HHS Public Access
Author manuscript
Br J Surg. Author manuscript; available in PMC 2023 March 15.

Published in final edited form as:
Br J Surg. 2022 March 15; 109(4): 311–314. doi:10.1093/bjs/znab463.

Robotic and laparoscopic right anterior sectionectomy and central hepatectomy: multicentre propensity score-matched analysis

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Introduction

The role of minimally invasive major hepatectomy today is a hotly debated topic. It is viewed as an innovative procedure that should be performed only by experienced surgeons in specialist centres[1–4]. Right anterior sectionectomy and central hepatectomy for centrally located tumours are traditionally viewed as complex and technically demanding procedures with a higher perioperative morbidity rate, especially via a minimally invasive approach[5,6]. This post hoc analysis of databases (2010–2020) aimed to establish outcome data.

Results

Of a total of 9293 patients, 233 (2.5 per cent) underwent minimally invasive right anterior sectionectomy or central hepatectomy (48 robotic and 185). See Supplementary methods, Tables S1–S3 and Figs S1–S5 for methods, definitions, surgical technique, inclusion criteria, definitions, and statistical methods[7–9]. Baseline clinicopathological characteristics and perioperative outcomes for both cohorts are summarized in Tables 1 and 2. Although hepatocellular carcinoma was the most common indication overall, patients undergoing robotic surgery were more likely to have other pathology (perhaps indicating selection). The distribution of minimally invasive resections was stable over time (Figs S6–S8).

Patients suitable for robotic surgery had less blood loss and morbidity than those having other approaches, but a similar duration of hospital stay, and rates of conversion and reoperation. Blood loss was lower with robotic surgery, even with propensity score matching, but it was not a clinically significant difference. No differences in transfusion requirements were observed as a result.

Discussion

A steep learning curve has proven to be a major stumbling block in widespread application of minimally invasive liver resection[10–12]. There is some evidence that robotic platforms may be beneficial at the expense of higher costs[13–18]. Right anterior and central resections are two of the most technically demanding owing to wide parenchymal planes with close proximity to critical structures and major vessels[5,6,19]. Those suitable for minimal access approaches have less blood loss, a shorter postoperative hospital stay, and lower morbidity, but longer operating times[5,6,19]. Both procedures were associated with a relatively low volume of blood loss in the present study, and it was better in the robotic group. It is likely that experienced surgeons with a special interest would have performed the robotic resections in selected patients[20].

There is an inherent risk of confounding bias with a relatively small sample size in this study. The relatively long time period inevitably confounds results, given the rapid and significant improvements in surgical technology and perioperative care over time. Nonetheless, there was no significant difference in the proportion of robotic versus laparoscopic approaches performed over time. There was no patient selection or operative standardization, but the multicentre study provides validity to the results.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosure.

B.K.P.G. has received travel grants and honoraria from Johnson and Johnson and Transmedic, the local distributor for the Da Vinci® robot. M.V.M. is a consultant for CAVA Robotics. J.P. reports a research grant from Intuitive Surgical Deutschland, and personal fees or non-financial support from Johnson & Johnson, Medtronic, AFS Medical, Astellas, CHG Meridian, Chiesi, Falk Foundation, La Fource Group, Merck, Neovii, NOGGO, pharma-consult Peterson, and Promedicis. M.S. (collaborator) reports personal fees or other support outside of the submitted work from Merck, Bayer, ERBE, Amgen, Johnson & Johnson, Takeda, Olympus, Medtronic, and Intuitive. F.R. reports speaker fees and support outside the submitted work from Integra, Medtronic, Olympus, Corza, Sirtex and Johnson & Johnson.

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Table 1

Comparison of baseline clinicopathological characteristics in patients undergoing robotic versus laparoscopic right anterior sectionectomy and central hepatectomy

	Unmatched cohort			1 : 2 propensity-matched cohort			1 : 1 propensity-matched cohort		
	R-RAS/CH (n = 48)	L-RAS/CH (n = 185)	p†	R-RAS/CH (n = 34)	L-RAS/CH (n = 68)	p‡	R-RAS/CH (n = 40)	L-RAS/CH (n = 40)	p§
Age (years)*	60 (51–67)	63 (56–70)	0.034	61 (54–70)	62 (55–68)	0.712	62 (55–68)	62 (54–72)	0.630
Men	37 of 48 (77.1)	142 of 185 (76.8)	0.962	28 of 34 (82.4)	57 of 68 (83.8)	0.855	32 of 40 (80.0)	33 of 40 (82.5)	0.901
ASA grade			0.587			0.888			0.881
I	8 of 48 (16.7)	19 of 185 (10.3)		4 of 34 (11.8)	9 of 68 (13.2)		5 of 40 (12.5)	5 of 40 (12.5)	
II	29 of 48 (60.4)	125 of 185 (67.6)		20 of 34 (58.8)	42 of 68 (61.8)		24 of 40 (60.0)	22 of 40 (55.0)	
III	11 of 48 (22.9)	40 of 185 (21.6)		10 of 34 (29.4)	17 of 68 (25.0)		11 of 40 (27.5)	13 of 40 (32.5)	
IV	0 of 48 (0)	1 of 185 (0.5)		0 of 34 (0)	0 of 68 (0)		0 of 40 (0)	0 of 40 (0)	
Right anterior sectionectomy	36 of 48 (75.0)	118 of 185 (63.8)	0.144	26 of 34 (76.5)	52 of 68 (76.5)	1.000	30 of 40 (75.0)	32 of 40 (80.0)	0.800
Central hepatectomy	12 of 48 (25.0)	67 of 185 (36.2)		8 of 34 (23.5)	16 of 68 (23.5)		10 of 40 (25.0)	8 of 40 (20.0)	
Previous abdominal surgery	12 of 48 (25.0)	60 of 185 (32.4)	0.321	10 of 24 (29.4)	20 of 68 (29.4)	1.000	11 of 40 (27.5)	13 of 40 (32.5)	0.683
Previous liver surgery	3 of 48 (6.3)	13 of 185 (7.0)	0.850	3 of 34 (8.8)	3 of 68 (4.4)	0.396	3 of 40 (7.5)	2 of 40 (5.0)	0.655
Malignant pathology	41 of 48 (85.4)	181 of 185 (97.8)	0.001	33 of 34 (97.1)	66 of 68 (97.1)	1.000	38 of 40 (95.0)	38 of 40 (95.0)	1.000
Pathological type			0.003			0.786			0.896
HCC	26 of 48 (54.2)	125 of 185 (67.6)		23 of 34 (67.7)	47 of 68 (69.1)		25 of 40 (62.5)	27 of 40 (67.5)	
CRM	7 of 48 (14.6)	39 of 185 (21.1)		6 of 34 (17.7)	14 of 68 (20.6)		7 of 40 (17.5)	6 of 40 (15.0)	
Others	15 of 48 (31.3)	21 of 185 (11.4)		5 of 34 (14.7)	7 of 68 (10.3)		8 of 40 (20.0)	7 of 40 (17.5)	
Cirrhosis	19 of 48 (39.6)	81 of 185 (43.8)	0.600	15 of 34 (44.1)	31 of 68 (45.6)	0.892	18 of 40 (45.0)	19 of 40 (47.5)	0.869
Child–Pugh grade			0.058			0.892			0.974
No cirrhosis	29 of 48 (60.4)	104 of 185 (56.2)		19 of 34 (55.9)	37 of 68 (54.4)		22 of 40 (55.0)	21 of 40 (52.5)	
A	16 of 48 (33.3)	79 of 185 (42.7)		15 of 34 (44.1)	31 of 68 (45.6)		16 of 40 (40.0)	17 of 40 (42.5)	
B	3 of 48 (6.3)	2 of 185 (1.1)		0 of 34 (0)	0 of 68 (0)		2 of 40 (5.0)	2 of 40 (5.0)	
Portal hypertension	4 of 48 (8.3)	14 of 185 (7.6)	0.859	1 of 34 (2.9)	5 of 68 (7.4)	0.403	3 of 40 (7.5)	3 of 40 (7.5)	1.000
Tumour size (mm)*	40 (30–50)	34 (26–50)	0.221	38 (29–47)	35 (30–51)	0.649	38 (30–49)	35 (30–50)	0.524
Multiple tumours	9 of 48 (18.8)	45 of 185 (24.3)	0.415	6 of 34 (17.6)	16 of 68 (23.5)	0.507	7 of 40 (17.5)	10 of 40 (25.0)	0.467
Multiple resections	0 of 48 (0)	14 of 185 (7.6)	0.049	0 of 34 (0)	0 of 68 (0)	1.000	0 of 40 (0)	0 of 40 (0)	1.000

	Unmatched cohort			1 : 2 propensity-matched cohort			1 : 1 propensity-matched cohort		
	R-RAS/CH (n = 48)	L-RAS/CH (n = 185)	P†	R-RAS/CH (n = 34)	L-RAS/CH (n = 68)	P‡	R-RAS/CH (n = 40)	L-RAS/CH (n = 40)	P§
Concomitant operation, not cholecystectomy	7 of 48 (14.6)	10 of 185 (5.4)	0.029	2 of 34 (5.9)	6 of 68 (8.8)	0.489	5 of 40 (12.5)	6 of 40 (15.0)	0.763
Iwate score			0.291			0.865			0.628
Low	0 of 48 (0)	0 of 185 (0)		0 of 34 (0)	0 of 68 (0)		0 of 40 (0)	0 of 40 (0)	
Intermediate	0 of 48 (0)	0 of 185 (0)		0 of 34 (0)	0 of 68 (0)		0 of 40 (0)	0 of 40 (0)	
High	8 of 48 (16.7)	44 of 185 (23.8)		7 of 34 (20.6)	15 of 68 (22.1)		8 of 32 (20.0)	4 of 40 (10.0)	
Expert	40 of 48 (83.3)	141 of 185 (76.2)		27 of 34 (79.4)	53 of 68 (77.9)		32 of 40 (80.0)	36 of 40 (90.0)	

Values in parentheses are percentages unless indicated otherwise;

* values are median (i.q.r.). R-RAS/CH, robotic right anterior sectionectomy/central hepatectomy; L-RAS/CH, laparoscopic right anterior sectionectomy/central hepatectomy; HCC, hepatocellular carcinoma; CRM, colorectal cancer metastases.

† From unpaired analyses i.e. Mann-Whitney U test and Pearson’s chi-square test;

‡ From Wilcoxon signed rank test and McNemar’s chi-square test;

§ From mixed-effects quantile regression (in which a random-effects parameter was used to denote the 1:2 matched data structure), conditional logistic, or mixed-effects ordinal logistic regression.

Table 2

Comparison of perioperative outcomes after robotic versus laparoscopic right anterior sectionectomy and central hepatectomy

	Entire unmatched cohort			1 : 2 propensity-matched cohort			1 : 1 propensity-matched cohort		
	R-RAS/CH (n = 48)	L-RAS/CH (n = 185)	P†	R-RAS/CH (n = 34)	L-RAS/CH (n = 68)	P‡	R-RAS/CH (n = 40)	L-RAS/CH (n = 40)	P§
Duration of operation (min)*	307 (209–496)	315 (231–435)	0.776	355 (248–530)	285 (210–365)	0.047	339 (228–505)	298 (210–358)	0.133
Blood loss (ml)*	200 (100–500)	371 (200–650)	0.001	200 (100–500)	300 (192–700)	0.020	200 (100–500)	350 (200–725)	0.019
Intraoperative blood transfusion	5 of 48 (10.4)	31 of 185 (16.8)	0.279	4 of 34 (11.8)	12 of 68 (17.6)	0.418	4 of 40 (10.0)	9 of 40 (22.5)	0.166
Pringle manoeuvre applied	29 of 48 (60.4)	123 of 185 (66.5)	0.431	18 of 34 (52.9)	47 of 68 (69.1)	0.082	21 of 40 (52.5)	32 of 40 (80.0)	0.131
Median duration of Pringle manoeuvre when applied (min)*	60 (38–82)	60 (30–98)	0.902	75 (50–89)	60 (30–100)	0.582	61 (50–84)	63 (53–98)	0.853
Conversion to open surgery	2 of 48 (4.2)	11 of 185 (5.9)	0.632	2 of 34 (5.9)	3 of 68 (4.4)	0.753	2 of 40 (5.0)	2 of 40 (5.0)	1.000
Duration of postoperative hospital stay (days)*	7 (5–10)	8 (6–12)	0.217	8 (6–11)	7 (6–10)	0.580	7 (6–11)	8 (5–10)	0.853
30-day readmission	2 of 48 (4.2)	7 of 184 (3.8)	0.908	1 of 34 (2.9)	3 of 68 (4.4)	0.726	1 of 40 (2.5)	4 of 40 (10.0)	0.180
Postoperative morbidity	9 of 48 (18.8)	62 of 185 (33.5)	0.048	8 of 34 (23.5)	20 of 68 (29.4)	0.548	8 of 40 (20.0)	14 of 40 (35.0)	0.201
Major morbidity (Clavien–Dindo grade . II)	3 of 48 (6.3)	13 of 185 (7.0)	0.850	2 of 34 (5.9)	2 of 68 (2.9)	0.488	2 of 40 (5.0)	2 of 40 (5.0)	1.000
Reoperation	1 of 48 (2.1)	2 of 185 (1.1)	0.583	1 of 34 (2.9)	0 of 68 (0)	0.155	1 of 40 (2.5)	0 of 40 (0)	0.317
30-day mortality	1 of 48 (2.1)	1 of 185 (0.5)	0.302	1 of 34 (2.9)	0 of 68 (0)	0.155	1 of 40 (2.5)	0 of 40 (0)	0.317
In-hospital mortality	1 of 48 (2.1)	1 of 185 (0.5)	0.302	1 of 34 (2.9)	0 of 68 (0)	0.155	1 of 40 (2.5)	0 of 40 (0)	0.317
90-day mortality	2 of 48 (4.2)	2 of 185 (1.1)	0.143	2 of 34 (5.9)	0 of 68 (0)	0.109	2 of 40 (5.0)	1 of 40 (0)	0.157
Close/involved margins (≤ 1 mm) for malignancies	6 of 48 (12.5)	31 of 185 (16.8)	0.472	6 of 33 (18.2)	13 of 66 (19.7)	0.850	6 of 38 (15.8)	8 of 38 (21.1)	0.791

Values in parentheses are percentages unless indicated otherwise;

*values are median (i.q.r.). R-RAS/CH, robotic right anterior sectionectomy/central hepatectomy; L-RAS/CH, laparoscopic right anterior sectionectomy/central hepatectomy.

†From unpaired analyses i.e. Mann-Whitney U test and Pearson’s chi-square test;

‡From Wilcoxon signed rank test and McNemar’s chi-square test;

§From mixed-effects quantile regression (in which a random-effects parameter was used to denote the 1:2 matched data structure), conditional logistic, or mixed-effects ordinal logistic regression.