Predictors of Robotic Inguinal Hernia Intraoperative Efficiency

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Background

- Robotic-assisted surgery has been introduced to surgical residency training.
- Real-time predictors of operative time are thus critical to monitor and improve overall efficiency of robotic inguinal hernia (RIH) cases involved intraoperative teaching.

Hypothesis

- We hypothesize that automated objective measures that reflect the operating surgeon/resident's intraoperative control of the robotic console can predict RIH operative efficiency defined as time spent on performing RIH step-specific movements.

Methods

- We annotated 519 functional surgical steps from 92 anonymous RIH cases performed on the dual console Da Vinci Surgical Robotic system with resident participation between 7/2020 and 6/2022 in our center.
- Eight objective performance indicators (OPIs), automated measurements captured by an Intuitive Data Recorder (IDR), were utilized.

Methods (cont.)

- Independent variables included five OPIs reflecting console-control behaviors; outcome variables were three RIH step-specific time measures, including surgical step duration, instrument active time, and the wrist joint active time.
- Descriptive statistical analysis and boosted tree algorithm were applied.

Results

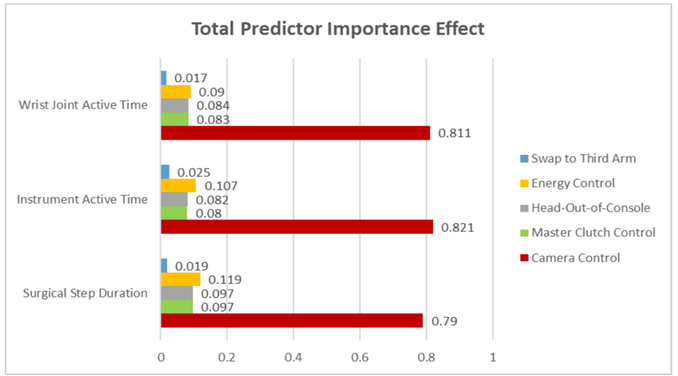


Figure 1. Predictor Importance. Note: Camera Control=Number of times the camera motion was activated by the operating surgeon (attending/resident); Master Clutch Control=Number of clutches a surgeon performed; Head-Out-of-Console=Number of times a surgeon removes their head from the surgical console; Energy Control= Number of energy activations; Swap to Third Arm= Number of swapping to 3rd robotic arm.

Results (cont.)

- Approximately 30.4% (28/92) RIH cases were bilateral hernia and 20.7% (19/92) had adhesions; 42.8% (222/519) steps were completed by resident and surgeon together.
- "Camera control" (i.e., number of camera control activations) was the strongest predictor of all three RIH intraoperative efficiency measures: surgical step duration, instrument active time, and instrument wrist joint active time (Figure 1).
- It was also the strongest predictor of these three efficiency measures in each of the five critical RIH steps: Creation of Peritoneal Incision (total predictor effect range 0.83-0.85), Flap Exploration & Exposure of Myopectineal Orifice (0.69-0.80), Reduction of Sac (0.36-0.48), Mesh Placement (0.80-0.88), and Closure of peritoneum (0.64).

Conclusion

- Our study suggests the camera control is the strongest predictor of intraoperative efficiency of RIH with resident involvement.
- These preliminary results provide useful information for future development of artificial intelligence (AI) systems to improve quality and efficiency.
- Future studies are needed to further explore and validate these findings.