the average of 3 Peg scans and the Rest scan. When compared with the expert group, the novice group had a significantly ($p<0.001$) higher activation in the right cerebellum, right middle temporal gyrus, right medial frontal gyrus, right precuneus (BA 31), left uncus (BA 38), and left rectal gyrus (BA 11). Alternatively, the expert group had a significantly higher activation in the left superior frontal gyrus (BA 10), left middle and medial frontal gyri, right superior temporal gyrus, and right cingulated gyrus ($p<0.001$).

CONCLUSIONS: This preliminary $^{15}O$ PET study of novice and expert laparoscopists indicates differential brain activation in frontal, limbic and occipital lobes when subjects perform surgery-related motor and visual tasks. This has broad neurophysiological implications for laparoscopic training as brain re-modeling occurs with experience. More subjects are needed to confirm these results.

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## 2263

### MEASUREMENT OF SURGEON FINE MOTOR HAND MOVEMENT USING ACCELEROMETERS: CORRELATION WITH LAPAROSCOPIC EXPERIENCE.

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INTRODUCTION AND OBJECTIVE: Assessment of surgical performance and the attainment of surgical skills have historically undergone subjective assessment. An accelerometer is a device for measuring acceleration and fine motor movement reaction forces. Single- and multi-axis models are available to detect magnitude and direction of the acceleration as a vector quantity. We sought to quantitate in an objective manner, the motor skills of novice and skilled laparoscopic surgeons using multiple accelerometers during laparoscopic intracorporeal suturing.

METHODS: Measurements (n=70,000) of fine motor movement were obtained from 6 subjects stratified by level of training (novice=35,000 measurements, intermediate=23,300 measurements, advanced=11,700 measurements). During a laparoscopic intracorporeal suturing task, trainees hands were attached to a tri-axial accelerometer on the dorsum of both right and left hands. The acceleration data was collected at 50 Hz using a Biopac MP 100 (Goleta, CA) using two 5g triaxial accelerometers and customized software. Acceleration reversals in the x- and y-direction were calculated and used as a measure of performance.

RESULTS: Time was found to be a reliable predicator of performance to differentiate surgical skill, as well as standard deviation to predict variability of performance. Novice students had an average time of 114.8 sec, Intermediate 57.3 sec and Expert 36.6 seconds. Accelerometer data demonstrates the average deceleration of movement and acceleration was 4x more frequent in novice students than experts.

CONCLUSIONS: The quantization of surgical skills acquisition has broad implications in progressive training of urology residents and demonstration of acquisition of surgical skill. Further studies will be needed to demonstrate construct validity and correlation with performance.

**Source of Funding:** None

## 2264

### ASSESSING SURGICAL SKILL THROUGH AUDIO/VISUAL ANALYSIS: A NEW LOOK AT A NOVEL SCALE.

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INTRODUCTION AND OBJECTIVE: Current standards for assessing laparoscopic and robotic surgical skill assessment are subjective and can biased in accurately assessing surgical skill. A systematic and objective method to assess laparoscopic and robotic surgical skill was established by employing a novel grading scale to assess intra-operative cognitive and motor skill. The aim of this study is to compare the current rating scales to the novel cognitive rating scale.

METHODS: Surgeons were categorized as novice, intermediate, or expert based on the number of years of experience and as determined by the lead expert surgeon (LRK). Audio and visual information was recording during colon and bladder mobilization procedures for nephrectomy and radical prostatectomies respectively. Subjects were asked questions regarding the procedure, potential pitfalls, anatomical features, and pertinent findings. Audio recordings were digitally scrambled and sent to three blinded judges, who graded each case using the validated global rating scale (GRS) and operation-specific rating scale (ORS), and the novel cognitive rating scale (CRS). Intraclass correlation (ICC) was performed to demonstrate agreement between the judges. Analysis of variance (ANOVA) was then performed for each component of the GRS, ORS, and CRS.

RESULTS: Data from 27 (84%) nephrectomy procedures and 5 (16%) radical prostatectomies were analyzed by the three blinded judges. ICC scores of each component of the three scales ranged from - 0.17379 to 0.89140. For questions with ICC of >0.4, ANOVA showed a detectable difference between novice, intermediate and expert surgeons using the GRS, ORS, and CRS on all but two questions. The CRS accurately predicted the surgeon's skill level for each component assessed, demonstrating construct validity ($p<0.05$).

CONCLUSIONS: The use of intra-operative audio is an innovative way to assess the clinical judgement and decision-making ability of the surgeon, which can be rated on a novel scale. The CRS demonstrates both content and construct validity as the scores are reproducible. The addition of the CRS to the already validated GRS and ORS creates a reliable and reproducible system to objectively evaluate and assess laparoscopic and robotic surgical skill.

**Source of Funding:** None

## 2265

### CAN THE LEARNING OF LAPAROSCOPIC SKILLS BE QUANTIFIED BY THE MEASUREMENTS OF SKILL PARAMETERS PERFORMED IN A VIRTUAL REALITY SIMULATOR?

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INTRODUCTION AND OBJECTIVE: For patient safety and surgical efficiency, much emphasis has been placed on the training of laparoscopic skills using simulators that replicate conditions encountered during actual surgery. However, it is not known if the use of these simulators results in quantifiable improvement in laparoscopic surgical skills. The purpose of this study is to determine if differences in actual surgical skills can be objectively quantified by the specific skill parameters that could be measured when performed in a virtual reality (VR) laparoscopic simulator. The goal of this study is to validate the use of these skill parameters to assess learning during the training process.

METHODS: Ten medical students (no laparoscopic experience) and ten urology residents (PGY3-5 with laparoscopic experience) were recruited to participate in a ten weeks training of laparoscopic basic skills (camera skill, cutting skill, peg transfer skill and clipping skill) on a VR laparoscopic simulator. Time to complete each task, errors, and complications were analyzed independently.

RESULTS: The mean time to complete all tasks was statistically different between the groups ($p=0.02$), with the residents on the average being 3 times faster (10.8 minutes compared to 28.3min). The residents group also completed the tasks with less errors ($p<0.001$). Increased complexity of the task resulted in a greater difference in task completion time and error rate between the two groups. Of all the skill parameters evaluated, the camera skill had least difference between the two groups. The majority of the medical students showed a significant improvement in task completion time and error rate between the first 5 and the last 5 training session ($p<0.001$). In contrast, the residents did not show any significant improvement with training ($p=0.82$).

CONCLUSIONS: The findings in this study demonstrated that learning of laparoscopic skills could be objectively measured using the