Analysis of the Clinical Characteristics of 19 Cases of Bacterial Liver Abscesses in Children and A Review of the Literature

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Research article

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Abstract

Background

To analyze the clinical characteristics of 19 children with bacterial liver abscesses and to explore the diagnosis, treatment and prognosis of children with bacterial liver abscesses.

Methods

Children with bacterial liver abscesses were selected from July 01, 2011, to July 31, 2020, at the Affiliated Children's Hospital of Suzhou University. The onset age, sex, clinical manifestations, imaging and laboratory examination data, treatment and outcomes were analyzed and summarized, and a literature review was performed.

Results

The average diagnostic age of 19 cases of bacterial liver abscesses was 5 ± 6.7 years old, and the ratio of males to females was 1.7. Ten cases had underlying diseases, including 8 cases of hematological diseases (including leukemia and aplastic anemia) (42.1%), 1 case of a choledochal cyst (5.3%) and 1 case of abdominal trauma (5.3%). The most common clinical manifestations were fever (16 cases, 84.2%), followed by right upper abdominal pain (9 cases, 44.4%) and cough and pleural effusion (6 cases, 31.6% each). Among the laboratory indexes, increases in serum C-reactive protein and leukocytosis were the most common, with 19 cases (100%) and 9 cases (44.4%), respectively. The proportion of patients with abnormal liver function was not high, and there were no cases of elevated bilirubin. The most common pathogens in pus and blood cultures were *Klebsiella pneumoniae* and *Escherichia coli*. Nineteen children with bacterial liver abscesses were treated with intravenous antibiotics, and the average duration of intravenous antibiotic use was 28.4 ± 14.7 days. Among the cases, 13 cases (68.4%) were treated with antibiotics alone, and 5 cases (26.3%) and 1 case (5.3%) were treated with percutaneous needle aspiration and surgical drainage, respectively. All 19 children with bacterial liver abscesses improved, and there were no complications or deaths.

Conclusion

The most common underlying disease was a hematological malignant tumor. *Klebsiella pneumoniae* and *Escherichia coli* were the most common pathogens in blood and abscess cultures. Through appropriate antibacterial treatment and timely drainage, the prognosis is usually good.

Introduction:

Young children cannot express discomfort subjectively and cannot cooperate with the examinations; these challenges lead to a hidden onset of bacterial liver abscesses and atypical clinical symptoms in children, which interferes with their diagnosis.[1] At present, there is no clear standard diagnosis and treatment plan, and the delay of diagnosis and treatment can lead to serious consequences such as abscess rupture, sepsis, and even death.[2] With the increase in understanding, the improvement of auxiliary examinations, the increase in hepatobiliary and neoplastic diseases, the increase in multiple drug-resistant bacteria, and the increase in invasive abdominal operations, the etiology and treatment of bacterial liver abscesses have changed greatly.[2,3] This paper analyzes the clinical characteristics of 19 children with bacterial liver abscesses diagnosed at the Children's Hospital affiliated with Soochow University from 2011 to 2020.

Subjects And Methods:

Objects

The data of 19 children with bacterial liver abscesses diagnosed in the Children's Hospital affiliated with Soochow University from 2011 to 2020 were collected, including age, sex, clinical manifestations, imaging and laboratory examinations, treatment and outcomes.

Diagnostic Criteria

(1) Liver abscesses with typical imaging findings respond to anti-infective treatment with antibiotics, (2) the culture of bacteria from the liver abscesses is positive, and (3) the liver abscesses are confirmed by surgery.[1] A case that meets any of the above criteria is a confirmed case.

Methods

Data collected from medical records included general information, duration of fever, laboratory values (peripheral blood leukocyte count, neutrophil count, serum CRP level, liver function index, hemoglobin, blood or abscess culture results), imaging results, duration of intravenous injection and total (intravenous plus oral) antibiotic treatment, interventional therapy (percutaneous puncture, percutaneous drainage or open surgery), complications, recurrence and mortality.

Statistical Methods

SPSS 22.0 statistical software was used for statistical analysis, and a t-test was used to compare the measurement data. Continuous variables are expressed as the average±standard deviation or as the median of quartile spacing, and classified variables are expressed as percentages. The chi-square test was used to analyze the classified data. Student’s t-test or the Mann-Whitney U test was used to compare and analyze the descriptive and inferential data. P 0.05 was defined as statistical significance.

Results:

General Information

The average age of the 19 children with bacterial liver abscesses was 5±6.7 years (6 months to 14 years and 6 months). The 0-5-year-old group was the majority (13/19, 68.4%). There were 12 males (12/19 63.2%) and 7 females (7/19 36.8%), with a male-to-female ratio of 1.7:1.

Clinical Manifestation

The most common clinical manifestation of the 19 children with bacterial liver abscesses was fever (16 cases, 84.2%), followed by abdominal pain (9 cases, 47.4%). The median duration of fever was 7 days (0-30 days). The average duration from fever to diagnosis was 6 days (1-30 days), as shown in Table 1.

Basic Diseases

The most common underlying disease in 19 children with bacterial liver abscesses was acute leukemia (7 cases, 36.8%), as shown in Table 2.

Laboratory Examination

In 19 children with bacterial liver abscesses, CRP was elevated (>5 mg/L) (100%), among which 6 cases were greater than 100 mg/L (31.6%), and 9 cases were leukocytosis (>10×10^9/L); among them, 6 cases were higher than 15×10^9/L (66.7%). Leukopenia occurred in 9 cases (44.4%), including 7 cases whose absolute neutrophil count was less than 1.5×10^9/L, all of which were children on immunosuppressants. Alkaline phosphatase increased in 2 cases (1 case was in the early stage of a leukemia recurrence, and 1 case was newly diagnosed leukemia). There were 8 cases of anemia, of which 6 cases were children post-chemotherapy. Albumin was decreased in 1 case, which was a postchemotherapy child. Serum alanine aminotransferase was increased in 2 cases (15.8%), and only 1 case was increased to more than four times the normal level. Aspartate aminotransferase was increased in 1 case (10.5%), and there was no case of elevated bilirubin.

Imaging Results

Nineteen children with bacterial liver abscesses were examined by abdominal ultrasonography and CT, and enhanced CT was performed in 14 cases (73.7%) and MRI in 1 case. The abscess mainly occurred in the right lobe of the liver, and a single abscess was common. Most abscesses were less than 5 cm, and no abscesses exceeded 10 cm, as shown in Table 3.

Blood and Abscess Culture Results

Nineteen children with bacterial liver abscesses were examined by blood culture, and the positive rate was 26.3% (n=5), among which *Klebsiella pneumoniae* (2/5 40%) and *Escherichia coli* (2/5 40%) accounted for the highest percentage. Five patients (26.3%) underwent interventional drainage (percutaneous

puncture, catheterization and surgical drainage). The culture positive rate of the pus obtained was 80% (n=5). *Streptococcus intermedius* (2/6, 33.3%) was the most common pathogen, as shown in Table 4.

Treatment and Outcome

Nineteen children with bacterial liver abscesses were treated with antibiotics. The early empirical broad-spectrum regimen was comprised of third-generation cephalosporins (raoxycephalosporin, ceftazidime or cefoperazone sulbactam) plus anti-anaerobic agents. Seven cases were upgraded to carbapenem because of no improvement in body temperature or laboratory examinations (leukocyte, CRP, abscess size) after routine treatment for 3-5 days. Among them, 1 case of cultured *Klebsiella pneumoniae* infection was replaced by amikacin according to drug sensitivity tests. The average duration of parenteral antibiotic therapy was 28.4±14.8 days, and the average duration of total antibiotic therapy was 37.7±11.1 days.

Among the 19 children with bacterial liver abscesses, 4 cases (21.1%) underwent image-guided percutaneous puncture, and 1 case (5.3%) underwent laparoscopic surgery and drainage tube placement due to the need to treat the illness and with the consent of their families. Table 5 compares the laboratory results and the total duration of fever before treatment between the drainage group (including percutaneous puncture and surgery) and the nondrainage group (antibiotics alone). The results showed that the size of the abscess in the drainage group was significantly larger than that in the nondrainage group, the duration of fever was longer, and the difference between the two groups was statistically significant. The white blood cell count and CRP level in the drainage group were higher than those in the nondrainage group, but the difference was not statistically significant. There was no significant difference in age, sex or liver enzyme level between the two groups. In addition, this study also found that all cases in the drainage group had extrahepatic manifestations, such as pleural and peritoneal effusion, and spleen and kidney and other organ abscesses; most of the drainage cases were single abscesses. All of the children were cured, and there were no complications or deaths, as shown in Table 5.

Discussion:

The liver communicates with the intestinal tract through the biliary tract and receives a dual blood supply from the portal vein and hepatic artery, so it is prone to bacterial liver abscesses. As far as children are concerned, the pathogenesis of suppurative liver abscesses may be as follows: (1) bacteria invade the liver through the hepatic artery due to various suppurative infections combined with bacteremia in infancy; (2) during intestinal infections and umbilical infections, bacterial emboli fall off and enter the liver through the branches of the portal vein, resulting in abscesses; (3) biliary tract infections, and this route of infection can cause multiple abscesses, and it is common in older children[3]; (4) infections secondary to liver trauma; and (5) cryptogenic.[4] In previous studies, the main pathogen of abscess cultures in children was aerobic *Staphylococcus aureus*. However, a pediatric study in Taiwan and several adult studies have found that the spectrum of pathogenic bacteria has changed, and *Klebsiella pneumoniae* and *Escherichia coli* have gradually become the main pathogens.[2,5,6] The results of this

study are similar to those in Taiwan. The possible reasons for this situation are that the incidence of *Staphylococcus aureu*s is low in the author's area due to relatively good economic, medical and health conditions. Second, it may be that before obtaining pus and bacterial cultures, the children have been treated with antibiotics for a certain period of time, resulting in a decrease in the positive rate of cultures.[7] In children, the cause of liver abscesses is usually unclear, and the proportion of cryptogenic liver abscesses is high. In this study, cryptogenic liver abscesses accounted for 52.6%, while a study of children in Taiwan showed that cryptogenic liver abscesses accounted for 70-80%.[5,6]

Fever and abdominal pain are the most common symptoms. This study suggests that the right lobe of the liver is the most common site of bacterial liver abscesses, so right upper abdominal pain is more common, and some children have symptoms such as cough, shortness of breath and chest pain caused by the liver abscess stimulating the diaphragm.[6,7] However, the above clinical manifestations are not specific,[8] and due to the widespread use of antibiotics and the children's own characteristics, early and timely diagnosis is difficult. In this study, 2 cases were misdiagnosed as atypical Kawasaki disease in the early stage and had symptoms of abdominal pain during the course of the disease, which were diagnosed by imaging examination.

The reasons for the misdiagnosis may be as follows: first, the incidence of Kawasaki disease in children is higher than that of bacterial liver abscesses, so it is easy to prioritize; second, there are similarities between the clinical symptoms and laboratory examination results. For example, repeated high fevers and elevated indexes of white blood cells, neutrophils and C-reactive protein in blood tests are shared by the conditions. Third, misdiagnosed children can have bayberry tongue and a rash at the same time, and the etiology of these patients may be Gram-positive cocci infection. Studies have confirmed that jaundice, diabetes, low immune status (tumors, use of immunosuppressants, malnutrition, etc.), sickle cell disease, abdominal trauma, some parasitic infections, appendicitis perforation and incorrect umbilical vein catheterization are high-risk factors for liver abscesses.[2,5,7,9,10] Children with the above conditions, such as fever of unknown causes, abdominal pain, hepatomegaly, elevated white blood cells, C-reactive protein and neutrophils on laboratory examination, should be considered for the possibility of a liver abscess.

When a bacterial liver abscess is not ruled out clinically, it can be diagnosed by ultrasound or computed tomography (CT) or magnetic resonance imaging (MRI). Ultrasonic examination has the advantages of convenience and speed, ease of operation and a low price, so it is the most commonly used tool for the diagnosis of liver abscesses, and its sensitivity can reach more than 97%. However, because the imaging manifestation of early liver abscesses can be atypical and sometimes there is no obvious change under B-ultrasound, dynamic observation is needed.[1,10] Combined with CT and MRI as a supplementary examination to confirm the ultrasound results in highly suspicious cases, and understanding the specific location of the abscess and the relationship between the abscess and the surrounding tissues is essential.

Early active anti-infective treatment of bacterial liver abscesses can delay the progression of liver abscesses that have not liquefied. Liver abscesses smaller than 3 cm have a good response to

intravenous or oral anti-infective treatment. Empirically, metronidazole combined with third-generation cephalosporins (such as ceftriaxone or cefoxitin) or piperacillin-tazobactam is the first choice. The total course of antibiotic treatment is generally 4-8 weeks,[11] but in the clinic, the actual use of antibiotics may be longer because of the lack of etiological results, the existence of a variety of basic diseases, hospital cross-infection and other complex situations. In addition, it should be noted that imaging abnormalities can last for a long time, and subsequent oral antibiotic treatment should be based on clinical symptoms and blood test results.[7] When the abscess is large and liquefied, percutaneous liver aspiration or catheter drainage can greatly improve the cure rate of bacterial liver abscesses.[5,7,12] However, the choice of percutaneous puncture or catheter drainage is still controversial, but a study by ZeremE suggests that for a multilocular abscess or for a single abscess larger than 5 cm, the effect of catheter drainage is better.[9,12] When catheter drainage fails, the abscess is at high risk of rupture, and if the abscess is close to the pleura, surgical intervention should be considered.[3] However, the decision between percutaneous puncture or surgical drainage is still controversial, so further evidence is needed about indications for surgical intervention in pediatric patients. In this study, only one case was treated with laparoscopic surgery and drainage because of severe clinical symptoms, poor effects after antibiotic treatment and obvious rapid enlargement of the abscess, and the rest were cured by simple antibiotics or antibiotics combined with percutaneous liver puncture. In addition, at the same time, other underlying diseases should be actively treated, and symptomatic supportive treatment should be given, including correcting hypoalbuminemia and treatments to protect the liver.

Abbreviations:

WBC, white blood cell; CRP, C reactive protein; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

Declarations

Ethics approval and consent to participate：This study was approved by the Ethics Committee of the Children's Hospital affiliated to Soochow University.This study does not require parental consent.

Consent for publication：Not applicable.

Availability of data and materials:The datasets supporting the conclusions of this article are included within the article and its additional files.

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Tables

Table 1
Clinical manifestations of 19 children with bacterial liver abscesses

Clinical manifestation	Number of cases (%)
Fever	16 (84.2)
Abdominal pain	9 (47.4)
Pleural effusion	6 (31.6)
Cough	6 (31.6)
Shortness of breath	2 (10.5)
Vomiting	2 (10.5)
Jaundice	0

Table 2
Nineteen cases of basic diseases in children with bacterial liver abscesses

Basic diseases	Number of cases (%)
Acute leukemia	7 (36.8)
Aplastic anemia	1 (5.3)
Diabetes	1 (5.3)
Choledochal cyst	1 (5.3)
Abdominal trauma	1 (5.3)
Total	11 (57.9)

Table 3
Image characteristics of abscesses.

Characteristics	N (%)
Lesion plurality	
Single	12 (63.2)
Multiple	7 (36.8)
Involved lobe	
Right, alone	14 (73.7)
Left, alone	2 (10.5)
Bilateral	3 (15.8)
Size (cm)	
≤5	15 (78.9)
≥ 5 cm	4 (21.1)
Splenic abscess	2 (10.5)
Hepatomegaly	5 (26.3)

Table 4
Blood and abscess culture results.

Blood and abscess culture results	%
Blood culture rate	100 (19/19)
Blood culture positive rate	26.3 (5/19)
Klebsiella pneumoniae	40 (2/5)
Escherichia coli	40 (2/5)
Stenotrophomonas maltophilia	20 (1/5)
Abscess culture rate	26.3 (5/19)
Abscess culture e positive rate	80 (4/5)
Streptococcus intermedius	50 (2/4)
Staphylococcus aureus	25 (1/4)
Enterococcus faecium	25 (1/4)

Table 5
Laboratory results and total fever time before treatment in the drainage group and nondrainage group

	Drainage group	Nondrainage group	P-value
Age (year, $\bar{X} \pm S$)	4.12 ± 2.8	5.3 ± 3.7	> 0.05
WBC ($\times 10^9$, $\bar{X} \pm S$)	17.5 ± 4.2	9.5 ± 6.4	> 0.05
CRP (mg/L, $\bar{X} \pm S$)	120.8 ± 21	71.6 ± 52.1	> 0.05
AST (U/L, $\bar{X} \pm S$)	26 ± 3.0	48.7 ± 37.5	> 0.05
ALT (U/L, $\bar{X} \pm S$)	20.6 ± 7.6	53.4 ± 46.0	> 0.05
Abscess size (cm, X ± S)	5.86 ± 2.0	2.96 ± 1.4	0.009
Febrile duration (day, X ± S)	17.6 ± 6.7	6.7 ± 5.3	0.01

WBC, white blood cell; CRP, C reactive protein; AST, aspartate aminotransferase; ALT, alanine aminotransferase.