Advantages of laparoscopic left hemihepatectomy A meta-analysis

Xiangbao Yin, MD, Dilai Luo, MD, Yong Huang, PhD * , Mingwen Huang, MD *

Abstract

Background: Laparoscopic left hemihepatectomy (LLH) has been widely accepted as a minimally invasive alternative to open liver surgery. We assessed the benefits and drawbacks of LLH compared with open left hemihepatectomy (OLH) using meta-analysis.

Methods: Relevant literature was retrieved using PubMed, Embase, Cochrane, and Ovid Medline databases. Multiple parameters of efficacy and safety were compared between the treatment groups. Results are expressed as odds ratio (OD) or mean difference (MD) with 95% confidence interval (95% CI) for fixed- and random-effects models.

Results: The meta-analysis included 13 trials involving 1163 patients. Compared with OLH, LLH significantly reduced intraoperative blood loss (MD, -91.01; 95% Cl, -139.12 to -42.89; P = .0002), transfusion requirement (OR, 0.24; 95% Cl, 0.11-0.54; P = .0004), time to oral intake (MD, -0.80; 95% Cl, -1.27 to -0.33; P = .0008), and hospital stay (MD, -3.94; 95% Cl, -4.85 to -3.03; P < .0001). However, operative time; complications rate; and postoperative alanine transferase, albumin, and total bilirubin levels did not differ significantly between the 2 surgical groups (P > .05). For hepatolithiasis treatment, there were no significant differences in operative time, residual stones, stone recurrence, and complications rate between the groups (P > .05), but LLH resulted in lower incisional infection rate (OR, 0.44; 95% Cl, 0.22-0.89; P = .02) than OLH. The LLH group demonstrated higher bile leakage rate (OR, 1.79; 95% Cl, 1.14-2.81; P = .01) and incurred greater hospital costs (MD, 618.56; 95% Cl, 154.47-1082.64; P = .009).

Conclusions: LLH has multiple advantages over OLH and should thus be considered as the first choice for left hemihepatectomy.

Abbreviations: CIs = confidence intervals, LH = laparoscopic hepatectomy, LLH = laparoscopic left hemihepatectomy, MDs = mean differences, NOS = Newcastle–Ottawa scale, OLH = open left hemihepatectomy, ORs = odds ratios, SD = standard deviation.

Keywords: hepatolithiasis, laparoscopic, left hemihepatectomy

1. Introduction

The ideal liver surgery technique should be simple, minimally invasive, and reliable. Additionally, it should allow fast functional recovery, cause minimal pain, and be affordable for patients. Laparoscopic hepatectomy (LH) fulfills these requirements.^[1,2] Indeed, LH has matured and become a widely applicable treatment option for benign and malignant liver lesions.^[3–9] Left hepatectomy is the most common procedure in

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The authors declare that they have no competing interests.

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many laparoscopic series worldwide and is particularly suitable for minimally invasive surgery because the left hemiliver is more likely to be exposed during surgery owing to its smaller volume in the abdominal cavity, relatively independent and acute angle tract, and clear vasculature gradation.^[10]

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Left-sided hepatectomy, including left lateral sectionectomy and left hemihepatectomy, is the main procedure performed for most patients with lesions in the left side of the liver. Our previous study confirmed these advantages, and we proposed that laparoscopic left lateral hepatic lobectomy should be considered as the gold standard for treatment of left hepatic lobe lesions.^[8] However, there has been no comprehensive meta-analysis directly comparing the benefits and drawbacks of laparoscopic left hemihepatectomy (LLH) to open left hemihepatectomy (OLH); therefore, no broad consensus on which approach is superior has been reached. Furthermore, there are no standard guidelines on indications for the laparoscopic approach. The purpose of this study was to compare the efficacy and safety between LLH and OLH by a meta-analysis of published trials.

2. Material and methods

2.1. Literature search

A systematic search was conducted using PubMed, Embase, Cochrane Database of Systematic Reviews, and Ovid Medline with the following keywords: hepatectomy, left hemihepatectomy, left-side hepatectomy, laparoscopic hepatectomy, and laparoscopic versus open. The search included articles published between the date of electronic database creation and May 30,

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2018. Additionally, we searched the reference lists of selected papers and systematic reviews for potentially relevant studies missed by the original search. Two reviewers independently selected the eligible studies. Disagreements on article inclusion were resolved by discussion with a third reviewer. The study protocol followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement and Cochrane Handbook for Diagnostic Test Accuracy Reviews. Institutional review board approval and patient consent were waived because of the retrospective, anonymized nature of the study. The quality of each study was assessed using the Newcastle–Ottawa scale (NOS).^[11] A star system of NOS (range, 0–9 stars) was developed for evaluation (Table 1). The study was approved by the ethics committee.

2.2. Inclusion and exclusion criteria

All case–control studies comparing LLH to OLH were selected for further review. Studies were included if they involved left hemihepatectomy with no requirement for additional procedures. The selected studies also reported malignancy, time to oral intake (days), blood transfusion, mortality, complications, operative time (minutes), length of hospital stay (days), hospital expense (dollars), blood loss (mL), number of residual stones, stone recurrence, and/or postoperative alanine transferase (ALT), albumin, and total bilirubin (TB) levels. Specific complications included bile leakage, incisional infection, bleeding, ascites, pneumonia, intra-abdominal fluid collection, incisional hernia, abscess, urinary tract infection, ulcer, and pulmonary embolus.

Articles not reporting any of these outcomes as well as editorials, review articles, and animal studies were excluded. Neither authorship nor publisher information influenced article selection.

2.3. Statistical analysis

Analyses were performed using Review Manager version 5.1 (RevMan, Cochrane Collaboration, Oxford, UK). Group differences in dichotomous data are expressed as odds ratios (ORs) and group differences in continuous data as mean differences (MDs), both with 95% confidence intervals (CIs). Continuous variables were pooled using the inverse variance method and dichotomous variables using the Mantel–Haenszel method. Statistical heterogeneity was evaluated by the χ^2 test. P < .05 (2-tailed) was considered statistically significant for all tests. If heterogeneity was significant, we used the random-effects model. Otherwise, we used the fixed-effects model. If data were reported as median and range rather than mean and standard deviation (SD), the mean and SD were estimated as described previously.^[12]

3. Results

3.1. Study selection and characteristics

Figure 1 illustrates the search process and final selection of relevant studies. We analyzed 13 trials^[13–25] involving 1163 patients that met all the criteria (Table 1). These included 10 trials comparing LLH to OLH for hepatolithiasis, 1 trial for hepatocellular carcinoma, and 1 trial for benign and malignant lesions, while 1 trial did not report the lesions.

3.2. Overall comparison of LLH versus OLH

We first compared intraoperative parameters, postoperative parameters, hospital costs, and indices of liver function between the LLH and OLH cohorts. Information on operative time (minutes) was provided in all 13 trials and did not differ significantly between the LLH and OLH groups (MD, 11.67; 95% CI, -9.56 to 32.91; P=.28; Fig. 2A). Twelve trials reported information on blood loss and 6 trials on transfusion information. Compared with the OLH group, the LLH group demonstrated significantly reduced blood loss (MD, -91.01; 95% CI, -139.12 to -42.89; P=.0002; Fig. 2B) and need for blood transfusion (OR, 0.24; 95% CI, 0.11-0.54; P=.0004; Fig. 2C).

The time to oral intake and length of hospital stay were evaluated in 6 and 12 studies, respectively. Patients in the LLH group exhibited a shorter time to oral intake (MD, -0.80; 95%) CI, -1.27 to -0.33; P = .0008; Fig. 3A) and shorter hospital stay (MD, -3.94; 95% CI, -4.85 to -3.03; P < .0001; Fig. 3B). Information on hospitalization costs was reported in 4 trials. Patients in the OLH group incurred less hospitalization costs than those in the LLH group (average, \$618.56; 95% CI, 154.47-1082.64; P=.009; Fig. 3C). Twelve trials provided information on complications (Table 2). Neither overall complication rate (OR, 0.74; 95% CI, 0.55-1.00; P=.05; Fig. 3D) nor severe grade III + IV complication rate (OR, 0.69; 95% CI, 0.30-1.60; P=.39) differed significantly between the 2 groups. There were no statistically significant differences in postoperative ALT (MD, -9.14; 95% CI, -39.75 to 21.47; P=.56), albumin (MD, 2.32; 95% CI, -2.56 to 7.21; P=.35), and TB levels (MD, -0.09, 95% CI -0.30 to 0.12; P = .39) between the LLH and OLH groups.

3.3. LLH versus OLH for hepatolithiasis

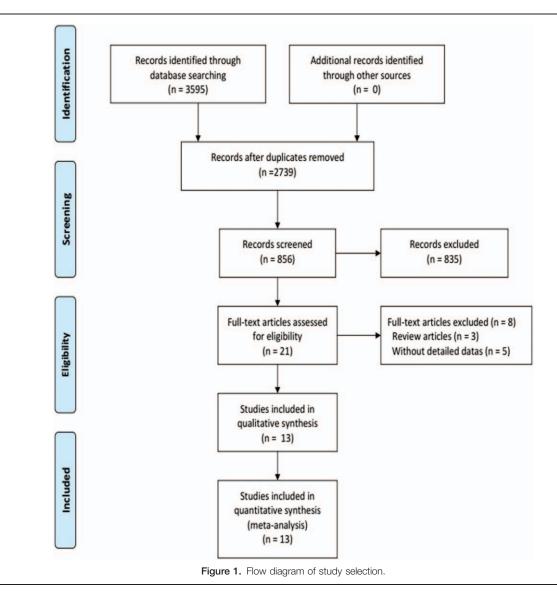
Ten trials compared LLH to OLH for hepatolithiasis patients. According to overall results, the operative time was not statistically different between the LLH and OLH groups (MD, 1.38; 95% CI, -19.98 to 22.73; P=.90; Fig. 4A), but the LLH group demonstrated significantly reduced blood loss (MD -0.91; 95% CI, -1.39 to -0.44; P=.0002; Fig. 4B), need for blood transfusion (OR, 0.24; 95% CI, 0.11-0.54; P=.0004), time to oral intake (MD, -0.91; 95% CI, -1.39 to -0.44; P=.0002; Fig. 4A), and hospital stay (MD, -3.46; 95% CI, -4.40 to -2.53; P<.001). Also consistent with overall results, hospital expenses were high in the LLH group (MD, 618.56; 95% CI, 154.47-1082.64; P=.009) than in the OLH group.

Nine trials for hepatolithiasis patients provided information on complications. The overall complication rate did not differ significantly between the LLH and OLH groups (OR, 0.81; 95% CI, 0.58–1.15; P=.24; Fig. 5A). Residual stone incidence was evaluated in 10 studies, and stones recurrence was evaluated in 5 studies. There were no significant group differences in the residual stone rate (OR, 0.86; 95% CI, 0.53–1.42; P=.56; Fig. 5B) or stone recurrence rate (OR, 0.69; 95% CI, 0.26–1.82; P=.45; Fig. 5C).

Further subgroup analyses revealed that the LLH group exhibited significantly lower incisional infection rate (OR, 0.44; 95% CI, 0.22–0.89; P = .02; Fig. 6B) than the OLH group, while incidences of intra-abdominal fluid collection (OR, 1.26; 95% CI, 0.52–3.03; P = .61; Fig. 6C), abdominal infection (OR, 1.09; 95% CI, 0.60–1.98; P = .78; Fig. 6D), and pneumonia (OR, 0.49; 95% CI, 0.13–1.83; P = .29; Fig. 6E) did not differ significantly between the groups. In contrast, bile leakage rate was higher in the LLH group (OR, 1.79; 95% CI, 1.14–2.81; P = 0.01; Fig. 6A) than in the OLH group

	LLH/		Age,		Total			Time to oral	Operating	Hospital	Blood	Hoenital	ALT 11/1		TD ma/dl
AUTUOL U		Country	yr	Male	score	Malignant	Transfused	intake, d	time, min	stay, day	loss, mL	expenses, USD	ALI, U/L	ALB, g/L	16, mg/aL
Cai ^[13] 19	19/19 (China	I	I	7	0/0	2/8	I	$222 \pm 104/$	9±5/13±7	$462 \pm 372/$	I	$145 \pm 77/$	33±5/	$2.3 \pm 2.6/$
									204 ± 59		895 ± 704		192 ± 17	28 ± 3	1.9 ± 1.8
Namgoong ^[14] 3]	37/112 k	Korea	I	I	9	0/0	0/10	$2.2 \pm 0.5/$	$257 \pm 50/$	8.8±4.1/	$280 \pm 97/$	I	I	Ι	I
								2.8 ± 0.5	237 ± 76	14.1 ± 5	347 ± 286				
Ye ^[15] 4(46/51 (China	54 (37,74)/	16/18	9	0/0	1/4	I	273±52/	12.8±3.4/	456±167/	I	I	I	I
			55 (41,74)						$265\pm51^{*}$	$14.3 \pm 3.8^{*}$	$489 \pm 194^{*}$				
Zheng ^[16] 8.	84/75 (China	59/56	29/36	œ	0/0	Ι	I	$211 \pm 36/$	15/15	400/400	4541 ± 984	I	Ι	I
									185 ± 44			$3625 \pm 710^{\dagger}$			
Shin ^[17] 7,	7/24 k	Korea	$55 \pm 8/$	0/8	7	0/0	1/3	I	$170 \pm 58/$	7.6 ± 1.9	244 ± 159	I	I	Ι	I
			54 ± 10						219 ± 61	13.7 ± 5	241 ± 591				
Yao ^[18] 5.	57/57 (China	23-68/	30/31	8	0/0	Ι	0.9 ± 0.2	$137 \pm 17/$	10.7 ± 0.8	$215 \pm 43/$	Ι	$72 \pm 26/$	$36 \pm 0.7/$	I
			24–69					2.3 ± 0.5	172 ± 21	13.4 ± 1.2	316 ± 51		74 ± 27	36 ± 1.1	
Zhang ^[19] 20	20/25 (China	$47 \pm 8.5/$	8/10	9	20/25	Ι	I	$143 \pm 36/$	7±1/12±2	$180 \pm 21/$	I	I	Ι	I
			52 ± 10.5						137 ± 30		350 ± 45				
Deng ^[20] 2	27/30 (China	$57 \pm 13/$	3/5	9	0/0	4/12	3.2 ± 0.9	339±53/	$8.5 \pm 2.5/$	$296 \pm 157/$	I	I	Ι	I
			57 ±11					4.5 ± 1	372 ± 52	11.3 ± 2.2	436 ± 241				
Peng ^[21] 1(15/16 (China	I	I	9	0/0	1/4	2.3 ± 0.8	$217 \pm 46/$	8.9 ± 2.4	$257 \pm 85/$	6120 ± 1509	I	Ι	I
								3.1±1	210 ± 41	12.8 ± 2.9	395 ± 185	5728 ± 1174			
Valente ^[22] 1	17/51 F	France	51 (35,83)/	6/38	9	I	I	I	$260 \pm 53/$	ę	$388 \pm 238/$	I	I	I	I
			59 (23,85)						$200\pm65^{*}$		$675 \pm 475^{*}$				
Wang ^[23] 63	62/60 (China	39±2/	28/30	9	0/0	I	I	$211 \pm 36/$	15.3 ± 3.4	$400 \pm 30/$	4541 ± 694	I	I	I
			39 ± 1						185 ± 43	17 ± 2.8	412 ± 32	$3623 \pm 713^{\dagger}$			
Cho ^[24] 6;	62/118 k	Korea	$55 \pm 11/$	23/72	9	18/65	I	2.2 ± 0.6	$250 \pm 54/$	9.5 ± 3.3	$282 \pm 132/$	I	192 ± 124	Ι	$1.4 \pm 0.6/$
			58 ± 12					2.5 ± 1	178 ± 68	14.9 ± 11.4	353 ± 190		172 ± 135		1.5 ± 0.8
Wu ^[25] 3(36/36 (China	$54 \pm 4/$	20/19	9	0/0	Ι	$1.9 \pm 1.5/$	$148 \pm 36/$	7 ± 1.2	$184 \pm 41/$	$2952 \pm 581/$	I	Ι	I
			53 ± 5					2.3 ± 0.5	134 ± 32	11.9 ± 2.8	183 ± 41	$2823 \pm 516^{\dagger}$			

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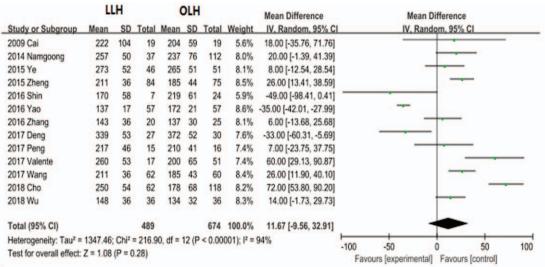
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Description of included trials and the specific complications.

Author	LLH/			Residual		Bile	Incisional	Intra-abdominal	Abdominal		
	OLH	Mortality	Morbidity	stones	Recurrence	leakage	infection	fluid collection	infection	Pneumonia	III + IV [*]
Cai ^[13]	19/19	0/0	2/4	0/1	_	0/1	1/2	1/0	-	-	
Namgoong ^[14]	37/112	0/0	4/20	0/4	0/2	0/1	2/12	2/2	0/4	0/1	0/2
Ye ^[15]	46/51	-	6/11	3/3	2/3	3/3	1/4	2/2	_	0/2	-
Zheng ^[16]	84/75	-	25/25	9/8	_	34/16	2/4	-	17/10	_	
Shin ^[17]	7/24	-	3/8	1/3	0/1	0/0	1/3	2/3	1/3	0/1	
Yao ^[18]	57/57	-	_	3/2	3/4	-	_	-	-	_	
Zhang ^[19]	20/25	-	0/10	-	_	-	_	-	-	_	0/2
Deng ^[20]	27/30	-	6/14	4/7	_	1/4	0/2	1/2	-	1/2	
Peng ^[21]	15/16	-	3/8	1/0	1/2	1/1	1/2	1/3	-	0/1	
Valente ^[22]	17/51	-	5/9	-	_	-	_	-	-	_	1/5
Wang ^[23]	62/60	-	32/26	7/10	_	22/12	2/4	-	8/10	-	
Cho ^[24]	62/118	0/0	11/26	-	_	-	-	-	_	-	6/13
Wu ^[25]	36/36	-	6/5	3/2	_	2/1	0/1	_	_	-	

LLH = laparoscopic left hemihepatectomy, OLH = open left hemihepatectomy.

^{*} The complications are divided as Dindo-Clavien classification.



Α

	LL	H.			OLH			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% Cl
2009 Cai	462	372	19	895	704	19	1.6%	-433.00 [-791.03, -74.97]	←
2014 Namgoong	280	97	37	347	286	112	9.8%	-67.00 [-128.50, -5.50]	·
2015 Ye	456	167	46	489	194	51	9.3%	-33.00 [-104.86, 38.86]	· · · · · · · · · · · · · · · · · · ·
2016 Shin	244	159	7	241	591	24	2.6%	3.00 [-261.16, 267.16]	· · · · · · · · · · · · · · · · · · ·
2016 Yao	215	43	57	316	51	57	11.5%	-101.00 [-118.32, -83.68]	-
2016 Zhang	180	21	20	350	45	25	11.5%	-170.00 [-189.90, -150.10]	·
2017 Deng	296	157	27	436	241	30	7.5%	-140.00 [-244.61, -35.39]	·
2017 Peng	257	85	15	395	185	16	7.8%	-138.00 [-238.34, -37.66]	•
2017 Valente	388	238	17	675	475	51	4.7%	-287.00 [-459.61, -114.39]	
2017 Wang	400	30	62	412	32	60	11.7%	-12.00 [-23.01, -0.99]	
2018 Cho	282	132	62	353	190	118	10.5%	-71.00 [-118.48, -23.52]	+
2018 Wu	184	41	36	183	41	36	11.5%	1.00 [-17.94, 19.94]	
Total (95% CI)			405			599	100.0%	-91.01 [-139.12, -42.89]	
Heterogeneity: Tau ² =	5140.67	Chi ²	= 264.8	2, df =	11 (P	< 0.000	01); I ² =	96%	
Test for overall effect:				1.			1.11		-100 -50 0 50 100
									Favours [experimental] Favours [control]

В

	LLH		O	.H		Odds Ratio		Odds	Ratio	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	<u> </u>	M-H, Fixe	ed, 95% CI	
2009 Cai	2	19	8	19	23.4%	0.16 [0.03, 0.91]	-			
2014 Namgoong	0	37	10	112	17.1%	0.13 [0.01, 2.28]	+	-	_	
2015 Ye	1	46	4	51	12.2%	0.26 [0.03, 2.43]	-			
2016 Shin	1	7	3	24	3.8%	1.17 [0.10, 13.36]			•	
2017 Deng	4	27	12	30	31.7%	0.26 [0.07, 0.95]		_		
2017 Peng	1	15	4	16	11.8%	0.21 [0.02, 2.19]	_		_	
Total (95% CI)		151		252	100.0%	0.24 [0.11, 0.54]		٠		
Total events	9		41							
Heterogeneity: Chi2 =	2.01, df = 5	6 (P = 0.	85); l ² = 0	1%				-		10
Test for overall effect:	Z = 3.52 (P	P = 0.000	04)				0.01 Favo	0.1 ours [experimental]	1 10 Favours [control]	10

Figure 2. Forest plots comparing the intraoperative parameters operative time (A), blood loss (B), and blood transfusion (C) between the entire LLH and OLH groups. LLH=laparoscopic left hemihepatectomy, OLH=open left hemihepatectomy.

3.4. Publication bias

Funnel plots for blood transfusion, blood loss, time to oral intake, hospital stay, bile leakage, and incisional infection showed basic symmetry, indicating no substantial publication bias.

4. Discussion

In the past, the drawbacks of laparoscopic hepatectomy included relatively greater technical complexity, longer operative time, and higher incidence of postoperative complications, such as

		LLH			DLH			Mean Difference	Mean Difference	
Study or Subgroup	Mean	1000	Total	1.			Weight		IV, Random, 95% C	L
2014 Namgoong	2.2	0.5	37	2.8	0.5	112	18.4%	-0.60 [-0.79, -0.41]	1	
2016 Yao	0.9	0.2	57	2.3	0.5	57	18.6%	-1.40 [-1.54, -1.26]	1	
2017 Deng	3.2	0.9	27	4.5	1	30	15.6%	-1.30 [-1.79, -0.81]	1	
2017 Peng	2.3	0.8	15	3.1	1	16	14.0%	-0.80 [-1.44, -0.16]	1	
2018 Cho	2.2	0.6	62	2.5	1	118	18.1%	-0.30 [-0.53, -0.07]	1	
2018 Wu	1.9	1.5	36	2.3	0.5	36	15.4%	-0.40 [-0.92, 0.12]	1	
Total (95% CI)			234			369	100.0%	-0.80 [-1.27, -0.33]		
Heterogeneity: Tau ² = Test for overall effect:				5 (P <	0.00	001); l²	= 94%		-100 -50 0	50 10
		1							Favours [experimental] Favours [control]
	1	LH.		C	DLH			Mean Difference	Mean Difference	
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Random. 95% CI	IV. Random. 95% C	
2009 Cai	9	5	19	13	7	19	3.8%	-4.00 [-7.87, -0.13]	-	
2014 Namgoong	8.8	4.1	37	14.1	5	112	8.6%	-5.30 [-6.91, -3.69]		
2015 Ye	12.8		46	14.3	3.8				1	
2016 Shin	7.6		7	13.7	5				-	
2016 Yao	10.7		57	13.4	1.2			and the second		
2016 Zhang	7		20	12	2					
2017 Deng	8.5		27	11.3	2.2					
2017 Peng	8.9		15	12.8	2.9				-	
2017 Valente	10		17	16.8	9.3				-	
2017 Wang	15.3		62	10.0	2.8					
Children and Chi						1	100000			
2018 Cho 2018 Wu	9.5		62 36	14.9	11.4			a contract of the second s		
	20							and there is and		
Total (95% CI)			405			599	100.0%	-3.94 [-4.85, -3.03]		
Heterogeneity: Tau ² = Test for overall effect					< 0.0	0001);	r = 04%		-100 -50 0 Favours [experimental] Favours	50 10 [control]
Test for overall effect	: Z = 8.5				< 0.0	0001);	I" = 04 %		Favours [experimental] Favours	
Test for overall effect	: Z = 8.5	2 (P < 0		c	OLH		Weight	Mean Difference IV. Random, 95% C	Favours [experimental] Favours Mean Difference	[control]
Test for overall effect	: Z = 8.5. L Mean	2 (P < 0	0.00001)	C	OLH		Weight	Mean Difference IV. Random, 95% C	Favours [experimental] Favours Mean Difference	[control]
Test for overall effect Study or Subgroup 2015 Zheng	Z = 8.5	2 (P < 0 LH SD 984	0.00001) Total M 84 3.	ean 625	SD 710	Total 75	Weight 28.7%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76]	Favours [experimental] Favours Mean Difference I. IV. Random. 95% C	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng	Z = 8.5 Mean 4,541 6,120	2 (P < 0 LH 984 1,509	<u>Total M</u> 84 3, 15 5,	625 728 1	SD 710 ,174	<u>Total</u> 75 16	Weight 28.7% 13.5%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07]	Favours [experimental] Favours Mean Difference I.V. Random. 95% C	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang	Z = 8.5	2 (P < 0 LH SD 984	0.00001) Total M 84 3, 15 5, 62 3,	625 728 1	SD 710	Total 75	Weight 28.7%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76]	Favours [experimental] Favours Mean Difference IV. Random, 95% C	[control]
	Z = 8.5 <u>Mean</u> 4,541 6,120 4,541	2 (P < 0 LH 984 1,509 694	0.00001) Total M 84 3, 15 5, 62 3,	625 728 1 623	SD 710 ,174 713	Total 75 16 60 36	Weight 28.7% 13.5% 29.0% 28.9%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78]	Favours [experimental] Favours Mean Difference IV. Random, 95% C	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² =	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7	2 (P < 0 LH 984 1,509 694 581 0; Chi ²	Total M 84 3, 15 5, 62 3, 36 2, 197 = 24.76,	ean 625 728 1 623 823	516	Total 75 16 60 36 187	Weight 28.7% 13.5% 29.0% 28.9% 100.0%	Mean Difference IV. Random. 95% C 916.00 (651.24, 1180.76) 392.00 (-564.07, 1348.07) 918.00 (668.22, 1167.78) 129.00 (-124.83, 382.83)	Favours [experimental] Favours Mean Difference IV. Random. 95% C	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect. 2	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7	2 (P < 0 LH 984 1,509 694 581 0; Chi ²	Total M 84 3, 15 5, 62 3, 36 2, 197 = 24.76,	ean 625 728 1 623 823	516	Total 75 16 60 36 187	Weight 28.7% 13.5% 29.0% 28.9% 100.0%	Mean Difference IV. Random. 95% C 916.00 (651.24, 1180.76) 392.00 (-564.07, 1348.07) 918.00 (668.22, 1167.78) 129.00 (-124.83, 382.83)	Favours [experimental] Favours Mean Difference IV. Random. 95% C	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: <i>i</i>	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7	2 (P < 0 LH 984 1,509 694 581 0; Chi ² P = 0.0	Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 09) (0)	ean 625 728 1 623 823	DLH SD 710 ,174 713 516 P < 0	Total 75 16 60 36 187 .0001);	Weight 28.7% 13.5% 29.0% 28.9% 100.0%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64]	Favours [experimental] Favours Mean Difference IV. Random, 95% C V. Random, 95% C - 100 - 50 0 Favours [experimental] Favours	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 2	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	2 (P < 0 LH 984 1,509 694 581 0; Chi ² P = 0.0 LLH	.00001) <u>Total M</u> 84 3, 15 5, 62 3, 36 2, 197 = 24.76, 09)	C 625 728 1 623 823 df = 3 (DLH SD 710 ,174 713 516 P<0	Total 75 16 60 36 187 .0001);	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 1° = 88%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect ; Study or Subgro	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	2 (P < 0 LH SD 984 1,509 694 581 0; Chi ² + 0; Chi ² + 0, Chi ² + LLH vents	Total M 84 3. 15 5. 62 3. 36 2. 197 = = 24.76. 09) Total Total	C 625 728 1 623 823 df = 3 (DLH SD 710 713 516 P < 0 OL 0L	Total 75 16 60 36 187 .0001); H Total	Weight 28.7% 13.5% 29.9% 28.9% 100.0% I ^P = 88% Weight	Mean Difference IV. Random. 95% C	Favours [experimental] Favours Mean Difference IV. Random, 95% C V. Random, 95% C - 100 - 50 0 Favours [experimental] Favours	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 2 	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	2 (P < 0 LH SD 984 1,509 694 581 0; Chi ² P = 0.0 LLH vents 2	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 09) Total 19 Total 19	C 625 728 1 623 823 df = 3 (DLH <u>SD</u> 710 ,174 713 516 P < 0 OL 0L 0L 0L 4	Total 75 16 60 36 187 .0001); H Total 19	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 17 = 88% Weight 3.5%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgro 2009 Cai 2014 Namgoong	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	2 (P < 0 LH <u>SD</u> 984 1,509 694 581 0; Chi ² P = 0.0 LLH <u>vents</u> 2 4	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 099) Total 19 37	C 625 728 1 623 823 df = 3 (DLH <u>SD</u> 710 174 713 516 P < 0 OL 0L 0L 4 20	Total 75 16 60 36 187 .0001): .H Total 19 112	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 17 = 88% Weight 3.5% 8.6%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Vang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgroo 2009 Cai 2014 Namgoong 2015 Ye	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ² P = 0.0 LLLH 2 4 6	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 099) Total 19 37 46	C 625 728 1 623 823 df = 3 (DLH SD 710 ,174 713 516 P < 0 OL 0L 0L 4 20 11	Total 75 16 60 36 187 .0001): .H Total 19 112 51	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 1° = 88% Weight 3.5% 8.6% 8.8%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H. Fixed. 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75] 0.55 [0.18, 1.62]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgro 2009 Cai 2014 Namgoong	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	2 (P < 0 LH <u>SD</u> 984 1,509 694 581 0; Chi ² P = 0.0 LLH <u>vents</u> 2 4	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 099) Total 19 37	C 625 728 1 623 823 df = 3 (DLH <u>SD</u> 710 174 713 516 P < 0 OL 0L 0L 4 20	Total 75 16 60 36 187 .0001): .H Total 19 112	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 17 = 88% Weight 3.5% 8.6%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Vang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgroo 2009 Cai 2014 Namgoong 2015 Ye	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ² , P = 0.0 LLLH 2 4 6	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 099) Total 19 37 46	C 625 728 1 623 823 df = 3 (DLH SD 710 ,174 713 516 P < 0 OL 0L 0L 4 20 11	Total 75 16 60 36 187 .0001): .H Total 19 112 51	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 1° = 88% Weight 3.5% 8.6% 8.8%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H. Fixed. 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75] 0.55 [0.18, 1.62]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Vang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgroo 2009 Cai 2014 Namgoong 2015 Ye 2015 Zheng 2016 Shin	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LLH <u>SD</u> 984 1,509 694 581 0; Chi ² P = 0.0 LLLH <u>vents</u> 2 4 6 25 3	0.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76, 099) Total 19 37 46 84 7	C 625 728 1 623 823 df = 3 (Eve	DLH SD 710 713 516 P < 0 Ol nts 4 20 11 25 8	Total 75 16 60 36 187 .0001): .H Total 19 112 51 75 24	Weight 28.7% 13.5% : 29.0% 28.9% 100.0% € # = 88% Weight 3.5% 8.6% 8.8% 8.8% 18.1% 2.0%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] 0456 [154.47, 1082.64] 0444 [0.07, 2.76] 0.56 [0.18, 1.75] 0.55 [0.18, 1.62] 0.55 [0.43, 1.66] 1.50 [0.27, 8.38]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Vang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgro 2009 Cai 2014 Namgoong 2015 Ye 2015 Zheng 2016 Shin 2016 Zhang	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ² + P = 0.0 LLH vents 2 4 6 25 3 0	100001) Total M 84 3, 15 5 62 3, 36 2, 197 = 24.76, 99) Total 19 37 46 84 7 20	C ean 625 728 1 623 823 df = 3 (Eve	DLH SD 710 174 713 516 P < 0 OL 0L 0L 125 8 10	Total 75 16 60 36 187 .0001): .H Total 19 112 51 75 24 25	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 100.0% 100.0% 100.0% 8.8% 8.6% 8.8% 18.1% 2.0% 8.9%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.75] 0.55 [0.18, 1.62] 0.55 [0.43, 1.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect ; Study or Subgroo 2009 Cai 2014 Namgoong 2015 Zheng 2015 Zheng 2015 Zheng 2016 Zhang 2016 Zhang 2017 Deng	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ² + P = 0.0 LLLH vents 2 4 6 25 3 0 6 6	1.00001) Total M 84 3. 15 5. 63 36 2. 197 = 24.76, 099) Total 19 37 466 844 7 200 27	C ean 625 728 1 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 01 11 25 8 10 14	Total 75 16 60 36 187 .0001); H Total 19 112 51 75 24 25 30	Weight 28.7% 13.5% 29.0% 28.9% 100.0% I [*] = 88% Weight 3.5% 8.8% 8.8% 8.8% 8.8% 8.8% 8.8% 8.9% 10.0%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H. Fixed. 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.75] 0.55 [0.18, 1.62] 0.55 [0.43, 1.62] 0.55 [0.47, 8.38] 0.04 [0.00, 0.66] ¹ 0.33 [0.10, 1.04]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: 7 Study or Subgroo 2009 Cai 2014 Namgoong 2015 Zheng 2016 Shin 2016 Shin 2016 Shin 2017 Deng 2017 Deng 2017 Peng	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ^p P = 0.0 0; Chi ^p P = 0.0 LLH vents 2 4 6 25 3 0 6 3 0 6 3	1.00001) Total M 84 3. 15 5. 62 3. 197 = 24.76, 099) Total 19 37 466 84 84 7 200 27 15	C 625 728 1 623 823 df = 3 (DLH SD 710 174 713 516 P < 0 OL 01 11 25 8 10 14 8	Total 75 16 60 36 187 .0001): 19 112 51 75 24 25 30 16	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 4" = 88% Weight 3.5% 8.8% 8.8% 8.8% 18.1% 2.0% 8.8% 10.0% 6.0%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio <u>M-H. Fixed, 95% Cl</u> 0.44 [0.07, 2.76] 0.55 [0.18, 1.62] 0.55 [0.43, 1.62] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 0.33 [0.10, 1.04] 0.25 [0.05, 1.24]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: 2 Study or Subgro 2009 Cai 2014 Namgoong 2015 Zheng 2015 Zheng 2016 Shin 2016 Zhang 2017 Peng 2017 Peng 2017 Valente	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH <u>SD</u> 984 1,509 694 581 0; Chi ^p P = 0.0 0; Chi ^p P = 0.0 LLH vents 2 4 6 25 3 0 6 3 5 5	100001) Total M 84 3. 15 5 62 3. 36 2. 197 = 24.76, 09) Total 197 37 46 84 7 200 27 15 17	C 625 728 1 623 823 df = 3 (DLH SD 710 174 713 516 P < 0 OL 01 11 25 8 10 14 8 9	Total 75 16 60 36 187 .0001): 19 112 51 75 24 25 30 16 51	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 10.0% 8.8% 8.8% 8.8% 18.1% 2.0% 6.0% 6.0% 3.1%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.75] 0.55 [0.43, 1.62] 1.50 [0.27, 8.38] 0.44 [0.00, 0.66] 1.50 [0.27, 8.38] 0.44 [0.00, 0.66] 0.33 [0, 10, 0.44] 0.25 [0.05, 1.24] 1.94 [0.55, 6.91]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect : 2009 Cai 2014 Namgoong 2015 Ye 2015 Zheng 2016 Shin 2016 Shin 2016 Zhang 2017 Deng 2017 Deng 2017 Valente 2017 Valente 2017 Wang	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH SD 984 1,509 694 1,509 694 581 0; Chi ^p , P = 0.0 LLH vents 2 4 6 25 3 0 6 3 5 32	1.00001) Total M 84 3. 15 5 62 3. 36 2. 197 = 24.76, 09) Total 197 37 466 844 7 200 27 15 17 62	C 625 728 1 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 125 8 10 14 8 9 26	Total 75 16 00 36 187 .0001): 19 112 51 75 24 25 24 25 24 25 30 16 51 60	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 8.8% 18.1% 2.0% 8.8% 18.1% 2.0% 8.9% 10.0% 3.1% 12.5%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75] 0.55 [0.18, 1.62] 0.65 [0.43, 1.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 0.33 [0.10, 1.04] 0.25 [0.05, 1.24] 1.39 [0.68, 2.85]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Veng 2017 Veng 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect: J 2009 Cai 2014 Namgoong 2015 Ye 2015 Zheng 2016 Shin 2016 Zhang 2017 Deng 2017 Deng 2017 Peng 2017 Valente 2017 Wang 2018 Cho	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH SD 984 1,509 694 581 1,509 694 581 Vents 2 4 6 25 3 0 6 3 5 32 11	Total M 84 3. 15 5. 62 3. 15 5. 62 3. 197 = 24.76, 09) 1 19 37 46 84 7 200 27 157 77 162 62	C 625 728 1 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 125 8 10 14 8 9 26 26	Total 75 16 60 36 187 .0001); 19 112 51 75 24 25 30 16 51 60 118	Weight 28.7% 13.5% 29.% 28.9% 100.0% 8.8% 10.0% 8.8% 18.1% 2.0% 8.8% 10.0% 3.1% 10.2% 10.2% 12.5%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.52] 0.55 [0.18, 1.62] 0.55 [0.18, 1.62] 0.55 [0.18, 1.62] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.55, 6.51] 1.39 [0.68, 2.85] 0.76 [0.35, 1.67]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect : 2009 Cai 2014 Namgoong 2015 Ye 2015 Zheng 2016 Shin 2016 Shin 2016 Zhang 2017 Deng 2017 Deng 2017 Valente 2017 Valente 2017 Wang	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH SD 984 1,509 694 1,509 694 581 0; Chi ^p , P = 0.0 LLH vents 2 4 6 25 3 0 6 3 5 32	1.00001) Total M 84 3. 15 5 62 3. 36 2. 197 = 24.76, 09) Total 197 37 466 844 7 200 27 15 17 62	C 625 728 1 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 125 8 10 14 8 9 26	Total 75 16 00 36 187 .0001): 19 112 51 75 24 25 24 25 24 25 30 16 51 60	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 8.8% 18.1% 2.0% 8.8% 18.1% 2.0% 8.9% 10.0% 3.1% 12.5%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.56 [0.18, 1.75] 0.55 [0.18, 1.62] 0.65 [0.43, 1.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 0.33 [0.10, 1.04] 0.25 [0.05, 1.24] 1.39 [0.68, 2.85]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect ; Study or Subgroo 2009 Cai 2014 Namgoong 2015 Zheng 2015 Zheng 2015 Zheng 2016 Zhang 2017 Deng 2017 Deng 2017 Peng 2017 Valente 2017 Wang 2018 Cho 2018 Wu	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH SD 984 1,509 694 581 1,509 694 581 Vents 2 4 6 25 3 0 6 3 5 32 11	Total M 84 3. 15 5. 62 3. 36 2. 197 = = 24.76, 09) Total 19 37 36 46 84 7 200 277 155 177 62 62 36	C 625 625 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 125 8 10 14 8 9 26 26	Total 75 16 60 36 187 .0001): 19 112 51 75 24 25 30 16 51 60 118 36	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 4" = 88% Weight 3.5% 8.8% 8.8% 8.8% 8.8% 18.1% 2.0% 8.9% 10.0% 6.0% 3.1% 12.5% 14.4% 4.1%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H. Fixed. 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.75] 0.55 [0.18, 1.62] 0.55 [0.43, 1.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] ⁷ 0.33 [0.10, 1.04] 0.25 [0.05, 1.24] 1.94 [0.55, 6.91] 1.39 [0.68, 2.85] 0.76 [0.35, 1.67] 1.24 [0.34, 4.50]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% CI) Heterogeneity: Tau ² = Test for overall effect: 2 2009 Cai 2014 Namgoong 2015 Zheng 2016 Shin 2016 Zhang 2017 Deng 2017 Deng 2017 Valente 2017 Valente 2017 Valente 2017 Wang 2018 Cho 2018 Wu Total (95% CI)	E Z = 8.5 Mean 4,541 6,120 4,541 2,952 177364.7 Z = 2.61	LH SD 984 1509 694 581 0; Chi ^p P = 0.0 0; Chi ^p P = 0.0 0; Chi ^p A 2 4 6 25 3 0 6 3 5 32 11 6	1.00001) Total M 84 3. 15 5. 62 3. 36 2. 197 = 24.76. 09) Total 19 37 46 84 7 20 27 15 7 62 62 3. 62 7. 7. 7. 7. 7. 7. 7. 7. 7. 7.	C ean 625 726 1 623 823 df = 3 (OLH SD 710 174 713 516 P < 0 OL 01 11 25 8 10 14 8 9 26 5	Total 75 16 60 36 187 .0001): 19 112 51 75 24 25 30 16 51 60 118 36	Weight 28.7% 13.5% 29.% 28.9% 100.0% 8.8% 10.0% 8.8% 18.1% 2.0% 8.8% 10.0% 3.1% 10.2% 10.2%	Mean Difference IV. Random, 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H, Fixed, 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.52] 0.55 [0.18, 1.62] 0.55 [0.18, 1.62] 0.55 [0.18, 1.62] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] 1.50 [0.55, 6.51] 1.39 [0.68, 2.85] 0.76 [0.35, 1.67]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]
Test for overall effect Study or Subgroup 2015 Zheng 2017 Peng 2017 Wang 2018 Wu Total (95% Cl) Heterogeneity: Tau ² = Test for overall effect ; Study or Subgroo 2009 Cai 2014 Namgoong 2015 Zheng 2015 Zheng 2015 Zheng 2016 Zhang 2017 Deng 2017 Deng 2017 Valente 2017 Valente 2017 Wang 2018 Cho 2018 Wu	L Mean 4,541 6,120 4,541 2,952 177364.7 2 = 2.61	LH SD 984 1.509 694 581 0; ChP P = 0.0 ULH 2 4 6 25 3 0 0 6 3 5 32 111 6 103	Total M 84 3. 15 5. 62 3. 36 2. 197 = = 24.76, 09) Total 19 37 46 84 7 200 27 155 17 62 3.6 432 36	C 625 623 823 df = 3 (Eve	SD SD 710 174 713 516 P < 0	Total 75 16 60 36 187 .0001): 117 51 112 51 75 24 25 30 16 51 60 118 36 617	Weight 28.7% 13.5% 29.0% 28.9% 100.0% 4" = 88% Weight 3.5% 8.8% 8.8% 8.8% 8.8% 18.1% 2.0% 8.9% 10.0% 6.0% 3.1% 12.5% 14.4% 4.1%	Mean Difference IV. Random. 95% C 916.00 [651.24, 1180.76] 392.00 [-564.07, 1348.07] 918.00 [668.22, 1167.78] 129.00 [-124.83, 382.83] 618.56 [154.47, 1082.64] Odds Ratio M-H. Fixed. 95% CI 0.44 [0.07, 2.76] 0.55 [0.18, 1.75] 0.55 [0.18, 1.62] 0.55 [0.43, 1.66] 1.50 [0.27, 8.38] 0.04 [0.00, 0.66] ⁷ 0.33 [0.10, 1.04] 0.25 [0.05, 1.24] 1.94 [0.55, 6.91] 1.39 [0.68, 2.85] 0.76 [0.35, 1.67] 1.24 [0.34, 4.50]	Favours [experimental] Favours Mean Difference IV. Random. 95% C V. Random. 95% C Favours [experimental] Favours Odds Ratio	[control]

Figure 3. Forest plots comparing postoperative parameters time to oral intake (A), length of hospital stay (B), hospitalization charges (C), and complications (D) between the entire LLH and OLH treatment groups. LLH=laparoscopic left hemihepatectomy, OLH=open left hemihepatectomy.

bleeding, than those in open hepatectomy.^[26] The liver is rich in blood vessels and blood supply, causing frequent bleeding during resection, and it is difficult to precisely control bleeding by laparoscopy. Furthermore, the lack of tactile feedback and

requirement for greater hand-eye coordination increase surgical difficulty and prolong the operative time. The availability of the equipment needed for laparoscopic hepatectomy is also limited compared to the basic equipment for open hepatectomy. With

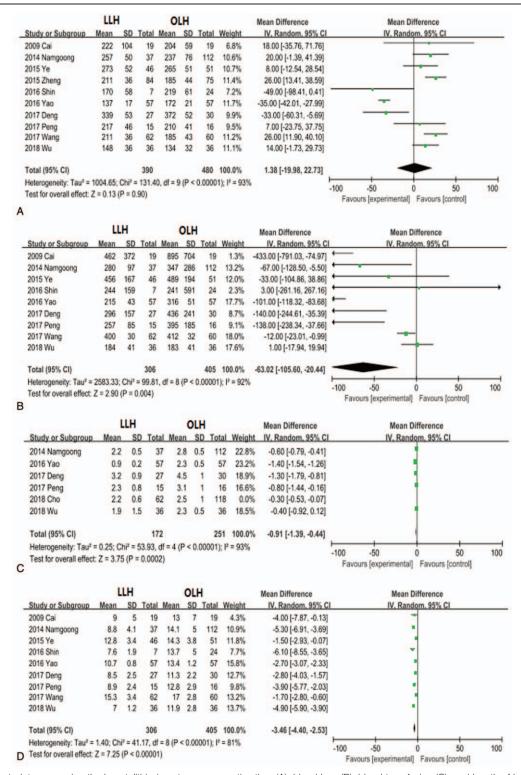


Figure 4. Forest plots comparing the hepatolithiasis outcomes operative time (A), blood loss (B), blood transfusion (C), and length of hospital stay (D).

recent advances in laparoscopic technology and equipment, all these problems have been mitigated, and the feasibility and safety of laparoscopic hepatectomy have been confirmed by several large-scale studies. However, none of these studies focused specifically on LLH.^[5–9] The left hemiliver exhibits a relatively

simple intrahepatic tract and clear borders with the surrounding organs, anatomical features favorable for laparoscopic surgery. Nonetheless, there was still a lack of clinical evidence supporting these proposed advantages from large-sample multi-center studies. In this work, we found that LLH indeed has many

	LLH		OL	.H		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	M-H, Fixed, 95% CI
2009 Cai	2	19	4	19	5.0%	0.44 [0.07, 2.76]	
2014 Namgoong	4	37	20	112	12.3%	0.56 [0.18, 1.75]	
2015 Ye	6	46	7	51	8.0%	0.94 [0.29, 3.04]	
2015 Zheng	25	84	25	75	25.7%	0.85 [0.43, 1.66]	
2016 Shin	3	7	8	24	2.9%	1.50 [0.27, 8.38]	
2017 Deng	6	27	14	30	14.3%	0.33 [0.10, 1.04]	
2017 Peng	3	15	8	16	8.6%	0.25 [0.05, 1.24]	
2017 Wang	32	62	26	60	17.7%	1.39 [0.68, 2.85]	
2018 Wu	6	36	5	36	5.8%	1.24 [0.34, 4.50]	
Total (95% CI)		333		423	100.0%	0.81 [0.58, 1.15]	•
Total events	87		117				
Heterogeneity: Chi ² =	8.50, df = 8	(P = 0.	39); l ² = 6	%			
Test for overall effect:							0.01 0.1 1 10 10 Favours [experimental] Favours [control]
		1.1.1.1.1.1.1					Pavouis (experimental) Pavouis (control)

	LLH		0	LH		Odds Ratio		Odds	Ratio	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	1	M-H, Fix	ed. 95% Cl	
2009 Cai	0	19	1	19	4.3%	0.32 [0.01, 8.26]				
2014 Namgoong	0	37	4	112	6.6%	0.32 [0.02, 6.11]	_			
2015 Ye	3	46	3	51	7.8%	1.12 [0.21, 5.83]			-	
2015 Zheng	9	84	8	75	22.3%	1.00 [0.37, 2.75]			• · · · · ·	
2016 Shin	1	7	3	24	3.4%	1.17 [0.10, 13.36]			•	
2016 Yao	3	57	2	57	5.6%	1.53 [0.25, 9.51]			· · · ·	
2017 Deng	4	27	7	30	16.7%	0.57 [0.15, 2.22]			_	
2017 Peng	1	15	0	16	1.3%	3.41 [0.13, 90.49]				
2017 Wang	7	62	10	60	26.6%	0.64 [0.23, 1.80]		_	-	
2018 Wu	3	36	2	36	5.4%	1.55 [0.24, 9.85]				
Total (95% CI)		390		480	100.0%	0.86 [0.53, 1.42]				
Total events	31		40							
Heterogeneity: Chi2 =	3.15, df = 9	(P = 0.	96); l ² = 0	%				1	! !	
Test for overall effect:							0.01	0.1	1 10	100
			2				Favo	ours lexperimentall	Favours [control]	

	LLH		OL	.н		Odds Ratio			Odds Ratio		
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C		M-H	I. Fixed. 95%	CI	
2014 Namgoong	0	37	2	112	12.1%	0.59 [0.03, 12.55]	-				
2015 Ye	2	46	3	51	26.6%	0.73 [0.12, 4.56]			-		
2016 Shin	0	7	1	24	6.7%	1.04 [0.04, 28.44]			-		5
2016 Yao	3	57	4	57	37.0%	0.74 [0.16, 3.45]					
2017 Peng	1	15	2	16	17.6%	0.50 [0.04, 6.17]			•		
Total (95% CI)		162		260	100.0%	0.69 [0.26, 1.82]		-	•		
Total events	6		12								
Heterogeneity: Chi2 =	0.14, df = 4	(P = 1.	$(00); I^2 = 0$	1%				1		10	100
C Test for overall effect:	Z = 0.74 (F	P = 0.46)				0.01 Fave	0.1 ours [experime	ntal] Favou	10 rs [control]	100
Figure 5. Forest plo	ts compar	ring the	hepatoli	thiasis	outcome	s complications rate	e (A), res	idual stones	(B), and sto	ne recurren	ce (C).

advantages over OLH, including reduced blood loss, less frequent transfusion requirement, shorter hospital stay, lesser time to oral intake, and lower frequencies of certain specific complications.

Contrary to expectations based on previous studies, the control of bleeding during LLH was actually superior to open

hepatectomy, possibly due to improved intraoperative magnification for surgical manipulations, better pressure control of the pneumoperitoneum, and new coagulating devices.^[27] Indeed, the LLH group was less likely to require blood transfusion and experienced less blood loss compared to the OLH group, with no

	LLH		0	LH		Odds Ratio	Odds	Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H. Fixed, 95% C	M-H, Fixe	ed, 95% CI
2009 Cai	0	19	1	19	5.2%	0.32 [0.01, 8.26]		
2014 Namgoong	0	37	1	112	2.6%	0.99 [0.04, 24.85]		
2015 Ye	3	46	3	51	9.4%	1.12 [0.21, 5.83]		
2015 Zheng	34	84	16	75	35.6%	2.51 [1.24, 5.07]		
2016 Shin	0	7	0	24		Not estimable		
2017 Deng	1	27	4	30	12.9%	0.25 [0.03, 2.39]		_
2017 Peng	1	15	1	16	3.2%	1.07 [0.06, 18.82]		
2017 Wang	22	62	12	60	27.8%	2.20 [0.97, 4.99]		-
2018 Wu	2	36	1	36	3.3%	2.06 [0.18, 23.77]		
Total (95% CI)		333		423	100.0%	1.79 [1.14, 2.81]		•
Total events	63		39			- PALE DE 2007 BALLES		
Heterogeneity: Chi2 =	5.71, df = 7	(P = 0.	57); l ² = 0	%				
Test for overall effect:		the second	and the second second second				0.01 0.1 Favours [experimental]	1 10 100 Favours [control]

A

	LLH		OL	H.		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	M-H, Fixed, 95% Cl
2009 Cai	1	19	2	19	7.3%	0.47 [0.04, 5.70]	
2014 Namgoong	2	37	12	112	21.6%	0.48 [0.10, 2.23]	
2015 Ye	1	46	4	51	14.2%	0.26 [0.03, 2.43]	
2015 Zheng	2	84	4	75	15.8%	0.43 [0.08, 2.43]	
2016 Shin	1	7	3	24	4.5%	1.17 [0.10, 13.36]	
2017 Deng	0	27	2	30	8.9%	0.21 [0.01, 4.52]	· · · · · · · · · · · · · · · · · · ·
2017 Peng	1	15	2	16	6.9%	0.50 [0.04, 6.17]	
2017 Wang	2	62	4	60	15.1%	0.47 [0.08, 2.65]	
2018 Wu	0	36	1	36	5.7%	0.32 [0.01, 8.23]	· · · · · · · · · · · · · · · · · · ·
Total (95% CI)		333		423	100.0%	0.44 [0.22, 0.89]	•
Total events	10		34				
Heterogeneity: Chi ² =	1.12, df = 8	(P = 1.	00); l ² = 0	%			
Test for overall effect:	Z = 2.29 (F	= 0.02)				0.01 0.1 1 10 10 Favours [experimental] Favours [control]
							Pavours (experimental) Pavours (control)

	LLH		0	H		Odds Ratio			Odds Ratio		
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	1	M-	H. Fixed, 95%	6 CI	
2009 Cai	1	19	0	19	5.3%	3.16 [0.12, 82.64]			-	_	_
2014 Namgoong	2	37	2	112	10.8%	3.14 [0.43, 23.14]					
2015 Ye	2	46	2	51	20.8%	1.11 [0.15, 8.24]		_	-		
2016 Shin	2	7	3	24	11.1%	2.80 [0.36, 21.49]					
2017 Deng	1	27	2	30	20.9%	0.54 [0.05, 6.30]			•	_	
2017 Peng	1	15	3	16	31.1%	0.31 [0.03, 3.36]	-				
Total (95% CI)		151		252	100.0%	1.26 [0.52, 3.03]			-		
Total events	9		12								
Heterogeneity: Chi ² =	3.51, df = 5	(P = 0.	62); l ² = 0	%			-	1		10	100
Test for overall effect:	Z = 0.51 (F	= 0.61)					0.01 Favo	0.1 urs (experim	ental] Favou	10 Irs [control]	100

Figure 6. Forest plots comparing hepatolithiasis complications bile leakage (A), incisional infection (B), intra-abdominal fluid collection (C), abdominal infection (D), and pneumonia (E).

substantial difference in the operative time. We believe that occasional bleeding and hepatic vein injury are the most common hepatectomy risks regardless of the approach. Hence, detailed preoperative evaluations, including computed tomography, magnetic resonance imaging, 3D visualization technology, and especially intraoperative ultrasound, to accurately reveal the size and location of the lesion, as well as individual variations in blood vessels and the biliary tract, are essential to reduce bleeding

		LLH		O	100.00		Odds Ratio	Odds Ratio	
	Study or Subgroup	Events	Total	Events		Weight	M-H. Fixed, 95% CI	M-H, Fixed, 95% Cl	_
	2014 Namgoong	0	37	4	112	10.8%	0.32 [0.02, 6.11]		
	2015 Zheng	17	84	10	75	40.8%	1.65 [0.70, 3.87]		
	2016 Shin	1	7	3	24	5.6%	1.17 [0.10, 13.36]		
	2017 Wang	8	62	10	60	42.8%	0.74 [0.27, 2.03]		
	Total (95% CI)		190		271	100.0%	1.09 [0.60, 1.98]	+	
	Total events	26		27					
	Heterogeneity: Chi ² = 2.14, df = 3 (P = 0.54); l ² = 0%							0.01 0.1 1 10 100	
	Test for overall effect: Z = 0.28 (P = 0.78)							Favours [experimental] Favours [control]	
D									
	LLH OLH						Odds Ratio	Odds Ratio	
	Study or Subgroup	Events	Total	Events	Total	Weight	M-H. Fixed, 95% CI	M-H, Fixed, 95% CI	_
	2014 Namgoong	0	37	1	112	10.6%	0.99 [0.04, 24.85]		
	2015 Ye	0	46	2	51	33.5%	0.21 [0.01, 4.55]	· · · · · · · · · · · · · · · · · · ·	
	2016 Shin	0	7	1	24	9.7%	1.04 [0.04, 28.44]		
	2017 Deng	1	27	2	30	26.0%	0.54 [0.05, 6.30]		
	2017 Peng	0	15	1	16	20.1%	0.33 [0.01, 8.83]		
	Total (95% CI)		132		233	100.0%	0.49 [0.13, 1.83]		
	Total events	1		7					
	Heterogeneity: Chi ² = 0.73, df = 4 (P = 0.95); l ² = 0%								1
	Test for overall effect: Z = 1.07 (P = 0.29)							0.01 0.1 1 10 100 Favours [experimental] Favours [control]	
E								Favours (experimental) Favours (control)	
					н		Odds Ratio	Odds Ratio	
	Study or Subgroup	Events	Total	Events		Weight	M-H, Fixed, 95% CI		
	2014 Namgoong	0	37	2	112	9.0%	0.59 [0.03, 12.55]		-
	2016 Zhang	0	20	2	25	15.7%	0.23 [0.01, 5.06]		
	2017 Valente	1	17	5	51	17.0%	0.57 [0.06, 5.30]		
	2018 Cho	6	62	13	118	58.3%	0.87 [0.31, 2.40]		
	Total (95% CI)		136		306	100.0%	0.69 [0.30, 1.60]	-	
	Total events	7		22					
	Heterogeneity: Chi ² = 0.71, df = 3 (P = 0.87); l ² = 0%								1
F								0.01 0.1 1 10 100 Favours [experimental] Favours [control]	1
Figure 6. Continued.									

risk regardless of the surgical approach. The rapid development of laparoscopic equipment, such as the Endo-GIA stapler, not only greatly reduce the operative time but also effectively prevent bleeding.^[28] Moreover, ultrasonic shears, argon beams, vessel sealing devices (eg, LigaSure), microwave coagulators, laparoscopic ultrasound systems, and suturing techniques are improving constantly, leading to a rapid global increase in the popularity of laparoscopic hepatectomy. In turn, increasing use of the procedure has resulted in enhanced surgical expertise and standardization of surgical steps.

The overall complication rate did not differ significantly between the LLH and OLH groups. However, subgroup analysis revealed a significantly lower incisional infection rate in the LLH group than in the OLH group. Residual stone and stone recurrence rates did not differ between the groups. Furthermore, the 2 groups did not differ significantly in postoperative ALT, albumin, and TB levels, suggesting no difference in the extent of perioperative liver injury or functional outcome. The only 2 unfavorable outcomes of LLH were higher bile leakage and greater total hospital expenses. Greater hospital expenses are understandable as laparoscopy requires numerous advanced instruments, such as trocars, which are not required for conventional open surgery. However, in some cases, greater surgical costs may be compensated by shorter hospital stay and less frequent need for blood transfusion.^[25,29] Alternatively, bile leakage may actually be underestimated because color distortion of the laparoscope camera and display could make smaller bile leakage volumes difficult to detect.^[30] At the same time, inflammation and edema due to cholangitis increase bile wall thickness relative to blood vessels. When the hepatic parenchyma

was separated with ultrasonic shears, only the blood vessels were coagulated, so the small bile duct may reopen after surgery. Therefore, the bile duct should be handled with care during ultrasonic scalpel use. The targeted section of the liver should also be carefully examined after dissection.^[31] For patients with high risk of bile leakage, such as those with severe cholangitis or perihepatitis, the use of T tube drainage is recommended for prevention and treatment.^[32]

Usually, we distinguish the left and right hemiliver by the hepatic ischemic line, but the middle hepatic vein is occasionally damaged due to deviation. Hence, it is very important to determine the direction of the middle hepatic vein before dissection. We first find the branch of the middle hepatic vein and then look for the trunk along the branch. Laparoscopic ultrasound can ensure complete avoidance of the middle hepatic vein while providing images of intrahepatic intubation.^[33] The LLH protocol used at our center and critical recommendations are as follows:

- (1) detailed preoperative evaluation by videography;
- (2) individual isolation and ligation of the left hepatic artery and left portal vein before hepatic parenchymal dissection (which is aided by their anatomic superiority and ease of left hepatic artery and portal branch division);
- (3) identification of the middle hepatic vein branch and then location of the trunk;
- (4) careful resection of the hepatic parenchyma using ultrasonic shears without pulling on the tissue (placement of T tubes is recommended for patients with severe cholangitis to prevent small bile duct injury before complete coagulation);
- (5) maintenance of central venous pressure between 4 and 6 cm H₂O, the optimal intraoperative range for reducing bleeding and hepatic vein reflux.^[34]

Limitations of this study are typical of most meta-analyses, including inter-trial heterogeneity, selection bias, and publication bias. Sources of heterogeneity include variations in patient inclusion, patient condition, parameter definition, and surgical expertise. Second, few trials included were randomized and controlled. Third, although we tried to identify all relevant data, some potentially relevant studies were excluded due to lack of reported data. Finally, this study was based only on reports published in English and Chinese.

This direct comparison indicates that LLH can improve multiple efficacy and safety metrics for left hemihepatectomy compared to OLH, such as wound infection rate, blood loss, time to oral intake, and hospital duration, without increased operative time or complications. Only hospital cost and bile leakage were greater for LLH. Therefore, our findings suggest overall enhanced recovery after surgery. We thus recommend LLH as the first choice for the treatment of left hemiliver lesions.

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