

Feasibility study of diffusion tensor imaging of Guyon's canal

Eiko Yamabe¹, Ryo Miyagi², Toshinori Sakai³, Toshiyasu Nakamura⁴, and Hiroshi Yoshioka¹

¹Department of Radiological Sciences, University of California Irvine, Orange, CA, United States, ²Department of Orthopaedic Surgery, Miyoshi City National Insurance Nishi-Iya Clinic, Tokushima, Japan, ³Department of Orthopedics, Institute of Health Biosciences, The University of Tokushima Graduate School, Tokushima, Japan, ⁴Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan

Target audience

The scientific information derived from this study should be useful for future patient care.

Purpose

Recently, the ulnar nerve in the forearm has been visualized with diffusion MRI such as diffusion tensor imaging (DTI) (1). However, changes in diffusion values such as FA and ADC around Guyon's canal, where is the second common site of entrapment neuropathy of the ulnar nerve, have not been addressed. In addition, comparison of the FA/ADC between ulnar nerve in Guyon's canal and median nerve in the carpal tunnel has not been previously reported. The purpose of this study was to demonstrate the clinical feasibility of diffusion tensor imaging of Guyon's canal in healthy volunteers and to compare the diffusion values of ulnar nerve with those of median nerve.

Methods

We examined eight wrists from healthy volunteers (mean age 42.4 y/o). All DTIs were obtained using an 8-channel wrist coil at 3T (four from Achieva and four from Ingenia, Philips Healthcare). Sequence parameters are as follows; TR/TE=4600-5258/79ms, flip angle=90, FOV=90mm, b-value=800s/mm², pixel size=1.07/1.02mm, slice thickness=4mm. Scan time was 6 min 15-59 sec. In order to assess the influences of the acquisition position, we examined the subjects with following two settings; prone position with the wrist over the head (P, n=4) and supine position with the wrist at the side of the body (S, n=8), using identical sequence parameters. As a qualitative evaluation, we tracked fibers of the ulnar nerve from the axial DTI. Zero point (0) was set at the level of the radial styloid tip, where was considered to be the proximal end of the carpal tunnel. Mean FA and ADC of the ulnar/median nerve at the 12, 8, 4mm proximal (-12, -8, -4) and 4, 8, 12, 16, 20 mm distal (+4, +8, +12, +16, +20) to the Zero were measured from the drawn fibers. Relationship between diffusion values and the location of each nerve was assessed with regression analysis. Comparisons between the two nerves and the two settings (P, S) were performed by Scheffe post hoc test. P<0.05 was considered to be statistically significant.

Results

Guyon's canal was situated from the +4 to +12/16 while carpal tunnel was from Zero to +28. On fiber tracking, the ulnar nerve and the median nerve were traced from -12 to +20 and from -12 to +28, respectively, both in S and P positions. Superficial (sensory) and deep (motor) branches were identified in Guyon's canal (Fig 1). FA and location of the ulnar nerve demonstrated a strong negative linear correlation from the proximal to the distal wrist in P and S ($r=-0.81$ and -0.83 , respectively), while ADC and ulnar nerve location showed a moderate positive linear correlation ($r=0.50$ and 0.51 , respectively) (Fig 2, 3). On the other hand, FA and location of the median nerve demonstrated a moderate to strong negative linear correlation from the proximal to the distal wrist in P and S ($r=-0.47$ and -0.88 , respectively) (Fig 2, 3). There were no significant differences in diffusion values of the ulnar or median nerve between P and S positions at each measuring point. FA values of the ulnar nerve were significantly lower than those of the median nerve from -12 to +16 in S position and from -4 to Zero in P position. ADC values of the ulnar nerve were significantly higher than those of the median nerve from +4 to +12 in S position.

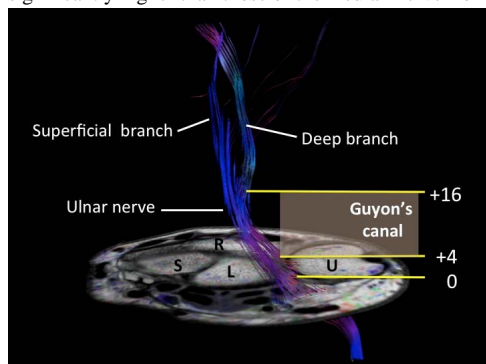


Fig 1: Fiber tracking image of ulnar nerve
R: radius, U: ulna, S: scaphoid, L: lunate

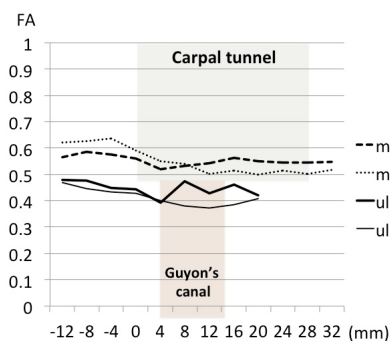


Fig 2: FA of ulnar and median nerve
med: median nerve, ul: ulnar nerve, P: prone position, S: supine position

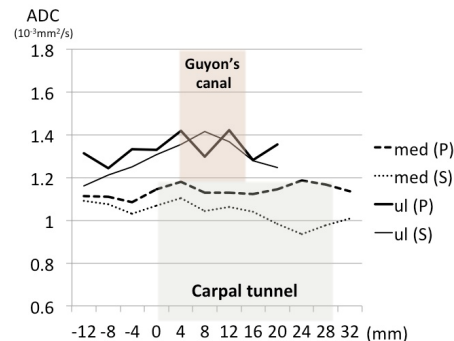


Fig 3: ADC of ulnar and median nerve
med: median nerve, ul: ulnar nerve, P: prone position, S: supine position

Discussion

With regard to the morphology of the nerve, the ulnar nerve has two kinking points, inlet and outlet of Guyon's canal, while the median nerve runs almost straight. Ulnar nerve's higher FA through the almost entire length and lower ADC in Guyon's canal, compared with the median nerve, may reflect the differences in anatomical structure and intra/extra canal pressure around Guyon's canal and carpal tunnel. Though further investigations on pathologic subjects are needed, high resolution MR imaging and fiber tracking of the ulnar nerve at Guyon's canal have the possibilities to clarify anatomical disorders such as nerve compression caused by pseudoarthrosis of the hook of the hamate or ganglion in Guyon's canal, as well as the degree of Wallerian degeneration of the ulnar nerve reflected by FA/ADC in the clinical settings.

Conclusion

We could demonstrate clear fiber tracking images of the ulnar nerve and quantitative diffusion values in supine and prone positions and showed a potential for a clinical use of diffusion weighted MR nerve imaging of the ulnar nerve at Guyon's canal. The ulnar nerve around Guyon's canal including small nerve fibers such as the superficial and deep branches was well appreciated on fiber tracking images. FA and location of the ulnar nerve demonstrated a strong negative linear correlation from the proximal to the distal while ADC showed a moderate positive linear correlation. FA presented significantly lower values compared with median nerve in supine position while ADC showed significantly higher values only in Guyon's canal.

References

1. Zhou Y, Kumaravel M, Patel VS, et al. Diffusion tensor imaging of forearm nerves in humans. *J Magn Reson Imaging* 2012; 36:920-927.

Acknowledgement

This study is granted by the Uehara Memorial Foundation.