.001*	0.010*
Third digit length (cm)						
r	−0.167	−0.058	−0.078	−0.089	0.099	0.078
p	0.534	0.087	0.432	0.459	0.356	0.134

tunnel. Wrist depth and WR were directly correlated with median motor and sensory onset latencies and inversely correlated with median motor and sensory response amplitudes, and sensory conduction velocity. In addition, HR was inversely correlated to median motor and sensory latencies, and directly correlated to median motor and sensory amplitudes and sensory conduction velocity.

These findings matched with the work of Mondelli et al., who suggest that square-shaped wrists and short-hand anatomy are associated with slower conduction of impulses along median nerve sensory and motor fibers through the carpal tunnel. This indicates that certain hand and wrist configurations predispose to the development of CTS and that these anatomical hand measurements could, to a certain degree, predict median nerve conduction across the carpal tunnel [6]. In agreement with the current study, Johnson et al. were the first to study WR in relation to CTS and demonstrated that patients with a more square-shaped wrist could have a greater tendency to develop CTS. These results were supported by many investigators [10].

In addition, Chiotis et al. found that the wider and shorter hand shape and square-shaped wrist are associated with slower impulse traveled along the sensory and motor fibers of the median nerve through the carpal tunnel. In the present study, patients had statistically significant low HR and significantly high WR. These findings were compatible with the results of previous studies. This indicates that anatomic differences appeared to be an important factor in the occurrence of CTS in individuals under the same occupational settings and stresses [16].

Conclusion

Anthropometric characteristics of the wrist and hand are important in the development of CTS, by providing the hand measurements. These measurements could be used in certain occupations to screen for those individuals who have increased liability to develop CTS.

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None

List of Abbreviations

BMI	Body mass index
CMAP	Compound muscle action potential
CTS	Carpal tunnel syndrome
HR	Hand ratio
MRI	Magnetic resonance imaging
PL	Peak latency
SNAP	Synaptic nerve action potential
SNCV	Sensory nerve conduction velocity
WR	Wrist ratio

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Conflict of Interests
None

Ethical Approval
Ethical approval was obtained form IRB, Faculty of Medicine, Suez Canal University.

Consent for publication
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