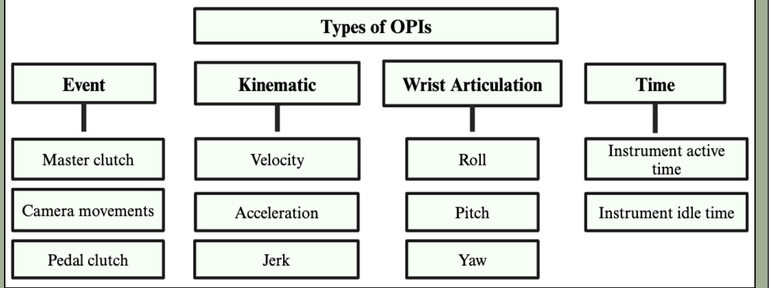
Differences in Objective Performance Indicators During Pelvic Dissection Steps of Robotic Proctectomy: Radiated versus Non-radiated Patients

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Introduction

- Despite perceived increased procedure complexity in radiated patients, there is an absence of objective intra-operative data
- *Objective performance indicators (OPIs),* metrics derived from robotic systems data, provide objective information regarding surgeon movements and robotic arm kinematics
- Aim: identify differences in OPIs during pelvic dissection steps of robotic proctectomy (RP) in rectal cancer patients who underwent preoperative radiation (XRT) or who had surgery alone (NRT)



Methods

- Endoscopic video synchronized to robotic systems data annotated to delineate surgical steps during 26 RPs (total of 1331 steps)
- 76 rectal mobilization and 613 total mesorectal excision steps analyzed
- OPIs compared between 10 XRT patients and 16 NRT patients
- Comparisons were made using T-test/Wilcoxon Sum-Rank test for numerical and Chi-square/Fisher's test for categorical covariates

Results

Differences in OPIs between XRT and NRT patients during pelvic dissection steps of RP

OPIs	Steps	XRT	NRT	p value
Step completion time [sec]	RM	172.2 [46.4 – 354.7]	77.1 [24.1 – 169.1]	**0.033**
Dominant wrist roll [rad]	RM	44.87 [9.02 - 80.61]	15.84 [4.99 - 37.26]	**0.013**
Dominant arm path length [m]	RM	3.70 [0.90 - 6.03]	1.43 [0.35 - 3.12]	**0.047**
Non-dominant arm path length [m]	RM	1.96 [0.41 – 3.58]	0.64 [0.19 – 1.48]	**0.020**
Non-dominant arm jerk [m/sec^3]	RM	23.54 [18.25 - 27.02]	19.17 [12.92 - 24.65]	**0.022**
Energy activation duration [sec]	PRD	2.5 [1.5 - 3.3]	2.0 [0.5 - 2.8]	**0.011**
Camera acceleration [m/sec^2]	PRD	0.83 [0.39 - 1.14]	1.01 [0.54 - 1.34]	**0.046**
Camera jerk [m/sec^3]	PRD	33.73 [20.28 - 48.61]	39.42 [24.05 - 55.47]	**0.045**
Dominant arm jerk [m/sec^3]	PRD	24.42 [19.89 - 30.21]	20.89 [16.99 - 29.06]	**0.033**
Dominant wrist roll [rad]	ARD	7.42 [2.68 - 19.94]	17.65 [4.27 - 46.08]	**0.030**
Dominant wrist pitch [rad]	ARD	6.08 [2.27 - 14.78]	12.91 [2.70 - 38.32]	**0.038**
Dominant arm velocity [m/sec]	ARD	0.06 [0.05 - 0.08]	0.08 [0.06 - 0.09]	**0.044**
Non-dominant wrist roll [rad]	RRD	1.17 [0.07 - 3.78]	2.68 [0.38 - 6.46]	**0.010**
Non-dominant arm acceleration [m/sec^2]	RRD	0.31 [0.10 - 0.49]	0.38 [0.19 - 0.57]	**0.048**
Master clutch use [n]	LRD	0 [0 – 2]	2 [0 – 5]	**0.025**
Camera path length [m]	LRD	0.02 [0 - 0.08]	0.07 [0.02 - 0.18]	**0.014**
Camera moving time [sec]	LRD	0.90 [0 - 3.33]	2.46 [0.78 - 7.43]	**0.010**
Camera velocity [m/sec]	LRD	0.05 [0 - 0.08]	0.07 [0.03 - 0.10]	**0.044**
Dominant wrist roll [rad]	LRD	5.64 [2.79 - 15.73]	15.77 [6.46 - 40.53]	**0.001**
Dominant wrist yaw [rad]	LRD	4.24 [2.16 - 12.13]	11.35 [5.52 - 29.75]	**<0.001**
Dominant wrist pitch [rad]	LRD	4.23 [2.22 - 12.44]	9.79 [4.79 - 25.90]	**0.002**

All variables are presented as median with interquartile range
RM = rectal mobilization, PRD = posterior rectal dissection, LRD = left rectal dissection, ARD = anterior rectal dissection, RRD = right rectal dissection, sec = seconds, rad = radians, m = meters, n = number

Clinical variables	XRT	NRT	p value
Distance from anal verge (median, cm)	7.0	15.0	**0.003**
T3/T4 stages (%)	100	42.9	**0.017**
Distal margin (median, mm)	18.5	39.0	**0.019**
Lymph node retrieval (median, n)	13.5	21	**0.002**

cm= centimeters, mm = millimeters, n = number

Discussion

- Assessment of surgery complexity is critical for understanding surgical workflow variability and intra-operative events
- In total, 35 OPIs significantly differed between the two groups
- Many differences were seen for instrument and camera kinematics, as well as surgeon wrist movements, across all pelvic dissection steps
- A **single patient characteristic**, pre-operative radiation, resulted in **objective differences** in surgeon techniques
- OPIs are unbiased, scalable metrics that may be useful in synoptic operative reporting

Conclusion

- Using OPIs, we identified significant differences in surgeon technique based on a single patient variable
- First study to identify step-specific OPIs that differ during RP in rectal cancer patients after radiation
- Lays the groundwork for understanding how varied patients require different surgeon techniques to achieve excellent outcomes