MRI Analysis of finger flexor tendon trajectory as a function of forearm and wrist posture

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Introduction

Work-related musculoskeletal disorders (WRMSD) represent a large economic burden on our population. In 2016, $2.25 billion on benefit payments were issued in Ontario alone. Upper extremity injuries represent the second most common WRMSD at 21.8% of all injury claims. Movements that require extremes of arm and hand postures, as well as prolonged static postures have been identified as prevalent occupational risks for injury development. Epidemiological and biomechanical evidence would suggest that jobs and tasks that require deviation away from the neutral wrist and the mid-pronated forearm are at increased risk of injury.

Purpose and Objectives

The interaction effect of these postures is not well understood, and there is a lack of research regarding the effect of forearm and wrist posture on tendon displacement. The primary goal of this study is to quantify the displacement of the finger flexor tendons as a function of radial-ulnar deviation, and pronation/supination of the forearm. Linear and angular displacements of the tendons will be assessed in the sagittal and frontal planes. Linear and angular displacements will be assessed proximal, and distal to the carpal tunnel. The change in angle as the tendons pass through the carpal tunnel will also be assessed. The main and interaction effects of radial-ulnar deviation and pronation/supination will be analyzed using repeated measures ANOVA. We hypothesize the following: (1) there will be main effects of radial-ulnar deviation, and pronation/supination of the forearm, and (2) there will be an interaction effect of radial-ulnar deviation, and pronation/supination of the forearm.

Methods

To quantify linear and angular displacements, anatomical reference frames will be created. These will be created from magnetic resonance images (MRI) of the wrist and distal forearm. These images will be segmented using a MRI analysis software to create 3D models of the radius, ulna, metacarpal, and the skin surface of the distal forearm. Anatomical landmarks will be identified and digitized. The models, as well as the landmarks in the neutral-mid posture will be registered onto the other 8 postures. The global coordinates of the landmarks will be imported into a custom MATLAB software to create the anatomical reference frames. The flexor digitorum superficialis and profundus tendons will also be segmented. The path of their centre lines will be rotated into their respective radial coordinate systems. Linear and angular displacements of the tendons in the sagittal and frontal planes will be assessed at locations proximal and distal to the carpal tunnel. The results will allow greater understanding of the relationship between work done and the injuries that occur. They will also help in quantifying
the relationship between postures adopted while working and the associated musculoskeletal loading.