CONCISE REPORT

Ultrasonographic measurement of the median nerve in patients with rheumatoid arthritis without symptoms or signs of carpal tunnel syndrome

Hilde Berner Hammer, Espen A Haavardsholm, Tore Kristian Kvien

Ann Rheum Dis 2007;66:825–827. doi: 10.1136/ard.2006.055988

Objectives: Ultrasonography (US) has shown increased cross-sectional area of the median nerve in carpal tunnel syndrome (CTS). Knowledge of the normal distribution of the areas is a prerequisite to evaluate pathology. Presently, the distribution of cross-sectional areas of the median nerve was explored in patients with rheumatoid arthritis (RA).

Methods: The median nerves of patients with RA having no symptoms or signs of CTS were examined with bilateral US at the entrance of the carpal tunnel.

Results: A total of 154 patients with RA were included. The median nerve was divided in 11.7% of the hands. The mean (SD) cross-sectional areas of the undivided median nerves were not significantly different on either sides (8.3 (1.5) mm² on the right side and 8.3 (1.4) mm² on the left side). The areas of the examined 308 median nerves ranged from 5.0 to 12.8 mm², with the 97.5 centile being 11.1 mm². Areas >10.0 mm² were found in 10% of the patients.

Conclusions: The mean cross-sectional areas of the median nerve in patients with RA were similar to those reported in healthy controls. However, 10% of the patients had values that overlap with areas commonly reported in patients with mild idiopathic CTS.

Ultrasonography (US) has shown increased cross-sectional areas of the median nerves in patients with carpal tunnel syndrome (CTS).^{1–9} Various US measurements may be used to measure pathology in the median nerve. The cross-sectional area at the entrance of the carpal tunnel seems to have the highest diagnostic sensitivity and specificity for CTS.^{2–6–10} In healthy controls, the mean (SD) cross-sectional area of the median nerve at this level has been found to be between 7.0 (1.0) mm² and 10.2 (2.5) mm².^{7–10} Areas of 10.0–13.0 mm² have been reported in patients with mild symptoms due to idiopathic CTS, 13.0–15.0 mm² represented symptoms of moderate CTS and areas >15.0 mm² were found in patients with severe idiopathic CTS.¹¹ We have previously found that patients with arthritis and CTS have an increase of similar magnitude in cross-sectional areas of the median nerve as observed in idiopathic CTS.¹²

CTS is a common condition in patients with rheumatoid arthritis (RA), but the normal cross-sectional area of the median nerve in patients with RA, without any signs and symptoms of CTS, has not been evaluated. RA is a systemic disease, and inflammatory activity may affect the area of the nerves. The aim of the present study was to explore the distribution of the cross-sectional areas of the median nerve in patients with RA who have no symptoms or signs of CTS, to ascertain the normal distribution is a prerequisite for a US-based diagnosis of CTS.

METHODS

Patients

Approximately half of the patients were recruited from a cohort of recent-onset RA (n = 75, with a disease duration of <1 year), whereas the other 79 patients had established disease with a mean (SD) disease duration of 11.9 (8.2) years. The patients were thoroughly interviewed for symptoms of CTS. A total of 154 patients (118 women) with no symptoms of CTS, negative Tinel's test and no muscular atrophy were included in this analysis. All patients fulfilled the American Rheumatism Association 1987 revised criteria for RA.¹³ The mean (SD) age was 54.4 (13.8) years, mean (SD) duration of RA was 6.5 (8.2) years and current anti-inflammatory drugs were as follows: disease-modifying antirheumatic drugs (DMARDs), 59.7%; prednisolone, 51.9%; anti-tumour necrosis factor α treatment, 35.1%; and non-steroidal anti-inflammatory drugs including coxibs, 44.8%. Mean (SD) erythrocyte sedimentation rate was 24.1 (19.5) mm/h and concentration of C reactive protein was 13.9 (18.6) mg/l. The mean (SD) height was 179.3 (6.0) and 165.7 (6.7) cm for men and women, respectively; and the mean (SD) weight was 84.7 (12.3) and 67.6 (12.0) kg in men and women, respectively. Of the relevant comorbidities, four were treated for diabetes mellitus and 18 were substituted for hypothyroidism. The patients gave written consent and the study was approved by the local ethics committee.

US measurements

All the US measurements were performed by the same person (HBH). Patients were sitting with their forearm resting in a supinated position on a small table. The US probe (an 8–16 MHz linear array transducer, Diasus, Dynamic Imaging, Scotland, UK) was held as lightly as possible to avoid disturbing the anatomy of the nerve. The median nerve was examined at the entrance of the carpal tunnel, between the pisiform bone and the tubercle of the scaphoid bone, where the distal volar crease is an external pisiform landmark. A continuous trace was made just within the hyperechogenic boundary of the nerve. The cross-sectional area of the median nerve was calculated directly by the software of the US equipment. Each median nerve was measured three times, and the mean value was used for further analyses.

Statistics

Comparisons between the cross-sectional areas of the right and the left hand were performed using paired samples t test and differences between groups were analysed using independent samples t test. The average of the right and the left areas of the median nerve were used when exploring bivariate correlations to other variables (Pearson's correlation coefficients). Multiple linear regression analysis was performed to look for associations

Abbreviations: CTS, carpal tunnel syndrome; RA, rheumatoid arthritis; US, ultrasonography

Figure 1 (A) Normal median nerve, transverse (arrow). An artery is marked with an arrowhead. (B) Same nerve as in (A), with a continuous trace just within the hyperechogenic boundary of the nerve (arrow). (C) A normal median nerve, divided into two parts at the entrance of the carpal tunnel (arrows). An artery was located between the two parts (arrowhead).

Figure 2 The distribution of the cross-sectional areas of the median nerves in patients with rheumatoid arthritis without symptoms or signs of carpal tunnel syndrome.

with the cross-sectional area. All statistics were performed using the SPSS V.12.0 and a p value <0.05 was considered significant.

Results

A total of 136 patients with RA had a single median nerve at the entrance of the carpal tunnel, and the mean (SD) cross-sectional areas were not significantly different on either side (8.3 (1.5) mm^2 on the right side and 8.3 (1.4) mm^2 on the left side, $p = 0.79$). Only six of these patients had a dominant left side. The median nerve was divided at the entrance of the carpal tunnel in 11.7% of the hands; 35 nerves were divided into two parts, whereas one nerve was divided into three parts. Eight of the patients had divided nerves in both hands. When the areas of the parts were summed, the mean (SD) cross-sectional area was 7.7 (1.4) mm^2 , with no significant difference between the right and the left side ($p = 0.52$). However, these areas were significantly lower than the single nerves ($p = 0.02$). Figure 1 shows the US pictures of a single and a divided median nerve. The distribution of the cross-sectional areas for the total number of median nerves ($n = 308$) ranged from 5.0 to 12.8 mm^2 (fig 2). Table 1 gives the centiles.

We have previously performed a study of patients having arthritis and CTS.¹² When the cross-sectional areas of the median nerves from these patients were compared with the areas found in this study, highly significant differences were found ($p < 0.001$), with a median (range) area of 15.7 (11.1 – 12.8) mm^2 in the patients with CTS and a median (range) of 8.2 (5.0 – 12.8) mm^2 in this study population. Of the 308 median nerves examined presently, 8 (2.6%) had areas of 11.1 – 12.8 mm^2 , which overlapped with the previously studied patients with CTS.

The dominant hand was examined for synovitis using US, and a total of 48 (31.2%) patients were found to have arthritis in the radiocarpal joint. However, there was no significant difference in

Table 1 The centiles for the cross-sectional areas of the median nerve

Centiles	2.5	5	10	25	50	75	90	95	97.5
Right hand* (n = 136)	5.8	5.9	6.3	7.0	8.2	9.0	10.3	11.0	11.4
Left hand* (n = 136)	5.6	5.8	6.4	7.5	8.2	9.0	10.0	10.7	11.3
Both† (n = 308)	5.7	5.9	6.3	7.1	8.2	9.0	10.1	10.8	11.1

*Values only for single right or left median nerves.

†Values including single and divided nerves for both hands.

the cross-sectional area of the median nerve in the patients with arthritis compared with those without arthritis ($p = 0.31$).

Four patients were treated for diabetes mellitus, and the mean (SD) area of their median nerve was 8.4 (1.6) mm², whereas 18 patients treated for hypothyroidism had a mean (SD) area of 8.2 (1.3) mm². There were no significant differences in cross-sectional areas between these patients and the patients with RA without endocrinopathy ($p = 0.72$). In addition, for the whole study population, there was no significant difference in cross-sectional areas between patients using and not using prednisolone ($p = 0.61$).

The average area of the median nerves from either sides did not correlate significantly to height ($r = 0.16$), weight ($r = 0.17$), age ($r = 0.11$) or disease duration ($r = 0.01$). When a multiple, linear regression analyses was performed with the average cross-sectional area of the median nerve as the dependent variable, the independent variables—namely, height, weight, age, use of prednisolone and disease duration—were found to have no significant associations. In addition, height, weight, age, use of prednisolone and disease duration were not significantly different in patients with an average cross-sectional area >10 mm² ($n = 16$, 8 women) and patients with areas ≤10 mm². The cross-sectional areas were significantly higher ($p < 0.001$) in males ($n = 36$, mean (SD) 8.8 (1.3) mm²) than in females (mean (SD) 8.0 (1.4) mm²).

Discussion

In this study, the mean value of the cross-sectional areas of the median nerves in patients with RA were similar to those reported in healthy controls.^{1–12} Further, these values in patients with RA without any signs and symptoms of CTS were independent of age and disease duration, which supports the fact that the nerves do not change in size during a chronic inflammation.

In all, 10% of the patients had cross-sectional areas >10 mm², which is similar in size to patients with mild idiopathic CTS.¹¹ Whether these patients had abnormal findings in electrophysiological tests was not explored. However, the included patients had neither symptoms nor signs of CTS, and thus would not have been diagnosed as having CTS, even in the presence of electrophysiological abnormalities. It is however possible that the distribution of cross-sectional areas had been somewhat different if absence of both symptoms and clinical signs of CTS as well as neurophysiological abnormalities had been the inclusion criteria.

No significant correlation was presently found between the cross-sectional area of the median nerve and the weight. This supports the study by Werner *et al*¹⁴ who did not find any difference in cross-sectional areas between thin and obese asymptomatic individuals. In addition, these authors found a strong association between slowing of median nerve conduction across the wrist in asymptomatic subjects and increased size of the nerve, and also found that a significant number of asymptomatic obese patients met criteria for a median nerve mononeuropathy when analysed using nerve conduction.

In this study, the patients with RA with concomitant diabetes mellitus or hypothyroidism had a similar median nerve size as patients with RA without endocrinopathy. However, this study included only 22 patients with endocrine diseases, and more

patients are required to draw firm conclusions on the influence of these endocrine disorders on the normal range of values.

The main conclusion in this study is that the patients with RA without symptoms or clinical signs of CTS have a broad range of cross-sectional areas of the median nerves, with single nerves with a mean of 8.3 mm², and also that as much as 10% of the total number of nerves have an area between 10 mm² and 12.8 mm². When considering the values of patients with RA with CTS,¹² and the present findings, we suggest that areas <10 mm² indicate no nerve involvement, areas >13 mm² suggest a diagnosis of CTS in patients with symptoms, whereas additional analyses like neurophysiological tests may be required to reach a final diagnostic conclusion in patients with RA and CTS symptoms if they have areas between 10 and 13 mm².

Authors' affiliations

Hilde Berner Hammer, Espen A Haavardsholm, Tore Kristian Kvien, Department of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway
Competing interests: None declared.

Correspondence to: Dr H B Hammer, Department of Rheumatology, Diakonhjemmet Hospital Box 23, Vinderen, N-0319 Oslo, Norway; h-hammer@diakonsyk.no

Accepted 2 December 2006

Published Online First 14 December 2006

REFERENCES

- Ziswiler H-R, Reichenbach S, Vögelin E, Bachmann LM, Villiger PM, Jüni P. Diagnostic value of sonography in patients with suspected carpal tunnel syndrome: a prospective study. *Arthritis Rheum* 2005;**52**:304–11.
- Wong SM, Griffith JF, Hui AC, Lo SK, Fu M, Wong KS. Carpal tunnel syndrome: diagnostic usefulness of sonography. *Radiology* 2004;**232**:93–9.
- Yesildag A, Kutluhan S, Sengul N, Koyuncuoglu HR, Oyar O, Guler K, *et al*. The role of ultrasonographic measurements of the median nerve in the diagnosis of carpal tunnel syndrome. *Clin Radiol* 2004;**59**:910–15.
- Nakamichi K-I, Tachibana S. Ultrasonographic measurement of median nerve cross sectional area in idiopathic carpal tunnel syndrome: diagnostic accuracy. *Muscle Nerve* 2002;**26**:798–803.
- Wong SM, Griffith JF, Hui ACF, Tang A, Wong KS. Discriminatory sonographic criteria for the diagnosis of carpal tunnel syndrome. *Arthritis Rheum* 2002;**46**:1914–21.
- Swen WAA, Jacobs JWG, Bussemaker FEAM, de Waard J-WD, Bijlsma JWJ. Carpal tunnel sonography by the rheumatologist versus nerve conduction study by the neurologist. *J Rheumatol* 2001;**28**:62–9.
- Nakamichi K-I, Tachibana S. Enlarged median nerve in idiopathic carpal tunnel syndrome. *Muscle Nerve* 2000;**23**:1713–18.
- Lee D, van Holsbeeck MT, Janevski PK, Ganos DL, Ditmars DM, Darian VB. Diagnosis of carpal tunnel syndrome. Ultrasound versus electromyography. *Radiol Clin North Am* 1999;**37**:859–72.
- Buchberger W, Schön G, Strasser K, Jungwirth W. High-resolution ultrasonography of the carpal tunnel. *J Ultrasound Med* 1991;**10**:531–7.
- Duncan I, Sullivan P, Lomas F. Sonography in the diagnosis of carpal tunnel syndrome. *Am J Roentgenol* 1999;**173**:681–4.
- El Miedany YM, Aty SA, Ashour S. Ultrasonography versus nerve conduction study in patients with carpal tunnel syndrome: substantive or complementary test? *Rheumatology* 2004;**43**:887–95.
- Hammer HB, Hovden IAH, Haavardsholm EA, Kvien TK. Ultrasonography shows increased cross-sectional area of the median nerve in patients with arthritis and carpal tunnel syndrome. *Rheumatology* 2006;**45**:584–8.
- Arnett FC, Edworthy SM, Bloch DA, McShane DJ, Fries JF, Cooper NS, *et al*. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. *Arthritis Rheum* 1988;**31**:315–24.
- Werner RA, Jacobson JA, Jamadar DA. Influence of body mass index on median nerve function, carpal canal pressure, and cross-sectional area of the median nerve. *Muscle Nerve* 2004;**30**:481–5.