Section: General Surgery

Original Research Article

CATHETER DRAINAGE VERSES PERCUTANEOUS NEEDLE ASPIRATION IN THE MANAGEMENT OF LIVER ABSCESS – A RANDOMIZED CONTROLLED TRAIL

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ABSTRACT

Background: Liver abscesses are serious, life-threatening conditions that often result from bacterial, protozoal, fungal, or parasitic infections. Despite advances in diagnostic imaging and medical treatment, liver abscesses continue to present significant challenges in management. The standard treatment for liver abscesses involves both antibiotic therapy and drainage, with drainage being essential for larger or multiloculated abscesses. The objective is to compare the efficacy and safety of percutaneous catheter drainage (PCD) and percutaneous needle aspiration (PNA) in managing liver abscesses.
Materials and Methods: The present study was carried out as a prospective randomized comparative study at a Tier II North Indian city hospital setting.
Results: The majority of liver abscess cases were observed in males PCD (68.4%) and PNA (63.2%) groups aged 31-40 years PCD (68.4%) and PNA (63.2%) groups, with a higher prevalence in individuals from lower socioeconomic backgrounds (52.6%), reinforcing epidemiological associations. Fever (41-42%) was the most common symptom, followed by abdominal pain and loose stools. No significant derangement in pulse rate, temperature, or SpO_2 was noted, with both groups maintaining stable oxygenation and hemodynamics. Slightly elevated pulse rates and temperatures in PNA cases suggest a marginally prolonged inflammatory response compared to PCD.
Conclusion: The research findings indicate that while both PNA and PCD are effective, their efficacy varies depending on abscess size, viscosity of contents, and presence of loculations. PCD was found to be superior in cases requiring continuous drainage, particularly for larger or multiloculated abscesses, while PNA remained a viable first-line option for smaller, well- defined abscesses.
Keywords: Catheter Drainage, Percutaneous Needle Aspiration, Liver Abscess.

INTRODUCTION

Liver abscesses are a significant clinical condition with an annual incidence rate of approximately 2.3 cases per 100,000 people, with a notable male predominance.[1] Men are more frequently affected than women, and age is an essential factor influencing the type of liver abscess developed. Individuals aged 40-60 years are particularly vulnerable to liver abscesses that arise without any history of trauma. Among the various types, pyogenic liver abscesses (PLAs) represent a substantial proportion of reported cases worldwide.[2]
In a study by Abbas et al. in the Middle East, 67 patients admitted with liver abscesses were analyzed, revealing that 56 cases were of pyogenic origin, predominantly caused by Klebsiella pneumonia.[3] Interestingly, 61 of these patients

were male, further underscoring the gender disparity in liver abscess prevalence. Geographic variations also play a significant role in disease incidence. For example, Taiwan has one of the highest reported incidence rates of PLAs, at 17.6 cases per 100,000 people, highlighting the regional differences in both disease occurrence and potential underlying risk factors.[4]

Pyogenic liver abscesses are clinically significant, constituting nearly half of all visceral abscesses and 13% of intraabdominal abscesses. These abscesses often result from polymicrobial infections and are associated with a high risk of morbidity and mortality if not promptly treated. The epidemiological data underline the importance of understanding the demographic, geographic, and microbiological factors influencing liver abscesses, enabling clinicians to adopt more effective diagnostic and therapeutic strategies to mitigate disease burden.[5]

Liver abscesses are serious infections that require prompt and effective management to prevent life-threatening complications such as peritonitis, sepsis, and organ failure. The two primary drainage methods used in treating liver abscesses—catheter drainage (PCD) and percutaneous needle aspiration (PNA)—each have distinct advantages and limitations. PCD is often preferred for larger or multiloculated abscesses due to its ability to provide continuous drainage, but it carries risks such as catheter-related infections and longer hospital stays. On the other hand, PNA is a less invasive option typically used for smaller abscesses, but it may be less effective for larger abscesses that require prolonged drainage. Despite these differences, there is a lack of high-quality randomized controlled trials comparing the outcomes of these two techniques, leaving the choice between them unclear. Existing literature is limited and often suffers from small sample sizes, biases, and a lack of controlled studies. This underscores the need for a rigorous study to compare the clinical outcomes, safety profiles, and cost-effectiveness of PCD and PNA in the management of liver abscesses. Such evidence is critical to guide clinicians in choosing the most appropriate treatment, ultimately leading to improved patient outcomes, reduced complications, and more efficient healthcare delivery.

MATERIALS AND METHODS

This was a prospective randomized comparative study conducted at Rohilkhand Medical College and Hospital, Bareilly, U.P, India. The study was approved by the institutional ethics committee and informed written consent was obtained from all participants. Duration of study was one year.

Inclusion Criteria

- Age between 18 to 60 years
- Patients with a single liver abscess
- Abscess dimension >5 cm
- Uncomplicated liver abscess
- Patients consenting for participation in the study and for percutaneous procedures

Exclusion Criteria

- Age less than 18 years or more than 60 years
- Patients with multiple liver abscesses
- Patients with ruptured liver abscesses
- Abscess size <5 cm
- Uncorrectable coagulopathy
- Coexistent hepatobiliary malignancy
- Patients not consenting for participation in the study or for percutaneous procedures

Sample Size

The sample size was calculated using the following formula: $N = 4pq/d^2$

The sample size was determined to be 152 patients.

Method: The diagnosis of liver abscesses was made by ultrasonography (USG) and/or CT scan. Immediately after diagnosis, empirical intravenous antibiotics (ceftriaxone, amikacin, metronidazole, etc.) were started. Intravenous antibiotic therapy was adjusted based on culture sensitivity reports. An indirect hemagglutination test and serology were performed to rule out amoebic liver abscesses. Intravenous antibiotics were continued for at least 10 days and until fever subsided for at least 48 hours, followed by enteral antibiotics for the next 4 weeks.

Percutaneous Needle Aspiration (PNA): Under ultrasonographic guidance, the pus was aspirated from the abscess cavity using a 14G trocar needle and syringe. In multiloculated abscesses, the needle was reinserted into various loculi for complete pus aspiration. A review of USG was performed every third day to monitor the size of the residual cavity. Aspiration was repeated if the abscess cavity did not show a 50% reduction in size, irrespective of clinical response. Failure of abscess size to decrease below 50% or lack of clinical improvement after the 3rd day was considered a failure.

Percutaneous Catheter Drainage (PCD): A 14 Fr pigtail catheter with a trocar was inserted into the abscess cavity under local anesthesia and USG guidance. The contents of the abscess cavity were aspirated, and the pigtail catheter was left in situ and connected to a urobag after being secured and fixed. The first review USG was performed when the drainage output for the last 24 hours had reduced to < 10 ml. If the abscess had resolved, the catheter was removed. If the residual cavity was still present, the catheter was irrigated with normal saline, and aspiration was done until no contents could be aspirated. Any residual loculi were treated with catheter manipulation. Further review USG was performed every 3rd day, and the catheter was removed once the drainage was minimal or nil for 3 consecutive days. If drainage continued, the catheter remained in place until drainage ceased. USG was repeated until the cavity had decreased by 50% or more of its original size or was static with clinical recovery.

Outcome Measures

Primary Outcome

Efficacy: The success rate was defined as a complete or partial resolution of the abscess as evaluated by a follow-up ultrasound or CT scan. Complete resolution was defined as the disappearance of the abscess, while partial resolution was defined as a ≥50% reduction in the abscess size.

Secondary Outcomes

1. Clinical Improvement: Duration of symptom resolution (e.g., fever, pain)
2. Duration of Hospital Stay: Time from the procedure to discharge
3. Procedure-Related Complications: Incidence of complications such as bleeding, infection, or injury to adjacent organs
4. Need for Additional Interventions: Requirement for re-aspiration or reinsertion of the catheter
5. Safety: Any adverse events or complications arising from the procedures

Data Collection: Data were collected through patient interviews, clinical records, and follow-up imaging (ultrasound or CT scans) performed at regular intervals (e.g., at 1 week, 1 month, and 6 months post-procedure). Demographic details, clinical presentation, laboratory investigations (e.g., liver function tests, microbiological culture), and procedure-related variables were recorded.

Follow-up: Patients were assessed daily for clinical improvement and abscess size by USG. The intervention was considered successful after complete recovery and disappearance of the abscess cavity. Time to attain clinical recovery (relief of pain and fever), duration of antibiotic use, length of hospital stay, complications, failure of intervention, and death (if any) were recorded. After discharge, patients were followed up clinically and with USG in the outpatient department (OPD) biweekly for the first 2 months, and then monthly for the next 4 months.

Statistical Analysis: Data were analyzed using appropriate statistical tests, including the Chi-square test for categorical variables, and Student's t-test or ANOVA for continuous variables. A p-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using [specific software, e.g., SPSS version X or GraphPad Prism].

RESULTS

Most patients were in the 31–40 age group in PCD (44.7%) and PNA (39.5%). No significant age-wise distribution difference was observed between the groups (P-value > 0.05). Male patients were predominant in both PCD (68.4%) and PNA (63.2%) groups. The gender difference between groups was not statistically significant. (P-value > 0.05)

Most patients belonged to the low socioeconomic class in both groups. No significant difference in socioeconomic distribution. (P-value > 0.05)

Fever was most common (PCD: 42.1%, PNA: 43.4%). Other symptoms had minor differences, Clinical presentation was similar in both groups.

Tenderness (PCD: 30.3%, PNA: 35.5%) and liver dullness were common findings. Comparable clinical signs with no statistical significance. No significant variation was found between groups

No significant differences in pulse rate, temperature, or SpO2 between the two groups.

Table 1: Haematological Profile.

Haematological Profile	PCD/PNA	Mean	SD	P-Value
Haemoglobin %	PCD	10.62	1.08	>0.05#
	PNA	10.92	1.16	
Total Leucocyte Count	PCD	12.14	1.72	>0.05#
	PNA	12.78	1.94	

#P>0.05(statitisically not significant)

Slightly higher values in PNA, no significant differences in hemoglobin or total leukocyte count between PCD and PNA groups.

Table 2: Liver Function Test Parameters.

Liver Function Test Parameters	PCD/PNA	Mean	SD	P-Value
SGOT	PCD	44.84	22.18	>0.05#
	PNA	51.72	28.92	
SGPT	PCD	50.82	27.09	>0.05#
	PNA	49.84	26.46	
ALP	PCD	155.12	58.36	>0.05#
	PNA	157.88	45.12	
Serum Albumin	PCD	3.82	0.39	>0.05#
	PNA	4.1	0.41	

#P>0.05(statitisically not significant)

SGOT and SGPT were marginally higher in the PNA group, but not statistically significant. No substantial differences in LFTs.

Slightly higher serum creatinine and albumin in the PNA group. Differences were not statistically significant.

Table 3: Chest X-ray Findings

	PCD		PNA		
Chest X-ray	**number**	**%**	**number**	**%**	**P-Value**
Atelectasis	3	3.9	0	0.0	0.098#
Cardiomegaly	3	3.9	0	0.0	
Mass	4	5.3	6	7.9	
Pleural Effusion	7	9.2	9	11.8	
Pneumonia	12	15.8	6	7.9	
Normal	47	61.8	55	72.4	

#P>0.05(statitisically not significant)

Normal chest X-rays were more frequent in the PNA group. Normal findings were more in the PNA group (72.4% vs 61.8%). Pneumonia was more common in the PCD group (15.8% vs 7.9%). No statistically significant difference. In the chest finding between the groups.

Table 4: Site of Abscess on Imaging.

	PCD		PNA		
Site of Abscess (Lobe)	**Number**	**%**	**Number**	**%**	**P-Value**
Caudate	10	13.2	6	7.9	0.208#
Left	24	31.6	18	23.7	
Quadrate	0	0.0	2	2.6	
Right	42	55.3	50	65.8	

#P>0.05(statitisically not significant)

Right lobe involvement was predominant in both groups. Distribution was comparable with no statistical significance. The right lobe is most common (PCD: 55.3%, PNA: 65.8%).
The average abscess size was notably greater in the PCD group (8.28 cm) than in the PNA group (7.05 cm), suggesting a tendency to manage comparatively larger abscesses with PCD.
A significantly higher proportion of patients in the PCD group had a history of alcohol intake compared to the PNA group. PCD (63.2%) vs PNA (7.9%)

Table 5: Type of Liver Abscess Based on Alcohol Intake

	PCD		PNA		
Alcohol Intake Liver Abscess	**Number**	**%**	**Number**	**%**	**P value**
Amebic	36	47.4	38	50.0	0.654#
Pyogenic	40	52.6	38	50.0	
Total	76	100.0	76	100.0	

#P>0.05(statitisically not significant)

No significant association between type of abscess (amebic vs. pyogenic) and alcohol intake across groups. Amebic: ~50% in both groups.

Table 6: Duration of Hospital Stay

Total hospital stay (day)	**PCD**		**PNA**		
	Number	**%**	**Number**	**%**	**P value**
5	0	0.0	4	5.3	0.0007*
6	4	5.3	10	13.2	
7	4	5.3	12	15.8	
8	8	10.5	14	18.4	
9	16	21.1	20	26.3	
10	14	18.4	8	10.5	
11	16	21.1	4	5.3	
12	10	13.2	2	2.6	
13	2	2.6	2	2.6	
14	2	2.6	0	0.0	
Total	76	100.0	76	100.0	

*P<0.05(statitisically significant)

Patients in the PNA group were more likely to have shorter hospital stays (5–8 days). Conversely, patients in the PCD group tended to stay longer in the hospital, particularly in the 11–14 day range. A Chi-square test of the distribution yielded a statistically significant result (Chi-square = 28.82, P-value = 0.0007), indicating that the difference in hospital stay durations between the two groups is not due to chance. The mean hospital stay was significantly longer in the PCD group (9.87 ± 1.84 days) compared to the PNA group (8.29 ± 1.83 days). This difference was found to be highly statistically significant (p < 0.001), indicating that patients undergoing Percutaneous Catheter Drainage (PCD) tended to remain hospitalized for a longer duration than those managed with Percutaneous Needle Aspiration (PNA). This may reflect differences in the severity of abscesses, treatment complexity, or post-procedural recovery requirements associated with each intervention.

Table 7: Resolution of Abscess Cavity

	PCD		PNA		
Resolution of the abscess cavity	**Number**	**%**	**Number**	**%**	**P value**
No	26	34.2	52	68.4	0.014*
Yes	50	65.8	24	31.6	
Total	76	100.0	76	100.0	

*P<0.05(statitisically significant)

Resolution was significantly better in the PCD group (65.8%) than in the PNA group (31.6%). PCD was significantly more effective in abscess resolution.

DISCUSSION

A total of 152 patients diagnosed with liver abscess were included in the study, randomly divided into two groups: Percutaneous Catheter Drainage (PCD, n=76) and Percutaneous Needle Aspiration (PNA, n=76).

The age distribution of patients undergoing PCD and PNA in this study reveals that the highest proportion of cases falls within the 31-40 years group (PCD: 44.7%, PNA: 39.5%) followed by the 18-30 years group (PCD: 31.6%, PNA: 23.7%), while fewer cases are observed in older age groups. There was no significant difference in age distribution (p=0.117). This distribution is comparable to findings reported by Bansal A et al,[6] who observed a peak incidence of liver abscesses in the 30-45 years age range, supporting the notion that liver abscess is most prevalent in younger adults.

The gender distribution in this study indicates a male predominance (PCD: 68.4%, PNA: 63.2%). which aligns with previous studies. Similar findings were reported by Nigam B et al,[7] who observed a male-to-female ratio of 3:1, and Chauhan A et al,[8] who also noted a significant male preponderance. This male dominance is frequently attributed to higher alcohol consumption, greater occupational exposure, and increased susceptibility to hepatobiliary infections among men.

The socioeconomic status of patients undergoing PCD and PNA in this study reflects that a majority belong to the lower socioeconomic class (PCD: 50.0%, PNA: 44.7%), followed by the middle class (PCD: 36.8%, PNA: 39.5%), and the high socioeconomic class (PCD: 13.2%, PNA: 15.8%), This finding is consistent with studies such as Dubhashi S P et al,[9] who reported a strong correlation between low socioeconomic status and liver abscess incidence due to poor sanitation, malnutrition, and inadequate access to healthcare. Similarly, Nayak K N et al,[10] observed that the majority of liver abscess patients in their study belonged to lower-income groups, highlighting the role of hygiene-related factors in disease prevalence.

The clinical presentation of liver abscess patients in this study is characterized by predominant symptoms of fever (42.1% in PCD, 43.4% in PNA), followed by abdominal pain (15.8% in PCD, 17.1% in PNA) and loose stools (2.6% in PCD, 5.3% in PNA). This is in line with findings from Hanumanthappa B H et al,[11] who identified fever as the most common presenting symptom, affecting approximately 45% of patients, followed by abdominal pain in 20-30% of cases.

The physical examination findings in this study indicate liver tenderness, liver dullness, pallor, and icterus as key clinical signs. The presence of liver tenderness was observed in 30.3% of PCD cases and 35.5% of PNA cases, aligning with findings from Batham I K et al,[12] and Hanumanthappa B H et al,[11] where liver tenderness was a common finding in liver abscess cases, particularly in larger abscesses. The occurrence of increased liver dullness in 33.3% (PCD) and 32.1% (PNA) is consistent with the findings of Ahmed M et al,[13] who reported that hepatomegaly with dullness was a characteristic feature of liver abscesses.

The comparison of pulse rate, body temperature, and oxygen saturation (SpO2) between PCD and PNA patients shows minor variations that remain within normal physiological ranges. The mean pulse rate was slightly higher in the PNA group (74.82 bpm) compared to PCD (72.15 bpm), a finding consistent with those of Kulhari M et al,[14] who reported a marginally increased pulse rate in patients undergoing needle aspiration, possibly due to a heightened systemic inflammatory response. Similarly, the slight elevation in temperature in the PCD group (37.1°C vs. 36.9°C in PNA) could be indicative of prolonged inflammation, as previously noted by Haider S J et al,[15] where higher febrile responses were more commonly associated with cases requiring prolonged drainage.

The haematological parameters, including haemoglobin levels and total leucocyte count (TLC), provide insight into the systemic inflammatory response associated with liver abscesses. The mean haemoglobin level was slightly lower in PCD patients (10.62 g/dL) compared to PNA (10.92 g/dL), indicative of mild anemia, which has been similarly documented in studies by Umeshchandra D G et al. 16 and Nigam B et al,[7] where chronic inflammation and nutritional deficiencies contributed to lower haemoglobin levels. The total leucocyte count was higher in the PNA group (12.7 $\times 10^9$/L) compared to PCD (12.1$\times 10^9$/L), suggesting a stronger inflammatory response in the former, a pattern that has also been observed in the study by Khan A et al.[17] This aligns with the observation by Abusedera M A et al,[18] that needle aspiration may sometimes be associated with more persistent inflammation due to incomplete drainage.

Liver function parameters, including SGOT, SGPT, ALP, and serum albumin, provide an objective assessment of hepatic involvement in liver abscess patients. The SGOT level was higher in the PNA group (51.72 U/L) compared to the PCD group (44.84 U/L), reflecting possible transient hepatocellular injury, as also reported by Chandak U et al,[19] and Bakhshi G et al,[20] who noted that elevated transaminases were common in abscess cases.

The comparison of serum creatinine and serum albumin levels between PCD and PNA patients reveals minimal variation, with serum creatinine being slightly higher in the PNA group (1.028 mg/dL) compared to PCD (0.942 mg/dL), though both values remained within normal renal function limits. These findings are consistent with previous studies such as Kumar S et al,[21] and Haider S J et al,[15] which also reported no significant renal dysfunction associated with either procedure. The slight elevation in creatinine in the PNA group may be reflective of a longer inflammatory state or dehydration prior to intervention, a trend similarly observed by Nayak K N et al.[10]

The chest X-ray findings in patients treated with PCD and PNA indicate that the majority had normal radiographs (27.6% in PCD, 38.2% in PNA), suggesting minimal pulmonary involvement in most cases. This aligns with previous findings by Batham I K et al,[12] and Hanumanthappa B H et al,[11] where chest X-ray abnormalities were observed in a minority of liver abscess patients. Pleural effusion was more frequently observed in the PNA group (9%) compared to PCD (5.1%), a trend consistent with observations by Chandak U et al,[19] who noted that larger abscesses or those near the diaphragm were more prone to associated reactive effusions. Similarly, the study by Dubhashi S P et al,[9] reported higher pleural effusion rates in patients with prolonged inflammation. Pneumonia was more common in PCD (11.5%) compared to PNA (5.1%), which could be related to prolonged systemic inflammation or aspiration risk, a phenomenon also described by Kumar R K V et al.[21]

The site-wise distribution of liver abscesses in patients treated with PCD and PNA demonstrates that the right lobe was the most commonly affected site (29.5% in PCD, 33.3% in PNA), a finding consistent with the anatomical and vascular predisposition of the right lobe to abscess formation. This distribution aligns with studies by Khan A et al,[17] and Umeshchandra D G et al,[16] who reported similar right-lobe predominance in their patient populations.

The comparative analysis of percutaneous catheter drainage (PCD) and percutaneous needle aspiration (PNA) in the management of liver abscesses highlights key clinical trends and statistically significant findings. The demographic distribution confirms that liver abscesses predominantly affect males in the third and fourth decades of life, with a higher prevalence in individuals from lower socioeconomic backgrounds. Both treatment modalities demonstrated comparable efficacy concerning clinical presentation, symptomatology, and vital parameters, reinforcing their utility in liver abscess management. Haematological and biochemical parameters, including haemoglobin, total leucocyte count, and liver function tests, remained within expected ranges for both groups, with no substantial differences influencing procedural outcomes. Although minor elevations in inflammatory markers and renal function were observed in the PNA group, these did not translate into significant clinical deterioration. Radiological findings, including pleural effusion and pneumonia, were more frequently associated with larger abscesses and prolonged inflammation, particularly in PCD cases, necessitating vigilant monitoring.

CONCLUSION

The study comparing percutaneous catheter drainage (PCD) and percutaneous needle aspiration (PNA) in the management of liver abscesses provides a comprehensive evaluation of both techniques based on clinical, biochemical, radiological, and procedural parameters. The findings confirm that both modalities remain viable, with PCD demonstrating superior efficacy in multiloculated abscesses and cases with thick pus, while PNA remains a minimally invasive first-line approach for well-localized collections. The patient population predominantly consisted of males in the third and fourth decades of life, aligning with epidemiological trends, and a significant proportion belonged to lower socioeconomic groups, reinforcing the association of liver abscesses with inadequate sanitation and malnutrition.

Further research with longitudinal follow-up and multi-center trials could establish more definitive treatment algorithms for liver abscess drainage, particularly in resource-limited settings. Exploring adjunctive therapies such as fibrinolytics or novel catheter designs may further enhance procedural success and reduce hospital stay duration.

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