

## MR IMAGING OF THE WRIST IN CARPAL TUNNEL SYNDROME

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### Abstract

**Purpose:** To determine whether specific parameters measured on MR images correlated to electrophysiological changes in carpal tunnel syndrome (CTS).

**Material and Methods:** Prospective clinical examinations were made of 20 patients with suspected CTS. We performed bilateral electrophysiological examinations of the median nerve and bilateral MR imaging of the wrists.

**Results:** The electrophysiological examination suggested median nerve entrapment in 18 wrists. These wrists were compared to the remaining 22 electrophysiologically normal wrists. In addition, we compared both wrists in 12 patients with unilateral symptoms of CTS without reference to the electrophysiological findings. We found no difference in specific MR parameters between the 2 groups.

**Conclusion:** Neither symptoms nor electrophysiological findings in CTS were related to specific MR parameters.

**Key words:** Wrist, carpal tunnel syndrome; MR imaging.

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Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy of the upper extremity. The condition is characterized by paresthesia of the fingers in the distribution of the median nerve, pain radiating into the forearm and unreliability of grip. The symptoms are often pronounced at night and can be relieved by shaking the hand (7).

The diagnosis is traditionally based on the characteristic CTS symptoms and confirmed by nerve conduction studies. In recent years MR imaging has been used in several studies to describe the normal anatomy of the carpal tunnel (2, 4, 6) and a variety of parameters have been proposed to describe the morphological changes in CTS (1, 3, 5). In one study, a significant difference was found between wrists with median nerve entrapment and normal controls with regard to: median nerve swelling at the carpal tunnel entry; flattening of the median nerve within the carpal tunnel; and palmar bowing of the flexor retinaculum (3). In another study comprising 8 patients, the carpus/tunnel index was

higher in symptomatic wrists than in asymptomatic wrists (1). However, these MR parameters have not been used in larger series of cases with CTS or in studies with more powerful MR systems.

The aim of this study was to determine whether specific parameters measured on MR images correlated to electrophysiological changes in CTS.

### Material and Methods

Twenty patients (9 men and 11 women) with suspected CTS were studied prospectively. We excluded patients with diabetes mellitus, severe renal disease, pregnancy within the last year, previously treated CTS, or contraindications to MR examination. Electrophysiological examination of the median nerve was performed bilaterally in all patients. Three other peripheral nerves were also assessed in order to exclude polyneuropathy.

We used a 1.5 T Philips ACS-NT superconduc-

tive MR unit. Both wrists were examined in the transversal plane from mid-palm to distal radius. Two sequences were used. First a T1-weighted spin-echo (SE) sequence (TR/TE 535/19 SE/M, NSA 4, 30 slices of 3 mm with a gap of 0.3 mm, using a surface coil, flow compensation and a rectangular field, a matrix of 256/205 and a field of view of 140 mm, scanning time 8.03 min). Then a gradient echo volume sequence (TR/TE 34/20/flip angle 10° FFE/M, NSA 1, 50 slices of 1.5 mm with no gap, using a surface coil, flow compensation and a rectangular field, a matrix of 256/244 and a field of view of 140 mm, scanning time 4.09 min). The measurements were conducted on an EasyVision workstation.

To determine the size of the median nerve as it runs through the carpal tunnel, we measured the length of the major and minor axes of the median nerve at three levels: 1) at the level of the distal radius corresponding to the most proximal slice with joint cartilage; 2) at the level of the pisiform bone, corresponding to the slice with the maximum diameter of the pisiform bone; and 3) at the level of the hamate bone corresponding to the largest part of the hook of the hamate. At the same three levels, we determined the cross-sectional area of the median nerve. The MR images were assessed by one of the authors (L.B.) without knowledge of the symptoms or clinical/electrophysiological findings.

In parallel to other studies (1, 2, 3), we determined the swelling ratio, flattening ratio, bowing ratio, and a carpus/tunnel index (Figs 1 and 2). Two swelling ratios were calculated by dividing the cross-sectional area of the median nerve at the level of the pisiform bone and at the level of the hamate bone by that at the distal radius. The flattening ratios at the levels of the distal radius and pisiform and hamate bones were calculated by dividing the length of the major axis of the median nerve by that of the minor axis of the nerve at each level. In addition, we determined the length of a straight line (TH) between the attachments of the flexor retinaculum to the tubercle of the trapezium and the hook of the hamate. The length of a perpendicular line (PD) from the line TH to the palmar apex of the flexor retinaculum was also assessed. The bowing ratio was then calculated as PD/TH. To estimate the ratio between the cross-sectional area of the carpal tunnel and the general skeletal frame at the level of the hook of the hamate, we determined the length of a line (FH) between the inner aspect of the flexor retinaculum and the inner aspect of the carpal arch. Finally we determined the length of a line (C) between the external demarcation of the hamate and the trapezium. The carpus/tunnel index was then calculated

as C divided by the product of TH and FH ( $C/(TH \times FH)$ ). The Mann-Whitney test was used for statistical analysis. The level of significance was set at 5%.

The study was approved by the local ethical committee.

## Results

Of the 20 patients with symptoms of CTS, 8 had bilateral symptoms. Electrophysiological examination suggested median nerve entrapment in 18 wrists. These wrists were compared to the remaining 22 electrophysiologically normal wrists (Table). There was no difference between the two groups as regards swelling ratios, flattening ratios, bowing ratio, or carpus/tunnel index.

In addition, we compared both wrists in 12 patients with unilateral symptoms of CTS without reference to the electrophysiological findings. Again, no difference was found between the two groups as regards the MR findings.

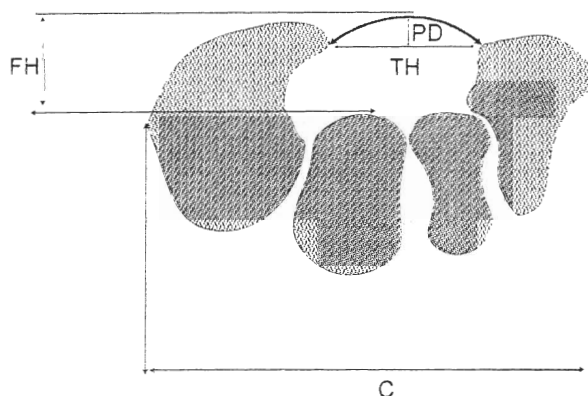


Fig. 1. Cross-section of the carpal tunnel at the level of the hook of the hamate bone. See text for explanations of PD, FH, TH, C.

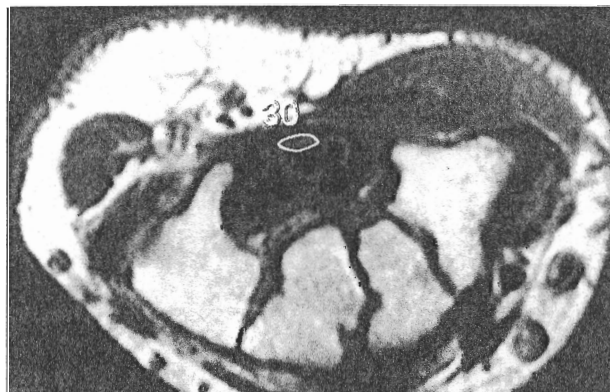


Fig. 2. Axial T1-weighted MR image at the level of the hook of the hamate bone. Calculated outline of the cross-sectional area of the median nerve (30).

**Table**  
*Comparison between MR findings and electrophysiological changes (ENG)*

MR parameters	Abnormal ENG		Normal ENG		
	mean	range	mean	range	
Swelling ratio (pisiform)	1.02	0.70–4.24	1.04	0.54–2.48	NS
Swelling ratio (hamatum)	1.04	0.36–3.58	1.10	0.56–1.93	NS
Flattening ratio (radius)	1.77	1.05–3.29	2.11	1.62–3.08	NS
Flattening ratio (pisiform)	2.48	1.27–3.79	2.28	1.48–3.85	NS
Flattening ratio (hamatum)	2.29	1.55–3.82	2.26	1.35–3.36	NS
Bowing ratio	0.11	0.05–0.29	0.10	0.06–0.14	NS
Carpus/tunnel index	0.24	0.17–0.39	0.26	0.18–0.39	NS

### Discussion

Our study showed no correlation between electrophysiological abnormalities and the specific MR parameters in CTS. This observation is in accordance with a previous study that also compared electrophysiological examinations and MR findings but without the use of the specific parameters in MR assessment (9).

In our study, we used wrists with normal electrophysiological properties as the control group but did not study totally asymptomatic subjects. However, severe entrapment of the median nerve hardly ever occurs in wrists with normal median nerve conduction velocities and therefore signs of nerve compression in MR images are not likely in these cases. Furthermore, the MR comparison between symptomatic and asymptomatic wrists with no reference to the electrophysiological findings confirmed the view that there was no difference between the two sides.

The pathophysiology of CTS is believed to be complex and also to include variable pressure within the carpal tunnel and transient episodes of compression-induced ischaemia of the median nerve (8). CTS is thus not exclusively the consequence of a simple narrowing of the carpal tunnel. This may explain the fact that no relation was found between the anatomy of the carpal tunnel and the function of the median nerve, as evaluated by electrophysiological tests.

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