RETROSPECTIVE ANALYSIS OF SURGICAL OUTCOMES AND COSTS COMPARING ROBOTIC VS LAPAROSCOPIC CHOLECYSTECTOMY FOR URGENT/EMERGENT PATIENTS IN A BUSY COMMUNITY SETTING

Monia A Yovic, MD1; Luis A Hernández-Flores, MD2; Daniel Aillaud-De-Uriarte, MD3; Eric Acosta Marquez2; Victor Peña, MD4; Diego Marines-Copado, MD2; 1General Surgery WBAMC, El Paso, Texas, USA; 2Houston Methodist Willowbrook Hospital, Houston, TX, USA; 3Harvard Medical School, Boston, USA; 4Universidad de Monterrey, Mexico
Houston Methodist Willowbrook

Objective of the study

Cholecystectomy, commonly performed in the United States with over 700,000 cases annually, incurs significant healthcare costs of approximately $6.5 billion USD. Despite advancements in robotic surgery since its FDA approval in 2000, its cost-effectiveness compared to traditional laparoscopic cholecystectomy (LC) in non-academic settings remains uncertain. This study compares the cost-effectiveness, safety, and feasibility of robotic-assisted cholecystectomy (RC) versus LC for urgent/emergent cases in a non-academic community hospital.

Methods and Procedures

This retrospective cohort study included 132 patients who underwent LC (n=110) or RC (n=22) from January 2019 to January 2022. Inclusion criteria were patients over 18 years with acute cholecystitis or acute cholangitis who had surgery within 24 hours of emergency department arrival. Data were collected from electronic medical records, focusing on cost-effectiveness, complications, and readmissions as primary outcomes, with secondary outcomes including operative time, estimated blood loss, hospital length of stay, imaging studies, and discharge pain management. Statistical analyses included Chi-square, Fisher's exact tests, Wilcoxon rank-sum test, and generalized linear modeling.

Table 1. Cost variables

	Total (N=131)	Laparoscopic (*n*=110)	Robotic (*n*=21)	p-value
Charges, median (IQR)	66270 (58258, 79643)	65263 (56380, 76711)	76589 (63061, 88883)	0.01
Actual Payments, median (IQR)	8202 (440, 12412)	7913 (150, 10526)	8701 (4051, 14464)	0.32
Net Revenue ENR, median (IQR)	8823 (1541, 12964)	8832.5 (1105, 12057)	8701 (5268, 16315)	0.34
Direct Cost, median (IQR)	5386 (4292, 6549)	5148.5 (4100, 6063)	6668 (6134, 8298)	<0.001
Contribution margin ENR, median (IQR)	3558 (-3176, 6819)	3709 (-3406, 6565)	2243 (-54, 10796)	0.96
Indirect Cost, median (IQR)	5207 (4164, 6822)	5033.5 (4107, 6666)	6441 (4894, 8320)	0.052
Net Margin ENR, median (IQR)	-2341 (-8707, 2283)	-2141 (-8707, 2189)	-3555 (-6175, 5837)	0.84
CC DEPR, median (IQR)	279.8 (238.5, 407)	262.6 (233.5, 378.1)	373.3 (298.7, 504.8)	0.003
CC DRUGS, median (IQR)	200.9 (128.8, 334.4)	172.3 (125.3, 311.6)	306.8 (194.8, 418.3)	0.01
CC MEDSUPPBILL, median (IQR)	39.3 (15.1, 112.3)	41.1 (15.9, 118.3)	26.2 (8, 74.7)	0.10
CC MEDSUPPNONBILL, median (IQR)	1253.4 (973.8, 1739.6)	1183.4 (937.4, 1510.2)	2297.7 (2198.3, 3045.6)	<0.001
CC OTHEREXP, median (IQR)	444 (303.4, 638.6)	387.1 (295.7, 566.9)	935.7 (584.8, 1092.7)	<0.001
CC SALARYBENEFITS, median (IQR)	2762.9 (2032.5, 3572.2)	2776.1 (2031.1, 3540)	2762.9 (2177.9, 3792.3)	0.81
Total adjusted Encounter level, median (IQR)	52268.9 (32667.8, 67338.1)	50260.9 (28935.9, 64463.9)	61524.6 (52012.7, 72391)	0.07
Direct cost per day, median (IQR)	3374 (2634, 5178)	3335.3 (2521, 4777)	5465 (3504, 6367)	0.03

IQR: Interquartile range, ENR: Expected net revenue, CC: Cost Center MEDSUPPBILL: Medical Support Billed, DEPR: Depreciation

Table 2. Patients' demographic

	Total (N=132)	Laparoscopic (*n*=110)	Robotic (*n*=22)	*p*-value
Demographic and clinical parameters				
Age (years), median (IQR)	42.0 (30.0, 53.0)	40.0 (28.0, 53.0)	44.5 (39.0, 51.0)	0.16
Sex				0.86
Female	98 (74.2)	82 (74.5)	16 (72.7)	
Male	34 (25.8)	28 (25.5)	6 (27.3)	
Body mass index (kg/m2), median (IQR)	30.2 (26.1, 36.3)	30.1 (26.3, 35.5)	31.3 (26.0, 41.5)	0.48
ASA group				0.77
1	8 (6.1)	6 (5.5)	2 (9.1)	
2	89 (67.4)	75 (68.2)	14 (63.6)	
3	34 (25.8)	28 (25.5)	6 (27.3)	
4	1 (0.8)	1 (0.9)	0 (0.0)	
Preoperative outcomes				
Any imaging procedure done				0.31
No	2 (1.5)	1 (0.9)	1 (4.5)	
Yes	130 (98.5)	109 (99.1)	21 (95.5)	
Number imaging procedure done				0.14
0-1	59 (44.7)	46 (41.8)	13 (59.1)	
≥2	73 (55.3)	64 (58.2)	9 (40.9)	
Type of imaging procedure done				
Any ultrasound done	112 (84.8)	95 (86.4)	17 (77.3)	0.28
CT abdomen pelvis with contrast	47 (35.6)	42 (38.2)	5 (22.7)	0.17
CT abdomen pelvis without contrast	5 (3.8)	3 (2.7)	2 (9.1)	0.19
HIDA	8 (6.1)	6 (5.5)	2 (9.1)	0.62
Intraoperative cholangiogram	12 (9.1)	11 (10.0)	1 (4.5)	0.69
MRI cholangiogram without contrast	11 (8.3)	11 (10.0)	0 (0.0)	0.21
Operative outcomes				
Procedure time (min), median (IQR)	42.0 (32.0, 64.0)	38.5 (31.0, 54.0)	76.0 (63.0, 105.0)	<0.001
Blood loss (mL), median (IQR)	10.0 (5.0, 20.0)	10.0 (5.0, 20.0)	10.0 (5.0, 20.0)	0.93
Postoperative outcomes				
Length of stay (days), median (IQR)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 2.0)	0.69
Pain management hospital	132 (100.0)	110 (100.0)	22 (100.0)	--
Opioid hospital	132 (100.0)	110 (100.0)	22 (100.0)	--
Non opioid hospital	113 (85.6)	95 (86.4)	18 (81.8)	0.52
Pain management home	120 (90.9)	101 (91.8)	19 (86.4)	0.42
Opioid home	116 (87.9)	97 (88.2)	19 (86.4)	0.73
Non opioid home	24 (18.2)	20 (18.2)	4 (18.2)	1.00
Readmission	--	--	--	--

CT: Computed tomography, HIDA: Hepatobiliary Iminodiacetic Acid Scan, IQR: Interquartile

Results

Of the 131 patients, demographic characteristics were similar between LC and RC groups. RC had a significantly longer operative time (76 minutes vs. 38.5 minutes, p=0.001) and higher costs, with direct and indirect costs significantly greater than LC (p=0.001 and p=0.05, respectively). No significant differences were observed in postoperative outcomes, including hospital length of stay, pain management, and readmission rates.

Conclusions

RC is as safe and feasible as LC for urgent/emergent cases, though it incurs higher costs and longer operative times. Decisions regarding surgical technique should consider the facility's capabilities and surgeon's expertise. Further research in diverse hospital settings is necessary to evaluate the broader applicability and economic impact of RC.

References

1. Shaffer EA: Gallstone disease: Epidemiology of gallbladder stone disease. Best Pract Res Clin Gastroenterol. 2006, 20:981–96. 10.1016/j.bpg.2006.05.004
2. Stinton LM, Shaffer EA: Epidemiology of Gallbladder Disease: Cholelithiasis and Cancer. Gut Liver. 2012, 6:172–87. 10.5009/gnl.2012.6.2.172
3. Schirmer BD, Winters KL, Edlich R: Cholelithiasis and Cholecystitis. J Long Term Eff Med Implants. 2005, 15:. 10.1615/JLongTermEffMedImplants.v15.i3.90
4. Everhart JE, Khare M, Hill M, Maurer KR: Prevalence and ethnic differences in gallbladder disease in the United States. Gastroenterology. 1999, 117:632–9. 10.1016/s0016-5085(99)70456-7
5. Tazuma S: Gallstone disease: Epidemiology, pathogenesis, and classification of biliary stones (common bile duct and intrahepatic). Best Pract Res Clin Gastroenterol. 2006, 20:1075–83. 10.1016/j.bpg.2006.05.009
6. Huang Y, Chua TC, Maddern GJ, Samra JS: Robotic cholecystectomy versus conventional laparoscopic cholecystectomy: A meta-analysis. Surgery. 2017, 161:628–36. 10.1016/j.surg.2016.08.061
7. Reynolds W: The first laparoscopic cholecystectomy. JSLS. 2001, 5:89–94.
8. Morrell ALG, Morrell-Junior AC, Morrell AG, Mendes JMF, Tustumi F, De-Oliveira-E-Silva LG, Morrell A: The history of robotic surgery and its evolution: when illusion becomes reality. Rev Colégio Bras Cir. 2021, 48:e20202798. 10.1590/0100-6991e-20202798
9. Himpens J, Leman G, Cadiere GB: Telesurgical laparoscopic cholecystectomy. Surg Endosc. 1998, 12:1091. 10.1007/s004649900788
10. Zaman JA, Singh TP: The emerging role for robotics in cholecystectomy: the dawn of a new era? Hepatobiliary Surg Nutr. 2018, 7:21–8. 10.21037/hbsn.2017.03.01