


# Is routine abdominal drainage necessary for patients undergoing elective hepatectomy? A protocol for systematic review and meta-analysis

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## Abstract

**Objectives:** To evaluate comparative outcomes of routine abdominal drainage (RAD) and non-routine abdominal drainage (NRAD) during elective hepatic resection for hepatic neoplasms.

**Materials and Methods:** We systematically searched MEDLINE, EMBASE, The Cochrane Library, Web of Science. The searching phrases included “liver resection,” “hepatic resection,” “hepatectomy,” “abdominal drainage,” “surgical drainage,” “prophylactic drainage,” “intra-peritoneal drainage,” “drainage tube,” “hepatectomy,” “abdominal drainage” and “drainage tube.” Two independent reviewers critically screened literature, extracted data and assessed the risk of bias. Post-operative morbidity and mortality were the outcome parameters. Combined overall effect sizes were calculated using fixed-effect or random-effect model.

**Results:** We have identified 9 RCTs and 3 comparative studies reporting total of 5726 patients undergoing elective hepatectomy under RAD (n = 3084) or NRAD (NRAD group, n = 2642). RAD was associated with significantly higher overall complication rate [odds risk = 1.79, 95% CI (1.10, 2.93),  $P = .02$ ] and biliary leakage rate [odds risk = 2.41, 95% CI (1.48, 3.91),  $P = .0004$ ] compared with NRAD. Moreover, it significantly increased hospital stays [mean difference = 0.95, 95% CI (0.02, 1.87),  $P = .04$ ] compared with NRAD. RAD showed no difference regarding intra-abdominal hemorrhage, wound complications, liver failure, subphrenic complications, pulmonary complications, infectious complications, reoperation and mortality compared with NRAD.

**Conclusions:** Although routine abdominal drainage may help surgeons to observe post-operative complication, it seems to be associated with increased post-operative morbidity and longer hospital stays. Non-routine abdominal drainage may be an appropriate option in selected patients undergoing hepatic resection. Higher level of evidence is needed.

**Abbreviations:** NRAD = non-routine abdominal drainage, OR = odds risk, RAD = routine abdominal drainage.

**Keywords:** complications, drainage, hepatectomy, meta-analysis

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The datasets generated during and/or analyzed during the current study are publicly available.

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## 1. Introduction

Hepatectomy is the main treatment modality for hepatic neoplasm with acceptable postoperative morbidity and mortality.<sup>[1]</sup> Abdominal drainage was accepted as routine and mandate procedure whenever hepatectomy was performed. The main reason was to drain residual abdominal fluid and diagnose postoperative bleeding and biliary leakage as early as possible.<sup>[2,3]</sup> Recent years, the practice of preoperative precise evaluation, meticulous surgical dissection and post-operative management drastically reduced post-hepatectomy morbidity and mortality. Although, routine abdominal drainage after elective hepatectomy may help surgeons to observe postoperative bleeding and possible leakage as early as possible, some studies showed even better clinical outcome when the abdominal drainage was not routinely placed. Therefore, questions were raised concerning the necessity for routine abdominal drainage in patients undergoing elective hepatic resections.<sup>[4–6]</sup>

Despite the “sentinel” nature of abdominal drainage during elective hepatectomy, it may increase postoperative complication and hospital stay.<sup>[7,8]</sup> The necessity and clinical efficacy for routine abdominal drainage in elective hepatectomy are still inconclusive.<sup>[9]</sup> Herein, we report a systematic review and meta-analysis to compare the clinical outcomes of routine abdominal drainage (RAD) and non-routine abdominal drainage (NRAD) during elective hepatic resection.

## 2. Methods

This study was approved by the ethical committee of the first affiliated hospital of Xinjiang Medical university and conducted according to the recommendations of the “Preferred Reporting Items for Systematic Reviews and Meta-Analyses, PRISMA”.<sup>[10]</sup>

### 2.1. Literature search

The patient-intervention-comparison-outcome scheme combining patient (hepatic resection), intervention (placing abdominal drainage), control (without abdominal drainage), and outcome (postoperative outcomes) characteristics was used. A thorough search was conducted by using electronic databases including PubMed, EMBase, Ovid Medline, The Cochrane Library, Web of Science to March 2020 for relevant trials that compare clinical outcome of routine abdominal drainage and non-routine abdominal drainage during elective hepatectomy. Searching phrases included “liver resection,” “hepatic resection,” “hepatectomy,” “abdominal drainage,” “surgical drainage,” “prophylactic drainage,” “intraperitoneal drainage,” “drainage tube,” “hepatectomy,” “abdominal drainage” and “drainage tube.” The retrieval strategy follows the Cochrane system evaluation manual.

### 2.2. Study selection

RCTs and comparative studies that compare the clinical outcomes of RAD and NRAD in patients undergoing elective hepatectomy were enrolled into current study. Animal studies, conference abstracts, duplicate publications and as well as non-English literatures were excluded; Besides, studies that reported emergent hepatectomy were excluded from current analysis.

### 2.3. Data extraction and outcomes

Data extraction was carried out independently by 2 authors. The included parameters were detailed in Table 1. The outcome indicators included ascites, intra-abdominal hemorrhage, wound complications (wound infection, drainage tube orifice leakage ascites, incision dehiscence, etc), bile leakage, liver failure, subphrenic complications (subphrenic effusion requiring puncture and drainage, subphrenic infection, etc), pulmonary

complications (pulmonary infection, pleural effusion, pneumothorax, atelectasis, etc), infectious complications (wound infection, pulmonary infection, sepsis, etc), reoperation, the complication rate, postoperative hospital stay, and mortality.

### 2.4. Risk of bias assessment

Risk of bias for enrolled RCTs and comparative studies were assessed and given in Figure 1 and Table 2, respectively.

### 2.5. Statistical analysis

The RevMan version 5.3 software, recommended by Cochrane collaboration, has been applied for analysis. Heterogeneity magnitude was estimated by  $I^2$  (if  $P < .1$ ,  $I^2 > 40\%$ , it is judged as heterogeneity; if  $P > .1$ ,  $I^2 \leq 40\%$ , it is judged as no heterogeneity). If there was no heterogeneity among study results, the fixed-effect model was used for meta-analysis; if there was heterogeneity in the results of various studies, the random effect model was used for analysis after excluding the effect of significant clinical heterogeneity. Odds risk (OR) was used to describe count data, and mean difference was used to describe continuous variables with the same units of measurement. Summary effect measures are presented together with their corresponding 95 per cent confidence intervals (95% CI).  $P < .05$  was considered statistically significant.

## 3. Results

### 3.1. Study selection

The systematic literature search produced 2610 matches for this study. Among them, 828 duplicate publications and 1754 irrelevant publications were excluded. Of remaining 28 publications, 12 met the inclusion criteria after careful full-text review (Fig. 2).<sup>[11–22]</sup> We have identified 5726 patients including 3084 in RAD and 2642 in NRAD group, respectively.

### 3.2. Pooled results for incidence of ascites

Ten studies reported the incidence of postoperative ascites in both groups. The results of  $I^2$  suggested no significant heterogeneity among studies ( $P = .56$ ,  $I^2 = 0\%$ ), and the fixed-effect model was

**Table 1**  
Basic characteristics of included studies.

References	Year	Country	Study design	No. of patients	RAD			NRAD		
					n	Sex (M/F)	Age	n	Sex (M/F)	Age
Belghiti J <sup>[10]</sup>	1993	France	RCT	81	42	13/29	47 ± 16	39	18/21	51 ± 12
Fong Y <sup>[11]</sup>	1996	USA	RCT	120	60	31/29	57 ± 2	60	35/25	57 ± 2
Fuster J <sup>[12]</sup>	2004	Spain	RCT	40	20	15/5	60 ± 6	20	15/5	58 ± 8
Liu CL <sup>[13]</sup>	2004	China	RCT	104	52	42/10	53.6 ± 1.5	52	44/8	52.8 ± 1.4
Aldameh A <sup>[14]</sup>	2005	New Zealand	RCT	211	126	60/66	60 (4–81)*	85	30/55	61 (1–84)*
Lu L <sup>[15]</sup>	2006	China	RCT	462	357	276/81	50.4 ± 0.6	105	80/25	50.9 ± 1.2
Sun HC <sup>[16]</sup>	2006	China	RCT	120	60	47/13	50.2 ± 13.1	60	45/15	49.2 ± 12.1
Kim YI <sup>[17]</sup>	2014	Korea	RCT	200	100	74/26	56.3 ± 13.4	100	74/26	54.9 ± 12.9
Squires MH 3rd <sup>[18]</sup>	2015	USA	CCS	1041	564	264/300	57.2 ± 13.3	477	214/263	57.1 ± 14.0
Shwaartz C <sup>[19]</sup>	2016	USA	CCS	1005	500	236/264	58.3 ± 14.3	505	253/252	55.7 ± 14.1
Brauer DG <sup>[20]</sup>	2016	USA	RCT	1868	934	450/484	59.3 ± 13.1	934	470/464	59.2 ± 13.2
Wada S <sup>[21]</sup>	2017	Japan	CCS	474	269	208/61	67 (26–88)*	205	151/54	65 (31–90)*

CCS = Case control study, NRAD = non-routine abdominal drainage, RAD = routine abdominal drainage, RCT = randomized controlled study.

\* Median (range).

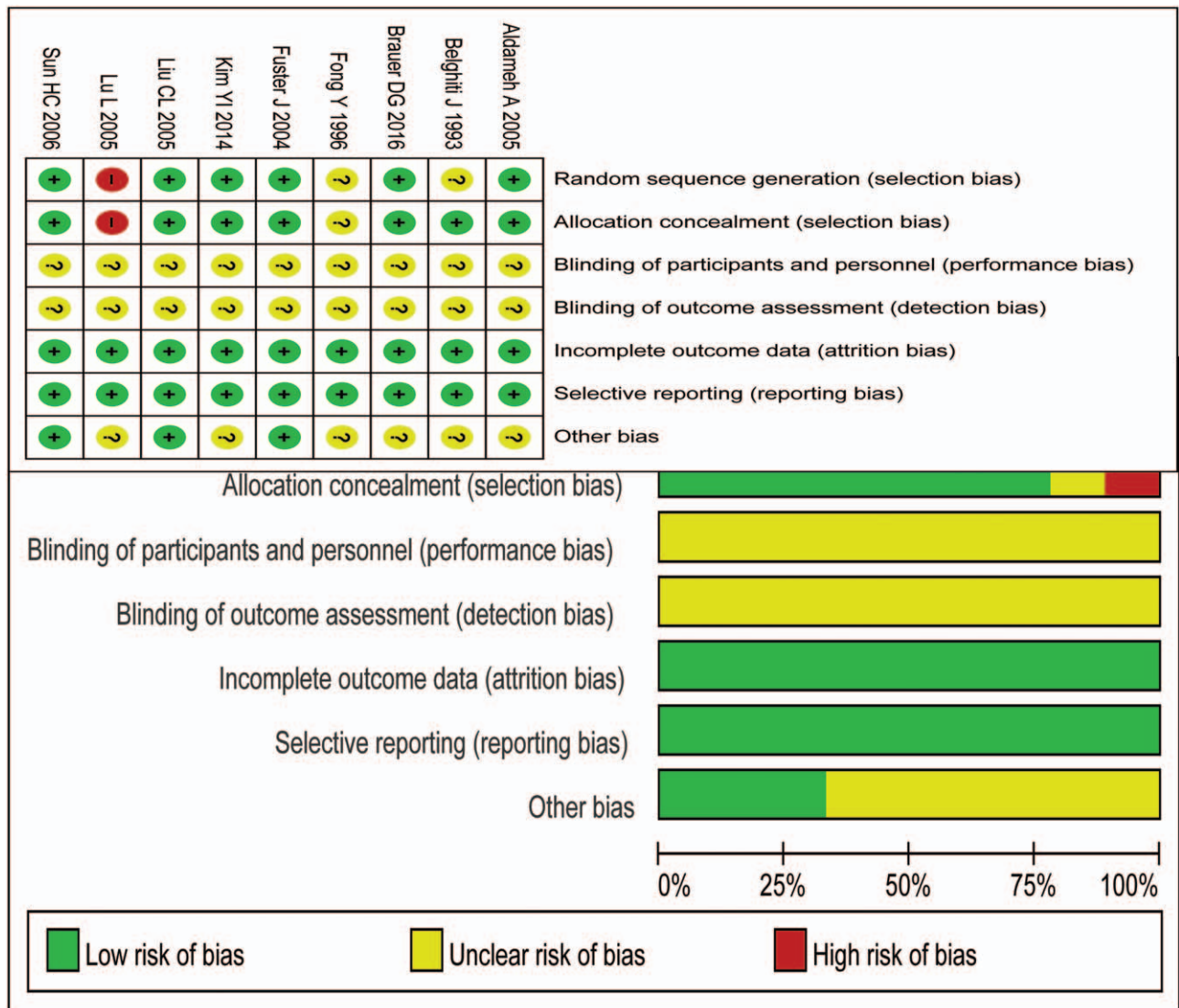


Figure 1. Risk-of-bias summary for the RCT studies.

selected for analysis. The results showed higher incidence of ascites in NRAD group than that in RAD group [OR=0.72, 95% CI (0.52, 0.98), P=.04] (Fig. 3A).

**3.3. Pooled results for incidence of intra-abdominal hemorrhage**

Six studies reported the incidence of postoperative intra-abdominal hemorrhage in both groups. No significant heterogeneity was observed among studies (P=.96, I<sup>2</sup>=0%), and the fixed-effect model was selected. The results showed no significant

difference between RAD and NRAD groups. [OR=1.77, 95% CI (0.61, 5.09), P=.29] (Fig. 3B).

**3.4. Pooled results for incidence of wound complications**

Ten studies reported the incidence of postoperative wound complications in both groups. Heterogeneity existed among studies (P<.00001, I<sup>2</sup>=85%), and thus random effects model was used for analysis. The results showed no significant difference between the 2 groups [OR=2.03, 95% CI (1.01, 4.06), P=.05] (Fig. 3C).

**Table 2**  
Evaluation of risk of bias in included studies.

Articles	①	②	③	④	⑤A	⑤B	⑥	⑦	⑧	NOS score
Squires MH 3rd	1	1	1	1	1	1	1	1	0	8
Shwaartz C	1	1	1	1	1	1	1	1	0	8
Wada S	1	1	1	1	1	0	1	1	1	8

NOS=Newcastle-Ottawa Scale.

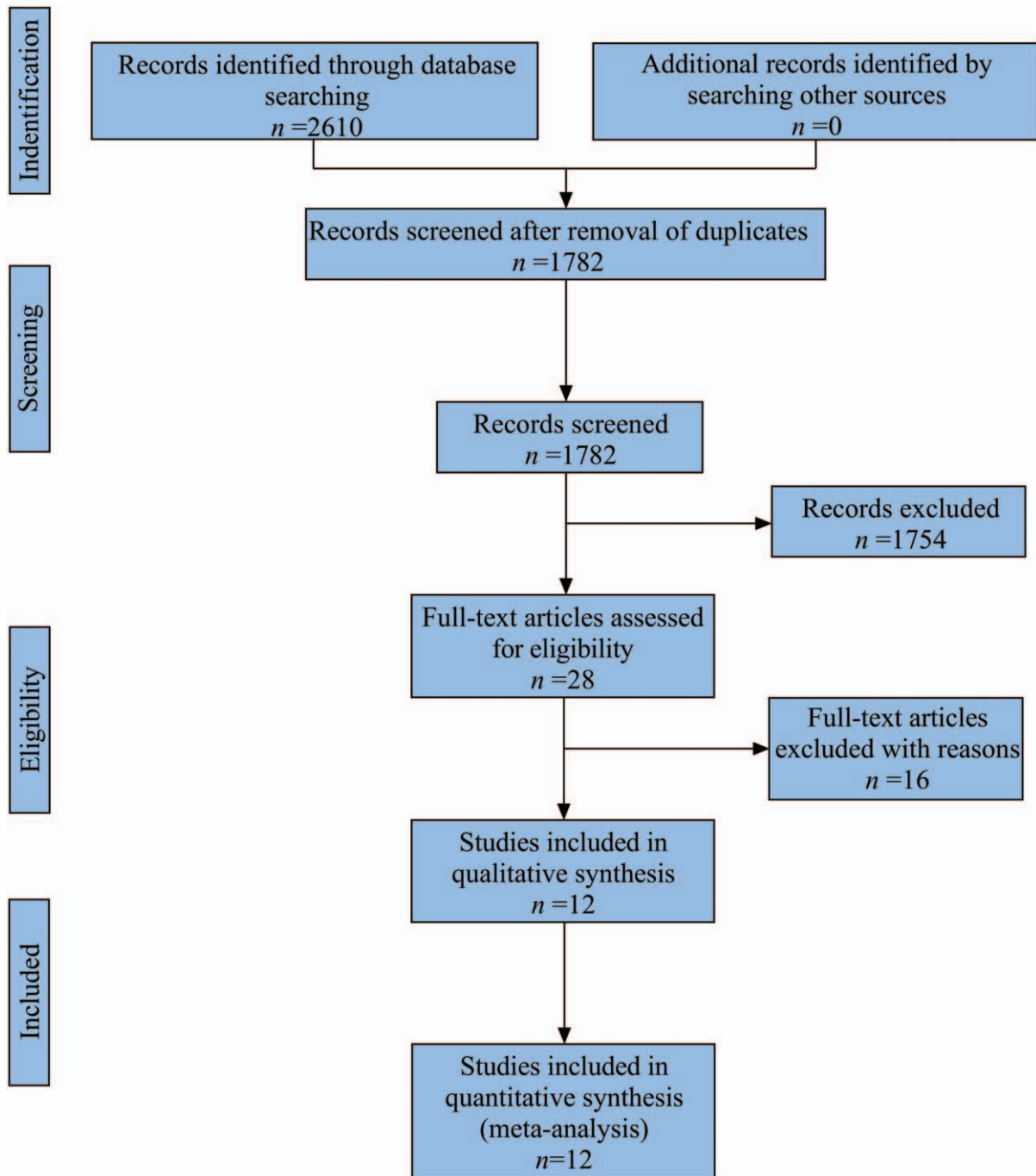


Figure 2. PRISMA flow chart showing selection of articles for review.

### 3.5. Pooled results for incidence of postoperative bile leakage

The incidence of postoperative bile leakage was reported in all included studies both for RAD and NRAD group. Heterogeneity was significant among studies ( $P=.04$ ,  $I^2=49\%$ ), and therefore random effects model was selected for analysis. Higher incidence of postoperative bile leakage was shown in RAD group compare to NRAD group [OR=2.41, 95% CI (1.48, 3.91),  $P=.0004$ ] (Fig. 3D).

### 3.6. Pooled results for incidence of postoperative liver failure

Nine studies reported the incidence of postoperative liver failure in both groups. No significant heterogeneity among studies were shown ( $P=.60$ ,  $I^2=0\%$ ), and the fixed-effect model was selected for analysis. The results showed no significant difference between the 2 groups regarding postoperative liver failure [OR=1.09, 95% CI (0.85, 1.40),  $P=.49$ ] (Fig. 4A).

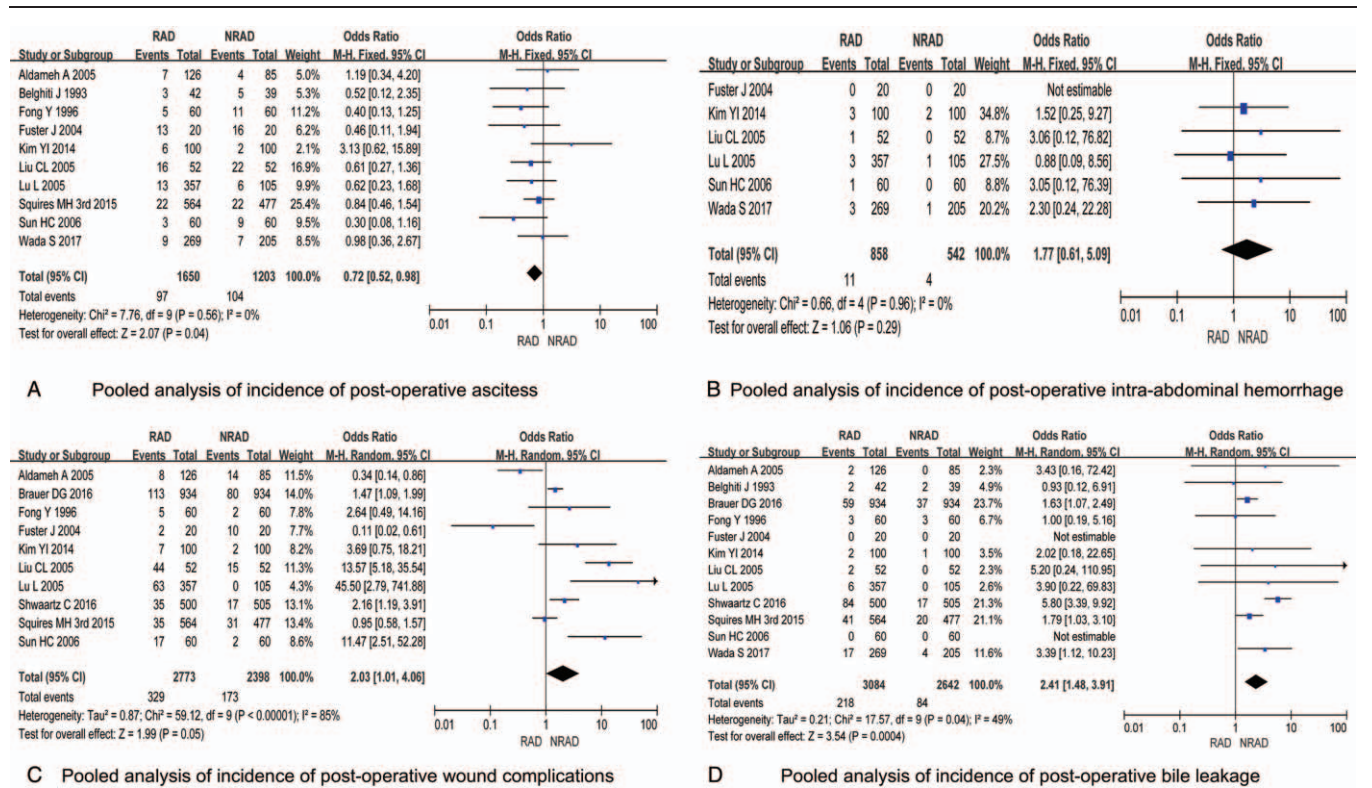


Figure 3. Pooled analysis of incidence of post-operative ascites/intra-abdominal hemorrhage/wound complications/ bile leakage in patients undergoing elected hepatectomy treated with and without routine abdominal drainage.

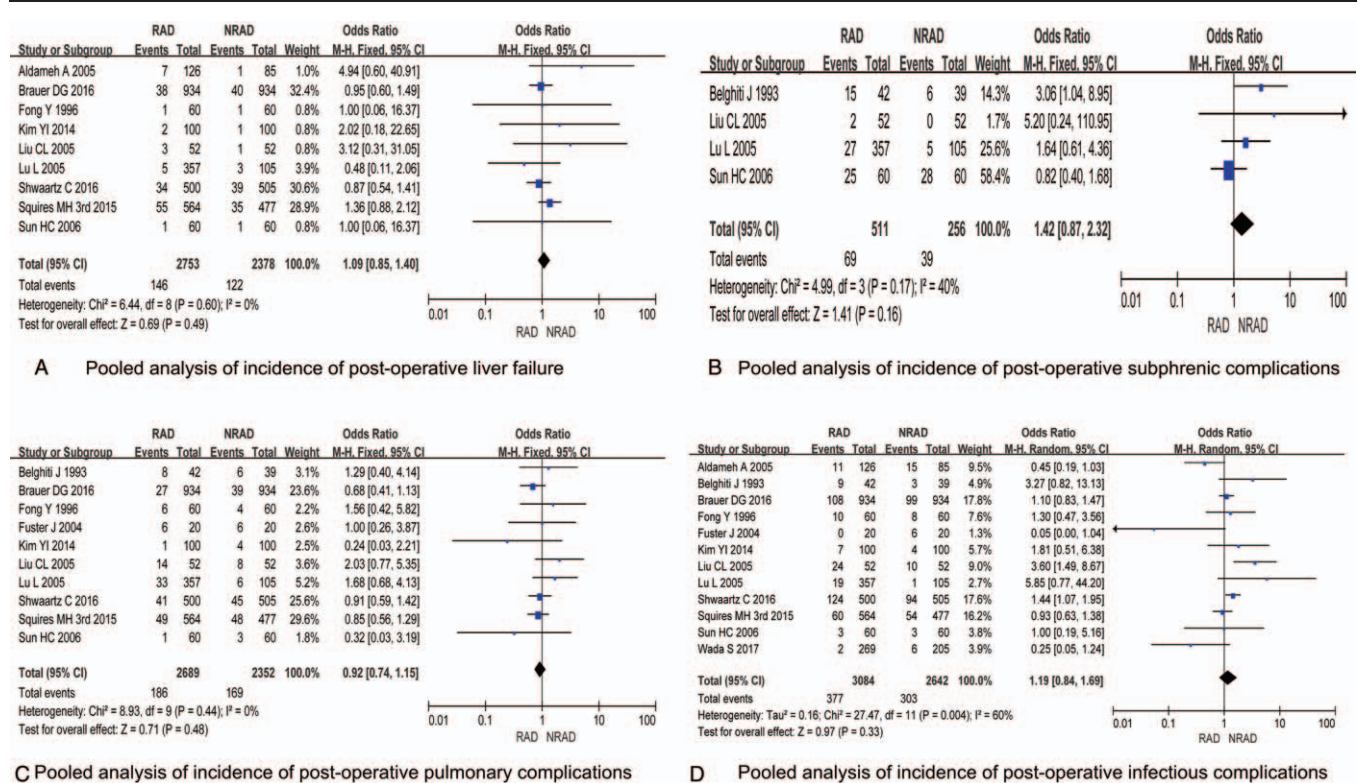


Figure 4. Pooled analysis of incidence of post-operative liver failure/subphrenic complications/ pulmonary complications/infectious complications in patients undergoing elected hepatectomy treated with and without routine abdominal drainage.

**3.7. Pooled results for incidence of subphrenic complications**

Four studies reported the incidence of postoperative subphrenic complications in both groups. No significant heterogeneity among studies ( $P=.17$ ,  $I^2=40\%$ ), and the fixed-effect model was selected for analysis. The results showed no significant difference between the 2 groups [OR=1.42, 95% CI (0.87, 2.32),  $P=.16$ ] (Fig. 4B).

**3.8. Pooled results for incidence of postoperative pulmonary complications**

Ten studies reported the incidence rate of postoperative pulmonary complications in both groups. No significant heterogeneity among studies was found ( $P=.44$ ,  $I^2=0\%$ ), and the fixed-effect model was selected for analysis. The results showed no significant difference between the 2 groups [OR=0.92, 95% CI (0.74, 1.15),  $P=.48$ ] (Fig. 4c).

**3.9. Pooled results for incidence of postoperative infectious complications**

All 12 studies reported the incidence of postoperative infectious complications in the RAD and NRAD groups. The results of heterogeneity test showed statistical heterogeneity among studies ( $P=.004$ ,  $I^2=60\%$ ), and random effects model was selected for analysis. The results showed no significant difference between the 2 groups [OR=1.19, 95% CI (0.84, 1.69),  $P=.33$ ] (Fig. 4D).

**3.10. Pooled results for incidence of postoperative reoperation**

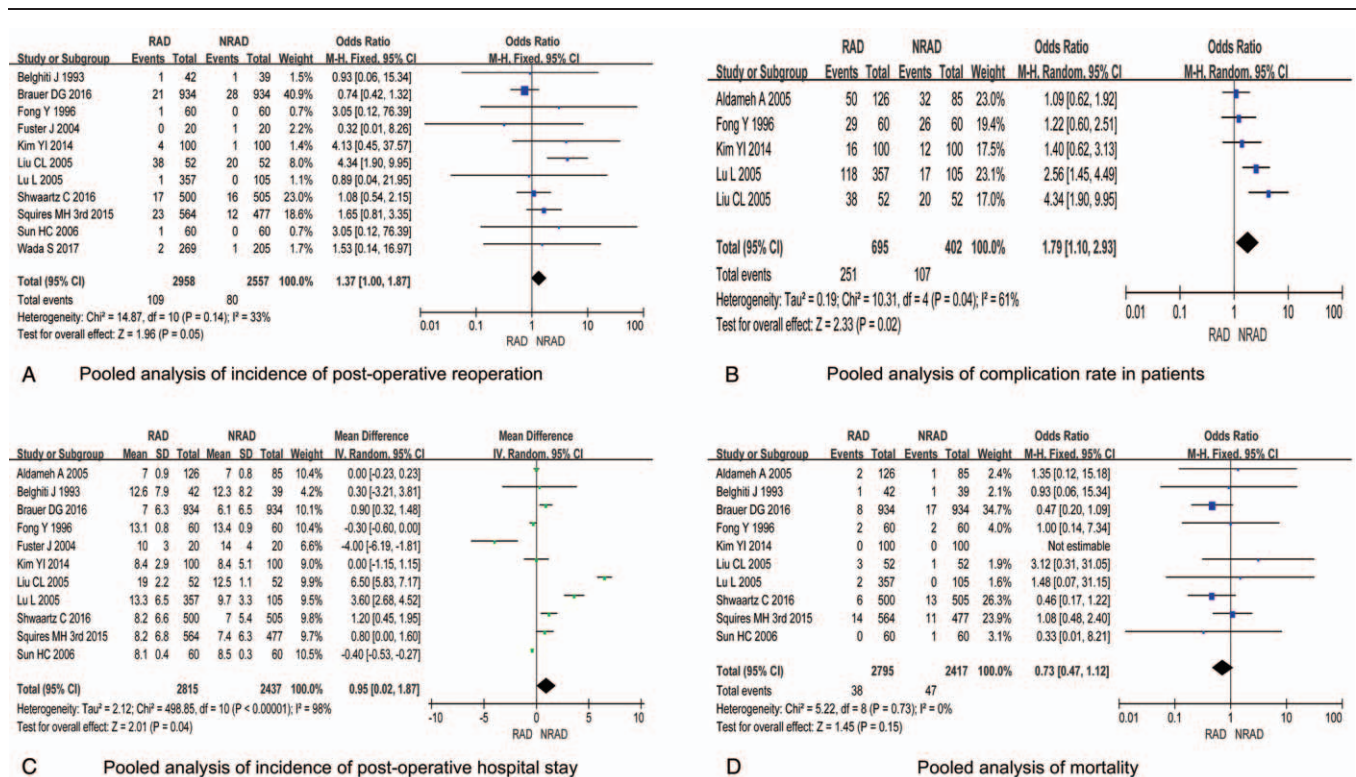
The incidence of postoperative reoperation in RAD group and NRAD group was reported in 11 included studies. No significant heterogeneity among studies was found ( $P=.14$ ,  $I^2=33\%$ ), and the fixed-effect model was selected for analysis. The results showed no significant difference between the 2 groups [OR=1.37, 95% CI (1.00, 1.87),  $P=.05$ ] (Fig. 5A).

**3.11. Pooled results for the overall complication rate**

Five studies reported the overall complication rate in both groups. Heterogeneity was found among studies ( $P=.04$ ,  $I^2=61\%$ ), and random model was selected for analysis. Higher overall complication rate was shown in RAD compare to NRAD group [OR=1.79, 95% CI (1.10, 2.93),  $P=.02$ ] (Fig. 5B).

**3.12. Pooled results for postoperative hospital stay**

All 12 studies reported the comparison of postoperative hospital stay in both groups. The relevant data in a literature<sup>[22]</sup> are expressed in the form of median, which cannot be counted. Therefore, no statistical analysis is performed in the figure. The results of heterogeneity test showed statistical heterogeneity among studies ( $P<.00001$ ,  $I^2=98\%$ ), and random effects model was selected for analysis. The results showed that the postoperative hospital stay was shorter in NRAD compare to RAD group [mean difference =0.95, 95% CI (0.02, 1.87),  $P=.04$ ] (Fig. 5C).



**Figure 5.** Pooled analysis of incidence of post-operative reoperation/complication rate/post-operative hospital stay/mortality in patients undergoing elected hepatectomy treated with and without routine abdominal drainage.

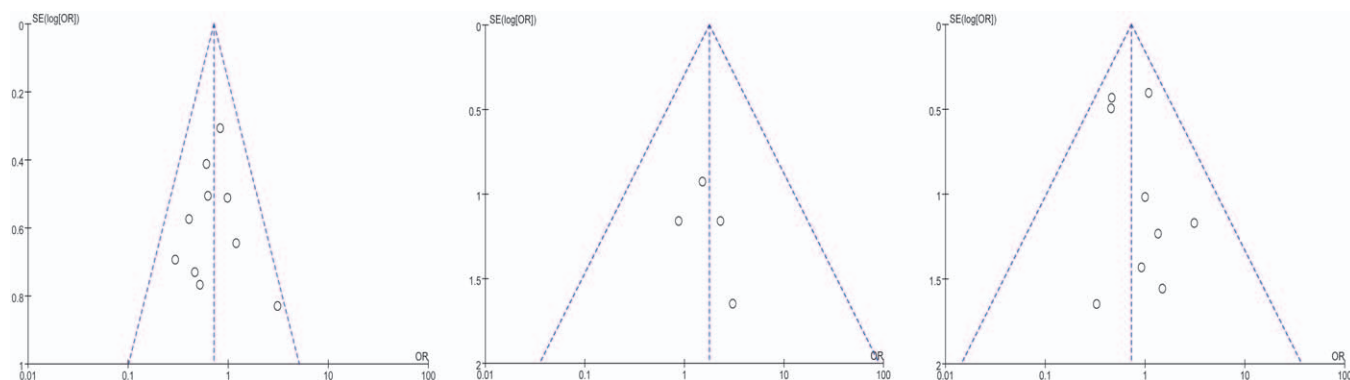


Figure 6. Funnel plot of meta-analysis of literature publication bias.

### 3.13. Pooled results for postoperative mortality

Ten studies reported postoperative mortality in both groups. No significant heterogeneity was found among studies ( $P=0.73$ ,  $I^2=0\%$ ), and the fixed-effect model was selected for analysis. The results showed no significant difference between the 2 groups [ $OR=0.73$ , 95%  $CI$  (0.47, 1.12),  $P=.15$ ] (Fig. 5D).

### 3.14. Publication bias analysis

The results of funnel plot analysis using the incidence of postoperative ascites, intra-abdominal hemorrhage and mortality showed that the symmetry of the funnel plot was good, and all scattered points in the plot were distributed in the funnel, indicating that publication bias had little effect on the results of the meta-analysis (Fig. 6).

## 4. Discussion

Routine abdominal drainage was considered to play important role in collecting post-hepatectomy abdominal fluid and thus help to diagnose intra-abdominal bleeding and biliary leakage during elective hepatectomy.<sup>[2,3,23]</sup> For such reasons, abdominal drainage has been a worldwide accepted as a routine procedure after abdominal surgery.<sup>[24]</sup> More recently, the surgical advancement, introduction of enhanced recovery after surgery and “TUBELESS” surgical practice urged surgeons to perform hepatic resection without routine abdominal drainage as long as possible and yielded better clinical outcome.<sup>[25]</sup> Recent studies showed that non-routine abdominal drainage after elective hepatic resection was associated with lower post-operative morbidity.<sup>[11,14]</sup>

This meta-analysis claimed that routine abdominal drainage after elective hepatic resection was associated with increased rate of overall complication, postoperative bile leakage and postoperative hospital stay compared to patients with no abdominal drainage. Our results support the practice of “tubeless” resection during hepatic surgery with lower morbidity and higher quality of life in selected patients.

The main reason for using drainage was better observation of postoperative intra-abdominal conditions.<sup>[26]</sup> Bleeding is 1 of the drastic complications after hepatectomy. Routine abdominal drainage may seem to be helpful for potential postoperative bleeding, however, postoperative bleeding rarely occurs after elective hepatectomy. Even if the patient with postoperative

massive bleeding could be judged by electrocardiogram monitoring of vital signs and laboratory tests, reoperation could be applied timely as long as it is necessary.<sup>[27]</sup> Besides, drainage placement is only observational and has no favor for hemostasis.

Biliary leakage is one of the common complications after hepatic resection. Our results showed that routine abdominal drainage increases postoperative biliary leakage and mostly happen after drainage removal. This is possibly due to the re-opening of biliary ducts after irritated by tube removal. Whenever postoperative biliary leakage happens, percutaneous puncture and drainage under ultrasound and CT guidance could easily solve the situation.<sup>[28]</sup> Moreover, routine placement of drainage tube may increase complication such as retrograde infection, pain, possible bowel injury and loss of excessive ascites. Furthermore, NRAD may reduce costs and promote early ambulation of the patients. The abdominal drainage tube restricts the patient’s activities, aggravates patient’s pain as well as increases the workload of medical staff.<sup>[29]</sup>

We have some limitations for current study. Surgical skills may vary for different center and this may influence on the placement of drainage and postoperative complications. Besides, both RCTs and retrospective controlled studies were included analysis and this may increase the selection bias.

## 5. Conclusion

Although routine abdominal drainage may provide better observation in patients after hepatectomy, however, it is associated with increased postoperative morbidity and longer hospital stays. Hepatectomy with non-abdominal drainage is practicable in high volume center and sophisticated hands with acceptable clinical outcomes.

### Author contributions

TT and LT developed study concept. Z JM helped and gave methodological advice. G SS and WJ carried out the literature search and data extraction. NA, SA and ZQ conducted statistical analysis. NA, SA and ZQ wrote the first draft of the manuscript. TT, Z JM and LT provided scientific input for the study’s background and rationale. SA and NA interpreted the results. All authors read, critically revised, and approved the final manuscript.

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**Writing – review & editing:** Tao Li, Tuerhongjiang Tuxun.

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