

Clinical Characteristics and Outcome of Infants with Biliary Atresia in Bahrain

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ABSTRACT

Objectives: Though the prevalence of biliary atresia (BA) in the Middle East is low, its role in causing life-threatening liver diseases is disproportionately high. This study aimed to assess the prevalence, clinical presentations, diagnosis, surgical interventions, and long-term outcomes including survival rate, and to analyze prognostic factors affecting the survival of infants with BA in Bahrain. **Methods:** A retrospective cohort review of cases of infants diagnosed with BA between January 1993 and December 2021 at Salmaniya Medical Complex, Bahrain, was conducted. Demographic, clinical, laboratory, imaging, and histopathological data were analyzed. Outcomes measured included 5-year native liver survival (NLS) and overall liver survival (OLS) rates. **Results:** Out of 27 infants diagnosed with BA, 26 were included in the study. The overall prevalence was 0.007% and was significantly higher among Bahraini (0.006%) compared to the non-Bahraini population (0.001%), $p < 0.001$. Most patients had clay-colored stool (19 of 22; 86.4%) and hepatomegaly (18; 81.8%). Kasai procedure was performed in 23 (88.5%) patients and primary liver transplant (LT) in three. Ten (38.5%) infants required LT after the Kasai procedure. The median age at diagnosis was 56 days with interquartile range (IQR) of 30–90, and the median age at the Kasai procedure was 61 days (IQR = 56–90). NLS and OLS rates were 53.8% and 65.4%, respectively. The overall mortality rate was 34.6%. Six of the 13 (46.2%) patients who were subjected to Kasai procedure alone died awaiting LT donors. Infants with lower birth weight and older age at diagnosis had significantly better odds of survival ($p < 0.029$ and $p < 0.044$, respectively). **Conclusions:** BA is uncommon among infants in Bahrain. Despite effective treatment options, late diagnosis can lead to significant morbidity and mortality. Our study found a relatively low prevalence of NLS (53.8%) and OLS (65.4%). Since the majority of the diagnosed patients had presented with clay-colored stools, implementing an infant stool card for screening may be beneficial in raising parental awareness and detecting BA early. Early detection and treatment using novel therapies are likely to improve the survival rates.

Despite being a rare pediatric disease with a prevalence of about one per 20 000 live births, biliary atresia (BA) is the most frequent reason for surgery in infants with persistent jaundice and the leading cause of pediatric liver transplants (LTs).^{1,2} BA is an idiopathic inflammatory liver disease that manifests in the neonatal period, and characterized by progressive fibrosis and obstruction of both intrahepatic and extrahepatic bile ducts.³ It presents with symptoms of cholestatic jaundice, which, if left untreated, results in cirrhosis and death in 50–80% of patients within a year and 90–100% at the age of three.^{4,5}

Currently, Kasai hepatic portoenterostomy (HPE)—commonly known as Kasai procedure—

and LT are the only two effective treatments for BA. HPE is the primary treatment, performed as soon as the diagnosis of BA is confirmed; LT is usually indicated if there is inadequate bile clearance after the Kasai procedure, growth failure, progressive liver dysfunction, or subsequent decompensated cirrhosis.^{6,7}

A well-performed Kasai procedure can transform BA from a fatal disease to a successfully treated one, in addition to delaying the requirement of LT. However, LT may become inevitable for around 60–80% of patients by adulthood due to the emergence of unmanageable complications.^{8–10} A systematic review on the outcomes in 184 adult patients with BA who survived to adulthood (> 20 years) with their native livers found that 60.5% of

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them ultimately had significant complications such as bacterial cholangitis, portal hypertension and its sequelae, and hepatocellular carcinoma.¹⁰ These figures are supported by other studies.¹¹

Overall survival rates and quality of life have improved impressively over the last few decades for those who successfully went through both Kasai and LT, but potential contraindications to surgery and accessibility of liver graft continue to impact the success rate. In the Middle East, only a few LT centers are available. Cultural and religious influences that discourage organ donation and low public awareness have also impacted the transplantation rates in this region.^{12,13}

Studies tackling BA in the Middle East are scarce. Therefore, our study aimed to assess the prevalence of BA in Bahrain, to review the clinical presentations, diagnoses, and management including surgical interventions. We also aimed to evaluate the long-term survival rates and other outcomes of BA and analyze the factors that affected the survival of the patients encountered in our center.

METHODS

In this retrospective cohort study, the subjects were all infants diagnosed with BA or followed-up for BA at Salmaniya Medical Complex, Manama, Bahrain, between January 1993 and December 2021.

Diagnosis of BA for each patient was observed to have been confirmed using a combination of radiographic and liver histology results. Not all patients included in our study had the Kasai procedure in Bahrain. All Kasai procedures performed in Bahrain were open surgeries. Those who required LT had been referred overseas due to the non-availability of the facility in the country.

Data retrieved from the hospital database included the year of presentation, age, sex, nationality, gestational age, mode of delivery, birth weight, perinatal history, parental consanguinity, family history of liver disease or BA, age at admission, age at diagnosis, the onset of jaundice, presence of dark urine, clay-colored stool, pruritus, vomiting, fever, and associated conditions. Physical examination findings including admission weight, abdominal distension, hepatomegaly, splenomegaly, ophthalmological findings, and involvement of other systems were also collected.

Laboratory, radiological, and histopathology data reviewed included the results of hemoglobin level, platelet count, coagulation profile, serum total protein, serum albumin and globulin, total bilirubin, direct and indirect bilirubin levels, alkaline phosphatase, alanine aminotransferase, gamma-glutamyl transferase, serum ammonia, serum lactate, metabolic workup, glucose, cholesterol and triglyceride, serum iron and ferritin level, serum alpha-1 antitrypsin level, sweat chloride test, and thyroid function tests. The results of urine culture, combined serology of toxoplasma, rubella, cytomegalovirus, and herpes simplex virus were also reviewed. Findings of chest X-ray, abdominal ultrasound (US), echocardiography, hepatobiliary iminodiacetic acid (HIDA) scan, liver biopsy and age at liver biopsy were collected. US scans with triangular cord signs, contracted gallbladder, and non-visualized common bile duct were taken as significant positive indicators for BA. A positive HIDA scan was considered to indicate that there was no uptake or excretion into the bowel. The infant's age at Kasai procedure and direct bilirubin levels before and after the procedure were also noted.

The patient outcomes were divided into three scenarios: (1) survival with complications, (2) death, and (3) need for LT. Age at LT, age at death, and cause of death were noted. Total serum bilirubin and age at the last follow-up visit were also acquired.

The collected data were analyzed using IBM SPSS Statistics (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). The frequencies, percentages, and overall prevalence of BA in Bahrain were calculated. Group data were presented as a mean \pm SD for normally distributed variables or median and interquartile range (IQR) for non-normally distributed variables. For normally distributed continuous variables, the independent student *t*-test was used to compare the group means, while the Mann-Whitney U test was used to compare group medians for non-normally distributed continuous variables including the difference in prevalence between the Bahraini and non-Bahraini patients. Chi-square and Fisher's exact tests were used to compare categorical variables. *P*-values < 0.05 were considered statistically significant. Survival analysis based on procedure type was estimated via the Kaplan-Meier method.

This study followed the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans and was ethically approved by the Secondary Health Care Research Committee, Salmaniya Medical Complex, Government Hospitals, Bahrain (IRB number: 103020821). It was noted that all parents/guardians had signed their written informed consent upon admission of their wards to the hospital.

RESULTS

During the study period, 27 infants were confirmed to have BA. One of them was excluded from our study due to a lack of information on the outcome. Thus, 26 infants comprised our study population. This included one Bahraini female initially diagnosed with Alagille syndrome in whom BA was confirmed intraoperatively during the Kasai procedure.

Demographic data of the patients with BA are shown in Table 1. Majority (15; 57.7%) were females. Sixteen (61.5%) infants were Bahraini and the remaining 10 (38.5%) were non-Bahraini, comprising three Egyptians (11.5%), three Pakistanis (11.5%), two Syrians (7.7%), one Indian (3.8%), and one Yemeni (3.8%). Clinical signs and physical examination findings are shown in Table 2. Most patients had clay-colored stool and hepatomegaly. According to the 2019 national health statistics, the total population of Bahrain was 1 483 756. The pediatric population was 378 410 (25.5%), of whom 280 029 (74.0%) were Bahraini and 98 381 (26.0%) non-Bahraini. The overall prevalence of BA was 6.87 per 100 000 (0.007%) of the pediatric population. The prevalence was significantly higher among Bahraini than non-Bahraini children, at 5.7 per 100 000 (0.006%) and 1.02 per 100 000 (0.001%), respectively ($p < 0.001$).

Results of antenatal US were available for 21 (80.8%) mothers and all were reported to be normal. Heart murmurs were noticed in three (13.6%) infants during physical examination at the presentation. Echocardiography revealed peripheral pulmonary stenosis in association with Alagille syndrome, ventricular septal defect, and patent ductus arteriosus in each patient. The median age at the onset of jaundice was five (IQR = 1–30) days. The median age at diagnosis was 56 (IQR = 30–90) days.

All the patients had direct hyperbilirubinemia at presentation with elevated levels of serum

Table 1: Demographic data of 26 infants with biliary atresia.

Variables	n (%)
Sex	
Female	15 (57.7)
Male	11 (42.3)
Nationality	
Bahrain	16 (61.5)
Non-Bahraini	10 (38.5)
Gestational age (n = 22)	
Term	19 (90.5)
Preterm	2 (9.5)
Type of delivery (n = 21)	
Normal	17 (85.0)
Cesarean section	3.0 (15.0)
Positive perinatal history[†] (n = 21)	2 (9.5)
Parental consanguinity (n = 19)	5 (26.3)
Age at admission (days), median, IQR (n = 21)	64 (32–124)
Age at diagnosis (days), median, IQR (n = 19)	56 (30–90)
Age at time of study (year), median, IQR	10.3 (7.2–17.2)
Admission weight (kg), mean \pm SD (n = 11)	4.8 \pm 1.4
Birth weight (kg), mean \pm SD (n = 22)	3.0 \pm 0.6

[†]One mother had gestational diabetes and another mother was a hepatitis B carrier; IQR: interquartile range.

Table 2: Clinical signs and physical examination of 22 infants with biliary atresia.

Variables	n (%)
Clinical signs	
Clay stool	19 (86.4)
Dark urine	18 (81.8)
Pruritus	3.0 (13.6)
Vomiting	1 (4.5)
Fever	1 (4.5)
Associated syndromes*	1 (4.5)
Physical examination	
Hepatomegaly (n = 21)	19 (90.5)
Splenomegaly (n = 21)	6 (28.9)
Abdominal distension	6 (27.3)
Heart murmur	3 (13.6)
Ophthalmology examination (n = 12) [‡]	1 (8.3)

*One infant had Alagille syndrome; [‡]posterior embryotoxon in one patient.

direct bilirubin (151.0 \pm 68.0 μ mol/L; normal = 0–5); alkaline phosphatase (740.0 \pm 270.0 IU/L; normal = 150–420), alanine aminotransferase (142.0 \pm 77.0 IU/L; normal: < 33), and gamma-glutamyl transferase (791.0 \pm 778.0 IU/L; normal < 185). Three out of 14 infants (21.4%) were

Table 3: Survival characteristics in infants with biliary atresia.

Intervention	Total cases	Died	Survived	Survival rate, %	Mean years of survival (CI [†])	Mean follow-up time in years* ± SD [‡]	p-value
Kasai procedure alone	13	6	7	53.8	11.2 (6.26–15.77)	6.4 ± 5.3	0.422
Kasai and liver transplant	10	2	8	80.0	23.1 (16.64–29.56)	10.7 ± 8.1	
Primary liver transplant	3	1	2	66.7	10.9 (2.25–19.54)	5.8 ± 9.0	
Overall	26	9	17	65.4	18.6 (13.52–23.70)	8.0 ± 7.0	

*Follow-up time is measured from the initial treatment date i.e., Kasai or liver transplant until the event (death) occurs or study end date; †95% CI.

cytomegalovirus positive on toxoplasma, rubella, cytomegalovirus, and herpes screening, and two out of 12 (16.7%) patients had positive urine cultures for *Enterobacter/Klebsiella* and *Escherichia coli*.

Abdominal US yielded positive findings in 11 of 14 (78.6%) patients, while HIDA scan results were positive for all the 12 (100%) patients who were subjected to it. Liver biopsy confirmed BA in all the 18 (100%) cases tested for the same.

Patients management and outcomes are displayed in Table 3. The Kasai procedure was performed in 23 (88.5%) infants at a median age of 61 (IQR = 56–90) days. Three (11.5%) patients underwent primary LT at 4.5, 7.3, and 30.0 months, respectively. One patient had a Kasai revision two weeks after the initial Kasai procedure. Seventeen of 23 (73.9%) infants had the Kasai procedure in Bahrain, three (13.0%) in Egypt, two (8.7%) in Pakistan, and one (4.3%) in Jordan. Thirteen (50.0%) patients had the Kasai procedure alone, while the remaining ten (38.5%) required LT after the Kasai procedure at a median age of 0.9 years (IQR = 0.8–7.0). For the ten infants who underwent both Kasai and transplant, the median time period between the two procedures was 0.8 years (IQR = 0.6–7.0); the youngest patient's age at transplant was 0.4 years, and the oldest was 13 years. All liver transplantation procedures were performed abroad—seven (53.8%) in Saudi Arabia, three (23.1%) in India, and one (7.7%) each in Turkey, Egypt, and the UK. All received liver tissue from living donors. Donor information was available for 12 patients, with mothers accounting for seven (58.3%), fathers for four (33.3%), and an uncle for one (8.3%). As of December 2021 (the end of our data collection period), 10 of 13 (76.9%) LT recipients remained alive and they were continuing to receive the immunosuppressant, tacrolimus.

Cirrhosis (16 cases; 76.2%) and cholangitis (13 cases; 61.9%) were the two most frequent complications that our patients experienced

prior to LT. Other complications included portal hypertension in six (28.6%) patients, ascites in four (19.0%), esophageal varices in three (14.3%), coagulopathy in two (9.5%), and intestinal obstruction in two (9.5%) patients. In total, 13 (54.2%) transplants were performed due to reasons such as late presentation, failed Kasai, end-stage liver failure, recurrent cholangitis, and other complications.

Four BA patients have entered adulthood, and the oldest was aged 28 years. Three of them have had LT, including the eldest patient. They had no complications related to the transplant or immunosuppressive medications. The fourth patient was approaching the age of 20 years with her native liver but is currently being reviewed for LT because of recurrent cholangitis.

The overall mortality rate during the study period was 34.6% (9 of 26 patients). The median age at death was 1.6 years (IQR = 0.9–3.5). Five were female, and four were male. One of the patients who underwent primary LT aged seven months died after a month due to graft rejection. Six of 13 (46.2%) patients who had only the Kasai procedure died awaiting LT donors. In one infant, Kasai was performed at the age of six months but later died aged two years owing to progressive liver failure. Two (20.0%) of the ten patients who underwent both Kasai and LT died because of multiorgan failure.

The native liver survival (NLS) rate was 53.8% and the overall liver survival (OLS) rate was 65.4% [Figure 1]. The survival rate reached up to 80% in those who underwent both Kasai and LT. The mean follow-up time measured from the initial treatment date i.e., from Kasai/LT until death or the end of our data collection period (December 2021) was 8.0±7.0 years. Data available for 15 (57.7%) patients revealed median total serum bilirubin to be 13 µmol/L (IQR = 8–48) at the last follow-up.

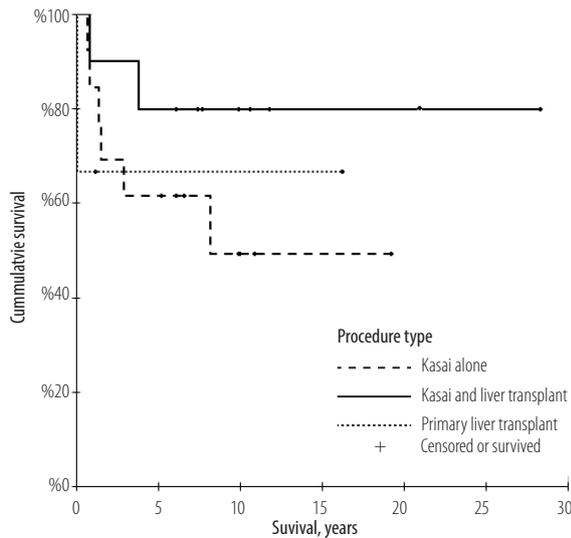


Figure 1: Survival analysis in patients with biliary atresia according to procedure type using the Kaplan-Meier method.

Among demographic data, birth weight and age at diagnosis seemed to have a predictive effect on survival [Table 4]. Infants with lower mean birth weight and older mean age at diagnosis were found to

be associated with an increased number of survivors ($p < 0.029$ and $p < 0.044$, respectively). After excluding one outlier patient who was diagnosed very late at the age of 231 days, the mean age at diagnosis was 36.6 ± 18.8 days for dead patients compared to 65.9 ± 28.7 days for survived patients ($p = 0.053$). None of the other factors such as sex, nationality, type of delivery, gestational age, consanguinity, age at Kasai, age at LT, and complications, had a statistically significant impact on survival.

DISCUSSION

This is the first study from Bahrain that evaluated the prevalence, clinical presentations, surgical interventions, and outcomes in patients diagnosed with BA. The prevalence of BA in the Middle East is low compared to Asia-Pacific and Europe. In a Saudi Arabian study, BA amounted to 4.7% of the causes of infantile cholestasis, significantly lower the range of 20–25% reported from LT centers in Western countries, which also placed BA as the second most common indication for LT (after progressive familial intrahepatic cholestasis).¹⁴

Table 4: Predictors of survival in patients with biliary atresia.

Variables	Survived, 17 (65.4%)	Died, 9 (34.6%)	<i>p</i> -value (95% CI)
Sex			
Female	10 (66.7)	5 (33.3)	0.873 [†]
Male	7 (63.6)	4 (36.4)	
Nationality			
Bahraini	10 (62.5)	6 (37.5)	0.696 [†]
Non-Bahraini	7 (70.0)	3 (30.0)	
Gestational age (n = 22)			
Term	16 (80.0)	4 (20.0)	0.334 [†]
Preterm	1 (50.0)	1 (50.0)	
Type of delivery (n = 21)			
Normal	13 (76.5)	4 (23.5)	0.950 [†]
Caesarean section	3 (75.0)	1 (25.0)	
Consanguinity (n = 5)			
	4 (80.0)	1 (20.0)	0.709 [†]
Birth weight (kg), mean ± SD (n = 22)			
	16 (2.9 ± 0.5)	6 (3.5 ± 0.5)	0.029 [§] (-1.10–0.07)
Admission weight (kg), mean ± SD (n = 11)			
	7 (5.2 ± 1.6)	4 (4.1 ± 0.8)	0.225 [§] (-0.81–2.99)
Age at admission (day), mean ± SD (n = 21)			
	15 (170.0 ± 307.0)	6 (43.0 ± 47.0)	0.080 ^{**}
Age at diagnosis (day), mean ± SD (n = 19)			
	14 (76.0 ± 49.0)	5 (37.0 ± 19.0)	0.044 ^{**}
Age at Kasai (day), mean ± SD (n = 23)			
	15 (73.0 ± 31.0)	8 (78.0 ± 44.0)	0.591 ^{**}
Age at liver transplant (year), mean ± SD (n = 13)			
	10 (4.0 ± 4.3)	3 (0.7 ± 0.2)	0.077 ^{**}
Recurrent cholangitis (n = 13)			
	9 (69.2)	4 (30.8)	0.68 [†]
Ascites (n = 4)			
	1 (25.0)	3 (75.0)	0.065 [†]
Portal hypertension (n = 6)			
	5 (83.3)	1 (16.7)	0.292 [†]

[†]Fischer's exact test; [§]Student's *t*-test; ^{**}Mann-Whitney *U* test.

In this study, the majority of BA patients were females (57.7%). Female predominance has also been reported in other studies from the Middle East,^{15–17} East Asia,^{18,19} and Western countries.^{20–22} This female predominance might have a scientific explanation. One of the many hypotheses for the cause of BA is that viral infection of cholangiocytes leads to an exaggerated humoral autoimmune response which eventually results in progressive bile duct damage and fibrosis. Anti-alpha-enolase antibodies have also been discovered in BA which is typically found in patients with autoimmune hepatitis.^{23–25} This supports the autoimmune hypothesis of the etiology of BA, as it has previously been established that autoimmune diseases are more prevalent in females than males.

Prompt diagnosis of BA and its timely correction depends on early referral, which in turn depends on vigilant caregivers recognizing symptoms and reporting them. The median age at diagnosis in our sample was 56 days and most (86.4%) infants presented with clay-colored stools, a characteristic of BA. In Taiwan, an infant stool color card (SCC) is being used as a nationwide screening program since 2004 which has resulted in early detections of BA, enabling earlier Kasai operations.²⁶ This scheme was also adopted in Japan where a large-scale study conducted a mass screening program over a period of 19 years and evaluated the sensitivity and specificity of the SCC.²⁷ The sensitivity and specificity of the cards at one-month health check up were 76.5% (95% CI: 62.2–90.7), and 99.9% (95% CI: 99.9–100.0), respectively.²⁷ Patients who reported stool color indicative of BA were more likely to have Kasai performed within 60 days. El-Shabrawi et al,²⁸ implemented SCC in tertiary centers in Egypt and the card proved to be highly sensitive (93.48%; 95% CI: 82.1–98.63) and specific (90.32%; 95% CI 80.12–96.37) for early diagnosis of BA, even where parental education level was low. Perhaps employing and promoting measures such as stool cards and measurement of serum conjugated bilirubin as part of newborn screening at our center may expedite earlier diagnosis of BA in children and facilitate better outcomes.²⁹

Conflicting results seen in our study, where patients diagnosed at an older age and with lower mean birth weight happened to be related to more survivors, might be due to the small sample of 26 babies in addition to missing data and because we did not find this reported elsewhere.

The median age for the Kasai procedure in our sample was 61 days which was comparable to other cohorts as shown in Table 5.^{5,8,16–18} There is a consensus between multiple studies that the Kasai procedure performed at earlier ages is associated with favorable outcomes with better jaundice clearance.^{1,5,18,35,36} The optimal age for infants to undergo the Kasai procedure has not yet been identified but ≤ 60 days has been suggested.^{35,36} Okubo et al,³⁶ classified BA patients into subgroups: early Kasai ≤ 60 days and late Kasai > 60 days. The early Kasai group was further subdivided into ≤ 30 , 31–45, and 46–60 days. Outcome analysis revealed that jaundice clearance rates and long-term survival were higher in the early Kasai group. The best results were seen in infants who had surgery during ≤ 30 and 46–60 days. Curiously, babies aged 31–45 days did not fare as well.

Post-transplant and waitlist mortality were significantly higher in patients who underwent transplants in infancy compared to those who got transplanted in childhood.^{33,37} This might be attributed to the smaller stature and lower weight of the former.³⁸ Our series clearly shows that the majority of the children (six out of nine) who passed away did so while waiting for LT and three who died post-transplant were operated on before the age of one year, owing to multiorgan failure and acute graft rejection.

Pre-transplant care is as crucial as post-transplant care. A study published in 2021 analyzed the waitlist mortality determinants in children with BA listed for LT and learned that small size (< 10 kg), raised total bilirubin level, ventilator dependence, and presence of complications such as portal vein thrombosis and ascites at the time of listing were linked with a significantly increased risk for negative outcomes.³⁸ Considering these factors might assist in prioritizing children awaiting LT. Furthermore, maintaining adequate nutrition and avoiding complications during the waiting period is cardinal to successful LT and better outcome.⁷

In the present study, the Kasai procedure was performed in 23 of 26 (88.5%) infants, one of whom also underwent a Kasai revision surgery. A Kasai revision can be considered in patients with persistent jaundice and multiple episodes of cholangitis. Studies have suggested that revision of Kasai could help defer progressive liver failure and LT, whether or not the initial Kasai was successful.^{39,40} Conversely,

Table 5: Review of treatments and survival outcomes of patients with biliary atresia in studies published after 2010.

Country of study	Author, year	Study period	No. of patients	Sex ratio (M:F)	Procedure	Median age at HPE, days	Native liver survival, year (%)	Overall survival, year (%)
Middle East								
Bahrain (present study)	Isa et al, 2023	1993–2021	26	11:15	HPE: 23, LT: 3	61	5 (53.8)	5 (65.4)
Saudi Arabia	Holdar et al, ¹⁴ 2019	2008–2015	21	11:10	HPE: 12, LT: 9	73	4 (14.3)	4 (81)
Saudi Arabia	Khayat et al, ¹⁵ 2021	1999–2017	23	10:13	HPE	77	(56)	(69.5)
Iran	Naghashi et al, ¹⁶ 2020	2006–2017	90	44:50	HPE: 71	64.7 [†]	5 (40)	NR [†]
Egypt	Gad et al, ¹⁷ 2021	2000–2019	410	186:224	HPE	65	5 (49.8)	5 (51.5)
Asia-Pacific								
Hong Kong	Chung et al, ¹⁸ 2021	1980–2017	231	97:134	HPE	59	10 (70.7)	NR
China	Wang et al, ³⁰ 2019	2009–2012	139	77:62	HPE	78.3 [†]	5 (58)	NR
India	Redkar et al, ³¹ 2017	2000–2014	121	75:46	HPE	96	1 (43.8)	NR
Europe								
Italy	Parolini et al, ³² 2019	1975–1996	174	91:83	HPE	60	5 (41)	NR
Nordic countries	Pakarinen et al, ²⁰ 2018	2005–2016	154	71:83	HPE: 148, LT: 6	64	5 (53)	5 (88)
Netherlands	de Vries et al, ⁵ 2012	1987–2008	214	110:104	HPE	59	4 (46 ± 4)	4 (73 ± 3)
France	Chardot et al, ⁸ 2013	1986–2009	1107	NR	HPE: 1044	59	5 (40)	5 (81)
England and Wales	Davenport et al, ³³ 2011	1999–2009	443	NR	HPE: 424, LT: 15	54	5 (46)	5 (90)
Africa								
South Africa	De Maayer et al, ³⁴ 2017	2009–2012	70	13:30	HPE: 43	64	2 (32.6)	NR

[†]mean days; NR: no record; HPE: hepatic portoenterostomy (Kasai procedure); M:F: male:female; LT: liver transplant.

another study cautioned that a Kasai revision should only be performed in patients who did not achieve jaundice-free status after the initial one and that it may increase the risk of morbidity post-LT.⁴¹ Despite the contradictory results, it might be worthwhile to consider Kasai revision as an alternative for children waiting for LT.

The five-year NLS rate for BA patients referred to our center was 53.8% which matches most of the other cohorts' survival rates ranging from 40%–60% [Table 5].^{8,15–17,20,30–34} Post-transplant survival rate was 76.9% (10/13). Our OLS rate was similar to the cohorts in other Middle Eastern countries but lower in comparison to European or Asian nations. Reasons for such suboptimal outcomes might be attributed to the lack of standardization in surgical and management practices of patients as the Kasai procedure and the LT had been performed in different countries.

The limitations of our study included its retrospective nature, the fact that it was a single-center study, the relatively small cohort, and the lack of standardized treatment. Information regarding different subtypes of BA and other data for a few patients could not be gathered due to missing data. Despite these limitations, our findings fill a long-standing research gap, being the first study from Bahrain focused on BA. Given that BA is one of the most common indications for pediatric liver transplantation, and the catastrophic consequences of delayed diagnosis and treatment of this condition, any new finding on BA in the Middle East is of great relevance. Moreover, the findings of this study can increase awareness about BA among healthcare providers and could form a foundation for any future research, systematic review, or meta-analysis that should include both local and international data.

CONCLUSION

Although BA is uncommon in infants in Bahrain, it has a disproportionately large role in causing morbidity and mortality despite the available treatment options, namely, HPE and liver transplantation. Our study cohort had relatively low rates of NLS (53.8%) and OLS (65.4%). Most diagnosed patients presented with clay-colored stools—a key warning sign of BA. Thus, implementing an infant stool card may be beneficial in raising parental awareness to facilitate

early detection. Further research into the etiology and course of BA and developing novel therapeutic strategies will help improve the survival rates of this rare but debilitating disease.

Disclosure

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