

# Magnetic Resonance Imaging Findings in Carpal Tunnel Syndrome

## *Karpal Tünel Sendromunda Manyetik Rezonans Görüntüleme Bulguları*

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### BACKGROUND

To describe the magnetic resonance imaging (MRI) findings in carpal tunnel syndrome (CTS).

### METHODS

Study included 44 patients with CTS and 18 healthy volunteers. Axial and coronal T1, T2 weighted images were obtained by 1.5 T MR scanner and diameter of median nerve, palmar bowing of flexor retinaculum, flattening of median nerve, increased signal intensity in median nerve, flexor tenosynovitis, loss of deep palmar fat and deep palmar bursitis were evaluated.

### RESULTS

Magnetic resonance imaging findings of 74 wrists with CTS and 36 normal wrists were compared. Statistically significant differences were detected between two groups for median nerve swelling, increased palmar bowing of flexor retinaculum, increased signal intensity in median nerve and decreased deep palmar fat.

### CONCLUSIONS

Morphological changes in the wrist detected by MRI can be helpful in the diagnosis of CTS.

Key words: Carpal tunnel syndrome; magnetic resonance imaging; wrist.

### AMAÇ

Karpal tünel sendromunda (KTS) manyetik rezonans görüntüleme (MRG) bulgularını tanımlamak.

### YÖNTEM

Çalışmaya KTS tanısı almış 44 hasta ile 18 sağlıklı gönüllü dahil edildi. 1.5 T MR cihazıyla aksiyel ve koronal T1, T2 ağırlıklı görüntüler alınarak; median sinirin çapı, fleksör retinakulumun yaylanması, fleksör tenosinovit, derin palmar yağ miktarı kaybı, median sinirde sinyal artışı ve derin palmar bursit parametreleri değerlendirildi.

### BULGULAR

Karpal tünel sendromu tanılı 74 bilek ile 36 normal bileğin MRG bulguları karşılaştırıldı. İki grup arasında, median sinir çapı, median sinir sinyal artışı, fleksör retinakulumda yaylanma ve derin palmar yağ dokusu miktarı kaybı bulgularında istatistiksel olarak anlamlı farklılık saptandı.

### SONUÇ

El bileğinde meydana gelen morfolojik değişikliklerin MRG ile saptanması KTS tanısının konulmasına yardımcı olmaktadır.

Anahtar sözcükler: El bileği; karpal tünel sendromu; manyetik rezonans görüntüleme.

Carpal tunnel syndrome (CTS) is a common neuropathy caused by compression of the median nerve. The syndrome is characterized by pain and discomfort in the wrist and the hand accompanied by paresthesia at the distribution of median nerve and atrophy of the thenar muscles. Its incidence is 1% in the general population and it is usually observed between 4th and 6th decades with a female to male ratio of 2-5:1. Many systemic and intra-tunnel causes have been described in the etiology.<sup>(1)</sup>

Magnetic resonance imaging (MRI) is frequently used for evaluation of the wrist pathologies other than CTS. Recently, MRI is being increasingly employed in the evaluation of CTS and some specific MRI findings have been described.<sup>(2,3)</sup>

In this study we aimed to delineate the morphological changes in carpal tunnels of the CTS patients via MRI.

## METHODS

We have prospectively examined 74 wrists of 44 patients with CTS and 36 wrists of 18 volunteers (control group) by MRI. Patient group consisted of 40 females and 4 males aged between 22 and 64 years (mean age 41.4 years) and the control group consisted of 14 females and 4 males aged between 20 and 55 (mean age 35,4). One wrist was affected in 14 patients and both wrists in 30 patients. Most frequent symptoms were hand discomfort and paresthesia (especially nocturnal) which were determined in all CTS patients. Electromyographic (EMG) examinations of both groups were performed by AMPLAID EMG 14 unit and sensory and motor conduction rates of ulnar, radial and median nerves were measured. CTS was diagnosed if the sensory conduction latency of median nerve was 0.32 msec or longer than the ulnar nerve. EMG was accepted as the gold standard in the diagnosis of CTS for this study.

Magnetic resonance images that included T1 weighted images on coronal and axial planes and T2 weighted, FLASH sequences on axial plane were obtained by the wrist coil of a 1.5 T MRI unit (Magnetom Vision Siemens Medical System, Erlangen, Germany). The slices were 3 mm thick with 1 mm gap intervals; matrix size was 128x256 or 256x256; FOV was 125 mm and 2 excitations per slice were performed. MR images

were analyzed by two independent radiologists who were blinded for the symptoms and EMG findings. The following parameters (MRI signs of CTS) were analyzed: increase in median nerve size (measured at the level of pisiform bone), increase in signal intensity in median nerve (compared with adjacent muscles), palmar bowing of flexor retinaculum (anterior margin convexity), flattening of median nerve (loss of normal ovoid appearance at the level of hamate bone), decreased deep tendon fat, presence of flexor tenosynovitis and deep palmar bursitis.

Sensitivity and specificity for each finding was calculated and the ratio of MRI findings in each group was analyzed by chi-square test. Results of each group were compared by student-t test. The study protocol was approved by the local ethics committee and informed consents of all volunteers were obtained before the study.

## RESULTS

The mean size of median nerve was 1.6 mm  $\pm$  0.2 (upper limit of normal: 2.0 mm) and palmar bowing of flexor retinaculum was 0.5 mm  $\pm$  0.7 (upper limit of normal: 1.9 mm) in the control group with normal EMG. Increased signal intensity in the median nerve was detected in 8 wrists, increased median nerve size was detected in 3 wrists, palmar bowing of flexor retinaculum was detected in 1 wrist, flattening of median nerve was detected in 7 wrists, decreased deep tendon fat was detected in 2 wrists and flexor tenosynovitis was detected in 6 wrists of the control group.

In patients with CTS, increased median nerve size was detected in 58 wrists, increased signal intensity of median nerve was detected in 47 wrists (Fig. 1), palmar bowing of flexor retinaculum was detected in 36 wrists (Fig. 2), flattening of median nerve was detected in 24 wrists (Fig. 3), decreased deep tendon fat was detected in 17 wrists and flexor tenosynovitis was detected in 18 wrists. In addition to these findings, a cystic lesion was determined in the carpal tunnels of three patients; a tumor expanding the tunnel was observed in one patient and extensor tenosynovitis was detected in two patients as the other few causes. Findings of the control and CTS group are summarized in Table 1 and sensitivity and specificity of the signs for CTS is listed in Table 2.

The findings of two groups were compared

**Table 1.** Prevalence of MRI Signs in CTS Patients and Non-CTS Cases.

MRI Signs	CTS Patients	Control Group
	No (%)	No (%)
Increased size of median nerve	58 (78.4)	3 (8.3)
Increased signal intensity in median nerve	47 (63.5)	8 (22.2)
Palmar bowing of flexor retinaculum	36 (48.6)	1 (2.7)
Flattening of median nerve	24 (32.4)	7 (19.4)
Flexor tenosynovitis	18 (24.3)	6 (16.6)
Decreased deep tendon fat	17 (22.9)	2 (5.5)

and increased size of median nerve, palmar bowing of flexor retinaculum and flexor tenosynovitis showed statistically significant difference between the two groups ( $p < 0.05$ ).

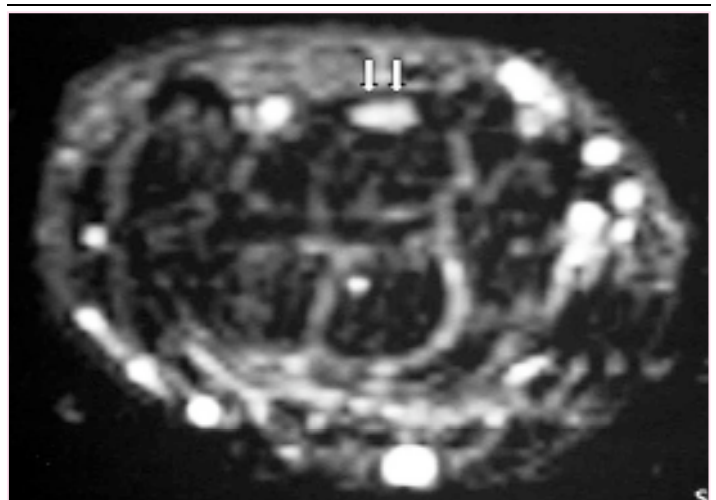
#### DISCUSSION

Carpal tunnel syndrome is an entrapment syndrome that is caused by chronic pressure on the median nerve within the carpal tunnel. The dominant hand is usually affected, but it may be bilateral in up to two-thirds of the patients.<sup>(4)</sup> Carpal tunnel contains flexor digitorum profundus (four) and superficialis (four) tendons, flexor pollicis longus tendon and the median nerve. It is surrounded by a rigid flexor retinaculum and the carpal bones posteriorly, thus any disorder that increases the size of the any content or decrease the volume of the tunnel leads to development of CTS.<sup>(4)</sup> EMG is the gold standard for the diagnosis of CTS whereas clinical findings are supportive.<sup>(4)</sup> However, changes in the wrist and the pathogenesis of CTS have not been clearly identified yet. Therefore, imaging of the carpal tunnel can help in planning of surgery (if necessary) or revealing the etiology.

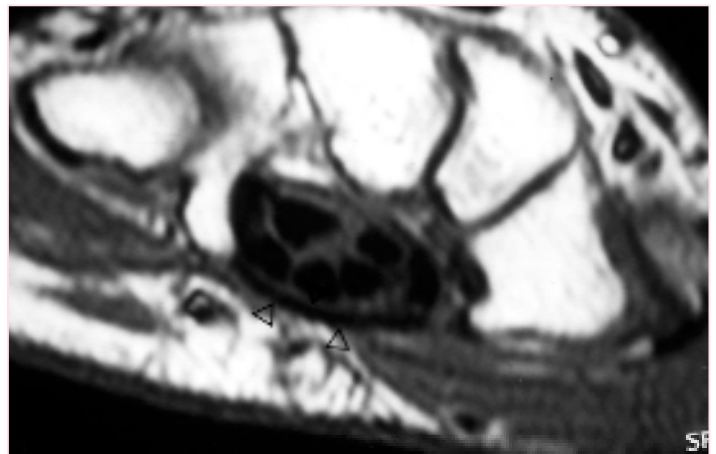
Median nerve was firstly visualized on sonography by Fornage.<sup>(5)</sup> Because the attenuation difference between the median nerve and other structures within the tunnel are very restricted, sonography is not sensitive enough to visualize the carpal tunnel. Computed tomography is also not sensitive enough for imaging of the carpal tunnel structures.<sup>(6)</sup>

Middleton et al.<sup>(7)</sup> has described the normal morphology of the carpal tunnel structures and the pathologic findings of CTS by MRI. Due to its high contrast resolution, MRI is the best imaging modality.

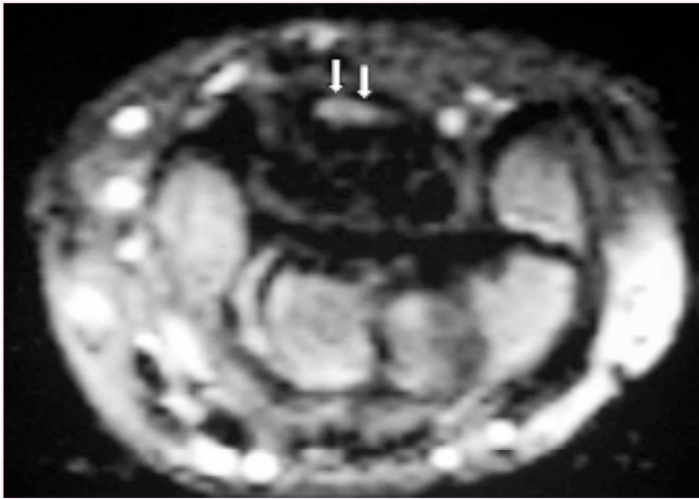
Increased size of the median nerve and palmar bowing of the flexor retinaculum were the most commonly reported findings of CTS by MRI and sonography.<sup>(8-10)</sup> In our study, we have also determined these two signs as the most frequent findings as well as the increased signal intensity of the median nerve which was the third commonest sign in our cases. High signal intensity in the median nerve was not a specific sign for CTS,<sup>(2)</sup> as it was also a common finding in the control group.



**Fig. 1.** Axial T2-weighted MR image obtained through carpal tunnel shows increased signal intensity in the median nerve.



**Fig. 2.** Axial T1-weighted MR image obtained through pisiform and hook of hamate shows palmar bowing (anterior convex margin) of flexor retinaculum.



**Fig. 3.** Axial T2-weighted MR image obtained through carpal tunnel shows flattening of median nerve along with increased signal intensity.

**Table 2.** Sensitivity and Specificity of MRI Findings in CTS.

MRI Signs	Sensitivity (%)	Specificity (%)	p
Increased size of median nerve	78.4	91.7	<0.01
Increased signal intensity in median nerve	63.5	77.8	>0.05
Palmar bowing of flexor retinaculum	48.6	97.3	<0.05
Flattening of median nerve	32.4	80.6	>0.05
Flexor tenosynovitis	24.3	83.4	>0.05
Decreased deep tendon fat	22.9	94.5	<0.05

Significance p<0.05.

Increased size of median nerve, palmar bowing of flexor retinaculum and flexor tenosynovitis were statistically significant signs in our study, the MRI signs other than these mentioned above (either described in literature or observed in our patients) are not specific enough to diagnose the CTS.

As for conclusion, although MRI is the best imaging technique for the examination of carpal tunnel, its findings are not specific for the diagnosis of CTS. It can be used to investigate the etiology of CTS, to decide for the therapeutic approach, or for follow up examinations.

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