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USG-Guided Percutaneous Drainage versus Open Laparotomy for Ruptured Liver Abscess: A Prospective Comparative Study

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Abstract: ***Background: Ruptured liver abscess is a life-threatening surgical emergency associated with substantial morbidity and mortality. Although ultrasound-guided percutaneous drainage is widely used for uncomplicated liver abscesses, evidence comparing it with open laparotomy in ruptured cases remains limited. This study compared the outcomes of these two treatment approaches. Methods: A prospective observational comparative study was conducted at a tertiary care centre in northern India between January 2024 and January 2025. A total of 100 adults with radiologically confirmed ruptured liver abscess were included. Patients underwent either ultrasound-guided percutaneous drainage (n=64) or open laparotomy (n=36) according to clinical condition and surgeon discretion. Clinical recovery, hospital stay, complications, and mortality were evaluated. Results: Patients treated with percutaneous drainage showed significantly earlier clinical recovery and shorter hospital stay than those undergoing open laparotomy (2.95±1.39 vs 4.56±1.18 days and 6.63±3.10 vs 9.67±3.97 days, respectively; p<0.001). Mortality was significantly higher in the open laparotomy group (19.4% vs 0%; p<0.001). Sepsis, bleeding, and wound infection were more frequent after surgery. Shock, leukocytosis, hyperbilirubinaemia, and elevated transaminases were more common among surgical patients. Conclusions: Percutaneous drainage was associated with faster recovery, fewer complications, and lower mortality, whereas open laparotomy remained necessary in severe or refractory cases.***

Keywords: Ruptured liver abscess; Percutaneous drainage; Open laparotomy; Pyogenic liver abscess; Surgical outcomes

1. Introduction

Liver abscess continues to be one of the major causes of illness and death in tropical and underdeveloped nations due to the high prevalence of both amoebic and pyogenic infections. [1] Amoebic liver abscess, which is primarily caused by Entamoeba histolytica infection, is a common entity in endemic areas, whereas pyogenic liver abscess is frequently seen in biliary disease, diabetes mellitus, and immunocompromised patients. [2]

Spontaneous rupture into the peritoneum can result in severe morbidity and mortality from peritonitis, septic shock, organ dysfunction, and increased in-hospital deaths.[3] The clinical manifestations of spontaneous rupture include acute abdomen, hemodynamic instability, and systemic inflammation requiring prompt management and diagnosis. [4] Various risk factors of spontaneous rupture of liver abscess have been described previously, including huge abscesses, left lobe liver abscesses, multiple abscesses, delayed presentation, and high serum bilirubin concentration. [2, 3]
The approach to liver abscess treatment has seen many developments in the past two decades. Ultrasound-assisted percutaneous drainage, through needle aspiration or catheterization, has become a replacement for open drainage in hemodynamically stable patients. [5] The benefits of percutaneous drainage include continuous drainage, precise guidance by imaging technique, no need for general anesthesia, and a repeatable procedure. Meta-analysis and systematic review have confirmed a higher success rate, quicker resolution of symptoms, reduced need for prolonged antibiotic therapy, and lower recurrence rate with catheter drainage than needle aspiration. [6, 7]

Although there has been growing support from the literature on minimally invasive techniques, the optimal management of ruptured liver abscess still eludes consensus among physicians. Laparotomy is indicated for a ruptured liver abscess in patients with peritonitis, persistent hemodynamic instability after resuscitation, and multiple cavities unsuitable for drainage. [8] Nevertheless, surgery is a major source of morbidity in critically ill patients with intra-abdominal infection, where risks include wound infection, hemorrhage, delayed recovery, and extended stay in hospital. [4] Few randomized controlled trials are comparing percutaneous versus surgical treatment of ruptured liver abscess; existing literature is retrospective or non-comparative study designs. [3] Moreover, no definite predictors of failure necessitating surgery after percutaneous intervention in these patients have yet been described. In previous studies among all patients

with liver abscesses, some common predictors of failure and death were noted to be presence of blood cultures positive for organisms, liver cirrhosis, persistent fever, jaundice, and septic encephalopathy. [9, 10] Nevertheless, no study has been conducted to assess predictors of treatment failure in a specific cohort of ruptured liver abscesses.

Hence, the current prospective comparative study was planned to assess the results of both ultrasound-guided percutaneous drainage and open laparotomy performed on patients with ruptured liver abscesses admitted at a tertiary care center located in northern India. The study was designed to compare various aspects of recovery, including hospital stay, post-procedure complications, necessity of re-intervention, and predictors of treatment failure necessitating surgery.

2. Materials and Methods

This prospective observational comparative study was conducted in the Department of General Surgery, BRD Medical College, Gorakhpur, which is a tertiary care referral center, from January 2024 to January 2025. This research work was carried out to compare the clinical results of percutaneous drainage under ultrasound guidance versus laparotomy for ruptured liver abscesses.

The criteria for including adult patients suffering from ruptured liver abscess after physical examination and diagnostic radiology (ultrasound and/or contrast-enhanced computed tomography) were set. The patients requiring interventions in the study period were enrolled in the study consecutively.

The patients whose ages were 18 years or more, having ruptured liver abscess as proved by radiology and treated with ultrasound-guided drainage or surgical intervention, were included in the study. Patients managed conservatively without any intervention or surgery, and who had cancer or any other coagulation disorder, were not included in the study.

The sample size was determined based on the outcome variable morbidity, taking into consideration that the expected prevalence of 28% is based on the study conducted by Hori et al., at a confidence level of 95%, with a margin of error of 7%. The minimum sample size required for this study was estimated to be 100 patients. A consecutive sampling procedure was employed, and all eligible patients were enrolled until the desired number of respondents was obtained.

Patients were categorised into two groups according to the intervention performed based on clinical condition, imaging findings, and the treating surgeon's discretion.

The Percutaneous Drainage Group (PDG) included patients managed with ultrasound-guided needle aspiration or catheter drainage. The Open Laparotomy Group (OLG) included patients who underwent exploratory laparotomy with open surgical drainage of the abscess cavity. Open surgical intervention was generally reserved for patients with diffuse peritonitis, haemodynamic instability, multiloculated abscesses, or failed percutaneous drainage.

The baseline patient characteristics, like age, gender, chief complaints, comorbidity, alcohol consumption, lab studies, and radiological imaging, were recorded at the time of admission. Abscess parameters, such as size, number, localization, and rupture, were also noted down. Intervention data, consisting of the type of procedure done, duration of the procedure, the necessity of repeat intervention, and peri-procedural complications, were recorded.

Clinical recovery and hospitalization duration formed the primary outcome measures, while the secondary outcome parameters were complication rate, further reintervention requirement, recurrence, and mortality rate.

Follow-up data were obtained for all subjects up to one month post-intervention. Follow-up data consisted of symptom relief, recurrence of liver abscess, post-procedural complications, and other procedures needed.

Selection bias was avoided by adopting consecutive enrollment for all subjects in the study period. The standard evaluation procedure was adopted for all clinical, laboratory, and radiographic evaluations in the subjects. The outcomes were evaluated using predetermined clinical and radiographic criteria.

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment. Patient confidentiality and data privacy were maintained throughout the study.

Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the independent Student's *t*-test or Mann–Whitney *U* test for continuous variables and chi-square test or Fisher's exact test for categorical variables, as appropriate. A two-tailed p value of <0.05 was considered statistically significant.

3. Observation and Analysis

In total, 100 patients with ruptured liver abscess were enrolled in the study, and follow-up analysis was performed. The interventions were divided into two groups: the percutaneous drainage group (PDG) and the open laparotomy group (OLG). The baseline demographic and clinical data are shown in Table 1. The mean age was comparable between the PDG and OLG (45.11 ± 13.56 years vs 46.56 ± 11.82 years; p=0.594). Male predominance was seen in both groups, with 95.31% and 94.44% of patients, respectively, being male (p=1.000). Likewise, the use of alcohol was prevalent in both groups and not statistically different (98.44% vs 94.44%; p=0.294) (Table 1). Haemodynamic stability at presentation was much more common in the PDG than in the OLG (96.88% vs 50.00%, p<0.001). On the other hand, the proportion of those who were shocked at admission was significantly higher in

patients who had undergone open laparotomy (50.00% vs 1.56%, p<0.001) (Table 1).

Table 1: Baseline demographic and clinical profile of study participants

Variable	Percutaneous drainage (n=64)	Open laparotomy (n=36)	p-value
Age, years	45.11 ± 13.56	46.56 ± 11.82	0.594
Male	61 (95.31%)	34 (94.44%)	1
Alcohol use	63 (98.44%)	34 (94.44%)	0.294
Stable at admission	62 (96.88%)	18 (50.00%)	<0.001
Shock at admission	1 (1.56%)	18 (50.00%)	<0.001

There were no significant differences in mean haemoglobin, platelet count, or INR between the two groups (p>0.05). However, patients in the OLG had significantly higher mean white blood cell counts (23275.03 ± 8009.86 vs 16753.13 ± 4870.77; p<0.001), serum bilirubin levels (1.81 ± 2.45 vs 0.99 ± 0.87; p=0.016), ALT levels (129.97 ± 114.32 vs 76.62 ± 49.93; p=0.002), and AST levels (141.97 ± 121.39 vs 77.87 ± 81.17; p=0.002) compared with the PDG (Table 2).

Table 2: Comparison of Laboratory Parameters and Abscess Characteristics between Percutaneous Drainage and Open Laparotomy Groups

Variable	Percutaneous drainage	Open laparotomy	p-value
Hemoglobin	10.36 ± 1.47	10.71 ± 1.73	0.299
WBC count	16753.13 ± 4870.77	23275.03 ± 8009.86	<0.001
Platelet count	241531.25 ± 132623.70	203805.56 ± 97156.67	0.138
Serum bilirubin	0.99 ± 0.87	1.81 ± 2.45	0.016
ALT	76.62 ± 49.93	129.97 ± 114.32	0.002
AST	77.87 ± 81.17	141.97 ± 121.39	0.002
INR	1.30 ± 0.33	1.31 ± 0.24	0.829

Patients who were treated by percutaneous drainage were found to have significantly shorter duration of clinical improvement (2.95 ± 1.39 days vs 4.56 ± 1.18 days; p<0.001) and hospital stay (6.63 ± 3.10 days vs 9.67 ± 3.97 days; p<0.001) than the OLG. No difference was seen between the two groups in terms of reintervention or intercostal drainage tube insertion (p>0.05). The OLG had significantly more mortalities than the PDG (p<0.001) (Table 3).

Table 3: Comparison of Clinical Outcomes and Treatment Effectiveness between the Two Treatment Groups

Outcome	Percutaneous drainage	Open laparotomy	p-value
Time to clinical improvement	2.95 ± 1.39 days	4.56 ± 1.18 days	<0.001
Hospital stay	6.63 ± 3.10 days	9.67 ± 3.97 days	<0.001
Re-intervention needed	4 (6.25%)	1 (2.86%)	0.651
ICD insertion	13 (20.31%)	6 (16.67%)	0.857
Mortality	0 (0.00%)	7 (19.44%)	<0.001

The PDG group had a significantly higher proportion of patients who did not have any complications (71.88% vs 30.56%, p<0.001). Biliary leak and tube blockage were seen in only the PDG, in 12.50% and 15.63% of patients, respectively. Sepsis, bleeding, and wound infection were, on the other hand, only seen in the OLG (25.00%, 44.44%, and 25.00%) (Table 4).

Table 4: Comparison of Post-Procedure Complications and Reintervention Rates between Treatment Groups

Complication	Percutaneous drainage	Open laparotomy	p-value
No complication	46 (71.88%)	11 (30.56%)	<0.001
Biliary leak	8 (12.50%)	0 (0.00%)	
Tube block	10 (15.63%)	0 (0.00%)	
Sepsis	0 (0.00%)	9 (25.00%)	
Bleeding	0 (0.00%)	16 (44.44%)	
Wound infection	0 (0.00%)	9 (25.00%)	

Patients who needed open laparotomy had significantly higher rates of shock at presentation than patients who did not need laparotomy (50.00% vs 1.56%; p<0.001). Also there was significant association of higher white blood cell count, serum bilirubin, ALT and AST with surgery (p<0.05). Moreover, the incidence of complications and deaths was significantly greater in the OLG (p<0.001) (Table 5).

Table 5: Predictors Associated with Treatment Failure Requiring Surgical Intervention in Patients with Ruptured Liver Abscess

Factor	Finding
Shock at admission	Much higher in OLG: 50.00% vs 1.56%, p<0.001
High WBC count	Higher in OLG, p<0.001
Raised bilirubin	Higher in OLG, p=0.016
Raised ALT/AST	Higher in OLG, p=0.002
Complications	Higher in OLG, p<0.001
Mortality	Higher in OLG, p<0.001

4. Discussion

In the current prospective comparative study, ultrasound-guided percutaneous drainage had more favourable clinical outcomes in patients with ruptured liver abscesses than open laparotomy. In patients undergoing percutaneous drainage, clinical improvement occurred more rapidly, hospital length of stay was shorter, and mortality was significantly reduced. The mortality rate in the PDG was nil, while it was 19.44% in the OLG. Among surgically treated patients, post-procedural complications like sepsis, haemorrhage, and wound infection were seen, whereas in the percutaneous drainage group, the post-procedural complications were mainly procedure-related, such as tube blockage and biliary leak, and were not fatal. These results are further prospective evidence in support of the utility of minimally invasive management of selected patients with ruptured liver abscess.

The predominant age group of the patients was in the middle age group, which mainly comprised alcohol users, similar to the epidemiological profile of the patients reported by ***Gupta et al.*** in the endemic regions of northern India for the disease. [11] Demographic characteristics, such as age and sex, as well as alcohol abuse, were the same for both groups of patients, which supports the validity of the comparison. Haemodynamic status at presentation was, however, distinctly different between the two groups, with half of the patients in the open surgery group being in shock when they arrived in the emergency department compared to less than 2% of the patients in the PDG. This may be due to the treatment policy in the institution, where unstable haemodynamics, diffuse peritonitis, and severe disease pattern were criteria for surgery. Thus, it must be recognized

that baseline severity of disease was an important confounder in the analysis.

The clinical improvement and hospital stay were much quicker for the PDG compared with the surgical group. This is consistent with the current scientific literature, which has supported the use of less invasive methods for the treatment of liver abscess. In their prospective comparative study, ***Kulhari and Mandia*** observed that patients who underwent pigtail catheter drainage showed a more rapid improvement of symptoms and shorter hospital stay than did patients who underwent needle aspiration. [12] Similarly, ***Lin et al.,*** in a recently published meta-analysis of 10 RCTs, showed that catheter drainage was associated with quicker time to improvement and fewer days of intravenous antibiotic courses. [6] The recovery period was shorter in this study than in previous studies, possibly due to the lower invasiveness of percutaneous intervention, lower physiological stress, and a relatively stable clinical status of the patients who underwent this procedure.

The case group receiving percutaneous drainage had significantly fewer complications than the case group that was operated on using the open approach. The surgical group experienced more cases of septicemia, bleeding, and wound infections, which is likely due to intra-abdominal sepsis, as well as surgical stress in critical patients. ***Reza et al.*** also reported that the complication rate and mortality rate were high in the surgical treatment group that had liver abscesses drained. [4] The other group, however, had mostly procedural complications such as biliary leakage and clogging of drains, which were managed effectively without mortality. Although rare, life-threatening complications like hepatic laceration after percutaneous drainage had been reported earlier, no such complication was found in the current study. [13]

Higher rates of mortality were observed in the OLG; however, this needs to be interpreted in the context of the presence of a markedly higher degree of severity of the illness in surgically treated patients. Patients who died all had septic shock, marked inflammatory response and symptoms of liver failure. The same observations had been made by other authors when studying the clinical outcomes of liver abscesses. For instance, ***Jindal et al.*** found a relatively low overall mortality rate in patients who were mostly managed with the use of percutaneous techniques, and found septic encephalopathy, cirrhosis of the liver, and jaundice as the factors contributing to the poor prognosis of the disease. [10] Similarly, ***Boaz et al.*** noted that a minority of patients needed surgery following the percutaneous treatment. [14] Overall, these data indicate that the higher mortality rate in the OLG was likely related to the severity of the underlying disease and haemodynamic instability, rather than to the laparotomy procedure itself, though the increased stress of laparotomy in the critically ill patient may be a factor.

At presentation, shock, leukocytosis, hyperbilirubinaemia, and high transaminase were also associated with surgery requirement in this current study. There have been reports in previous literature concerning similar findings regarding adverse outcomes and subsequent need for escalation in management. In one of these studies, by ***Czerwonko et al.,*** elevated bilirubin and both lobes of the liver involvement were found as independent predictors of mortality in the liver abscess patients. [15] Similarly, in another study conducted by ***Zhang et al.,*** the presence of positive blood cultures, cirrhosis of the liver, and failure to achieve a rapid resolution of fever are independent risk factors for treatment failure in percutaneous drainage alone. [9] Moreover, in another study by ***Cho et al.,*** haemodynamic instability and systemic signs of sepsis were also identified as factors associated with the progression to septic shock and mortality. [16] These clinical and biochemical abnormalities could, therefore, indicate a higher risk of failure of percutaneous treatment and may warrant closer clinical monitoring and early surgical evaluation.

For haemodynamically stable patients, including some cases of ruptured liver abscess, percutaneous drainage has become the primary treatment modality of choice. ***Priyadarshi et al.*** had reported that ultrasound-guided catheter drainage has achieved good technical success and clinical success in the treatment of AMLA, with high success rates even in cases with intraperitoneal rupture, and recommended it as an effective initial management approach in the treatment of ruptured AMLA. [3] In the same way, ***Li and Pan*** showed in a recent meta-analysis that percutaneous catheter drainage yielded higher rates of treatment success, quicker clinical recovery, and fewer recurrences than needle aspiration, while having similar complication rates. [17] The advantages of percutaneous drainage, including real-time imaging guidance, reduced procedural invasiveness, avoidance of general anaesthesia, and the possibility of repeat intervention, make it particularly valuable in resource-limited settings where postoperative intensive care resources may be constrained.

However, despite these advantages, open laparotomy continues to play an important role in selected patients, particularly those presenting with diffuse peritonitis, persistent haemodynamic instability, inaccessible multiloculated collections, or failure of minimally invasive drainage. ***Ndong et al.,*** in a systematic review, also highlighted the potential role of laparoscopic drainage as an intermediate option between percutaneous and open approaches in suitable cases. [18] These findings suggest that open surgery should be reserved mainly for severe or refractory disease rather than used as the routine initial approach.

Several limitations of the present study should be acknowledged. The non-randomised observational design introduces the possibility of selection bias, as treatment allocation was based on clinical judgement. Patients undergoing open laparotomy had greater disease severity at baseline, which likely influenced outcomes. In addition, this was a single-centre study conducted at a tertiary care institution, which may limit the generalisability of the findings. Although the sample size was adequate for comparison of major outcomes, it may not have been sufficient for detailed multivariable analysis. The relatively short follow-up period also limited assessment of long-term recurrence and delayed complications.

The findings of this study are most applicable to tertiary-care centres in tropical and resource-limited settings where liver abscess remains common. Overall, the present study supports

ultrasound-guided percutaneous drainage as an effective initial management strategy for ruptured liver abscess in haemodynamically stable patients, with shorter recovery, fewer complications, and lower mortality compared with open laparotomy. Open surgery remains essential in patients with severe sepsis, diffuse peritonitis, haemodynamic instability, or failed minimally invasive management. Clinical and biochemical markers such as shock, marked leukocytosis, hyperbilirubinaemia, and elevated transaminase levels may help identify patients requiring early surgical escalation.

Ultrasound-guided percutaneous drainage was associated with faster recovery, shorter hospital stay, fewer complications, and lower mortality than open laparotomy in haemodynamically stable patients with ruptured liver abscess. However, laparotomy remained essential in patients with diffuse peritonitis, severe sepsis, haemodynamic instability, or failed minimally invasive management. Shock at presentation, marked leucocytosis, hyperbilirubinaemia, and elevated transaminase levels may help identify patients requiring early surgical intervention.

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Declaration

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References

[1] Khim G, Em S, Mo S, Townell N. Liver abscess: diagnostic and management issues found in the low resource setting. Br Med Bull. 2019;132(1):45-52. Available at: https://doi.org/10.1093/bmb/ldz032.
[2] Sahu V, Pipal DK, Singh Y, Verma V, Singaria M, Pipal VR, et al. Epidemiology, clinical features, and outcome of liver abscess: a single-center experience. Cureus. 2022;14(10):e29812. Available at: https://doi.org/10.7759/cureus.29812
[3] Priyadarshi RN, Prakash V, Anand U, Kumar P, Jha AK, Kumar R. 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. Abdom Radiol (NY). 2019;44(3):877-885. Available at: https://doi.org/10.1007/s00261-018-1810-y
[4] Reza E, Hasan R, Hossain A, Islam M. Outcome of management of liver abscess by surgical approach in a tertiary care hospital. Mymensingh Med J. 2021;30(1):85-89.
[5] Levin DC, Eschelman D, Parker L, Rao VM. Trends in use of percutaneous versus open surgical drainage of abdominal abscesses. J Am Coll Radiol. 2015;12(12 Pt A):1247-1250. Available at: https://doi.org/10.1016/j.jacr.2015.06.015
[6] Lin JW, Chen CT, Hsieh MS, Lee IH, Yen DH, Cheng HM, et al. Percutaneous catheter drainage versus percutaneous needle aspiration for liver abscess: a systematic review, meta-analysis and trial sequential analysis. BMJ Open. 2023;13(7):e072736. Available at: https://doi.org/10.1136/bmjopen-2023-072736
[7] Mahmoud A, Abuelazm M, Ahmed AAS, Elshinawy M, Abdelwahab OA, Abdalshafy H, et al. Percutaneous catheter drainage versus needle aspiration for liver abscess management: an updated systematic review, meta-analysis, and meta-regression of randomised controlled trials. Ann Transl Med. 2023;11(5):190. Available at: https://doi.org/10.21037/atm-22-4663
[8] Rismiller K, Haaga J, Siegel C, Ammori JB. Pyogenic liver abscesses: a contemporary analysis of management strategies at a tertiary institution. HPB (Oxford). 2017;19(10):889-893. Available at: https://doi.org/10.1016/j.hpb.2017.06.005
[9] Zhang S, Xu Q, Liu C, Wu Z, Chen Z, Gu S. Management and prognostic prediction of pyogenic liver abscess in a Chinese tertiary hospital: percutaneous needle aspiration vs catheter drainage. PLoS One. 2024;19(12):e0315371. Available at: https://doi.org/10.1371/journal.pone.0315371
[10] Jindal A, Pandey A, Sharma MK, Mukund A, Vijayaraghavan R, Arora V, et al. Management practices and predictors of outcome of liver abscess in adults: a series of 1630 patients from a liver unit. J Clin Exp Hepatol. 2021;11(3):312-320. Available at: https://doi.org/10.1016/j.jceh.2020.10.002
[11] Gupta A, Thakur N, Chaudhary AK, Patel U, Arti. Clinical outcomes of liver abscesses in adults: a 10-year experience at a tertiary care center in northern India. Cureus. 2024;16(12):e75454. Available at: https://doi.org/10.7759/cureus.75454
[12] Kulhari M, Mandia R. Prospective randomized comparative study of pigtail catheter drainage versus percutaneous needle aspiration in treatment of liver abscess. ANZ J Surg. 2019;89(3):E81-E86. Available at: https://doi.org/10.1111/ans.14917
[13] Zhang L, Wan D, Zhang L, Xu S, Xie H, Lin S. Hepatic rupture: a case report of a severe complication of percutaneous catheter drainage. Medicine (Baltimore). 2018;97(2):e9499. Available at: https://doi.org/10.1097/MD.0000000000009499
[14] Boaz E, Ben-Chetrit E, Bokhobza Y, Yellinek S, Ben-Haim M, Reissman P, et al. Pyogenic liver abscess: contemporary trends in a tertiary institute. Int J Clin Pract.
[15] Czerwonko ME, Huespe P, Bertone S, Pellegrini P, Mazza O, Pekolj J, et al. Pyogenic liver abscess: current status and predictive factors for recurrence and mortality of first episodes. HPB (Oxford). 2016;18(12):1023-1030. Available at: https://doi.org/10.1016/j.hpb.2016.09.001
[16] Cho H, Lee ES, Lee YS, Kim YJ, Sohn CH, Ahn S, et al. Predictors of septic shock in initially stable patients with pyogenic liver abscess. Scand J Gastroenterol. 2017;52(5):589-594. Available at: https://doi.org/10.1080/00365521.2017.1288757

[17] Li XF, Pan DM. Comparative analysis of percutaneous aspiration and percutaneous catheter drainage for the treatment of liver abscess: a systematic review and meta-analysis. Medicine (Baltimore). 2025;104(37):e44465. Available at: https://doi.org/10.1097/MD.0000000000044465
[18] Ndong A, Tendeng JN, Diallo AC, Dieye A, Diao ML, Diallo S, et al. Efficacy of laparoscopic surgery in the treatment of hepatic abscess: a systematic review and meta-analysis. Ann Med Surg (Lond). 2022;75:103308. Available at: https://doi.org/10.1016/j.amsu.2022.103308