Routine abdominal drainage versus no drainage after elective hepatectomy: A systematic review and meta-analysis

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ABSTRACT

Introduction: The value of routine abdominal drainage after hepatectomy remains controversial. Although drains have traditionally been used to detect bile leakage or postoperative bleeding and to evacuate intra-abdominal collections, their routine use after elective liver resection has increasingly been questioned.

Materials and Methods: A systematic review and meta-analysis of randomized controlled trials comparing routine abdominal drainage with no drainage after elective hepatectomy was performed. PubMed/MEDLINE, Embase, Web of Science, and the Cochrane Library were searched from inception to 1 April 2026 using predefined terms related to hepatectomy, drainage, and randomized trials. The outcomes of interest included overall postoperative morbidity, postoperative mortality, wound-related complications, bile leakage or biliary fistula, subphrenic or perihepatic fluid collection, and length of hospital stay. Risk of bias was assessed using the Cochrane RoB 2 tool.

Results: Six randomized controlled trials involving 1,025 patients were included, with 513 patients allocated to routine drainage and 512 to no drainage. Routine drainage was associated with higher overall postoperative morbidity (RR 1.41, 95% CI 1.16-1.71; I^2 = 32.5%) and more wound-related complications (RR 2.75, 95% CI 1.56-4.86; I^2 = 36.1%). Postoperative mortality remained low and did not differ significantly between groups (RR 1.20, 95% CI 0.50-3.00; I^2 = 0%). Reported bile-leakage events were more frequent in the drainage group (RR 5.02, 95% CI 1.53-16.48; I^2 = 0%); however, this outcome is highly susceptible to ascertainment bias because the opportunity to detect bile leakage differs according to drain status. Subphrenic/perihepatic collection did not differ clearly between groups (RR 1.02, 95% CI 0.48-2.15; I^2 = 71.4%). Length of hospital stay showed a small pooled difference favoring drainage (MD -0.35 days, 95% CI -0.50 to -0.20), but between-study heterogeneity was substantial (I^2 = 82.3%) and the trial-level directions were inconsistent.

Conclusion: Current randomized evidence does not support routine abdominal drainage after elective hepatectomy, particularly in uncomplicated or standard-risk cases. A selective rather than routine strategy appears more appropriate, and the apparent bile-leakage signal and hospital-stay result should be interpreted in light of ascertainment bias, outcome-definition differences, and substantial between-study heterogeneity.

KEYWORDS:
Hepatectomy, liver resection, abdominal drainage, no drainag

INTRODUCTION

Hepatectomy is a technically demanding procedure that carries a risk of postoperative complications, including bile leakage, hemorrhage, intra-abdominal fluid collection, surgical-site infection, and liver failure.[1-2] For decades, routine abdominal drainage after liver resection was widely adopted on the assumption that it might facilitate early detection of postoperative bleeding or bile leakage and help evacuate fluid from the operative field.[3]

However, the routine use of drains has increasingly been challenged across abdominal surgery.[3-4] Drains may themselves become a source of retrograde infection, impair mobilization, prolong hospitalization, and increase discomfort.[5] In liver surgery specifically, the theoretical advantages of drainage must be balanced against the possibility that drains may not prevent clinically relevant complications and may instead contribute to wound- or drain-related morbidity.[3,5]

Several randomized controlled trials have evaluated routine abdominal drainage after hepatectomy, beginning with the early studies by Belghiti, et al.(6) , Fong, et al.(7), and Liu, et al.(8) , and followed by later trials from China, East Asia, and Japan.[6-11] These studies have not shown a consistent benefit of routine drainage, and some have suggested worse outcomes in the drainage group.[6-12] In addition, enhanced recovery pathways and contemporary perioperative care have further reduced the rationale for routine prophylactic drainage after uncomplicated liver resection.[13-14] The aim of the present study was therefore to update the evidence by systematically reviewing randomized controlled trials comparing routine abdominal drainage with no drainage after elective hepatectomy and to synthesize the available data using meta-analytic methods.

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MATERIALS AND METHODS

Study design and reporting

This systematic review and meta-analysis was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement.15 The review was not prospectively registered.

Search strategy

A systematic literature search was performed in PubMed/MEDLINE, Embase, Web of Science, and the Cochrane Library inception to 1 April 2026. Reference lists of relevant reviews and eligible studies were also screened manually to identify additional records. The PubMed search strategy used for this review was as follows: `((("Hepatectomy" OR "Liver Resection" OR "Hepatic Resection" OR "Partial Hepatectomy" OR "Hepatic Lobectomy") AND ("drainage" OR "Surgical Drainage" OR "Abdominal Drainage" OR "Drain" OR "Drains") AND (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized[tiab] OR placebo[tiab] OR clinical trials as topic[mesh:noexp] OR randomly[tiab] OR trial[ti])) AND (((((((randomized controlled trial [pt]) OR (controlled clinical trial [pt])) OR (randomized [tiab])) OR (placebo [tiab])) OR (drug therapy [sh])) OR (randomly [tiab])) OR (trial [tiab])) OR (groups [tiab])) NOT ((animals [mh]) NOT (humans [mh]))` Equivalent search terms and syntax were adapted for the other databases. Only studies published in English were considered.

Eligibility criteria

Studies were eligible if they met all of the following criteria: (i)randomized controlled trial; (ii) adult patients undergoing elective hepatectomy or liver resection; (iii) direct comparison between routine abdominal drainage and no drainage; (iv) reporting of at least one postoperative outcome of interest.

Studies were excluded if they: (i) were non-randomized; (ii) involved procedures other than hepatectomy alone; (iii) evaluated interventions other than routine abdominal drainage versus no drainage; (iv) contained overlapping patient cohorts without extractable independent data; (v) lacked sufficient outcome data for analysis.

Outcomes

The primary outcome was overall postoperative morbidity.
Secondary outcomes included postoperative mortality, wound-related complications, bile leakage or biliary fistula, subphrenic or perihepatic fluid collection and length of hospital stay.

Other postoperative outcomes, including severe complications or septic complications, were recorded when reported, but were summarized narratively if definitions were inconsistent or extractable data were insufficient for pooled analysis.

Study selection and data extraction

Two reviewers independently screened titles and abstracts, assessed potentially eligible full-text articles, and extracted data using a standardized form. Disagreements were resolved by discussion and consensus. For each study, the following information was extracted: (i) author and year; (ii) country or region; (iii) sample size; (iv) characteristics of the study population; (v) intervention details; (vi) outcome data.

For dichotomous outcomes, event counts and total numbers in the drainage and no-drainage groups were extracted. For continuous outcomes, means, standard deviations, and sample sizes were extracted. When continuous data were reported as mean ± standard error, the standard deviation was calculated using the formula SD = standard error (SE) $SE \times \sqrt{n}$ in accordance with standard Cochrane guidance.[16]

Risk of bias assessment

Risk of bias was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool [17] across the following domains: (i) bias arising from the randomization process; (ii) bias due to deviations from intended interventions; (iii) bias due to missing outcome data; (iv) bias in measurement of the outcome; (v) bias in selection of the reported result. Each study was judged as having low risk of bias, some concerns, or high risk of bias.

Statistical analysis

Meta-analysis was performed using Stata/SE version 17.0 (StataCorp LLC, College Station, TX, USA) with a random-effects model because clinical and methodological heterogeneity was anticipated among studies. For dichotomous outcomes, risk ratios (RRs) with 95% confidence intervals (CIs) were calculated using the Mantel-Haenszel method. For continuous outcomes, mean differences (MDs) with 95% CIs were calculated using the inverse-variance method. The between-study variance in the random-effects model was estimated using the DerSimonian-Laird method. For rare-event outcomes, studies with zero events in both groups were retained in the descriptive summary but did not contribute to the pooled RR estimate under the Mantel-Haenszel model; for studies with a zero event in one group, a continuity correction of 0.5 was applied. Statistical heterogeneity was assessed using the I^2 statistic.[18] An I^2 value of 25%, 50%, and 75% was interpreted as low, moderate, and high heterogeneity, respectively. Studies were pooled only when outcome definitions and extractable data were sufficiently comparable. Because fewer than 10 studies were available for each pooled outcome, publication bias was not formally assessed.

RESULTS

Study selection

The study selection process is presented in Figure 1. After database searching, deduplication, title and abstract screening, and full-text assessment, six randomized controlled trials met the eligibility criteria and were included in the final review and quantitative synthesis.

Characteristics of included studies

Six randomized controlled trials published between 1993 and 2021 were included 6-11. These studies were conducted in France, the United States, Hong Kong/China, mainland China, East Asia, and Japan. Altogether, 1,025 patients were analyzed, of whom 513 were assigned to routine drainage and 512 to no drainage.

Table I: Characteristics of the randomized controlled trials included in the updated review

Study	Year	Region	N (Drain / No drain)	Population	Primary or main reported endpoint	Main conclusion
Belghiti et al.	1993	France	42 / 39	Elective hepatectomy, mixed indications	Postoperative complications	Routine drainage not necessary
Fong et al.	1996	USA	60 / 60	Elective liver resection, mainly malignant disease	Morbidity and postoperative outcome	Drainage unnecessary after elective liver resection
Liu et al.	2004	Hong Kong, China	52 / 52	Hepatectomy in chronic liver disease	Operative morbidity	Routine drainage contraindicated in chronic liver disease
Sun et al.	2006	China	60 / 60	Elective hepatectomy	Postoperative complications	Routine drainage unnecessary
Kim et al.	2014	Korea	100 / 100	Elective hepatectomy; mixed major/minor resection; chronic liver disease and normal liver parenchyma subgroups	Postoperative morbidity and complications directly related to drainage	Systematic drainage not recommended after satisfactory hepatectomy
Arita et al.	2021	Japan	199 / 201	Uncomplicated hepatic resection	Severe complications and postoperative outcome	Drain placement associated with worse postoperative outcome

Table II: Risk of bias

Study	Randomization process	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of reported result	Overall
Belghiti et al.	Some concerns	Some concerns	Low	Some concerns	Low	Some concerns
Fong et al.	Some concerns	Some concerns	Low	Some concerns	Low	Some concerns
Liu et al.	High	Some concerns	Some concerns	High	Some concerns	High
Sun et al.	Low	Low	Low	Low	Low	Low
Kim et al.	Some concerns	Some concerns	Low	Low	Low	Some concerns
Arita et al.	Low	Low	Low	Low	Low	Low

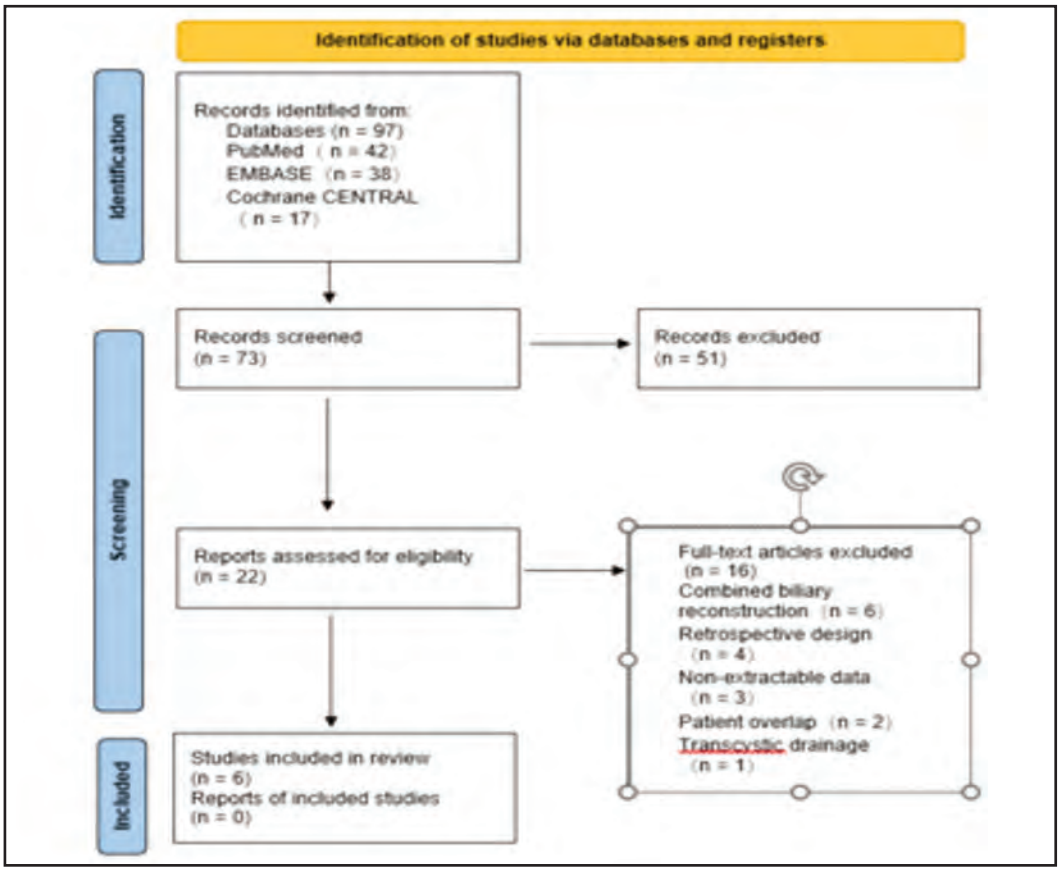

Fig. 1: PRISMA flow diagram illustrating the process of study identification, screening, eligibility assessment, and inclusion

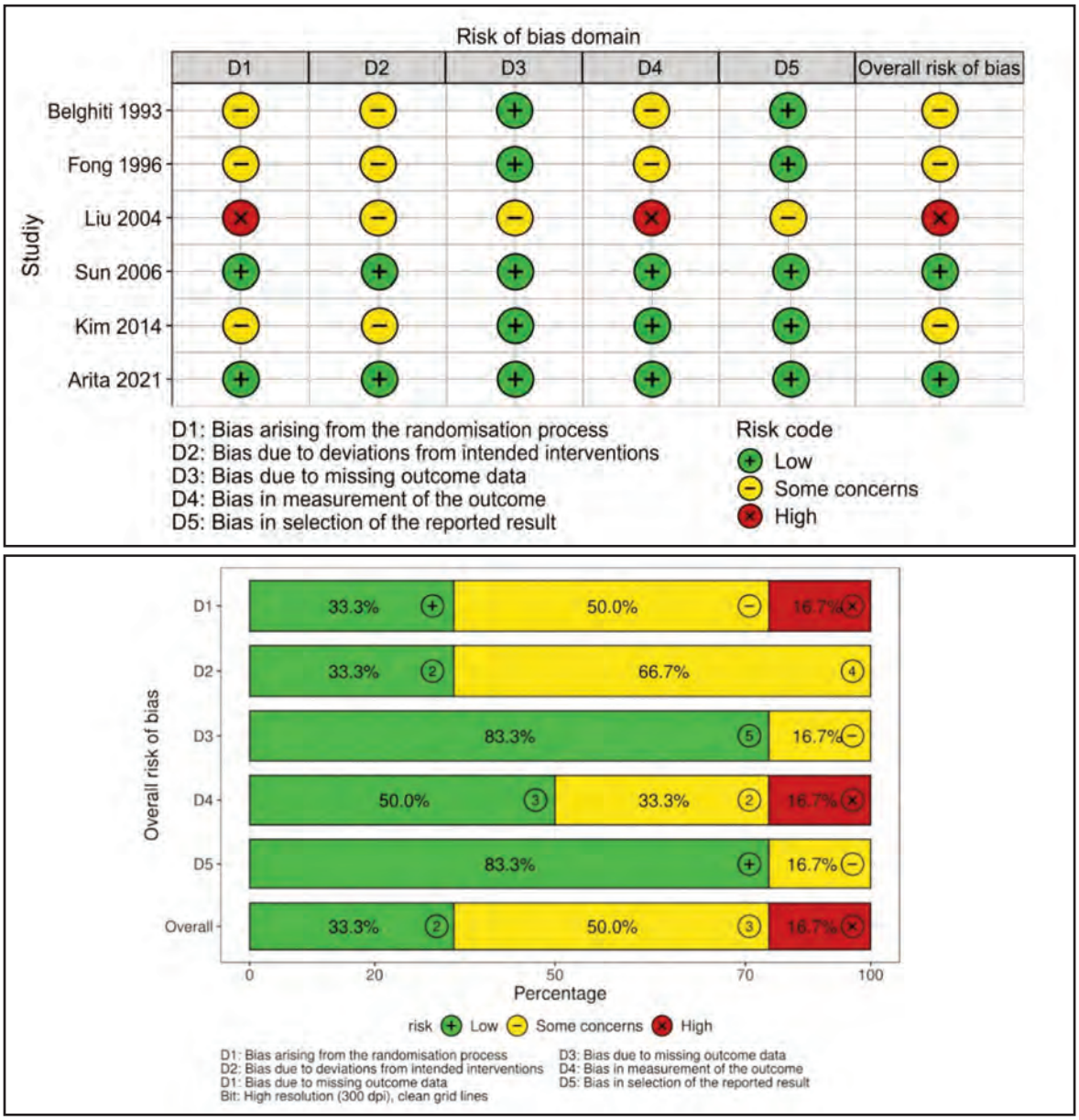

Fig. 2: Risk of bias traffic light plot (RoB 2); B: Risk of bias summary plot (RoB 2)

The included trials varied in case mix, underlying liver disease, and perioperative practice, but all directly compared routine abdominal drainage with no drainage after elective hepatectomy.[6-11] The main characteristics of the included studies are summarized in Table I.

Risk of bias

Risk-of-bias assessment showed that two studies were judged to be at low overall risk of bias, three raised some concerns, and one was judged to be at high risk of bias. The principal source of concern in the earlier trials related to randomization reporting, outcome measurement, and incomplete detail regarding allocation procedures. The domain-level assessments are presented in Table II and Figure 2.

Overall postoperative morbidity

Overall postoperative morbidity was reported in five trials comprising 944 patients. Event counts were 29/60 versus 26/60 in Fong, et al. (7), 38/52 versus 20/52 in Liu, et al. (8), 22/60 versus 16/60 in Sun ,et al. (9), 16/100 versus 12/100 in Kim ,et al. (10), and 77/199 versus 55/201 in Arita, et al. (11) (any Clavien-Dindo grade).[7-11] As shown in Figure 3, the pooled analysis favored no drainage, with a significantly higher overall morbidity rate in the drainage group (pooled RR 1.41, 95% CI 1.16–1.71; I^2 = 32.5%).

Postoperative mortality

Postoperative mortality was reported in all six trials comprising 1,025 patients. Deaths were uncommon: 1/42 versus 1/39 in Belghiti, et al. (6), 2/60 versus 2/60 in Fong, et al. (7), 3/52 versus 1/52 in Liu, et al. (8), 0/60 versus 1/60 in Sun, et al. (9), 0/100 versus 0/100 in Kim, et al. (10), and

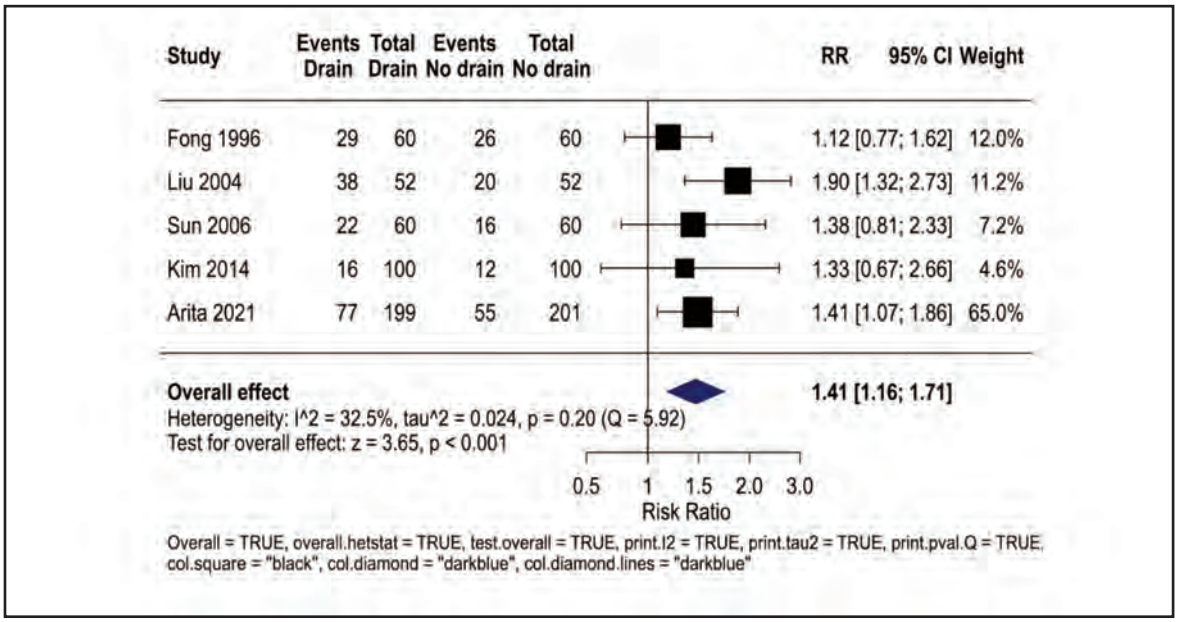

Fig. 3: Overall postoperative morbidity

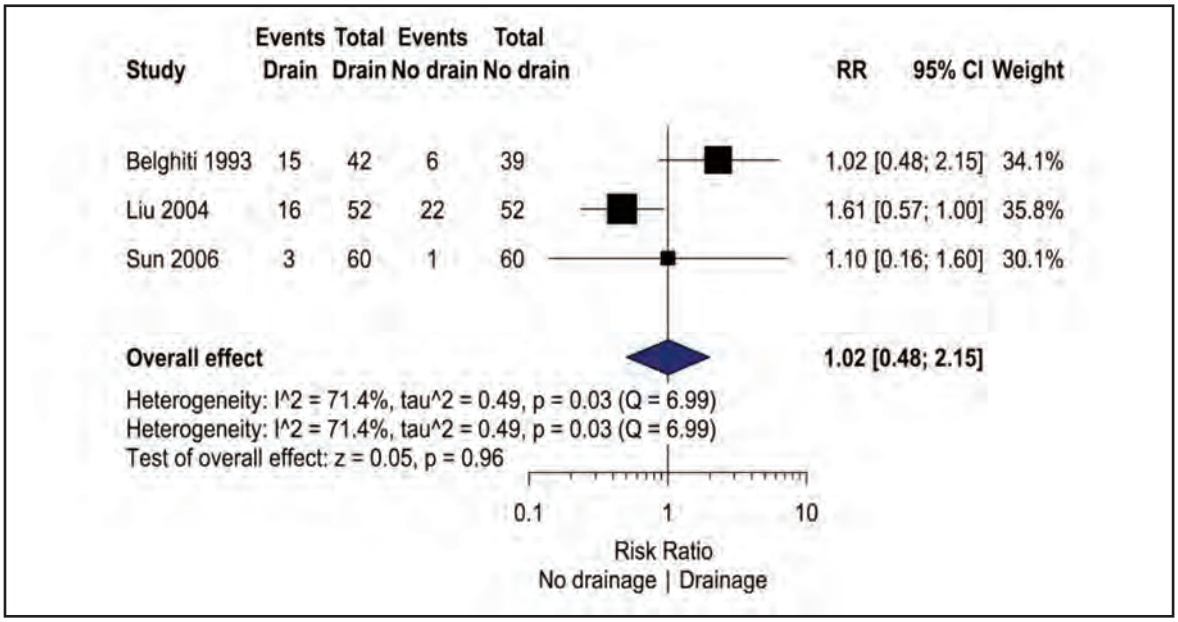

Fig. 4: Subphrenic / Perihepatic collection

0/199 versus 0/201 in Arita , et al. (11). As shown in Figure 4, there was no significant difference between strategies (pooled RR 1.20, 95% CI 0.50–3.00; $I^2 = 0\%$).

Wound-related complications

Wound-related complications were reported in three trials comprising 624 patients. Rates were 32/52 versus 11/52 in Liu, et al. (8), 17/60 versus 2/60 in Sun, et al. (9), and 16/199 versus 8/201 in Arita, et al. (11). Figure 5 demonstrates a clear excess of wound- or drain-related morbidity with routine drainage (pooled RR 2.75, 95% CI 1.56–4.86; $I^2 = 36.1\%$), consistent with the possibility of drain-site leakage, local contamination, or retrograde infection.

Bile leakage or biliary fistula

Bile leakage or biliary fistula was extractable from four trials. Event counts were 3/60 versus 3/60 in Fong, et al. (7), 2/52 versus 0/52 in Liu, et al. (8), 0/60 versus 0/60 in Sun, et al. (9), and 16/199 versus 0/201 in Arita, et al. (11). The pooled analysis in Figure 6 favored no drainage and suggested more reported bile-leakage events in the drainage group (pooled RR 5.02, 95% CI 1.53-16.48; $I^2 = 0\%$). Reported bile-leakage events were more frequent in the drainage group; however, this outcome is highly susceptible to ascertainment bias because the opportunity to detect bile leakage differs according to drain status. Therefore, this finding should be interpreted cautiously and should not be taken as definitive evidence that drainage increases the true biological incidence of bile leakage.

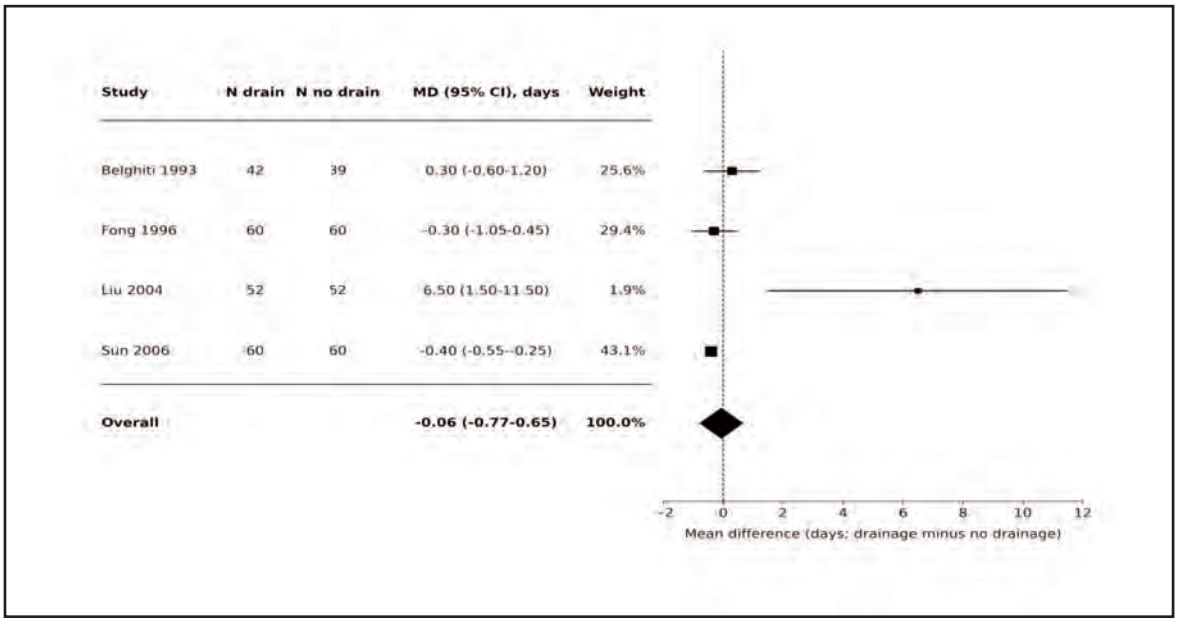

Fig. 5: Length of hospital stay

Subphrenic or perihepatic fluid collection

Subphrenic or perihepatic fluid collection was reported in three trials comprising 305 patients, but definitions remained heterogeneous. Figure 4 used the extractable counts available from Belghiti, et al. (6) (15/42 versus 6/39), Liu, et al. (8) (16/52 versus 22/52), and Sun, et al. (9) (3/60 versus 1/60). The pooled estimate showed no clear difference between strategies (RR 1.02, 95% CI 0.48–2.15; I^2 = 71.4%), and the substantial heterogeneity indicates that this outcome should be interpreted cautiously.

Length of hospital stay

Length of postoperative hospital stay was reported in four early trials comprising 425 patients. Mean stay was 12.6 versus 12.3 days in Belghiti, et al. (6), 13.1 versus 13.4 days in Fong, et al. (7), 19.0 versus 12.5 days in Liu, et al. (8), and 8.1 versus 8.5 days in Sun, et al. (9). Figure 5 showed a pooled mean difference of -0.35 days (95% CI -0.50 to -0.20). However, heterogeneity was considerable (I^2 = 82.3%), and the individual trials pointed in different directions. Given the substantial heterogeneity and inconsistent direction of individual trials, this pooled estimate should be interpreted as hypothesis-generating rather than definitive.

Narrative synthesis of other outcomes

Other postoperative outcomes were synthesized narratively because definitions were heterogeneous. In the contemporary ND trial, severe complications of Clavien-Dindo grade 3 or higher occurred in 16/199 patients with drainage and 5/201 without drainage.[11] Liu, et al. (8) also found more septic complications with drainage (17/52 versus 9/52) 8. Kim, et al. (10) reported no significant difference in overall morbidity (16/100 versus 12/100), but complications directly related to drainage were more frequent in the drainage group overall (9 versus 3 patients) and particularly among patients with chronic liver disease (4 versus 1 patients).[10]

DISCUSSION

Principal findings

This updated systematic review and meta-analysis included six randomized controlled trials with a total of 1,025 patients undergoing elective hepatectomy. Routine drainage was associated with higher overall postoperative morbidity and more wound-related complications, whereas mortality and postoperative fluid collection did not differ clearly between groups. Although reported bile-leakage events were more frequent in the drainage group, this outcome is particularly vulnerable to ascertainment bias because the opportunity to detect bile leakage differs according to drain status. Similarly, although the pooled analysis of length of hospital stay showed a small numerical difference, the marked between-study heterogeneity and inconsistent trial-level directions mean that this estimate should be regarded as hypothesis-generating rather than definitive.

Interpretation in context

The rationale for prophylactic drainage after hepatectomy has historically been based on concern regarding bile leakage and postoperative hemorrhage. However, a prophylactic drain does not prevent these complications from occurring. Instead, it may function mainly as a monitoring device while also introducing the possibility of retrograde infection, patient discomfort, restricted mobility, and drain-site morbidity.[5] The observed excess in overall morbidity and wound-related complications is therefore biologically plausible and is consistent with modern perioperative principles that favor avoidance of unnecessary tubes and drains whenever safe.[13]

These findings are also consistent with enhanced recovery pathways and contemporary liver surgery practice, in which careful hemostasis, secure control of biliary radicals, selective postoperative imaging, and image-guided percutaneous intervention have reduced the need for routine prophylactic drainage.[13-14] Importantly, the pooled bile-leakage signal

should not automatically be interpreted as proof that drains cause bile leakage. Reported bile-leakage events were more frequent in the drainage group; however, this outcome is highly susceptible to ascertainment bias because the opportunity to detect bile leakage differs according to drain status.

Clinical implications

The present findings support a selective rather than routine approach to abdominal drainage after elective hepatectomy. In standard cases without biliary reconstruction, gross contamination, uncontrolled oozing, or other specific intraoperative concerns, omission of routine drainage appears reasonable and evidence-based.[13-14] These findings are most applicable to uncomplicated or standard-risk resections, and extrapolation to more complex or high-risk hepatectomy should be made cautiously.

The decision to place a drain should remain individualized and should ultimately be made intraoperatively by the operating surgeon. Selective drainage may be justified when there is concern about a high risk of postoperative bile leakage, localized bleeding, difficult or incomplete hemostasis, biliary reconstruction, or other procedure-specific factors. This decision should also consider the surgeon's expertise and the availability of timely postoperative diagnostic imaging and image-guided or other interventional management if a leak, collection, or hemorrhage is suspected. Such selective use should not be conflated with a routine drainage policy for all patients.

This review has several strengths. Only randomized controlled trials were included, thereby reducing confounding. The intervention of interest was strictly defined as routine abdominal drainage versus no drainage after hepatectomy. In addition, the review followed PRISMA 2020 reporting guidance, and the study selection process is documented transparently, which improves reporting quality, transparency, and reproducibility.[15]

LIMITATIONS

Several limitations should be acknowledged. First, although six randomized trials were identified, not every outcome was reported in every study, which limited the number of trials available for some pooled analyses. Second, outcome definitions were not fully standardized across the included studies, especially for wound-related complications, septic events, bile leakage, and postoperative fluid collections. Third, some older trials did not report all continuous variables in a uniform format, requiring limited data conversion. Fourth, perioperative management evolved substantially over the period covered by the included studies, which may have introduced clinical heterogeneity. Fifth, the direction of the bile-leakage outcome may have been influenced by ascertainment differences between drainage and no-drainage strategies, and the hospital-stay analysis showed marked heterogeneity. Sixth, this review was not prospectively registered, which may limit transparency regarding a priori methods. Finally, because fewer than 10 studies were available for each outcome, formal assessment of publication bias was not reliable and was not performed. Sensitivity analyses were limited by the small number of available randomized trials and were not prespecified in a registered protocol.

CONCLUSION

Current randomized evidence does not support routine abdominal drainage after uncomplicated elective hepatectomy. A selective drainage strategy based on intraoperative findings and patient-specific risk appears more appropriate than routine prophylactic drainage. The final decision should remain with the operating surgeon, particularly in patients with a high intraoperative risk of bile leakage or bleeding, and should consider surgical expertise and the availability of prompt postoperative diagnostic and interventional support. The apparent bile-leakage signal and the pooled hospital-stay estimate should be interpreted cautiously because of likely ascertainment bias and substantial between-study heterogeneity.

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