


Successful Treatment of Pyogenic Liver Abscess Caused by *Klebsiella Pneumoniae* Using Antibiotics Alone: A Case Report

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Abstract: Liver abscess (LA), particularly pyogenic liver abscess (PLA) is a prevalent infectious disease of the digestive system in clinics. Some patients with PLA exhibit non-specific symptoms and signs, increasing the risk of missed and misdiagnoses. We report a case of a life-threatening PLA caused by *Klebsiella pneumoniae*, which was initially overlooked at presentation. A previously healthy male, one of the authors of this paper, presented with unexplained fever. Chest CT showed no pulmonary abnormalities, but the low-density shadow in the right lobe of the liver was not given sufficient attention. Based on local epidemiological trends of respiratory infections at that time, the patient was diagnosed with a respiratory infection and treated with oral levofloxacin. Later, due to uncontrollable disease progression and recurrent fever, the patient was hospitalized. MRI revealed an LA in the right lobe, and next-generation sequencing (NGS), tissue culture, and blood culture all indicated an infection with *K. pneumoniae*. Despite unsuccessful drainage, the patient received 22 days of intravenous anti-infective treatment with meropenem, levofloxacin, and cefoperazone/sulbactam. His condition improved and he was subsequently discharged. After discharge, the patient continued oral treatment with levofloxacin and cefuroxime axetil for another 21 days until the abscess completely disappeared. The PLA took a total of 48 d from detection to complete resolution.

Keywords: liver abscess, pyogenic liver abscess, *Klebsiella pneumoniae*, antibiotics

Introduction

Liver abscess (LA) is a localized, purulent lesion within the liver caused by the invasion of microorganisms into the hepatic parenchyma through the bile ducts or bloodstream (with the portal vein being the most common).¹ Bacteria, fungi, and amoebas are common causes of LA, with pyogenic liver abscesses (PLA) being the most prevalent, accounting for 80% of the incidence of liver abscesses.¹ The primary causes of PLA were *Escherichia coli*, *Klebsiella spp*, *Streptococcus anginosus group*, *Staphylococcus aureus*, and anaerobes.² *Klebsiella pneumoniae* is a community- and hospital-acquired Gram-negative pathogen that causes various infectious diseases. Since the first report of LA caused by *K. pneumoniae* in Taiwan in the 1980s, *K. pneumoniae* has become a more common primary cause of LA than *Escherichia coli*, especially in China and other Asian countries.³ Due to the particular hypervirulence of *K. pneumoniae*, PLA caused by this pathogen has a worse prognosis compared to PLA caused by other pathogens.⁴ Over the past 30 years, the incidence of PLA in China has increased. This trend may be attributed to the significant increase in the number of patients with diabetes mellitus (DM) and cancer, which have become the main predisposing factors for *K. pneumoniae*-caused PLA.⁵ PLA has no specific clinical manifestations, with fever and abdominal pain being the main symptoms. Age over 50 years old, DM, hypertension, history of hepatobiliary or pancreatic disease, and history of liver transplantation are generally considered risk factors for PLA. However, here we report a case of PLA with no medical or medication history and no risk factors.



Figure 1 Liver abscesses before treatment. (A) An abdominal CT scan on February 22nd, 3.49×2.98 cm. (B and C) Coronal and axial MRI scan (arrow) on February 29th, 4.94×4.54 cm.

Case Presentation

A previously healthy 30-year-old man, one of the authors, was admitted to hospital with unexplained fever. Nine days ago, he visited an outpatient clinic with a high fever, fatigue and diarrhea, and was diagnosed with upper respiratory tract infection, subsequently prescribed oral levofloxacin (LEV) and loxoprofen.

After admission, the physician noted a subtle low-density shadow in the right hepatic lobe on the outpatient CT (3.49×2.98 cm, [Figure 1A](#)), suggesting a possible liver abscess, treatment with piperacillin sodium and tazobactam sodium was given for infection management. On the 3rd day of admission, an MRI scan revealed a multiple compartments abscess in the right lobe of the liver (4.94×4.54 cm, [Figure 1B](#) and [C](#)), the antimicrobial treatment plan was upgraded to meropenem and vancomycin to cover potential pathogens and MRSA. On the 4th day, percutaneous liver abscess drainage yielded no fluid; NGS biopsy and tissue culture, along with blood culture, confirmed *K. pneumoniae* infection, which was highly sensitive to most antibiotics except ampicillin ([Table 1](#)). Considering the antimicrobial

Table 1 Antimicrobial Susceptibility Testing of *Klebsiella Pneumoniae*

Antibiotic agent	Minimum Inhibitory Concentration (µg/mL)	Sensitivity
Ampicillin	≥32	R
Ampicillin/Sulbactam	4	S
Piperacillin	≤4	S
Piperacillin/Tazobactam	≤4	S
Cefazolin	≤2	S
Cefuroxime sodium	≤1	S
Cefuroxime axetil	≤1	S
Cefotetan	≤4	S
Ceftazidime	≤1	S
Ceftriaxone	≤1	S
Cefepime	≤1	S
Aztreonam	≤1	S
Imipenem	≤1	S
Meropenem	≤0.25	S
Amikacin	≤2	S
Gentamicin	≤1	S
Tobramycin	≤1	S
Ciprofloxacin	≤0.25	S
Levofloxacin	≤0.25	S
Cotrimoxazole	≤20	S

Abbreviations: S, susceptible; R, resistant.

susceptibility test results, epidemiological characteristics, and the patient's condition, this led to a strong suspicion of hypervirulent *K. pneumoniae* (hvKp), the treatment regimen was changed to LEV combined with meropenem. On the 11th day, bedside ultrasound showed reduced abscess (3.10×2.90 cm), and no significant abnormalities in blood cultures, LEV combined with cefoperazone sodium and sulbactam sodium were given to therapy. On the 17th day, an MRI showed liver abscess was smaller than the primary MRI (3.49×3.00 cm, Figure 2), and anti-infection treatment was continued. On the 22nd day, an ultrasound indicated a significant reduction of the abscess (2.80×2.50 cm), with a marked improvement in the patient's condition and was allowed to be discharged.

Post-discharge, the patient continued to take LEV and cefuroxime axetil. An ultrasound re-examination after 21 days showed that the abscess had disappeared entirely. The infection treatment spanned 8 weeks from hospitalization to discontinuation. Figure 3 shows a detailed timeline of the patient's treatment experience.

Discussion

PLA is a potentially life-threatening infectious disease of the liver parenchyma. In Europe and America, *Escherichia coli* and *Streptococcus* are common pathogenic bacteria of PLA, whereas in China, *Klebsiella* is the primary pathogen.^{6–9} The incidence of PLA is increasing year by year worldwide, with a higher incidence rate in Asia compared to Western countries (11.99–17.59/100 000 people per year vs 1.0–4.1/100 000 people per year).¹⁰

Unlike the “classical” *K. pneumoniae*, the “hypervirulent” *K. pneumoniae* (hvKp) is prone to cause highly invasive infections, and about half of hvKp infections occur in young, healthy people, leading to severe community-acquired infections, and being the most common cause of PLA in the Asian region.¹¹ hvKp is naturally resistant to ampicillin and rarely develops resistance to other commonly used antimicrobial drugs. However, with the global spread of mobile genetic elements that confer antibiotic resistance, reports of drug-resistant hvKp have increased.¹² The recent WHO report on the global spread of hvKp highlights the increased prevalence and potential severity of infections, particularly the rising number of hvKp strains carriers of carbapenem antibiotic resistance genes.¹³ Early diagnosis and anti-infection treatment are particularly important, especially in patients with PLA like the one in this case where hvKp infection is

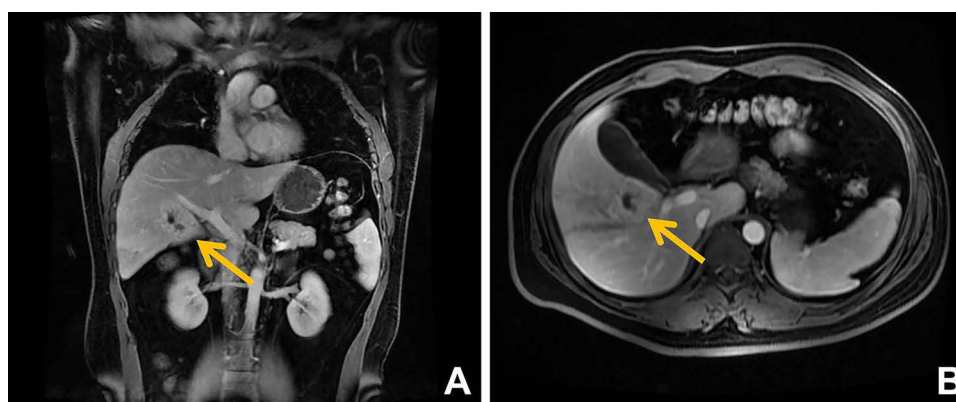


Figure 2 Liver abscesses after treatment. (A and B) Coronal and axial MRI scan (arrow) on March 14th, 3.49×3.00 cm.

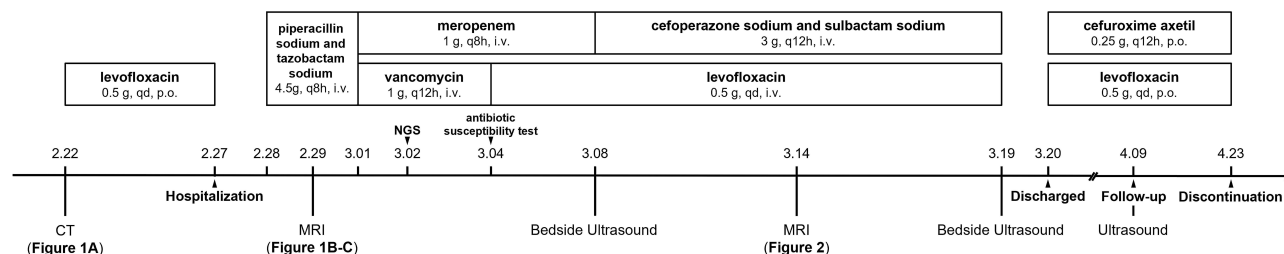


Figure 3 Time axis of patients' treatment (including important time points and therapeutic drugs).

highly suspected. A summary was conducted of the case reports on PLA caused by hvKp that have been published to date (Table 2). [Supplementary Table 1](#) lists the specific information and references of these patients in detail.

K1 and K2 are the main serotypes of *K. pneumoniae*, associated with invasive hvKp and are the major serotypes that cause nearly all severe infectious bacteremia, LA, and extrahepatic infections.^{14,15} The infection rate of serotype K1 is

Table 2 Summarized 89 Cases with Liver Abscesses Due to Hypervirulent Klebsiella Pneumoniae

	n
Patient characteristics	
Age (Mean, range)	55.6 (14–86)
Sex	
Male	67
Female	21
Unknown	1
Region (Asia)	52
Hospital time* (d) (Mean, range)	40.9 (4–142)
Risk factors	
Diabetes mellitus	42
Hypertension	10
Liver disease/transplantation	7
Biliary, Pancreatic and Intestinal Diseases/Surgery	6
Malignant disease	3
Immunodeficiency	3
Clinical Symptoms	
Fever without abdominal pain/jaundice	38
Fever with abdominal pain/jaundice	37
Only abdominal pain/jaundice	3
Other	11
Liver abscesses	
Abscess number	
Single	59
Multiple	28
Unknown	2
Size (diameter)	
≤ 5 cm	22
5–10 cm	20
≥ 10 cm	11
Unknown	36
Complication	
Endophthalmitis	26
Central nervous system infection	20
Lung abscess	17
Prostatic abscess	9
Septic shock	8
Pleural effusion	6
Multiple organ dysfunction syndrome	5
Endocarditis	4
Portal vein thrombosis	4
Treatment plan	
Medical only	26
Medical + Puncture drainage	59
Combined with surgical resection	4

(Continued)

Table 2 (Continued).

	n
Top 5 most frequently used antibiotics	
Ceftriaxone	36
Meropenem	34
Piperacillin-Tazobactam	25
Metronidazole	20
Ciprofloxacin	19
Microbiological characteristics	
Number of cases with positive string test performed	56
Number of cases with K1 serotype	33
Number of cases with K2 serotype	17
Number of cases with detection of virulence factors	48
Outcomes	
Cured	77
Died	12

Note: Hospital time*: Patients with outcomes of “cured” and explicitly mentioning the duration of hospitalization were included in the statistics.

higher in Chinese patients (non-diabetics) than in non-Chinese patients (mainly diabetics),¹⁶ which may be related to the easier intestinal colonization of K1/K2 serotype in this population.¹⁵ The latest research data shows that the proportions of K1 and K2 serotypes among PLA patients in China are 46.5% and 23.3%, respectively.¹⁷ PLA exhibits a certain degree of racial susceptibility. In the summarized cases, molecular confirmation of the presence of K1 or K2 was performed in 56.18% (50/89) of the cases. Among these, 52% (26/50) were from the Asian population, with detection rates of K1 and K2 being 69.23% (18/26) and 30.77% (8/26), respectively (Table 2).

In our described case, the patient had no medical or medication history and no risk factors for PLA, the initial symptom was fever, and the *Mycoplasma* antibody test was weakly positive, which was consistent with the epidemic of *Mycoplasma* in this area, so the pulmonary infection was considered at the first diagnosis, and a subtle low-density shadow in the right hepatic lobe shown on CT images was missed. In series cases, 23 patients (23/89, 25.84%) were previously healthy, similar to the patient we reported, with no underlying diseases or risk factors. Among them, 10 (10/23, 43.48%) had fever and other non-specific symptoms without abdominal pain or jaundice (Table 2). A PLA should be vigilantly considered for these patients, especially those from or with a travel history to endemic areas.

We observed a high proportion of DM patients (42/89, 47.19%). This may be related to poor glycemic control, impairing neutrophil phagocytic activity against bacteria.¹⁸ The vascular endothelium changes in DM patients make PLA more prone to hematogenous dissemination, entering the liver directly via the portal vein, hepatic artery, or biliary system.¹⁹ Furthermore, PLA can cause stress-induced hyperglycemia and increase insulin resistance, leading to higher blood glucose levels.²⁰ The hyperglycemic state in the local lesion area can exacerbate the condition of patients with PLA, thereby creating a vicious cycle. Aggressively controlling the patient’s blood glucose levels is also essential to the treatment regimen. Among the patients studied, excluding the cases where complications were not mentioned, 63 patients (73.26%) developed complications, with a relatively high frequency of metastatic infections. Patients with PLA caused by hvKp were especially at risk for extrahepatic invasive syndromes. The most common site of infection was the eye, causing endophthalmitis in 41.27% (26/63) of cases. Some patients presented with red, swollen, and painful eyes, while others developed these symptoms after admission. This infection was insidious in onset and rapidly progressive and could result in irreversible vision loss or blindness.

The patient had an insidious onset and rapid progression, with the liver abscess reaching a maximum size of 4.94×4.54 cm and not liquefying for drainage or extrahepatic spread. The patient was treated solely with antibiotics and had a good prognosis. In this case, the effective control of the abscess with only antibiotics treatment may be related to the early therapy with broad-spectrum antimicrobials. Secondly, LEV, a broad-spectrum fluoroquinolone antibiotic, was used almost throughout the treatment process for this patient. Out of the summarized cases, 26 patients were also treated with antibiotics alone.

Ceftriaxone (CRO) was the most frequently used, followed by meropenem (MEM). Studies have shown that when rats were administered 20 mg/kg of CRO subcutaneously or 120 mg/kg of MEM intravenously, the drug concentrations in liver tissue were only half of those in the blood.^{21,22} A single intravenous injection of 500 mg of LEV rapidly penetrated human liver tissue, with only a slight decrease within a few hours,²³ and a physiologically based pharmacokinetic (PBPK) study indicated that the concentration ratio of LEV in human liver tissue to plasma was 2.276.²⁴ Thus, the permeability of LEV in liver tissue is stronger than CRO and MEM. A study compared the effectiveness of β -lactams and fluoroquinolones in treating *K. pneumoniae*-caused PLA and found that starting with intravenous fluoroquinolones and then switching to oral administration could shorten intravenous infusion time and hospital stays.¹⁹ The good liver tissue permeability of LEV and the transition from intravenous to oral was also one of the reasons for the successful treatment in this case. Additionally, the patient's youth and previous good health status might also be contributing factors.

Patients with PLA often have atypical clinical symptoms and signs, which can lead to missed or misdiagnoses. In recent years, hvKp has become the main pathogen causing PLA in the world and is prone to cause extrahepatic invasion. For patients with high suspicion of PLA, early empirical antimicrobial treatment is particularly important before definitive etiological evidence. Moreover, the treatment plan should be dynamically assessed and adjusted based on culture results and antimicrobial susceptibility testing to achieve a good prognosis.

Data Sharing Statement

Data on this case clinical information, detailed laboratory examination, and images are available from the corresponding author upon reasonable request.

Ethical Approval

The waiver of ethical review for publishing photographs and medical records in this signal-case report complies with the Declaration of Helsinki and has been approved by the Medical Ethics Committee of the Medical Supplies Center of Chinese PLA General Hospital.

Consent

Verbal and written informed consent was obtained from the patient. The patient consented to the publication of this case report and images.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the New Medicine Clinical Research Fund (4246Z512).

Disclosure

The authors declare no conflicts of interest in this study.

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