FEASIBILITY OF SAGITTAL T2 MAPPING OF HUMAN MEDIAN NERVE FOR LOCALIZATION OF ABNORMAL REGION IN PATIENTS WITH CARPAL TUNNEL SYNDROME

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Introduction

The diagnosis of carpal tunnel syndrome (CTS) has been generally based on clinical features and electrophysiological data, however, localization of entrapment point in the median nerve and quantification in severity of the disease were difficult. Recent advanced MRI technology with use of dedicated microscopy coils has provided high-resolutional axial images of the wrist, and allowed quantification of CTS regarding signal intensity, thickness and cross-sectional area of the median nerve[1,2], and bowing of the flexor retinaclum [3]. Although some relationships between those measurements and clinical symptom were shown in previous studies, accurate detection of abnormal region along the median never was still difficult.

T2 measurement of water proton has potential for quantitative evaluation of neuropathy due to its high sensitivity of change in fluid dynamics and water content in the endoneurial compartment. We evaluated patients with CTS using T2 mapping of the median nerve at 3Tesla. Sagittal images of the median nerve were employed to improve detection of localized abnormal region, as compared with adjacent normal nerve region.

Materials＆Methods

Three patients with CTS (all women, aged 35, 50 and 80 years]) and one female healthy volunteer (28 years) were studied in a neutral position of the wrist. MR imaging were performed on the 3.0T MR imaging system (General Electric Signa HDx 3.0T scanner) using a dedicated microscopy surface single channel coil (50mm in diameter) fixed onto the wrist in prone position. 2D axial gradient echo images (TR/TE=667/20.0ms) were acquired for anatomical localization of the median nerve. T2sagittal maps were obtained using mono-exponential fit from 2D multi-spin echo sequences (TR=1500ms, 8 echoes between 10-80 ms, voxel size 0.15X0.15X1.0mm). Three ROIs at the carpal tunnel areas (ROI 1 to ROI 3) and one control ROI distal to the carpal tunnel area (ROI-C) with equal length were defined on the median nerve (Fig 1,2), and T2 ratio at ROI 1 to 3 (T2 value at each ROI /T2 value at ROI-C) was calculated using a custom-made software. On three axial gradient echo images at the level of proximal metacarpal bone (L1), hook of hamate (L2) and piriformis (L3), the ratio of width/height of the median nerve (flattening ratio: F-ratio) was measured.

Results (Table)

Clinically, all 3 patents were at Stage 3 by Glberman scale (advanced CTS－loss of sensory and/or motor function, thenar atrophy). On axial images, a normal volunteer showed relatively round shape of median nerve (F-ratio: 1.6) at the proximal level (L3), while all CTS patients showed flat shape of the median nerve (F-ratio: 1.9 or higher) along the all level of the carpal tunnel (Table). On sagittal T2 mapping, the medial nerve of a normal volunteer showed relatively constant T2 values at all ROIs with the T2 ratio ranging from 1.03 to 1.11 (Fig3.A). On the other, relatively large variation of T2 was seen among the ROIs in the CTS patients (Fig 3B and 3C). Region of highest T2 value (T2 ratio >1.2) was different among patients, being at ROI 1 in one patient and at ROI 2 in 2 patients.

Conclusion

In previous studies the cross-sectional area of CTS and median nerve were mostly evaluated on axial MR images, and there were few reports regarding sagittal MR images of the median nerve, presumably owing to difficulty in localization of the nerve. Simon et al reported that qualitative compression scale on sagittal images of the medial nerve was not significantly associated with clinical outcomes [4]. The present study showed that T2 abnormality was not correlated with morphological shape of the median nerve (flattening ratio), and was in accordance with the finding of Simon et al. Interestingly, localization of most abnormal T2 region in the median nerve differed among patients, in spite of generally accepted opinion that distal portion of the carpal tunnel is prone to entrapment. In conclusion, sagittal T2 mapping is feasible for identifying abnormal T2 region of the median nerve, presumably relating with nerve damage (swelling, edema, or disturbance of nerve fiber arrangements).

References

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[3] Britz GW.et al. Neurosurgery .1995:27(6)1097-103. [4]Simon A. et al. J Neurosurg 2002.96:1046–1051.

Table1:subject's profiles

case (No)	age/sex (years)	clinical diagnosis	Flattening ratio			T2 ratio		
			Level1	Level2	Level3	ROI1	ROI2	ROI3
1	27/F	Normal volunteer	2.1	1.9	1.6	1.05	1.03	1.11
2	35/F	CTS	2.2	2.2	1.9	1.46	1.13	1.14
3	50/F	CTS	2.2	2	2.1	1.02	1.2	1.13
4	80/F	CTS	2.3	2.1	2.4	1.09	1.34	1.19

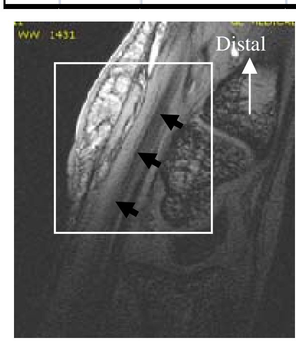

Fig 1; Median nerve at sagittal MR image (black arrows)

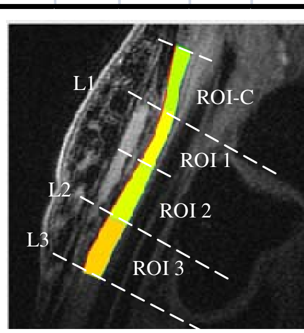

Fig2; Definition ROIs and the level of axial images.
ROI 1 to ROI 3: in the carpal tunnel area with equal length.
ROI-C (control ROI): distal to the carpal tunnel.
L1: Level of distal edge of carpal tunnel.
L2 :Level of middle of carpal tunnel
L3 : Level of proximal edge of carpal tunnel

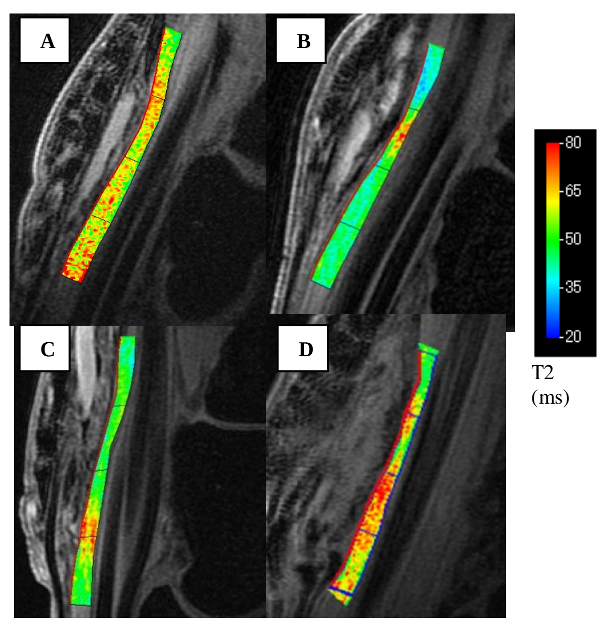

Fig 3. T2 mapping of the median nerve. Low T2 value is represented by blue color and high T2 value is represented by red color.
A: healthy volunteer (Case 1). Constant T2 value
B: Patient with CTS (Case 2). High T2 ratio at ROI 1
C: Patient with CTS (Case 3). High T2 ratio at ROI 2
D; Patient with CTS (Case 3). High T2 ratio at ROI 2