Correlation Between Blinded Expert Subjective Assessment and Objective Data on a Laparoscopic Cholecystectomy Virtual Reality Simulator

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Background

Virtual reality (VR) simulation allows trainees to repeatedly perform various complicated tasks, such as laparoscopic cholecystectomy (LC) without impacting patient care and can provide immediate objective metrics. This study aims to explore the correlation between subjective assessment and objective metrics, and to explore at which skill level they are found.

Hypothesis

There is a direct correlation between subjective assessment & objective metrics.

Material and Method

Study participants: PGY2–4 University of Chicago general surgery residents and invited attending surgeons who work in the Department of Surgery at NorthShore University HealthSystem.

Task and Objective metrics: LC case 1 on the Synbionix 3D LAP Mentor™ (3D Systems Healthcare, CO, USA). Average speed of instrument movement, number of movements, path length, and operative time were recorded.

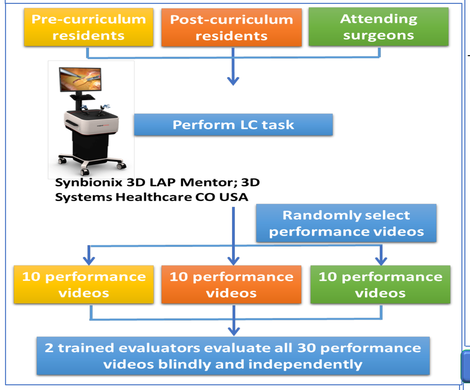
Subjective Assessment Sheets:

- LC-specific simulation assessment form (LC-SIM)
- Objective Structured Assessment of Technical Skills (OSATS)
- Global Operative Assessment of Laparoscopic Skills (GOALS)

Statistical analysis: 3 groups were compared using the Kruskal-Wallis test with the Dwass Steel, Critchlow-Flinger method for multiple comparisons. Spearman correlation coefficients were used to assess the association between evaluator assessment and objective simulator metrics.

	Pre-curriculum residents	Post-curriculum residents	Attending surgeons	*p*-value
Total Participants	10	10	10	-
Male [N (%)]	6 (60.0)	5 (50.0)	7 (70.0)	0.893
Age [Mean ± SD]	30 ± 2	29 ± 2	42 ± 9	**<0.001**
Experience [N (%)]				**<0.001**
PGY2	3 (30.0)	6 (60.0)	0 (0.0)	
PGY3	6 (60.0)	4 (40.0)	0 (0.0)	
PGY4	1 (10.0)	0 (0.0)	0 (0.0)	
< 10 years	0 (0.0)	0 (0.0)	4 (40.0)	
10-19 years	0 (0.0)	0 (0.0)	4 (40.0)	
20+ years	0 (0.0)	0 (0.0)	2 (20.0)	
Lap Procedures as a Primary Surgeon [N (%)]				**<0.001**
1-25	6 (60.0)	6 (60.0)	0 (0.0)	
26-50	0 (0.0)	1 (10.0)	0 (0.0)	
51-100	3 (30.0)	3 (30.0)	0 (0.0)	
101-200	1 (10.0)	0 (0.0)	2 (20.0)	
200+	0 (0.0)	0 (0.0)	8 (80.0)	
Lap Choles as a Primary Surgeon [N (%)]				**<0.001**
1-5	1 (10.0)	4 (40.0)	0 (0.0)	
6-25	7 (70.0)	5 (50.0)	0 (0.0)	
26-50	2 (20.0)	1 (10.0)	0 (0.0)	
51-100	0 (0.0)	0 (0.0)	2 (20.0)	
100+	0 (0.0)	0 (0.0)	8 (80.0)	
Hours spent on FLS or VR simulator [N (%)]				0.671
No Experience	0 (0.0)	3 (30.0)	1 (10.0)	
1-5 hours	2 (20.0)	1 (10.0)	2 (20.0)	
6-10 hours	4 (40.0)	3 (30.0)	2 (20.0)	
11-20 hours	1 (10.0)	1 (10.0)	1 (10.0)	
20+ hours	3 (30.0)	2 (20.0)	4 (40.0)	

Table 1. Participant demographics (Bolded value statistically significant with *p* value<0.001)



Result

- 30 performances were selected, 10 each from: 17 pre-curriculum residents, 23 post-curriculum residents, and 11 attendings.
- Significant differences were seen in age, years of experience, prior experience with laparoscopic procedures, and LC as primary surgeon. (p<0.001)

	Average speed of instrument movement (cm/sec)		Number of movement			Path length (cm)			Operation time (sec)	
	Left	Right	Total	Left	Right	Total	Left	Right	Total	To extract GB
Pre-curriculum residents										
LC-SIM(5-25)	-0.12	*-0.69*	**-0.83**	*-0.69*	**-0.80**	*-0.78*	*-0.74*	*-0.78*	*-0.69*	*-0.74*
OSATS(5-25)	-0.18	-0.36	**-0.83**	*-0.73*	**-0.81**	*-0.75*	**-0.83**	*-0.75*	*-0.70*	*-0.70*
GOALS(5-25)	-0.50	-0.50	**-0.84**	*-0.63*	**-0.87**	**-0.82**	**-0.95**	**-0.82**	*-0.75*	*-0.66*
Post-curriculum										
LC-SIM(5-25)	0.27	-0.30	-0.10	-0.05	-0.08	-0.12	0.14	-0.15	0.10	0.05
OSATS(5-25)	-0.08	-0.21	0.18	0.19	0.18	0.23	0.26	0.30	0.39	0.26
GOALS(5-25)	0.05	-0.14	0.36	0.31	0.42	0.42	0.47	0.39	0.57	0.45
Attending surgeons										
LC-SIM(5-25)	0.19	0.42	-0.11	-0.51	-0.09	0.08	-0.58	0.21	-0.18	-0.18
OSATS(5-25)	0.59	0.48	-0.24	0.15	-0.39	-0.04	-0.01	-0.25	-0.52	-0.52
GOALS(5-25)	0.48	0.48	-0.45	0.12	-0.59	-0.28	0.03	-0.47	*-0.72*	*-0.72*

Table2.Spearman Correlation Coefficients (r) between Total score of each Subjective Assessmet Score and Objective Metrics, 3 groups. (Bold&turned yellow mean|r|>0.8 p<0.05, Italic mean |r|>0.6 p<0.05, GB mean gallbladder)

- Pre-curriculum residents: As total LC-SIM, OSATS & GOALS scores increased, number of movements (Total & R) decreased. As OSATS total score increased, path length (L) shortened. As GOALS total score increased, path length (Total, L & R) shortened. (r<-0.08, p<0.05)
- No correlation between objective metrics and subjective assessment scores was seen for post-curriculum residents and attending surgeons.

	Average speed of instrument movement (cm/sec)		Number of movement			Path length (cm)			Operation time (sec)	
	Left	Right	Total	Left	Right	Total	Left	Right	Total	To extract GB
LC-SIM										
Incision/Port Placement (1-5	-0.03	-0.59	-0.42	-0.32	-0.33	-0.35	-0.23	-0.35	-0.21	-0.10
Exposure (1-5)	-0.01	-0.36	*-0.73*	-0.61	*-0.72*	*-0.66*	*-0.66*	*-0.66*	*-0.65*	-0.62
Duct Dissection (1-5)	0.05	-0.47	-0.44	-0.39	-0.44	-0.40	-0.46	-0.40	-0.54	-0.50
Cystic Artery Dissection (1-5	-0.45	*-0.76*	-0.46	-0.38	-0.43	-0.52	-0.46	-0.52	-0.36	-0.37
Gallbladder Dissection (1-5)	-0.25	-0.31	*-0.75*	-0.49	*-0.75*	*-0.70*	*-0.70*	*-0.70*	-0.59	-0.52
OSATS										
Instrument Handling (1-5)	-0.17	-0.48	**-0.89**	**-0.80**	**-0.86**	**-0.82**	**-0.86**	**-0.82**	*-0.77*	*-0.79*
Respect for tissue (1-5)	-0.52	-0.56	**-0.86**	*-0.69*	**-0.86**	**-0.90**	**-0.84**	**-0.90**	*-0.72*	*-0.72*
Time and Motion (1-5)	-0.36	-0.34	*-0.79*	*-0.67*	*-0.77*	*-0.70*	**-0.86**	*-0.70*	-0.63	-0.60
Operation Flow (1-5)	-0.03	-0.16	*-0.75*	**-0.82**	*-0.73*	*-0.68*	*-0.72*	*-0.68*	*-0.75*	*-0.75*
Overall Performance (1-5)	-0.13	-0.44	**-0.84**	*-0.73*	**-0.82**	*-0.77*	**-0.80**	*-0.77*	*-0.72*	*-0.75*
GOALS										
Depth Perception (1-5)	-0.21	-0.18	*-0.76*	*-0.73*	*-0.73*	*-0.67*	*-0.79*	*-0.67*	-0.62	-0.62
Bimanual Dexterity (1-5)	-0.56	0.06	-0.40	-0.16	-0.45	-0.38	-0.59	-0.38	-0.30	-0.14
Efficiency (1-5)	-0.28	-0.43	*-0.78*	*-0.70*	**-0.80**	-0.75	**-0.88**	-0.75	**-0.81**	*-0.72*
Tissue Handling (1-5)	-0.69	*-0.75*	-0.60	-0.31	*-0.68*	*-0.71*	*-0.69*	*-0.71*	-0.58	-0.44
Autonomy (1-5)	-0.34	-0.41	*-0.76*	*-0.64*	*-0.79*	*-0.74*	*-0.85*	*-0.74*	*-0.76*	*-0.67*

Table 3. Spearman Correlation Coefficients (r) between each item of each Subjective Assessment and Objective Metrics, pre-curriculum residents. (Bold&turned yellow mean|r|>0.8 p<0.05, Italic mean |r|>0.6 p<0.05, GB mean gallbladder)

- OSATS: As "Instrument handling" scores increased, number of movements (Total, L & R) decreased and path length (Total, L & R) shortened. As "Respect for tissue" scores increased, number of movements (Total & R) decreased and path length (Total, L & R) shortened. As "Time and Motion" scores increased, path length (L) shortened. As "Operation flow" scores increased, number of movements (L) decreased. As "Overall Performance" scores increased, path length (L) shortened. (r<-0.08, p<0.05)
- GOALS: As "Efficiency " scores increased, number of movements (R) decreased and path length (L) & operation time shortened. (r<-0.08, p<0.05)

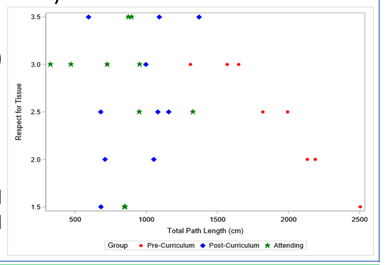


Figure 1. Scatterplot of Total Path Length and "Respect for Tissue" scores in OSATS, stratified by group.

Discussion and Conclusion

Pre-curriculum residents who performed significantly fewer movements with shorter path lengths had higher subjective assessment scores. A combination of subjective assessment and objective metrics might provide more accurate and instantaneous feedback for pre-curriculum residents.