Changes in Objective Performance Indicators are Associated with Experience in Robotic Inguinal Hernia Repair

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Introduction

Evaluating surgeon performance in robotic inguinal hernia repair (RIHR) is a challenge, especially for the surgeon who adopts robotic surgery after residency. The advent of objective performance indicators (OPI) has introduced a potentially transformative assessment of technical skill. OPI data for RIHR and association with patient outcomes is emerging. Our study investigates changes in OPI during RIHR in an experienced laparoscopic surgeon's learning curve.

Methods

We collected video, system event, and kinematic data streams of a single surgeon's RIHR cases with the DaVinci XI platform utilizing Intuitive Data Recorder over a two-year period. Videos were segmented into surgical steps by professional annotators, and OPIs were calculated for each step. Initial review of combined 45 bilateral and unilateral IHR procedures (~160-205th career RIHR) were analyzed for step-specific changes in OPIs over time. A Pearson test was performed to evaluate correlations between OPIs and a surgeon's RIHR cases.

Results

A

Step –OPI name	Correlation coefficient	p-value
Creation of Peritoneal Incision		
Right hand Speed (50%)	-0.524	0.015
Left Hand Speed (50%)	0.473	0.030
Camera Speed (50%)	0.364	0.009
Angular Distance Wrist Roll Right	-0.915	0.004
Angular Distance Wrist Pitch Right	-0.818	0.024
Angular Distance Wrist Yaw Right	-0.819	0.024
Active Time Right Hand	-0.825	0.023
Active Time Left Hand	-0.616	0.002
Active Time Camera	0.582	0.005
Total active time	-0.571	0.004
Camera control	-0.435	0.049

B

Average	1st Tertile	2nd Tertile	3rd Tertile
Age	67	59	62
BMI	27.6	27.1	24.9
ASA	2.1	2.5	1.9
OR time (minutes)	74	64	66
Time in recovery (hours)	3.0	3.3	3.0

Figure 1. A) Summary of significant data in CPI step of bilateral RIHR. B) Patient Demographic Data (from October 2020 to October 2021)

In CPI, 11 OPIs exhibited significant correlations with surgeon case volume. The total angular motion distance in the left sided CPI in the dominant instrument arm demonstrated a negative correlation with the total case count. Furthermore, the step duration was closely approximated by the active time of the robotic system during the operation, which exhibited a negative correlation with the total case count. More specifically, the active time of the dominant and nondominant instrument arms demonstrated significant negative correlations while the active time of the camera increased overtime.

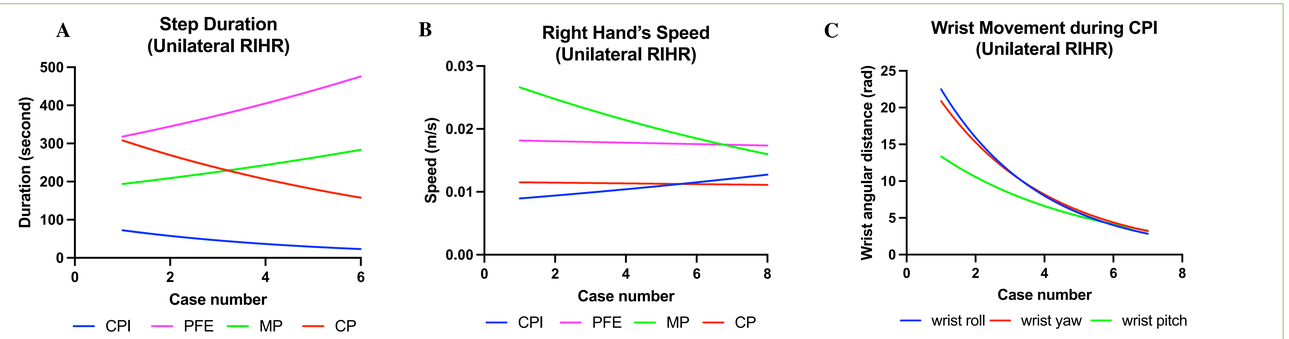


Figure 2. Unilateral RIHR. A) Comparison of step durations. B) Comparison of right hand speeds during each step. C) Comparison of angular distances of different wrist movements (CPI = creation of peritoneal incision, PFE = peritoneal flap exploration, MP = mesh placement, CP = closure of peritoneum)

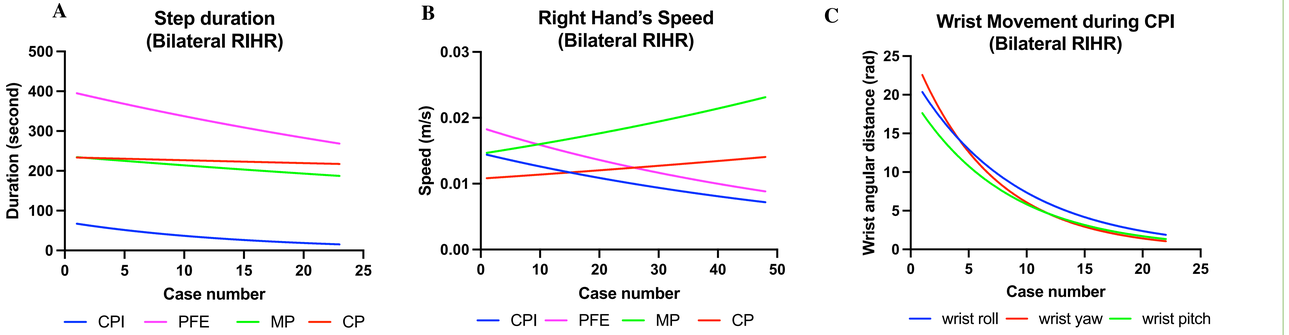


Figure 3. Bilateral RIHR. A) Comparison of step durations. B) Comparison of right hand's speeds during each step. C) Comparison of angular distances of different wrist movements (CPI = creation of peritoneal incision, PFE = peritoneal flap exploration, MP = mesh placement, CP = closure of peritoneum)

Conclusions

This study is the first to assess OPI changes over time in general surgery. Although the data captured was from an experienced laparoscopic surgeon with robotic experience (over 100 RIHRs), significant OPI differences were identified, potentially uncovering a refinement phase of mastery not otherwise observable with traditional assessments. Together, this study provides the proof of concept for OPIs to be utilized to optimize surgical training through learning curve tracking and objective evaluations of skills.