Non-invasive Brain Imaging Demonstrates that Surgical Skills Transfer from Training Simulators to Ex-vivo Models

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INTRODUCTION: Published research shows that surgical simulation trainers provide effective and safe ways to acquire technical surgical motor skills. However, few published studies conclude that these motor skills transfer from simulation to operative environments. The purpose of this study is to measure surgical motor skill transfer from training simulators to ex-vivo tissue models using brain activation and task performance metrics.

METHODS: Of 19 participating medical students, six practiced over 100 physical FLS pattern cutting tasks, eight practiced over 100 virtual FLS pattern cutting tasks, and five control students had no practice. Students performed the tasks on ex-vivo cadaver peritoneum tissue mimicking the simulation environments. Performance scores were calculated using official FLS metrics and transfer task scores were quantified by total completion time. Since the primary motor cortex (M1) is heavily involved in the stages of motor skill learning, brain activation was quantified by the change in oxygenated hemoglobin concentration in M1 measured by functional near-infrared spectroscopy.

RESULTS: Results indicate that both the physical trainer (7.9 ± 3.3 min) and virtual trainer (13.05 ± 2.6 min) groups completed the transfer task significantly faster than the control group (15.5 ± 5.6 min, $p<0.05$). Furthermore, cortical activation was significantly higher for the FLS group in the M1 compared to the control group ($p<0.05$) as seen in Figure 1.

CONCLUSIONS: Motor skills transfer from simulation to ex-vivo environments based on brain activation and task performance metrics. This type of measurement will provide valuable insight into competency based skill assessment as well as skill degradation and recovery assessment.