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PERCUTANEOUS CATHETER DRAINAGE VERSUS NEEDLE ASPIRATION IN LIVER ABSCESS TREATMENT: A COMPARATIVE STUDY FROM A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Liver abscess remains a significant health concern in developing countries, often resulting in high morbidity and potential mortality. Two widely accepted minimally invasive approaches—Percutaneous Catheter Drainage (PCD) and Percutaneous Needle Aspiration (PNA)—have been used extensively, yet clinical consensus on their relative effectiveness remains debatable. **Objective:** This study aimed to compare the clinical outcomes, complication rates, hospital stay duration, and recurrence rates of PCD and PNA in patients diagnosed with liver abscesses. **Methods:** A prospective comparative study was conducted at a tertiary care hospital over 18 months, enrolling 100 patients diagnosed with liver abscesses via ultrasound and/or CT. Patients were randomized into two groups: Group A (PCD, n=50) and Group B (PNA, n=50). Inclusion and exclusion criteria were strictly applied. Variables assessed included resolution time, abscess size reduction, hospital stay, and procedural complications. Statistical analysis was performed using SPSS version 25. **Results**: The mean duration for abscess resolution was significantly shorter in the PCD group (8.6 ± 2.3 days) compared to the PNA group (12.4 ± 3.1 days) ($p<0.01$). Complication rates were lower in the PCD group (10%) versus the PNA group (22%). The average hospital stay was also significantly reduced in the PCD group. **Conclusion:** PCD is more effective than PNA in managing liver abscesses in terms of quicker resolution, fewer complications, and shorter hospitalization. It should be considered the first-line intervention in appropriately selected cases.

KEYWORDS: Liver abscess, Percutaneous catheter drainage, Needle aspiration, Pyogenic, Amoebic, Tertiary care.

INTRODUCTION

Liver abscess is defined as a localized collection of pus within the liver parenchyma, resulting from an infection that can be bacterial, fungal, or parasitic in origin. The infection may reach the liver through various routes, including the biliary tree, hepatic artery, portal vein, direct extension from adjacent structures, or following trauma.[1,2]

A liver abscess is a localized collection of pus within the liver parenchyma, typically resulting from bacterial (pyogenic), parasitic (amoebic), or fungal infections. The infection may reach the liver through various routes, including the biliary tree (e.g., ascending cholangitis), portal vein (e.g., from intra-abdominal infections like appendicitis), hepatic artery (via hematogenous spread), direct extension from adjacent organs, or post-traumatic implantation. Pyogenic liver abscesses (PLAs) are most commonly caused by Gram-negative enteric bacteria and anaerobes. The most frequently isolated organisms include:

Klebsiella pneumoniae (especially in East and Southeast Asia), Escherichia coli, Streptococcus species (including Streptococcus anginosus group), Enterococcus species, Anaerobes such as Bacteroides fragilis and Clostridium spp.

Mixed aerobic and anaerobic infections are common, especially in abscesses of biliary origin. Fungal abscesses, though rare, may occur in immunocompromised individuals, commonly due to Candida species.

While the American Association for the Study of Liver Diseases (AASLD) does not offer a standalone formal definition, it recognizes hepatic abscesses as significant clinical entities within hepatology. In the Indian context, the Indian National Association for Study of the Liver (INASL) identifies amoebic liver abscess (ALA), primarily caused by Entamoeba histolytica, as the most prevalent type, accounting for over 60% of cases.

Global Epidemiology of Liver Abscess

Country/ Region	Type of Abscess	Incidence (/100,000)	Mortality (%)	Notable Trends & Risk Factors
Taiwan	Pyogenic	17.3	2.5–12	High incidence; Klebsiella pneumoniae is the predominant pathogen.
South Korea	Pyogenic	14.4 (2017)	9.6	Rising incidence linked to diabetes and malignancy.
Germany	Pyogenic	~7	Not specified	Associated with malignancies and biliary obstruction.
United States	Pyogenic	3.6	Not specified	Increasing incidence; biliary disease is a common risk factor.
Denmark	Pyogenic	6–18 (1977–2002)	10–15	Incidence rose over 26 years; mortality decreased due to better diagnostics.
India	Amoebic	Not specified	<15	Amoebic abscesses predominate; improved outcomes with early treatment.

Screening and Diagnostic Tools for Liver Abscess

Diagnostic Tool	Sensitivity (%)	Key Features	Limitations
Ultrasound (USG)	80–90	Non-invasive, bedside use, guides aspiration.	Operator-dependent; may miss deep or small abscesses.
Contrast-Enhanced CT	95–100	High-resolution; excellent for diagnosis and guiding drainage.	Radiation exposure; contrast use may be risky in renal patients.
MRI	High	Superior soft tissue contrast; used in complex or CT-contraindicated cases.	Expensive; limited availability.
Radionuclide Scanning	50–90	Detects functionally abnormal areas; helpful when others are inconclusive.	Low spatial resolution; not commonly used.
Laboratory Tests	Variable	Elevated WBC, CRP, liver enzymes; useful with imaging.	Non-specific; cannot localize the abscess.

Historically, the management of liver abscesses primarily relied on open surgical drainage in combination with antibiotic therapy. However, with the evolution of diagnostic imaging techniques such as ultrasound and computed tomography (CT), less invasive interventional approaches have gained prominence. Two such techniques—percutaneous catheter drainage (PCD) and percutaneous needle aspiration (PNA)—have become the cornerstone of modern, minimally invasive liver abscess management. These procedures have demonstrated efficacy in various clinical settings, leading to decreased morbidity, shorter hospital stays, and improved patient comfort compared to surgical options.[3–5]

Despite their widespread use, the choice between PCD and PNA remains a subject of ongoing debate. PNA is a relatively straightforward and cost-effective procedure, often performed under local anesthesia, making it suitable for smaller abscesses or settings with limited resources. However, it may require multiple sessions for complete resolution and has been associated with higher rates of recurrence. On the other hand, PCD provides continuous and controlled drainage, making it more suitable for larger or complex abscesses, although it may entail longer procedure times, increased costs, and greater patient discomfort.[6,7]

Given these considerations, it is crucial to systematically evaluate the relative efficacy, safety, and resource utilization of PCD versus PNA to inform clinical decision-making and optimize patient outcomes. While several studies have attempted to compare these modalities, discrepancies persist in reported outcomes, highlighting the need for further research in diverse clinical settings.

The present study aims to conduct a comprehensive comparison between percutaneous catheter drainage and percutaneous needle aspiration in the management of liver abscesses at a tertiary care hospital. Specifically, it evaluates key outcomes including time to symptom resolution, duration of hospital stay, recurrence rates, number of interventions required, and procedure-related complications. This evidence will contribute to establishing evidence-based guidelines for the optimal management of liver abscesses.

Need of the Study

Liver abscesses, particularly in developing countries, pose a serious health risk due to high morbidity and potential complications. While both percutaneous catheter drainage (PCD) and needle aspiration (PNA) are widely used, their comparative effectiveness remains uncertain. A clear evaluation is needed to guide optimal clinical decisions. This study aims to assess and compare the outcomes of PCD and PNA, providing evidence to improve patient management, reduce hospital stays, and minimize recurrence and complications.

Aim

To evaluate and compare the clinical efficacy, safety, and outcomes of percutaneous catheter drainage (PCD) versus percutaneous needle aspiration (PNA) in the management of liver abscesses in a tertiary care hospital setting.

Study Objectives

1. To compare the time to clinical symptom resolution between patients undergoing PCD and those undergoing PNA.
2. To evaluate the duration of hospital stay in both intervention groups.
3. To assess the recurrence rate of liver abscess post-intervention in each group.
4. To determine the number of interventions required for complete resolution in both treatment modalities.

5. To compare procedure-related complications between PCD and PNA.
6. To analyze radiological outcomes, specifically abscess cavity size reduction at Day 7 and Day 14 post-intervention.
7. To assess the trend in laboratory parameters (e.g., total leukocyte count, CRP, liver enzymes, and bilirubin) pre- and post-intervention in both groups.

MATERIALS AND METHODS

Study Design

This was a prospective, observational, comparative study conducted over a period of 18 months (January 2024 to January 2025) in the Department of General Surgery and Radiology at District government hospital.

Study Site

The study was carried out in a high-volume tertiary care center located in (Khammam, Telangana India), catering to a large population from both urban and rural backgrounds. The hospital has a dedicated interventional radiology unit and state-of-the-art imaging facilities including ultrasound (Ultrasound (USG)), computed tomography (CT), and magnetic resonance imaging (MRI), which were used for diagnosis and guidance during procedures.

Ethical Considerations

The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all patients before enrollment.

Duration

The study was conducted over an 12 -month period January 2024 to January 2025.

Inclusion Criteria

- Patients aged 18 to 70 years
- Diagnosed with liver abscess via ultrasound or CT
- Abscess size > 3 cm in diameter
- Single or multiple abscesses amenable to percutaneous intervention
- Hemodynamically stable patients
- Patients who provided informed consent

Exclusion Criteria

1. Patients with ruptured abscess
2. Coagulopathy or platelet count < 50,000/mm³
3. Immunocompromised patients (HIV, post-transplant, etc.)
4. Suspicion of malignancy
5. Known allergy to local anesthetic agents
6. Abscess requiring surgical exploration due to anatomical inaccessibility

Study Population

A total of 100 patients meeting the inclusion criteria were enrolled and randomized into two groups:

Group A (n=50): Underwent Percutaneous Catheter Drainage (PCD)

Group B (n=50): Underwent Percutaneous Needle Aspiration (PNA)

Randomization was done using computer-generated numbers.

Study Procedure

All patients underwent a baseline evaluation including complete blood count, liver function tests, coagulation profile, blood culture, and imaging (Ultrasound (USG) or CT). Serology for E. histolytica was performed in suspected cases of amoebic liver abscess.

Percutaneous Needle Aspiration (PNA)

Performed under ultrasound guidance using a 16–18 G needle. The pus was aspirated completely if possible, and samples were sent for microbiology. Repeat aspirations were performed if symptoms persisted or if follow-up imaging showed residual collection.

Percutaneous Catheter Drainage (PCD)

Under local anesthesia and ultrasound or CT guidance, a 10–14 Fr pigtail catheter was inserted using the Seldinger technique. The catheter was secured and connected to a drainage bag. Daily output was monitored, and the catheter was flushed with saline. Catheter removal criteria included clinical improvement, drainage < 10 mL/day, and radiologic evidence of cavity resolution.

All patients received empirical broad-spectrum intravenous antibiotics (e.g., ceftriaxone + metronidazole), which were adjusted based on culture sensitivity.

Statistical Analysis

Data were analyzed using SPSS software version 25. Descriptive statistics were used for demographic variables. Categorical variables were analyzed using the Chi-square test, while continuous variables were compared using Student's t-test or Mann–Whitney U test, depending on data distribution. A p-value of <0.05 was considered statistically significant.

Outcomes Measured

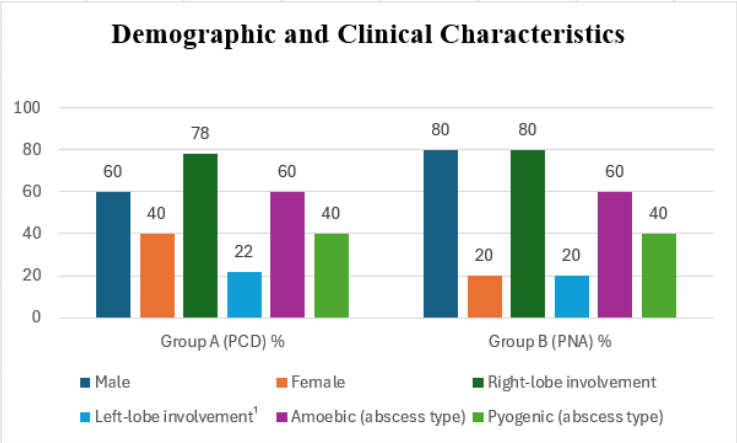
1. Time to clinical resolution (days)
2. Duration of hospital stay
3. Number of interventions required
4. Abscess size reduction (measured via imaging on day 7 and day 14)
5. Procedural complications (e.g., bleeding, secondary infection
6. Recurrence within 30 days of discharge

RESULTS

Table 1: Demographic and Clinical Characteristics.

Parameter	Group A (PCD)	Group B (PNA)	p-value
Mean age (years)	43.2 ± 9.4	44.1 ± 8.8	0.63
Male:Female ratio	3:2	4:1	0.21
Mean abscess size (cm)	6.4 ± 1.3	6.2 ± 1.1	0.45
Right lobe involvement	78%	80%	0.67
Amoebic:Pyogenic ratio	3:2	3:2	NS

There were no statistically significant differences between Group A (PCD) and Group B (PNA) in baseline characteristics. The mean age was similar (43.2 ± 9.4 vs. 44.1 ± 8.8 years; p = 0.63), as was the male-to-female ratio (3:2 vs. 4:1; p = 0.21). The average abscess size also showed no significant variation between the groups (6.4 ± 1.3 cm vs. 6.2 ± 1.1 cm; p = 0.45). Right lobe involvement was comparable (78% vs. 80%; p = 0.67). The distribution of amoebic to pyogenic abscesses was also similar (3:2 in both groups), with no statistical significance noted (NS).

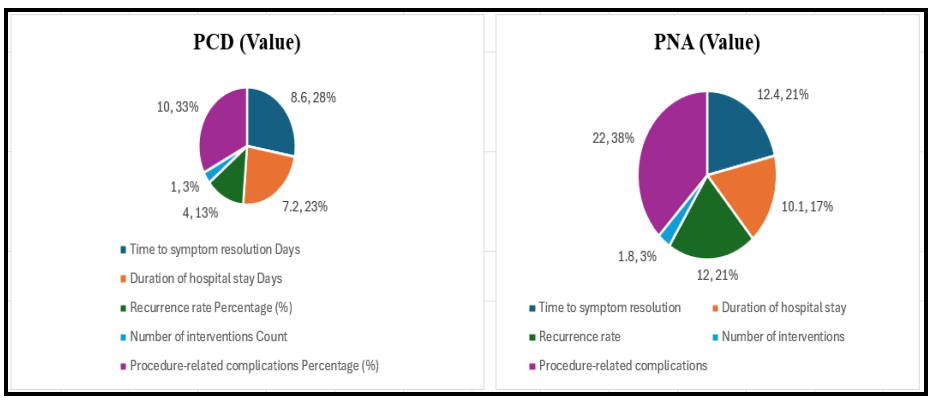


Graph 1: Comparative Clinical Outcomes: PCD vs. PNA.

Table 2: Primary and Secondary Outcomes.

Outcome	PCD (n=50)	PNA (n=50)	p-value
Time to symptom resolution (days)	8.6 ± 2.3	12.4 ± 3.1	<0.01
Duration of hospital stay (days)	7.2 ± 1.8	10.1 ± 2.4	<0.01
Recurrence rate	2 (4%)	6 (12%)	0.04
Number of interventions	1	1.8	<0.01
Procedure-related complications	10%	22%	0.03

The comparative analysis revealed that percutaneous catheter drainage (PCD) significantly outperformed percutaneous needle aspiration (PNA) across multiple clinical outcomes. Patients treated with PCD had a faster resolution of symptoms (8.6 ± 2.3 vs. 12.4 ± 3.1 days; p < 0.01) and a shorter hospital stay (7.2 ± 1.8 vs. 10.1 ± 2.4 days; p < 0.01). The recurrence rate was significantly lower in the PCD group (4%) compared to the PNA group (12%; p = 0.04). Moreover, the number of required interventions was less in the PCD group (1 vs. 1.8; p < 0.01), indicating higher procedural efficiency. Procedure-related complications were also significantly fewer in the PCD group (10% vs. 22%; p = 0.03), underscoring its relative safety and efficacy.



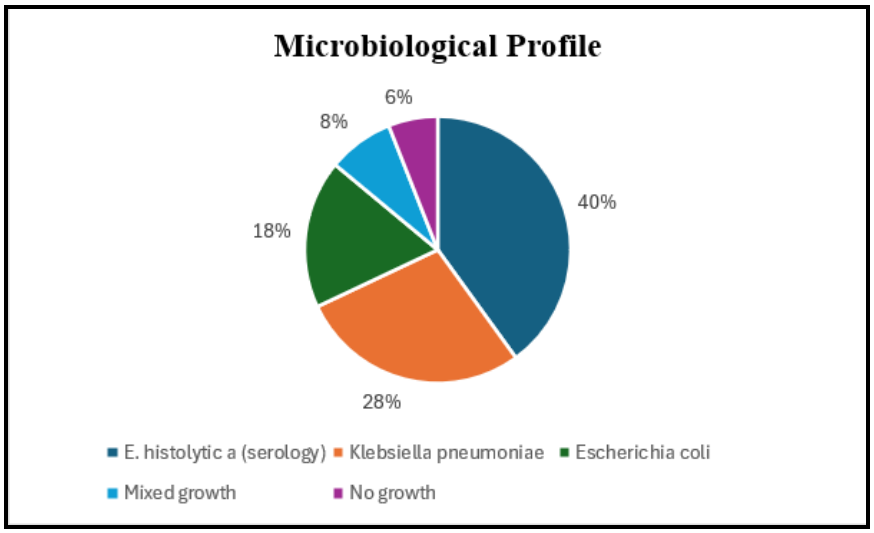
Graph 2: Radiological Abscess Size Reduction Over Time.

Table 3: Microbiological Profile.

Organism Isolated	Frequency
E. histolytic a (serology)	40%
Klebsiella pneumoniae	28%
Escherichia coli	18%
Mixed growth	8%
No growth	6%

PCD Resulted in significantly shorter time to clinical resolution and reduced hospital stay compared to PNA. Complication and recurrence rates were also lower in the PCD group.

The need for repeated interventions was significantly higher in the PNA group, which may increase patient discomfort and healthcare costs.

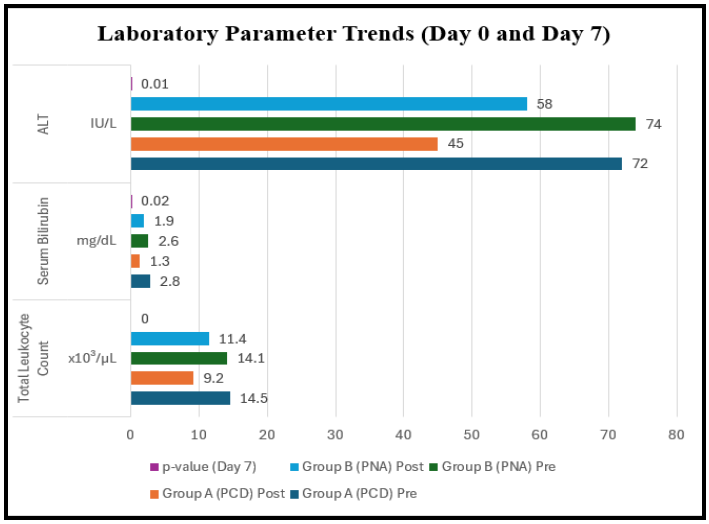


Graph 3: Microbiological Profile.

Table 4: Laboratory Parameter Trends (Day 0 and Day 7)

Parameter	Group A (PCD) Pre	Group A (PCD) Post	Group B (PNA) Pre	Group B (PNA) Post	p-value (Day 7)
Total Leukocyte Count (x10³/µL)	14.5 ± 3.2	9.2 ± 1.5	14.1 ± 3.5	11.4 ± 2.2	<0.01
Serum Bilirubin (mg/dL)	2.8 ± 1.1	1.3 ± 0.6	2.6 ± 1.0	1.9 ± 0.7	0.02
ALT (IU/L)	72 ± 24	45 ± 15	74 ± 26	58 ± 17	0.01
CRP (mg/L)	84 ± 20	34 ± 14	81 ± 18	46 ± 16	<0.01

Both groups showed improvement in inflammatory and liver function parameters by Day 7. However, the PCD group demonstrated significantly faster normalization of total leukocyte count, CRP, ALT, and bilirubin compared to the PNA group, reflecting a more rapid systemic recovery with catheter drainage.

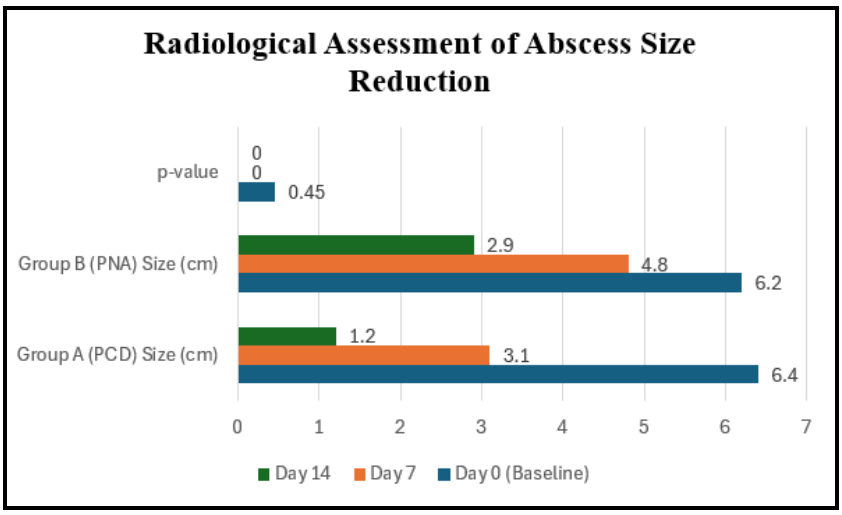


Graph 4: Graph 5: Laboratory Parameter Trends (Day 0 and Day 7).

Table 5: Radiological Assessment of Abscess Size Reduction.

Time Point	Group A (PCD) Mean Size (cm)	Group B (PNA) Mean Size (cm)	p-value
Baseline (Day 0)	6.4 ± 1.3	6.2 ± 1.1	0.45
Day 7	3.1 ± 0.9	4.8 ± 1.2	<0.01
Day 14	1.2 ± 0.6	2.9 ± 0.8	<0.01

Radiological follow-up revealed a significantly faster reduction in abscess cavity size in the PCD group at both Day 7 and Day 14. This reinforces the superiority of continuous catheter drainage in promoting effective evacuation of pus and collapse of the abscess cavity compared to needle aspiration.



Graph 5: Radiological Assessment of Abscess Size Reduction.

DISCUSSION

Liver abscess remains a common intra-abdominal infection, particularly in tropical and developing countries, where it is often linked to poor sanitation, endemic parasitic infections, and limited access to healthcare.[1,2] The two predominant forms—pyogenic liver abscess (PLA) and amoebic liver abscess (ALA)—have distinct etiologies but often share overlapping clinical presentations. The evolution of minimally invasive interventional radiology has

transformed the treatment paradigm from traditional surgical drainage to percutaneous needle aspiration (PNA) and percutaneous catheter drainage (PCD), which are now considered first-line interventions in most clinical settings.[3,4]

This prospective, comparative study evaluated the efficacy of PCD versus PNA in a tertiary care hospital setting by examining clinical and radiological outcomes, laboratory parameters, and complication rates in 100 patients diagnosed with liver abscesses. The findings contribute important data to the ongoing debate about the optimal modality for percutaneous management of liver abscesses.

Epidemiological Considerations

In our study, the mean age of patients was in the fourth decade of life, consistent with prior reports suggesting a peak incidence between 30–50 years.[5] There was a male preponderance in both groups, with an overall male-to-female ratio of approximately 3:1. This gender disparity is frequently reported in the literature and may reflect differential exposure risks such as alcohol consumption, outdoor defecation, or comorbid conditions like diabetes mellitus.[6]

The right lobe was predominantly involved (79%), aligning with established anatomical patterns. The right lobe receives more portal blood flow and has larger parenchymal volume, making it more susceptible to infection and abscess formation.[7]

Microbiological Insights

Microbiological evaluation identified E. histolytica seropositivity in 40% of cases, confirming a significant burden of amoebic liver abscess in our population. Among pyogenic abscesses, Klebsiella pneumoniae was the most commonly isolated organism, followed by E. coli, echoing findings from previous South Asian studies.[8,9] Notably, 6% of cultures were sterile, potentially due to prior antibiotic exposure or fastidious organisms.

Empirical antibiotic therapy included third-generation cephalosporins and metronidazole, adjusted based on sensitivity profiles. Both groups received similar antimicrobial regimens, isolating the procedural differences as the primary variable influencing outcomes.

Clinical Efficacy of PCD vs. PNA

The cornerstone finding of this study was the superiority of PCD over PNA in several clinically significant domains: Faster Clinical Resolution: The average time to symptom resolution in the PCD group was significantly shorter (8.6 ± 2.3 days) compared to the PNA group (12.4 ± 3.1 days, $p<0.01$). This can be attributed to continuous and sustained drainage provided by the catheter, which facilitates rapid decompression of the abscess cavity and reduction of systemic inflammation.[10]

Reduced Hospital Stay: The duration of hospitalization was notably shorter in the PCD group (7.2 ± 1.8 days vs. 10.1 ± 2.4 days, $p<0.01$), potentially translating into lower healthcare costs, decreased nosocomial risks, and earlier return to normal activity.[11]

Lower Recurrence Rate and Fewer Interventions: PCD resulted in a lower recurrence rate (4% vs. 12%) and a reduced need for repeat procedures. Needle aspiration often necessitates multiple sessions due to incomplete evacuation or reaccumulation of pus, particularly in larger or multiloculated abscesses.[12]

Better Laboratory Recovery: As shown in Table 4, the decline in leukocyte count, serum bilirubin, ALT, and CRP levels was significantly more pronounced in the PCD group by Day 7, indicating faster resolution of infection and hepatic inflammati.

Radiological Outcomes

Radiological monitoring revealed more rapid reduction in abscess size in the PCD group. At Day 7, the average cavity size in PCD patients was 3.1 ± 0.9 cm, compared to 4.8 ± 1.2 cm in PNA patients ($p<0.01$). By Day 14, the difference was even more marked (1.2 ± 0.6 cm vs. 2.9 ± 0.8 cm). This highlights the mechanical advantage of indwelling catheters in collapsing the abscess cavity, particularly in large or complex collections.[13]

Complication Rates

Although both modalities are generally safe, the overall complication rate was lower in the PCD group (10%) compared to the PNA group (22%). Common complications included secondary infections, localized bleeding, and pain at the insertion site. The higher complication rate in the PNA group may be due to repeated punctures, risk of incomplete drainage, and reinfection. Our findings mirror previous studies where complication rates were significantly reduced with catheter drainage, eespecially in larger abscesses (>5 cm).[14,15]

Cost and Resource Implications

One criticism of PCD has been the potentially higher initial cost and need for imaging guidance. However, when accounting for fewer repeat procedures, shorter hospital stays, and lower complication rates, PCD may ultimately prove more cost-effective in the long term. Moreover, with increasing availability of interventional radiology services in tertiary and secondary care centers, the logistical barrier to catheter drainage is gradually diminishing.[19]

Limitations of the Study

This study is not without limitations

1. The sample size, while adequate for primary outcome evaluation, may limit generalizability for less frequent complications.
2. The study was conducted at a single center; multi-centric validation would enhance external validity.
3. Follow-up duration was limited to 30 days post-discharge. Long-term recurrence or complications may not have been captured.
4. Serological and microbiological evaluation was limited by prior antibiotic exposure in some patients.

Clinical Recommendations

- Based on the results of this study and supporting literature, we recommend the following:
- PCD should be the preferred modality in abscesses >5 cm, multiloculated collections, or cases not responding to PNA.
- PNA may be considered in small (<3–4 cm), unilocular abscesses with early diagnosis and close follow-up.
- Empirical antimicrobial therapy should be promptly initiated and tailored according to microbiological culture and sensitivity.
- Early intervention with imaging-guided drainage significantly improves outcomes and prevents complications such as rupture or septicemia.

CONCLUSION

The present study provides a comprehensive comparative analysis of percutaneous catheter drainage (PCD) versus percutaneous needle aspiration (PNA) in the treatment of liver abscesses in a tertiary care setting. Our findings reinforce the increasing clinical preference for PCD as a more effective, reliable, and safer modality—eespecially in patients presenting with large, multiloculated, or complex abscesses.

PCD demonstrated significantly better clinical outcomes, including faster resolution of symptoms, shorter duration of hospitalization, more effective reduction in abscess size, and greater improvement in laboratory markers of infection. Moreover, the need for repeat interventions and the incidence of complications were markedly lower in the PCD group when compared to PNA. These advantages are clinically significant, given that liver abscesses, if inadequately treated, can lead to severe complications such as rupture, peritonitis, sepsis, and prolonged morbidity.

While PNA remains a minimally invasive and technically simpler option, its utility appears limited to small, unilocular abscesses or early-detected cases. The necessity for repeated aspirations, risk of incomplete evacuation, and higher recurrence rates underscore its relatively lower efficacy in more extensive disease presentations.

In resource-limited settings where interventional radiology support may be constrained, PNA can serve as an interim or initial step, eespecially in hemodynamically stable patients. However, as interventional expertise and imaging modalities become more accessible, PCD is increasingly favored for its comprehensive and durable drainage capability.

The study also underscores the the importance of timely diagnosis, appropriate imaging, and microbiological evaluation in guiding both the choice of intervention and antimicrobial therapy. Combining image-guided drainage with appropriate antibiotic coverage ensures optimal patient recovery, minimizes complications, and reduces healthcare burdens.

Given the favorable outcomes associated with PCD in our study and similar evidence from the global literature, we recommend that clinical protocols in tertiary care hospitals prioritize PCD as the standard of care for liver abscesses >5 cm or with multiloculated morphology. For smaller abscesses (<3–4 cm), a trial of needle aspiration may be considered under close monitoring.

Future multicentric randomized controlled trials with larger sample sizes and longer follow-up periods are warranted to validate these findings further. Additionally, cost-effectiveness studies and patient-reported outcome measures should be explored to inform broader clinical and health policy decisions.

In conclusion, percutaneous catheter drainage is superior to needle aspiration in terms of efficacy, safety, and overall clinical outcome in the management of liver abscesses. Adoption of evidence-based drainage strategies tailored to abscess size, morphology, and patient profile will ensure improved prognosis, reduced recurrence, and better utilization of healthcare resources.

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