Liver abscesses in the Western pediatric population

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Abstract

Background and study aims: **Liver abscesses are rare in the Western pediatric population and data on predisposing factors and etiology are scarce. We aimed to describe predisposing factors, microbiological characteristics, and treatment.**

Patients and methods: **Retrospective analysis of children admitted to two tertiary care hospitals in Belgium from 1 January 1996 to 31 December 2019. We analyzed clinical features, predisposing factors, imaging characteristics, microbiological data, treatment, and outcome in children with a liver abscess and compared these data with the literature.**

Results: **We collected 24 cases with a male to female ratio of 1.4 and a median age of 3.2 years at time of diagnosis. Survival was 95.8%. Invasive culture specimens were obtained in 83.3% and showed growth of bacteria in 55%. Parenteral antibiotics were administered before invasive culture sampling in 80%. Liver abscesses were cryptogenic in four (16.7%) patients. Hepatobiliary disease was the most prevalent predisposing factor (n = 6; 25%), followed by recent antineoplastic therapy for malignancies (n = 5; 20.8%), intra-abdominal surgical pathology (n = 4; 16.7%) and umbilical venous catheters (n = 2; 8.3%). In two patients there was a parasitic origin (n = 2; 8.3%) and in one it was caused by Bartonellosis. There was no diagnosis of chronic granulomatous disease (CGD) in our cohort.**

Conclusions: **Pediatric liver abscesses have a favorable outcome in the developed world. Whenever feasible, invasive abscess culture specimens should be obtained. In patients presenting with a cryptogenic liver abscess or atypical disease course, immunological workup should be ensured.** (Acta gastroenterol. belg., **2022,** 85, **439-445**).

Keywords: predisposing factors, microbiology, treatment.

Introduction

Liver abscesses are a rare disease entity in the Western pediatric population when compared to the developing world (1-4). In cohorts from the developing world (5-8), a higher incidence is thought to be mainly due to higher rates of protein-energy malnutrition and exposure to gastrointestinal pathogens associated with poorer hygiene facilities. In the absence of these environmental factors in the developed world, liver abscesses are thought to present predominantly in the presence of other predisposing factors (1,3-7,9-13).

Pathogenesis is either by hematogenic spread, biliary tract infection, contiguous spread, or by any trauma to the liver (14,15). Penetrating trauma can directly inoculate bacteria in the liver parenchyma, whereas in blunt trauma it is believed that hematoma formation can predispose to bacterial seeding with subsequent abscess development (12). Depending on the underlying cause, multiple routes of hepatic invasion are possible. Liver abscesses as an iatrogenic complication can occur after invasive procedures such as percutaneous liver biopsy, percutaneous cholangiography, and umbilical venous catheterization (12).

Presenting symptoms of liver abscesses in children are most often non-specific and consist of fever, chills, and abdominal pain (1,11). Tender hepatomegaly is considered rare in children presenting with liver abscesses. Laboratory markers of inflammation are often elevated but are nonspecific. Markers of cholestasis are often within normal range, although elevated serum alkaline phosphatase levels have been reported in up to 73% of patients (11).

In this report, we present a case series of pediatric patients admitted to two tertiary care centers in Belgium and we extensively reviewed the literature.

Methods

We retrospectively collected data on pediatric patients (aged <16 years old) admitted to the department of Pediatrics of the University Hospitals Leuven, Belgium and to the department of Pediatrics of the Cliniques Universitaires Saint-Luc, Brussels, Belgium, from 1 January 1996 until 31 December 2019. Permission was obtained from the respective ethical committees. Our search yielded 24 cases in the research period. Liver abscesses were defined as either typical imaging characteristics, or proof of liver abscess during surgical drainage. Data were collected on clinical and laboratory characteristics, radiographic features, microbiology, treatment, and outcome. We systematically recorded the following clinical and demographic data: age at diagnosis, gender, predisposing conditions, fever, abdominal tenderness, and hepatomegaly. Laboratory parameters included C-reactive protein, white blood cell counts, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and total serum bilirubin. Imaging

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Table 1. — **Patient characteristics, laboratory parameters and ultrasonographic characteristics**

	Demographics		*Clinical signs*			*Laboratory values*						*Ultrasonographic characteristics*
No.	Age	Gender	Fever	Abdominal pain	Hepato-megaly	CRP (mg/L)	WBC count (x10^9/L)	TSB (mg/dL)	ALT (U/L)	AST (U/L)	ALP (U/L)	Anatomical localization
1	5.7 years	M	+	-	+	12	2.86	0.3	25	42	508	Multifocal Orthotopic liver transplant
2	1 year	M	+	+	-	21.1	30.43	2.2	17	44	ND	Perihepatic
3	1.1 years	M	+	-	-	280	21.35	3.5	342	301	ND	Multifocal
4	3.8 years	M	-	-	-	15.6	29.65	3.4	321	339	144	Right border Orthotopic liver transplant
5	1 year	M	+	+	+	158	23.80	8.6	168	81	263	Multifocal
6	1.5 years	M	+	+	+	29.5	15.04	2.7	59	80	ND	Left lobe (segment III) Orthotopic liver transplant
7	5.4 years	M	+	+	-	215.8	2.07	0.7	159	42	ND	Right lobe (segment VI, VII) and perihepatic
8	15.2 years	M	+	+	+	120	5.2	0.18	121	94	93	Left lobe
9	5.7 years	M	+	+	+	11.7	0.39	ND	ND	25	ND	Left lobe (segment IV)
10	1.1 years	F	+	-	-	28.8	1.39	0.7	23	18	ND	Multifocal
11	15.6 years	F	+	+	-	265	2.34	1.9	26	32	282	Multifocal
12	14.1 years	F	+	+	-	13.5	16.66	0.2	4	21	ND	Right lobe (segment VI)
13	1 year	F	+	+	-	217	18.51	<0.2	9	9	ND	Right liver lobe
14	1.3 years	M	+	+	-	25	26.22	ND	19	37	ND	Prehepatic 3-4 cm, 1 collection
15	9.5 years	M	-	+	-	138.2	14.91	0.2	11	18	163	Right lobe (segment VI)
16	5 days	F	+	-	+	48.0	18.26	1.5	42	99	223	Left lobe (segment II, Iva, Ivb) and Right lobe (segment VIII)
17	6 days	F	-	+	-	142	3.95	10	13	60	221	Right lobe (segment VII)
18	11.1 years	F	-	+	+	7	9.36	0.9	16	33	30	Right and left lobe
19	12.9 years	F	+	+	-	121.6	6.8	0.80	56	38	239	Right lobe (segment VI)
20	1.6 years	M	+	-	+	35	13.04	ND	8	19	ND	Multifocal
21	64 days	F	+	-	- *	68.9	21.54	0.19	18	27	183	Perihepatic
22	2.6 years	M	+	+	-	182.6	10.53	0.58	21	25	158	Left lobe
23	5.8 years	F	+	+	-	80.7	15.37	0.18	13	20	173	Right lobe (segment VI, VII)
24	4.7 years	M	+	+	+	8.6	15.10	ND	ND	ND	ND	Perihepatic

M: male; F: female; ND: not determined; CRP: C-reactive protein; WBC count: white blood cell count; TSB: total serum bilirubin; ALT: alanine aminotransferase; AST: aspartate aminotransferase; ALP: alkaline phosphatase

data, via ultrasound, comprised abscess localization, presence of an abscess-associated venous thrombosis and presence of appendicitis Microbiological data included conventional blood cultures and culture results of abscess content. When available, microbial detection polymerase chain reaction (PCR) data were additionally collected. Treatment and outcome parameters included interventional treatment, type of antimicrobial treatment and duration, follow-up duration, and survival. Continuous variables are expressed as mean ± SD and as median with interquartile range for variables with a non-normal distribution, whereas categorical variables are expressed as rates and percentages.

We searched the PubMed database (accessed December 2021) for studies reporting on liver abscesses in children. Both pyogenic and amebic liver abscess studies were considered. Keywords used were: "children", "pediatric", "liver abscess", "pyogenic liver abscess", "amebic liver abscess". The search covered studies from 1969 to December 2020. The list of references in the identified studies was curated separately for studies not found in the database search. The search was limited to studies in English and studies conducted in patients under 18 years of age. Articles were initially selected based on title, keywords and abstract.

Results

Clinical characteristics

Median age at diagnosis was 3.2 years (interquartile range 1.07 years to 6.72 years) and fourteen out of twenty-four were male (58.3%, male to female ratio 1.4). All but four (83.3%) subjects presented with fever (temperature >38.0°C). Abdominal pain was reported by fourteen out of twenty-four patients (58.3%). Hepatomegaly was present on clinical examination in nine (37.5%) of cases, and one infant was referred because of

Table 2. — **Predisposing factors, microbiology and treatment data**

No.	Predisposing conditions or specific etiology	Invasive culture specimen	Blood culture	Treatment			
				Parenteral antimicrobials	Treatment duration		Abscess drainage
					Parenteral	Total	
1	Hepatobiliary disease Biliary stenosis after liver transplant	*Haemophilus aphrophilus*	Sterile	Vancomycin, temocillin	10 d	43 d	Percutaneous
2	Hepatobiliary disease Liver transplant, directly postoperative	*Enterococcus faecium*	Sterile	Meropenem; vancomycin	21 d	21 d	Surgical
3	Hepatobiliary disease Cirrhosis due to biliary atresia	*Pseudomonas aeruginosa, Stenotrophomonas maltophilia, Enterococcus faecium*	*Pseudomonas aeruginosa*	Colymycin, gentamycin, aztreonam Fluconazole, ganciclovir	154 d	154 d	Percutaneous
4	Hepatobiliary disease Acute liver failure (Hepatitis A)	*Klebsiella oxytoca* *Escherichia coli*	Sterile	Temocillin, ampicillin; meropenem, amikacin	24 d	24 d	Surgical
5	Hepatobiliary disease Cirrhosis due to biliary atresia	*Klebsiella pneumoniae* (ESBL)	*Klebsiella pneumoniae* (ESBL)	Amoxicillin, temocillin; meropenem	64 d	64 d	Surgical
6	Hepatobiliary disease Biliary stenosis after liver transplant	Sterile	*Escherichia coli* (ESBL)	Ampicillin, temocillin; meropenem	17 d	17 d	-
7	Malignancy Acute lymphoblastic leukemia	ND	*Pseudomonas aeruginosa*	Piperacillin/tazobactam, amikacin, vancomycin; ciprofloxacin Caspofungin	28 d	28 d	-
8	Malignancy Neuroblastoma	Sterile	Sterile	Vancomycin, meropenem, amikacin Amphotericin B, caspofungin Cidofovir, ribavirin	65 d	65 d	-
9	Malignancy Neuroblastoma	Sterile	Sterile	Piperacillin/tazobactam	20 d	20 d	-
10	Malignancy Acute lymphoblastic leukemia	ND	*Enterobacter cloacae*	Piperacillin/tazobactam; meropenem, caspofungin; voriconazole	46 d	46 d	-
11	Malignancy Burkitt leukemia	ND	*Geotrichum clavatum*	Piperacillin/tazobactam; meropenem, vancomycin; caspofungin, amikacin; voriconazole, amphotericin B, metronidazole	72 d	72d	-
12	Intra-abdominal pathology Prior needle ingestion	Sterile	Sterile	Ciprofloxacin, fluconazole; amoxicillin/clavulanic acid	21 d	21 d	Surgical
13	Intra-abdominal pathology Appendicitis	Sterile	Sterile	Metronidazole; amoxicillin/clavulanic acid	11 d	28 d	Surgical
14	Intra-abdominal pathology Intestinal perforation	*Citrobacter freundii, Klebsiella pneumoniae*	Sterile	Meropenem, amikacin; vancomycin; ceftazidim	16d	21 d	Surgical
15	Intra-abdominal pathology Appendicitis	Sterile	Sterile	Cefuroxim, metronidazole	28 d	38 d	Surgical
16	Umbilical venous catheter	Sterile	Sterile	Piperacillin/tazobactam; amoxicillin/clavulanic acid	26 d	47 d	Percutaneous
17	Umbilical venous catheter	*Staphylococcus epidermidis*	*Staphylococcus epidermidis*	Vancomycin	28 d	28 d	Surgical
18	Parasitic	*Enterococcus faecalis*	Sterile	Temocillin, amoxicillin; meropenem, amikacin Albendazole	76 d	114 d	Surgical
19	Parasitic	Sterile	Sterile	Piperacillin/tazobactam; meropenem; vancomycin Albendazole, praziquantel	27 d	30 d	-
20	Cat scratch disease	ND	Sterile	Amoxicillin/clavulanic acid; azithromycin, rifampicin, ciprofloxacin	9 d	29 d	-
21	None	*Staphylococcus aureus* (MSSA)	Sterile	Piperacillin/tazobactam; oxacillin	14 d	31 d	Percutaneous
22	None	Sterile	Sterile	Piperacillin/tazobactam	46 d	46 d	Percutaneous
23	None	*Streptococcus anginosus*	Sterile	Piperacillin/tazobactam; amoxicillin/clavulanic acid	42 d	46 d	Percutaneous
24	None	*Staphylococcus aureus* (MSSA)	Sterile	Amoxicillin/clavulanic acid	14 d	14 d	Surgical

ND: not determined, MSSA: methicillin-sensitive *Staphylococcus aureus*, ESBL: extended-spectrum beta-lactamase producing strain, d: days

a palpable mass in the right upper abdominal quadrant. Clinical characteristics, laboratory parameters and ultrasonographic characteristics are summarized in table 1.

Laboratory parameters

All patients presented with elevated C-reactive protein levels (CRP). Mean ± SD CRP value was 126.1±104.5 mg/L (range 7-280 mg/L; normal <5 mg/L). In those of whom data were available, elevated levels according to age or to international reference values were present for serum alkaline phosphatase in two out of thirteen (15%), total serum bilirubin in seven out of twenty (35%), alanine aminotransferase in seven out of twenty-two (32%), and aspartate aminotransferase in twelve out of twenty-three (52.2%).

Radiographic findings

All but one liver abscesses were initially detected by abdominal ultrasound. In the other patient, abdominal MRI was performed at the time of diagnosis, to

Table 3. — **Comparison of references reporting on predisposing conditions, antibiotic treatment, and survival**

	Muorah et al (1)	Pineiro-Carrero et al (3)	Hendricks et al (5)	Salahi et al (9)	Yeh et al (11)	Thavamani et al (16)	Srirastava et al (4)	Tsai et al (20)	Hsu et al (21)	Grossar et al (this cohort)
Geographic region	United Kingdom	United States of America	South Africa	Iran	Taiwan	United States of America	India	Taiwan	Taiwan	Belgium
N patients	15	11	84	18	38	4057	39	15	15	24
M/F ratio	0.875	0.83	1	1.6	1.92	1.56	NR	NR	0.67	1.4
Era	1993-2003	1975-1986	1983-1992	1998-2008	2000-2019	2003-2014	2000-2008	1986-2001	1995-2011	1996-2019
Chronic granulomatous disease	20%	18.2%	1.2	5.6	0	NR*	NR	NR	0	0
Diabetes mellitus	6.7%	NR	NR	NR	7.9%	NR**	NR	NR	20%	0
Sickle cell disease	6.7%	NR	NR	NR	0	NR	NR	NR	0	0
Malignancy	0	27.3%	0	5.6%	28.9%	11.0%	NR	NR	0	20.8%
Hepatobiliary pathology	0	0	0	NR	23.7%	21.7%	NR	NR	0	25%
Intra-abdominal surgical pathology	6.7%	9.1%	0	NR	NR	NR	NR	NR	13.3%	16.7%
Others	NR	Cat scratch disease (9.1%)	Protein energy malnutrition (56%)	11.1%	UVC (5.3%)	IBD (4.2%), CKD (0.5%)	NR	NR	Thalassemia (6.7%)	UVC (8.3%) Parasitic (8.3%) Cat scratch disease (4.2%)
Cryptogenic	NR	27.3%	NR	66.7%	47.4%	60.8%	NR	NR	80%	20.8%
Percutaneous drainage	20%	36.3%	0	66.7%	57.9%	45.4%	61.5%	73.3%	93.3%	25%
Surgery	20%	54.5%	62%	27.8%	22.7%	4.1%	17.9%	6.7%	6.7%	41.7%
Survival	100%	90.1%	95%	94.4%	100%	99.2%	97.4%	100%	100%	95.8%

*Primary immunodeficiency disorder in 4.2%, specific information suppressed. **Diabetes mellitus excluded from analysis in this cohort. NR: not reported, IBD: inflammatory bowel disease, CKD: chronic kidney disease.

differentiate the lesion from an abdominal tumor. Liver abscesses were localized in the left lobe (33.3%), right lobe (16.7%), or both (8.3%). Multiple tiny lesions localized in both lobes were considered as multifocal (25%). Four abscesses (16.7%) were described as perihepatic (table 1).

Predisposing factors

Predisposing factors, culture results and treatment are summarized in table 2.

In twenty out of twenty-four cases (83.3%), predisposing factors to developing a liver abscess were found. Hepatobiliary disease requiring liver transplantation was the most prevalent predisposing factor in our cohort (n = 6; 25%), either in the direct peri-transplant period (n = or when graft biliary stenosis (n = 2) occurred after transplantation. In four cases (16.7%) the liver abscess was related to intra-abdominal surgical pathology, such as appendicitis (n = 2), intestinal perforation (n = 1), or prior needle ingestion (n = 1). Two newborns (8.3%) presented with liver abscess linked to indwelling umbilical venous catheters.

Two other cases (8.3%) were considered of parasitic origin. One patient (4.2%) had diffuse liver and splenic abscesses due to cat scratch disease. Five children (20.8%) had an underlying malignancy, with liver abscess occurring under treatment with antineoplastic therapy. No patient in our cohort had neutropenia (0.5x10^9 neutrophils per microliter or lower) at time of diagnosis, however this was invariably present in the recent history of these latter cases.

Of the remaining four cryptogenic abscesses (16.7%), one was lost to follow-up. The remaining three underwent immunological work-up. No patient had a diagnosis of chronic granulomatous disease by rhodamine testing. Furthermore, lymphocyte immunophenotyping and dosing of immunoglobulin levels were normal according to age in these three patients. During follow-up, none of these patients had other serious bacterial infections.

None of our patients had a diagnosis of diabetes mellitus or sickle cell disease. Table 3 provides an overview of the literature reporting on predisposing factors and treatment

Microbiology

Invasive culture specimens of abscess content were obtained in twenty out of twenty-four (83.3%) patients, either percutaneously (n = 13), or during surgery (n = 7).

Overall positive culture ratio for invasive culture specimens was 55%. In sixteen (80%) of the twenty patients who underwent invasive sampling, parenteral antibiotics were started before the sample was obtained and this group had a positive culture ratio of 56.3%. Of the remaining four where no antibiotics were started before invasive sampling, two (50%) had positive pus cultures.

Blood culture results were positive in seven out of twenty-four (29.2%; bacterial growth (n = 6) or fungal growth (n = 1)) patients.

Bacterial detection by PCR was additionally performed on abscess content in four cases and returned positive in two. In both patients, PCR results did not

influence treatment. In one patient who was severely immunocompromised after antineoplastic treatment, *Adenovirus*-detection by PCR was strongly positive in blood, stool, and abscess content.

Of the two parasitic abscesses, one had a suggestive history of travel to regions endemic to parasitic pathogens and showed improvement when antiparasitic treatment regimens were added, after failure to respond to prolonged broad-spectrum antibiotic therapy. The other case was in a thirteen-year-old girl with hydatid cysts.

Invasive specimens were obtained in all patients with hepatobiliary or intra-abdominal surgical pathology, eighty percent of patients with cryptogenic abscesses, half of those with abscesses of parasitic origin and those related to umbilical venous catheters, and in forty percent of patients with malignancy. In the cat scratch disease liver abscess, serology was positive for *Bartonella henselae* and no invasive procedure was performed.

Treatment

All patients were empirically treated by parenteral antibiotics with anaerobic coverage and considering host risk factors such as presence of indwelling central venous catheters and known bacterial colonization in patients with known hepatobiliary disease. In patients with a malignancy, antifungals (such as liposomal amphotericin, caspofungin, and voriconazole) were used in case of insufficient clinical response to antibiotics. Whenever possible, antibiotics were streamlined according to susceptibility of the cultured pathogen. Median parenteral and total antimicrobial treatment duration were 25 days (interquartile range 16 days to 46 days) and 31 days (interquartile range 23 days to 46 days), respectively.

Invasive treatment by abscess content drainage was performed in sixteen (66.7%) patients, either per-cutaneously (n = 6; 25%) or surgically (n = 10; 41.2%).

The hydatid cysts were treated by surgical marsupialization and parenteral antibiotics due to bacterial superinfection and failure of initial treatment by percutaneous drainage and injection of hypertonic saline. Treatment by azithromycin and rifampicin was successful for the *Bartonella* abscesses.

Outcome

One patient in our cohort succumbed during the disease course, while being extremely immunocompromised and suffering overwhelming Adenovirus-infection. He was under intensive antineoplastic treatment for stage IV neuroblastoma and suffered from deep and prolonged leukopenia. Furthermore, this patient was known with Adenovirus-reactivation in blood after immunosuppressive treatment. At time of liver abscess detection, PCR was strongly positive for Adenovirus in blood, stool, and abscess content in this patient. Conventional blood cultures and bacterial PCR, obtained after broad-spectrum antimicrobials were started, remained sterile.

All other subjects survived the course of their hospitalization (survival rate 95.8%). In another patient, an abscess-associated hepatic vein thrombosis was detected during the disease course, which resolved completely after treatment with low-molecular weight heparin. Thrombophilia screening in this patient yielded a heterozygous factor V Leiden-deficiency. Serious liver graft infection together with acute cellular rejection led to graft failure requiring a second liver transplantation in one case.

Median clinical follow-up time was 905 days (interquartile range 316 to 1 748 days).

Discussion

This is, to the best of our knowledge, the largest series of pediatric liver abscesses in Europe. Our positive culture rate for invasive culture specimens is in line with the literature (1,11,13,16), however great variation exists between studies. Reported rates range from 39% to 73.3% and not all reports differentiate between positive blood culture results and invasive culture results. Especially in younger infants who present with signs of a serious systemic infection and nonspecific clinical signs, broad-spectrum antibiotics are often admnistered before the diagnosis of a liver abscess is made and thus before an invasive culture specimen is obtained. Both in our cohort and in others (1,11), a relatively high positive culture rate for invasive specimens was achieved after parenteral antibiotics were started. Therefore, it seems justifiable to perform invasive culture sampling after antibiotic treatment is started. Consequently, whenever clinically tolerated, obtaining invasive culture specimens should be attempted to guide appropriate antimicrobial treatment.

Staphylococcus aureus has been reported as the most prevalent causative pathogen in pediatric liver abscesses in most series from both the developed as the developing world (1,6,12,16,17). Recent data from the United States however, showed that prevalence of Streptococci preceded that of Staphylococci. In Taiwan and Southeast Asia (11,18-24), *Klebsiella pneumoniae* is acknowledged as the most frequent causative pathogen in both children and adults. We report a more heterogeneous collection of pathogens without a clear predominant strain. This may be due to the specific population with predisposing conditions in our cohort.

The use of PCR-detection based on the universal 16S bacterial ribosomal RNA, holds a potential additional value in patients with invasive pyogenic infections, when conventional cultures remain sterile. Indeed, higher positive detection rates have been reported (25,26) by molecular sequencing compared to conventional culture-dependent methods, especially when cultures remain sterile. On the other hand, contamination during abscess content aspiration and detection of non-pathogenic species in a polymicrobial abscess can complicate inter-

pretation of these results (25,26). Considering these data, further research is warranted to elucidate the diagnostic value of these molecular methods in liver abscesses and other invasive pyogenic infections. When bacterial detection by PCR was employed in our cohort, results did not impact treatment.

Protein-energy malnutrition is historically considered as the most important predisposing factor associated with development of liver abscesses in children in the developing world, as evidenced by a historical cohort from South Africa (5). In the developed world, typical predisposing factors are diabetes mellitus and sickle cell disease (1,11,17). Disorders of granulocyte function, especially chronic granulomatous disease (CGD), are reported as underlying host defense defects in up to 20% of series (1,9,13). Inversely, liver abscesses are frequently encountered infections in CGD-patients, both in developing (27) and developed countries (28,29). In cases of children undergoing antineoplastic therapy, the occurrence of any deep pyogenic infection is linked to prolonged periods of neutropenia (9,30). In a recent nation-wide retrospective analysis in the United States (16), liver transplantation was the single most important risk factor for liver abscess development in children.

We report comparable mean antibiotic treatment duration to other reports (1,11,21). As of interventional treatment, surgical drainage was performed more frequently than percutaneous drainage in our cohort. This is in contrast with many other reports (4,9,11,16,20,21), where percutaneous drainage was the most frequently employed approach. Since in our population the proportion of patients with hepatobiliary disease leading to liver transplantation and intra-abdominal surgical pathology was relatively high, this might explain the relative predominance of surgical drainage. Two other cohorts (3,5) reporting more surgical than percutaneous drainage were recorded in an era when ultrasonography- or fluoroscopy-guided percutaneous aspiration were not yet routinely performed.

Our survival rate is in line with other cohorts (1,3-5,9,11,16,20,21). Our one patient with a portal venous thrombosis, had an abnormal procoagulant profile. Since any abscess can be thrombogenic, the presence of a portal venous thrombosis should be systematically screened for in follow-up of patients with a liver abscess. When thrombosis is present, a procoagulant screen is warranted.

In conclusion, liver abscesses in the Western pediatric population are a rare entity with favorable outcome, provided adequate treatment is applied in a timely manner. Whenever clinically tolerated, invasive culture specimens should be obtained. However, given the positive culture rate, antibiotic administration should not be postponed to obtain invasive specimens when infection is not well tolerated by the patient. Direct microbial detection methods can improve diagnostic yield, but further research is needed to optimize interpretation of results. In every patient presenting with a liver abscess without a likely predisposing factor and/or in case of atypical disease course, immunological work-up should be ensured.

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