Metacarpophalangeal Joint Flexion and the Deformation of Median Nerve

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1. Introduction

Carpal tunnel syndrome (CTS) is one of the peripheral neuropathy of the upper limb. The symptoms of CTS include numbness, tingling and weaken muscles of the hand and fingers. CTS causes the decrease in work production as well as increase in the socioeconomic burden.[1]

Carpal tunnel is a confined space with total nine extrinsic flexor tendons and a median nerve. Therefore, median nerve is vulnerable to compression stress from the flexor tendons. Active gliding of the extrinsic finger flexors is known to cause compression stress and deformation of the median nerve at carpal tunnel region.[2]

Both flexor digitorum superficialis and flexor digitorum profundus contribute to the flexion of interphalangeal joints (IPJ) and metacarpophalangeal joint (MCPJ). Moreover, intrinsic hand muscles such as lumbricals are considered as the main contributor to the flexion of the MCPJ.[3] The intrinsic lumbricals are origin from the flexor digitorum profundus near the distal carpal tunnel and insert to the extensor expansion at the dorsal aspect of each finger. MCPJ and IPH flexion could lead to intrusion of lumbricals muscles into the distal carpal tunnel and exist as a potential cause of carpal tunnel syndrome.[4]

Previous studies suggest wrist flexion-extension causes significant reduction of the median nerve cross-sectional area (MNCSA).[5,6] However, the impact of the hand intrinsic muscles on the median nerve compression are not well-studies. The objective of this study is to examine the main effects of active flexion of the MCPJ on the deformation of the MNCSA at wrist region.

2. Methods

Twelve healthy right-handed young adults (age = 24.2 ± 1.7 years; height = 167.3 ± 7.7 cm; BMI = 20.8 ± 2.0 kg/m²) were recruited in this study.

Ultrasound examination was performed using a GE Healthcare Ultrasound System (LOGIQ e) with a 5-13 MHz transducer (Model 12L-RS). The median nerve of dominant wrist was examined at the proximal carpal tunnel level in the transverse plane. Two MCPJ flexion movements were examined. First examined postures were extended MCPJ and IPJ changed to MCPJ 90° flexion with extended IPJ (Fig. 1a). Second examined postures movements were extended MCPJ and full flexed IPJ changed to MCPJ 90° flexion with full flexed IPJ (Fig. 1b). The participants kept the wrist at neutral (0°) during ultrasound examination. The MNCSA was measured by tracing method along the hypoechogenic rim of the median nerve (Fig. 2). The deformation of the MNCSA with flexed MCPJ was calculated. Wilcoxon signed-rank test was used to compare the differences of MNCSA at two set of finger postures (Fig. 1).

Figure 1. (a) MCPJ flexion with extended IPJ; (b) MCPJ flexion with flexed IPJ.

Figure 2. Measurement of median nerve cross-sectional area by tracing method.
3. Results

MCPJ 90° flexion with full flexed IPJ (Fig. 1b) caused the MNCSA reduced significantly (p < 0.05), but the MNCSA at MCPJ 90° flexion with extended IPJ (Fig. 1a) showed no significant changes (Fig. 3). The deformation of MNCSA extended MCPJ and full flexed IPJ changed to MCPJ 90° flexion with full flexed IPJ (Fig. 1b) were approximately – 2.5%, respectively.

Figure 3. Comparison of median nerve cross-sectional area at two set of finger postures.

4. Discussion

Both extrinsic finger flexors muscles and intrinsic lumbricals muscles control the flexion of the MCPJ and IPJ. The excursion and displacement of both flexor digitorum superficialis and flexor digitorum profundus tendons cause deformation of the median nerve.[7] Furthermore, the intrusion of lumbricals muscles into distal carpal tunnel may increase the intra-carpal tunnel pressure and lead to further deformation of the median nerve.[4]

This study examines the deformation of the median nerve caused by the MCPJ flexion at proximal carpal tunnel region. Active contraction of the lumbricals muscles changes the straight finger to MCPJ flexion with extended IPJ, meanwhile the proximally excursion amplitude of the finger flexor tendons is lesser. However, the flexor tendons glide further proximally as the MCPJ moved from extension to flexion with the full flexion of IPJ (Fig. 1b). Our results are in agreement with previous study that active full finger flexion causes the deformation of the median nerve in the carpal tunnel.[8] Our results suggest that active contraction of lumbricals muscles in MCPJ flexion does not lead to significant deformation of the median nerve. However, the combination of active contraction of the lumbricals and higher excursion amplitude of the finger flexor tendons through the carpal tunnel leads to significant reduction of the MNCSA (Fig. 3b).

Occupational factors such as forceful grip and use of hand-held tools are known to associate with CTS incidents at workplace.[9] Therefore, CTS prevention should include comprehensive assessment and special consideration regarding the hand tool use in each work task. Future research on the forceful grip and repetitive finger-wrist movements are in need to have a better understanding of the deformation of the median nerve at carpal tunnel region.

References