Section: Miscellaneous

Original Research Article

LAPAROSCOPIC DRAINAGE VERSUS IMAGE GUIDED PIGTAIL CATHETER DRAINAGE IN LIVER ABSCESS: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Liver abscesses are common visceral infections, and although antibiotics are essential, the optimal minimally invasive drainage approach – Ultrasound -guided pigtail catheter versus laparoscopic drainage – remains debated, particularly for single-cavity lesions. The objective is to compare postoperative complications and duration of hospital stay between laparoscopic and Ultrasound - guided pigtail catheter drainage in liver abscess. **Materials and Methods:** This single-centre, hospital-based randomized controlled trial (July 2024–December 2025) enrolled adults (20–60 years) with a single liver abscess and allocated them 1:1 to laparoscopic drainage or ultrasound-guided pigtail catheter drainage. Data were analysed using SPSS v27. **Result:** Across 98 randomized patients (49 per arm), baseline characteristics were well balanced; mean age 44.2±9.8 vs 45.1±10.2 years (p=0.674), males 69.4% vs 71.4% (p=0.827), comorbidity 36.7% vs 34.7% (p=0.835), and similar smoking/alcohol patterns. Anthropometry and vitals were comparable. Laboratory profiles and ultrasound disease burden matched; maximum abscess diameter 7.0±1.8 vs 7.1±1.9 cm (p=0.790), right-lobe involvement 73.5% vs 75.5% (p=0.817). Intraoperatively, complications were infrequent (10.2% vs 4.1%; p=0.436), but operative time was longer with laparoscopy (68.5±15.2 vs 32.4±10.8 min; p<0.001), and surgeon-rated ease favoured pigtail drainage (4.4±0.7 vs 3.6±0.8; p<0.001). Postoperative complications were comparable (18.4% vs 14.3%; p=0.785), bleeding rare, and pain lower with pigtail through day 3 (all p<0.05), converging by day 7. Length of stay favoured pigtail (4.8±1.5 vs 6.2±1.7 days; p<0.001). Recurrence by day 21 was low and similar (4.1% vs 2.0%; p=0.972). **Conclusion:** Ultrasound-guided pigtail catheter drainage provided comparable safety but superior peri-operative recovery to laparoscopy – supporting it as the preferred first-line intervention for single-cavity liver abscesses.

INTRODUCTION

Liver abscess is an infectious, space-occupying lesion of the liver and represents the most common visceral abscess because the organ is continually exposed to microorganisms via the portal circulation and biliary tree.[1] Two entities account for the vast majority of cases: pyogenic liver abscess caused by bacteria, and amoebic liver abscess due to Entamoeba histolytica; fungal and parasitic (e.g., echinococcal) abscesses are far less frequent.[2,3] The right hepatic lobe is involved in most patients (70–75%), with solitary cavities present about half the time.[4] Routes of hepatic infection include ascending biliary sepsis, portal venous spread from intra-abdominal sources, hematogenous seeding via the hepatic artery, direct extension, and trauma. Among these, biliary pathology has emerged as the leading cause of pyogenic liver abscess in modern series.[5]

Amoebic liver abscess is concentrated in tropical and subtropical settings where E. histolytica is endemic and sanitation is suboptimal; it typically affects younger adults and shows a striking male preponderance. Between 3% and 9% of individuals with amoebiasis will develop liver abscess, and amoebic liver abscess continues to cause substantial morbidity and mortality in endemic regions. In contrast, pyogenic liver abscess is relatively more common in older adults and in health systems with higher burdens of biliary disease and metabolic

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comorbidity; clinical microbiology varies by geography, with Klebsiella pneumoniae predominating in many Asian series.[2,6,7] Diagnosis rests on imaging and targeted laboratory testing. Ultrasonography is the preferred first-line modality because it is rapid, bedside-capable, and highly sensitive (85–95%); contrast-enhanced CT offers even higher sensitivity (95–100%), detects small or deep lesions, maps loculations, and helps identify an underlying intra-abdominal source. In amoebic liver abscess, serology or antigen testing for E. histolytica supports the diagnosis, whereas Gram stain and aerobic/anaerobic cultures of aspirate and blood are central for pyogenic liver abscess.[8,9]

Management integrates early sepsis care, appropriate antimicrobials, and timely source control. Small, uncomplicated cavities (<3–4 cm) may resolve with antibiotics alone, but most clinically significant abscesses benefit from drainage. Evidence from randomized and meta-analytic studies indicates that ultrasound-guided percutaneous catheter drainage (PCD) provides higher success and faster clinical resolution than percutaneous needle aspiration (PNA) for larger or complex collections, while maintaining similar safety. When percutaneous access is not feasible or fails – such as with thick, multiloculated, or ruptured abscesses – laparoscopic drainage offers definitive deroofing and lavage with favourable recovery compared with open surgery.[10]

The local clinical context underscores the need for comparative-effectiveness data between minimally invasive strategies that are both in routine use. Although PCD is widely adopted and supported by trials versus PNA, there are limited head-to-head randomized data directly comparing PCD with laparoscopic drainage, and practice patterns vary across centres. A recent Indian randomized study highlighted the feasibility of such comparisons but also the need for more robust, context-specific evidence to inform operative time, ease of use, complication profiles, and length of stay.[11]

Against this background, the present study compared postoperative complications and the duration of hospital stay between laparoscopic drainage and ultrasound-guided pigtail catheter drainage in patients with liver abscess.

MATERIALS AND METHODS

This was a single-centre, hospital-based, prospective, randomized controlled trial conducted in the Departments of General Surgery, Radiology and Microbiology, Aarupadai Veedu Medical College and Hospital, Puducherry, India between July 2024 and December 2025. The study was approved by the Institutional Human Ethics Committee (IHEC) with reference number AV/IHEC/01/2024/053 dated 07/06/2024. The participants were given the Participant Information Sheet (PIS) in their native language, and its contents were verbally explained to ensure their understanding and satisfaction. Enrolment into the study proceeded upon receipt of written informed consent. Patients 20–60 years of age, of both gender, alcoholic, with liver abscess (single) were included. However, patients <20 years or >60 years of age; with multiple abscesses; systemic hypertension and/or cardiac disease; coagulopathies; and malignancy were excluded.

The sample size was calculated for comparing two independent means, using a two-sided $\alpha = 0.05$ and power = 90% ($\beta = 0.10$). Based on a similar study (Chitrambalam et al.),[11] the expected mean difference in pain score (δ) was 1.85 and the pooled standard deviation (S) was 2.8; the minimum required sample size was rounded off to 98 (49 in each arm). The patients were enrolled using nonprobability sampling technique – purposive sampling/consecutive enumeration. Randomization was carried out in a 1:1 ratio using a computer-generated sequence with variable block sizes of 4 and 6, prepared by an independent statistician. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes, which were opened in the operating theatre only after eligibility had been confirmed and written informed consent had been obtained. All procedures were performed by the same surgeon to minimize operator-related variability. Blinding of the operating surgeon and participants was not feasible because of the distinct nature of the interventions (laparoscopic drainage versus ultrasound-guided pigtail catheter drainage).

Each enrolled patient underwent a detailed clinical evaluation, during which vital signs and relevant systemic examination findings were documented, followed by baseline investigations comprising complete blood count, urine routine and microscopy, serum urea, electrolytes, serum creatinine, liver function tests, and ultrasonography of the abdomen and pelvis. These data were collected to confirm the diagnosis, characterize the extent of disease, and assess fitness for intervention. Eligible and consented participants were then randomized into two equal groups (n = 49 per group): participants in Group 1 underwent laparoscopic drainage of the liver abscess, while those in Group 2 underwent ultrasound-guided pigtail catheter drainage. Peri-operative and postoperative data were collected prospectively using a standardized case-record form. The duration of surgery was recorded in minutes from incision to completion of the procedure, intra-operative complications—particularly bleeding—were documented, and the surgeon's perceived ease of use for the assigned technique was recorded contemporaneously. Participants were monitored daily until discharge for postoperative complications, and postoperative hospital stay was measured in days from the date of surgery to the date of discharge. Recurrence of infection/abscess during follow-up was assessed.

The dependent (outcome) variables included postoperative complications (presence/absence and type: bleeding, wound infection, bile leak, peritonitis, and need for re-intervention), duration of

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postoperative hospital stay (days), intraoperative complications (especially bleeding), duration of surgery (minutes), surgeon-perceived ease of use (rating), and recurrence of infection/abscess during follow-up, while the independent variables comprised the intervention arm (laparoscopic drainage vs ultrasound-guided pigtail catheter drainage), age, gender, anthropometry (height, weight, and BMI), vital signs (pulse rate and blood pressure), laboratory parameters (complete blood count, serum urea/creatinine, electrolytes, and liver function tests), ultrasonographic disease characteristics (abscess size/volume and site/lobe, with a single cavity as per eligibility), and treatment-related context where available (time from diagnosis to intervention and pre-procedure antibiotic use).

Statistical analysis: Analyses were two-sided (α=0.05) in IBM SPSS Statistics v27. Continuous data were checked for normality (Shapiro–Wilk) and variance homogeneity (Levene). Normally distributed variables are presented as mean±SD and compared with independent-samples t-tests; non-normal data used Mann–Whitney U. Categorical variables are shown as n (%) and compared with χ^2 or Fisher's exact tests. Primary analysis followed intention-to-treat with de-identified group codes.

RESULTS

Of 110 patients assessed, 12 were excluded (7 ineligible and 5 declined), and 98 were enrolled and randomized equally to ultrasound-guided pigtail catheter drainage (n=49) or laparoscopic drainage (n=49), with all receiving the allocated intervention. Both groups completed 21-day postoperative follow-up with no losses, and all 98 participants were included in the final analysis. Baseline characteristics were comparable between Group 1 and Group 2 (n=49 each), with no statistically significant differences across variables (all p>0.05). The mean age was similar (44.2±9.8 vs 45.1±10.2 years; p=0.674), and most participants were aged 41–60 years (59.2% vs 63.3%; p=0.678). Males predominated in both groups (69.4% vs 71.4%; p=0.827), and comorbidities were present in about one-third of participants (36.7% vs 34.7%; p=0.835). Smoking patterns were comparable, with 59.2% in each group being never-smokers (p=0.916), and alcohol history also showed similar distribution (never 53.1% in both; p=0.884). Anthropometry and vitals were closely matched, including weight (58.2±8.7 vs 57.6±9.1 kg; p=0.742), BMI (21.7±3.2 vs 21.6±3.4 kg/m²; p=0.926), pulse rate (81.2±7.6 vs 80.8±7.9/min; p=0.812), and blood pressure (SBP 123.6±11.4 vs 124.1±10.8 mmHg; DBP 79.8±7.2 vs 80.2±7.5 mmHg; p=0.842 and 0.841).

Mean hemoglobin levels were similar (11.2±1.4 vs 11.3±1.5 g/dL; p=0.782), as were inflammatory and hematological indices including total leukocyte count (12.4±3.2 vs 12.7±3.4 ×10³/µL; p=0.694) and platelet count (254.6±68.2 vs 261.4±70.8 ×10³/µL; p=0.641). Liver biochemistry was also comparable, with serum bilirubin (1.4±0.6 vs 1.5±0.7 mg/dL; p=0.573), AST (52.8±18.4 vs 54.6±19.2 U/L; p=0.654), ALT (48.2±17.6 vs 49.1±18.1 U/L; p=0.812), ALP (168.4±42.3 vs 171.6±44.1 U/L; p=0.733), and albumin (3.4±0.5 vs 3.3±0.5 g/dL; p=0.528) showing no meaningful difference. Renal function and electrolytes were likewise similar, including creatinine (0.9±0.3 vs 0.9±0.3 mg/dL; p=0.842), blood urea (31.2±9.4 vs 32.4±8.8 mg/dL; p=0.534), sodium (136.8±3.4 vs 137.2±3.6 mmol/L; p=0.618), and potassium (4.1±0.5 vs 4.2±0.6 mmol/L; p=0.512). On ultrasound, disease severity was comparable with similar maximum abscess diameter (7.0±1.8 vs 7.1±1.9 cm; p=0.790) and abscess volume (210.0±85.0 vs 214.0±87.0 mL; p=0.818), and right-lobe involvement predominated in both groups (73.5% vs 75.5%; p=0.817). Pre-procedure characteristics were also balanced, including time from diagnosis to intervention (1.9±0.8 vs 2.0±0.9 days; p=0.561) and high rates of pre-procedure antibiotic use (87.8% vs 89.8%; p=0.749).

Intraoperative and postoperative complication rates were comparable between the two groups, with intraoperative complications occurring in 10.2% (5/49) of Group 1 versus 4.1% (2/49) of Group 2 (p=0.436), and intraoperative bleeding noted in 6.1% versus 2.0%, respectively (p=0.617). However, the duration of surgery was significantly longer in Group 1 than Group 2 (68.5±15.2 vs 32.4±10.8 minutes; p<0.001), while surgeon-perceived ease of use was significantly higher in Group 2 (4.4±0.7) compared with Group 1 (3.6±0.8; p<0.001)." Postoperative complications were observed in 18.4% of Group 1 and 14.3% of Group 2 (p=0.785), with low and similar rates of specific events such as wound infection (6.1% vs 4.1%), bile leak (4.1% vs 2.0%), bleeding (4.1% vs 2.0%), peritonitis (2.0% in both), and need for re-intervention (4.1% in both) (all p>0.05). "Despite similar complication profiles, Group 1 had a significantly longer postoperative hospital stay than Group 2 (6.2±1.7 vs 4.8±1.5 days; p<0.001).

Postoperative bleeding was uncommon and did not differ between groups, occurring at 6 hours in 4.1% of Group 1 versus 2.0% of Group 2 and at 24 hours in 2.0% versus 0%, with no bleeding reported from 48 hours onward in either group (all p>0.05). Postoperative pain scores were consistently higher in Group 1 during the early period, with significant differences at 6 hours (5.8±1.1 vs 4.2±1.0), 24 hours (4.3±1.0 vs 3.1±0.9), and 48 hours (3.0±0.9 vs 2.4±0.8) (all p<0.001), and a smaller but significant difference on day 3 (2.1±0.8 vs 1.8±0.7; p=0.043); by day 7, pain was similar (1.2±0.6 vs 1.1±0.5; p=0.370). Recurrence of infection/abscess was rare across follow-up, with no cases on day 3, one case in Group 1 at day 7 (2.0%), one case in each group at day 14 (2.0% each), and none at day 21; overall cumulative recurrence by day 21 was low and comparable (4.1% vs 2.0%; p=0.972).

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Table 1: Baseline demographic and clinical characteristics of study participants (N=98)

		Group 1 N = 49	Group 2 N = 49	P value
		n (%)	n (%)	
Age (in years), Mean (SD)		44.2 (9.8)	45.1 (10.2)	0.674
Age (in years)	20 to 40	20 (40.8)	18 (36.7)	0.678
	41 to 60	29 (59.2)	31 (63.3)	
Gender	Male	34 (69.4)	35 (71.4)	0.827
	Female	15 (30.6)	14 (28.6)	
Comorbidity	Present	18 (36.7)	17 (34.7)	0.835
	Absent	31 (63.3)	32 (65.3)	
Smoking	Current	11 (22.4)	12 (24.5)	0.916
	Past	9 (18.4)	8 (16.3)	
	Never	29 (59.2)	29 (59.2)	
Alcohol	Current	15 (30.6)	16 (32.7)	0.884
	Past	8 (16.3)	7 (14.3)	
	Never	26 (53.1)	26 (53.1)	
Weight (in kgs), Mean (SD)		58.2 (8.7)	57.6 (9.1)	0.742
Height (in cm), Mean (SD)		163.4 (7.5)	162.8 (8.1)	0.781
BMI (in kg/m2), Mean (SD)		21.7 (3.2)	21.6 (3.4)	0.926
Pulse rate (per minute), Mean (SD)		81.2 (7.6)	80.8 (7.9)	0.812
SBP (in mmHg), Mean (SD)		123.6 (11.4)	124.1 (10.8)	0.842
DBP (in mmHg), Mean (SD)		79.8 (7.2)	80.2 (7.5)	0.841
*Statistically significant at p<0.05				

Table 2: Comparison of baseline laboratory, ultrasonographic, and pre-procedure characteristics between the study groups (N = 98)

		Group 1 N = 49	Group 2 N = 49	P value
		Mean (SD)	Mean (SD)	
Laboratory investigations				
Haemoglobin (g/dL)		11.2 (1.4)	11.3 (1.5)	0.782
Total leukocyte count (×10³/µL)		12.4 (3.2)	12.7 (3.4)	0.694
Platelet count (×10³/µL)		254.6 (68.2)	261.4 (70.8)	0.641
Serum bilirubin (mg/dL)		1.4 (0.6)	1.5 (0.7)	0.573
AST (U/L)		52.8 (18.4)	54.6 (19.2)	0.654
ALT (U/L)		48.2 (17.6)	49.1 (18.1)	0.812
ALP (U/L)		168.4 (42.3)	171.6 (44.1)	0.733
Serum albumin (g/dL)		3.4 (0.5)	3.3 (0.5)	0.528
Serum total protein (g/dL)		6.8 (0.6)	6.7 (0.7)	0.571
Serum creatinine (mg/dL)		0.9 (0.3)	0.9 (0.3)	0.842
Blood urea (mg/dL)		31.2 (9.4)	32.4 (8.8)	0.534
Serum sodium (mmol/L)		136.8 (3.4)	137.2 (3.6)	0.618
Serum potassium (mmol/L)		4.1 (0.5)	4.2 (0.6)	0.512
Ultrasound				
Maximum abscess diameter (cm), Mean (SD)		7.0 (1.8)	7.1 (1.9)	0.790
Abscess volume (mL), Mean (SD)		210.0 (85.0)	214.0 (87.0)	0.818
Lobe involved	Right	36 (73.5)	37 (75.5)	0.817
	Left	13 (26.5)	12 (24.5)	
Pre-procedure characteristics				
Time from diagnosis to intervention (days), Mean (SD)		1.9 (0.8)	2.0 (0.9)	0.561
Pre-procedure antibiotic use	Present	43 (87.8)	44 (89.8)	0.749
	Absent	6 (12.2)	5 (10.2)	
*Statistically significant at p<0.05				

Table 3: Comparison of intraoperative and postoperative outcomes between the study groups (N = 98)

		Group 1 N = 49	Group 2 N = 49	P value
		n (%)	n (%)	
Intraoperative complications	Present	5 (10.2)	2 (4.1)	0.436
	Absent	44 (89.8)	47 (95.9)	
Intraoperative bleeding		3 (6.1)	1 (2.0)	0.617
Duration of surgery (minutes), Mean (SD)		68.5 (15.2)	32.4 (10.8)	<0.001*
Surgeon‑perceived ease of use (1–5), Mean (SD)		3.6 (0.8)	4.4 (0.7)	<0.001*
Postoperative complications	Present	9 (18.4)	7 (14.3)	0.785
	Absent	40 (81.6)	42 (85.7)	
Bleeding		2 (4.1)	1 (2.0)	0.972
Wound infection		3 (6.1)	2 (4.1)	0.891
Bile leak		2 (4.1)	1 (2.0)	0.972
Peritonitis		1 (2.0)	1 (2.0)	1.000
Need for re‑intervention		2 (4.1)	2 (4.1)	1.000
Duration of postoperative hospital stay (days), Mean (SD)		6.2 (1.7)	4.8 (1.5)	<0.001*
*Statistically significant at p<0.05 Ease of use: 1=very difficult, 5=very easy				

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Table 4: Comparison of postoperative bleeding, pain scores, and recurrence during follow-up between the study groups (N = 98)

		Group 1 N = 49	Group 2 N = 49	P value
		n (%)	n (%)	
Postoperative bleeding	6 hours	2 (4.1)	1 (2.0)	0.972
	24 hours	1 (2.0)	0 (0.0)	0.984
	48 hours	0 (0.0)	0 (0.0)	1.000
	3rd day	0 (0.0)	0 (0.0)	1.000
	7th day	0 (0.0)	0 (0.0)	1.000
Postoperative pain	6 hours	5.8 (1.1)	4.2 (1.0)	<0.001*
	24 hours	4.3 (1.0)	3.1 (0.9)	<0.001*
	48 hours	3.0 (0.9)	2.4 (0.8)	<0.001*
	3rd day	2.1 (0.8)	1.8 (0.7)	0.043*
	7th day	1.2 (0.6)	1.1 (0.5)	0.370
Recurrence of infection/abscess	3rd day	0 (0.0)	0 (0.0)	1.000
	7th day	1 (2.0)	0 (0.0)	0.984
	14th day	1 (2.0)	1 (2.0)	1.000
	21st day	0 (0.0)	0 (0.0)	1.000
*Statistically significant at p<0.05 Cumulative recurrence by Day 21: Group 1 = 2/49 (4.1%), Group 2 = 1/49 (2.0%); p = 0.972				

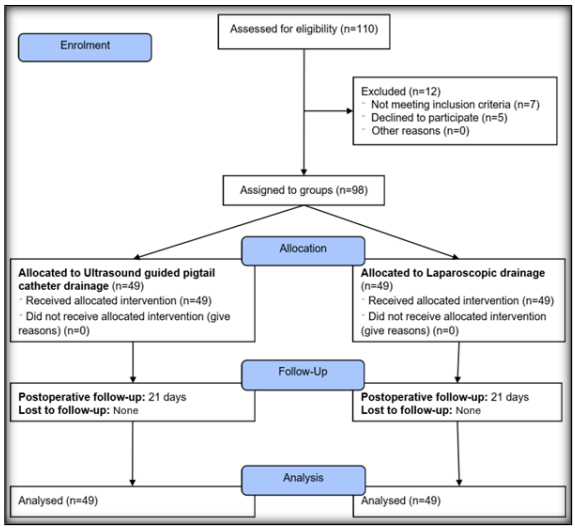

Figure 1: CONSORT flow diagram

DISCUSSION

The present trial enrolled two well-balanced cohorts, strengthening internal validity of comparative findings between laparoscopic drainage and ultrasound-guided pigtail catheter drainage (PCD). Demographic, anthropometric, vital, and laboratory parameters – including age (45 years), sex distribution (70% male), haemoglobin (11 g/dL), inflammatory indices (TLC 12.5×10³/µL), liver enzymes, nutritional markers, and renal/electrolyte profiles – were closely matched, minimizing confounding from baseline illness severity or physiological reserve. Such balance is essential because comorbidity burdens (present in 35%) and substance-use patterns can influence peri-operative risk and convalescence in liver abscess management. These features parallel Akhondi & Sabih (2025) in which patient factors rather than demographics per se drive outcomes, and they align with guidance that treatment choice should primarily reflect abscess characteristics and response to early therapy.[12]

Ultrasonographic disease characteristics were also comparable. The mean maximum cavity diameter was 7 cm with volumes 210–214 mL, and right-lobe predominance (74%) mirrored the known anatomic pattern attributed to portal flow dynamics.[13] Right-lobe preponderance and single-cavity morphology fall within typical clinical spectra where percutaneous drainage plus antibiotics constitutes first-line therapy,[14] reserving operative approaches for failures, inaccessible sites, or complex loculations, as noted by Heneghan et al. (2011).[15] This case-mix therefore provides a fair test of two minimally invasive strategies in the setting most frequently encountered in practice.[12] Peri-interventional processes were standardized. The diagnosis-to-intervention interval (2 days) and high uptake of pre-procedure antibiotics (>85%) were similar and are consistent with best practice emphasizing early resuscitation, blood cultures (when feasible), prompt antimicrobials, and timely source control once sepsis is stabilized and anatomy delineated.[16,17] Such timing accords with consensus recommendations that abscesses of this size typically warrant drainage soon after diagnosis rather than prolonged observation, to expedite defervescence and reduce complications.[18]

Intra-operative safety profiles were broadly comparable and encouraging. Overall intra-operative complications occurred in 10% vs 4% (ns), and bleeding in 6% vs 2% (ns) for laparoscopic and PCD arms, respectively. Das et al. (2022), Li & Pan (2025) and Ndong et al. (2022) underscores that both laparoscopy and image-guided PCD are generally safe in experienced hands; selection should be individualized by cavity complexity, location, and operator expertise.[19-21] Notably, systematic review of laparoscopic drainage by Ndong et al. (2022) report low recurrence and very low mortality, supporting its role as a definitive option when percutaneous measures are unsuitable (e.g., multiloculation, rupture, caudate lobe, failure of percutaneous therapy).[19]

Operative efficiency and user-experience favoured the PCD arm. Mean procedure time was approximately halved (32 vs 69 minutes), and

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surgeon-perceived ease-of-use scores were higher with PCD (4.4 vs 3.6 on a 5-point scale; both $p<0.001$). These findings fit longstanding experience that percutaneous catheter techniques are technically straightforward for single cavities, require fewer resources (no general anaesthesia or pneumoperitoneum), and can be rapidly deployed at bedside or interventional suites – advantages particularly salient in resource-constrained settings and for patients with limited physiological reserve. These findings corroborate with that reported by Eastiak et al. (2015), Kinikar et al. (2025) and Kumar et al. (2021).[22-24]

Post-operative clinical trajectories further favoured PCD in the early period. Pain scores were lower at 6, 24, and 48 hours and remained modestly lower on day 3, converging by day 7. Reduced incisional and peritoneal irritation likely accounts for this difference, given that laparoscopy – even with small ports – introduces pneumoperitoneum, port-site nociception, and more tissue handling than percutaneous access. In a randomized comparison of catheter drainage versus other image-guided strategies by Kulhari & Mandia (2019), percutaneous catheterization was associated with faster symptom relief and earlier reduction in cavity size than needle aspiration; while that trial did not compare against laparoscopy, its trajectory data support smoother early recovery with continuous drainage systems, which plausibly generalizes to less pain when effective decompression is achieved rapidly.[9,25]

Crucially, these symptom and workflow advantages translated into a clinically meaningful reduction in length of stay (LOS); 4.8 days after PCD versus 6.2 days after laparoscopy ($p<0.001$). While surgical drainage can provide thorough debridement and break loculations, it often entails operating-room logistics, anaesthesia, and post-operative monitoring that prolong hospitalization. Harclerode & Gnugnoli (2025) places PCD plus antibiotics as the standard in most pyogenic abscesses, with surgery reserved for specific indications or salvage – an approach consistent with our LOS and pain findings.[14]

Importantly, safety endpoints did not differ materially between arms. Aggregate post-operative complication rates were low and similar (18% vs 14%, ns), with individual events (bleeding, wound infection, bile leak, peritonitis) infrequent and evenly distributed; re-intervention rates were identical (4.1% each). These results are congruent with evidence that, in single-cavity disease of moderate size, both modalities achieve satisfactory source control with low adverse-event profiles. For laparoscopy, a meta-analysis documented low recurrence and favourable safety,[19] while interventional literature emphasizes low complication rates for well-sited catheters and the importance of follow-up imaging to guide timely removal.[14] Notably, literature is not monolithic; Chitrambalam et al. (2019) reported advantages for laparoscopy (less pain, faster cavity resolution, shorter LOS) when treating complex or larger abscesses, likely reflecting case-mix differences (e.g., multiloculation, viscous contents) and aggressive adhesiolysis/deroofing that PCD cannot achieve.[11] A surgical review by Wadhera et al. (2022) likewise suggested that for abscesses >5 cm, treatment failures may be more common with percutaneous approaches, supporting a tailored, anatomy-driven choice of modality.[10]

From a systems perspective, the shorter operative time, lower early pain, and reduced LOS with PCD carry implications for operating-room throughput, bed utilization, and patient satisfaction – key considerations in tertiary centres with high procedural volumes. Conversely, laparoscopy remains indispensable for selected presentations; ruptured abscess, failure of percutaneous therapy, anatomically inaccessible cavities, or need for concomitant surgical management (e.g., addressing biliary pathology or dense adhesions).

This study had several limitations that temper generalizability. First, eligibility was narrow – adult patients with a single liver abscess and frequent alcohol use – excluding multiple/complex cavities and important comorbid groups; results may not extend to broader real-world case-mix or lower-resource settings. Second, blinding of the operator and participants was impossible, and subjective outcomes (e.g., surgeon-perceived ease, early pain scores) are vulnerable to expectation and performance bias despite assessor blinding. Third, the study was powered for differences in pain and length of stay, not for uncommon but clinically important events (e.g., bile leak, peritonitis, re-intervention), so null findings for complications could reflect limited power. Fourth, follow-up for recurrence was short (21 days), potentially underestimating late relapse or biliary complications; imaging-based cavity resolution beyond discharge was not protocolized." Finally, we did not assess costs, quality of life, or time- to functional recovery, precluding a fuller appraisal of comparative effectiveness and health-system impact.

CONCLUSION

In this randomized comparison of adults with a single liver abscess, ultrasound-guided pigtail catheter drainage achieved equivalent safety to laparoscopic drainage – similar rates of intra-/postoperative complications and short-term recurrence – while delivering clear peri-operative advantages; markedly shorter procedure time, lower early postoperative pain, and a reduced length of hospital stay. Surgeon-perceived ease of use also favoured the percutaneous approach. Taken together, these findings support ultrasound-guided pigtail catheter drainage as the preferred first-line intervention for appropriately selected, single-cavity liver abscesses, reserving laparoscopy for failures of percutaneous therapy, complex anatomy, or concomitant surgical indications.

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