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ORIGINAL ARTICLE

Role of Anthropometric Characteristics in Idiopathic Carpal Tunnel Syndrome

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Abstract

Objective: To investigate the possible association of external and ultrasonographic measurements of the hand and wrist with median nerve conduction studies.

Design: Two group comparison study.

Setting: Outpatient neurophysiology laboratory and radiology department in a university hospital.

Participants: Patient group (n=50; 40 women) with clinically overt and electrophysiologically proven idiopathic carpal tunnel syndrome and a control group of age- and sex-matched healthy volunteers (n=50).

Interventions: Not applicable.

Main Outcome Measures: The following measurements were taken: (1) motor and sensory conduction studies of the median nerve; (2) external hand and wrist dimensions (hand ratio and wrist ratio); and (3) ultrasonographic dimensions of the carpal tunnel (carpal tunnel inlet ratio and carpal tunnel outlet ratio) and inlet cross-sectional area and outlet cross-sectional area of the median nerve at the tunnel.

Results: Differences between patients and controls were significant for hand and wrist ratios and all ultrasonographic dimensions. Sensory conduction velocity and distal motor latency of the median nerve in all 100 subjects were well correlated with hand ratio, wrist ratio, carpal tunnel inlet ratio, and carpal tunnel outlet ratio estimates. Wrist ratio was significantly correlated with carpal tunnel inlet ratio and carpal tunnel outlet ratio.

Conclusions: A particular hand and wrist configuration, that is, short and wide hand with square wrist matching to narrow and deep tunnel entrance demonstrated increased liability for idiopathic carpal tunnel syndrome. For screening purposes, it was suggested that simple external hand or wrist measurements could be used to predict the tendency for carpal tunnel syndrome.

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Carpal tunnel syndrome (CTS) is a result of compression of the median nerve as it passes through the nonflexible carpal tunnel, where increased pressure, ischemia, and/or inflammation lead primarily to segmental demyelination and consequently to secondary axonal damage.[1] CTS-related morbidity leading to the loss of working hours, medical expenses for surgical nerve decompression, compensation claims, and the occasionally permanent compromise of thumb movements has substantial socioeconomic and health care consequences.[2,3] CTS is a very common condition accounting for almost 90% of all entrapment neuropathies in the upper limbs and has an incidence of 2 for 1000 person-years in the general population.[1,4] It occurs during people's productive life, compromising the use of their hands; symptoms often persist for many months (sleepless nights) prior to seeking medical help, and even the postoperative recovery period requires a long time off work. Therefore, any markers or signs for predicting the tendency to develop CTS would be useful.

Although hand injury and several medical conditions, such as diabetes, rheumatoid arthritis, pregnancy, and renal failure, are predisposing factors to this syndrome, the majority of cases occur without any obvious causes, and this is considered idiopathic

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carpal tunnel syndrome (ICTS).[5,6] Mechanical irritation caused by repetitive wrist movements in an occupational setting has been implicated in ICTS, but it does not explain why under the same conditions CTS occurs in some and not in other individuals. In several studies, hand and wrist dimensions and other anthropometric characteristics, such as body weight, height, and body mass index (BMI), have been assessed in order to define the tendency of a particular individual to develop CTS under given conditions, or even without any predisposing factors.[5,7-11] In each study, a single anatomical characteristic was examined, whereas its association to other parameters aiming to provide a more comprehensive hand anatomy in CTS cases has not been attempted. Other studies employed ultrasonographic techniques to measure the thickening and flattening of the median nerve within the carpal tunnel, as well as the shape and dimensions of the tunnel itself.[1,12,13] In the latter category, all the articles but 1 focused on the sensitivity versus specificity of the ultrasonography, suggesting that it constitutes an alternative means for CTS diagnosis. There is 1 study where both the external hand-wrist dimensions and the inner wrist dimensions, as estimated by ultrasonography, have been linked to 1 of 2 conditions: health or CTS.[9]

We hypothesized that in cases of ICTS, certain morphology of the hand-wrist is the key predisposing factor to median nerve compression; thus, we aimed herein to define the anatomical characteristics that best describe the hand-wrist type favoring CTS development. In order to do this, we examined the association of hand and wrist external dimensions as well as the internal ultrasonographic estimations of the carpal tunnel and compared them to the standard median nerve conduction measurements, used as indices of the nerve functional state.

Methods

Participants

Fifty consecutive patients (40 women; mean age ± SD, 50.9±12.7y) who fulfilled the inclusion criteria were chosen for the study: inclusion criteria included clinically overt CTS with typical symptoms (ie, paresthesias and nocturnal pain in the distribution of the median nerve) and electrophysiologic confirmation of the diagnosis with definite abnormalities in the median nerve conduction studies, as described in the nerve conduction methodology. Excluded criteria included women who were pregnant and patients with trauma or fracture of the wrist, hypothyroidism, rheumatoid arthritis, diabetes, or other conditions related to CTS. The control group consisted of 50 age- and sex-matched healthy volunteers (40 women; mean age, 50.0±11.9y) who had no symptoms of CTS and had none of the exclusion criteria applied to the patient group. A brief questionnaire regarding residence, profession, hobbies, and hand use was completed for all individuals (appendix 1). Care was also taken so that residence and occupational activities were not statistically different between the 2 groups. All subjects who participated in this study gave informed consent, and the study protocol was approved by the hospital's ethics committee.

Employing commercially available instruments, that is, a metallic caliper (Mitutoyo 532-120 Vernier Caliper)[a] and a stadiometer combined with a digital scale (Soehnle Professional 2755),[b] anthropometric measurements were performed in both groups by the same researcher (K.C.). To ensure reproducibility and consistency, a second researcher (N.D.) repeated, in a blind manner, several randomly selected measurements. The following estimates were obtained. (1) External dimensions were taken of the extended hand: hand length was the distance from the distal flexor crease of the wrist on the volar surface to the distal end of the third digit, and palm width was the maximal distance of the palm at the level of the heads of the index and fifth finger metacarpal (fig 1). The hand ratio (HR) was calculated by dividing the hand length by the palm width. (2) External wrist dimensions were taken: dimensions included wrist depth (palmodorsal dimension) and wrist width (mediolateral dimension) at the level of the distal flexor crease. The wrist ratio (WR) was calculated by dividing the depth by the width (see fig 1). A higher WR indicated a more square wrist. (3) Subject's height, weight, and BMI were also measured (table 1).

Employing a Philips iU22 apparatus,[c] ultrasonographic measurements were performed by a single researcher (A.R.) and supervised by a senior examiner (A.C). Both radiologists were blind as to the group to which each individual belonged. The subjects maintained their elbow flexed at 90° while their forearm was supported in supination with the wrist at a neutral position. Ultrasonographic estimates were performed at 2 levels: the carpal tunnel inlet ratio (CTRin) (at the level of the pisiform bone) and the carpal tunnel outlet ratio (CTRout) (at the level of the hook of hamate) and included the following: (1) depth (maximal dorso-palmar diameter) and width (maximal radio-ulnar diameter) of the carpal tunnel: the CTRin and CTRout were calculated by dividing the depth by the corresponding width (fig 2); and (2) the inlet cross-sectional area (CSAin) and outlet cross-sectional area (CSAout) of the median nerve at the inlet and outlet of the tunnel (see fig 2). The perimeter of the nerve was traced, and the area was calculated by the software program of the device.

Nerve conduction studies were performed on an electromyographic apparatus.[d] In the patient group, the symptomatic side or the more severely affected side in cases with bilateral symptoms were studied. In the healthy controls, measurements were performed on the dominant hand. In all patients and controls, the full CTS protocol of our laboratory was applied, which included motor and sensory conduction studies of the median and ulnar nerves bilaterally, supplemented with techniques to detect mild conduction abnormalities, such as comparisons between median and ulnar or radial conduction velocities. For the purposes of the present study, the sensory conduction velocities (SCVs) of the median and ulnar nerves (with orthodromic stimulation at the second and fifth fingers, respectively) and distal motor latency (DML) of the median nerve were registered. Criteria for the diagnosis of CTS were set at: 4.2ms or higher for DML and 49m/s or lower for SCV of the median nerve.[5]

List of abbreviations:

BMI	**body mass index**
CSA	**cross-sectional area**
CSAin	**inlet cross-sectional area**
CSAout	**outlet cross-sectional area**
CTR	**carpal tunnel ratio**
CTRin	**carpal tunnel inlet ratio**
CTRout	**carpal tunnel outlet ratio**
CTS	**carpal tunnel syndrome**
DML	**distal motor latency**
HR	**hand ratio**
ICTS	**idiopathic carpal tunnel syndrome**
SCV	**sensory conduction velocity**
WR	**wrist ratio**