



Prospective Randomized Comparison of Ultrasound-Guided Percutaneous Needle Aspiration with Percutaneous Catheter Drainage of Liver Abscesses

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Background and Aims: Modern treatment of liver abscesses comprises combination of antibiotics and image-guided percutaneous needle aspiration (PNA) or percutaneous catheter drainage (PCD). However, there is debate regarding the choice of these interventions as the first line of management. Our aim was to compare the results of ultrasound-guided PCD with PNA in the management of liver abscesses. **Materials and Methods:** A total of 66 patients (55 males; 11 females, 18–65 years) who were diagnosed with liver abscesses were randomly divided into two groups of 33 patients each, namely ultrasound-guided PNA group (with a maximum of three attempts) and the PCD group. The outcomes of the treatment of the patients of these groups were documented and analyzed. **Results:** PNA was effective in 20 (61%) of the 33 patients after one ($n = 14$), two ($n = 4$), or three ($n = 2$) aspirations while PCD was therapeutic in all 33 patients after one ($n = 29$) or two ($n = 4$) procedures and without any major complications in both groups. All abscesses 45 mm or less in longest dimension were efficaciously managed, by both PCD as well as PNA while the later failed in case of multiloculated abscesses. The mean duration of intravenous antibiotics and time to clinical relief were significantly lesser in the PCD group. However, a period of hospital stay and time to complete resolution of abscess cavities did not differ significantly between the groups. **Conclusions:** Overall, PCD is more effective than PNA in the management of liver abscesses; the later, however, can be employed for smaller and simple abscesses.

Key words: Liver abscess, percutaneous needle aspiration, percutaneous catheter drainage aspiration, catheter, drainage

INTRODUCTION

Both amebic and pyogenic liver abscesses persist to be a significant source of illness and mortality in tropical countries. Although, the latest developments in interventional radiology, antibiotic therapy, and imaging techniques such as ultrasound have led to timely identification and management of patients with liver abscess, thus improving the patient outcome. The main method of management of amebic liver abscess is medical; yet about 15% of amebic abscesses may be intractable to medical treatment. Moreover, the superadded bacterial infection may complicate some of the amebic liver abscesses. In these patients and in patients with pyogenic liver abscesses, surgical drainage has been the conventional approach of treatment. However, operative drainage may lead to considerable morbidity and mortality.¹⁻⁴

Current management comprises intravenous (IV) broad-spectrum antibiotics and image-guided percutaneous needle aspiration (PNA) or percutaneous catheter drainage (PCD). Percutaneous drainage of liver abscess has been a significant innovation in the treatment of liver abscesses. Presently, indications for surgical drainage comprise unapproachability or multiple abscesses that cannot be drained percutaneously or unsuccessful percutaneous drainage. Some authors consider that PCD is more successful than PNA in the treatment of liver abscess, on the other hand, some studies have revealed that therapeutic needle aspiration to be a easier, cost-effective, and equally efficient method of treatment.⁴⁻⁷ Consequently, there is a debate about the first line

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of management of liver abscesses, especially in developing countries, where infections including liver abscesses are common, and the majority of the patients are from lower socioeconomic strata. Therefore, the main aim of this study is to analyze and to equate the clinical outcome of percutaneous ultrasound-guided catheter drainage with intermittent needle aspiration of pyogenic liver abscesses.

MATERIALS AND METHODS

Study design

This study was a single-center prospective randomized comparative study and included a total of 66 patients. These patients were randomized into two groups; PNA ($n = 33$) and pigtail catheter drainage (PCD) ($n = 33$) which was inserted using the Seldinger technique.⁸ This study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all the participants.

Participants

All the patients that visited the outpatient and emergency departments of the hospital and subsequently identified to have liver abscesses clinically and radiologically (on ultrasonography and/or CT scan) were incorporated in the study. All the age groups were involved with following exclusion criteria's: preceding liver intervention; ruptured abscess; indeterminate diagnosis; associated biliary tract malignancy; and uncorrectable coagulopathy.

Methods

All the participants fulfilling the inclusion conditions were worked up with regard to a comprehensive history, clinical checkup, and laboratory/imaging examinations. An informed consent was taken from the participating patients, and all the agreeable patients were given medical treatment as per our protocol.

Randomization was carried out by means of computer software, agreeing to a standardized earlier reported protocol.⁹ The two sets of random numbers produced by the software were allocated to the two intervention groups, and numbered envelopes (sealed) were prepared with the serial number cited outside and intervention stated inside by a nonparticipating person. When the participating patient gave a legitimate consent, the specified intervention was done.

Percutaneous catheter drainage

The PCD was done by the introduction of a 12 Fr pigtail catheter in the abscess cavity under ultrasound guidance utilizing the Seldinger technique.⁸ The patient underwent

ultrasound of the abdomen, and the features of the abscess cavity were documented. Local anesthetic was permeated in the intended area of puncture. Employing a sterile blade a minor stab was made on the anesthetized skin. A percutaneous pigtail catheter set having a 12 Fr catheter was utilized for drainage. Under real-time ultrasound guidance, the puncture needle was introduced through the skin stab and directed to the middle of the abscess cavity. The stylet was removed, and pus was aspirated to reconfirm the location, and the aspirated pus was transmitted to the laboratory for examination. A guide wire was introduced through the needle, and the needle was withdrawn without dislodging the guide wire. The tract was widened with plastic dilators one after the other up to 12 Fr size. The 12 Fr pigtail catheter was then introduced over the guide wire into the abscess cavity and the later was withdrawn, and the catheter was secured to the skin using suture. The catheter was fixed to a collecting bag by the connector, which was supplied along with the catheter set. Apart from documenting the clinical and laboratory details of the patient every day, the day-to-day output of the catheter was also measured. A decision to withdraw the pigtail catheter was made in case the overall drainage from the catheter diminished to <10 mL/24 h for two successive days.

Percutaneous needle aspiration

Aspiration of pus was done under ultrasound guidance using an 18 Gauge disposable trocar needle and 50cc syringe. In multiloculated abscesses, the needle tip was introduced into different loculi for thorough removal of pus. Repeat ultrasound was performed every 4th day, and the dimensions of the residual cavity were recorded.

Assessment of the response to intervention

The clinical outcome and laboratory parameters were documented on a daily basis. In the patients who underwent PNA, sonography was again done after a period of 4 days and aspiration repeated in case the cavity size was still found to be larger than 50% of the original size. The identical procedure was again done after a period of another 4 days and aspiration repeated if necessary. The failure of clinical relief with respect to fever, pain, tenderness, and leukocytosis or reduction in dimensions of the abscess cavity following a third attempt of aspiration was considered as unsuccessful needle aspiration. In such patients, open surgical drainage of the abscess cavities was done.

Data of the following outcomes were documented, analyzed, and compared between two intervention groups: success percentage; period of hospital stay; complications related to the procedures; days to attain clinical relief; days to

accomplish a 50% decrease in the dimensions of the abscess cavity; and days to realize total or near-total resolution of the abscess cavity and mortality. The criteria for an effective percutaneous intervention were defined as the sufficient drainage of the abscess to attain the resolution of infection without the necessity for surgical drainage and with the consequent discharge of the patient from the hospital. Clinical relief was defined as the resolution of fever, a normal leukocyte count, and the respite from local signs and symptoms after effective PCD or PNA.

Follow-up

The patients were followed up every week for a month and for every month for 6 months, for clinical assessment and sonographic evaluation of the abscess cavity till entire resolution of the abscesses was accomplished. Data were documented and analyzed by the researcher.

Statistical evaluation

The success of both techniques was calculated and compared with respect to the period of hospital stay; days to attain clinical relief; days to realize 50% decrease in abscess cavity dimensions; and days to realize the total/near-total resolution of abscess cavity. Independent *t*-test was employed to evaluate these parameters. The level of statistical significance was fixed at $P < 0.05$, and range and mean values were computed.

RESULTS

A total of 66 patients randomized into two groups of 33 each were involved in the study. The following interpretations were made.

Patient characteristics

The age of the patients ranged from 18 years to 65 years with majority of the patients falling within the age range from 40 to 50 years ($n = 28$). The second most common age group was 31–40 years ($n = 15$ patients) that was followed by 21–30 years ($n = 10$ patients). Majority of the patients were males ($n = 55$) with females accounting for only minority of the participants [Table 1].

Clinical features

Right upper quadrant pain of the abdomen was the most frequent symptom, which was followed by fever. Other symptoms comprised anorexia, generalized weakness, weight loss, night sweats, pain in the right shoulder region, and cough. On clinical examination, hepatomegaly and mild jaundice were common findings whereas pleural effusion was found in only seven patients [Table 1].

Table 1: Demographic variables, clinical, and laboratory findings of the patients of percutaneous catheter drainage and percutaneous needle aspiration groups

Patient characteristics	PNA ($n=33$)	PCD ($n=33$)
Mean age $\pm$ SD (years)	41 $\pm$ 8.2	42 $\pm$ 8.4
Sex; n (male:female)	27:6	28:5
Clinical findings		
Abdominal pain	30	28
Fever	24	22
Jaundice	20	18
Right shoulder pain	4	6
Anorexia/malaise	16	18
Weight loss	9	10
Pleural effusion	3	4
Comorbidity		
Diabetes	8	9
Colitis	6	7
Laboratory investigations (mean $\pm$ SD)		
Hb (mg%)	10.8 $\pm$ 2.3	11.2 $\pm$ 2.4
TLC ($\times 10^9/L$)	12.9 $\pm$ 2.9	12.8 $\pm$ 2.8
SGOT (IU/L)	42 $\pm$ 20.9	39 $\pm$ 19.9
SGPT (IU/L)	77 $\pm$ 40.1	74 $\pm$ 39.1
ALP (IU/L)	142 $\pm$ 55	139 $\pm$ 52.2
Prothrombin time (s)	15 $\pm$ 3.8	14 $\pm$ 4.4

PNA=Percutaneous needle aspiration; PCD=Percutaneous catheter drainage; Hb=Hemoglobin; ALP=Alkaline phosphatase; SGOT=Serum glutamic-oxaloacetic transaminase; SGPT=Serum glutamic-pyruvic transaminase; TLC=Total leukocyte count; SD=Standard deviation

Laboratory analysis

Majority of the patients had leukocytosis, elevation of serum alkaline phosphatase, and positive amoebic serology [Table 1]. On the other hand, pus cultures were found to be positive in only one-third of the cases with majority of them revealing *Escherichia coli*.

Characteristics of abscesses

Amebic liver abscesses were most commonly seen that was followed by pyogenic abscesses. The abscesses in majority of the patients were located in the right lobe of liver along with a solitary abscess cavity [Figure 1]. It was seen that the diameter of the abscess cavities varied between 35 and 160 mm [Table 2].

Clinical and treatment outcomes after interventions

A total of 66 patients underwent one of these two percutaneous methods randomly, and their outcomes to treatment were documented and analyzed. Pigtail catheter

Table 2: Data of the nature, dimensions, number, and location of liver abscesses seen in the patients of percutaneous catheter drainage and percutaneous needle aspiration groups

Abscess features	PA (n=33)	PCD (n=33)	Total number (%)	P (between both groups)
<i>n</i>				
Single	28	30	88	0.85
Multiple	5	3	12	
Location				
Right lobe	25	24	74	0.66
Left lobe	3	6	14	
Both lobes	5	3	12	
Dimensions				
Volume of pus at the time of 1 st intervention (cc)				
Mean±SD	131±92	142±98		0.58
Range	18-365	20-371		
Diameter of cavity at the time of 1 st intervention (mm)				
Mean±SD	77±44.8	78±42.1		0.61
Range	35-160	39-155		
Nature				
Amebic	25	26	77	0.77
Pyogenic	8	7	23	

PCD=Percutaneous catheter drainage; SD=Standard deviation

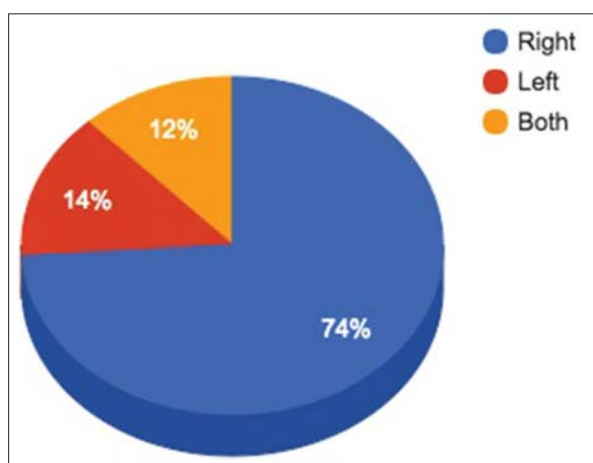


Figure 1: The location of liver abscesses in all the patients by percentages

drainage was efficacious in all the 33 cases, in contrast, the ultrasound-guided needle aspiration was effective only in 20 of 33 patients, and the difference was statistically significant ($P < 0.05$). Out of these 20 patients effectively treated by PNA, 14 patients needed only one aspiration, 4 needed two aspirations, and 2 needed three aspirations. The 13 patients who did not demonstrated clinical improvement and/or reduction in abscess cavity size even after three aspirations were labeled as failures. The median period of catheter insertion was 10 days (range 7–21 days, average 10.4 days). The average duration of

IV antibiotics and time to clinical improvement were smaller in the PCD group as compared to the aspiration group, and that was statistically significant ($P < 0.05$). No major complication was seen in either of the groups.

In the PNA group, the mean longest span of the abscess was significantly more (11.8 ± 3.2 cm) in patients with ineffective than in patients with efficacious (4.9 ± 2.0 mm) needle aspiration ($P = 0.03$). The mean volume of abscesses (320 ml) in the 13 patients in whom PNA was ineffective was significantly ($P = 0.04$) greater than the mean volume (160 ml) of the abscesses in the 20 patients in whom 1st or 2nd or 3rd aspirations were effective. Intermittent needle aspiration was efficacious for all patients with abscesses up to 4.5 cm in longest diameter. Nevertheless, this treatment was futile for three patients who had multiloculated abscesses.

The average size of abscess at hospital discharge was 3.5 cm in catheter group and 4.8 cm in needle aspiration group, which was statistically significant ($P < 0.05$). All the patients were treated efficaciously by PCD ($n = 33$) had overall ultrasonographic resolution of abscess cavities, compared to only 20 patients treated by PNA ($P < 0.05$) at 6 months of follow-up with no relapse seen in either of the groups on follow-up. Nevertheless, there was no statistically significant difference among the successfully treated cases of the two groups regarding the period of hospital stay or the time needed for total or near-total resolution of the abscess cavity [Table 3].

Table 3: Outcomes of the treatment of the patients of percutaneous catheter drainage and percutaneous needle aspiration groups along with their comparison

Parameters	PCD group (n=33)		PNA group (n=33)		P
	Number of patients (n)	Range, mean (%)	Number of patients (n)	Range, mean (%)	
Success rate	33	100	20	61	0.031
1 st procedure	29		14		
2 nd procedure	4		4		
3 rd procedure			2		
Hospital stay duration (days)	33	5-24, 5.6	20	7-27, 6.2	0.52
Duration of IV antibiotics	33	5-20, 10.4	20	5-29, 17.7	0.040
Clinical recovery (days)	33	4-9, 7.1	20	5-15, 12.4	0.038
Time					
50% resolution (days)	33	2-9, 6.8	20	3-10, 7.2	0.39
Complete resolution (weeks)		9-22, 10.1		10-24, 10.7	0.41
Period of drainage (days)	33	7-21, 10			

PNA=Percutaneous needle aspiration; PCD=Percutaneous catheter drainage; IV=Intravenous

DISCUSSION

In the present era of minimal invasiveness, percutaneous interventions have become the desired method for the management of liver abscess.⁷ We did ultrasound-guided percutaneous interventions in 66 patients with uncomplicated liver abscess and got decent outcomes. There was no mortality or any significant complication necessitating any action. A number of investigators have used both the procedures, with variable degrees of success and have revealed that the combination of IV antibiotics and image-guided percutaneous interventions (PCD and PNA) are efficacious. The aim of this study was to establish which method is better. Whether to do PCD or PNA continues to be debated especially in developing countries where not all patients are affording to undergo costly procedures.

The findings of the present study regarding patient characteristics such as age, sex predilection, clinical presentation, and number, type, location, and features of pus of the abscesses match with the previously reported studies except for minor differences.⁴ Both percutaneous techniques resulted in speedy clinical improvement with majority of the patients displaying the resolution of signs and symptoms within the initial few days of the interventions. The period required for 50% decrease in the cavity size was significantly less in the PCD group in contrast to PNA group which is likely due to the fact that indwelling catheter offers uninterrupted drainage, and consequently, pus gets evacuated more often and the abscess cavity shows a quicker rate of collapse during the early phase in such patients. Nevertheless, the interval required for total or near-total resolution of the abscess cavity, and hospital stay did not display any significant dissimilarity in the two groups.

It can be established that the abscess cavities exhibited quicker collapse during the early phase in the PCD group; however, it did not have any benefit as far as that complete or near-total resolution of the cavity is concerned. Similar to the results of the present study, other researchers have documented similar opinions as well.^{4,10,11}

Both these percutaneous procedures have several shortcomings. Many attempts of PNA are often required for large abscesses that may be painful and felt as more distressing by patients. Moreover, during the interval between two aspirations fluid may get reaccumulated. For smaller abscess cavities, the day-to-day formation of pus may be insignificant, but bigger abscesses may generate higher amount of pus, which have to be drained uninterruptedly. As PCD offers continuous drainage unlike PNA, it has this clear advantage over PNA, which might have led to faster clinical relief, smaller period of IV antibiotics, and smaller unsuccessful rate among patients who underwent PCD in our study. This substantiates the better success rates (100%) detected in our study and some previous studies.^{4,10,12}

However, the introduction of a catheter requires more skill and subsequent good catheter care. One of the causes for unsuccessful PCD is the viscous pus that could not be drained percutaneously. That is why we employed larger bore 12 F catheters for PCD in the present study. On the other hand, the main benefits of PNA over PCD are that it is simpler, less invasive, and less costly, devoid of difficulties associated with catheter care; and many abscesses can be aspirated at ease in the same setting.^{4,10-12}

Only few earlier prospective randomized clinical studies have compared PNA with PCD. All these studies encompassed abscesses of all the dimensions. The study done by Yu *et al.*

involved the patients with pyogenic abscesses only and revealed no significant difference in the outcomes of the two techniques. They determined that PNA was perhaps as successful as PCD. They endorsed PNA as a first-line method owing to procedure ease, patient comfort, and low price and recommended a multicenter study to offer a conclusive solution.¹³

In the study done by Rajak *et al.*, the authors concluded that catheter drainage was better with respect to success rate; however, they restricted the number of needle aspirations to two and that may be a cause for inferior success rate (60%) of percutaneous aspiration.¹⁴ Zerem and Hadzic in their study endorsed PNA for simple abscesses of 5 cm or lesser in dimensions.¹⁰ Similar to study done by Zerem and Hadzic¹⁰ we did maximum of three attempts of PNA as 14 out of 20 patients had effective drainage after the first attempt and only four in the second attempt. The third stab was effective in only two patients out of 20. This corroborates that repeated needle aspiration is rarely successful.

On the other hand, the results of our study confirmed that repetitive PNA and PCD are equally efficient in the management of liver abscesses 45 mm or less in the longest diameter. As documented in previous studies, PNA of all multiloculated abscesses was unsuccessful in our study also, and in such cases, PCD should be the preferred intervention.⁴

A small number of studies also state that the initial size of the abscess cavity does not influence the final result.⁴ On the other hand, Rajak *et al.*¹⁴ considered that large abscesses are more challenging to aspirate entirely in a single try and favored PNA for abscesses <5 cm, and PCD for bigger abscesses. In dissimilarity to few of the former studies that revealed that the original size of the abscess cavity did not influence the final result;⁴ we found that bigger abscesses are harder to evacuate totally in one attempt, requiring successive aspirations. The mean volume of the 13 patients in whom PNA was unsuccessful was significantly greater than the mean volume of the patients who could be efficaciously treated with PNA. Incapability to totally evacuate the thick viscous pus and quick reaccumulation of pus in such abscesses are other additional reasons, which have been described in literature for failure of needle aspiration.⁴ Introduction of an indwelling drainage catheter tackles all three of these concerns as it offers uninterrupted drainage, evacuates thick pus owing to broader caliber catheter, and avoids reaccumulation.

On the basis of earlier documented results, we omitted patients with concomitant malignant biliary disease, which are a poor prognostic factor and the important reason of mortality among patients with liver abscesses.⁴ This might be the reason that we had a superior overall success rate with percutaneous

interventions, especially PCD, than previous studies and is possibly why there were no mortalities in our series. Since our institution is a tertiary care referral hospital, several patients had been incompletely managed with antibiotics before being referred to us; this perhaps explains the fact that many abscesses had negative results of pus cultures in the present study. Period of hospital stay and time interval required for the resolution of abscess cavities in effectively treated patients did not significantly differ in both PNA and PCD groups and is similar to the findings of previous studies.⁴ Furthermore, no relapse happened in any of the successfully treated cases in both groups during the 6-month follow-up period.

Baek *et al.*¹⁵ and Giorgio *et al.*¹⁶ have documented a considerable lesser frequency of complications with PNA than with PCD as one of the major benefits of PNA over PCD. Yu *et al.*,¹³ in their study, had documented five mortalities (four in the PCD group and one in the PNA group) while Singh *et al.*¹¹ described one patient, in the PCD group, who experienced abscess rupture and expired. These results are different from the findings of the current study, which indicate no significant difference between PNA and PCD. We feel that the complications of these procedures depend on the experience and precision of the healthcare professional performing these procedures apart from underlying comorbidity conditions that the patients might be having.

CONCLUSIONS

Ultrasound-guided percutaneous drainage (PCD) is better than intermittent PNA in the treatment of liver abscesses; however, the latter is a suitable substitute in abscesses cavities that are 45 mm or less in longest dimensions. On the other hand, PNA is not effective for multiseptated liver abscesses for which PCD should be the preferred option.

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Conflicts of interest

There are no conflicts of interest.

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