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Ultrasound-guided percutaneous catheter drainage of various types of ruptured amebic liver abscess: a report of 117 cases from a highly endemic zone of India

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Abstract

Objective: To determine the efficacy and safety ultrasound-guided percutaneous catheter drainage (US-PCD) in management of various types of ruptured amebic liver abscess including free rupture (FR) with diffuse intraperitoneal fluid collections (DIFC).
Methods: This study analyzed 117 patients with ruptured ALA who underwent US-PCD. The indication for US-PCD was failure to respond to conservative treatment and/or percutaneous needle aspiration.
Results: Majority of patients were locally fermented alcohol abusers (95%), and malnourished (75%). Ninety-eight patients had intraperitoneal rupture including 66 contained rupture (CR) with localized intraperitoneal fluid collection (LIFC) and 32 FR with DIFC. Pleuropulmonary complication was found in 19 patients including 13 pleural and 6 pulmonary. A total of 333 catheters were used to drain 202 abscess cavities and associated fluid collections. US-PCD was technically and clinically successful in all cases. Multiple sessions (median 2; range 2–5) of PCD required with upsizing the catheter (median 14 F; range 14–20 F) and placement of additional catheter in 26 (22%) patients. The patients with FR with DIFC required more number of catheters ($p = 0.01$) and had longer hospital stay ($p = 0.01$). No major procedure related complication was observed. Six patients developed secondary bacterial infection; two of them presented with cavito-cutaneous fistula at catheter insertion site, and one with cholangitis due to biliary stricture formation necessitating subsequent endoscopic treatment. Post-procedural death occurred from sepsis in a patient with FR.
Conclusion: US-PCD is a safe and effective mode of treatment for ruptured ALA including FR with DIFCs. We recommend PCD as a first-line therapy for ruptured ALA.

Key words: Amebic liver abscess—Ultrasound-guided percutaneous catheter drainage—Ruptured liver abscess—Amebic peritonitis—Perforated liver abscess

Amebic liver abscess (ALA) is common health problem in Bihar (India) where amebiasis is considered to be highly endemic [1]. Rural habitat, illiteracy, poor sanitation, and overcrowding have been the contributing risk factors for amebiasis in this part of country [2]. Amebiasis is a parasitic infection acquired by ingestion of *Entamoeba histolytica* cysts through food or water contaminated by human feces. Liver abscess is the commonest extraintestinal presentation of amebiasis affecting 3–9% of cases [3]. Rupture of ALA into the peritoneal or thoracic cavity is the most common fatal complication and the reported incidence of rupture ranges from 10% to 24% [4, 5].

Unruptured ALA is effectively managed by medical therapy. However, ruptured cases, particularly with generalized peritonitis, are considered surgical emer-

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gency and frequently require surgery. The mortality rate in surgically treated patients with generalized peritonitis is high and has been reported up to 50% [4–6]. Although conservative approach in form of percutaneous catheter drainage (PCD) is increasingly used since early 80s, it has not yet been widely embraced as the standard of care for ruptured ALA with generalized peritonitis [7–10]. A few studies have consistently documented the success of PCD in ruptured abscess but these studies were limited by their small size [11, 12]. Therefore, this study aimed to determine the efficacy of ultrasound-guided percutaneous catheter drainage (US-PCD) in various types of ruptured ALA with emphasis on free rupture with generalized peritonitis.

Materials and methods

Ethical approval for this study was obtained by the ethical committee of the institute. Between 2014 and January 2018, a total of 405 patients with ALA underwent US-PCD at a tertiary care center, Patna (Bihar), India. Of these, 117 patients who presented with ruptured ALA constituted this retrospective study cohort. The diagnosis of ALA was based on typical US appearance (i.e., peripherally located well-defined cystic lesion with internal echoes representing necrotic tissues), positive serological test, and characteristic nature of aspirated pus (i.e., odorless, chocolate-brown in color and thick in consistency, classically described as anchovy paste). All patients received standard dose of anti-amebic drug and broad spectrum antibiotic during treatment [13]. The indication for US-PCD was failure to respond to conservative treatment and/or percutaneous needle aspiration. Failure of medical or percutaneous needle aspiration was defined as patient who, after being treated by the standard medical treatment with or without percutaneous needle aspiration, was identified by at least the first two of three features: (a) persistence of clinical symptoms; (b) persistence of liquefied liver abscess or fluid collection; and (c) no improvement in laboratory parameters such as TLC, bilirubin, or creatinine level.

The demographic, clinical, and laboratory findings of all patients were noted. Ultrasound (US) was performed for all cases at admission. ALA was defined as collection of liquefied necrotic hepatic tissues within the liver parenchyma, and collection was defined as accumulation of extrahepatic fluid resulting from ruptured of ALA. Rupture of liver abscess was diagnosed when US showed a breach in the abscess wall and extrahepatic collection. In case of diagnostic doubt regarding differentiation between collection and pleural effusion or ascites, diagnostic aspiration of fluid was performed (Fig. 1). The size, number, and appearance of abscess cavities as well as collections were documented. The initial volume of abscesses, duration of drainage, and number of subsequent catheter manipulations was also recorded. Location of collection was carefully noted. Depending on the location of collection, the patients with intraperitoneal rupture were classified into two types: contained rupture (CR) and free rupture (FR). CR was defined as when localized intraperitoneal collection (LIFC) was noted in perihepatic space or other supramesocolic compartments including the right subphrenic, right subhepatic, gastrohepatic recess, lesser sac, and left subphrenic space (Figs. 1, 2, 3). FR was defined as when diffuse intraperitoneal collection (DIFC) extended caudally to accumulate predominantly in inframesocolic compartment of greater sac (Fig. 4). When concurrent rupture was found in both intraperitoneal and thoracic cavity concurrently, the patient was grouped on either side depending upon predominant involvement for statistical analysis. The nature of drained fluid was also documented. Computed tomography (CT) scan was done in cases in which pleuropulmonary rupture was suspected with USG.

Technique

PCD was performed in all patients under local anesthesia using US guidance. The drainage catheters were placed with Seldinger technique. The procedure was defined as technically successful when the radiologist placed the drainage catheters into the target abscess cavities or collections. We used Malecot catheters, made from radiopaque polyurethane material (Devon Innovations, India) in 86% of cases and pigtail catheters in remaining cases. Depending on the fluidity of pus, we selected 10–12 F catheters at first session drainage. However, catheters were subsequently exchanged for wide bore (up to 20 F) polyvinylchloride (PVC) catheters, if smaller catheters could not evacuate the necrotic material in first 3 days after the procedure. We manually created two-to-four side-holes of adequate size in proximal 5–10 cm of Malecot or PVC catheters depending on the size of cavity and collection to achieve better drainage (Fig. 3C).

The catheter was manipulated with forward and backward movement while applying a gentle suction through the distal hub of catheter with a 20-mL syringe (for small size catheters) or 50-mL bladder wash syringe (for wide bore catheters). The aim was to completely evacuate the entire necrotic material of the abscess cavity, and to drain out maximum collection achievable to relieve the peritonitis. In the selected cases of multiple liver abscesses, besides catheter drainage of the larger abscesses and collections, needle (18-gage) aspiration was also performed for smaller lesion (< 50 cc) (Fig. 3). US-

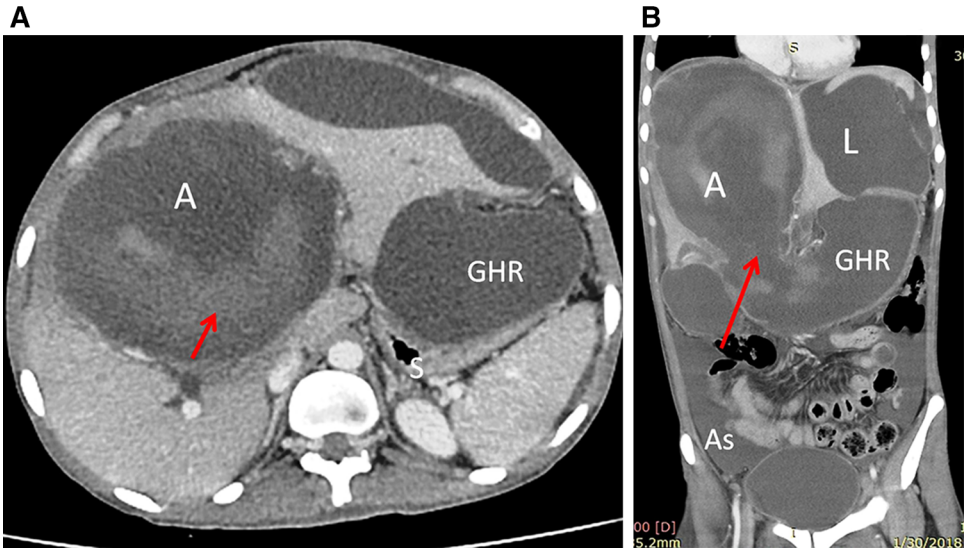

Fig. 1. Axial (**A**) and coronal (**B**) MDCT images demonstrate a large amebic abscess (A) in right lobe of liver with massive rupture though a wide rent in the abscess wall (long arrow). The collections are localized in supramesocolic compartment, predominantly in gastrohepatic recess (GHR). Displaced stomach is marked with (S).The fluid present in inframesocolic compartment was confirmed to be reactionary ascites (As) after needle aspiration. Small arrow indicates slight internal hemorrhage within abscess cavity in this patient.

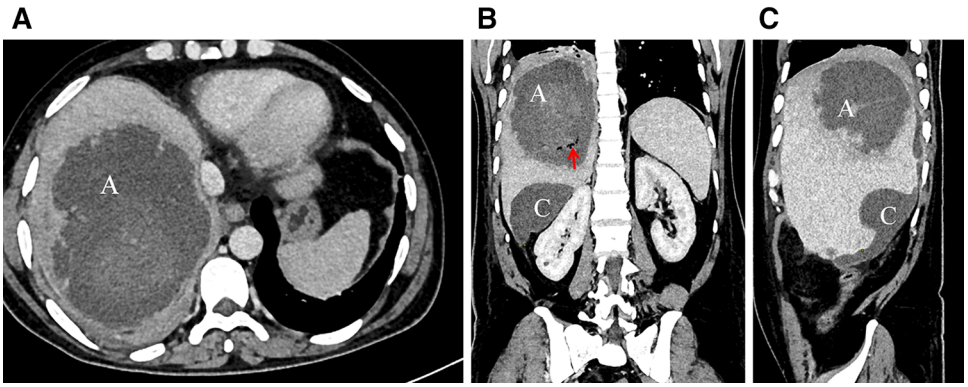

Fig. 2. Axial (**A**), coronal (**B**), and sagittal (**C**) MDCT images show large abscess cavity (A) in right lobe of liver and small localized collection (C) in subhepatic space (Morison pouch). Note the locules of gas (arrow) within the abscess cavity related to prior unsuccessful needle aspiration in this patient.

guided angled needle approach was used for drainage pulmonary abscess [14].

Assessment of treatment outcome

All patients were followed up every alternate day during hospital stay with US to assess the residual volume of cavity and collection. The post-treatment blood investigations were recorded every alternate day. The catheter was removed when the drain output was less than 10 mL/day, and clinical success was achieved. Clinical success was defined if the patient met the following criteria: (1) resolution of major symptom and sign of toxicity, including fever, peritonitis, or pleurisy, (2) improvement of leucocytes count, (3) near-total reduction in abscess size, (4) more than 50% resolution in size of collection, and (5) no further requirement of surgical drainage. Diagnosis of intrahepatic biliary communication was made when either first aspirate was bilious fluid or persistent bilious fluid of more than 50 mL/day was observed after 7 days of procedure. Post-procedural secondary bacterial infection was considered when the characteristic amebic pus turned purulent or pus culture yielded bacterial growth during the treatment course. All the patients were followed up every month for next 6 months. A minimum of 4 months of follow-up was available for all patients at the time this study was completed.

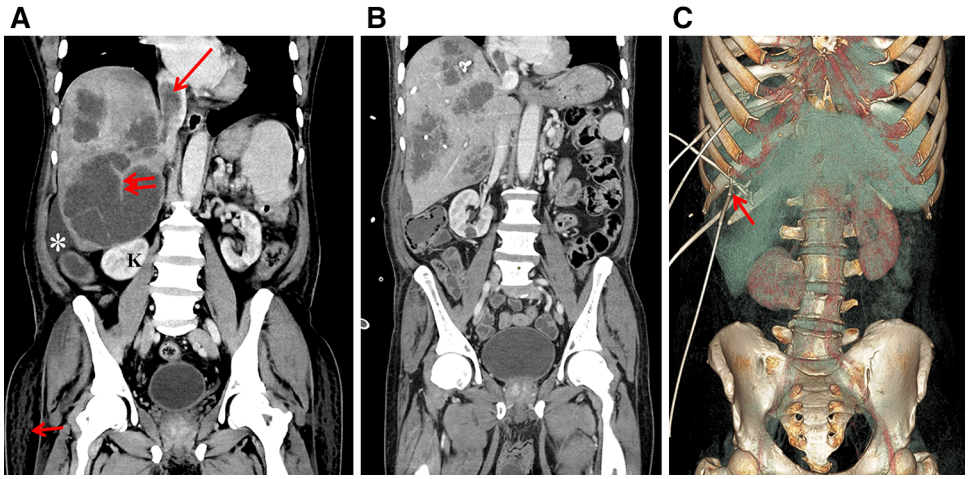

Fig. 3. MDCT of a 67-year-old male patient. Coronal image (**A**) shows multiple large abscesses with partial septation (double arrows) and small localized perihepatic fluid collection (*). Note the IVC thrombus (long arrow), subcutaneous edema (short arrow) in upper thigh, and enlarged liver with mass effect on the right kidney (K). This patient was treated by draining hepatic abscesses with multiple catheters and aspirating the collection with needle. Coronal MDCT image (**B**) obtained on sixth post-procedure day shows not only significant decrease in the size of the abscess and collection but also significant resolution of IVC thrombus size and subcutaneous edema. The three-dimensional volume-rendered image (**C**) demonstrates multiple drainage catheters placed in abscess cavities through the intercostal or subcostal approach. Note the manually created side hole (arrow) in the catheter.

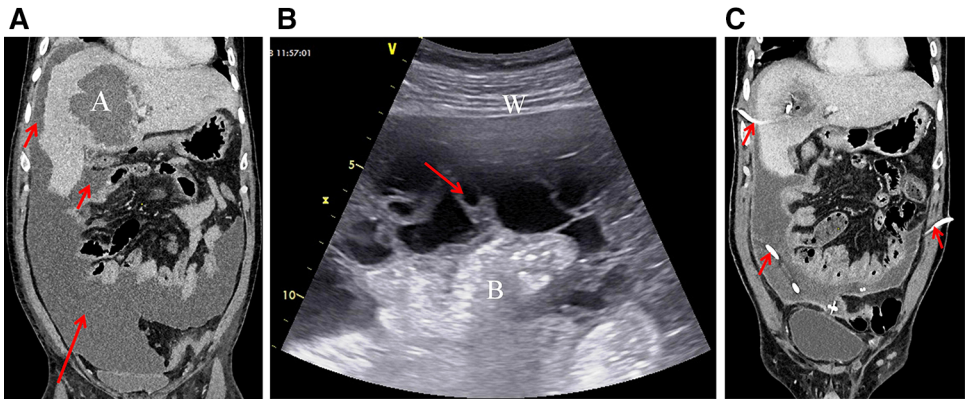

Fig. 4. MDCT of a 45-year-old patient who presented with generalized peritonitis. **A** Coronal image shows an abscess (A) in right lobe of liver with diffuse intraperitoneal collection involving both supramesocolic (small arrows) and inframesocolic (long arrow) compartments. **B** US scan image obtained at the time of PCD shows complex septations (arrow) in pelvic collection; these septations were not detected by CT scan. Note the available safety window between anterior abdominal wall (W) and bowel loops (B) available for placement of catheters. **C** MDCT obtained 3 days after PCD using multiple catheters (arrows) when the symptoms of peritonitis significantly resolved, coronal image shows more than 80% reduction in the abscess cavity size but only about 50% resolution in intraperitoneal collection.

Statistical analysis

To analyze the treatment outcome in intraperitoneal (CR and FR) and thoracic rupture (pleural and pulmonary), the variables including cavity size, amount of pus, number of catheter used, and duration of hospital stay were tested for normality; none of the variables were found to be normal after applying Shapiro–Wilk W test for normality ($p = 0.0001$). Hence non-parametric Kruskal–Wallis test was applied to test the equality of distribution of each variable by type. The descriptive data were reported as mean ± standard deviation, median, and range in text and tables.

Results

Demography

The age ranged from 12 to 76 years with a median of 51 years. The diseases occurred predominantly (97%; $n = 114$) in male. Ninety-five percent ($n = 111$) of the patients were chronic *toddy* drinkers. Majority (83%; $n = 97$) of the patients belonged to rural areas, were

unemployed, and did not complete primary schooling. Seventy-five percent (n = 88) were malnourished and emaciated as evidenced by low body mass index (mean 17.2 kg/m^2) and low albumin (mean 2.2 g/dL).

Clinical and laboratory findings

The duration of symptoms before presentation ranged from 5 to 27 days with a median of 10 days. Average duration between admission and PCD was 1.2 days (range 1–3 days). Abdominal pain and tenderness in the right hypochondrium were the most common presenting symptoms noted in all patients. History of fever with chill was found in 72% patients. Localized tenderness at the right hypochondrium was found in 66% patients with CR, while 93% patients with FR presented with features of generalized peritonitis including abdominal distention, guarding, and shock. About one-third of patients with localized rupture had palpable lump in right hypochondrium or epigastric region. Other symptoms were anorexia (69%), weakness (41%), and jaundice (16%). All patients with pleuropulmonary complications had respiratory symptoms including cough (5%), dyspnoea with chest pain (4%), and history of expectoration of dirty dark brown material (3%).

Laboratory investigations revealed marked leukocytosis in about 83% of patients with a mean WBC count of 27,420/mm^3. The bilirubin level was elevated in the 47% of patients with a mean of 2.1 mg/dL (range 0.5–8.0). Impaired renal function was found in 23% of patients (range 1.0–4.8 mg/dL). About one-third (38%) of patients were anemic with hemoglobin level less than 8.0 g/dL.

Characteristics of ruptured liver abscess, and collection

A total of 269 separate abscesses were detected in 117 patients; a solitary ruptured abscess was identified in 70 (60%) patients and remaining 47 had more than one cavity (median 3, range 2–16). Sixty-one percent (n = 71) of abscesses were located in the right lobe, and 15.3% (n = 18) were in the left lobe of the liver. The remaining (n = 28) abscesses were found in both lobes of the liver. Though partial septa (Fig. 3a) were noted in about 30% of acutely ruptured abscesses, all abscesses were found to be unilocular.

USG detected CR with LIFC in 66 (56%) patients. These collections were predominantly in right subphrenic space in 17 patients, subhepatic in 14, gastrohepatic recess in 10, hepatic subcapsular space in seven, lesser sac in four, left subphrenic in four, and in the remaining 10 cases the specific perihepatic space was not recorded. All patients with LIFC had echogenic collection without septations, and the nature of fluid resembled the amebic pus. FR with DIFC was found in 32 patients. In patients with DIFC, the fluid predominantly accumulated in pelvic cavity followed by paracolic recesses. The US demonstrated complex septations and multilocularity (Fig. 4B) in these patients, and the drained fluid was relatively serous with trace of debris and necrotic tissue. In none of these patients were the collections located along deep interloop mesenteric folds. Twelve patients had concurrent intraperitoneal and thoracic rupture.

Nineteen patients were found with isolated or predominant pleuropulmonary complications. Of them, 13 patients had septated right pleural collection representing empyema formation, and six were diagnosed with well-defined pulmonary cavity in right lower lobe representing lung abscess. Of six lung abscess, three showed continuity with the ruptured hepatic abscess; we observed bronchial breathing sound from catheter-hub and spells of coughing immediately after catheter placement suggestive of hepatobronchial fistula (HBF). In all patients with HBF, CECT showed the presence of air pockets within the cavity (Fig. 5).

A total of 333 drainage catheters were placed in the abscess cavities (n = 202) or in collection (n = 131). Number of catheter ranged from 1 to 16 (median 2). The DIFCs required more catheters than localized (p = 0.01, statistically significant). The median catheter size was 12 F for the first session and 14 F for multiple session procedure. Pus culture was performed in nine patients in whom possibilities of secondary infection were considered, and in none of them was trophozoites discovered.

Technical and clinical success

A comparison of treatment outcome of PCD in all types of ruptured ALA is summarized in Table 1. PCD was technically successful in all cases. Marked reduction in the volume of abscess cavities and the LIFCs noted immediately after the procedure. Pain, fever, and toxicity disappeared in all patients in 3 days. Laboratory parameters including leukocyte count, serum bilirubin, and serum creatinine significantly improved in 2–5 days.

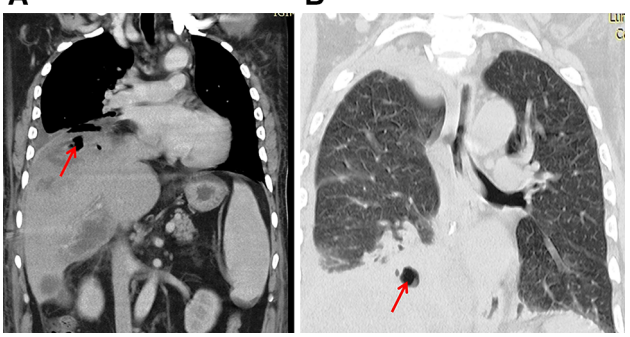

Fig. 5. Coronal MDCT images, soft tissue (**A**) and lung window (**B**). A pocket of gas (arrow) within the abscess cavity is seen in a patient with hepatobronchial fistula.

Table 1. Shows treatment outcome of percutaneous drainage in 117 patients with intraperitoneal and pleuropulmonary rupture

Variables	Intraperitoneal (n = 98[a])		Pleuropulmonary (n = 19[a])		p value
	CR with LIFC (n = 66)	FR with DIFC (n = 32)	Pleural (n = 13)	Pulmonary (n = 6)	
Median number of abscess present(range)	1(1–13)	2(1–12)	1(1–3)	1	0.01
Volume of abscess drained in cc (mean ± SD)	240 ± 126	330 ± 172	245 ± 179	225 ± 118	0.08
Technical success (%)	100 (66/66)	100 (31/32)	100 (13/13)	100 (6/6)	NS
Clinical success (%)	100 (66/66)	97.29 (31/32)	100 (13/13)	100(6/6)	NS
Duration of hospital stay in days (mean ± SD)	5.8 ± 3.3	7.8 ± 2.3	5.7 ± 1.5	5.1 ± 1.6	0.01
Mean catheter per patient (median)	2.4 ± 1.5 (2)	3.8 ± 1.7 (3)	2.1 ± 0.27 (2)	1.5 ± 0.5 (1)	0.01

CR contained rupture, *LIFC* localized intraperitoneal fluid collection, *FR* free rupture, *DIFC* diffuse intraperitoneal fluid collection, *NS* non-significant
[a]12 patients had both intraperitoneal and thoracic rupture

A total of 26 (22%) patients required multiple session (median 2; range 2–5) procedure including catheter exchange for larger size (range 14–20 F) in 20 patients, and additional catheter placement in 9 patients. The additional catheters were placed if the follow-up US revealed undrained pockets of fluid collection or abscess cavity, which was not appreciated at first session in patients. None of our patients required surgical procedure. The mean duration of hospital stay after the PCD was 6.3 days (range 3–18 days) and the mean duration of catheter removal was 11 days (range 3–57 days). Fourteen patients were discharged with catheters in situ and were managed on an outpatient basis. Whereas all LIFCs resolved almost completely at the time of catheter removal, majority of DIFCs showed significant (up of 50% of total volume) residual multiseptate fluid collection. Patients with DIFCs had a longer in-hospital stay than those with contained rupture (p = 0.01, statistically significant).

Complications of percutaneous drainage

Minor hemorrhage was the most common immediate procedure related complications observed in 14 cases; self-limiting intracavitary hemorrhage occurred in majority (n = 9) that did not require further management. Localized perihepatic hematoma developed in five patients; two of them required blood transfusion. Biliary communication with abscess cavity observed in 13 patients. Prolonged catheter drainage (median 25 days; range 9–62 days) cured the biliary fistula in all, but one 52-year-old patient developed biliary stricture at the level of confluence necessitating subsequent endoscopic treatment. This patient had a large abscess in segment IV, dilated intrahepatic duct with frank biliary communication, and cholangitis at presentation. Moderate pleural effusion developed in 13 patients after PCD; intercostal approach was used in all of them and transpleural in seven patients; spontaneous resolution occurred in all within 4 week of catheter removal. Six patients developed secondary bacterial infection after they were discharged. Three of them had been on catheter in situ, two presented with external fistula with intermittent pus discharge at catheter insertion site and in one patient, pus reaccumulated within cavity; these cases responded to multiple session wide bore catheter drainage, aggressive saline irrigation, and broad spectrum antibiotics. One 66-year-old patient with FR died within 24 h of the procedure; he had 11 abscesses and initially presented with sepsis and multiorgan failure.

Discussion

We have found that US-PCD is very effective in the management of ruptured amebic liver abscess in which medical treatment with or without percutaneous needle aspirations fails. PCD was technically successful in all types of ruptured ALA. We experienced no difficulty in drainage of any abscess or collection. Marked clinical improvement was observed in all patients within 72 h and most of them were discharged from hospital after 1 week. All patients except one were cured. None of our patients required open surgical drainage.

The first report of ruptured ALA, exclusively managed by PCD, was documented by Ken and his colleague in 1989 [12]. All of their five patients with perforated liver abscess were treated successfully by PCD under CT/US guidance. Subsequently, Baijal et al. confirmed that PCD can effectively treat the complications of ruptured ALA; they treated 13 consecutive patients with ruptured ALA using US-PCD and none of their patients required CT guidance for placement of catheters [13]. However, both of the study groups were small and free rupture cases were very few. Furthermore, authors of these two studies mentioned little about the characteristics of intraperitoneal collections and its impact on the outcome of PCD.

Our observation replicates the findings of Ken et al. and Baijal et al. in term of technical and clinical success. In this study, we have reported largest number of suc-

cessfully treated ALA patients with free intraperitoneal rupture described in the literature. The major clinical symptoms and complications in these patients are related to collection rather than the abscess. Patients with FR with DIFCs appeared more symptomatic with features of generalized peritonitis than CR. The aim of the PCD, therefore, is to drain the both collection and the abscess cavity.

The knowledge of nature and pattern of the intraperitoneal collection is important for planning treatment for both radiologist and surgeon. In this study, we found two distinct pattern of intraperitoneal collection: CR with LIFC, and FR with DIFC. LIFCs constituted about 2/3rd of intraperitoneal rupture cases; the right subphrenic space was the commonest location followed by subhepatic space. The localized collections were found to be non-septated and the fluid characters resembled the parent ruptured abscess, and were easily evacuated by single catheter. DIFCs, on the other hand, were serous in nature and showed complex septations; they required more catheters and were incompletely evacuated in most cases. These qualities of diffuse collection perhaps were because of intense reactionary ascites and associated peritonitis. In long-standing collections, development of adhesion and fibrinous peritonitis further complicates the DIFCs leading to difficulty in PCD. Localization of collection appears to be influenced by the number of abscess and total volume of abscess cavities. In our study, CR cases were more common with multiple and smaller cavities. We agree with Sarda et al. that slow leak from abscess may allow adhesion to form around the collection, leading to LIFC, whereas abrupt rupture results in DIFC [4].

Though these findings have not been described in detail in PCD series, surgical series support our observations that intraperitoneal rupture exhibit two distinct pattern. In a study published from India many years ago in 70s, Monga et al. described two patterns of rupture associated with amebic peritonitis [15]. They were convinced that CR cases can be managed conservatively while FR requires open drainage. Subsequently, a new study purported to show that the two distinct pattern genuinely affect the outcome, and conservative approach was indeed sufficient for the management of LIFCs; however, their 50% cases with generalized peritonitis required surgery [4]. Depending on the type of rupture, these authors tried to make recommendation on when surgery is appropriate in ruptured ALA. The mortality associated with surgery in management of amebic peritonitis, however, remained high and were reported up to 50% in their series [4, 15–17].

Despite complex septations, all FR cases were treated successfully. However, they required more number of catheters, and had longer hospital stay compared to CR cases. In these patients, even drainage of 50% of the collection, rather than complete evacuation, was found to be adequate as management to relieve the symptoms of peritonitis (Fig. 4C). Thus, complex septation does not preclude PCD as a therapeutic option of ruptured ALA with generalized peritonitis.

Another key factor of management of ruptured ALA is efficient evacuation of intracavitary thick necrotic material. We believe that some distinctive steps in the technique contributed in success. First of all, we used mostly multi side-holes Malecot catheter and attempted to evacuate the entire content at the time of procedure. Second, we had a low threshold for subsequent session whenever US showed significant residual debris and drainable fluid component after 2–3 days of procedure. As many as 22% of our cases required multiple session interventions which included upsizing with wide bore PVC catheter, addition of catheters, catheter manipulation, and aggressive saline irrigation to ensure evacuation of all necrotic components. Finally, we adopted a policy to discharge the patients from hospital with catheter in situ once the clinical and laboratory parameters optimally improved; this led to overall shorter hospital stay compared to previous studies [11, 12].

The presence of multiple intrahepatic abscesses and multilocularity are usually considered as factors that increase the risk of failure for PCD [18]. In our study, 40% of patients had multiple liver abscesses, and we experienced no difficulty in placement of multiple catheters (up to 16) in these cases (Fig. 3). Although, some authors have reported multilocularity in up to 30% of their cases, all of the drained abscesses in this study were unilocular [12, 19].

Thoracic complications occur from direct transdiaphragmatic invasion of the pleura or lung by the *Entamoeba histolytica*. Extension to the pleura results in pleural collection or empyema, and invasion into lung leads to pneumonic consolidation or a lung abscess, which subsequently may empty into bronchi resulting in HBF. Gas within the abscess cavity and expectoration of sputum resembling amebic abscess is highly suggestive of HBF (Fig. 5); this was found in three of six patients with thoracic complications [19]. Low incidence of thoracic complications in this study may be for two reasons. First, this study included only those cases in whom medical therapy had failed and second, we might have missed diagnosis of thoracic complications, since US has low sensitivity for thoracic complications; in this study, CECT was performed in selected cases only. Although, none of our patients demonstrated abscess ruptured into retroperitoneum, pericardium, and bowel, these complications have been documented in various studies [19, 20].

The major limitation of this study was lack of control group. This study has only evaluated those patients who were referred to radiology department for PCD. We had no group of surgically or medically treated patients for head-to-head comparison.

Complications of US-PCD are usually minor. We observed a high incidence of secondary bacterial infection in this study; this occurred predominantly in those patients who required prolonged catheter drainage. This could be due to combination of factors which facilitated bacterial growth in residual cavity including thick necrotic residual material, inadequate drainage by small size catheter, prolonged drainage, malnutrition, and poor catheter care. Two of these patients presented with cavito-cutaneous fistula; this is a rare complication of PCD and has been not described in literature. Both these patients had multiple superficially located abscesses which required prolonged drainage for more than a week, were severely malnourished, and probably had subclinical secondary infection within the cavity at the time of catheter removal; these factors prevented healing of the tract, resulting in fistula formation. Like others, all our cases of biliary fistula were cured by prolonged catheter drainage except one who developed biliary stricture requiring endoscopic stenting [12, 18, 21]. We believe that secondary bacterial infection in ALA with wide biliary communication leads to cholangitis and eventually may facilitate the formation of fibrous stricture. Self-limiting pleural effusion also was relatively frequent complication in our study. This is thought to be the consequence of catheter-induced irritation of the diaphragm or pleura with intercostals approach for PCD.

Amebic liver abscess is almost exclusively a disease of men [22]. The reason for this strong sex predilection is unknown but we believe that high prevalence of chronic *toddy* drinking and associated malnutrition may be a contributing factor for the high incidence of ALA in this part of country [22]. *Toddy* is a locally fermented alcoholic beverage made from sap of palm tree in India and the habit of its consumption is highly prevalent in rural area of Bihar especially among the males of low socioeconomical class. More than 90% of our patients were chronic *toddy* drinkers, and about three-fourths of patients were hypoproteinemic. Hai et al. in a review of 220 patients from the same area have discovered a strong association between *toddy* drinking and ALA [23]. Studies published from Sri Lanka and Bangladesh also revealed a strong association between consumption of similar locally fermented alcoholic beverage and ALA [24, 25]. Parasitic contamination of the unhygienically prepared drink seems the most plausible explanation for this association.

US-PCD is technically feasible in most cases of ruptured ALA. None of our patients required CT guidance for drainage purpose. Although caution must be used in placing the catheter under US guidance to avoid the needle puncture of bowel, we found bowel loops clearly off the intraperitoneal collection in all patients (Fig. 4B). Ability of US to depict the degree of liquefaction of ALA and complexity of collection provides valuable information to both the radiologist and the surgeon in planning of drainage. US is a cheap and widely available modality. Therefore, based on the result of this study, we believe that US guidance alone may suffice in most of the cases, and CT guidance is seldom needed for management of complications of ALA.

In conclusion, US-PCD is safe and highly effective in treating all types of ruptured ALA, and can obviate the need for surgical drainage in most of the cases. We recommend it as a first-line therapy for ruptured ALA.

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Compliance with ethical standards

Funding No funding was received for this study.

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Our institutional review board approved this retrospective study and waived the requirement for informed consent.

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