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A Novel Approach to Evaluating the Learning Curve in Laparoscopic Liver Resections Incorporating Case Complexity

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Why study the learning curve



Goals

- Strategies to soften the learning curve
- Credentialing
- Assist with patient selection
- Training fellows and tracking progress
- Standardization

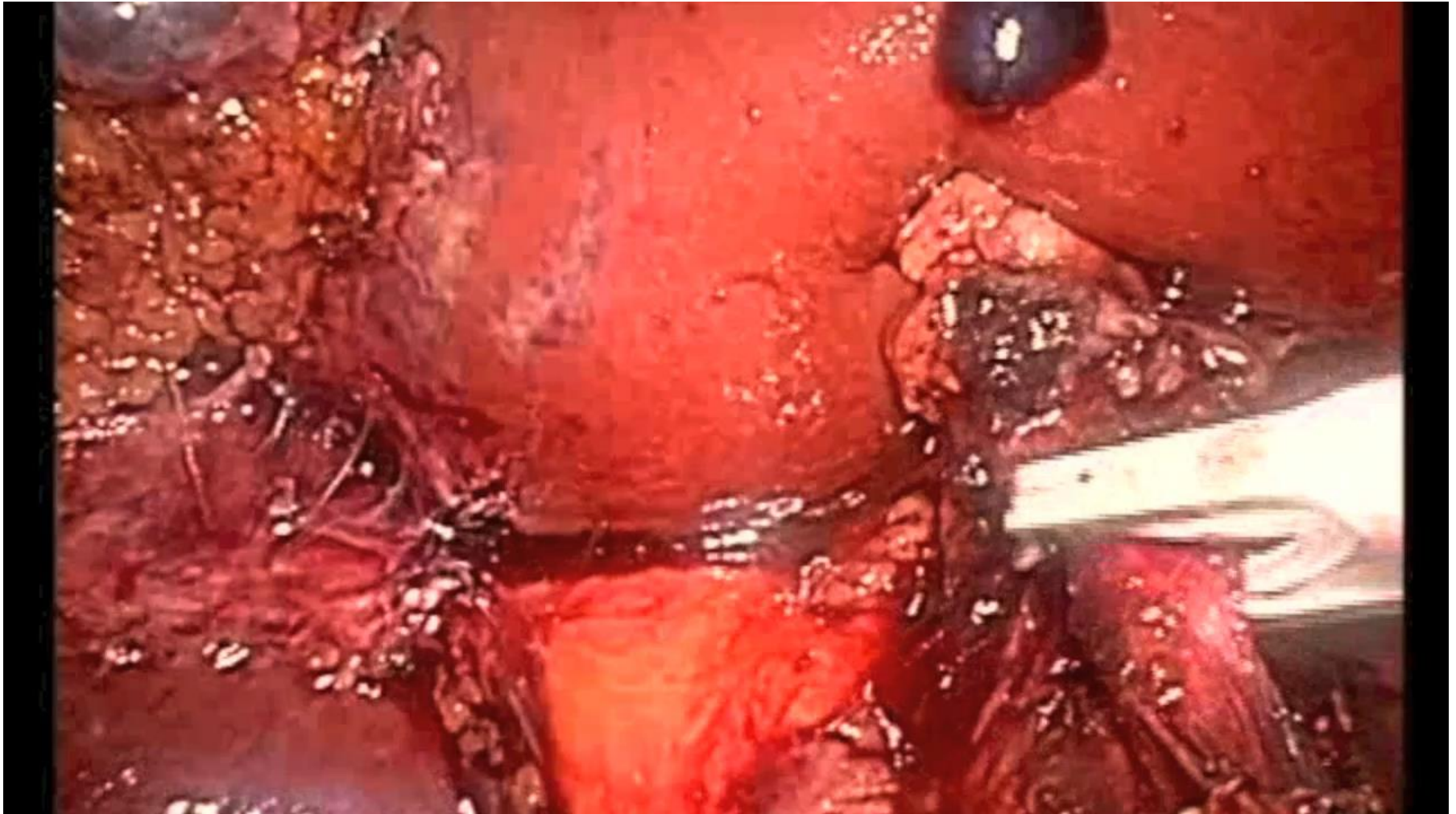
Challenges

- Methodology
 - Variable skills may require different methodology
 - Case complexity
- Open and lap learning curve
- Reproducibility
- Retrospective
 - Video

The start of my learning curve...

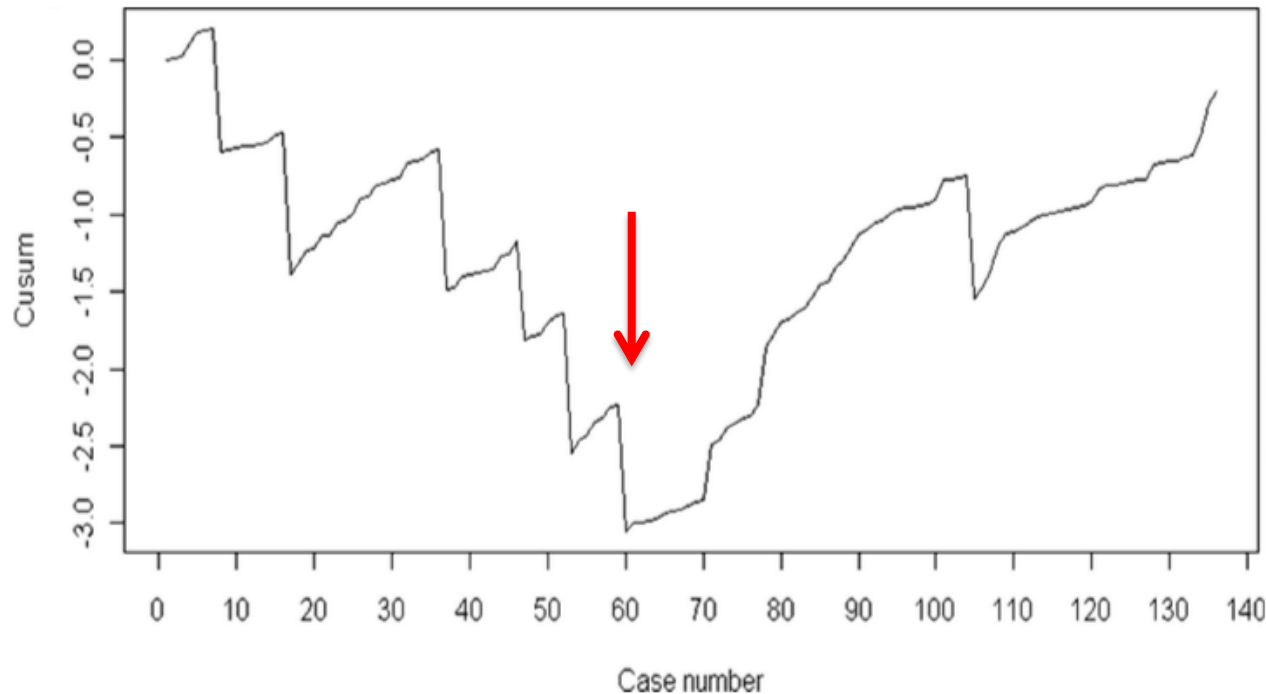


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Learning Curve in LLR



Conversion rate through
3 periods adjusted for:

- type of resection
- age
- Size of lesions
- presence of cirrhosis

FIGURE 3. Risk-adjusted CUSUM chart of a series of 136 consecutive laparoscopic minor hepatectomies.

MSK Learning Curve in LLR



Study aim

- Evaluate the learning curve for LLR using an objective difficulty score describing case complexity

Methods

- 153 LLR, majority 2011-2015
- 60 consecutive cases from highest volume surgeon further stratified, cases divided into groups of 15 cases
- Exclusion: cyst fenestrations, two surgeon cases, robotic liver resections/pumps
- Stratified by difficulty of laparoscopic resection using a difficulty score¹

MSK Learning Curve in LLR



Assessing for difficulty of laparoscopic resection: 10-point scale

Tumor location		Tumor size																	
<table border="1"> <thead> <tr> <th>Segment</th> <th>Score</th> </tr> </thead> <tbody> <tr><td>S2</td><td>2</td></tr> <tr><td>S3</td><td>1</td></tr> <tr><td>S4</td><td>3</td></tr> <tr><td>S5</td><td>3</td></tr> <tr><td>S6</td><td>2</td></tr> <tr><td>S7</td><td>5</td></tr> <tr><td>S8</td><td>5</td></tr> </tbody> </table>	Segment	Score	S2	2	S3	1	S4	3	S5	3	S6	2	S7	5	S8	5			Score
	Segment	Score																	
S2	2																		
S3	1																		
S4	3																		
S5	3																		
S6	2																		
S7	5																		
S8	5																		
		<3 cm	0																
		≥3 cm	1																
Extent of liver resection		Proximity to major vessel																	
	Score	Proximity to major vessel*	Score																
Hr0 (partial resection)	0	no	0																
Hr-LLR (left lateral sectionectomy)	2	yes	1																
Hr-S (segmentectomy)	3																		
Hr-1, 2 (not less than a sectionectomy)	4																		
		Liver function																	
			Score																
		Child-Pugh A	0																
		Child-Pugh B	1																

*The main or second branches of Glisson's tree, Major hepatic vein, and inferior vena cava

MSK Learning Curve in LLR



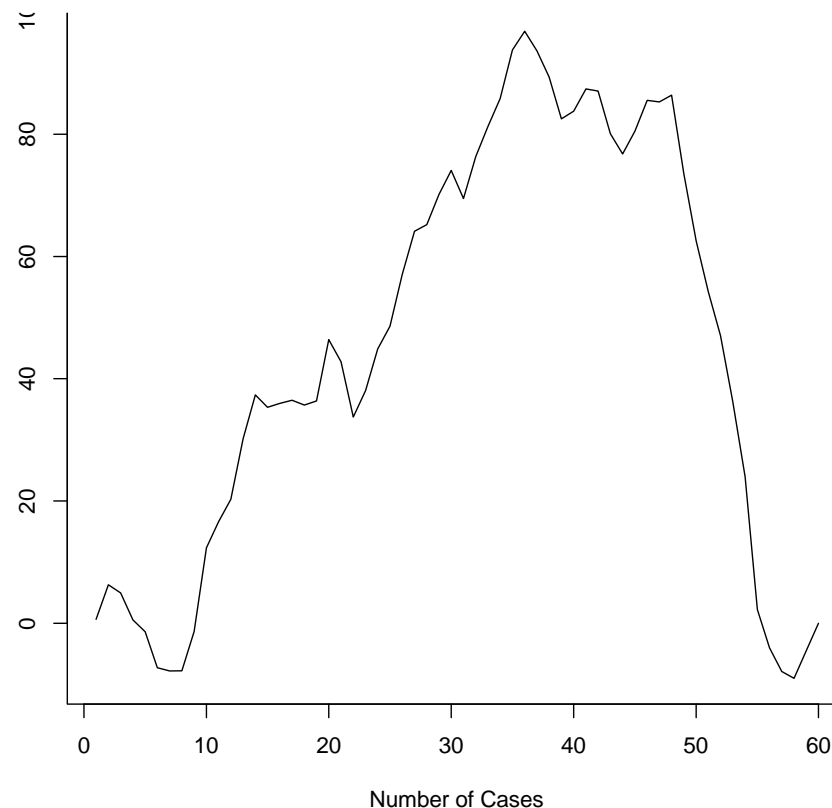
Assessing for difficulty of laparoscopic resection

Difficulty of laparoscopic liver resection										
10-level index	1	2	3	4	5	6	7	8	9	10
Three-level index	Low			Intermediate			High			
Definition	<ul style="list-style-type: none"> For surgeons starting laparoscopic liver resection For surgeons with experience of <10 cases of laparoscopic liver resection 			<ul style="list-style-type: none"> For surgeons who can consistently perform laparoscopic liver resection in “low difficulty” cases For surgeons with experience of ≥ 10 and <50 cases of laparoscopic liver resection 			<ul style="list-style-type: none"> For surgeons who can consistently perform laparoscopic liver resection in “intermediate difficulty” cases For surgeons with experience of ≥ 50 cases of laparoscopic liver resection 			
Landmark Operation										

MSK Learning Curve in LLR



- Difficulty score was a significant predictor for all outcome measures ($p < 0.05$)
- Conversion rate ($B = -0.57$; $p < 0.001$) and blood loss ($B = -0.01$, $p = 0.038$) improved over time



MSK Learning Curve in LLR



Variable	Value (% or range)
BMI (median)	29 (18-49)
Pre-malignant/benign	12 (20%)
Primary liver cancer	8 (13%)
Gallbladder cancer	2 (3%)
Liver metastases	37 (62%)
Number of tumors	
1	42 (70%)
2-3	10 (17%)
4-5	3 (5%)
unknown	5 (8%)

MSK Learning Curve in LLR



Variable	Cases 0-15	Cases 46-60
Operative time (min), range	245 (90-464)	189 (74-401)
Blood loss (log scale), range	5.7 (2.3-6.9)	4.8 (3-6.2)
Conversion to open (%)	7 (47)	1 (7)
Any complications (%)	3 (20)	3 (20)
Length of Stay (days), median, range	5 (1-8)	4 (1-7)
Difficulty Score (median)	5 (3-10)	6 (2-9)

MSK Learning Curve in LLR



Logistic regression: number of prior procedures and difficulty score

		Beta	95% CI	P-value
Op time (min)	# Procedures	-0.79	-2.04-0.45	0.21
	Difficulty score	22.90	13.54-32.26	<.001
Length of stay	# Procedures	-.01	-0.04-0.02	0.66
	Difficulty score	0.32	0.09-0.54	0.007
EBL (log)	# Procedures	-0	-0.02-0.01	0.63
	Difficulty score	0.19	0.06-0.33	0.006

MSK Learning Curve in LLR



Outcomes by number of prior procedures controlling for difficulty score

		Beta	95% CI	P-value
Any complications	# Procedures	0.99	.95-1.03	0.63
	Difficulty score	1.22	0.91-1.63	0.18
Conversion to open	# Procedures	0.91	0.86-0.97	0.002
	Difficulty score	1.79	1.18-2.72	0.006

Conversion rate learning curve:

- <10 procedures: 70% chance
- 20 procedures: 25% chance
- 40 procedures: 6%

Conclusions



1. Conversion rates significantly decreased over time with increasing case volume – best outcome measure for a learning curve?

2. The difficulty score was a significant predictor for all outcome measures

3. This score can be used
 - Early in the laparoscopic liver experience to identify optimal cases
 - For standardization

Thank you



- Prof. Gayet
- Prof. Jarnagin
- Prof. Blumgart