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HIGH RESOLUTION ULTRASOUND OF FASCICLES IN THE ULNAR AND MEDIAN NERVES

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ABSTRACT

Background: The objective of this work is to study the nerve fascicles of the ulnar and median nerves at two predetermined sites bilaterally. **Methods:** Twenty seven healthy volunteers underwent imaging of the median nerve and ulnar nerves at the wrist and the forearm bilaterally. **Results:** The mean fascicular number of the median and ulnar nerves were estimated (two sites for each nerve). Demographic factors did not correlate positively with the fascicular number. Cross sectional area correlated positively with the fascicular number at four sites. **Conclusions:** The results of this study could be used in the diagnosis of different diseases involving the nerve fascicles, especially Charcot-Marie Tooth.

KEYWORDS: Ultrasound, median nerve, ulnar nerve, fascicles.

Abbreviations: CSA, cross-sectional area; BMI, body mass index.

INTRODUCTION

High resolution ultrasound is a rapidly developing diagnostic imaging modality for the diagnosis of different peripheral nerve disorders. Over the last two decades it has been used as a simple, relatively cheap tool, in addition to electro-physiological assessment, especially if compared to magnetic resonance imaging. Its dynamic ability together with the possibility of comparison to the other side gave it additional privilege for diagnosis of a variety of pathologies, including focal and diffuse diseases, together with neoplastic and non-neoplastic lesions.[1-3] The nerve cross sectional area (CSA), is the most frequently used measurement for diagnosis of nerve pathology. Most studies were performed in adults, fewer considered children.[4-6] The rapid development of this modality, mandated the use of additional criteria other than the CSA. In our study we consider studying the nerve fascicles. Few studies in literature considered the nerve fascicles.

Nerve ultrasound is well known to be useful in the diagnosis of some diseases which involve the nerve fascicles. Further studies of the number of fascicles and pattern of involvement could affect disease management in the future. The purpose of this study is to study of the fascicles of the median and ulnar nerves by a high resolution 18 MHZ probe.

METHODS

Participants

The local institutional review board committee approved the study protocol and all participants provided an informed consent before enrollment. Twenty seven healthy adult volunteers, 19 to 60 years old, were recruited from January 2016 to April 2016, at a university hospital. For each participant, age, height, weight and body mass index (BMI) were recorded before ultrasound scanning, The participants were free of any diseases related to neuromuscular system, as indicated by history taking and clinical examination.

Technique

The ultrasound scanning of the median and ulnar nerve was carried out using Philips ultrasound diagnostic scanner, (Epic 7 version 1.5, Ultrasound system: Philips, Bothell, USA) using a L18-5 MHZ linear transducer. All studies were performed by two examiners, the first (M.B.) with 11 years experience in neuromuscular ultrasound and results reviewed by another sonographer, with 4 year experience in neuromuscular sonography. Each exam was performed three times, bilaterally to assess for intrarater reliability. In order to avoid anisotropy, the probe was positioned perpendicular to the scanned nerve. In each subject 4 sites were scanned [8 bilaterally].

The median nerve was scanned at two predetermined sites, with the elbow in a flexed position, examination was done in the palmar aspect, first site was inside the carpal tunnel level, the second site was 10 cm proximal

to the wrist. The ulnar nerve was also scanned at two sites, with the elbow in a flexed position, and the forearm supinated, the first site was at the Guyon's canal between the ulnar artery and the pisiform bone, the second site was 10 cm above the wrist in the forearm (Figure 1). The cross sectional area at each scanned site was measured by circumferential tracing inside the hyperechoic rim of each nerve (Figures 1,2,3 and 4). Each nerve was made its anatomical site as mentioned above and by identification of the fascicular pattern and honey comb appearance. Images and results were saved by the picture archiving system and analyzed.

Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 21 software (SPSS Inc., Chicago, IL, USA). All data were presented as mean ± standard deviation (SD) and range. The mean CSA were compared between both sides using Wilcoxon signed rank test. The correlations between the CSA of the scanned nerves; age, weight, height and BMI were evaluated using Pearson's correlation coefficient (r). A *P* value of < 0.05 was considered significant.

RESULTS

During the recruitment period we studied 27 healthy adult volunteers, 8 males, 19 females, with a mean age of 33.6 ± 10 years (range: 19 –60). The mean height was 161 cm ± 9.2 (range: 146-179) and weight 67.2 kg±14.9 (range 44-102.5). The mean BMI was 26 kg/m^2 ± 6.1.

The mean fascicular diameter was estimated as follows: The median nerve at the carpal tunnel (11.64), the median nerve at the forearm (7), the ulnar nerve at Guyon's canal (5.2), and the ulnar nerve at the forearm (5.89). The interrater reliability calculations showed an overall intraclass correlation coefficient of 0.80.

We compared the CSA values of the eight scanned sites at the right and left sides, no significant differences were noted. No statistical difference could be noted between both sexes regarding the fascicular number. Age, weight, height and BMI showed no significant statistical correlation with fascicular number. Positive statistical correlation was noted between the CSA and the fascicular number in the following sites: The right median nerve at the forearm, the right ulnar nerve at the Guyon's canal, the left median nerve at the carpal tunnel and the left median nerve at the forearm. The mean fascicular number of scanned nerves is demonstrated in Table 1. The statistical correlation of each nerve CSA with its fascicular number is shown in Table 2.

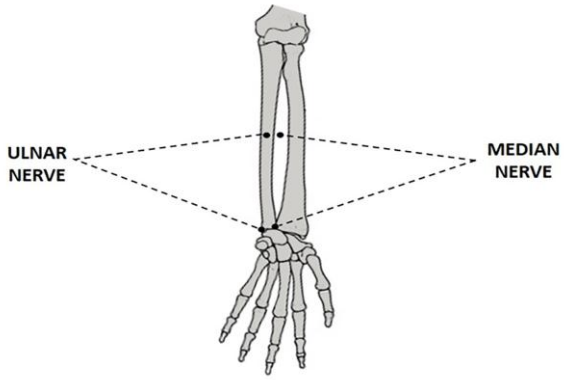

Figure 1: Diagram for sites of scanning of the median and ulnar nerves at our study.

Figure 2: Short axis high resolution ultrasound scan of the median nerve fascicles at the wrist.

Figure 3: Short axis high resolution ultrasound scan of the median nerve fascicles at the forearm.

Figure 4. Short axis high resolution ultrasound scan of the ulnar nerve fascicles at the Guyon's canal.

Figure 5. Short axis high resolution ultrasound scan of the ulnar nerve fascicles at the forearm.

TABLE 1: Correlation between nerve cross sectional area and fascicular number.

	RT MN CT	RT MN FA	RT UN FA	LT MN CT	LT MN FA	LT UN FA	RT UN GUY	LT UN GUY
Mean Fascicular Number	11.8	7.19	5.85	11.48	6.89	5.93	5.74	4.74
Range	8-17	5-13	4-9	6-20	4-11	4-10	3-8	3-8

RT = RIGHT, LT = LEFT, MN = MEDIAN NERVE, UN = ULNAR NERVE, FA= FOREARM, GUY= GUYON'S CANAL.

TABLE 2: Correlation between nerve cross sectional area and fascicular number.

	RT MN CT	RT MN FA	RT UN FA	LT MN CT	LT MN FA	LT UN FA	RT UN GUY	LT UN GUY
Pearson Correlation	0.122	0.428*	0.103	0.667**	0.499**	0.308	0.468*	0.275
P Value	0.544	0.26	0.610	0.000	0.008	0.117	0.014	0.196

* significant at 0.05 ** significant at 0.01

RT = RIGHT, LT = LEFT, MN = MEDIAN NERVE, UN = ULNAR NERVE, FA= FOREARM, GUY= GUYON'S CANAL.

DISCUSSION

Over the past two decades many research projects considered studying the cross sectional area of peripheral nerves, however only few studies dealt with the nerve fascicles. In our study we estimated the fascicular number for two important upper extremity peripheral nerves (the median and ulnar nerves) at two predetermined sites (total 8 sites bilaterally). The CSA and fascicular number were estimated for the scanned nerves by an 18 MHz linear transducer. The mean fascicular number did not correlate statistically with the demographic factors. The CSA and the fascicular number correlated positively at four out of 8 sites. Three studies were found in literature considering high resolution sonography of the peripheral nerve fascicles. The first in 2004, by Jacob et al,[7] who studied the ulnar nerve at the level of the medial epicondyle, by multiple linear transducers, the highest was 13 MHz, however, they only studies the division of the ulnar nerve into two or three fascicles only without further count. The second study was by Bedewi et al,[8] who considered the fascicular number of the ulnar nerve by a 13 MHz linear transducer (which is comparable to our transducer), however, this study scanned the ulnar nerve only at the level of the medial epicondyle, which is different from our scanned sites.

The third study was by Cartwright et al,[9] who reported a mean fascicular number of 22.68 for the median nerve at the wrist (single site), and found no correlation with the demographic factors, however, the results obtained by Cartwright et al study cannot be compared to our study since their study used a recently approved 70 MHz transducer (compared to 18 MHz at our study). Magnification of the median nerve before measuring the cross sectional area was another attempt in the same path of better visualization of the detailed sonoanatomy of the peripheral nerves, done at 2015 by Jesling et al.[10] Some diseases like Charcot- Marie- Tooth, are well known to cause fascicular enlargement and hence associated overall increase in the CSA, others like inflammatory demyelinating polyneuropathy especially in the chronic form could also benefit to a lesser degree.[11,12] Assessment of the fascicular integrity in post traumatic nerve injuries is also promising. In conclusion, we believe that studying the individual nerve fascicles by high resolution ultrasound could improve the diagnosis of some important acquired and congenital diseases. Further studies considering the nerve fascicles should be conducted with the same probe frequency to compare their results with ours. Also we recommend extension of new studies to include other important upper extremity nerves like the radial and musculocutaneous nerves.

Study limitations

Several limitations are noted at the current study. First the sample size is small. Second, only two raters were included for inter-rater reliability, we suggest addition of a third rater for future studies. Third, only two sites were included for each nerve, the addition of more sites along the course of the whole nerve would be more informative.

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