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Comparison of laparoscopic and open living donor hepatectomy

A meta-analysis

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Abstract

Laparoscopic donor hepatectomy (LDH), accepted as a minimally invasive approach, has become increasingly popular for living donor liver transplant. However, the outcomes of LDH remain to be fully clarified when compared with open living donor hepatectomy. Thus, our meta-analysis was designed to assess the efficacy of laparoscopic in comparison with conventional open donor hepatectomy.

The PubMed, Cochrane, and Embase electronic databases were searched to identify the articles concerning the comparison of the efficacy of laparoscopic versus open surgery in treatment of living donor liver transplantation updated to March, 2020. The main search terms and medical Subject Heading terms were: "living donor," "liver donor," "minimally invasive," "laparoscopic surgery," and "open surgery." After rigorous evaluation on quality, the data was extracted from eligible publications. The outcomes of interest included intraoperative and postoperative results.

The inclusion criteria were met by a total of 20 studies. In all, 2001 subjects involving 633 patients who received laparoscopic surgery and 1368 patients who received open surgery were included. According to the pooled result of surgery duration, the laparoscopic surgery was associated with shorter duration of hospital stay (MD = −1.07, 95% CI −1.85 to −0.29; $P = .007$), less blood loss (MD = −57.57, 95% CI −65.07 to −50.07; $P < .00001$), and less postoperative complications (OR = 0.61, 95% CI 0.44–0.85; $P = .003$). And the open donor hepatectomy achieved a trend of shorter operation time (MD = 30.31, 95% CI 13.93–46.69; $P = .0003$) than laparoscopic group. Similar results were found in terms of ALT ($P = .52$) as well as the AST ($P = .47$) peak level between the 2 groups.

LDH showed the better perioperative outcomes as compared with open donor hepatectomy. The findings revealed that LDH may be a feasible and safe procedure for the living donor liver transplantation.

Abbreviations: LDH = laparoscopic donor hepatectomy, ODH = open donor hepatectomy.

Keywords: laparoscopy donor hepatectomy, liver transplantation, living donor, meta-analysis, open donor hepatectomy

1. Introduction

Liver transplantation from living donors is an established therapy choice for patients with end-stage liver disease due to the shortage of available livers from deceased donor organs. Although conventional open donor hepatectomy (ODH) has been well established and accepted as the standard treatment option for living donor liver transplantation, high rate of donor morbidity remains the greatest challenge.[1–3]

Therefore, the less invasive technique has made impressive advancements and proposed as an ideal method for previously healthy donors. Laparoscopic donor hepatectomy (LDH) has been well developed and is considered to be a safe procedure in this field.[4]

Compared with the conventional open technique, laparoscopic surgery has the advantages of reducing surgical morbidity, intraoperative blood loss, postoperative pain, length of hospital stay, and in achieving better quality of life.[5–7] However, the LDH still remains the most controversial application of laparoscopic liver surgery.[8] The most important issue for the transplant community is donor safety. Advocates of ODH have declared that LDH has been too rapidly extended to liver donor from living candidates.[9] Additionally, due to technical difficulties of this minimally invasive approach, the application of LDH requires both proven technique in living donor surgery and a well-developed hospital transplantation program.

Several studies have compared the outcome between LDH and ODH.[5–7,9] However, no definite consensus has been reached. The superiority and safety of LDH are still under-debate. Therefore, we conducted a systematic review with

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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meta-analysis to compare the safety and feasibility between LDH and ODH, and determine the potential superior effects of laparoscopic resection to open resection for living donor liver transplantation.

2. Methods and materials

Our study has got approval from the Ethics Committee of The First Affiliated Hospital of Chongqing Medical University

2.1. Search strategy

Two reviewers independently conducted a systematic screening process through Embase, PubMed, Cochrane library from their dates of inception updated to March 2020. The main search terms and medical Subject Heading terms were: "living donor," "liver donor," "minimally invasive," "laparoscopic surgery," and "open surgery." References of retrieved articles that dealt with the topic of interest also hand-searched for additional articles.

2.2. Eligibility criteria

Inclusion criteria were studies relating to: studies focused on comparing the laparoscopic and open living donor hepatectomy; patients were clinical diagnosis of end-stage liver disease; articles reporting data of surgery-related and postoperative outcomes for both 2 approaches; the original literature should provide complete data.

Studies with the following exclusion criteria were excluded from our meta-analysis: the studies without a placebo or treatment group; the providing data was incomplete, and unable to achieve research outcomes; duplicated or overlapped previous literature.

2.3. Risk-of-bias assessments

The quality in each included study was evaluated based on Newcastle-Ottawa Quality Assessment Scale. Study quality was justified using Jadad scale. Two investigators separately carried out the relevant data from each article independently.

2.4. Data extraction

Two researchers performed the data extraction based on predefined criteria, independently. In case of disagreement, differences were revolved through discussion. Each eligible article included the main contents that rely on the following parameters: the lead author, year of publication, country, sample size, donor age, the procedure of laparoscopic.

2.5. Statistical analysis

The degree of heterogeneity across researches was examined using the I^2 statistic.[10]

Studies with an $I^2 \geq 50\%$ was considered to have moderate and high degree of heterogeneity, $I^2 < 50\%$ was considered to indicate low heterogeneity, respectively.[11] The fixed-effect model was adopted when low heterogeneity showed in studies; otherwise, we used the random-effect model for merging. A P value less than .05 was thought to have statistical significance. The statistical analyses were performed using Review Manager version 5.3 software (Revman; The Cochrane Collaboration Oxford, UK). Forest plots showed the pooled outcome of our meta-analysis.

3. Results

3.1. Literature search process and study characteristics

A total of 337 articles were initially identified for evaluation. Based on the criteria described in the Methods, 25 publications were searched out for detail assessment, but some failed to offer sufficient data of outcomes of 2 groups. Therefore, a final total of 20[12–31] studies were included in our meta-analysis (Fig. 1).

Table 1 showed the characteristics of the retrieved studies.

3.2. Outcomes and synthesis of results

3.2.1. Intraoperative parameters. Pooled data showed that open living donor hepatectomy was associated with a trend of shorter operative time (MD = 30.31, 95% CI 13.93–46.69; $P = .0003$) compared with the laparoscopic group (Fig. 2) and less blood loss (MD = −57.57, 95% CI −65.07 to −50.07; $P < .00001$) (Fig. 3). While, in the analysis of the peak level of AST ($I^2 = 44\%$; $P = .47$) and ALT ($I^2 = 44\%$; $P = .52$) comparing laparoscopic versus open living donor hepatectomy,

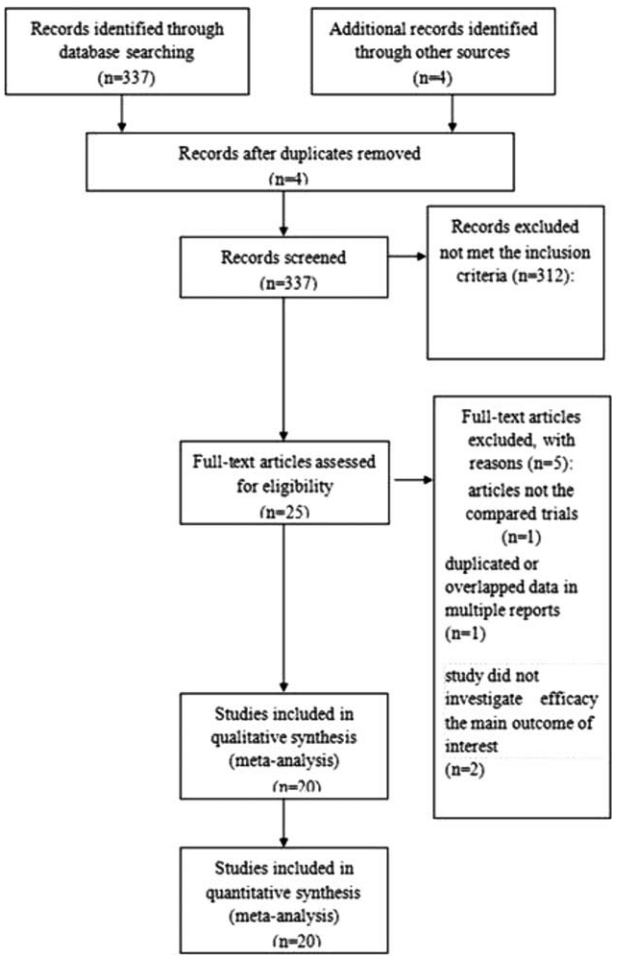

Figure 1. PRISMA flow chart of selection process to identify studies eligible for pooling.

Table 1

Characteristics of the retrieved studies.

		No. of patients		Gender (male)		Donor age (mean)		
Author year	Country	Laparoscopic	open	Laparoscopic	open	Laparoscopic	open	Laparoscopic procedure
Baker 2009	American	33	33	15	13	37	39.1	Hybrid Laparoscopic
Thenappan 2011	American	15	15	7	6	33.9	35.7	Hybrid Laparoscopic
Choi 2012	Korea	60	90	35	58	31.2	36.8	Hybrid Laparoscopic
Marubashi 2013	Japan	31	79	13	54	35.8	37.8	Hybrid Laparoscopic
Makki 2014	India	26	24	13	18	27.4	32.4	Hybrid Laparoscopic
Soyama 2015	American	22	20	12	8	37.2	31.1	Pure Laparoscopic
Suh 2014	Korea	14	268	1	206	24.9	34	Hybrid Laparoscopic
Shen 2016	China	28	20	15	13	40.4	38.3	Hybrid Laparoscopic
Kitajima 2017	Japan	153	77	36	43	42	43	Hybrid Laparoscopic
Kurosaki 2006	Japan	13	13	8	9	39	31	Hybrid Laparoscopic
Zhang 2014	China	25	25	13	18	27.4	32.4	Hybrid Laparoscopic
Kim 2011	Korea	11	11	1	6	29.6	35.2	Pure Laparoscopic
Soubrane 2006	France	16	14	10	9	29	32	Pure Laparoscopic
Choi 2014	Korea	25	484	1	346	25	31.5	Hybrid Laparoscopic
Nagai 2012	American	4	30	3	9	43.2	38.6	Hybrid Laparoscopic
Ha 2013	Korea	20	20	11	17	25	29	Hybrid Laparoscopic
Samstein 2015	American	22	20	12	8	37.2	31.1	Pure Laparoscopic
Gautier 2018	Russian	35	35	6	19	28.6	29.1	Pure Laparoscopic
Hong 2019	Korea	8	18	8	16	41	37	Pure Laparoscopic
Park 2019	Korea	72	72	40	43	28.5	29.5	Pure Laparoscopic

no statistically significant levels were found based on the data that are shown in Figures 4 and 5.

3.3. Postoperative outcomes

The length of hospital stay was available for 17 studies. The pooled result showed that hospital stay rate was shorter in laparoscopic surgery in comparison of open surgery group (Fig. 6). In addition, the pooled data indicated that laparoscopic surgery had lower overall complications rate (OR = 0.61, 95% CI 0.44–0.85; $P = .003$) than open living donor hepatectomy (Fig. 7).

4. Discussion

Minimally invasive surgery from living donors has widely been applied because it reduces the donor morbidity and improves postoperative recovery, minimizes tissue trauma, and satisfies the cosmetic and functional demands of donors.[32] Laparoscopic techniques and instruments for living donor hepatectomy, which

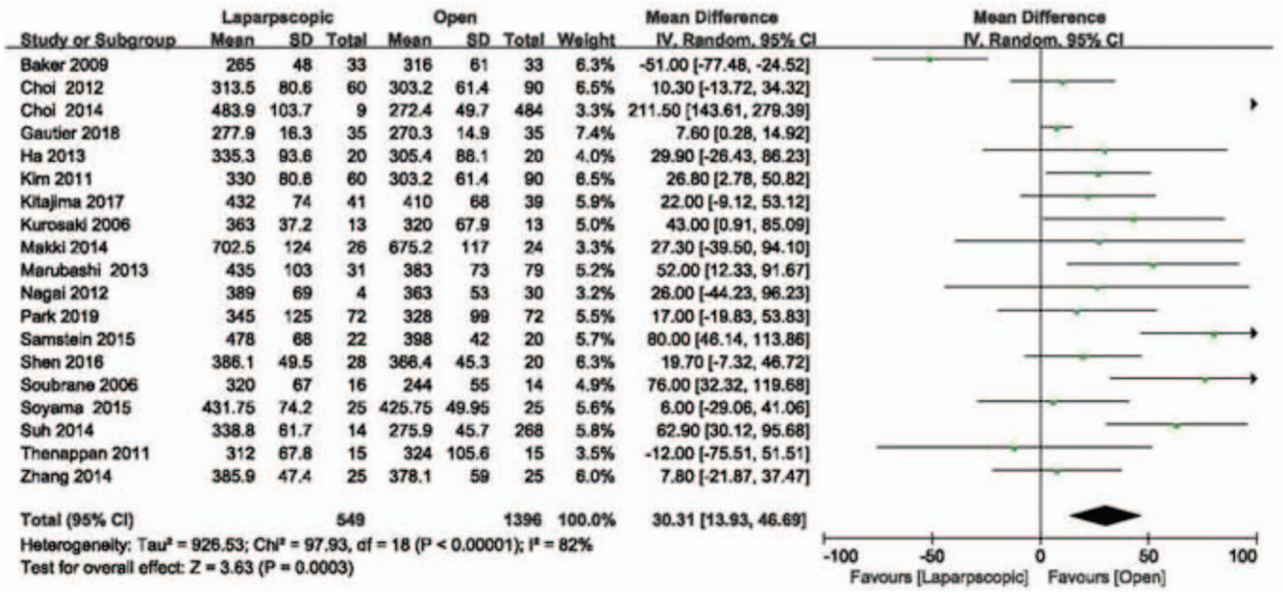

Figure 2. Pooled analysis of operative time.

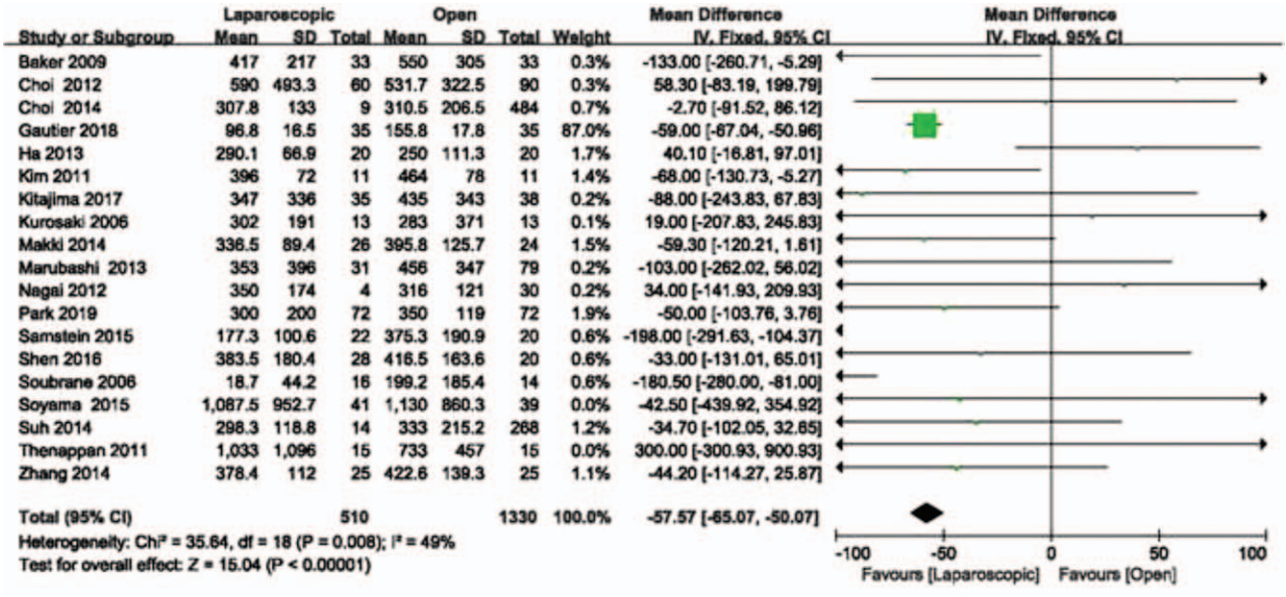

Figure 3. Pooled analysis of blood loss.

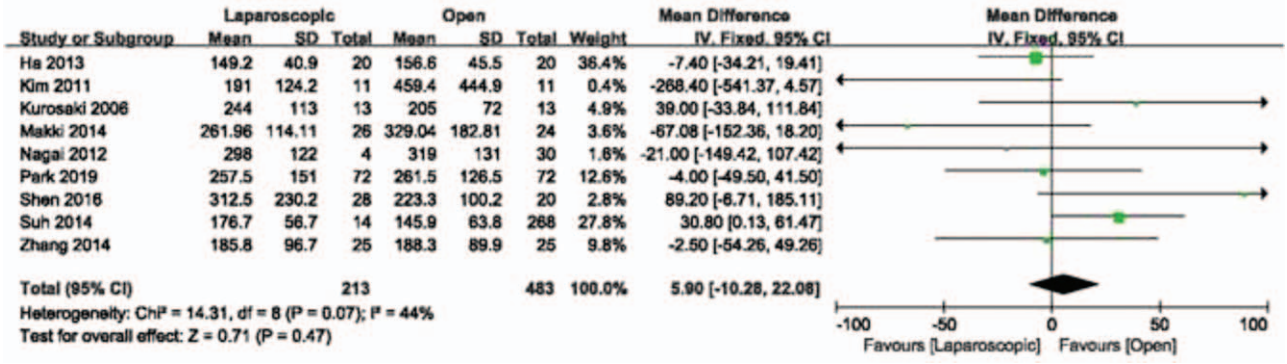

Figure 4. Synthesis of results in terms of the peak level of AST.

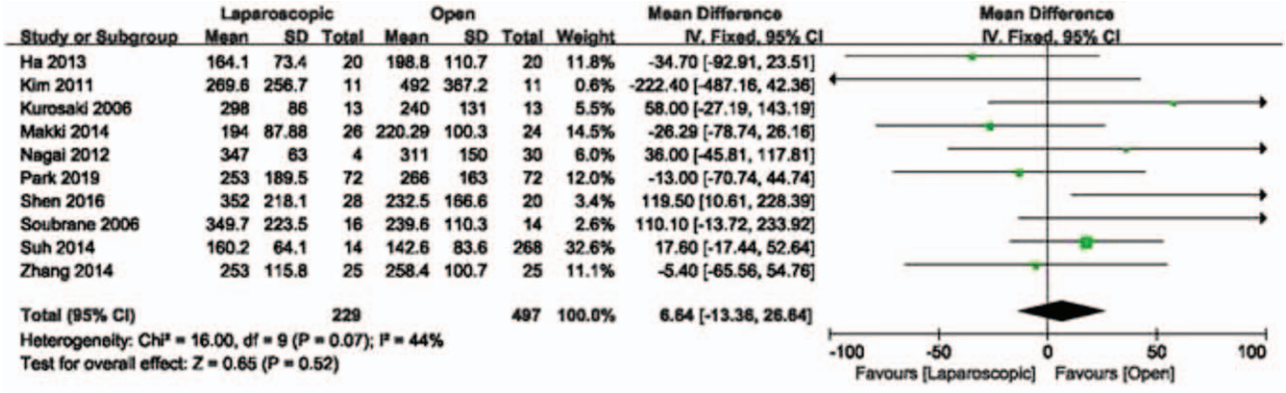

Figure 5. Synthesis of results in terms of the peak level of ALT.

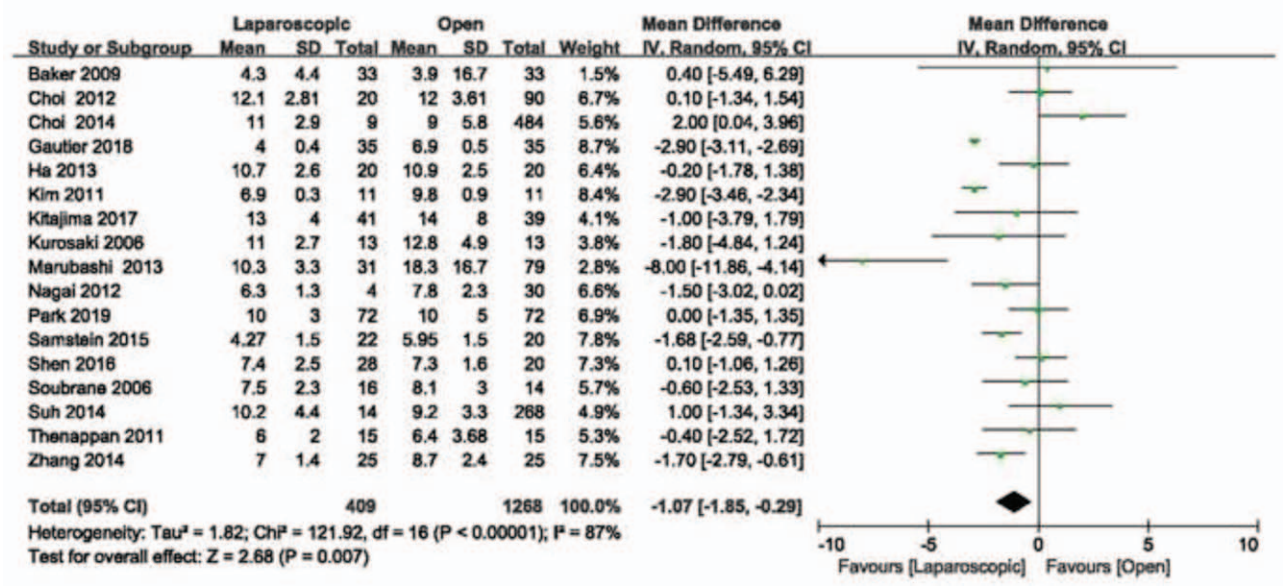

Figure 6. Pooled analysis of the length of hospital stay.

has become increasingly accepted in the minimally invasive surgery era,[33,34] have a number of differences compared with standard open approach.

Some retrospective articles have compared the outcome of laparoscopic procedure in living donors with open living donor hepatectomy.[16–18] However, no consensus has been reached on this topic. The major advantage of laparoscopic surgery is that the incision is small and midline, in the supra-umbilical area, which helps prevent scar discomfort.[12] Despite those remarkable features, laparoscopic surgery has not been widely performed for donor hepatectomy in many transplant centers, due to the unassured safety and technical feasibility.[9] We therefore conducted a meta-analysis to better clarify this issue.

Our findings observe that LDH offers shorter hospital stay, lessens blood loss and postoperative complications, while longer operative duration in comparison with conventional ODH.

By examining the operative outcomes, there were remarkably less blood loss and postoperative complications under laparoscopy than open surgery. These results are mainly due to the smaller incision on the abdominal wall and less invasive procedures with clear dissection of blood vessels during laparoscopic operation.[35]

The duration of operative was significantly longer in LDH as compared with the ODH group. This result is consistent with other previous comparative articles,[12,30] which could be explained by time-consuming laparoscopic devices, mobilization

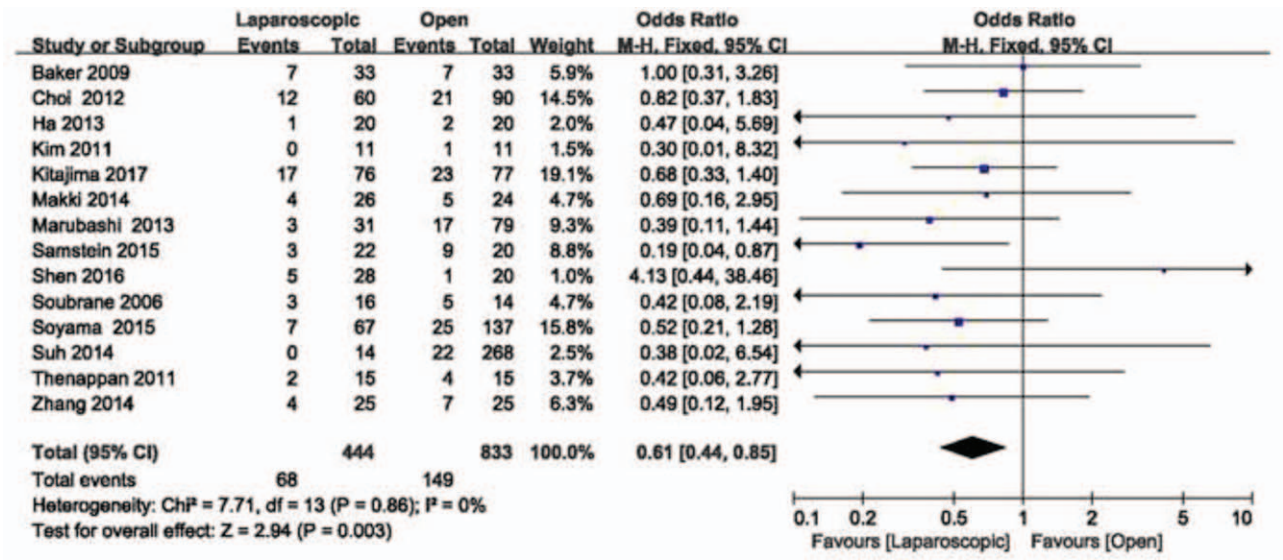

Figure 7. Pooled analysis of complications rate.

and dissection of the liver, as well as experience of surgeon,[17,19] even the type of hepatectomy was a crucial factor.[16] Indeed, it is the most difficult technically of the laparoscopic procedure, especially the graft retrieval after the inflowing of both graft and remnant liver is essential for transplantation.[8,36]

Besides, the length of hospital stay was an important indicator of rehabilitation of patient. Besides, given the minimally invasive features of laparoscopic approach, the LDH group achieved shorter duration in hospital, which indicated the better rehabilitation of patient with laparoscopic technique. This can be attributed to the rare postoperative complications, earlier recovery of bowel function, and less postoperative analgesic use,[37,38] raising the possibility of better cosmetic results and, possibly, faster return to work and normal physical activities.

The main strength of our study is overcoming the drawbacks of each individual article and may provide the most convincing results based on updated databases. Nevertheless, potential bias exists by the intrinsic retrospective study, which may somewhat underpowered the outcomes of interested. Considering the different surgical procedure among surgeons (laparoscopy-assisted donor hepatectomy or totally laparoscopic donor hepatectomy) and type of hepatectomy (left hepatectomy or right hepatectomy) that need to be concerned, there is no sufficient data for analysis.

5. Conclusion

In conclusion, our meta-analysis revealed that the laparoscopic approach for living donors could further minimize its invasiveness and benefit donors' postoperative recovery in comparison with open living donor hepatectomy, which can be recognized as a feasible and efficacious procedure for a living donor. Nonetheless, further subgroup evaluation and longer follow-ups results are needed to standardize and proliferate this approach.

Author contributions

Conceptualization: Yuye Gao, Wu Wu.
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Project administration: Heng Xiao.
Supervision: Wu Wu.
Visualization: Tao Liu.
Writing – original draft: Yuye Gao, Wu Wu, Chunyu Liu, Tao Liu, Heng Xiao.
Writing – review & editing: Heng Xiao.

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