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A Comparative Study of Ultrasound-Guided Percutaneous Catheter Drainage Versus Ultrasound-Guided Percutaneous Needle Aspiration in the Management of Liver Abscess

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KEYWORDS

Liver abscess, percutaneous catheter drainage, percutaneous needle aspiration, pyogenic abscess, amoebic abscess, ultrasound-guided drainage

ABSTRACT

Background: Liver abscess remains a significant clinical challenge requiring prompt diagnosis and intervention. While both percutaneous needle aspiration (PNA) and percutaneous catheter drainage (PCD) are minimally invasive treatment modalities, their comparative efficacy remains debated.

Objective: To compare the therapeutic effectiveness, safety profile, and clinical outcomes of ultrasound-guided PCD versus PNA in the management of liver abscess.

Methods: This prospective randomized study was conducted at Basaveshwar Teaching and General Hospital, Kalaburagi, between October 2019 and March 2021. Fifty patients with ultrasonographically confirmed liver abscess were randomly allocated into two groups: PNA group (n=25) and PCD group (n=25). All patients received empirical intravenous antibiotics (Ceftriaxone 1g twice daily and Metronidazole 500mg thrice daily). Primary outcome measures included treatment success rate, clinical improvement time, hospital stay duration, and complications.

Results: The mean age was 42.06±11.92 years with male predominance (94%). Pyogenic abscesses constituted 74% of cases. The PCD group demonstrated significantly higher treatment success rate (100% vs 76%, p=0.029) compared to PNA. Mean clinical improvement time was comparable (4.44±2.12 days for PCD vs 4.92±2.25 days for PNA, p=0.441). Hospital stay duration showed no significant difference (14.64±5.85 days for PCD vs 12.88±5.50 days for PNA, p=0.278). No major complications occurred in either group.

Conclusion: Ultrasound-guided PCD is more effective than PNA for treating liver abscesses, offering superior treatment success rates with comparable safety profiles. PCD should be considered the preferred first-line interventional approach for liver abscess management.

INTRODUCTION

Liver abscess represents a potentially life-threatening suppurative condition characterized by encapsulated pus collections within the hepatic parenchyma. Despite advances in diagnostic imaging and therapeutic interventions, liver abscess continues to pose significant morbidity and mortality risks, particularly in tropical and subtropical regions. Historically, mortality rates associated with pyogenic liver abscess were exceedingly high, but improved diagnostic capabilities and therapeutic interventions have significantly enhanced patient outcomes.[1]

The pathophysiology varies according to etiology. Pyogenic liver abscesses typically arise from biliary tract disease, portal bacteremia from intra-abdominal infections, direct extension from contiguous infections, or hematogenous seeding.[2] The changing trends in causation reflect evolving patterns of underlying

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pathology, with biliary stones and biliary tract disease emerging as predominant etiological factors in contemporary series.[3] The need for complete gastrointestinal evaluation in pyogenic liver abscess patients has been well recognized.[4]

Klebsiella pneumoniae and Escherichia coli represent the most frequently isolated organisms in pyogenic liver abscess, with significant geographic variations in microbial profiles.[5],[6] Anaerobic organisms also play an important role, particularly in abscesses arising from intra-abdominal sources.[7] Changing management patterns reflect the evolution in both etiology and available treatment modalities.[8]

Amoebic liver abscess, caused by Entamoeba histolytica, represents a significant global health problem with considerable disease burden in endemic regions.[9] The pathology and pathogenesis involves complex host-pathogen interactions with characteristic anchovy sauce pus formation.[10] Amoebiasis control remains a challenge requiring coordinated public health interventions.[11] The infection typically exhibits a predilection for the right hepatic lobe and can present with various complications including rupture.[12]

The diagnosis of liver abscess has been revolutionized by modern imaging modalities, particularly ultrasonography and computed tomography, which enable early detection and precise characterization of abscess collections.[13] Sonographic diagnosis has become the standard approach for identifying amoebic liver abscess.[14] These advances have fundamentally transformed both diagnostic accuracy and therapeutic planning.

Treatment strategies have undergone dramatic evolution over recent decades. Historically, surgical drainage represented the definitive management approach but was associated with substantial morbidity and mortality rates.[15] Percutaneous drainage techniques have increasingly supplanted open surgical drainage as first-line therapy for most liver abscesses. Both percutaneous needle aspiration and percutaneous catheter drainage have been employed, though optimal drainage strategy selection remains debated.

AIMS AND OBJECTIVES

The present study was designed with the following specific objectives:

1. To compare and correlate the therapeutic effectiveness of percutaneous catheter drainage and percutaneous needle aspiration in the treatment of liver abscess
2. To study the clinical outcomes including treatment success rate, time to clinical improvement, duration of hospital stay, and duration of intravenous antibiotic therapy between both intervention modalities
3. To identify and compare the morbidities, complications, and adverse effects associated with percutaneous catheter drainage and percutaneous needle aspiration

MATERIALS AND METHODS

Study Design and Setting

This prospective randomized comparative study was conducted in the Department of General Surgery at Basaveshwar Teaching and General Hospital, Kalaburagi, Karnataka, India, over an 18-month period from October 2019 to March 2021. Institutional ethical committee clearance was obtained prior to study initiation. Written informed consent was procured from all participants after explaining the study protocol, potential risks, and benefits.

Study Population and Sample Size

A total of 50 consecutive patients diagnosed with liver abscess who satisfied predetermined inclusion and exclusion criteria were enrolled. Patients were randomly allocated into two equal groups of 25 patients each: Group A (Percutaneous Needle Aspiration) and Group B (Percutaneous Catheter Drainage).

Inclusion Criteria

1. Patients aged 12 years and above
2. Clinical diagnosis of liver abscess confirmed by ultrasonographic examination
3. Patients willing to provide informed consent

Exclusion Criteria

1. Patients with already ruptured liver abscess
2. Patients with very small volume abscesses (less than 3 cm)

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3. Patients with multiple small abscesses not amenable to drainage
4. Patients below 12 years of age

Clinical Assessment and Investigations

All patients underwent comprehensive clinical evaluation including detailed history and physical examination. Complete hemogram, liver function tests (serum bilirubin, SGOT, SGPT, alkaline phosphatase, serum proteins, serum albumin), and coagulation profile (PT/INR) were performed. Anemia and coagulopathy were corrected prior to intervention. Ultrasonography was performed to confirm diagnosis and guide procedures. Chest radiography was obtained in all cases. Computed tomography was performed when diagnosis was uncertain.

Abscess Classification

Amoebic abscess was identified by clinical features, ultrasonography, anchovy sauce pus appearance, and presence of Entamoeba histolytica. Identification of bacteria in pus was considered diagnostic of pyogenic liver abscess, as spontaneous bacterial contamination of amoebic abscess is exceedingly rare.

Management Protocol

Upon admission, patients were resuscitated and empirical broad-spectrum antibiotics initiated (intravenous Ceftriaxone 1g twice daily and Metronidazole 500mg thrice daily). Antibiotics were subsequently modified according to culture sensitivity.

Intervention Techniques

Percutaneous Needle Aspiration (PNA): Performed under ultrasound guidance with strict aseptic precautions. After local anesthesia (2% Lignocaine), an 18-gauge lumbar puncture needle was advanced into the abscess cavity. Maximum aspiration was performed. Pus was sent for culture and sensitivity. Repeat aspiration was performed if needed, with maximum three attempts. Failure after three aspirations was considered treatment failure.

Percutaneous Catheter Drainage (PCD): Performed under ultrasound guidance. After local anesthesia and small skin incision, a 12-French pigtail catheter was introduced using trocar technique. The catheter was connected to a closed drainage system and secured with sutures. Daily output was monitored. Catheter was removed when output decreased below 10ml/day and ultrasonography showed significant resolution.

Outcome Measures

Primary Outcomes:

1. Treatment success rate (complete clinical resolution and >50% radiological reduction)
2. Time to clinical improvement (relief of pain, absence of fever for 24 hours, absence of hepatic tenderness)

Secondary Outcomes:

1. Duration of hospital stay
2. Duration of intravenous antibiotics
3. Procedure-related complications
4. Recurrence during follow-up

Follow-up Protocol

Patients were followed with clinical examination and ultrasonography every third day during hospitalization. After discharge, regular follow-up continued until complete abscess resolution, with long-term follow-up extending to six months.

Statistical Analysis

Statistical analysis was performed using SPSS version 18.0. Continuous variables were expressed as Mean ± SD, categorical variables as frequencies and percentages. Shapiro-Wilk test assessed normality. Unpaired t-test or Mann-Whitney U test was applied for continuous variables. Chi-square test or Fisher's exact test compared categorical variables. P-value <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

The study enrolled 50 patients equally distributed between PNA (n=25) and PCD (n=25) groups. Age ranged from 20-80 years with mean age 42.06 ± 11.92 years. Highest incidence occurred in the 31-40 years age group (44%). Mean age was 40.6 ± 11.68 years in PNA group versus 43.52 ± 12.22 years in PCD group.

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Table 1: Age Distribution of Study Population

Age Group (years)	PNA Group n (%)	PCD Group n (%)	Total n (%)
≤30	5 (20%)	2 (8%)	7 (14%)
31-40	10 (40%)	12 (48%)	22 (44%)
41-50	6 (24%)	6 (24%)	12 (24%)
51-60	3 (12%)	3 (12%)	6 (12%)
61-70	1 (4%)	1 (4%)	2 (4%)
71-80	0 (0%)	1 (4%)	1 (2%)
Mean ± SD	40.6 ± 11.68	43.52 ± 12.22	42.06 ± 11.92

Male patients constituted 94% (47 cases) while females were 6% (3 cases), demonstrating marked male predominance with male to female ratio of approximately 16:1.

Clinical Presentation

Table 2: Clinical Symptoms

Symptom	PNA Group n (%)	PCD Group n (%)	Total n (%)
Pain abdomen	24 (96%)	25 (100%)	49 (98%)
Fever	20 (80%)	20 (80%)	40 (80%)
Anorexia	14 (56%)	18 (72%)	32 (64%)
Weight loss	2 (8%)	5 (20%)	7 (14%)
Dysentery	2 (8%)	8 (32%)	10 (20%)

Abdominal pain was the most common symptom (98%), followed by fever (80%), anorexia (64%), dysentery (20%), and weight loss (14%).

Table 3: Clinical Signs

Sign	PNA Group n (%)	PCD Group n (%)	Total n (%)
Abdominal tenderness	25 (100%)	25 (100%)	50 (100%)
Hepatomegaly	9 (36%)	9 (36%)	18 (36%)
Pallor	7 (28%)	14 (56%)	21 (42%)
Icterus	6 (24%)	7 (28%)	13 (26%)

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Abdominal tenderness was universally present (100%). Hepatomegaly was detected in 36%, pallor in 42%, and icterus in 26%.

Laboratory Investigations

Table 4: Laboratory Parameters

Parameter	Abnormal Cases n (%)	Mean ± SD
Total Leukocyte Count (>11,000/µL)	39 (78%)	18,156.4 ± 7,832.72
Platelet Count (<1.5 lakh/µL)	6 (12%)	3.74 ± 1.85
Prothrombin Time (>15 sec)	30 (60%)	16.7 ± 2.40
INR (>1.5)	15 (30%)	1.37 ± 0.31
Serum Bilirubin (>2 mg/dL)	20 (40%)	2.46 ± 3.49
SGOT (>40 U/L)	39 (78%)	81.74 ± 81.49
SGPT (>40 U/L)	35 (70%)	59.42 ± 32.35
Alkaline Phosphatase (>150 IU/L)	32 (64%)	212 ± 135.01
Serum Proteins (<6 g/dL)	16 (32%)	6.39 ± 0.94
Serum Albumin (<3 g/dL)	28 (56%)	2.81 ± 0.7

Leukocytosis was present in 78% with mean TLC of 18,156.4 ± 7,832.72 cells/µL. Thrombocytopenia occurred in 12%. Prolonged prothrombin time was seen in 60% and elevated INR in 30%. Liver function tests showed derangement in majority: elevated SGOT (78%), SGPT (70%), and alkaline phosphatase (64%). Hypoalbuminemia was present in 56%.

Microbiological Profile

Table 5: Abscess Characteristics and Microbiology

Characteristic	PNA Group n (%)	PCD Group n (%)	Total n (%)
Pus Appearance			
Anchovy sauce	5 (20%)	8 (32%)	13 (26%)
Non-anchovy	20 (80%)	17 (68%)	37 (74%)
Culture Results			
Positive growth	6 (24%)	12 (48%)	18 (36%)
No growth	19 (76%)	13 (52%)	32 (64%)

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Characteristic	PNA Group n (%)	PCD Group n (%)	Total n (%)
Organisms Isolated			
Escherichia coli	3 (12%)	5 (20%)	8 (16%)
Klebsiella pneumoniae	1 (4%)	3 (12%)	4 (8%)
Staphylococcus aureus	2 (8%)	2 (8%)	4 (8%)
Pseudomonas aeruginosa	0 (0%)	2 (8%)	2 (4%)
Abscess Etiology			
Pyogenic	20 (80%)	17 (68%)	37 (74%)
Amoebic	5 (20%)	8 (32%)	13 (26%)

Anchovy sauce pus was observed in 26% of cases. Bacterial culture was positive in 36%. Escherichia coli was most frequently isolated (16%), followed by Klebsiella pneumoniae (8%), Staphylococcus aureus (8%), and Pseudomonas aeruginosa (4%). Pyogenic abscess constituted 74%, amoebic abscess 26%.

Radiological Findings

Right hepatic lobe was predominantly affected (92%), isolated left lobe involvement was rare (2%), and both lobes were involved in 6%. Mean abscess volume was 244 ± 134.15 ml in PNA group and 294.4 ± 121.82 ml in PCD group (p=0.170).

Intervention Characteristics

In PNA group, single aspiration achieved success in 72%, two aspirations in 12%, and three aspirations in 16%. In PCD group, mean catheter drainage duration was 7.92 ± 3.09 days, with 72% requiring 5-9 days drainage.

Treatment Outcomes

Table 6: Comparative Clinical Outcomes

Parameter	PNA Group (Mean ± SD)	PCD Group (Mean ± SD)	P-value
Abscess volume (ml)	244 ± 134.15	294.4 ± 121.82	0.170
Duration of catheter drainage (days)	-	7.92 ± 3.09	-
Hospital stay (days)	12.88 ± 5.50	14.64 ± 5.85	0.278
Clinical improvement (days)	4.92 ± 2.25	4.44 ± 2.12	0.441
IV antibiotics duration (days)	11.0 ± 4.22	10.76 ± 3.39	0.825
Success rate	**19 (76%)**	**25 (100%)**	**0.029***

*Statistically significant (p<0.05)

Treatment success rate was significantly higher in PCD group (100%) compared to PNA group (76%), p=0.029. Six patients (24%) in PNA group experienced treatment failure. Clinical improvement time was comparable

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(4.44 ± 2.12 days for PCD vs 4.92 ± 2.25 days for PNA, p=0.441). Hospital stay showed no significant difference (14.64 ± 5.85 days for PCD vs 12.88 ± 5.50 days for PNA, p=0.278). Duration of IV antibiotics was similar (10.76 ± 3.39 days for PCD vs 11.0 ± 4.22 days for PNA, p=0.825).

Complications

No major procedure-related complications occurred in either group. No hemorrhage, bowel perforation, peritonitis, septic shock, or procedure-related mortality was observed.

DISCUSSION

This prospective randomized study compared ultrasound-guided percutaneous catheter drainage with percutaneous needle aspiration in liver abscess management. Our findings demonstrate significant advantages of PCD over PNA in treatment success rates while maintaining comparable safety profiles.

Demographic and Clinical Profile

The mean age of 42.06 years with peak incidence in the 31-40 years age group aligns with previous studies reporting maximum incidence in the fourth and fifth decades.[16],[17] The marked male predominance (94%) is consistent with existing literature reporting male to female ratios ranging from 2:1 to 7:1.[18] This preponderance may reflect higher rates of alcohol consumption and occupational exposures in males.

The predominance of abdominal pain (98%) and fever (80%) as presenting symptoms corresponds with established clinical patterns. Universal presence of abdominal tenderness underscores its importance as a cardinal sign. Pyogenic liver abscess constituted 74% of our cases while amoebic abscess represented 26%, reflecting changing etiological patterns in recent decades.[3],[8]

Microbiological Considerations

Escherichia coli was the most common isolate (16%), followed by Klebsiella pneumoniae (8%) and Staphylococcus aureus (8%). This distribution aligns with contemporary microbiological profiles, though geographic variations exist.[5],[6] The high percentage of culture-negative cases (64%) may result from prior antibiotic exposure or truly sterile amoebic abscesses.

Treatment Success Rates

The most significant finding was the superior treatment success rate achieved with PCD (100%) versus PNA (76%), with statistical significance (p=0.029). This strongly supports PCD as the more effective drainage modality. Our results corroborate landmark studies demonstrating PCD superiority.

Rajak et al. reported success rates of 100% for PCD versus 60% for PNA in their randomized trial of 50 patients, concluding that catheter drainage was more effective than needle aspiration.[16] The average time for 50% reduction in abscess cavity size was significantly greater in the aspiration group (11 days) compared to catheter group (5 days), though total resolution time was similar (15 weeks) in successfully treated patients.

Zerem and Hadzic demonstrated 100% success with PCD compared to 74% with PNA in their randomized study.[17] Singh et al. reported treatment success rates of 96.7% with PCD compared to 70% with PNA in a prospective randomized study.[18] Yu et al. found that PCD was more effective as first-line treatment, with statistically significant better success rate compared to PNA.[19]

The superior efficacy of PCD can be attributed to continuous drainage ensuring complete pus evacuation, prevention of reaccumulation, and ability to monitor drainage adequacy. In contrast, PNA provides only intermittent drainage and may incompletely evacuate viscous or multiloculated abscesses.[20]

Clinical Improvement and Hospital Stay

Our study demonstrated comparable time to clinical improvement between PCD (4.44 days) and PNA (4.92 days) groups, with no statistical difference (p=0.441). This suggests that among successfully treated patients, both modalities achieve similar symptomatic relief rates. However, the 24% who failed PNA and required rescue PCD experienced delayed improvement.

Duration of hospital stay showed no significant difference (12.88 days for PNA vs 14.64 days for PCD, p=0.278). The slightly longer stay in PCD group likely reflects catheter management time, though this did not reach significance. Several studies reported similar findings, with no significant difference in hospital stay among successfully treated patients in both groups.[16],[21]

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Abscess Characteristics and Treatment Selection

While mean abscess volumes were comparable between groups, existing literature suggests that abscess characteristics significantly influence drainage success. Large abscesses exceeding 5 cm, multiloculated collections, and thick viscous pus respond better to catheter drainage.[22],[23] Our results support PCD as superior therapy regardless of abscess size, suggesting it should be considered first-line intervention when technically feasible.

Safety Profile

A crucial finding was the absence of major complications in both groups, demonstrating excellent safety for both percutaneous techniques. No hemorrhage, bowel injury, peritoneal contamination, or mortality occurred. This safety record aligns with contemporary literature reporting low complication rates for image-guided drainage.[24],[25]

The safety of percutaneous techniques has positioned them as preferred alternatives to surgical drainage, which historically carried higher morbidity rates. Modern surgical drainage is reserved for specific indications including ruptured abscesses with peritonitis, failed percutaneous therapy, and presence of underlying pathology requiring surgical correction.

Study Limitations

Our study has certain limitations including single-center design which may limit generalizability, relatively small sample size of 50 patients, and short follow-up period of six months. Larger multicenter trials with extended follow-up would provide more robust evidence. Additionally, we did not stratify outcomes based on abscess size, which may influence treatment selection in clinical practice.

CONCLUSION

This prospective randomized study demonstrates that ultrasound-guided percutaneous catheter drainage is significantly more effective than percutaneous needle aspiration for treating liver abscesses, achieving 100% treatment success compared to 76% with needle aspiration (p=0.029). While both modalities demonstrate comparable safety profiles with no major complications, and similar times to clinical improvement, the superior success rate of catheter drainage establishes it as the preferred first-line interventional approach. The 24% treatment failure rate with needle aspiration necessitates rescue catheter drainage, potentially delaying definitive treatment and prolonging patient morbidity. Based on our findings, percutaneous catheter drainage should be considered the standard of care for liver abscess management in patients amenable to percutaneous intervention, offering definitive treatment with excellent safety and efficacy profiles.

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