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Waist circumference and waist-to-hip ratio in carpal tunnel syndrome: A case–control study

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ABSTRACT

Background: The association between carpal tunnel syndrome (CTS) and high body mass index (BMI) and some hand measures is well known. No study has been specifically focused on waist circumference (WC) and waist-to-hip-ratio (WHR). The aim of this prospective case–control study is to evaluate the association between CTS and WC, WHR and other body and hand anthropometric measures.
Methods: We consecutively enrolled one "idiopathic" CTS case for two controls in 3 outpatient electromyography labs. The main anthropometric measures were BMI, WC, WHR, wrist ratio (WR) and hand ratio (HR). We performed univariate and multivariate analyses.
Results: Female cases and controls were 250 and 474 and male cases and controls were 120 and 273, respectively. At univariate analysis there were differences in many anthropometric measures between cases and controls. At multivariate logistic regression analyses high BMI, WC and WHR and abnormal HR and WR were independent risk factors for CTS. Crossing two categories between BMI, WC and WHR, the overweight subjects, especially females, were at risk only if they had very high WC or high WHR. The risk increased if they were obese.
Conclusions: High WC/WHR doubles the risk of CTS, the risk further increased if overweight/obese subjects have also very high WC or high WHR. The obese subjects were always at risk regardless of WC and WHR values. Metabolic causes of this association with CTS were hypothesised. BMI is not the only and most powerful body predictor of "idiopathic" CTS, but also WHR and WC should be considered. These measures may not be interchangeable and it may be desirable to consider the utility of their joint use.

1. Introduction

Carpal tunnel syndrome (CTS) is the most frequent focal peripheral neuropathy. Many risk factors for CTS were identified as female gender, age, diabetes, rheumatoid arthritis, thyroid dysfunction, renal failure, pregnancy, hand and wrist trauma, use of oral contraception, smoking, and occupations that involved forced and repetitive exertions of hand and wrist, high handgrip forces and using vibrating tools [1–7]. Many studies have focused on hand/wrist and body anthropometric characteristics. There is almost unanimous agreement that a high body mass index (BMI), a squared wrist and a short hand predispose to CTS [4,5,8–13].

Recently the World Health Organization (WHO) suggested that waist circumference (WC) and waist-to-hip-ratio (WHR) are better predictors than BMI in some diseases [14]. In literature there are no studies on WC and WHR expressly designed to demonstrate whether high WC and high WHR may be independent risk factors for CTS.

The purpose of our prospective case–control study is to evaluate the association between CTS and WC, WHR and other anthropometric measures.

2. Methods

2.1. Enrolment and definition of cases and controls

We decided in advance to recruit one case with CTS for two controls. We prospectively enrolled cases among all consecutive patients, regardless of age, gender and occupation, who were admitted to three outpatient electromyography labs to perform an electrodiagnostic testing (EDX) for the first time because of CTS symptoms. We prospectively enrolled convenience controls among all the other consecutive patients, regardless of age, gender and occupation, who were admitted to the same three outpatient electromyography labs to perform EDX for the first time because of upper limb complaints, other than CTS. All patients who underwent hand and wrist surgery, with polyneuropathy, amyotrophic lateral sclerosis, diabetes, rheumatic or thyroid diseases, renal failure, gout, history of alcoholism, malignancy in the previous 5 years, hand, wrist and arm trauma with or without fracture, onset of symptoms during

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pregnancy or lactation, and previous intake of medication considered toxic to the peripheral nervous system were excluded from cases and controls. The collection of cases lasted six months (from 15 January to 15 July 2011) and that of controls further eight months (up to 15 March 2012), the time necessary to obtain a ratio of 1 case to 2 controls.

CTS diagnosis was made on the basis of the clinical findings and delay of distal conduction velocity of the median nerve according to a consensus conference on criteria for the classification of CTS in epidemiological studies [15]. For clinical diagnosis, the inclusion criteria were those recommended by the American Academy of Neurology summarized here as: dull, aching discomfort in the hand, forearm, or upper arm; paraesthesia, weakness or clumsiness of the hand provoked or worsened by sleep, sustained hand or arm position, repetitive actions of the hand or wrist and mitigated by changing posture or by shaking the hand [16]. Sensory deficit in the median innervated region of the hand and motor deficit or hypotrophy of median innervated thenar muscles could be present, but they were non-necessary to fulfil the diagnosis in the presence of typical symptoms.

Local ethics committee approved the study and all patients gave informed consent.

2.2. Electrophysiological methods

To confirm the clinical diagnosis of CTS we performed EDX according to our protocol inspired by the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) and based upon the recommendations of Werner et al. [17–19]. The EDX protocol included "standard" and "optional" tests.

"Standard" EDX included motor conduction velocity in the elbow–wrist segment of the median nerve and below the elbow–wrist segment of the ulnar nerve, recording from the abductor pollicis brevis and abductor digiti minimi muscles, respectively. Distal motor latency (DML) was calculated at a fixed distance of 7 cm from the point of stimulation at the wrist to the muscle from which compound muscle action potential was recorded. Sensory conduction velocity (SCV) was orthodromically measured in the third and fourth finger–wrist (M4) tracts for the median nerve and in the fourth finger–wrist tract for the ulnar nerve (U4). Differences between U4–M4 SCV and median–ulnar DML were also calculated. The amplitudes of sensory nerve and compound muscle action potentials were measured but not used for diagnosis of CTS. If at least one absolute parameter of the median nerve plus one differential value at "standard" EDX were abnormal, the diagnosis of CTS was electrophysiologically confirmed. When none or only one value of "standard" protocol was abnormal, the following "optional" tests were performed: SCV in the first finger–wrist tracts for the median (M1) and radial (R1) nerves, differences between R1–M1 SCVs, and differences between the latencies of the median and ulnar nerves in 8 cm palm-to-wrist segment and between the second lumbrical–second interosseous muscles' DML.

The patients were definitively included in the cases when at least one absolute plus one differential value or two differential values were abnormal at "standard" or "optional" EDX.

Skin temperature of the hand was maintained above 32 °C with an infrared lamp and measured with a digital thermometer.

Neurographic values that differed by at least 2 SDs from the mean of the normative data of each lab were considered abnormal. These abnormal values varied little between the three labs. In the lab that identified the most cases, DML of the median nerve in adults was considered significantly delayed if it was more than 4.4 ms. The M1, M3 and M4 SCVs were considered significantly slowed if they were below 40.8, 45.3 and 42.7 m/s, respectively. We considered significantly abnormal the differences >9.5 and >10.2 m/s between U4–M4 and R1–M1 SCVs, respectively, >0.44 ms in median–ulnar 8 cm palm-to-wrist latency, >1.56 ms in median–ulnar DML recording from abductor pollicis brevis and abductor digiti minimi muscles and >0.7 ms in median–ulnar DML recording from the second lumbrical–interosseous muscles.

The EDX was performed in the controls according to the clinical suspicion. However "standard" EDX (to confirm the absence of CTS) was mandatory normal to enrol the patient in the control group. In addition the patients with clinical diagnosis of CTS and normal distal conduction velocity of the median nerve and patients with asymptomatic distal delay of the median nerve were excluded from the cases and controls.

All three electromyographers were experienced, received the same neurophysiological training, and used the same standardised methods for clinical and electrophysiological diagnosis of CTS.

2.3. Anthropometric measurements

We measured the external hand and wrist dimensions (in mm) in cases and controls using a standard sliding calliper (accurate to 0.1 mm) from the palm side. The fingers were fully extended on a flat and hard support surface. The measurements were: 1) wrist width: maximum transverse distance between the borders at the level of the distal flexor wrist crease; 2) wrist depth: anterior–posterior depth at the level of the distal flexor wrist crease; 3) hand length: distance of the volar surface between the distal flexor crease of the wrist to the tip of the third finger; and 4) palm width: maximum distance of the volar surface between the second and fifth metacarpal heads.

Based on these measures two ratios were calculated: wrist ratio (WR): wrist depth/wrist width and hand-ratio (HR): hand length/palm width.

The difference in the measurements between dominant and non-dominant hands was randomly tested in 20 cases and 40 controls. There were no significant interside differences in all hand measures using the non-parametric sign test. In the patients with bilateral symptoms we measured the hand with worst symptoms or if there was no difference between sides, the dominant hand. Therefore we analysed the data at patient level and not at hand level because including a patient with bilateral CTS as two cases may be a source of statistical bias and the results may be overstated if the correlation between the two hands is not taken into account [20].

We measured waist and hip circumferences (HC), in cm, according to WHO recommendation.

The subject is standing upright during the measurement, with arms relaxed at the side, feet evenly spread apart and body weight evenly distributed. The WC was measured at the end of several consecutive natural breaths, at a level parallel to the floor, midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the midaxillary line. The HC was calculated at a level parallel to the floor, at the largest circumference of the buttocks. Both measurements were made with a stretch-resistant tape that is wrapped snugly around the subject, but not to the point that the tape is constricting. WHR was calculated dividing WC by HC [14].

Height and weight were also measured and BMI calculated (kg/m^2).

2.4. Reliability of measurements

Four examiners (three electromyographers and one neurophysiological technician) performed all anthropometric measures and then clinical and electrophysiological examinations. The four examiners underwent a common training to standardise the measurement techniques. The interexaminer agreement of all body and hand measures was tested in a single blind measurement session with 17 volunteers of various body sizes (12 women and 5 men, mean age 46.6 ± 10.2 years [range 30–64], mean height 166.8 ± 7.8 cm [range 150–178], and mean weigh 74 ± 19.3 kg [range 49–120]). There were no significant differences in all anthropometric measures between the four operators (Friedman test) and the intrameasure and intermeasure errors of WC and HC were less than 2 cm according to WHO recommendations [14].