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Egypt J Neurol Psychiatry Neurosurg (2021) 57:129
https://doi.org/10.1186/s41983-021-00385-2

The Egyptian Journal of Neurology, Psychiatry and Neurosurgery

RESEARCH Open Access

Assessment of carpal tunnel syndrome via ultrasonography among hospital workers: a screening study

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Abstract

Background: Carpal tunnel syndrome is a reasonably common disorder among working individuals. It may also be a cause of functional impairment. The aim of the study was to screen for the presence of carpal tunnel syndrome among hospital workers by non-invasive ultrasound.

Results: The prevalence of carpal tunnel syndrome diagnosed by ultrasound among hospital workers was 21.5%. Age and Boston carpal tunnel questionnaire scale were positively correlated to median nerve cross sectional area.

Conclusions: Ultrasound can be used as a non-invasive and convenient method for screening for carpal tunnel syndrome.

Keywords: Carpal tunnel syndrome, Median nerve, Occupational risks, Ultrasound, Hospital workers, Screening

Background

Carpal tunnel syndrome (CTS) is one of the most common painful and disabling conditions related to hand usage. Moreover, it is commonly a source of substantial disability [1]. It was estimated that 34% of hospital workers have CTS [2]. Ultrasonographic measurements of the median nerve cross sectional area (CSA) provides comparatively high diagnostic accuracy for CTS and can be considered as a non-invasive, alternative and complimentary diagnostic modality for the evaluation of CTS [3]. Neurophysiological studies have a false negative result with sensitivity ranging from 49 to 86%. In addition, they provide no anatomical information regarding the median nerve and possible etiologic factors [4].

Accordingly median nerve assessment by ultrasound (US) is considered the chief reliable screening tool in screening for CTS [5]. US is an imaging modality that can be used as a first-line diagnostic tool for CTS due to its noninvasiveness, wide availability and accuracy [6]. Screening for CTS presumably will help to reduce the disability burden caused by CTS within the work places [1].

The aim of the study was to screen for the presence of carpal tunnel syndrome among hospital workers by non-invasive ultrasound.

Methods

This is an observational cross-sectional study. This study included 274 wrists of 137 participants working in Ain Shams University hospital. Participants were included if they were more than 18 years, working as doctors, nurses, secretaries or manual workers. Participants with history of diabetes mellitus, thyroid disorder, renal or hepatic disorders, rheumatoid arthritis, gouty arthritis, chemotherapy intake, direct trauma to upper limb, symptoms suggestive of peripheral neuropathy, or current pregnancy were excluded. All participants were subjected to clinical assessment by Arabic version of Boston carpal tunnel questionnaire (BCTQ) [7]. The BCTQ questionnaire is formed of two sections: A Symptom Severity Scale and a Functional Status Scale. The Symptom Severity Scale comprises 11 questions and

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the FSS comprises eight questions. Each question scoring ranges from one (no symptoms) to five (very severe symptoms) [7]. Median nerve area was measured using ultrasound (Esaote, my lab five, Italy). Linear 5–12 MHz probe was placed on distal wrist between pisiform bone medially and scaphoid bone laterally to provide short axis view of median nerve at its inlet to carpal tunnel. CSA of both median nerves was measured from inner border of epineurium. A CSA > 10 mm^2 was considered to be diagnostic for CTS. CSA > 10 mm^2 and less than 13 mm^2 was considered mild, CSA > 13mm^2 and less than 15 mm^2 was considered moderate. CSA > 15mm^2 was considered severe [8].

All procedures performed in the study were in accordance with the ethical standards of the faculty of medicine, Ain Shams University research and ethical committee. Written informed consent was obtained from participants for participation.

Statistical analysis: Statistical analyses were done using SPSS 25 (IBM SPSS ver. 25, NY, USA, 2017). Level of significance was defined as $p < 0.05$. *T* test was used for continuous variables (results are referred to as means ± standard deviation), and Chi square test for categorical ones (results are referred to as frequency and percentage). In addition, Kruskal–Wallis as well as Mann–Whitney Test were used in subgroup analysis. Pearson correlation and linear regression were used to test correlation and prediction between related continuous variables.

Table 1 Demographics of total sample

			Total subjects (Number = 137)	
			Number	Percent
Age (mean ± SD)/median			(40.53 ± 11.234)/41	
Gender	Male		35	25.5
	Female		102	74.5
Occupation	Medical	Physician	20	14.6
		Nurse	56	40.9
	Non-medical	Secretary	36	26.3
		Worker	25	18.2

Results

The mean age of participants was 40.53 ± 11.234 (range = 20–75). Among them 35 (25.5%) were males, 102 (74.5%) were females, 20 (14.6%) were physicians, 56 (40.9%) were nurses, 36 (26.3%) were secretaries, 25 (18.2%) were manual workers (Table 1). The mean BCTQ was 19.86 ± 3.42 (range = 19–51). The mean median nerve CSA by ultrasonography was 9.08 ± 2.5 mm^2. Among the study population 59(21.5%) were found to have abnormal median nerve CSA, 47(79.7%) were mild, 7 (11.9%) were moderate and 5(8.5%) were severe (Table 2). Abnormal BCTQ (≥ 19) was found in 39(14.2%) participants. There was a positive significant correlation between median nerve CSA and both BCTQ score ($r = 0.388$, $p = < 0.001$) and age ($r = 0.346$, $p = < 0.001$) (Fig. 1). There was also a weak positive correlation between BCTQ score and age ($r = 0.158$, $p = 0.009$). There was significant difference between participants with normal and abnormal median nerve CSA regarding age being older in the abnormal group (39.25 ± 11.378; 45.17 ± 9.403) ($p = < 0.001$), while there was no difference between both groups regarding gender and occupation ($p = 0.718$, 0.622, respectively). There were significant differences between means of median nerve CSA and BCTQ ($p = < 0.001$) when compared by *T* test between normal and abnormal groups (Table 3). It was found that 29(19.1%) of the medical group (physicians and nurses) and 30(24.6%)

Table 2 Clinical characteristics of total sample

			Total examined nerves (number = 274)	
			Number	Percent
Median nerve CSA by US (mm^2) (mean ± SD)/median			(9.08 ± 2.5)/9	
BCTQ (mean ± SD)/median			(19.86 ± 3.42)/19	
BCTQ		Normal (≤ 19)	236	85.8
		Abnormal (> 19)	39	14.2
Median nerve CSA by US	Normal (≤ 10 mm^2)		215	78.5
	Abnormal (> 10 mm^2)	Mild (> 10 $mm2^2$)	47	79.7
		Moderate (> 13 $mm2^2$)	7	11.9
		Severe (> 15 $mm2^2$)	5	8.5
		Total	59	21.5

CSA cross sectional area, *US* ultrasound, *BCTQ* Boston carpal tunnel questionnaire

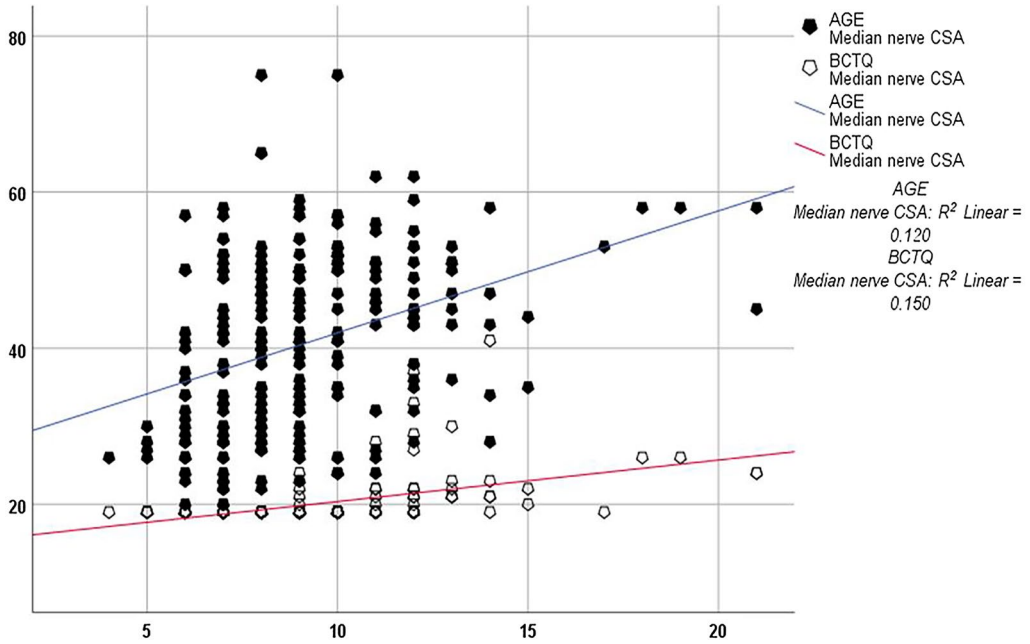

Fig. 1 Correlation between median nerve CSA and both age and BCTQ

Table 3 Comparison between participants with normal and abnormal median nerve CSA

		Normal (No. = 215)		Abnormal (No. = 59)		*T* test/Chi*	
		Mean/Number	**SD/percent**	**Mean/Number**	**SD/percent**	***t*/chi***	***p***
Age		39.25	11.378	45.17	9.403	−4.083	**< 0.001****
Gender	Male	56	26	14	23.7	0.131*	0.718
	Female	159	74	45	76.3		
Occupation	Medical	123	57.2	29	49.2	1.217*	0.270
	Non-medical	92	42.8	30	50.8		
Median nerve CSA by US (mm^2)		8.09	1.373	12.69	2.299	14.690	**< 0.001****
BCTQ		19.07	0.506	22.71	6.600	4.230	**< 0.001****

CSA cross sectional area, *US* ultrasound, *BCTQ* Boston carpal tunnel questionnaire

*Chi test

***p* value is significant if < 0.05

of the non-medical group (secretaries and workers) had abnormal median nerve CSA yet without significant difference ($p = 0.325$). However, there was a significant difference regarding BCTQ (19.27 ± 1.003; 20.59 ± 4.915, $p = 0.004$). Fourteen (20%) males and 45(22.1%) females had abnormal median nerve CSA yet with no significant difference among gender ($p = 0.851$), although there was a significant difference regarding BCTQ score (19.20 ± 0.861; 20.08 ± 3.909) ($p = 0.003$) (Fig. 2). In the current study, it was found that most of participants with abnormal median nerve CSA had mild degree (47 nerves), while 7 showed moderate degree and only 5 nerves showed severe degree of abnormal CSA. On comparing clinical characteristics among different degree of abnormal median nerve CSA, it was found that those with severe degree were older with significant difference yet gender, occupation as well as BCTQ showed no significant statistical difference among them (Table 4).

Using linear regression analysis, it was found that age and BCTQ score can be used to predict change in median nerve CSA by u/s, i.e., increased age by 1 year causes increase in CSA by 0.065 mm^2, and any increase

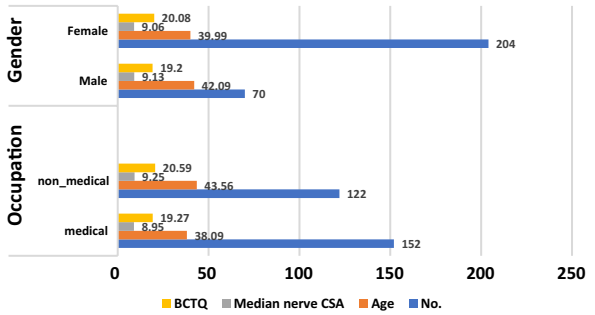

Fig. 2 Comparison between medical versus non-medical and male versus female participants regarding number, age, median nerve CSA and BCTQ

in BCTQ score by one cause increase in CSA by 0.25 mm^2 (Table 5).

Discussion

In this study hospital workers were screened for probable CTS using BCTQ score and median nerve CSA. Ultrasound can be used as a single screening tool for CTS independent from nerve conduction studies [9]. This study showed that 21.5% of hospital workers have CTS diagnosed by ultrasonography, a study by Castro et al. stated that CTS was diagnosed by ultrasonography in 34% of their sample [2]. We found that age and BCTQ significantly correlated with CSA and they can also be used as predictors of change in CSA. This finding was compatible with several studies [10–12]. Median nerve CSA was correlated to BCTQ values, previous studies showed positive association between ultrasound and other methods to diagnose CTS including the BCTQ score [13]. Ultrasound detected CTS in 21.5%, while BCTQ detected CTS in 14.2% indicating the ability of neurosonology to detect subclinical cases. Aktürk et al. stated that the CSA correlates to BCTQ severity and functional disability [14]. Despite higher BCTQ scores among females, there was no significant difference between both sexes regarding CSA. Both sexes, when adjusting the number and workload, they would present almost equally with CTS [15]. Cazares-Manríquez et al. mentioned that CTS is a work-related disorder almost equally among both sexes despite higher women sensitivity to describe their symptoms [16]. Our results showed that there was significant difference regarding BCTQ between both medical and non-medical group. The higher score of BCTQ in the medical group could be explained by the number of females in this group which are more sensitive to pain and express

Table 4 Comparison between participants with abnormal median nerve CSA regarding clinical characteristics

		Mild (No. = 47)	Moderate (No. = 7)	Severe (No. = 5)	Kruskal–Wallis/Chi*	Mild vs moderate	Mild vs severe	Moderate vs severe
		Mean rank/ number (%)	Mean rank/ number (%)	Mean rank/ number (%)	*p*	*p*	*p*	*p*
Age		29.26	22.29	47.80	**0.032****	0.290	**0.018****	**0.032****
Gender	Male	11(23.4%)	2(28.6%)	1(20%)	0.936*			
	Female	36(76.6%)	5(71.4%)	4(80.0%)				
Occupation	Medical	21(44.7%)	5 (71.4%)	3(60.0%)	0.368*			
	Non-medical	26 (55.3%)	2 (28.6%)	2(40.0%)				
Median nerve CSA by US (mm^2)		24.00	51.00	57.00	**< 0.001****	**< 0.001****	**< 0.001****	**0.003****
BCTQ		27.79	36.57	41.60	**0.103**			

CSA cross sectional area, *US* ultrasound, *BCTQ* Boston carpal tunnel questionnaire

*Chi test

***p* value is significant if < 0.05

Table 5 Linear regression analysis

	Unstandardized coefficients		Standardized coefficients beta	*t*	Sig.	Collinearity statistics	
	B	Std. error				Tolerance	VIF
Age	0.065	0.012	0.292	5.426	**< 0.001***	0.975	1.026
BCTQ	0.249	0.039	0.341	6.339	**< 0.001***	0.975	1.026

Dependent variable; Median nerve diameter by US

**p* value is significant if < 0.05

more symptoms. CTS is a common condition, resulting not only in impaired quality of life, but also in a significant financial burden to the health system [17]. This study had some limitations as we did not correlate clinical and ultrasound findings with electrophysiological studies and most of the participants were females (74.5%).

Conclusions

The prevalence of CTS diagnosed by US among hospital workers was 21.5%. Age and BCTQ were positively correlated to median nerve CSA. CTS can represent a burden among hospital workers so it is recommended to screen for the presence of CTS to lessen such burden. Ultrasound can be used as a noninvasive diagnostic tool for screening for CTS.

Abbreviations

BCTQ: Boston carpal tunnel questionnaire; CSA: Cross sectional area; CTS: Carpal tunnel syndrome; US: Ultrasound.

Acknowledgements

Not applicable.

Authors' contributions

MF: designed and conceptualized the study, drafting the manuscript, performing the Ultrasound. AS: conception of the work and manuscript revision. IH: acquisition and statistical analysis of data. AA: conception of the work, data collection, drafting the manuscript. All authors have agreed to conditions noted on the Authorship Agreement Form. The content of the manuscript has not been published, or submitted for publication elsewhere. All authors read and approved the final manuscript.

Funding

No funds were received to fulfill this work.

Availability of data and materials

The corresponding author takes full responsibility for the data, has full access to all of the data; and has the right to publish any and all data separate and apart from any sponsor.

Declarations

Ethics approval and consent to participate

All procedures performed in the study were in accordance with the ethical standards of the faculty of medicine, Ain Shams university research and ethical committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. We obtained approval from research ethics committee no. FWA 000017585. On 15/10/2020. Written informed consent was obtained from participants for participation. We obtained approval from research ethics committee no. FWA 000017585. On 15/10/2020.

Consent for publication

Not applicable.

Competing interests

None of the authors has any competing interest.

Received: 10 March 2021 Accepted: 9 September 2021
Published online: 23 September 2021

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