INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common form of peripheral nerve entrapment neuropathy and is caused by compression of the median nerve in the carpal tunnel. Within the carpal tunnel, the subsynovial connective tissue (SSCT) lies between tendons and the visceral synovium of the ulnar bursa. The most common finding during carpal tunnel release surgery is non-inflammatory fibrosis and thickening of the SSCT. A better understand of the mechanics of the SSCT may shed light on the etiology of CTS. The purpose of this study was to explore the possibility of detecting the relative motion of flexor tendon and SSCT using ultrasound in a human cadaver model.

METHODS

Cadaver selection and preparation: We used eight upper extremities (4 right and 4 left) from 7 fresh frozen human cadavers (3 male, 4 female) with no antemortem history of carpal tunnel syndrome and a mean age of 72.4 years (range 49-89). The specimens were fixed in a custom-made mounting device, holding the wrist in the neutral position, by clamping the proximal end of the radius and ulna and with support to the dorsum of the hand. The middle finger FDS and FDP tendons were attached to a 200mg weight. The tendon excursion during passive finger manipulation was measured by an electro-potentiometer.

Ultrasound Imaging: An Acuson Sequoia 512® ultrasound system (Acuson Sequoia 512®, Siemens Medical Solutions, Malvern, PA, USA) was used, equipped with the 15L8 linear array transducer set to 15-MHz acquisition frequency for anatomical imaging and 8-MHz frequency during Doppler measurements. The transducer was placed on the palmar surface of the cadaver wrist, with the wrist in neutral position.

The cadaver fingers were flexed and extended manually to achieve continuous motion of the middle finger FDS tendon. Although different absolute velocities of finger motion were generated in this way and the velocities were not perfectly constant, the purpose of the study was to compare the velocity the SSCT with respect to that of the tendon rather than an analysis of absolute velocities.

Excursions of tendon motion were measured with the electro-potentiometer simultaneously with Doppler data acquisition by ultrasound. An event marker (electrical spike) was used to delimit, in the time domain, the beginning and end of motion of the tendon. The peak velocities of the tendon and SSCT were obtained from and extensions for the two structures was obtained. Doppler velocity measurements started by placing a small, approximately 1-mm pulse-wave Doppler transducer on the FDS III tendon and the SSCT from the middle finger FDS tendon. In addition, we have shown that high-frequency ultrasound can functionally differentiate the SSCT from the tendon by comparing peak velocities during flexion and extension cycles.

Ultrasound is a fast and non-invasive technique and has relatively low cost. High-resolution ultrasound is a very precise method to display the anatomy of the tendon and SSCT within the carpal tunnel and it is possible to detect their different velocities with Doppler. Ultrasound may prove to be a useful tool in studying the mechanics of the SSCT in normal individuals and patients with CTS noninvasively, with the potential to learn more about the pathogenesis of changes within the SSCT in this important and common clinical problem.

REFERENCES


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