GENDER DIFFERENCE IN CARPAL TUNNEL COMPLIANCE

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INTRODUCTION

The carpal tunnel is formed by the carpal bones and the transverse carpal ligament, and is unaccommodating for the expansion of its contents. The detrimental mechanical limitation by the ligament is exemplified by carpal tunnel release, a universal surgical procedure to release the transverse carpal ligament for the treatment of carpal tunnel syndrome. Previous studies have shown that myofascial release manipulation applied to the carpal tunnel caused tunnel enlargement and improvement of carpal tunnel symptoms [1]. The stretchablility of the transverse carpal ligament was also demonstrated in cadaver studies [2]. In addition, hypertrophy of the transverse carpal ligament has been proposed as one of the pathogeneses of carpal tunnel syndrome [3]. To date, little is known about the mechanical properties of the carpal tunnel. The purposes of this study were (i) to characterize the force-displacement relationship resulting from indentation applied to the palmar aspect of the wrist overlying the transverse carpal ligament, and (ii) to study gender difference in carpal tunnel compliance as determined by the indentation test.

METHODS

A hand-held Myotonometer (Neurogenic Technologies, Inc) was used to measure force and displacement during indentation testing. The indentation probe has a flat end with a diameter of 10 mm. To standardize indentation location on the skin overlying the transverse carpal ligament, a line was drawn to connect the palpable pisiform and scaphoid. A point 10 mm distal from the connection line on the bisector was marked as the center of indentation (Figure 1A). During the testing, the hand was placed in an arm holder with the palmar side facing upward (Figure 1B). The probe was manually pressed down perpendicular to the skin surface. The device took measurements from 0.25 to 2.00 kg at an increment of 0.25 kg. Twelve males (age 29.3 ± 6.6 years) and twelve females (age 26.2 ± 4.3 years) who had no neuromusculoskeletal disorders to the upper extremity participated in the study. Effective compliance was defined as the slope of the linear regression line of a set of force-displacement data. Repeated measures 2-way ANOVAs were used to compare the displacement differences. An independent t-test was used to compare the effective compliances between males and females.

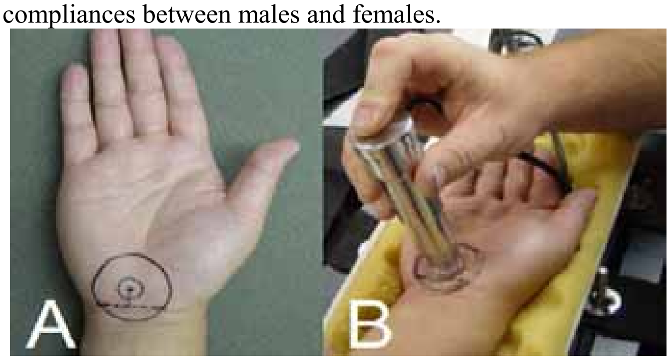

Figure 1. Center of indentation above the transverse carpal ligament (A), and manual indentation testing (B).

RESULTS

In the tested force range, the displacement increased linearly with applied force for either male or female group (Figure 2, R^2 ranges from 0.936 to 0.981). Females showed significantly smaller displacements than males ($F = 30.4$, $P < 0.001$). Force increases from 0.25 to 2.00 kg caused average indentation displacements of 1.82 ± 0.30 mm and 1.38 ± 0.25 mm for males and females, respectively. The effective compliance of females, 0.075 ± 0.012 mm/N, was 24.5% lower than that of males, 0.101 ± 0.018 mm/N ($P < 0.005$, Figure 3).

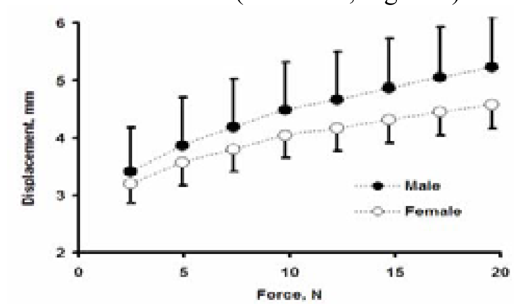

Figure 2. Force and displacement from indentation testing.

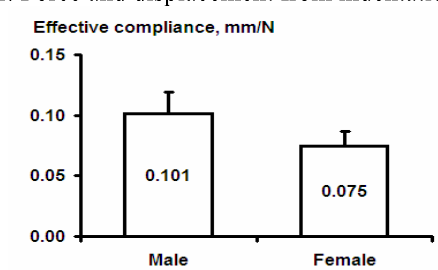

Figure 3. Effective compliance (mm/N).

DISCUSSION

An indentation testing was performed non-invasively to the palmar wrist overlying the transverse carpal ligament. A linear force-displacement relationship was shown in the tested force range. The results confirmed the hypothesis that females have less compliant carpal tunnels than males. This finding may partially explain the higher prevalence of carpal tunnel syndrome in women than in men [4]. Future studies are needed to investigate the material and structural properties of the transverse carpal ligament, the relationship of the ligament to the carpal tunnel pressure, and the biological and biomechanical adaptations of the ligament to repetitive hand use.

REFERENCES

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