

Evaluation of an Ergonomic Laparoscopic Handle Design and Upper Extremity Musculoskeletal Disorder Risk Factors

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Introduction and Objective

Many laparoscopic surgeons complain about pain and fatigue in their upper extremities. This has been attributed to the awkward postures and high hand forces surgeons assume when operating on their patients¹. These risk factors, when paired with the long operating durations, present an elevated risk for Upper Extremity Musculoskeletal Disorders (UEMSDs) like carpal tunnel syndrome. A laparoscopic tool handle utilizing a pistol-grip was designed to reduce wrist flexion and required finger forces while operating the cutting/grasping mechanism. The goal of this study is to investigate the effect of this new laparoscopic handle on UEMSD risk factors including: posture (wrist flexion/extension angles), duration of exertion (time to task completion), and hand/grip forces (finger flexor surface electromyogram - sEMG). We hypothesized that there would be a significant decrease in wrist flexion/extension angles, time to task completions, and required grip forces with the pistol-grip design.

Methods

The pistol-grip design was created to reduce contact stress points on the hand and fingers, promote a more neutral wrist posture, and reduce the grip forces required to operate the tool. A traditional pinch-grip handle design was evaluated as our control (Stryker, Inc. Kalamazoo, MI). Twenty-three (13 M, 10 F) medical students with no existing UEMSDs and no prior experience performing FLS tasks were selected for this study. Prior to testing, participants performed practice trials in a FLS trainer (SAGES, Los Angeles, CA) with both handles. During data collection, participants performed three FLS evaluation tasks. Electrodes (Delsys Inc., Boston, MA) were placed over the flexor digitorum profundus to measure muscle activation during each trial and a 3D motion capture system (OptiTrack, Corvallis, OR) was used to record upper extremity posture (joint angles).

Preliminary Results

Time to trial completion is significantly lower when participants use the pistol-grip handle ($P < 0.05$, cutting and peg-transfer). Participants spent significantly more time in a neutral posture when operating the pistol-grip handle ($P < 0.001$, all tasks). Finally, preliminary analysis of sEMG data suggests that participants had lower activation of their flexor digitorum profundus using the pistol-grip handle (Figure 1). Future work will combine these three factors and others to determine injury risk.

Average % Max sEMG Activation

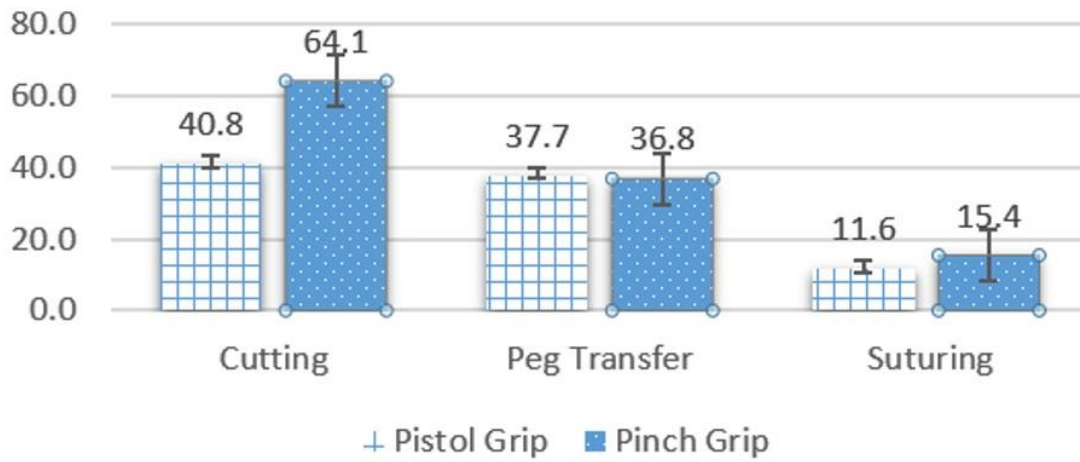


Figure 1. Sample data of percentage of maximal sEMG activation for a single subject; sEMG data is presented for pistol-grip tasks followed by pinch-grip tasks

Reference

Avinash N Supe, Gaurav V Kulkarni, and Pradnya A Supe. Ergonomics in laparoscopic surgery. J Minim Access Surg. 2010 Apr-Jun; 6(2): 31-36.