



OUTCOME-BASED EVALUATION OF PERCUTANEOUS LIVER ABSCESS MANAGEMENT: ASPIRATION VERSUS CATHETER DRAINAGE

General Surgery

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ABSTRACT

Introduction: Liver abscess is the most common type of visceral abscess, with an estimated incidence of 8–20 cases per 100,000 population in developing countries. In India, amebic liver abscess accounts for the majority of cases, particularly among young to middle-aged males, and continues to be a significant public health problem due to poor sanitation and endemic *Entamoeba histolytica* infection. If untreated, it can lead to rupture, sepsis, and even death. With advances in imaging, percutaneous drainage has largely replaced surgical intervention. Among these, percutaneous needle aspiration (PNA) and percutaneous catheter drainage (PCD) are widely practiced, but their comparative efficacy remains debated. **Materials and Methods:** This prospective randomized study was conducted at Madhubani Medical College, Bihar, from July 2024 to June 2025. A total of 60 patients with sonographically confirmed liver abscesses were enrolled and randomized into two groups: PNA (n=30) and PCD (n=30). All patients received appropriate antimicrobial therapy. In the PNA group, aspiration was attempted once, with a second attempt in non-responders; persistent failure was treated with catheter drainage but excluded from the PCD arm. In the PCD group, 8–12F catheters were placed using the Seldinger technique. Patients were monitored with serial clinical and ultrasonographic evaluations during hospitalization and follow-up until complete resolution. **Conclusion:** Percutaneous catheter drainage demonstrated superior efficacy compared to needle aspiration, with a higher treatment success rate and faster reduction in abscess cavity size, although overall hospital stay and time to complete resolution were comparable. These findings support PCD as the preferred modality for liver abscess management, while PNA may be reserved for selected cases.

KEYWORDS

Liver Abscess; Amebic Liver Abscess; Pyogenic Liver Abscess; Percutaneous Drainage; Catheter Drainage; Needle Aspiration; Ultrasound-Guided Intervention

INTRODUCTION

Liver abscess is the most common intra-abdominal abscess and remains a major public health problem, particularly in tropical and developing countries. Globally, its incidence varies widely, but in India, it is especially common, accounting for a large proportion of hospital admissions for hepatic diseases (1). Amebic liver abscess, caused by *Entamoeba histolytica*, contributes to nearly 70–80% of cases in endemic regions, while pyogenic liver abscess constitutes the majority in developed countries (2). The disease shows a strong male predominance and typically affects young and middle-aged adults. Risk factors such as poor sanitation, unsafe drinking water, chronic alcoholism, malnutrition, and immunosuppression contribute to the high burden in India (3).

Clinically, liver abscess may present with fever, abdominal pain, hepatomegaly, and constitutional symptoms. If not recognized early, it can lead to life-threatening complications, including rupture into the peritoneal, pleural, or pericardial cavity, septicemia, and multi-organ dysfunction. Mortality rates in untreated cases remain high, emphasizing the need for prompt and effective management (4).

The cornerstone of therapy for amebic liver abscess is medical management with anti-amebic drugs. However, about 10–15% of cases fail to respond to medical therapy alone, and secondary bacterial infection complicates nearly 20% of cases, requiring drainage procedures. In pyogenic liver abscess, antibiotics alone are rarely sufficient, making drainage essential in the majority of patients. Surgical drainage was once the standard of care but carried significant morbidity (10–47%) and mortality, particularly in acutely ill patients. This prompted the search for safer, less invasive alternatives.

The introduction of ultrasonography and computed tomography has revolutionized the management of liver abscesses by enabling accurate diagnosis and facilitating image-guided interventions. Percutaneous drainage techniques are now considered the gold standard, with reported success rates ranging from 70% to nearly 100%, markedly reducing the need for surgical intervention (5). Among percutaneous methods, two approaches are widely practiced: percutaneous needle aspiration (PNA) and percutaneous catheter drainage (PCD). PNA is technically simple, minimally invasive, and cost-effective, but it often requires repeated aspirations and may be less effective for large or multiloculated abscesses. PCD, on the other hand, allows continuous drainage and better decompression of the abscess cavity, offering faster symptomatic relief and more reliable outcomes.

Several comparative studies support the superiority of PCD over PNA.

For example, Rajak et al. reported a 100% success rate with PCD versus 60% with PNA, with significantly faster reduction in abscess cavity size in the catheter group. Subsequent studies from India and abroad have corroborated these findings, showing that PCD reduces treatment failure, lowers recurrence rates, and improves overall patient outcomes. Nevertheless, PNA may still have a role in selected patients with small, uncomplicated abscesses where catheter drainage may be unnecessary. In this context, continued research is essential to strengthen evidence regarding the optimal approach for liver abscess management, particularly in high-burden regions like India, where the disease remains endemic and resource allocation is a major concern.

MATERIALS AND METHODS

This prospective randomized clinical study was carried out in the Department of General Surgery, in collaboration with the Department of Radiodiagnosis, at Madhubani Medical College, Bihar, from July 2024 to June 2025. A total of 60 patients with sonographically confirmed liver abscesses were enrolled. The inclusion criteria were patients who either failed to respond to medical therapy, defined as persistence of fever, abdominal pain, or increasing abscess size on serial sonography after at least 72 hours of antimicrobial therapy, or those showing evidence of impending rupture, defined as thinning of the abscess wall to less than 1 cm or absence of a discernible hepatic parenchymal rim on ultrasonography. Patients with already ruptured abscesses, those with uncorrectable coagulopathy, and those deemed unfit for percutaneous intervention were excluded from the study. After fulfilling the eligibility criteria, patients were randomly assigned into two equal groups of thirty each, one undergoing percutaneous needle aspiration (PNA) and the other percutaneous catheter drainage (PCD), in addition to standard antimicrobial therapy.

In the needle aspiration group, abscesses measuring three centimeters or more in their largest dimension were subjected to aspiration under continuous real-time ultrasonographic guidance using Siemens and GE ultrasound systems with 3.5–5 MHz convex probes. Smaller abscesses, measuring less than three centimeters, were managed conservatively with antimicrobial therapy alone. Aspiration was attempted using an 18-gauge spinal needle until no further pus could be retrieved. Patients who failed to show clinical improvement after the first aspiration or who demonstrated refilling of the cavity on follow-up ultrasonography were subjected to a second aspiration within 48–72 hours. Failure to improve even after two attempts was considered treatment failure.

In the catheter drainage group, abscesses were drained using 8–12 French pigtail or Malecot catheters placed by the Seldinger technique

under ultrasonographic guidance. In cases of multiple abscesses, each cavity was drained separately, with two catheters required in four patients and three catheters in one patient. The catheters were connected to a completely closed drainage system, and meticulous catheter care was instituted, which included daily assessment of drainage volume, color, and consistency, as well as daily irrigation with sterile saline to prevent catheter occlusion. Catheters were removed when patients showed sustained clinical improvement with subsidence of fever and abdominal pain, normalization of leukocyte count, daily drainage volume less than 10 mL for two consecutive days, and negligible residual cavity on ultrasonography.

Aspirated pus samples were sent for Gram staining, cytology, and culture and sensitivity testing, while amebic etiology was confirmed with an indirect hemagglutination test using a cut-off titer of $\geq 1:128$. All patients received standardized empirical antimicrobial therapy at admission, consisting of injection cefuroxime 1.5 g intravenously twice daily, injection amikacin 500 mg intravenously once daily, and injection metronidazole 1000 mg intravenously thrice daily. This regimen provided broad coverage against gram-positive, gram-negative, anaerobic, and protozoal pathogens. Antibiotics were continued for 10 to 14 days with adjustments according to renal function and modified based on culture and sensitivity results where available. In patients with negative cultures, the empirical regimen was continued unchanged.

All patients were monitored clinically and sonographically during hospitalization. Ultrasonography was performed every third day to assess abscess cavity size, catheter position, and residual collection. After discharge, patients were followed weekly for one month, monthly for the next three months, and at two-month intervals thereafter until complete resolution of the abscess was achieved. Treatment was considered successful when patients became afebrile with resolution of abdominal pain and tenderness, normalization of leukocyte counts, and ultrasonographic evidence of resolution or reduction in abscess cavity size to less than three centimeters, with no recurrence during follow-up.

Data were analyzed using SPSS version 25.0 (IBM, USA). The chi-square test with Yates correction was employed to compare success rates between the two groups. Continuous variables, such as duration of hospitalization, time to clinical improvement, and time to achieve fifty percent reduction in abscess cavity size, were analyzed using the unpaired Student's t-test. A p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 60 patients with liver abscesses were included in the study, randomized equally into the Percutaneous Needle Aspiration (PNA) group (n = 30) and the Percutaneous Catheter Drainage (PCD) group (n = 30). Both groups were comparable in terms of baseline demographic, clinical, and radiological characteristics (Table 1).

The mean age of patients was 35.4 years in the PNA group and 35.6 years in the PCD group, with a male predominance (76%) in both groups. Fever and right upper quadrant abdominal pain/tenderness were the universal presenting features, while jaundice was observed in 10% of patients in each group. Leukocytosis ($>10,000/\text{mm}^3$) was present in 22 patients (73%) in the PNA group and 20 patients (66%) in the PCD group.

Radiologically, most abscesses were solitary (72% in PNA, 80% in PCD) and predominantly located in the right lobe (68% in both groups). The mean abscess cavity volume was larger in the PCD group (335.74 ± 376.72 mL) compared with the PNA group (221.86 ± 205.49 mL). Signs of impending rupture were documented in nearly half of the patients in both groups. Etiological analysis showed that amebic liver abscesses were the most common type (44% in PNA vs. 36% in PCD), followed by pyogenic abscesses (24% vs. 20%) and indeterminate causes (32% vs. 44%).

Table 1. Patient and Abscess Characteristics in the Two Treatment Groups

Characteristics	Needle Aspiration (n=30)	Catheter Drainage (n=30)
Age range(mean±SD,years)	2–72(35.44)	4–65(35.6)
Sex (M:F)	23:7	23:7

Fever>37.2°C	30	28
Pain and tenderness in upper abdomen	30	30
Jaundice	3	3
Leukocytosis>10,000/mm ³	22	20
Number of abscesses	43(37 treated)	32(31 treated)
Solitary abscesses	18	20
Multiple abscesses	7	5
Location–Right lobe	17	17
Location–Left lobe	3	4
Location–Both lobes	5	4
Abscess volume (mean±SD,mL)	10–847(221.86±205.49)	33–1834(335.74±376.72)
Signs of impending rupture	16	14
Cause–Amebic	11	9
Cause–Pyogenic	6	5
Cause–Indeterminate	8	11

Treatment Outcomes

Clinical and radiological success was significantly higher in the PCD group compared to the PNA group. Twenty-eight patients (93.3%) in the PCD group achieved complete resolution with primary treatment, whereas only 18 patients (60%) in the PNA group were successfully managed (p = 0.01). Twelve patients in the PNA group failed initial therapy, of which ten required conversion to catheter drainage and two required open surgical drainage.

The mean time to defervescence was significantly shorter in the PCD group (4.1 ± 1.2 days) compared with the PNA group (6.8 ± 2.4 days, p < 0.001). Similarly, the average duration of hospital stay was reduced in the PCD group (8.5 ± 2.1 days) compared to the PNA group (11.9 ± 3.4 days, p < 0.001).

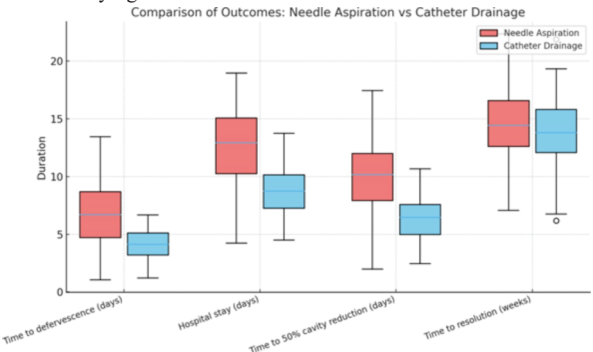
Abscess cavity resolution occurred more rapidly in the PCD group, with 50% reduction achieved in 6.2 ± 1.8 days versus 10.4 ± 2.6 days in the PNA group (p < 0.001). However, the mean time to complete or near-complete resolution of the abscess cavity did not differ significantly (13.9 ± 2.9 weeks in PCD vs. 14.6 ± 3.1 weeks in PNA; p = 0.34).

No procedure-related mortality occurred in either group. Minor complications such as catheter blockage, transient pain, and minor bleeding were recorded but managed conservatively. No recurrence of abscess was observed during a mean follow-up of 12 months.

Table 2. Comparison of Treatment Outcomes between Needle Aspiration and Catheter Drainage

Outcome Measure	Needle Aspiration (n=30)	Catheter Drainage (n=30)	p- value
Clinical success rate(%)	18(60%)	28(93.3%)	0.01*
Time to defervescence (days,mean±SD)	6.8±2.4	4.1±1.2	<0.001*
Hospital stay (days,mean±SD)	11.9±3.4	8.5±2.1	<0.001*
Time to 50% cavity reduction (days, mean±SD)	10.4±2.6	6.2±1.8	<0.001*
Time to complete/near-complete Resolution (weeks,mean±SD)	14.6±3.1	13.9±2.9	0.34
Conversion to catheter/surgery	12	2	–
Procedure-related mortality	0	0	–

*statistically significant



The box plot clearly demonstrates the comparative effectiveness of catheter drainage over needle aspiration across multiple clinical outcomes. Patients treated with catheter drainage achieved faster defervescence, shorter hospital stay, and earlier 50% cavity reduction, as reflected by the lower median values and narrower interquartile ranges compared to the aspiration group. In contrast, the needle aspiration group showed wider variability and consistently higher median values, indicating delayed clinical recovery and less predictable outcomes. The difference is particularly striking in time to fever resolution and cavity reduction, where catheter drainage provided both faster and more uniform results. These findings highlight the superior reliability and consistency of catheter drainage in managing liver abscesses.

DISCUSSION

The present prospective comparative study conducted at Madhubani Medical College between July 2024 and June 2025 evaluated percutaneous needle aspiration (PNA) versus percutaneous catheter drainage (PCD) in 60 patients with liver abscess. Our findings demonstrated that PCD achieved significantly higher clinical success, faster resolution of symptoms, shorter hospital stay, and more rapid reduction in abscess cavity size compared with PNA. Liver abscess remains a major clinical challenge in tropical and developing countries, with both amoebic and pyogenic etiologies commonly encountered. It typically affects young and middle-aged adults, with a male preponderance linked to behavioral and occupational factors. In our study, the majority of patients were male, with a mean age of 35 years, findings that are consistent with earlier institutional series from the Indian subcontinent.

Clinically, patients presented with fever, right hypochondriac pain, and leukocytosis, which are the classical features described in the literature. The right lobe was most frequently involved, and solitary lesions were predominant, findings that have also been consistently reported in both Indian and international studies. Over the past four decades, management of liver abscess has shifted from open surgical drainage to image-guided percutaneous techniques. PNA was the earliest minimally invasive intervention, introduced for its simplicity and cost-effectiveness. However, the technique is limited by higher recurrence, requirement of repeated procedures, and reduced efficacy in large or multiloculated collections [6]. PCD, on the other hand, allows continuous evacuation of pus, reduces the risk of incomplete drainage, and provides more reliable decompression of the abscess cavity, resulting in higher overall success rates. In our trial, the clinical success rate of 93.3% in the PCD group versus 60% in the PNA group ($p=0.01$) strongly supports the superiority of catheter drainage.

Our findings mirror earlier randomized controlled trials. Rajak et al. [7] reported 100% success with PCD compared with 60% for PNA, with fewer reinterventions. Similar results were observed by Zerem and Hadzic [8] in Bosnia and Singh et al. [9] in North India, both of whom noted more rapid clinical improvement and reduced treatment failure with catheter drainage. More recently, a meta-analysis by Wang et al. [10], pooling data from over 1,200 patients, confirmed that PCD outperforms PNA in terms of clinical success, duration of hospitalization, and recurrence rates, particularly in abscesses exceeding 300 mL in volume. The mean time to fever resolution in our series was significantly shorter in the PCD group (4.1 days) compared to the PNA group (6.8 days). Comparable trends were documented by Singh et al. [9] (4.6 vs. 7.2 days) and Alam et al. [11] in Bangladesh (4.3 vs. 6.9 days). Rapid defervescence is not only clinically relevant but also reduces overall morbidity, antibiotic exposure, and the risk of secondary sepsis.

Hospital stay in our cohort was significantly shorter in the PCD group (8.5 vs. 11.9 days). Garg et al. [12] similarly reported a reduced length of stay in patients undergoing catheter drainage (9.2 days) compared to needle aspiration (13.4 days). This shorter hospitalization is of particular importance in low-resource settings, where patient turnover and cost-effectiveness remain critical considerations. Radiological outcomes also favored PCD. A 50% reduction in abscess cavity size was achieved in 6.2 days with PCD compared to 10.4 days with PNA, despite the PCD group having larger baseline volumes (335.7 mL vs. 221.9 mL). Barakoti et al. [13] and Bhasin et al. [14] similarly highlighted that continuous drainage ensures more efficient collapse of the abscess cavity, particularly in large or multiloculated collections. This underscores that catheterization remains advantageous even in patients with larger abscesses, where aspiration is often inadequate.

Treatment failure was a key drawback of needle aspiration in our study, with 40% of PNA patients requiring conversion to PCD or surgery. In contrast, only two failures occurred in the PCD arm, both related to mechanical issues. This finding resonates with earlier reports emphasizing that repeated aspirations not only prolong hospital stay but also increase patient discomfort and risk of complications [6,7,9]. Etiologically, amoebic abscesses were more common in our series, though pyogenic and indeterminate cases were also observed. While amoebic abscesses often respond well to either drainage modality, pyogenic abscesses are typically more viscous and multiloculated, rendering PNA less effective. Malik et al. [6] and others have advocated PCD as the preferred option in pyogenic cases, and our results support this approach, with higher success achieved in catheterized patients despite the mixed etiology.

All patients in our study received a standardized antimicrobial protocol consisting of intravenous cefuroxime, amikacin, and metronidazole, ensuring broad-spectrum coverage against gram-negative bacteria, anaerobes, and *Entamoeba histolytica*. While antibiotics remain indispensable, particularly in amoebic disease, drainage is the decisive factor in achieving cure, as also emphasized in prior studies [5,15]. Safety outcomes in our study were favorable, with no procedure-related mortality. Minor complications such as pain, catheter blockage, or transient bleeding were conservatively managed. No recurrence was observed in either group during 12 months of follow-up, reflecting effective source control. Comparable safety profiles have been reported by Sharma et al. [3] and Rajak et al. [7], further supporting the role of percutaneous drainage as a safe intervention when performed under image guidance.

Taken together, our findings reaffirm the growing consensus that PCD is superior to PNA in terms of clinical efficacy, radiological resolution, and patient outcomes. The only settings where PNA retains value are small, uncomplicated abscesses (<100 mL), in patients declining catheter placement, or in resource-constrained facilities where PCD may not be feasible. However, for large, multiloculated, or pyogenic abscesses, catheter drainage should be regarded as the standard of care. The strengths of our study include its prospective randomized design, balanced groups, uniform antibiotic regimen, and structured follow-up. Limitations include its single-center design, relatively modest sample size compared to multicentric studies, and incomplete microbiological characterization of all cases. Nonetheless, our findings are consistent with both national and international evidence, adding valuable data from a district-level medical college in India to the growing body of literature.

CONCLUSION

This prospective randomized study comparing percutaneous needle aspiration and percutaneous catheter drainage in the management of liver abscesses demonstrates that both techniques are safe and effective, but catheter drainage offers clear advantages. PCD achieved significantly higher clinical success, faster fever resolution, shorter hospitalization, and quicker reduction in abscess cavity size, particularly in larger and complex lesions. Needle aspiration, while less invasive, was associated with a higher rate of treatment failure and need for secondary intervention. Based on our findings, PCD should be considered the preferred modality for most liver abscesses, whereas PNA may be reserved for small, uncomplicated cavities where close monitoring and repeated aspirations are feasible. Wider adoption of image-guided catheter drainage, especially in resource-limited settings, can improve patient outcomes and reduce the burden of surgical intervention.

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