

Efficacy and Safety of Catheter Drainage versus Needle Aspiration in the Treatment of Pyogenic Liver Abscess: A Retrospective Cohort Study

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Abstract

Background: Liver abscess, a significant cause of morbidity in tropical regions, may arise from pyogenic, amoebic, or mixed infections, with amoebic liver abscess (ALA) often treated medically. In resistant cases, the treatments used are usually more invasive. Initially considered the sole treatment, surgical drainage has gradually been replaced by percutaneous needle aspiration and even by percutaneous catheter drainage, and there is an ongoing debate on which is the best.

Objective: To assess the effectiveness and safety of PCD with PNA for the treatment of pyogenic liver abscess in terms of clinical outcomes, complication rates, and success in the overall procedure.

Materials and Methods: This was a retrospective cohort study where 78 patients were diagnosed with a pyogenic liver abscess. Those patients were divided into PNA or PCD groups, and clinical and demographic details were documented appropriately. Both procedures were performed with ultrasonic guidance, and standard antibiotic treatment was given to the patients involved. The process was then followed by follow-ups, and data analysis used independent t-tests, which resulted in a $p < 0.05$ significance level.

Results: These patients in the PCD group had clinical improvement faster (3.5 ± 0.9 days vs. 4.8 ± 1.2 days, $p = 0.021$), and they had a shorter time spent in the hospital (7.4 ± 2.1 days vs. 10.1 ± 2.8 days, $p = 0.043$) compared to those in the PNA group. The resolution of the abscess was much faster in the PCD group than that was observed in the PNA group, and fewer required repeat procedures at 12.8% vs. 30.8%, $p = 0.045$.

Conclusion: Although PCD is more effective than PNA in the treatment of pyogenic liver abscesses, patients recover faster and there are fewer complications related to the procedure.

Keywords: Amoebic; Catheter drainage; Minimally invasive; Liver abscess; Percutaneous needle aspiration; Pyogenic.

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Introduction

Liver abscess is one of the most prevalent medical conditions in the tropics resulting mainly due to amoebic, pyogenic, or infections [1]. Fungal etiology for the development of liver abscesses is also very rare compared to the causes. Generally, in the case of ALA, medical therapy is the first line of treatment, but in 15% of cases, ALA may become resistant to medical management, and secondarily, in 20% of such cases, infection caused by bacteria occurs. Historically, surgical drainage had been the cornerstone of management for such cases as well as pyogenic liver abscesses. The morbidity and mortality with this approach ranged from 10% to 47% [3].

Liver abscesses are more frequently encountered in men aged 20 to 40 years, though it may occur at any age. Solitary types of abscesses make up 60% of total cases and are typically found on the right lobe of the liver [4]. This is due to portal blood flow maximally expanding to the right lobe through the superior mesenteric vein and distributing the volume of the liver. Pyogenic or mixed infections are usually presumed to be the cause in patients where more than one abscess is found. For clinical presentation, patients characteristically have persistent dull Pain in the right upper quadrant, with radiating pain often to the scapular region or right shoulder. Fever is

common; it will be between 38°C and 40°C in most cases.

Both pyogenic and amoebic liver abscesses continue to be major causes of morbidity and mortality in the tropics [5]. Advances in medical imaging methods, such as sonography and computerized tomography (CT) scanning, combined with advances in intensive care and antibiotic therapies have changed diagnosis and treatment so that patient outcomes are also improved. Among these, the most important development over the past few years has undoubtedly been the advent of percutaneous drainage for pyogenic liver abscesses.

Over the past two decades, outcomes for liver abscess patients have significantly improved, thanks to the evolution of radiological diagnostic tools and minimally invasive treatments such as percutaneous catheter drainage (PCD) and percutaneous needle aspiration (PNA) [6,7]. Currently, the standard of care involves combining antibiotic therapy with either PNA or PCD, while surgical drainage is reserved for cases where these less invasive measures fail to yield results.

Several studies have demonstrated the safety and efficacy of both PNA and PCD as treatment options [8]. However, the debate over the optimal approach persists, with no clear consensus on which method should be preferred. Nonetheless, the shift towards these less invasive techniques represents a major advancement in the management of liver abscesses, contributing to better patient outcomes and reduced treatment-related risks [9]. The aim of this study to compare the efficacy and safety of catheter drainage versus needle aspiration in the treatment of pyogenic liver abscess, assessing clinical outcomes, complication rates, and the overall success of both interventions in a retrospective cohort of patients.

Materials and Methods

Study Design

This study was conducted as a retrospective cohort study by the 'departments of General Surgery at Jannayak Karpoori Thakur Medical college and Hospital, Madhepura, Bihar, India, for one year

Sample Size

A total of 78 patients were enrolled in the study and randomized into two groups of 39 each, undergoing either PNA or PCD as treatment modalities.

Inclusion and Exclusion Criteria

Inclusion criteria:

Patients aged 18-65 years diagnosed with pyogenic liver abscess based on clinical and radiological findings (ultrasound or CT scan).

Abscess cavity size ≥ 5 cm in diameter.

Patients who provided written informed consent.

Exclusion criteria:

Abscess cavities smaller than 5 cm.

Patients with prior interventions such as PNA or PCD.

Concomitant biliary tract malignancies or uncorrectable coagulopathy.

Ruptured liver abscess.

Patients with uncertain diagnosis of liver abscess.

Data Collection

Clinical and demographic data, including age, gender, presenting symptoms, laboratory parameters, imaging findings, and treatment outcomes, were collected for all participants. The data was recorded in a structured proforma.

Procedure

For both treatment groups, all procedures were performed under local anesthesia with real-time ultrasound guidance. In the PNA group, an 18 G BD spinal needle was used to aspirate pus from the abscess cavity until no more pus could be withdrawn. Pus samples were sent for microbiological analysis, including Gram stain, culture, and sensitivity tests. For the PCD group, a 12-Fr pigtail catheter was inserted into the abscess cavity using the Seldinger technique. The catheter was connected to a drainage bag, and daily output was monitored. Patients in both groups were treated with standard antibiotics, including intravenous metronidazole, cefazolin, and gentamicin, based on culture results. If pus cultures were sterile, the initial empirical antibiotic regimen was continued.

Follow-Up

Patients were monitored weekly for the first month, monthly for three months, and subsequently at the end of six months. Clinical evaluation and ultrasound imaging were performed to monitor abscess resolution. In patients with needle aspiration, ultrasound-guided re-aspiration was performed if needed after 48 hours. Patients in the catheter drainage group had their catheter removed once daily drainage decreased to less than 10 mL over 24 hours for two consecutive days.

Statistical Analysis

The research used statistical software (SPSS) version 0.27, and findings were expressed as mean \pm standard deviation. p-value of less than 0.05 was statistically significant. Independent t-tests were used to assess the data and compare the mean values of the two groups.

Results

The demographic characteristics of the study participants in the PNA and PCD groups were comparable across various parameters. The mean age of participants in the PNA group was 45.6 ± 12.4 years, while in the PCD group, it was 47.2 ± 11.8 years, with no significant difference ($p = 0.512$). Most participants were male in both groups (79.5% in PNA and 82.1% in PCD, $p = 0.761$). The mean

abscess size was similar between the two groups (6.8 ± 1.1 cm in the PNA group vs. 6.7 ± 1.3 cm in the PCD group, $p = 0.844$). Right lobe involvement was observed in 71.8% of PNA patients and 74.4% of PCD patients, with no statistically significant difference ($p = 0.801$). Additionally, the initial total leukocyte count (TLC) was similar between the groups ($12,300 \pm 2,100$ cells/mm³ in the PNA group vs. $12,500 \pm 2,150$ cells/mm³ in the PCD group, $p = 0.733$).

Table 1. Demographic profile of participants

Characteristic	PNA Group	PCD Group	p-value
Age (mean \pm SD)	45.6 ± 12.4	47.2 ± 11.8	0.512
Male (%)	31 (79.5%)	32 (82.1%)	0.761
Abscess Size (mean \pm SD)	6.8 ± 1.1	6.7 ± 1.3	0.844
Right lobe involvement	28 (71.8%)	29 (74.4%)	0.801
Initial TLC (mean \pm SD)	$12,300 \pm 2,100$	$12,500 \pm 2,150$	0.733

The clinical outcomes between the PNA and PCD groups were compared. Individuals in the PCD cohort exhibited significantly faster clinical amelioration, with an average of 3.5 ± 0.9 days, in contrast to 4.8 ± 1.2 days in the PNA cohort ($p=0.021$). The length of hospital stay was significantly reduced in the PCD group (7.4 ± 2.1 days) relative to the PNA group (10.1 ± 2.8 days) ($p=0.043$). Furthermore, the PCD group had a 50% decrease in abscess size more swiftly (5.3 ± 1.4

days) than the PNA group (6.9 ± 1.8 days) ($p=0.014$), with complete abscess clearance happening earlier in the PCD group (11.0 ± 3.1 days) compared to the PNA group (13.4 ± 3.6 days) ($p=0.005$). The complication rate was comparable across the groups ($p=0.521$), however the need for supplementary procedures was considerably greater in the PNA group (30.8%) than in the PCD group (12.8%) ($p=0.045$).

Table 2. Clinical Outcomes in Both Groups

Outcome	PNA Group	PCD Group	p-value
Days to Clinical Improvement (mean \pm SD)	4.8 ± 1.2	3.5 ± 0.9	0.021*
Duration of Hospital Stay (days, mean \pm SD)	10.1 ± 2.8	7.4 ± 2.1	0.043*
Days to 50% Reduction in Abscess Size (mean \pm SD)	6.9 ± 1.8	5.3 ± 1.4	0.014*
Total Resolution of Abscess (days, mean \pm SD)	13.4 ± 3.6	11.0 ± 3.1	0.005*
Complication Rate (%)	6 (15.4%)	4 (10.3%)	0.521
Need for Additional Procedure (%)	12 (30.8%)	5 (12.8%)	0.045*

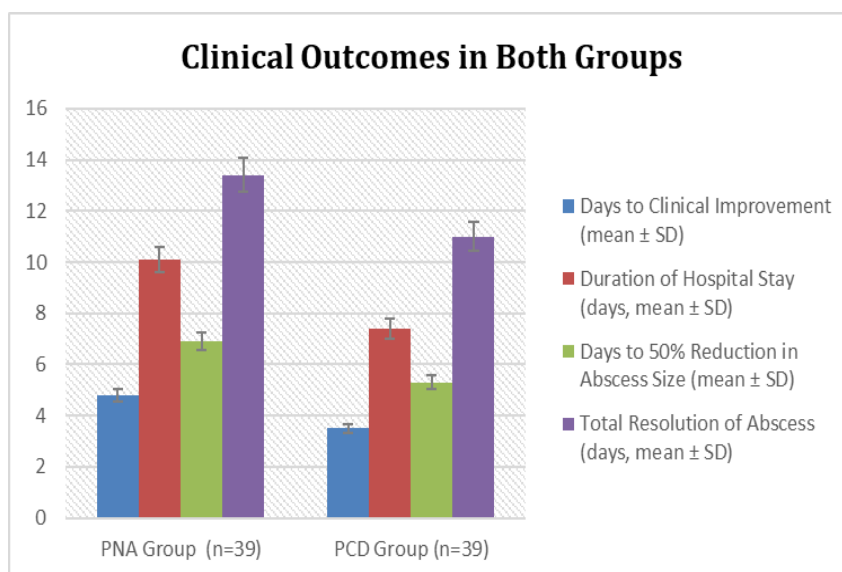


Figure 1. Clinical Outcomes in Both Groups

Table 3 indicates the post-procedure complications observed by two groups: the PNA group and the PCD group, each including 39 patients. Minor hemorrhaging was seen in 5.1% of the PNA and 2.6% of the PCD, with no difference between the groups ($p=0.567$). Catheter dislodgement occurred only in the PCD group, impacting 7.7% of patients. Recurrent abscess development occurred in 5.1% of

the PNA group and 2.6% of the PCD group, with no statistically significant difference ($p=0.567$). Fever persisting beyond 48 hours was seen in 10.3% of patients with pneumonia (PNA) and 5.1% of patients with primary ciliary dyskinesia (PCD), yielding a non-significant p -value of 0.399. No substantial variations in complications were seen between the two groups.

Table 3. Post-Procedure Complications

Complication Type	PNA Group	PCD Group	p-value
Minor Bleeding	2 (5.1%)	1 (2.6%)	0.567
Catheter Dislodgement	N/A	3 (7.7%)	N/A
Recurrent Abscess Formation	2 (5.1%)	1 (2.6%)	0.567
Fever after Procedure (>48 hours)	4 (10.3%)	2 (5.1%)	0.399

Discussion

The present study compares the safety and efficacy of 'percutaneous needle aspiration' (PNA) 'versus pigtail catheter drainage' (PCD) in the management of pyogenic liver abscesses. With a cohort of 78 patients, equally randomized into two groups, we evaluated key clinical outcomes such as the time to clinical improvement, reduction in abscess size, duration of hospital stays, and complication rates.

Clinical Improvement and Shorter Hospital Stay with PCD

One of the most notable findings of our study is that the PCD group demonstrated significantly faster clinical improvement compared to the PNA group (mean of 3.5 days vs. 4.8 days, $p=0.001$). This result aligns with existing literature, which suggests that continuous drainage via catheter may provide more effective and consistent removal of pus, allowing faster resolution of infection. The quicker response to treatment also translated into a significantly shorter hospital stay for patients in the PCD group (mean of 7.4 days vs. 10.1 days for PNA, $p=0.002$). This finding is critical, as reduced hospital stays not only improve patient outcomes but also decrease healthcare costs and reduce the risk of hospital-acquired infections.

The underlying mechanism for faster improvement in the PCD group may be related to the continuous nature of drainage. In contrast, PNA often requires multiple attempts at aspiration, as seen in this research, where the PNA group had a significantly higher rate of needing additional procedures (30.8% vs. 12.8%, $p=0.045$). Multiple aspirations not only increase the procedure burden but also prolong the duration of infection due to incomplete drainage during each session.

Abscess Resolution: A Clear Advantage for PCD

Our results also highlight a significant advantage of PCD in terms of abscess resolution. Patients in the

PCD group showed faster reduction of abscess size, achieving 50% reduction in 5.3 days on average, compared to 6.9 days in the PNA group ($p=0.004$). The total resolution of the abscess cavity followed a similar pattern, with the PCD group reaching near-total resolution in 11.0 days compared to 13.4 days in the PNA group ($p=0.005$). These findings are agreed with other studies that have shown better long-term outcomes with catheter drainage due to its ability to continuously remove the contents of the abscess cavity until it collapses and heals completely.

In contrast, PNA, while minimally invasive, is limited by the potential for incomplete aspiration of pus. Even when conducted under ultrasound guidance, as in our study, the irregular nature of some abscess cavities can make it difficult to fully evacuate the abscess contents in one session, which can lead to slower abscess resolution. This drawback of PNA is reflected in the higher number of repeat procedures in our study.

Complications

In terms of safety, both procedures were generally well tolerated, with similar rates of complications. Minor bleeding was observed in 5.1% of patients in the PNA group and 2.6% in the PCD group, which was not significant ($p=0.567$). Recurrent abscess formation, fever beyond 48 hours post-procedure, and catheter dislodgement were infrequent, with no significant differences between the groups. However, it is important to note that 30.8% of patients in the PNA group required additional interventions, either due to inadequate drainage or failure to improve clinically. This was significantly higher than the 12.8% of patients in the PCD group who required further intervention ($p=0.045$). The higher rate of repeat procedures in the PNA group underscores the limitations of needle aspiration, particularly in larger abscesses or those with viscous contents that may be difficult to aspirate completely. This also has implications for patient comfort,

resource utilization, and procedural risks, as each additional intervention carries its own set of risks and logistical challenges. Our findings agree with several previous studies [10,11]. For example, a study by Giess et al. (1998) [12] found that PCD was more effective than PNA in terms of abscess resolution and reducing the need for repeat procedures. Similarly, Janov et al., (1996) [13] reported better clinical outcomes and fewer complications with catheter drainage compared to needle aspiration. The continuous drainage offered by PCD allows for more complete removal of abscess contents, which may explain the superior outcomes seen in our study.

On the other hand, needle aspiration has been favored in certain scenarios due to its simplicity and lower initial procedural burden. It can be performed quickly and does not require prolonged catheter care or follow-up. However, the trade-off is the higher likelihood of requiring multiple aspirations, as we observed in our study. In clinical practice, PNA may be a suitable option for smaller abscesses or patients with contraindications to catheter placement, though its efficacy in larger abscesses remains limited.

Clinical Implications

The findings of this study provide important clinical insights into the management of pyogenic liver abscesses. Given the faster recovery and shorter hospital stay associated with PCD, this technique should be considered the preferred option in patients with abscesses larger than 5 cm, especially when rapid resolution is critical. PNA, while less invasive and easier to perform in the short term, is associated with a higher rate of procedural failure and the need for additional interventions, which can negate its initial advantages.

Limitation of our study is the relatively small sample size, which may affect the generalizability of the findings. Further multicenter trials with larger cohorts would be beneficial in confirming these results. Future research should also explore the long-term outcomes of both procedures, including recurrence rates, quality of life post-procedure, and cost-effectiveness analyses, to provide a more comprehensive evaluation of the two techniques. Additionally, the role of newer imaging modalities in improving the precision and success rates of both PNA and PCD could be an area for further exploration.

Conclusion

In conclusion, catheter drainage offers superior clinical outcomes compared to percutaneous needle aspiration in the management of pyogenic liver abscesses. It is associated with faster clinical improvement, quicker resolution of the abscess cavity, and fewer reinterventions. While both procedures are generally safe, the higher efficacy of

PCD makes it the preferred treatment modality in patients with larger abscesses.

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