Virtual ACS 2021 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research In-Progress

Development of an Ergonomic Model to Assess Musculoskeletal Risks in Minimally Invasive Surgery

Dimitrios I. Athanasiadis, MD; Sara Monfared, MD; Hamed I. Asadi, MS; Denny Yu, PhD; and Dimitrios Stefanidis, MD PhD.

Indiana University School of Medicine, Indianapolis, IN; Purdue University, West Lafayette, IN

Introduction: Work-related musculoskeletal injuries among minimally invasive surgeons are alarmingly high due to technically demanding and static postures. The primary outcome was to assess the ergonomic demands of MIS surgeons and trainees. Secondary outcome was to assess the relationship between ergonomic objective and subjective measurements.

Methods: An IRB-approved prospective study was conducted between July and February 2019. Ergonomic data was obtained during minimally invasive procedures from 6 surgical attendings and 6 residents and fellows using subjective tools (Musculoskeletal Symptoms Response questionnaire and the National Aeronautics and Space Administration Task Load Index) and objective metrics (electromyography [EMG] activity and inertial measurement unit recordings). Statistical analysis was performed to determine the relationship between objective and subjective measurements.

Preliminary Results: A total of 57 case observations were performed (45 laparoscopic and 12 robotic procedures). The average percentage of time that the participant spent in trunk static position was 67% and neck static position was 52%, while the average percentage of time spent in trunk demanding position was 11% and neck demanding position was 38%. 51% of participants reported neck stiffness after surgery which was significantly associated with a higher percentage of time in static position of the trunk (70% vs 62%, p=0.01) and neck (56% vs 48%, p=0.01). Table 1 shows the correlations between perceived effort and EMG activity. Both attendings and trainees spent similar time in demanding and static positions of the trunk, neck, right and left shoulder and their perceived effort did not differ significantly.

Next Steps: We observed high static positioning with low weight shifting during MIS procedures that increase the ergonomic strain on the body. These findings can be used as biomechanical engineering markers to develop a musculoskeletal risk predictor model and assess the impact of interventions such as exoskeleton devices in alleviating ergonomic risk.

Table 1. EMG activity correlated to perceived physical effort

Perceived Effort Right Trapezius	Left Trapezius	Left Deltoid	Left Deltoid
Neck	0.426 (p<0.01)	0.25 (p=0.079)	0.25 (p=0.079)
Back	0.289 (p<0.05)	0.272 (p=0.056)	0.272 (p=0.056)
Right Arm	-0.024 (p=0.868)	0.005 (p=0.975)	0.005 (p=0.975)
Left Arm	0.041 (p=0.779)	0.243 (p=0.089)	0.243 (p=0.089)
Overall physical Demand	0.472 (p<0.001)	0.310 (p<0.05)	0.310 (p<0.05)