Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

Original Research

A retrospective analysis of pyogenic liver abscess and antibiotic Susceptibility of common pathogens at a tertiary centre

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Received: 29 October, 2023 Accepted:15 November, 2023

Abstract

Background: Pyogenic liver abscess is a life-threatening disease with high morbidity and mortality. The aim was to investigate the common pathogens and discern the clinical features and microbiological characteristics of PLA more broadly, as well as to identify the most suitable antibiotics for the prevention and treatment of PLA.

Materials and Methods: The present retrospective observational study consisted of 80 male patients diagnosed with pyogenic liver abscesses. The study was evaluated based on history-taking and clinical examination. The medical and microbiological records of all the PLA patients who were hospitalized and treated at NMCH, Patna, were retrospectively reviewed. Demographic data and medical information were also retrospectively collected.

Results: Males were more commonly affected than females. The mean age of the study patient was 46±16.50 years, and the P value was 0.02 (significant). The mean length of hospital stay was 14.27 ± 4.61 days, and the P value was <0.001 (significant). In our current study, K. pneumoniae and E. coli were the most common pathogens causing pyogenic liver abscess, affecting 65% and 15% of patients, respectively. The most common lobe affected in liver abscesses was the right hepatic lobe (76.25%). Both gender and size of liver abscess between 5 and 10 cm were common.

Conclusion: Needle aspiration under USG is done for small abscesses (≤200 ml), whereas percutaneous drainage with pigtail catheter placement was done for large abscesses (>200 ml) under USG guidance were most effective interventions.

Keywords: pyogenic liver abscess (PLA), Klebsiella pneumonia, E. coli, Citrobacter, antibiotic susceptibility

Introduction

The liver is the most vital metabolic core and the largest organ of the human body. Hepatocytes are the main functional unit of the liver and perform many crucial roles, which include bile production, lipid metabolism, and protein synthesis [1]. Pyogenic liver abscess (PLA) is a life-threatening disease with high morbidity and mortality [2]. Recent studies reported a worldwide increase of PLA to 11–31% mortality rates, with nearly 10,000 acute morbidities annually [3]. According to recent reports, PLA has become an emerging public health problem worldwide, even affecting the European and American populations [4, 5]. The diagnosis and therapeutic strategies of PLA are medical challenges due to the wide (non-specific) and numerous symptoms, which include fever, nausea, vomiting, abdominal pain, and asthenia [6, 7]. PLA is accompanied by many chronic diseases or risk factors, including diabetes mellitus, cardiovascular diseases, malignancies, cholangitis, urinary tract disease, pneumonia, autoimmune disease, and malnutrition [8]. PLA diagnosis has increased due to advances in medical science, including ultrasonography and computed tomography scans [9]. Surgical drainage was the only definitive supplement to antimicrobial therapy. With advances in cross-sectional imaging, percutaneous drainage has now become the first choice, while surgical intervention is reserved as a salvage therapy [10].

Aims and objectives

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The aim was to investigate the common pathogens and discern the clinical features and microbiological characteristics of PLA more broadly, as well as to identify the most suitable antibiotics for the prevention and treatment of PLA.

Materials and Methods

The present retrospective observational study consisted of 80 male patients diagnosed with pyogenic liver abscess attaining out-patient departments (OPD) or emergencies at the Department of General Surgery in collaboration with the Department of Microbiology at Nalanda Medical College & Hospital, Patna, Bihar, India, for a period of two years (July 2021–June 2023). The Institutional Ethics Committee gave the study its approval. I found 165 patients with liver abscesses during the current study period. Out of the 165 patients, 80 had a pyogenic liver abscess, and 85 had an amoebic liver abscess. Only patients with pyogenic liver abscesses based on culture media were taken into consideration in the current study. All the cases of liver abscess admitted were male.

Keeping power (1-beta error) at 80% and confidence interval (1-alpha error) at 95%, the minimum sample size required was 60 patients; therefore, we included 80 (more than the minimum required number of cases) patients in the present study.

Inclusion criteria

- All males cases of liver abscess diagnosed clinically and/or ultrasonographically
- Clinical symptoms of liver abscess, such as fever, chills, and abdominal pain;
- Microbiological identification of the blood and the pus
- Image examinations for abscesses in the liver judged by abdominal ultrasonography (USG), computerised tomography (CT), or magnetic resonance imaging (MRI) and
- Surgical findings.

Exclusion criteria

- Past history of liver abscesses
- Amoebic liver abscesses
- diagnosed with an amoebic liver abscess or an infected liver cyst;
- Patients with incomplete medical treatment data
- Bleeding tendency
- Pregnant.
- Traumatic liver abscess

The study was evaluated based on history-taking and clinical examination. The medical and microbiological records of all the PLA patients who were hospitalized and treated at NMCH, Patna, were retrospectively reviewed. Demographic data and medical information were also retrospectively collected. A comprehensive analysis of demographic characteristics, clinical manifestations, microbiological identification, auxiliary examinations, management, and outcome was performed. Data were collected by reviewing the medical records of each patient. The clinical records included demographic characteristics (age and sex), length of hospital stays, accompanying diseases, clinical patterns (signs and symptoms), laboratory values (hematologic and biochemical), microbiological reports, imaging features, diagnosis, management (antimicrobial therapies, interventional drainages, surgeries), and outcome. Samples from each patient were cultured under aerobic conditions only. We collected the peripheral blood samples when patients were in the following situations:

- body temperature above 38°C or less than 36°C;
- had chills;
- Leukocyte count above 10 109/L or less than 4 109/L

Culture was done conventionally on Mac Conkey agar, blood agar, and Brain Heart Infusion Broth (BHIB). The incubation temperature was set at 37°C for 5 days. Samples from each patient were cultured aerobically only.

Antibiotic treatments: All patients received intravenous antibiotic therapy empirically at the beginning. Individualized treatments were selected according to the condition. Antibiotics included the third generation of cephalosporin, fluoroquinolone, carbapenems, and metronidazole. If there was no response to the initial treatments, the antibiotics were adjusted according to the results of the cultures. The course of intravenous antibiotic therapy lasted from two to four weeks individually. Abdominal ultrasound, CT scan, or MR imaging can identify the abscess effectively. All the samples, including blood and pus, were processed for bacterial culture in the Department of Microbiology at Nalanda Medical College and Hospital, Patna. The pathogens causing pyogenic liver abscesses were also exposed to antibiotic susceptibility testing. The antibiotic susceptibility testing was performed by the agar disc diffusion method following current CLSI guidelines. The antibiotics used for the susceptibility test included: amoxycillin, cefotaxime, cefixime, cefoxitin, norfloxacin, ciprofloxacin, gentamicin, amikacin, clindamycin, erythromycin, piperacillin, doxycycline, cotrimoxazole, and enoxacin.

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Statistical analysis: Analysis used the SPSS version 22.0 statistical software and Microsoft 16. All the categorical variables were described as percentages. Continuous data were presented as the mean with the standard deviation (SD). The Student's t-test and Chi-square test were used to evaluate the differences in variables. Logistic regression analysis was applied to analyse the risk factors for disease outcomes. Statistical tests were performed with a two-tailed significance level of 0.05.

Results

The present study included 80 male patients who were diagnosed with liver abscesses. Males were more commonly affected than females. Ages ranged from 10 to 56 years, and the mean age of the study patient was 34±12.50 years, and the P value was 0.02 (significant). The mean length of hospital stay was 14.27 ± 4.61 days, and the P value was <0.001 (significant).

Table 1: Demographic characteristics of patients with Liver Abscess

Age in years	**No. of cases**	Percentage
10-20	7	8.75%
21-30	12	15%
31-40	22	27.5%
41-50	31	38.75%
>50	8	10%
Total	**80**	**100%**

Table 3 show that, the most of patient with PLA lies between 30-50 years old**.**

Table 2: Clinical manifestations of patients with liver abscess

Clinical Manifestations	No. of patients	Percentage
Intercostal tenderness	72	90%
Fever	69	86.25%
Upper right abdominal pain	27	33.75%
Nausea /Vomiting	20	25%
Chills	17	21.25%
Jaundice	3	3.73%

Table 2 shows that, Clinical manifestations of study 80 patients included fever (86.25%), upper right abdominal pain (33.75%), nausea or vomiting (25%), and chills (20.0%), whereas jaundice was not common and only presented in three patients (3.73%).

Table 3: Laboratory findings (mean value) for pyogenic liver abscess patients

Variable	Cut-off range	Mean ± SD	P value
Haemoglobin (g/dL)	11.5-15	12.79 ± 2.81	0.82
WBC ($\times 10^9$/L)	4-10	10.85± 0.50	0.60
Neutrophil (%)	50-70	78.65± 1.72	0.25
Platelet ($\times 10^9$/L)	150-350	215.92± 16.20	0.40
ALT (U/L)	10-50	66.47±12.63	0.72
AST (U/L)	5-40	60.93±11.72	0.20
ALP (U/L)	30-120	162.58±15.40	0.002*
GGT (U/L)	10-60	142±14.50	0.01*
CRP (mg/L)	0-8	106.57 ± 8.32	0.001*
PCT (ng/ml)	0-0.5	12.57 ± 3.76	0.10

*ALT = Alanine transaminase, AST = Aspartate transaminase, ALP = Alkaline phosphatase, GGT = Gamma glutamyl transpeptidase, C = reactive protein, PCT = procalcitonin, *Significant value*

Table 3 show that, Laboratory findings (mean value) for pyogenic liver abscess patients showed that inflammatory biomarkers were generally elevated, including C-reactive protein (CRP = 106.57 mg/L), leukocyte counts (58.6%, 41/70), neutrophil counts (78.65%), and procalcitonin (12.57 ng/ml). Patients presented with a normal mean value of haemoglobin and platelet count, whereas liver function test mean values were elevated: ALT (66.47 U/L), AST (60.93 U/L), alkaline phosphatase (ALP =162.58u/l), and γ-glutamyl transferase (142 u/l), respectively.

Table 4: Aetiology of liver abscess

Causative agents	No. of patients	Percentage

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K. pneumoniae	52	65
E. coli	12	15
Pseudomonas	3	3.75
Enterococcus	6	7.50
Streptococcus	3	3.75
Staphylococcus	4	5

In our current study, K. pneumoniae and E. coli were the most common pathogens causing pyogenic liver abscess, affecting 65% and 15% of patients, respectively, followed by Enterococcus (7.50%), Streptococcus (3.75), and Staphylococcus (5%). However, sometimes more than one person was involved in an infection.

Figure 1: Aetiology of pyogenic liver abscess

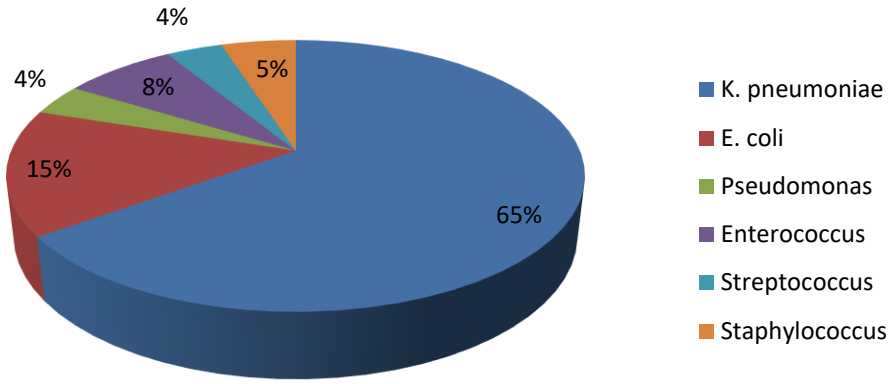

Table 5.Radiological findings in pyogenic liver abscess patients

Parameters	No. of patients (n=80)	Percentage
Location of abscess		
Left hepatic lobe	12	15%
Right hepatic lobe	61	76.25%
≥ 2 lobes	7	8.75%
Size of abscess		
Size < 5 cm	32	40%
5 cm ≤ Size ≤ 10 cm	41	51.25%
Size > 10 cm	7	8.75%

The most common lobes affected in liver abscesses were the right hepatic lobe (76.25%). The size of liver abscess between 5 and 10 cm were common (51.25%).

Table 6: Mode of treatment and outcome in pyogenic liver abscess patients

Mode of Treatment	No. of patients (n=80)	Percentage
Antibiotics only	56	70%
Percutaneous drainage	20	25%
Surgical drainage	4	5%
Clinical outcome		
Cure and improvement	74	92.5%
Non-improvement and death	6	7.5%

Table 7: Susceptibility test of PLA causing microbes against β-Lactam antibiotics (inhibit cell wall synthesis)

Microbes	Amoxycillin	Cefixime	Cefotaxime	Cefoxitin	Oxacillin	Piperacillin
E. coli	0	100	72	0	0	21
K. pneumoniae	0	100	60	48.3	4.71	12.5
E. aerogenes	0	100	54	0	0	0
Pseudomonas	11.5	78.1	30.1	0	23.10	0

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Staph. aureus	9.2	60.3	13.5	4.10	5.91	0
Citrobacter	10	100	69.7	0	0	10.7

Table 7 shows that, β-lactams are broad-spectrum antibiotics. These antibiotics inhibit bacterial growth and progression by inhibiting the cell wall synthesis of the target bacteria. According to the antibiotic susceptibility tests in the present study, the microbes showed a significant rate of resistance against oxycillin. Since the microbes can build resistance to the antibiotics, it is essential, before any sort of treatment is initiated, to examine the patient's blood or pus samples in order to accurately identify the key pathogen(s) involved in causing PLA. Among the β-lactam antibiotics, cefixime was found to be the most efficient antibiotic. E. coli, K. Pneumoniae, E. aerogenes, and Citrobacter were 100% sensitive to Cefixime, followed by Cefotaxime (72%, 60%, 54%, and 69.7% susceptibility rate, respectively).

Table 8: Susceptibility test of PLA-causing microbes against protein synthesis inhibiting antibiotics

Microbes	Amikacin	Gentamycin	Clindamycin	Erythromycin	Doxycycline
E. coli	53.2	55.3	35.1	80	0
K. pneumoniae	34.5	72	36.9	85.3	22.5
E. aerogenes	0	100	21	56.7	15
Pseudomonas	11.91	42	18.5	35	0
Staph. aureus	0	32.1	78.4	60	0
Citrobacter	0	51	28.6	100	0

Table 8 shows that antibiotics are responsible for inhibiting protein synthesis by interacting with the bacterial 70S ribosome. Among the protein-inhibiting antibiotics used, gentamicin and erythromycin significantly limited bacterial progression by inhibiting protein synthesis. E. coli, K. pneumoniae, and Citrobacter were noted as being susceptible to erythromycin (80%, 85.3%, and 100% susceptibility rates, respectively. In the present study, the microbes showed a significant rate of resistance against amikacin, doxycycline, and fusidic acid.

Table 9: Susceptibility test of PLA-causing microbes against Quinolones antibiotics (inhibit DNA synthesis)

Microbes	Ciprofloxacin	Norfloxacin	levofloxacin	Enoxacin
E. coli	100	18.3	85	0
K. pneumoniae	100	45.2	56	22.6
E. aerogenes	100	100	45	0
Pseudomonas	45	0	12	0
Staph. aureus	55	18.5	40	0
Citrobacter	100	35	35	0

Quinolones are a vital group of antibiotics that are responsible for inhibiting DNA synthesis by limiting DNA gyrase activity. Among the quinolone antibiotics used, Ciprofloxacin exhibited the greatest harmful effects on the various bacteria. Indeed, E. coli, K. pneumonia, E. aerogenes, and Citrobacter were 100% sensitive when exposed to Ciprofloxacin. In the present study, the microbes showed a significant rate of resistance against enoxacin (Table 9).

Table 10: Alcoholism associated with pyogenic liver abscess

Parameters	No. of patients (n=80)	Percentage
Alcoholic	67	83.75%
Non alcoholic	11	13.75%

Alcoholism is associated with 83.75% of the cases. Amoebic liver abscess is uncommon in children and more common in men than in women; particularly in individuals between the ages of 10 and 46 years old (one 10-year-old child had PLA and was drained). The reason for such a striking difference is not clear but is thought to be due to factors such as tobacco and alcohol consumption. All 80 pyogenic liver abscess patients gave a history of toddy and alcohol drinking. Worldwide, areas with high rates of infection include India, Africa, and Mexico, as well as parts of Central and South America.

The majority of infections occur from eating or drinking contaminated food or water. Around 3–5% of patients with intestinal amebiasis may end up with liver abscesses. This organism is distributed throughout the world, including India, posing a substantial risk in countries without adequate sanitation of municipal water supplies.

Socio-economic status associated with pyogenic liver abscess

Most of the patients admitted to this hospital came from low socioeconomic status, were illiterate, anaemic, malnourished, and very solely responsible for their family's earnings. Because of this, the disease not only caused physical and mental problems but also had serious repercussions on the physiological as well as economic status of the whole family.

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Complications: Study showed Early diagnosis and intervention prevented the development of complications like intraperitoneal rupture, rupture into the pleural or pericardial cavity, and biliary leak. The pleural effusions seen in this study are only reactive and subsided by conservative management.

Management of a pyogenic liver abscess: The choice of antibiotics should cover the most common microorganisms cultured from liver abscesses. Drainage of pyogenic liver abscesses is the mainstay of the treatment. Drainage can be accomplished either surgically or US/CT-guided percutaneously. In the present study, needle aspiration under USG is done for abscesses less than 5 cm, or <200 ml, but percutaneous drainage with pigtail catheter placement was done for abscesses larger than 5 cm, or >200 ml, under USG guidance were most effective. Compared to antibiotic treatment and surgical treatment, the hospital stay with percutaneous drainage was significantly shorter.

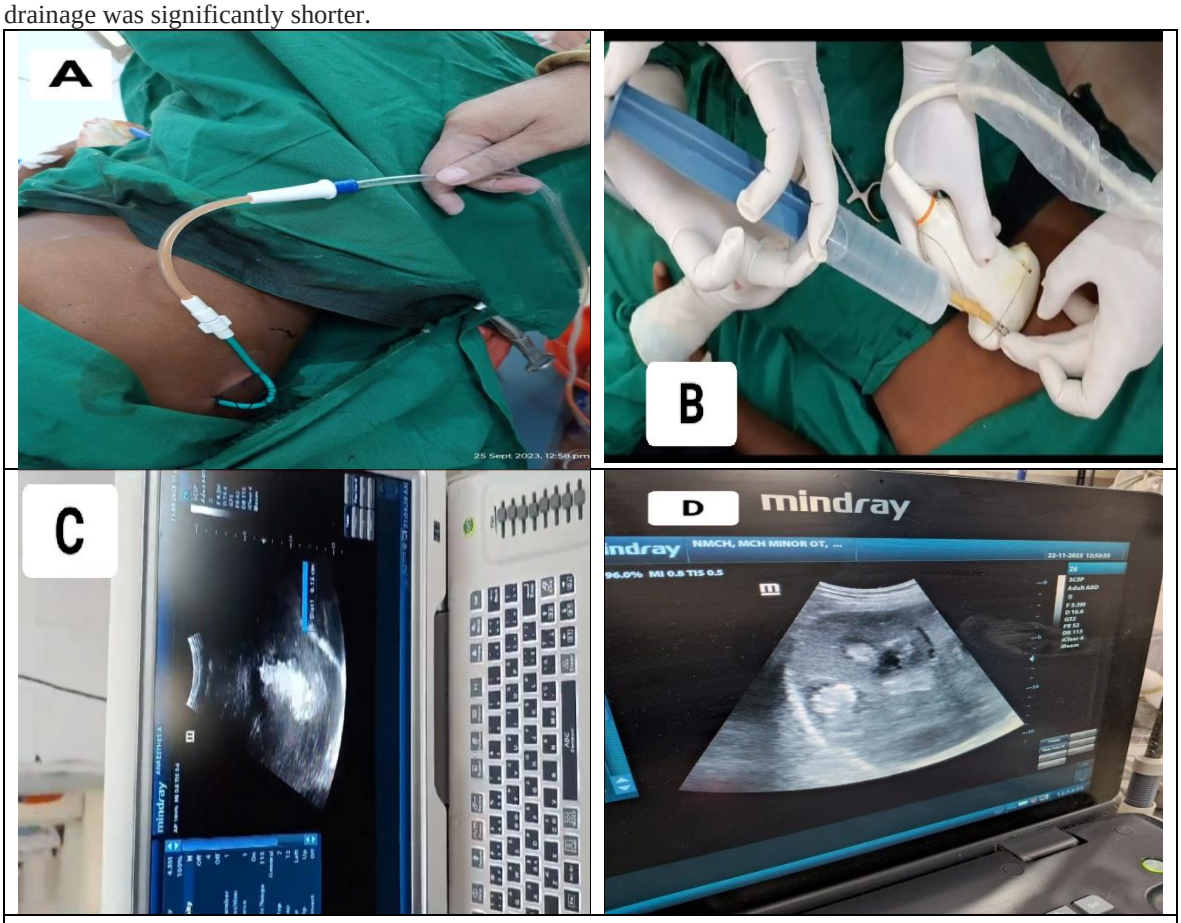

Figure A: USG-guided 12 F pigtail insertion;
Figure B, C: Suction irrigation of USG-guided Metron infusion in liver abscess;
Figure D: Multiple liver abscess

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Figure E, F: USG-guided, aspiration of liver abscess using a 16-F liver needle

Discussion

Pyrogenic liver abscesses are a hazardous health problem common in Asia and rapidly spreading around the world, and they require immediate hospitalization. A clear profile of the antibiotics with potential against pathogenic microbes is indicated.

In the present study, out of 80 patients diagnosed with liver abscess, 100% were males (males were predominant), and the majority of patients with PLA were between 30 and 50 years old, and only 10% were over 50 years old. Males were more commonly affected than females. The present findings are in correlation with previous studies that reported on the male predominance in PLA [11–15]. The most common clinical manifestations were fever (86.25%), followed by upper right abdominal pain (33.75%), nausea or vomiting (25%), and chills (20.0%), whereas jaundice was not common and only presented in three patients (3.73%). The present findings are in correlation with previous studies [11–12]. In the present study, we observed that elevated inflammatory factors (CRP, PCT, WBC, and procalcitonin) and liver dysfunction (GGT, ALP, ALT, and AST) might indicate PLA. Patients presented with a normal mean value of haemoglobin and platelet count. However, the confirmed diagnosis of PLA relied on an image investigation. As we reported, 76.25% of PLA lesions were in the right hepatic lobe, mainly due to the portal vein anatomy. Similar findings were also observed in the previous study [11–12]. In the current study, K. pneumoniae and E. coli were the most common pathogens causing pyogenic liver abscess, affecting 65% and 15% of patients, respectively. Shi S-h et al. [6], Yuanyuan Zhou et al. [11], and Shelat VG et al. [16] observed that K. pneumonia has surpassed E. coli in becoming the leading cause of PLA.

Biochemical tests and antibiotic susceptibility

Pathogens isolated from PLA patients are highly sensitive to almost every kind of antibiotic, such as β-lactamases, third-generation cephalosporins, and carbapenems. Among the β-lactam antibiotics, cefixime was found to be the most efficient antibiotic. E. coli, K. pneumoniae, E. aerogenes, and Citrobacter were 100% sensitive to Cefixime, followed by Cefotaxime (72%, 60%, 54%, and 69.7% susceptibility rate, respectively). Similar findings were also observed by Nadia Bashir et al. [12], Kong H et al. [13], and Chen J et al. [14].

According to the antibiotic susceptibility tests in the present study, the microbes showed a significant rate of resistance against amoxycillin, oxyacillin, and fusidic acid. Since the microbes can build resistance to the antibiotics, it is essential, before any sort of treatment is initiated, to examine the patient's blood or pus samples in order to accurately identify the key pathogen(s) involved in causing PLA [12].In the present study, E. coli, K. pneumonia, E. aerogenes, and Citrobacter were 100% sensitive when exposed to Ciprofloxacin, and the microbes showed a significant rate of resistance against Enoxacin. In the present study, needle aspiration under USG is done for abscesses less than 5 cm, or <200 ml, but percutaneous drainage with pigtail catheter placement was done for abscesses larger than 5 cm, or >200 ml, under UG guidance. The present findings are in correlation with previous treatments carried out by Zerem E et al. [19] and Cai YL et al. [20]. Compared to antibiotic treatment and surgical treatment, the hospital stay with percutaneous drainage was significantly shorter. Similar findings were also observed by Nadia Bashir et al. [12]. The mean length of hospital stay was 14.27 days in the current study. According to a study by Abbas et al. [21], patients with pyogenic liver abscesses spent an average of 13.6 days in the hospital. Their course of antibiotic treatment lasted for about 34.7 days. One patient passed

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away. Conversely, patients with amoebic liver abscesses underwent an average of 7.7 days in the hospital and 11.8 days of treatment, during which time all patients recovered.

Limitations of the study: This was a single-centre retrospective study, and the results might not be generalizable. A population-based or large-scale study is required to clarify the association between genotypes, resistance spectrum, phenotypes, and clones of microbes isolated from patients with PLA.

Conclusion

In the current study, alcohol use, toddy intake, and malnutrition were all highly correlated risk factors for PLA. In case of bacteria, K. pneumonia and E. coli are the leading microbes causing pyrogenic liver abscesses in elderly patients with male predominance. Inflammatory biomarkers are generally elevated, and dysfunction of the liver is common. Needle aspiration under USG is done for small abscesses (≤200 ml), whereas percutaneous drainage with pigtail catheter placement was done for large abscesses (>200 ml) under USG guidance were most effective interventions. Analysis of the microbes demonstrates that they are significantly resistant to amoxycillin, oxacillin, and fusidic acid. As the microbes advance and develop greater resistance to drugs, it is crucial to perform prompt identification of the disease-inducing pathogens, followed by empiric antimicrobial and other effective therapeutic strategies. Further studies should be conducted to better understand K. pneumonia-induced PLA, increase awareness, and develop and deliver more effective treatments for PLA patients.

Acknowledgement: The authors would like to acknowledge the entire faculty and residents of the Department of Surgery and Department of Microbiology, Nalanda Medical College and Hospital, Patna, Bihar, India, for their valuable support and time-to-time suggestions in undertaking the present study. Special thanks to Dr. (Prof.) Ramesh Kumar Ajai, Professor, Head of Department, Department of Surgery, and Dr. Rajnish Chandran, Assistant Professor, Department of Microbiology, Nalanda Medical College and Hospital, Patna, Bihar, India, who gave valuable suggestions during the study.

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