Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Comparison of adverse events and outcomes between patients with and without drain insertion after laparoscopic liver resection: A randomized controlled trial in Japan (CSGO- HBP-016)

Yoshiaki Ohmura

y-ohmura@rgmc.izumisano.osaka.jp

Rinku General Medical Center

Yutaka Takeda

Kansai Rosai Hospital

Yoshiteru Katsura

Suita Municipal Hospital

Hiroshi Wada

Osaka International Cancer Institute

Takehiro Noda

Osaka University

Junzo Shimizu

Toyonaka Municipal Hospital

Masanori Tsujie

Osaka Rosai Hospital

Shogo Kobayashi

Osaka International Cancer Institute

Yuichiro Doki

Osaka University

Hidetoshi Eguchi

Osaka University

Research Article

Keywords: no drain, laparoscopic liver resection, RCT

Posted Date: November 13th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11486821/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations:
No competing interests reported.

Tables are available in the Supplementary Files section.

Comparison of adverse events and outcomes between patients with and without drain insertion after laparoscopic liver resection: A randomized controlled trial in Japan (CSGO-HBP-016)

Yoshiaki Ohmura MD, PhD1,2,8), Yutaka Takeda MD, PhD2,8), Yoshiteru Katsura MD, PhD2,3,8), Hiroshi Wada MD, PhD4,8), Takehiro Noda MD, PhD5,8), Junzo Shimizu MD, PhD6,8), Masanori Tsujie MD, PhD7,8), Shogo Kobayashi MD, PhD4,5,8), Yuichiro Doki MD, PhD5,8), Hidetoshi Eguchi MD, PhD5,8)

1) Rinku General Medical Center, Department of Surgery, Izumisano, Osaka, Japan
2) Kansai Rosai Hospital, Department of Surgery, Amagasaki, Hyogo, Japan
3) Suita Municipal Hospital, Department of Surgery, Suita, Osaka, Japan
4) Osaka International Cancer Institute, Department of Surgery, Osaka, Osaka, Japan
5) Osaka University, Department of Gastroenterological Surgery, Suita, Osaka, Japan
6) Toyonaka Municipal Hospital, Department of Surgery, Toyonaka Osaka, Japan
7) Osaka Rosai Hospital, Department of Surgery, Sakai, Osaka, Japan
8) Clinical Study Group of Osaka University, Hepato-Biliary-Pancreatic Group

KEYWORDS

no drain, laparoscopic liver resection, RCT

Corresponding author:

Yoshiaki Ohmura, MD, PhD,

Department of Surgery, Rinku General Medical Center,

2-23, Rinku Orai Kita, Izumisano, Osaka, 598-8577, Japan.

Phone: +81-72-469-3111; Fax: +81-72-469-7929;

E-mail: y-ohmura@rgmc.izumisano.osaka.jp

5

Abstract

Background: Laparoscopic liver resection (LLR) is a safe, effective, and minimally invasive approach to liver tumor management. Here we aimed to identify the risks and benefits of drain insertion in LLR.

Methods: This randomized controlled trial included patients who underwent LLR, without biliary tract reconstruction or simultaneous resection of other organs, at the Department of Surgery, Graduate School of Medicine, Osaka University, and its affiliated institutions, from 2018–2023. Adverse events (AEs) were graded using the Clavien-Dindo classification. Univariate analysis was performed to identify the risks and benefits of drain insertion.

Results: Among 321 included patients, 17 (5.3%) experienced AEs. The AE rate did not differ between patients with drain insertion (n = 167) versus without drain insertion (n = 154). Postoperative hospital stay did not significantly differ between patients with drains versus without drains among the total patient group (9.4 vs. 9.2 days, p = .650); among patients without AEs (n = 304; 8.8 vs. 8.0 days, p = .888); or among patients with AEs (n = 17; 23.7 vs. 25.5 days, p = .137).

Conclusion: Drain insertion after LLR does not influence the AE rate or hospital stay duration.

1 | INTRODUCTION

Laparoscopic liver resection (LLR) has become markedly safer due to innovations in diagnostic imaging techniques (e.g., preoperative simulation),[1,2] advances in surgical devices, and improved intraoperative and postoperative management. However, complications still occur, including postoperative bleeding and bile leakage.

Traditionally, LLR commonly included postoperative intra-abdominal drain insertion for several days, to obtain early information about possible complications;[3] to prevent progression to serious conditions in cases of organ/space infection, refractory ascites, sepsis, etc.; and to provide a drainage route in the event of bile leakage or organ/space infection. However, the guidelines issued by the Centers for Disease Control and Prevention of the USA indicate that routine insertion of an intra-abdominal drain is unnecessary. These guidelines recommend the use of a closed drain, and removal within a short time period.[4,5]

Despite these guidelines and the improved safety of LLR, questions persist regarding the practice of routine drain insertion. Several studies have examined the need for intra-abdominal drainage after hepatectomy (Hx). Among randomized controlled trials (RCTs) published since 2000, some show that drain insertion is an independent risk factor for complications[6] or a risk factor for wound complications.[7] On the other hand, one RCT reported that controlling refractory ascites in patients with liver cirrhosis is more difficult without drain insertion, ultimately leading to a prolonged postoperative hospital stay.[8] However, few reports have focused on this issue in LLR; therefore, a consensus has yet been to be reached.

In Japan, routine drain insertion after LLR is becoming less common, based on the widespread perception that drain insertion increases the potential for infection. Tanaka et al. observed that not inserting an intra-abdominal drain was not associated with increased occurrence of postoperative complications.[9] Moreover, Yamada et al. found that drain insertion

after Hx may lead to longer hospital stays among patients with and without adverse events (AEs).[10] Arita et al. found that drain placement after uncomplicated hepatic resection increases severe postoperative complication rate.[11] Some studies have reported that not inserting an intra-abdominal drain during laparoscopic liver resection was not associated with the occurrence of postoperative complications.[12,13] However, no RCT has examined intraoperative drain insertion in LLR, therefore, the available results cannot be considered definitive evidence.

In the present study, we conducted an RCT to compare complications with versus without drain insertion, to assess the present safety of LLR, and to identify the risks and benefits of LLR without drain insertion in Japan.

2 | METHODS

We conducted a randomized controlled trial involving several institutions. This study included patients who were scheduled to undergo LLR without biliary tract reconstruction or simultaneous resection of other organs, except the gallbladder. Patients were enrolled from the Department of Surgery, Graduate School of Medicine, Osaka University, and its affiliated institutions, during a 5-year period from April 2018 to March 2023. The enrolled patients were preoperatively randomly allocated to two groups: patients without drain insertion during surgery, and patients in whom closed-suction drains were inserted through a separate stab incision and placed during surgery.

Prior to surgery, written informed consent was obtained from patients who met the inclusion criteria. Patients who gave consent were enrolled, and patient data were prospectively collected and stored, as shown in Figure 1. This study was approved by the ethics committees of each involved institution (approval number 16527-4; Graduate School of Medicine, Osaka University), and was registered at UMIN (UMIN000029217).

Data collected before surgery included the patients' sex, age, body mass index, primary disease, history of abdominal surgery, concomitant diabetes mellitus, use of immunosuppressive agents, hepatitis B surface antigen, hepatitis C virus antibody, white blood cell count, platelet count, hemoglobin, aspartate aminotransferase, alanine aminotransferase, total bilirubin, albumin, creatinine, prothrombin time, and indocyanine green 15-min retention rate. Intraoperatively collected data included type of LLR (anatomical or non-anatomical), conversion to laparotomy, resected liver weight, intraoperative blood loss volume, operative time, and drain insertion. Data collected during the postoperative course included perioperative transfusion, duration of drain insertion, duration of postoperative hospital stay, and AEs. In the group with drain insertion during surgery, the volume and nature of drainage were recorded.

All AEs occurring within 30 days after surgery were graded using the Clavien-Dindo (CD) classification.[14] Mullen et al. defined an AE as death due to hepatic failure within 90 days.[14] However, we investigated complications occurring within 30 days, because most drain-related complications are considered to occur within this time period.

The primary end-point was the presence or absence of AEs occurring within 30 days postoperatively. We compared and assessed factors, such as patient characteristics, between the groups with and without drains. To identify risks and benefits of drain insertion, univariate analysis was performed in all cases. Comparisons were performed using Fisher's exact test and/or the Mann-Whitney U test. Results were considered significant at $p < .05$.

3 | RESULTS

3.1 | Patient characteristics (Table 1)

During the enrolment period, 353 patients were enrolled before surgery. Among these patients, 32 met the exclusion criteria, and thus the analysis ultimately included 321 patients. Two

patients withdrew consent, and five patients did not receive LLR. Moreover, 16 patients received C-tube placement, and 10 patients received drain insertion despite assignment to the group without drains (Figure 1).

The mean patient age was 69.5 years (median, 71 years), and the male-to-female ratio was approximately 2:1. Among the performed surgical procedures, 19.6% were anatomical resection. The mean intraoperative blood loss volume was 69.3 mL (median, few), and the mean resected liver weight was 95.9 g (median, 42 g). The mean operative time was 305 min (median, 275 min). Perioperative transfusion was performed in 3.4% of patients. The mean duration of drain insertion was 3.3 days (median, 3 days; range, 1–13 days). The mean postoperative hospital stay was 9.3 days (median, 8 days).

3.2 | Postoperative AEs (Table 2)

Postoperative AEs, the primary end-point of this study, occurred in 18 patients (5.6%). AEs associated with LLR occurred in 14 patients (4.4%). Table 2 shows the grades of all AEs, based on the CD classification. Grade I AE occurred in one patient, Grade II AE in eight patients, and Grade IIIa AE in five patients. The Grade I AE was urinary retention, which did not require pharmacological treatment or surgical, endoscopic, or radiological intervention. The observed Grade II AEs included bile leakage, hemorrhage of port site, ascites, pleural effusion, intra-abdominal abscess, and urinary tract infection (each occurred in one patient), and pneumonia (in 2 patients). The observed Grade IIIa AEs required surgical, endoscopic, or radiological intervention not under general anesthesia, and included ascites (in two patients), pleural effusion (in one patient), intra-abdominal abscess (in one patient), and acute renal failure (in one patient). Four patients exhibited Grade IIIa AE ascites, pleural effusion, and intra-abdominal abscess, which required interventional drainages. In this study, bile leakage was

defined as persistent drainage of fluid with a bilirubin level at least 5 times higher than that of serum, for 3 days or longer.

Among the seven patients with drains who experienced AEs, the drain was useful for early AE diagnosis (bile leakage) in only one patient. The intraoperatively inserted drains could be used for bile leakage treatment.

3.3 | Comparison between groups with and without drains (Table 3)

Table 3 presents the comparison of patients with and without drains. These patient groups did not exhibit statistically significant differences in background characteristics. AEs were observed in 7 patients with drains (4.2%), and in 11 patients without drains (7.1%). These AE rates did not significantly differ between groups (p = .3188). Moreover, the rate of AEs associated with LLR did not significantly differ between groups: 2.4% (n = 4) in patients with drains, and 3.2% (n = 5) in patients without drains.

The mean postoperative hospital stay also did not significantly differ between patients with drains versus patients without drains (9.4 days vs. 9.2 days, p = .7664). Moreover, the mean postoperative hospital stay also did not significantly differ between patients with versus without drains among patients who did not experience AEs (8.8 days vs. 8.0 days, p = .8878), or among patients who did experience AEs (23.7 days vs. 25.5 days, p = .1371). Additionally, among patients with AEs associated with LLR, the mean postoperative hospital stay among patients with drains (30.0 days) was not significantly longer than that among patients without drains (20.6 days) (p = .2542).

4 | DISCUSSION

The overall rate of AE occurrence in our study population was 5.6%. This rate is lower than

that reported by other institutions,[16–20] indicating the safety of LLR performed at our affiliated institutions. Moreover, all observed AEs in our study were Grade IIIa or lower. Specifically, we observed low rates of bile leakage (0.3%; 1 of 321), hemorrhage (0.3%; 1 of 321), and intra-abdominal abscess (0.6%; 2 of 321). The low SSI occurrence rate was most likely due to implementation of the best practices recommended for prevention against postoperative infection, such as iodine drape application,[21] closed drain use,[5] perioperative antimicrobial therapy,[22] and early drain removal,[23] at all institutions.

The 16th Nationwide Survey of Endoscopic Surgery in Japan reported a 2.2% rate of bile leakage occurrence after LLR.[24] In our study, this rate was 0.3%. Our lower rate might be attributable to more appropriate decisions concerning surgical indications, and the planning of surgical procedures with consideration of background liver conditions and hepatic functions. In this study, we observed one case of Grade II bile leakage as a postoperative AE, which was in a patient in the group with drain insertion. Notably, in routine clinical practice, bile leakage would not be detected in patients without drain insertion. Within the present study, in patients without drain insertion, biloma formation was detected only after computed tomography was performed in patients with clinical symptoms, such as fever and abdominal pain, or abnormal laboratory findings. Moreover, in this study, we did not investigate the development of delayed bile leakage due to blood flow insufficiency in the bile duct wall, etc., occurring more than 30 days postoperatively.

Postoperative bleeding is regarded as the most serious complication of LLR, and can be fatal if left untreated. Notably, one report has indicated that drain insertion is important for providing information about this complication.[25] However, the frequency of postoperative bleeding after liver resection is very low, with recently reported rates of only 1.0–2.0%.[6,7,26] Moreover, the 16th Nationwide Survey of Endoscopic Surgery in Japan reported an extremely

low postoperative bleeding occurrence rate of 0.6% after LLR.[23] Based on improvements in postoperative management, emergency hemostasis techniques using interventional radiology, and other advances, it is reasonable to assume that the importance of drain insertion, in terms of providing information regarding bleeding, has been substantially reduced.

Intra-abdominal drain insertion has traditionally been regarded as a routine procedure in LLR, and the usefulness of closed drains has been demonstrated.[27] Closed drains are commonly used in most institutions in Japan. However, Franco et al. reported that routine peritoneal drain insertion for liver resection is unnecessary.[28] Subsequently, several studies, including RCTs, have examined the significance of peritoneal drain insertion. Belighiti et al. found that drain insertion is unnecessary for minor Hx, and not essential even in cases of major Hx.[29] Moreover, Fong et al.[30] and Liu et al.[6] suggested that drain insertion may increase, rather than reduce, the occurrence of complications, presenting drain insertion in a negative light. Sporadic reports have indicated a low need for routine drain insertion.[7] Several studies have found that not inserting an intra-abdominal drain in LLR did not increase the occurrence of postoperative complications.[12,13]

However, all of these previous reports have had several limitations, including small sample sizes. Notably, in the study of Liu et al.,[6] the assessed outcomes included renal failure, respiratory infection, and other conditions that are not directly associated with peritoneal drainage, and the end-points included the drainage fluid volume, which cannot be examined in patients without drain insertion. Additionally, Liu et al.[6] reported that 4 of 104 patients died due to liver failure during hospitalization, presenting a mortality rate that was much higher than the rate in Japan. Their study may include many features that are inconsistent with the actual conditions in Japan, in terms of surgical indications, liver resection types, postoperative management methods, etc.

Several reports from Japan have examined the need for intra-abdominal drainage. Some have concluded that drain insertion can be omitted after partial liver resection, if appropriately low-risk cases are selected. On the other hand, others state that drain insertion is unnecessary in all post-LLR cases. These differences highlight that the decision of whether to insert a drain should be based on the circumstances of individual patients. However, many studies conducted in Japan are retrospective. Examining case selection, or the validity of drain insertion, requires the design and performance of multicenter prospective RCTs at institutions with relatively large numbers of LLR cases, and where procedures are performed following an appropriate protocol that is compatible with the actual conditions and levels of medical techniques in Japan. Thus, we designed the present randomized controlled trial using postoperative complications as the primary end-point, and conducted this investigation at institutions affiliated with the Department of Surgery, Graduated School of Medicine, Osaka University.

In this study, we attempted to compare the patients with and without drains, using randomization to reduce background bias, because we did not intervene in decisions regarding drain insertion. Notably, one limitation of this study is that we did not exclude a potential selection bias, i.e., that drains may have been inserted in patients with higher risk of postoperative complications. Such patients included those with liver cirrhosis (which is likely to induce liver failure), and those who had undergone central liver resection or S8 subsegmentectomy (which are likely to induce bile leakage).[31] Surgeons could decide to insert the C-tube and drains due to suspected intraoperative bile leakage, and such cases were excluded from the present analysis. When considering only the cases with C-tube, no bile leakage was observed; however, the postoperative hospital stay was significantly longer in the group with drains compared to in the group without drains

Overall, we found no statistically significant difference in the AE rate between the patient groups with and without drains. Not inserting a drain rarely caused clinical problems, and there was no delayed or severe detection of bile leakage or bleeding, and there was no significant difference compared to the drain group. Furthermore, it is unclear whether the complications that occurred in the no-drain group could have been avoided if a drain had been inserted.

As described, the performance of an RCT to examine drain insertion in Japan is difficult due to the very low complication rate after LLR, which may be regarded as the primary end-point. Furthermore, in clinical practice, management without drain insertion has become common for many surgical procedures, due to advancements in surgical techniques and based on the concept of enhanced recovery after surgery. Our present data may support the notion that drain insertion after LLR may not generally be required in the near future.

5 | CONCLUSION

This randomized controlled trial revealed that AEs occurred in 5.6% of patients after LLR, and that all events were Grade IIIa or lower according to the CD classification. These results verify the safety of LLR performed at Osaka University and its affiliated institutions. Moreover, our findings demonstrated that a lack of drain insertion after LLR was not associated with a higher AE rate or longer hospital stay.

6 | Disclosures section

Drs. Yoshiaki Ohmura, Yutaka Takeda, Yoshiteru Katsura, Hiroshi Wada, Takehiro Noda, Junzo Shimizu, Masanori Tsujie, Shogo Kobayashi, Yuichiro Doki, and Hidetoshi Eguchi have no conflicts of interest or financial ties to disclose.

Reference

1) Saito S, Yamanaka J, Miura K, Nakao N, Nagao T, Sugimoto T, et al. A novel 3D hepatectomy simulation based on liver circulation: application to liver resection and transplantation. Hepatology 41: 1297-1304, 2005. https://doi.org/10.1002/hep.20684.

2) Takamoto T, Hashimoto T, Ogata S, Inoue K, Maruyama Y, Miyazaki A, et al. Planning of anatomical liver segmentectomy and subsegmentectomy with 3-dimensional simulation software. Am J Surg 206: 530-538, 2013. https://doi.org/10.1016/j.amjsurg.2013.01.041.

3) Dougherty SH, Simmons RL. The biology and practice of surgical drains. Part 1. Curr Probl Surg 29: 559-623, 1992. https://doi.org/10.1016/0011-3840(92)90022-u.

4) Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection. Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol 1999 (20): 250-278, 1999. https://doi.org/10.1086/501620.

5) Alexander JW, Solomkin JS, Edwards MJ. Updated recommendations for control of surgical site infections. Ann Surg 253: 1082-1093, 2011. https://doi.org/10.1097/SLA.0b013e31821175f8.

6) Liu CL, Fan ST, Lo CM, Wong Y, Ng IO, Lam CM, et al. Abdominal drainage after hepatic resection is contraindicated in patients with chronic liver diseases. Ann Surg 239: 0194-201, 2004. https://doi.org/10.1097/01.sla.0000109153.71725.8c.

7) Sun HC, Qin LX, Lu L, Wang L, Ye QH, Ren N, et al. Randomized clinical trial of the effects of abdominal drainage after elective hepatectomy using the crushing clamp method. Br J Surg 93: 422-426, 2006. https://doi.org/10.1002/bjs.5260.

8) Fuster J, Llovet JM, Garcia-Valdecasas JC, Grande L, Fondevila C, Vilana R, et al. Abdominal drainage after liver resection for hepatocellular carcinoma in cirrhotic patients: a

randomized controlled study. Hepatogastroenterology 51(56): 526-540, 2004.

9) Tanaka S, Yamamoto T, Ishihara K, Watanabe C, Kaneda K, Sakae M, et al. Practical experience of a study on no use of intraabdominal drainage in patients with liver cancer undergoing liver resection. J Jpn Surg Assoc 69: 2156-2162, 2008. https://doi.org/10.3919/jjsa.69.2156.

10) Yamada T, Gotoh K, Marubashi S, Asaoka T, Miyamoto A, Kobayashi S, et al. Comparison of adverse events and outcomes between patients with and without drain insertion after hepatectomy: A propensity score-matched, multicenter, prospective observational cohort study in Japan (CSGO-HBP-001). World J Surg 42: 2561-2569, 2018. https://doi.org/10.1007/s00268-018-4461-9.

11) Arita J, Sakamaki K, Saiura A, Konishi M, Sakamoto Y, Hashimoto M, et al. Drain placement after uncomplicated hepatic resection increases severe postoperative complication rate. A Japanese multi-institutional randomized controlled trial (ND-trial). Ann Surg 273(2): 224-231, 2021. https://doi.org/10.1097/SLA.0000000000004051.

12) Ishizawa T, Zuker NB, Conrad C, Lei HJ, Ciacio O, Kokudo N, et al. Using a 'no drain' policy in 342 laparoscopic hepatectomies: which factors predict failure? HPB (Oxford) 16: 494-499, 2014. https://doi.org/10.1111/hpb.12165.

13) Sugimoto M, Gotohda N, Kudo M, Kobayashi S, Takahashi S, Konishi M. Laparoscopic liver resection can be performed safely without intraoperative drain placement. Surg Endosc 36(12): 9019-9031, 2022. https://doi.org/10.1007/s00464-022-09364-x.

14) Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240: 205-213, 2004. https://doi.org/10.1097/01.sla.0000133083.54934.ae.

15) Mullen JT, Ribero D, Reddy SK, Donadon M, Zorci D, Gautam S, et al. Hepatic

Insufficiency and Mortality in 1059 Non-cirrhotic Patients Undergoing Major Hepatectomy. J Am Coll Surg 204: 854-862, 2007. https://doi.org/10.1016/j.jamcollsurg.2006.12.032.

16) Virani S, Michaelson JS, Hutter MM, Lancaster RT, Warshaw AL, Henderson W, et al. Morbidity and mortality after liver resection: results of the patient safety in surgery study. J Am Coll Surg 204: 1284-1292, 2007. https://doi.org/10.1016/j.jamcollsurg.2007.02.067.

17) Mayo SC, Shore AD, Nathan H, Edil BH, Hirose K, Anders RA, et al. Refining the definition of perioperative mortality following hepatectomy using death within 90 days as the standard criterion. HPB (Oxford) 13: 473-482, 2011. https://doi.org/10.1111/j.1477-2574.2011.00326.x.

18) Hyder O, Pulitano C, Firoozmand A, Dodson R, Wolfgang CL, Choti MA, et al. A risk model to predict 90-day mortality among patients undergoing hepatic resection. J Am Coll Surg 216: 1049-1056, 2013. https://doi.org/10.1016/j.jamcollsurg.2013.01.004.

19) Ide T, Miyoshi A, Kitahara K, Noshiro H. Prediction of postoperative complications in elderly patients with hepatocellular carcinoma. J Surg Res 185: 614-619, 2013. https://doi.org/10.1016/j.jss.2013.07.016.

20) Itoh S, Uchiyama H, Kawanaka H, Higashi T, Egashira A, Eguchi D, et al. Characteristic risk factors in cirrhotic patients for posthepatectomy complications: comparison with noncirrhotic patients. Am Surg 80: 166-170, 2014.

21) Yoshimura Y, Kubo S, Hirohashi K, Ogawa M, Morimoto K, Shirata K, et al. Plastic iodophor drape during liver surgery operative use of the iodophor-impregnated adhesive drape to prevent wound infection during high risk surgery. World J Surg 27: 685-688, 2003. https://doi.org/10.1007/s00268-003-6957-0.

22) Kobayashi S, Gotohda N, Nakagohri T, Takahashi S, Konishi M, Kinoshita T. Risk factors of surgical site infection after hepatectomy for liver cancers. World J Surg 33: 312-317,

2009. https://doi.org/10.1007/s00268-008-9831-2.

23) Kawai M, Tani M, Terasawa H, Ina S, Hirono S, Nishioka R, et al. Early removal of prophylactic drains reduces the risk of intra-abdominal infections in patients with pancreatic head resection: prospective study for 104 consecutive patients. Ann Surg 244: 1-7, 2006. https://doi.org/10.1097/01.sla.0000218077.14035.a6.

24) Shiroshita H, Inomata M, Takifuchi S, Akira S, Kanayama H, Yamaguchi S, et al. Update on endoscopic surgery in Japan: Results of the 16th National Survey of endoscopic surgery by the Japan Society for Endoscopic Surgery. Asian J Endosc Surg 17(2): e13285, 2024. https://doi.org/10.1111/ases.13285.

25) Bona S, Gavelli A, Huguet C. The role of abdominal drainage after major hepatic resection. Am J Surg 167: 593-595, 1994. https://doi.org/10.1016/0002-9610(94)90104-x.

26) Tanaka K, Kumamoto T, Nojiri K, Takeda K, Endo I. The effectiveness and appropriate management of abdominal drains in patients undergoing selective liver resection: a retrospective analysis and prospective case series. Surg Today 43: 32-380, 2013. https://doi.org/10.1007/s00595-012-0254-1.

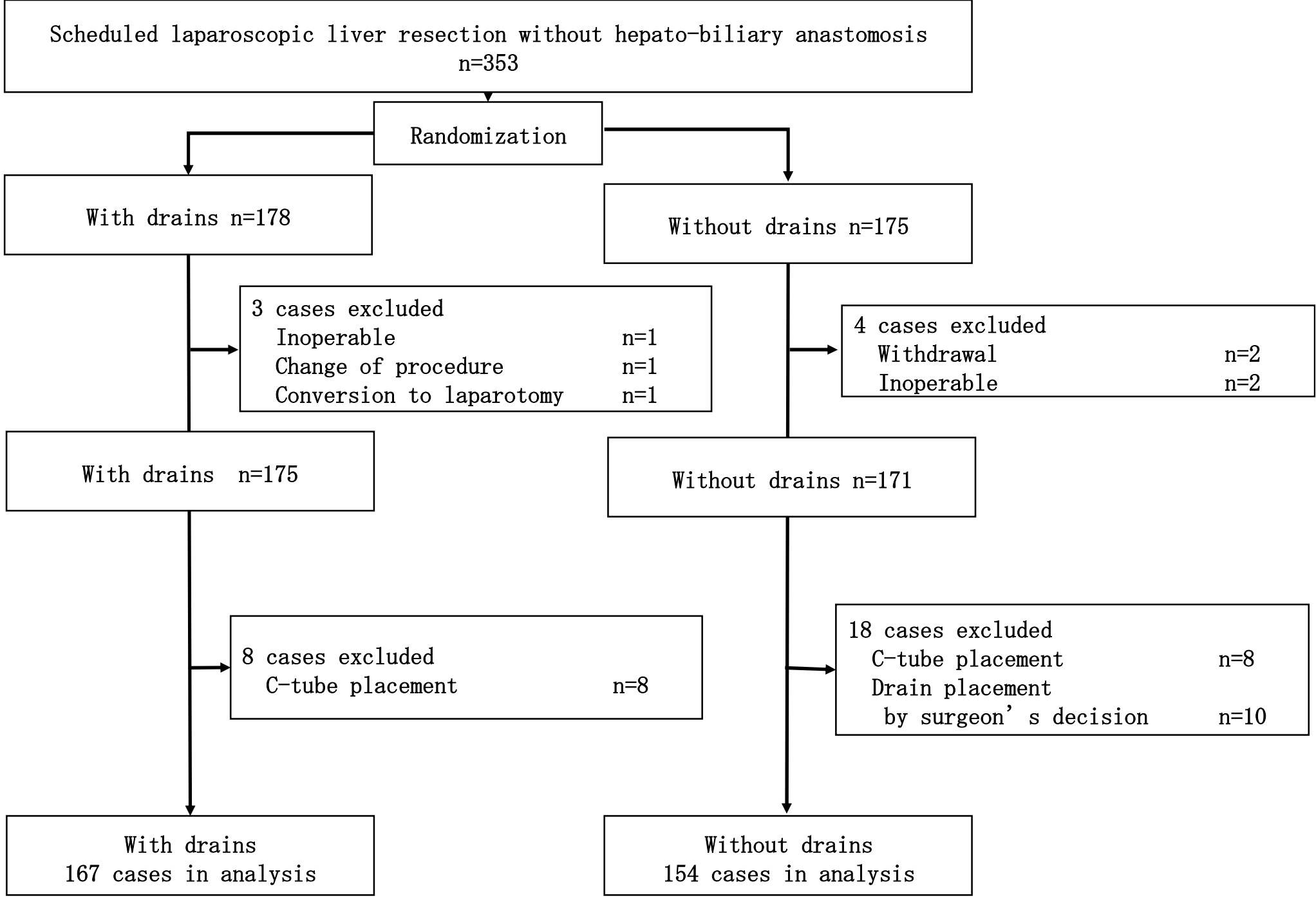
27) Uetsuji S, Kwon AH, Komada H, Okuda Y, Imamura A, Kamiyama Y. Clinical evaluation of closed suction drainage following hepatectomy. Surg Today 27: 298-301, 1997. https://doi.org/10.1007/BF00941801.

28) Franco D, Karaa A, Meakins JL, Borgonovo G, Smadja C, Grange D. Hepatectomy without abdominal drainage. Results of a prospective study in 61 patients. Ann Surg 210: 748-750, 1997. https://doi.org/10.1097/00000658-198912000-00009.

29) Belghiti J, Kabbej M, Sauvanet A, Vilgrain V, Panis Y, Fekete F. Drainage after elective hepatic resection. A randomized trial. Ann Surg 218: 748-753, 1993. https://doi.org/10.1097/00000658-199312000-00008.

30) Fong Y, Brennan MF, Brown K, Heffeman N, Blumgart LH. Drainage is unnecessary after pelective liver resection. Am J Surg 171: 158-162, 1996. https://doi.org/10.1016/s0002-9610(99)80092-0.

31) Nagano Y, Togo S, Tanaka K, Masui H, Endo I, Sekido H, et al. Risk factors and management of bile keakage after hepatic resection. World J Surg 27: 695-698, 2003. https://doi.org/10.1007/s00268-003-6907-x.


Scheduled laparoscopic liver resection without hepato-biliary anastomosis
n=353
Randomization
With drains n=178
Without drains n=175
3 cases excluded
Inoperable n=1
Change of procedure n=1
Conversion to laparotomy n=1
4 cases excluded
Withdrawal n=2
Inoperable n=2
With drains n=175
Without drains n=171
8 cases excluded
C-tube placement n=8
18 cases excluded
C-tube placement n=8
Drain placement
by surgeon's decision n=10
With drains
167 cases in analysis
Without drains
154 cases in analysis

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table220261023.xlsx
- Table320261023.xlsx