Journal of Population Therapeutics & Clinical Pharmacology

Prognostic Factors of Kasai Operation in Patients with Biliary Atresia

Asmaa Abdelrazek Helmy Abdelrazek Hashem
Pediatric resident, Kafrelshiekh University Hospital.
Prof. Osama Abdelfatah Ali Elagamy.
Professor and head of Pediatric department, Faculty of Medicine, Kafrelshiekh University.
Prof. Mohamed Ezz Elregal Abbas Amin.
Professor of Pediatrics and head of Gastroenterology and Hepatology Unit at Mansoura University Children Hospital, Mansoura University.
Dr Mohamed Ibrahim Ibrahim Abdelghafar.
Lecturer of Pediatrics, Faculty of Medicine, Kafrelshiekh University.
Corresponding author:Asmaa Abdelrazek Helmy
asmaa.med_0051@med.kfs.edu.eg

Abstract

Background Biliary atresia (BA) is a progressive liver disease. It is the most frequent indication for pediatric liver transplantation. Kasai portoentostomy (KPE) is used as the first line of treatment. This study aimed to identify possible short-term outcome prognostic factors of KPE for BA in infants.

Subjects and Methods: The study involved 30 infants with BA who underwent KPE through 3 years from January 2021 to December 2023, then followed up for 6 months after the operation at the Pediatric Hepatology Unit, Mansoura University children Hospital, Egypt. According to the outcome of Kasai procedure (KP), Patients categorized into failed and successful groups. The successful outcome was determined by the clearance of

jaundice within 6 months after KP where total serum bilirubin ≤ 2 mg/dl. Both groups were compared according to demographic, perioperative clinical, laboratory, ultrasonographic and histopathological characteristics and postoperative complications.

Results 40% of Infants had successful KPE while 60% had failed outcome. The parameters significantly associated with successful outcome were younger age at operation (P=0.018), lower levels of post-operative 1-month, 3-month and 6-month serum total and direct bilirubin (p=0.001). Atretic gallbladder, marked fibrosis, small bile duct < 150μm, presence of ductal plate malformation, severe duct proliferation and cholangitis were all significantly associated with failed outcome (P=0.03, P=0.03 P=0.03, P=0.025, P=0.03, P=0.018) respectively.

Conclusions Younger age, lower post-operative 1-month and 3-month serum total and direct bilirubin levels are good predictors for the outcome of Kasai operation in BA infants. Atretic gallbladder, marked fibrosis, small bile duct <150μm, presence of ductal plate malformation, severe duct proliferation and cholangitis were all poor predictors of Kasai outcome.

Keywords Biliary atresia, Kasai portoenterostomy, outcome, predictors

INTRODUCTION:

Biliary atresia (BA) is a progressive fibro-obliterative cholangiopathy affecting the biliary tree to various degrees and resulting in obstruction in bile flow that mostly presents with jaundice, dark urine and pale stools during neonatal period [1]. It can lead to hepatic fibrosis, end-stage liver disease

and if untreated, this disease is uniformly fatal in the first years of life [2]. BA considers the most frequent indication for liver transplantation in pediatric age [1].

BA is a rare disease with variable incidence worldwide ranging from 1 in 5,000–10,000 in Taiwan and Japan to 1 in 15,000–20,000 in Europe and North America [3]. Etiology of BA remains unclear but appears to be multifactorial [4].

The more intrusive "gold standard" intra-operative cholangiography or liver biopsy is typically necessary to diagnose or totally rule out BA because there isn't a single optimum non-invasive testing method [5].

The definitive management of this condition is entirely surgical, including Kasai portoenterostomy as an initial attempt of restoration of bile flow and preservation of the native liver. If it fails or cirrhosis or life-threatening complications develop, liver transplant may be carried out [6].

Factors known to influence the success of KPE include early age at surgery, experience of the surgical centre, presence of associated abnormalities, and anatomic and histological appearance of the extrahepatic biliary tree. Steroids, by virtue of their anti-inflammatory and choleretic roles, can favourably influence the outcome of BA. Repeated episodes of cholangitis can adversely affect the outcome of BA after KPE [7].

Several studies have linked histopathological features of BA to outcome, including the presence of ductal plate malformation, the extent of histologic or molecular fibrosis , hepatic inflammation , bile duct proliferation and

the presence of large bile ducts at the porta hepatis, with large lumen ducts defined as ducts with the largest lumen diameter size of ≥150 μm [8, 9].

we conducted this study to determine the factors predicting the short-term outcome of KP.

PATIENTS AND METHODS:

This cohort study included infants with BA who underwent KPE between January 2021 to December 2023, then they followed up for at least 6 months after surgery. The study was conducted at the Pediatric Gastroentrology and Hepatology Unit, Mansura University Children Hospital(MUCH), Egypt. This study involved 30 Patients after exclusion of patients with insufficient data in their files and those who were lost to follow-up.

All recruited cases underwent full history taking, thorough clinical examination, and routine investigations including Complete blood count, serum electrolytes, renal and liver function tests with special consideration for liver function tests in our study in the form of serum bilirubin (total and direct), albumin, aspartate transaminase (AST), alanine transaminase (ALT), gammaglutamyl transpeptidase (GGT), alkaline phosphatase ALP), prothrombin time (PT), International normalized ratio (INR).

Preoperative abdominal ultrasonography (US) was done while the patient was fasting (at least 4 hours) and after oral feeding by expert radiologist by "Philips,

Affiniti 50G, Minnesota, USA" device for assessment of biliary tree , detection of organomegaly and any associated anomalies . US identified the biliary atretic process by the triangular cord (TC) sign which described as the thickness of the echogenic anterior wall of the anterior branch of the right portal vein just distal to the right portal vein on a longitudinal image and usually reported positive when thickness >3–4 mm [10].

Several gallbladder abnormalities associated with biliary atresia have been reported: absence of visibility of the gallbladder lumen, small gallbladder with a cut-off length <15–19 mm, abnormal shape and wall of the gallbladder and no emptying of the gallbladder after feeding with taking in mind that a normal gallbladder did not rule out biliary atresia [10].

Preoperative liver biopsy was also done for all patients where a tru cut specimen of optimum size was obtained and stained with hematoxylin and eosin (H&E), Mason-Trichrome stain, PAS-diastase and Perls' Prussian blue stains then analyzed by expert pathologists before confirming the diagnosis.

The classic histologic features of biliary obstruction were bile duct proliferation, bile plugs, portal or perilobular fibrosis, and edema, with preservation of the basic hepatic lobular architecture. Giant cell transformation can be found in 20% to 50% of patients with BA and also ductal plate malformation can be seen [11].

The predictive parameters evaluated to detect their effect on outcome of Kasai procedure were onset of jaundice, methods for diagnosis, histopathological findings of preoperative liver biopsy and preoperative abdominal ultrasonographic

findings, other congenital anomalies, age at surgery, perioperative therapy, postoperative treatment protocol, development of complications (cholangitis, portal hypertension) in the 6 months following KPE.

All patients after the operation received intravenous antibiotics. Prednisolone started on day 7 postoperative if no evidence of infection was found for one week at a dose of 2 mg/kg/day, followed by gradual tapering over the next 2 weeks. All operated children received prophylactic cyclical antibiotics including trimethoprim/sulfamethoxazole for at least 6 months postoperative. All children received also ursodeoxycholic acid (dose 10–15 mg/kg/day), fat soluble vitamins and nutritional rehabilitation.

All patients had follow up visits at 1, 3 and 6 months post-operative at GIT clinic at MUCH for evaluation of clinical improvement, adjustment of drug doses and assessment of complications and outcome of Kasai procedure.

At each visit, they underwent complete physical examination, routinely do liver function tests (total and direct bilirubin, AST, ALT, PT, INR, ALP, GGT, Albumin) and abdominal US when needed.

Successful outcome of Kasai operation for biliary atresia was determined by the clearance of jaundice within 6 months where total serum bilirubin $\leq$ 2 mg/dL [7]. The studied cases were divided according to the outcome into two groups, successful group (n = 12) and failed group (n = 18).

Ethical approval:

All parents who agreed on participation of their infants in the study signed an informed consent and the study was reviewed and approved by the Scientific Research Ethics Committee – Kafrelshiekh University (KFSIRB200-236) and was performed in accordance with the Declaration of Helsinki.

Statistical analysis:

Data analysis was performed by SPSS software, version 26 (SPSS Inc., PASW statistics for windows version 26. Chicago: SPSS Inc.). Qualitative data were described using number and percent. Quantitative data were described using mean ± Standard deviation. Chi-Square ($\chi 2$), Fisher exact test were used to compare qualitative data between groups as appropriate. Mann Whitney U test (z), was used to compare between 2 studied groups for non-normally distributed data. Student t-test was used to compare 2 independent groups for normally distributed data and calculating p-value. Receiver operating characteristics curve (ROC curve) was used to calculate validity (sensitivity & specificity) of continuous variables with calculation of best cut off point. Predictive values and accuracy are assessed using cross tabulation. P-values <0.05 were considered statistically significant.

Results:

This study included 30 BA infants. They were 21 (70%) males and 9 (30%) females. They underwent Kasai operation with a mean age at surgery (77.03±21.48), and range (50–127 days). According to surgical outcome, successful operation achieved in 12 infants (40%), named as successful group, while 18 infants (60%) had failed operation. Comparing the preoperative

baseline characteristics between both, age at time of surgery was the only parameter significantly affect the outcome (P=0.018) (Table 1).

Table 1: Demographic, Clinical and basic laboratory findings according to the outcome:

Variables		**Success N=12(%)**	**Failure N=18(%)**	**p value**
Age at operation	≤60 days	6(50.0)	2(11.1)	P=0.018*
	>60 days	6(50.0)	16(88.9)	
Sex	Male	9(75.0)	12(66.7)	P=0.626
	Female	3(25.0)	6(33.3)	
Weight at operation (kg) Mean ±SD		4.05±1.19	4.33±1.42	p=0.581
Onset of jaundice (weeks)		3.25±1.96	2.56±2.12	p=0.373
AST		188.42±52.06	229±60.99	p=0.07
ALT		98.42±44.49	132.50±60.25	p=0.105
PT		12.12±0.27	12.39±0.49	p=0.095
INR		1.02±0.03	1.02±0.03	p=0.541
Total bilirubin		8.45±1.63	9.36±2.1	p=0.221

Direct bilirubin	6.10±0.98	7.32±2.38	p=0.106
Albumin	3.83±0.45	4.01±0.37	p=0.230
GGT level	935.92±737.16	1074.17±720.41	p=0.614
ALP	341.42±112.42	379.44±89.11	p=0.311

(AST) Aspartate transaminase, (ALT) Alanine transaminase, (GGT) Gammaglutamyl transpeptidase, (ALP) Alkaline phosphatase, (PT) Prothrombin time, (INR) International normalized ratio, *statistically significant.

Both studied groups were comparable regarding pre-operative ultrasonographic findings except atretic gallbladder was significantly associated with failed outcome (P=0.03) (Table 2).

Table 2: Ultrasound findings according to the outcome:

Variables		**Success n=12(%)**	**Failure n=18 (%)**	**p value**
Gall bladder	Non-visualized	2(16.7)	1(5.6)	P=0.32
	Normal	5(41.7)	2(11.1)	P=0.052

	Contracted	3(25.0)	4(22.2)	P=0.860
	Small	1(8.3)	3(16.7)	P=0.511
	Atretic	1(8.3)	8(44.4)	P=0.03*
Non-visualized CBD		2 (16.7)	4(22.2)	P=1.0
TC sign		1 (8.3)	2(11.1)	P=0.804
Hepatomegaly	-ve	8(66.7)	9(50.0)	P=0.367
	+ve	4(33.3)	9(50.0)	
Splenomegaly	-ve	7(58.3)	10(55.6)	P=0.880
	+ve	5(41.7)	8(44.4)	

(CBD) Common bile duct, (TC sign) Triangular cord sign, *statistically significant.

Preoperative liver biopsy was done for all infants. Marked hepatic fibrosis, bile duct size in remnant < 150 μm, ductal plate malformation and severe duct proliferation were all significantly associated with failed outcome (P=0.03), (P=0.03), (P=0.025), (P=0.03) respectively (Table 3).

Table 3: Liver biopsy findings according to the outcome:

Variables	**Success n=12(%)**	**Failure n=18(%)**	**p value**

Fibrosis	Mild	7(58.3)	1(5.6)	P=0.001*
	Moderate	4(33.3)	9(50.0)	P=0.36
	Marked	1(8.3)	8(44.4)	P=0.03*
Giant cell transformation		5(41.7)	8(44.4)	P=0.880
Bile duct size < 150µm		2(16.7)	10(55.6)	P=0.03*
Ductal plate malformation		3 (25.0)	12(66.7)	P=0.025*
Bile plugs		11 (91.7)	15(83.3)	P=0.511
Duct proliferation	Mild	8(66.7)	3(16.7)	P=0.005*
	Moderate	3(25.0)	7(38.9)	P=0.42
	Severe	1(8.3)	8(44.4)	P=0.03*

*statistically significant

Post-operative laboratory findings:

Liver function tests at 1, 3 and 6 months postoperative were comparable, except for serum total and direct bilirubin which were significantly lower in the successful group than in the failed group (Table 4).

Table 4: Post-operative laboratory findings according to the outcome:

Variables	Success	Failure	p value

		n=12	n=18	
Total bilirubin	1 month	5.0±2.41	7.67±1.52	p=0.001*
	3 months	3.55±1.46	7.35±1.38	p=0.001*
	6 months	0.458±0.235	4.99±1.82	p=0.001*
Direct bilirubin	1 month	3.03±1.61	6.06±1.84	p=0.001*
	3 months	0.742±1.38	5.76±1.79	p=0.001*
	6 months	0.133±0.05	4.15±2.67	p=0.001*

***statistically significant**

Post-operative complications:

Early complications (≤6 months) after KP occurred in (73.3%) of cases with cholangitis was the most common one with percentage of (33.3%) and was significantly associated with failed outcome (P=0.018) (Table 5).

Table 5: post-operative complications according to the outcome:

Complications	**Success**	**Failure**	**p value**

		n=12(%)	n=18(%)	
Cholangitis:	Total	1(8.3)	9(50.0)	P=0.018*
	Recurrent (≥ 2 attacks)	1(8.3)	8(44.4)	P=0.03*
Signs of portal hypertension		2(16.7)	7(38.9)	P=0.193

*statistically significant

Clinical performance of age and postoperative serum bilirubin level in predicting surgical success:

Age of 67.5 days or less was predictive of successful outcome with (75%) specificity and (77.8%) sensitivity with (95%) confidence interval (95% CI 0.588-0.953), Area under ROC curve (AUROC) was 0.771 (Figure 1). Also, 1-month post-operative serum total and direct bilirubin level had a good performance in predicting surgical success at a cut-off value of ≤6.15mg/dl, ≤4.75mg/dl with (88.9%) sensitivity and (83.3%) specificity for both, (95% CI 0.700-1.0 and (95% CI: 0.887-1.0), AUROC were 0.866 and 0.954 respectively (Figures 2, 3).

3-month post-operative serum total and direct bilirubin level had a good performance in predicting surgical success at a cut-off value of ≤4.95 mg/dl, ≤4.05 mg/dl with (88.9%) and (83.3%) sensitivity and (83.3%) and (100%) specificity, (95% CI 0.903-1.0 and (95%

CI: 1.0-1.0), AUROC were 0.963 and 1.0 respectively (Figures 2, 3).

6-month post-operative serum total and direct bilirubin level had a better performance in predicting surgical success at a cut-off value of ≤1.75 mg/dl, ≤0.8 mg/dl with (100%) sensitivity and (100%) specificity, (95% CI: 1.0-1.0), AUROC were 1.0 for both (Figures 2, 3).

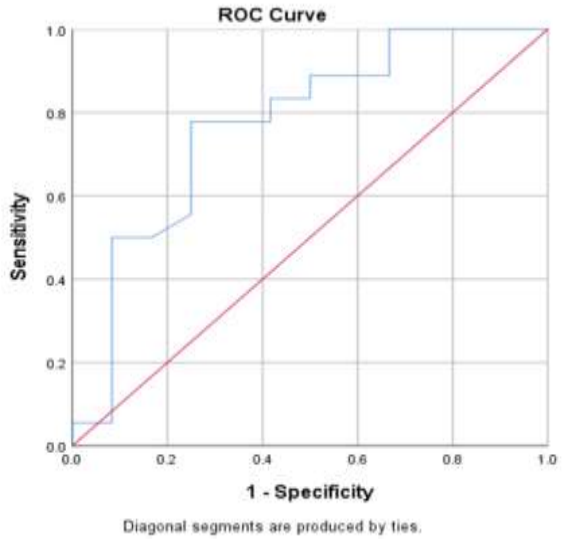

Figure 1: Receiver operating characteristic (ROC) curve of age at surgery by days for predicating success of Kasai procedure in treatment of biliary atresia.

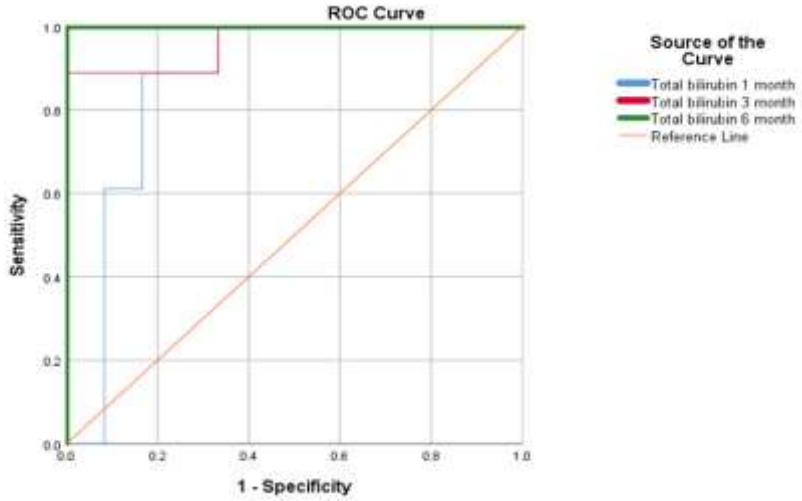

Figure 2: ROC curve of total bilirubin at 1, 3 and 6 months after Kasai procedure in differentiating failed and successful outcome

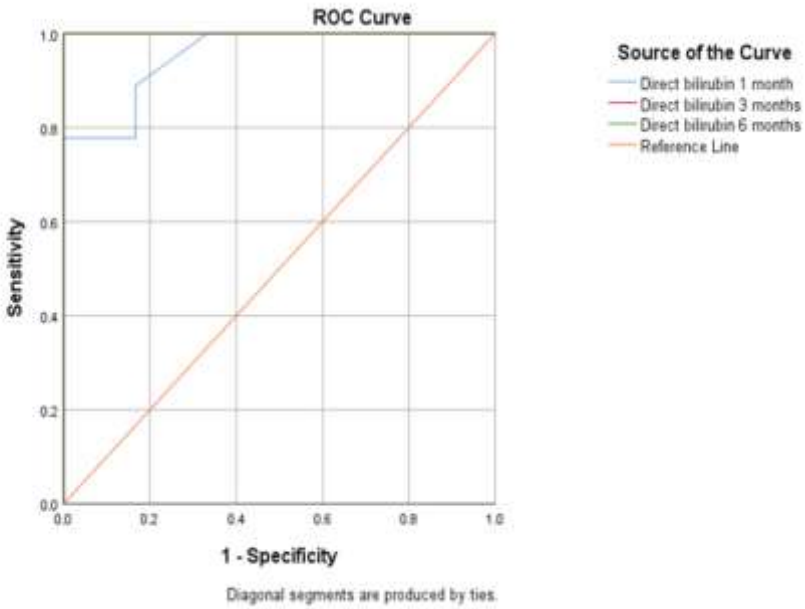

Figure 3: ROC curve of direct bilirubin at1, 3 and 6 months after Kasai procedure in differentiating failed and successful outcome.

Discussion:

Biliary atresia is a progressive fibrosing obstructive cholangiopathy affecting both the extrahepatic and intrahepatic biliary systems [12].

The definitive management of this condition is entirely surgical; including Kasai portoenterostomy with liver transplant may be carried out [6].

The aim of our study was to evaluate early predictive parameters that can affect outcome of Kasai operation which known to be Successful after complete clearance of jaundice (serum bilirubin < 2 mg/dl) within 6 months of the operation [7].

Our study involved 30 cases of BA patients who underwent Kasai portoentrostomy then they were followed up for 6 months for evaluation of the outcome of the operation and the results were as the following: 12 cases out of 30 (40%) had successful outcome, while the other 18 cases (60%) had failed outcome.

Our results come in agreement with many studies that reported similar outcomes as Chardot et al. [13] and Wildhaber et al. [14] who reported successful outcome in 38% of cases and Sanghai et al. who reported success rate of 41.7% [15].

Lower success rates (27%) reported by Abdelaziz et al. [16] while Davenport et al. showed higher success rates (55%) in their study [17].

In our study, among demographic, clinical and pre-operative laboratory characteristics, the age at Kasai operation was the only significant factor affecting the outcome of the operation. The age group of ≤60 days was mostly associated with success of the operation while the age group of >60 days was mostly

associated with failed operation where 16 cases out of 22 cases had failed outcome, while 6 cases only had successful outcome.

These results come in agreement with many studies that showed that the outcome was best when infants were operated before 60 days of age [18, 19, 20].

Traditionally, the first 60 days of life are critical in establishing bile flow to prevent or ameliorate liver-related morbidity and mortality in BA patients [5].

Wong et al. showed that performing Kasai operation beyond the age of 60 days was not associated with a worse outcome and that a high percentage of patients could still achieve good bile flow with normal bilirubin postoperatively. Thus, they believed that until the age of 100 days, the age of the patients does not play a significant role in determining the success of the Kasai operation [21].

In our study, other associated congenital anomalies were found in 40% of cases, the most common anomaly was inguinal hernia (13.3%), only one case (3.3%) had polysplenia with left isomerism and it showed successful outcome.

Khayat et al. [5] reported that 43.5% of their cases had other associated congenital anomalies, namely heart, kidney or other system anomalies. One patient had congenital anomalies suggestive of the syndromic type of BA: polysplenia and an absent hepatic portion of the inferior vena cava.

In our study, regarding preoperative laboratory findings, we found that ALT, AST, GGT, total bilirubin (TB) and direct bilirubin (DB) were all elevated in the

failed group than the successful one, but they were not statistically significant.

This came in agreement with Kumar et al. [7] and Sanghai et al. [15] who also reported elevated preoperative live functions in the failed group without statistically significant values.

Yassin et al. [22] found that the preoperative serum level of AST was a good outcome predictor, and it was significantly higher in the failed group than in the successful group.

Namasemayam et al. reported that preoperative total bilirubin level >10 mg/dl was found to be a poor prognostic factor [23].

A prior study reported that the total and direct bilirubin levels reflect the degree of cholestasis, while ALT and AST levels reflect inflammation and damage of liver cells with future fibrosis [24].

In our study, regarding preoperative ultrasonographic findings and the outcome of Kasai operation, we found that the only significant US finding was atretic gallbladder which was found in 9 cases, 8 cases (44.4%) had failed outcome and only one case (8.3%) had successful outcome, so it was significantly associated with Kasai failure (P=0.03).

Similarly, Abdel-Aziz et al. [18] compared between US findings in their study and the outcome of KP and reported that gall bladder atresia was found in 48 cases; 39 (58.2%) of cases were in the failure group and 9 (27.3%) of cases were in the successful group, hence atretic gallbladder was significantly associated with the failed outcome. Additionally, they found that gall bladder contractility was statistically significant factor affecting the outcome of BA after surgery (P = 0.003).

In our study, liver biopsy was done for all cases and regarding its findings, fibrosis and bile duct proliferation were graded as mentioned in the study by Muthukanagarajan et al. [25] and they were found in all cases with different degrees, bile plugs were found in 86.7%, giant cell transformation in 63.3%, ductal plate malformation in 30%, and bile duct size in biliary remnant was <150 μm in 40% of cases.

In our study, regarding degree of fibrosis, mild fibrosis seen in 26.7% and 30% had marked fibrosis. Nearly all cases with mild fibrosis (7 out of 8) showed successful outcome (58.3%), but almost all cases (8 out of 9) of marked fibrosis had failed outcome (44.4%), so increased degree of fibrosis was significantly associated with failure of KP (P=0.03).

We are in agreement with several studies [8, 18, 25, 26, 27] that reported significant association between increased degree of fibrosis in liver biopsy at time of KP and failed outcome. This may be due to that fibrosis is considered a progressive and an irreversible process and it impairs flow of bile leading to jaundice and worst outcome even after surgery [27].

Baruah et al. [28] found that presence of fibrosis was not significant in relation to Kasai outcome but noted that good results obtained with reduction of fibrosis and progression of fibrosis was associated with poor results. Yassin et al. [22] also reported in their study that fibrosis had no clinical significance.

In our study, in liver biopsy we found that diameter of remnant bile duct <150μm was significantly associated with failed outcome. It was found in 12 cases (40%); 10 cases (55.6%) in the failed group and 2

cases (16.7%) in the successful group (P=0.03).

We are in agreement with Gad et al. who found that bile duct <150μm is significant predictor of jaundice clearance at the 6th postoperative month [29]. Additionally, Nguyen et al. [30] and Abdel-Aziz et al. [18] reported that diameter of remnant bile duct <150μm was significantly associated with the failed outcome.

Nguyen et al. [30] postulated that small bile duct size at the ductal remnant reflects advanced distal bile duct destruction and obliteration with parallel intrahepatic histopathologies of toxic bile acid retention and hepatocyte necrosis.

In our study regarding ductal plate malformation, it was found in 15 cases, 3 of them show successful outcome (25%) and 12 showed failed outcome (66.7%). It was a significant parameter toward Kasai failure (P=0.025).

We are in agreement with Muthukanagarajan et al. [25] who found that the presence of DPM points to poor prognosis which was found to be statistically significant (p=0.0064). Other studies reported significant association between presence of DPM and failed outcome [31, 32].

The persistence of ductal plate histology DPM with bile duct fetal morphologies in the portal tracts of BA is thought to be an intrauterine arrest in the normal maturation of the fetal biliary tract, hence leads to poor bile drainage [30].

In our study regarding duct proliferation in liver biopsy, we found that mild degree was mostly associated with success (66.7%), but sever degree was significantly associated with failure (44.4%), (P=0.03).

We are in agreement with Muthukanagarajan et al. [25] who noted that lesser the degree of bile duct proliferation better the prognosis and Gunadi et al. who reported that severe bile duct proliferation is associated with worst prognosis [8].

On the other hand, Baruah et al. [28] and Yassin et al. [22] reported that ductular proliferation didn't show significance regarding Kasai outcome in their study.

In our study, we found that level of 1-month post-operative total and direct bilirubin was significantly lower in the successful cases (5.0±2.41, 3.03±1.61) vs. (7.67±1.52, 6.06±1.84) respectively in the failed cases (p=0.001).

This comes in agreement with Sangkhathat et al. [33] who reported that bilirubin level at 1-month after surgery can be used as predictors of jaundice clearance -reflecting effective bile drainage- and as a marker for cholangitis and with Abdel-Aziz et al. [18] who reported that at 1 month after surgery, serum TB and DB were significantly lower in the successful group (4.7 ± 2.8, 3.2 ± 2.3) vs. (8.4 ± 2.5, 6.1 ± 2) respectively in the failed group ($P < 0.05$).

In our study, we found also that level of 3-month post-operative total and direct bilirubin were significantly lower in the successful group (3.55±1.46, 0.742±1.38) vs. (7.35±1.38, 5.76±1.79) respectively in the failed group (p=0.001).

Similarly, Shneider et al. [34] reported that TB <2.0 mg/dl within 3 months of HPE may enhance early outcomes and Celtik et al. [35] reported that bilirubin levels of 1st and 3rd months are reliable predictors for success of portoenterostomy.

Previous results come in difference with Qisthi et al. [36] who not found significant relation between total bilirubin 1, 3 months post-operative and outcome of Kasai and postulated that it may due to small sample size.

In our study regarding post-operative complications, cholangitis was found in 33.3% of cases and this comes on agreement with Yassin et al. [22] who reported occurrence of cholangitis in 30% of cases.

Lower rates (21%) reported by Redkar et al. [20], however higher rates (59%) reported by Ernest et al. [37].

In our study cholangitis occurred in 10 cases, among them one case (8.3%) had successful outcome and 9 cases had failed outcome (50%), so it was a significant predictor of failed outcome (P=0.018).

We are in agreement with several studies reported significant association between occurrence of cholangitis and Kasai failure [7, 31, 37].

In our study, recurrent cholangitis was significantly associated with failed outcome (44.4%) (P=0.03).

We are in agreement with Koga et al. [38] who reported that repeated cholangitis causes poor post-Kasai outcomes; however Yassin et al. [22] reported that repeated cholangitis was not a significant risk factor for predicting failure of KPE.

Other studies observed that the only significant prognostic variable predicting KPE outcome was the occurrence of recurrent cholangitis as bile drainage is compromised by bacteria and inflammation in the sclerotic bile ductules and cholestasis leading to further liver injury and fibrotic changes [23, 39].

There were some limitations in our study as it had a small sample and not all parameters which affect Kasai operation could be assessed.

Conclusion:

Younger age, lower post-operative 1-month and 3-month serum total and direct bilirubin levels are good predictors for the outcome of Kasai operation in BA infants. Atretic gallbladder, marked fibrosis, small bile duct <150μm, presence of ductal plate malformation, severe duct proliferation and cholangitis were all poor predictors of Kasai outcome.

References:

[1] Nizery L, Chardot C, Sissaoui S, et al. (2016): Biliary atresia: Clinical advances and perspectives. Clinics and Research in Hepatology and Gastroen terology, 40(3):281-287.

[2] Jimenez-Rivera C, Jolin-Dahel KS, Fortinsky KJ, et al. (2013): International incidence and outcomes of biliary atresia. Journal of Pediatric Gastroenterology and Nutrition, 56(4):344-354.

[3] Burns J, Davenport M (2020): Adjuvant treatments for biliary atresia. Translational Pediatrics, 9(3):253-265.

[4] Kakos CD, Ziogas IA, Alexopoulos SP, et al. (2021): Management of biliary atresia: To transplant or not to transplant. World Journal of Transplantation, 11(9):400-409.

[5] Khayat A, Alamri AM, Saadah OI (2021): Outcomes of late Kasai portoenterostomy in biliary atresia: a single-center experience. Journal of International Medical Research, 49(5):3000605211012596.

[6] Davenport M, Madadi-Sanjani O, Chardot C, et al. (2022): Surgical and Medical Aspects of the Initial Treatment of Biliary Atresia: Position Paper. Journal of Clinical Medicine, 11(21):6601.

[7] Kumar R, Lal BB, Sood V, et al. (2019): Predictors of Successful Kasai Portoenterostomy and Survival with Native Liver at 2 Years in Infants with Biliary Atresia. Journal of Clinical and Experimental Hepatology, 9(4):453-459.

[8] Gunadi, Sirait D, Budiarti L, et al. (2020): Histopathological findings for prediction of liver cirrhosis and survival in biliary atresia patients after Kasai procedure. Diagnostic Pathology, 15:1-8.

[9] Gupta L, Gupta SD, Bhatnagar V. (2012): Extra hepatic biliary atresia: Correlation of histopathology and liver function tests with surgical outcomes. Journal of Indian Association of Pediatric Surgeons, 17(4):147-52.

[10] Napolitano M, Franchi-Abella S, Damasio MB, et al. (2021): Practical approach to imaging diagnosis of biliary atresia, Part 1: prenatal ultrasound and magnetic resonance imaging, and postnatal ultrasound. Pediatric Radiology, 51(2):314-331.

[11] Fawaz R, Baumann U, Ekong U, et al. (2017): Guideline for the Evaluation of Cholestatic Jaundice in Infants: Joint Recommendations of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition and the European Society for Pediatric Gastroenterology, Hepatology and Nutrition. Journal of Pediatric Gastroenterology and Nutrition, 64(1):154-168.

[12] Scottoni F, Davenport M (2020): Biliary atresia: Potential for a new decade. Seminars in Pediatric Surgery, 29(4):150940.

[13] Chardot C, Buet C, Serinet MO, et al. (2013): Improving outcomes of biliary atresia: French national series 1986-2009. Journal of Hepatology, 58(6):1209-1217.

[14] Wildhaber BE, Coran AG, Drongowski RA, et al. (2003): The Kasai portoenterostomy for biliary atresia: A review of a 27-year experience with 81 patients. Journal of Pediatric Surgery, 38(10):1480-1485.

[15] Sanghai SR, Shah I, Bhatnagar S, et al. **(2009):** Incidence and prognostic factors associated with biliary atresia in western India. Annals of Hepatology, 8(2): 120-122.

[16] Abdel-Aziz SA, Sira MM, Gad EH, et al. **(2019):** Preoperative alkaline phosphatase is a potential predictor of short-term outcome of surgery in infants with biliary atresia. Clinical and Experimental Hepatology, 5(2):155-160.

[17] Davenport M, Ong E, Sharif K, et al. **(2011):** Biliary atresia in England and Wales: results of centralization and new benchmark. Journal of Pediatric Surgery, 46(9):1689-1694.

[18] Abdel-Aziz SA, Taha M, Balabel M, et al. (2023): Prognostic factors determining the surgical interference of biliary atresia in Egyptian infants: single-center experience. Egypt Liver Journal, 38 (13):18-38.

[19] Lemoine CP, LeShock JP, Brandt KA, et al. (2022): Primary Liver Transplantation vs. Transplant after Kasai Portoenterostomy for Infants with Biliary

Atresia. Journal of Clinical Medicine, 11(11):3012.

[20] Redkar R, Karkera PJ, Raj V, et al. **(2017):** Outcome of Biliary Atresia After Kasai's Portoenterostomy: A 15-year Experience. Indian Pediatrics, 54(4):291-294.

[21] Wong KK, Chung PH, Chan IH, et al. (2010): Performing Kasai portoenterostomy beyond 60 days of life is not necessarily associated with a worse outcome. Journal of Pediatric Gastroenterology and Nutrition, 51(5):631-634.

[22] Yassin NA, El-Tagy G, Abdelhakeem ON, et al. **(2020):** Predictors of Short-Term Outcome of Kasai Portoenterostomy for Biliary Atresia in Infants: a Single-Center Study. Pediatric Gastroenterology and Nutrition, 23(3):266-275.

[23] Namasemayam D, Nallusamy M (2017): Factors influencing outcome after hepatic portoenterostomy among extrahepatic bile duct atresia patients in Hospital Sultanah Bahiyah, Alor Setar. Medical Journal of Malaysia, 72(6):329-332.

[24] Goda T, Kawahara H, Kubota A, et al. (2013): The most reliable early predictors of outcome in patients with biliary atresia after Kasai's operation. Journal of Pediatric Surgery, 48(12):2373-2377.

[25] Muthukanagarajan SJ, Karnan I, Srinivasan P, et al. **(2016):** Diagnostic and Prognostic Significance of Various Histopathological Features in Extra hepatic Biliary Atresia. Journal of clinical and diagnostic research, 10(6):EC23-7.

[26] Webb NL, Jiwane A, Ooi CY, et al. (2017): Clinical significance of liver

histology on outcomes in biliary atresia. Journal of Pediatric Child Health, 53(3):252-256.

[27] Roy P, Chatterjee U, Ganguli M, et al. (2010): A histopathological study of liver and biliary remnants with clinical outcome in cases of extra hepatic biliary atresia. Indian
Journal of Pathology and Microbiology, 53(1):101-105.

[28] Baruah RR, Bhatnagar V, Agarwala S, et al. (2015): Correlation of pre- and post-operative liver function, duct diameter at porta hepatis, and portal fibrosis with surgical outcomes in biliary atresia. Journal of Indian Association of Pediatric Surgeons, 20(4):184-188.

[29] Gad EH, Kamel Y, Salem TA, et al. (2021): Short- and long-term outcomes after Kasai operation for type III biliary atresia: Twenty years of experience in a single tertiary Egyptian center-A retrospective cohort study. Annals of Medicine and Surgery, 62: 302-314.

[30] Nguyen AP, Pham YHT, Vu GH, et al. (2021): Biliary atresia liver histopathological determinants of early post-Kasai outcome. Journal of Pediatric Surgery, 56(7):1169-1173.

[31] Lemoine CP, Melin-Aldana H, Brandt KA, et al. (2022): Identification of Early Clinical and Histological Factors Predictive of Kasai Portoenterostomy Failure. Journal of Clinical Medicine, 11(21):6523.

[32] Safwan M, Ramachandran P, Vij M, et al. (2015): Impact of ductal plate malformation on survival with native

liver in children with biliary atresia. Pediatric Surgery International, 31(9):837-843.

[33] Sangkhathat S, Patrapinyokul S, Tadtayathikom K et al. (2003): Peri-oper- ative factors predicting the outcome of hepatic porto-enterostomy in infants with biliary atresia. Journal of Medical Association of Thailand, 86(3):224–231.

[34] Shneider BL, Magee JC, Karpen SJ, et al. (2016): Total Serum Bilirubin within 3 Months of Hepatoportoenterostomy Predicts Short-Term Outcomes in Biliary Atresia. Journal of Pediatrics, 170:211-7.e72.

[35] Celtik U, Sakul G, Karakoyun M, et al. (2021): Bilirubin Levels at 1st and 3rd Postoperative Months are Significant in Determining the Success of the Kasai Portoenterostomy. The Journal of Pediatric Research, 8(3):343-349.

[36] Qisthi SA, Saragih DSP, Sutowo DW, et al. (2020): Prognostic Factors for Survival of Patients with Biliary Atresia Following Kasai Surgery. Kobe Journal of Medical Sciences, 66(2):E56-E60.

[37] Ernest van Heurn LW, Saing H, Tam PK (2003): Cholangitis after hepatic portoenterostomy for biliary atresia: a multivariate analysis of risk factors. Journal of Pediatrics, 142(5):566-571.

[38] Koga H, Wada M, Nakamura H, et al. (2013): Factors influencing jaundice-free survival with the native liver in post-portoenterostomy biliary atresia patients: results from a single institution. Journal of Pediatric Surgery, 48(12):2368-2372.

[39] Chung PH, Wong KK, Tam PK (2015): Predictors for failure after Kasai operation. Journal of Pediatric Surgery. 50(2):293-296.