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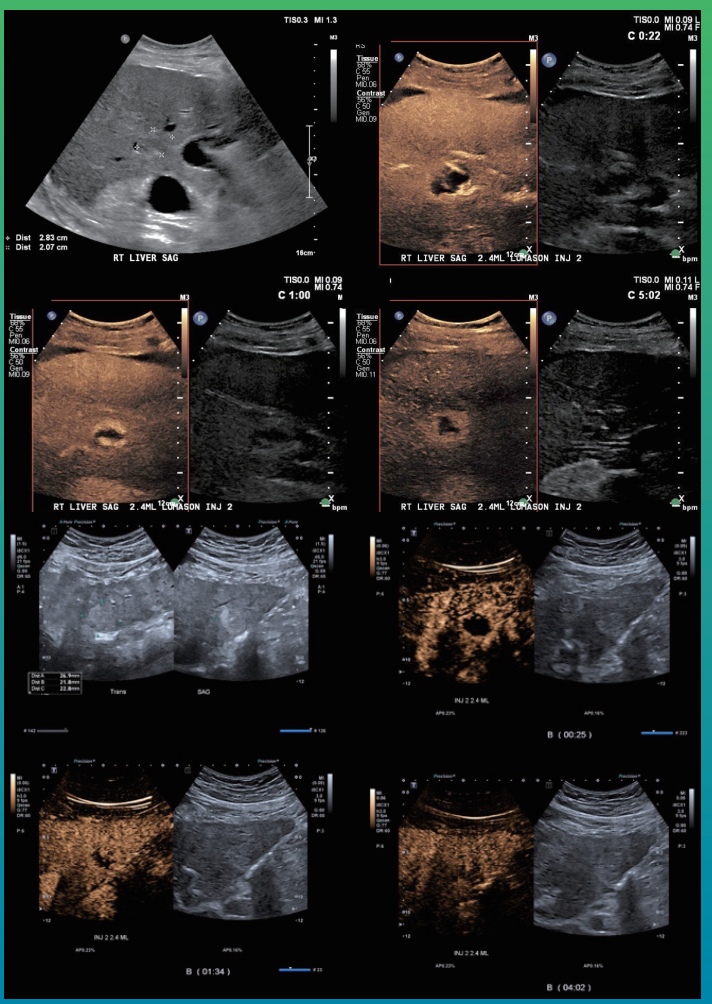

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Case Reports

ORIGINAL RESEARCH

Evaluation of the Effect of Age on Median Nerve Cross-sectional Area: A Cross-sectional Study

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Objective: This cross-sectional study was designed considering disagreements on the normal range of Median Nerve Cross-Sectional Area (MNCSA) and its association with age.

Methods: In this cross-sectional descriptive study, the upper limbs of 98 healthy subjects (46 men and 52 women) were assessed bilaterally by sonography, and MNCSA was measured at the distal wrist crease.

Results: Mean MNCSA values for subjects older and younger than 40 were 11.25 mm^2 and 10.21 mm^2, respectively. The results showed that the MNCSA significantly increased after 40 years of age.

Conclusion: According to the present study's findings, advances in age can increase the MNCSA and affect the diagnostic accuracy of MNCSA measurement in CTS diagnosis.

Key words: Median nerve cross-sectional area; Sonography; Age

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Carpal tunnel syndrome (CTS) is a compressive neuropathy caused by entrapment or compression of the median nerve inside the carpal tunnel [1].

A passageway in the palmar wrist, carpal tunnel, or carpal canal is composed of wrist bones dorsally and flexor retinaculum ventrally. Tendons of flexor digitorum superficialis and profundus and the median and ulnar nerve, are embedded in a common sheet. Since the canal is a narrow structure, even small swellings in these tendons can result in median nerve entrapment and the development of carpal tunnel syndrome.

In recent years, diagnostic musculoskeletal ultrasonography has become more popular. CTS diagnosis is made clinically but confirmed by other tests, of which electrodiagnosis is the most reliable. In this regard, sonographic evaluation of nerves- particularly of the median nerve at the wrist for diagnosis of CTS - has been considerable. Providing anatomical information through high-resolution images and being noninvasive and less time-consuming, are advantages of this method over the routine method of electrodiagnosis. Sonographic objectives favoring the presence of CTS include: increased Median Nerve Cross-Sectional Area (MNCSA), flattening of the nerve, and bowing of flexor retinaculum [2]. Despite some controversies on the precise location, MNCSA seems to be the most reliable measure in sonographic diagnosis of CTS [3-6]. In a study by Rayegani et al., measuring MNCSA at the wrist was a fairly sensitive method for CTS diagnosis [7]. Normal ranges for MNCSA at the distal wrist crease vary among reports, ranging from 7.2 to 9.8 mm^2 [8-12].

The MNCSA can be affected by factors such as age, gender, Body Mass Index (BMI), height, and underlying diseases like diabetes mellitus and rheumatoid arthritis [13-17]. The present study was designed to evaluate the association between age and MNCSA.

Methods

A total of 98 healthy subjects (46 men and 52 women) enrolled in this cross-sectional descriptive study. Participants were selected from individuals without signs

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or symptoms of median nerve compromise who attended university-affiliated hospitals. The study was evaluated and approved by the university ethics committee. All participants gave informed consent. Age ranging from 18 to 70 and absence of diseases or risk factors that raise the possibility of affecting the median nerve were considered as inclusion criteria. Exclusion criteria were as follows: the presence of CTS signs or symptoms, history of diabetes or rheumatological diseases, history of previous wrist fracture, pregnancy, and cervical radiculopathy. Demographic characteristics, including age and sex, were obtained. An ultrasonographic study was performed by a physical medicine and rehabilitation specialist expert in musculoskeletal sonography. The ultrasound device was a Philips HD6 with a 3-12 MH linear probe. Median nerves at both wrists were evaluated. To obtain images, subjects sat in front of the practitioner with their forearm resting in supination, wrist in neutral position, and fingers semi-flexed. The probe was positioned at distal wrist crease in a transverse orientation to detect the median nerve. The cross-sectional area of the nerve was measured by tracking the nerve margin with a sonography caliper (Fig. 1). The intersection of hypoechoic nerve fascicles and hyperechoic nerve sheet was considered the nerve margin. Measurements were repeated three times, and mean values were recorded as the final result. To assess the impact of age, we categorized the participants into two groups: older and younger than 40.

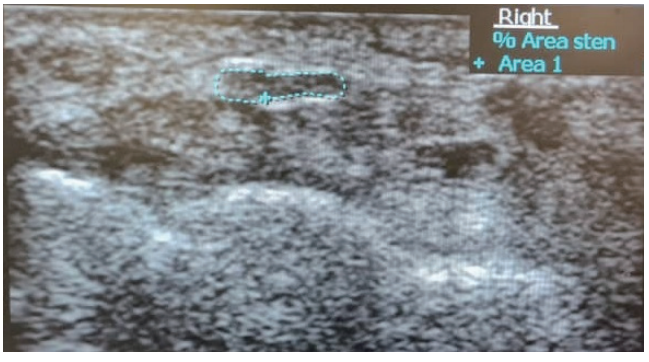

Figure 1 Measuring MNCSA at distal wrist crease. Dotted line: median nerve

Statistical Analysis

Data analysis was performed using SPSS 21 software. Quantitative data were described as mean ± SD, and qualitative data were shown as frequency and percentage. T-test, Mann-Whitney, and ANOVA were used to assess qualitative data.

Results

Data from 196 hands of 46 men and 52 women (a total of 98) were analyzed. The mean age of subjects was 41 years, which lay in a range of 19-63. Median nerve CSA was measured at the level of the distal wrist crease. The mean MNCSA value was 10.71 mm^2. Detailed results are presented in Table 1.

Participants comprised 50 individuals older and 48 younger than 40. MNCSA values were 11.25 mm^2 and 10.21 mm^2 for subjects older and below 40 years, respectively. The results showed that CSA is significantly increased in ages above 40 (Table 2).

Table 1 Mean median nerve cross-sectional area (MNCSA) values

Item	Mean (SD)	Minimum- maximum
Right	10.67 (2.04)	6.50-15.40
Left	10.76 (2.09)	6.20-16.00

SD, standard deviation

Table 2 Correlation between age and median nerve cross-sectional area (MNCSA)

Item	Below 40 (n = 48) Mean (SD)		Above 40 (n = 50) Mean (SD)	
	Right	Left	Right	Left
	10.23 (2.08)	10.20 (2.08)	11.14 (1.90)	11.36 (1.94)
P value	0.020		0.005	

SD, standard deviation

Discussion

In this cross-sectional descriptive study on 98 healthy participants, MNCSA was measured bilaterally at the level of the distal wrist crease. The mean value of MNCSA was 10.71 mm^2, which was shown to be significantly greater in subjects older than 40. The normal range of MNCSA is highly controversial in the literature. A broad range of 8.5-15 mm^2 is reported as the normal MNCSA range [18-26]. Considering the effects of age, this disputation can increase even more.

In a study by Bathala et al., the mean MNCSAs ± SD at the distal wrist crease was 7.2 ± 1 mm^2, which increased with advancing age ($P < 0.002$) [27]. Compared to the results of our study, the mean MNCSA was smaller in the mentioned study. This difference can be due to the wider age range of participants, sex distribution, and even ethnic differences.

In another study by Kang et al., the mean MNCSA was significantly larger in males and females in their 30 s compared to those in their 20 s. This study's results demonstrated that the MNCSA of the participants in their 20 s was 6.88-7.38 mm^2 in the male group and 5.69-6.99 mm^2 in the female group. MNCSA of individuals in their 30s was 6.32-8.89 mm^2 in the male group and 6.15-7.17 mm^2 in the female group, respectively [28].

In a study on 349 Japanese participants, there was a significant difference in CSA between women in their sixties and those who were younger (P = 0.02) [29]. In their study, Alsop Loh et al. found that aging increases MNCSA [30].

Bae et al. evaluated MNCSA in different age groups. According to their categorization, subjects were assigned to a younger group (20-40 years, n = 40), a middle group (40-59 years, n = 40), and an older group (60-80 years, n = 27). A significant difference in CSA values at wrist level was found between age groups (P = 0.003) [31].

There is consensus on the effect of aging on MNCSA at the wrist but not at other sites. However, Ito et al. found a significant correlation between MNCSA at the tunnel inlet and age (r = 0.501, P < 0.001). Their results demonstrated no significant correlation at mid-forearm [32].

Since the main application of MNCSA measurement is CTS diagnosis, age-related changes can affect the diagnostic accuracy of MNCSA measurement and need to be considered when diagnosing CTS based on MNCSA-especially in the elderly population. Since significant changes in MNCSA are more likely to occurat higher age, the authors of this study decided to regard 40 as the critical point.

Considering the lack of age-adjusted MNCSA cut-off points, it might be helpful to compare sonographic results with other diagnostic tests, such as electrodiagnosis and clinical signs and symptoms in this group of patients. Further studies with more detailed results are needed to determine precise cut-off points for different age groups.

The present study has several limitations, the first of which is a small sample size. Secondly, our categorization was not detailed. For more concise results, it was preferable to categorize subjects into 10-year age groups. This problem was raised due to the small sample size since breaking down the participants into more groups led to a smaller number of cases in each group and prevented reaching significant results. The other limitation was that we measured MNCSA only at one site. Results would have been more robust if we had measured CSA in different sites of the wrist and forearm.

Conclusion

According to the present study's findings, advances in age can increase MNCSA and affect the diagnostic accuracy of MNCSA measurement in CTS diagnosis. Further studies are needed to define the normal range of MNCSA in different age groups more precisely.

Conflict of Interest

The authors have no conflict of interest to declare.

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