Finger position alters the Median nerve properties in the Carpal Tunnel: A pre-post MRI comparison study

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Introduction

Carpal Tunnel Syndrome (CTS) is common neuropathy disorder encountered by healthcare specialists and is caused by prolonged abnormal force exerted on the median nerve within the Carpal Tunnel (CT). Finger flexion has been suggested to contribute to the etiology of CTS.

In one study, the pressure in the CT canal during active grip and neutral wrist was reported to be more than when the wrist was in extension and fingers relaxed.[1] Cadavers studies also demonstrated that finger flexion leads to significant increase in CT pressure.[2] Clinical findings have further correlated isometric squeeze grip with producing positive CTS symptoms is some patients, which became known as the "Closed Fist Test" of CTS.[3]

This cumulative evidence indicates the finger movements directly increased the force exerted on the median nerve within the CT, which may contribute to median nerve compression. The **objective** of this study was to compare the immediate effects of finger position (finger extension versus isometric squeeze grip) on anatomical alterations on the Median nerve and the Carpal Tunnel.

Materials and Methods

Subjects
Thirty-six healthy volunteers participated in the study. Participants with known factors resulting in increased content of the CT were excluded from the study.

Procedure
The measurements were performed with a General Electric 3T MRI scanner. With the wrist in neutral position. Participants maintained their fingers in two different positions for MRI imaging; (a) fingers in full extension and (b) fingers in a forceful isometric squeeze grip.

Outcome measures
A 2D axial section of the CT was selected at the level of hook of hamate (Figure 1) to objectively assess the following:
The **flattening ratio** was calculated by dividing the major axis of the nerve by its minor axis. The median nerve cross-section area (**MNA**) was calculated by manually tracing the boundaries of the median nerve by using the tools available within the MRI system software. The **pressure angle** of the median nerve was measured by connecting the end of the perpendicular line (which measures the flexor retinaculum bowing) and the beginning of the trapezium tubercle - hook of hamate strait line. To measure the **palmar bowing** of the flexor retinaculum, we drew a straight linear line to unite the hook of hamate with the trapezium and then measured (in millimeters) the perpendicular distance from the linear line between the hook of hamate and trapezium to the most palmar point (apex) of the transverse carpal ligament.

The primary hypothesis was analyzed by using paired t-tests with a significant p-value < .05. A Bonferroni correction for 4 combinations of factors was adapted. Thus, p-values < .013 (0.05/4) were considered significant for each variable.

Results

Thirty four subjects participated in this study, of whom 22 were males and 12 were females, with a mean age of 23.7 (SD: 6.6) years (range: 16-37). See table 1 for participant characteristics.

The flattening ratio of the median nerve at the level of hook of hamate was 2.27 (SD = .34) for finger extension and 2.64 (SD = .76) for the isometric squeeze grip. The paired sample $t(33) = 4.308$, $p < .001$, indicated a significant reduction of the median nerve flattening ratio during the squeeze grip condition.

Results

The mean MNA at the hook of hamate level was 8.74mm^2 (SD=1.48) for finger extension and 8.41mm^2 (SD = 1.12) for the squeeze grip. The paired sample $t(33)= 2.508$, $p = 0.017$, showing a non-significant decrease in MNA with finger extension compared to isometric squeeze grip.

The change in pressure angle of the median nerve was nearly negligible between the two conditions ($p > .05$). The mean palmar bowing of the flexor retinaculum during finger extension and isometric squeeze grip was 2.27 mm (SD= 0.93) and 3.34 mm (SD = 1.13), respectively, indicating greater palmar bowing during the isometric squeeze grip $t(33) = 7.67$, $p < .001$. A summary of the results is presented in table 2.

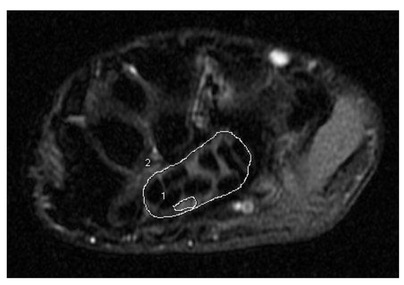

Figure 1. MRI of the wrist

	Min.	Max	Mean	SD
Age (yrs.)	16	37	23.7	6.5
Height (cm)	153	179	170.3	7.6
Weight (Kg)	43	117	78.7	18.9
BMI	18.40	39.6	26.8	5.3
Education (yrs.)	10	20	14.0	2.8

Table 1. Descriptive statistics of participants (n = 34)

	Finger extension mean (SD)	Isometric grip mean (SD)	Percent difference	t	df	Sig.
Flattening ratio	2.27 (0.34)	2.64 (0.76)	16.2 %	4.308	33	p < .001
MNA	8.74mm^2 (1.48)	8.41mm^2 (1.12)	3.77 %	2.508	33	p = .017
Pressure angle	26.3 (3.5)	25.9 (4.2)	1.5 %	0.321	33	P = .75
Palmar bowing	2.27 mm (0.93)	3.34 mm (1.13)	47.1 %	7.67	33	p < .001

Table 2: Summary of the anatomical changes within the Carpal canal

Conclusion

Performing an isometric squeeze grip resulted in statistically significant variations within the CT area that had direct effect on the median nerve, namely a significantly flatter median nerve ratio and a significant palmar bowing of the flexor retinaculum. The changes in the cross sectional area and the pressure angle of the median nerve were not significant.

The results of this study support previous studies that associate finger flexion with increased pressure within the carpal tunnel area. The anatomical variations produced by forceful finger flexion, which may be caused by lumbrical muscle incursion into the confined space of the CT, may contribute to aggravating the symptoms of Carpal Tunnel Syndrome and may delay healing.

References

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