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Value of preoperative APRI and FIB-4 in assessing short-term prognosis after Kasai portoenterostomy

Bingliang Li ,[1,2] Yingyu Jia,[1,2] Hongxia Ren[1]

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[1]Department of Neonatal Surgery, Children's Hospital of Shanxi, Taiyuan, Shanxi, China
[2]Department of Pediatrics, Shanxi Medical University, Taiyuan, Shanxi, China

Correspondence to
Dr Hongxia Ren;
renhongxia100@sina.com

ABSTRACT

Objective To explore the value of preoperative Aspartate Aminotransferase-to-Platelet Ratio Index (APRI) and Fibrosis-4 score (FIB-4) in predicting short-term prognosis of children with biliary atresia (BA) undergoing Kasai portoenterostomy (KPE).

Methods Clinical data from children who underwent KPE were analyzed. Patients were divided into two groups based on their 2-year native liver survival after KPE. General information and laboratory findings were collected before KPE. The difference in liver fibrosis between the two groups was analyzed. The predictive efficacy of each index for short-term prognosis of children with BA was evaluated using the receiver operating characteristic curve.

Results The APRI and FIB-4 in the good prognosis group were lower than those in the poor prognosis group (p=0.008 and 0.023, respectively), and postoperative jaundice clearance rate was higher (p=0.002). In the poor prognosis group, gamma-glutamyl transpeptidase levels in the F3+F4 fibrosis subgroup were significantly higher than those in the F1 subgroup (p=0.038). The area under the curve (AUC) for preoperative APRI in predicting short-term prognosis was the highest at 0.667, with a cut-off value of 1.190. The AUC for preoperative FIB-4 was predicted to be 0.642. The combination of preoperative APRI and alanine aminotransferase showed a higher AUC for prognosis prediction compared with either marker alone.

Conclusions Preoperative APRI and FIB-4 may havepredictive values for short-term prognosis. The predictive value of APRI and FIB-4 combined with liver function indicators for the short-term prognosis of children is superior to that of a single indicator, but the results are not satisfactory.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Non-invasive biomarkers such as Aspartate Aminotransferase-to-Platelet Ratio Index (APRI) and Fibrosis-4 score (FIB-4) are increasingly used to assess liver fibrosis in biliary atresia. However, their preoperative predictive values for short-term prognosis after Kasai portoenterostomy remains understudied, and existing research primarily focuses on postoperative outcomes.

WHAT THIS STUDY ADDS

⇒ This study demonstrates that preoperative APRI and FIB-4 have moderate predictive values for 2-year native liver survival, with area under the curves of 0.667 and 0.642, respectively. Combining APRI with liver biochemical markers improves predictive accuracy, highlighting the utility of integrating non-invasive indexes for preoperative risk stratification.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These findings provide clinicians with preoperative tools to counsel families about prognosis and optimize surgical decision-making. Future research should validate these biomarkers in larger cohorts and explore their integration with postoperative management strategies to enhance long-term outcomes.

INTRODUCTION

Biliary atresia (BA) is a congenital liver disease in neonates characterized by progressive inflammation and fibrotic obstruction of the intrahepatic and extrahepatic bile ducts.[1] Currently, Kasai portoenterostomy (KPE) is the standard early treatment for BA. It restores the flow of bile through the intestinal tract, thereby reducing the damage of cholestasis to the liver and prolonging native liver survival (NLS). While KPE can effectively restore bile flow in 50%–75% of children, it does not yield favorable long-term outcomes and fails to halt the advancement of bile duct inflammation and liver fibrosis.[2] A significant number of patients experience various complications after KPE, such as ascites, splenomegaly, and hepatic encephalopathy, leading to an unsatisfactory overall prognosis. Faced with these challenges, parents often hesitate to proceed with surgery for their children. While they are concerned about their child's future health, they lack a reliable foundation for making surgical decisions, which may lead to missed opportunities for timely treatment. Therefore, predicting the prognosis of KPE through non-invasive examination before surgery has significant value in guiding pediatricians to formulate appropriate treatment plans. Determining the prognosis of children

before Kasai surgery has long been a challenging issue in the field.

Liver fibrosis is the most common and prominent feature of BA and serves as one of the most important prognostic markers after KPE.[3] Therefore, in theory, assessing the degree of liver fibrosis can also indirectly evaluate the prognosis of the KPE. Liver biopsy is considered the gold standard for assessing liver fibrosis; however, it is not a routine examination method due to its invasiveness.[4] Currently, studies have shown that the Aspartate Aminotransferase-to-Platelet Ratio Index (APRI) can serve as an effective non-invasive indicator for evaluating the degree of liver fibrosis.[5] Academics have previously shown that APRI is effective in assessing the degree of liver fibrosis in children with BA.[6] In addition, the Fibrosis-4 score (FIB-4) is a commonly used marker for non-invasive diagnosis of liver fibrosis in adults with chronic liver disease.[7] FIB-4 provides a different perspective from APRI by assessing the degree of liver fibrosis more comprehensively through a combination of age, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and platelet (PLT) count. However, its research in children is limited, and further research is needed. The main advantages of these two non-invasive indicators, APRI and FIB-4, for diagnosing liver fibrosis are their low cost, ease of use, and minimal trauma. As a result, in recent years, APRI and FIB-4 scores have gradually replaced liver biopsy in clinical practice.[8 9] Despite their growing use, there is a lack of research on assessing liver fibrosis using preoperative APRI and FIB-4 scores to determine the prognosis of KPE. Therefore, this article investigates the effectiveness of preoperative APRI, FIB-4, and liver biochemistry in predicting short-term outcomes for children with BA following KPE.

METHODS

Patients

All patients diagnosed with type III BA underwent KPE at Shanxi Provincial Children's Hospital between January 2016 and August 2022 were enrolled. The inclusion criteria were as follows: (1) patients diagnosed with BA by intraoperative exploration and/or cholangiography who underwent KPE, (2) procedures performed by the same surgical team with standardized postoperative care based on the guidelines in "Diagnosis and Treatment of Biliary Atresia in Chinese Mainland",[10] and (3) availability of complete clinical data. Exclusion criteria included (1) perioperative deaths and (2) deaths due to non-BA-related diseases during the follow-up period.

Observation indicators and follow-up

Clinical data included gender, age at KPE, and biochemical parameters 3 days before KPE, including ALT, AST, gamma-glutamyl transpeptidase (GGT), serum albumin (ALB), total bilirubin (TBIL), direct bilirubin (DBIL), total bile acid (TBA), alkaline phosphatase (ALP), PLT, and liver pathological fibrosis grading. APRI and FIB-4 were calculated according to the formula: APRI=[AST (U/L)/ULN (40 U/L)×100]/PLT (10^9/L),[11] FIB-4=[age (mon)×AST (U/L)]/[PLT (10^9/L)×ALT (U/L)$^{1/2}$].[12] Jaundice clearance was defined as a serum TBIL level <34.2 µmol/L at 3 months post-KPE. Liver pathological specimens were collected from the anterior margin of the right lobe of the liver during KPE. They were fixed with 10% formaldehyde, paraffin-embedded, sectioned by pathologists, and stained with H&E and Masson. The degree of liver fibrosis was graded under an optical microscope using the METAVIR fibrosis grading standard: F0 indicating no fibrosis; F1 indicating mild fibrosis in the liver portal area; F2 indicating mild bridging fibrosis adjacent to the portal area; F3 indicating severe bridging fibrosis extending to adjacent portal areas; and F4 indicating cirrhosis and the formation of pseudolobules.

Regular outpatient visits and telephone communication were used to monitor the patients. The follow-up period concluded in August 2024.

Case grouping

Patients were divided into two groups based on their NLS status 2 years after KPE: good prognosis and poor prognosis. The poor prognosis group included those who either died or underwent liver transplantation (LT) within 2 years after KPE. According to the results of intraoperative liver histopathological examination, liver fibrosis was categorized as F1, F2, F3, and F4.

Statistical analysis

SPSS V.26.0 was used for statistical analysis. Normally distributed measurements were expressed as mean ± standard deviation (SD), and comparisons between two groups were made using the independent samples *t*-test. Non-normally distributed measurements were expressed as median and interquartile range (IQR), and comparisons between two groups were made using the Mann-Whitney *U* test. Categorical data were described by number and percentage (%), with comparisons between groups made using the $\chi 2$ test. For multiple comparisons, a one-way analysis of variance test was carried out. ROC curves were used to analyze the predictive efficacy of each index on the prognosis of children with BA. The area under the curve (AUC) was calculated, and the optimal cut-off value was determined using the Youden index. Statistical significance was defined as a $p<0.05$.

RESULTS

Comparison of preoperative basic data

The case identification, inclusion, and exclusion process for this study is shown in figure 1. Among the 88 patients, 51 cases (57.9%) were in the good prognosis group, and 37 cases (42.1%) were in the poor prognosis group. Preoperative levels of APRI and FIB-4 were lower in the good prognosis group compared with the poor prognosis group ($p=0.008$ and $p=0.023$). The proportion of patients with jaundice clearance was significantly higher

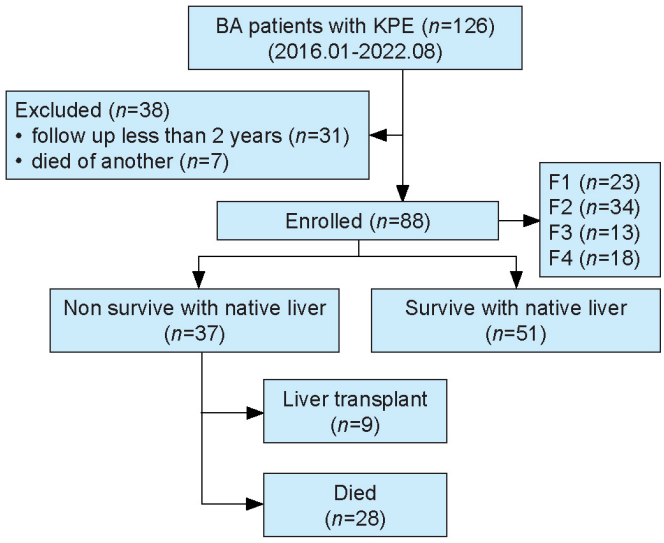

Figure 1 The process of case identification, inclusion, and exclusion in this study. BA, biliary atresia; KPE, Kasai portoenterostomy.

in the good prognosis group than in the poor prognosis group (68.6% *vs.* 35.1%, p=0.002). Subgroup analysis revealed that this difference was only significant in the F3+F4 group (p=0.036) (table 1). No statistically significant differences were observed between the two groups in terms of gender, preoperative ALT, AST, GGT, ALB, TBIL, DBIL, TBA, ALP, PLT, and age at KPE (table 1).

Relationship between stages of liver fibrosis and various indexes in patients

Among the 51 children with BA who had a good prognosis, the ages of the F1, F2, and F3+F4 groups showed an increasing trend, but the differences were not statistically significant (p>0.05). No significant differences were observed in terms of ALT, AST,GGT, ALB, TBIL, DBIL, TBA, ALP, PLT, APRI, and FIB-4 among F1, F2, and F3+F4 groups (p>0.05, table 2).

Among the 37 children with BA in the poor prognosis group, the GGT level in the F3+F4 group was significantly higher than that in the F1 group (p=0.038). The AST and TBA levels in the F1, F2, and F3+F4 groups all showed an

Table 1 Comparison of preoperative baseline data between patients in the good prognosis group and the poor prognosis group

	All (*N*=88)	Good prognosis group (*n*=51)	Poor prognosis group (*n*=37)	*P* value
Age at KPE (days)	65.5±18.5	65.1±15.7	66.1±21.9	0.788
Sex (male)	39 (44.3)	25 (49.1)	14 (37.8)	0.297
ALT (U/L)	170.0 (100.3, 257.3)	176.0 (86.0, 263.0)	150.0 (112.5, 235.7)	0.704
AST (U/L)	242.5 (161.5, 325.4)	236.0 (155.0, 301.0)	250.0 (187.0, 414.0)	0.407
GGT (U/L)	406.0 (281.0, 697.0)	451.0 (324.0, 822.0)	335.0 (266.0, 577.5)	0.131
ALB (g/L)	36.7 (33.8, 38.7)	36.5 (33.7, 39.6)	36.9 (33.9, 38.6)	0.859
TBIL (μmol/L)	192.2 (157.7, 238.9)	193.2 (151.1, 239.2)	185.7 (162.1, 245.9)	0.738
DBIL (μmol/L)	119.5 (96.7, 151.6)	121.8 (96.6, 151.4)	112.5 (93.4, 156.9)	0.793
TBA (μmol/L)	111.6 (89.2, 131.8)	114.2 (94.6, 136.3)	108.1 (85.4, 126.7)	0.120
ALP (U/L)	550.5 (422.5, 744.5)	607.0 (432.0, 747.0)	489.0 (395.5, 690.5)	0.245
PLT (×10^9/L)	426.8±158.5	448.8±158.4	396.5±155.8	0.127
APRI	**1.331 (0.948, 2.264)**	**1.131 (0.873, 1.542)**	**1.511 (1.125, 2.751)**	**0.008**
FIB-4	**0.105 (0.071, 0.166)**	**0.094 (0.065, 0.137)**	**0.129 (0.083, 0.274)**	**0.023**
Grading of liver fibrosis				
F1	23 (26.1)	13 (25.5)	10 (27.0)	0.522
F2	34 (38.6)	21 (41.2)	13 (35.2)	
F3	13 (14.8)	9 (17.6)	4 (10.8)	
F4	18 (20.5)	8 (15.7)	10 (27.0)	
Jaundice clearance	**48 (54.5)**	**35 (68.6)**	**13 (35.1)**	**0.002**
F1 group	15 (65.2)	10 (76.9)	5 (50.0)	0.179
F2 group	20 (58.8)	15 (71.4)	5 (38.5)	0.058
F3+F4 group	**13 (41.9)**	**10 (58.8)**	**3 (21.4)**	**0.036**

F3+F4: combined group of severe fibrosis (F3) and cirrhosis (F4) in METAVIR fibrosis grading.
Items in bold in the table indicate p<0.05
The data was presented as mean±sd or *n* (%) or median (IQR).
ALB, albumin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APRI, Aspartate Aminotransferase-to-Platelet Ratio Index; AST, aspartate aminotransferase; DBIL, direct bilirubin; FIB-4, Fibrosis-4 score; GGT, gamma-glutamyl transpeptidase; KPE, Kasai portoenterostomy; PLT, platelet; TBA, total bile acid; TBIL, total bilirubin.

Table 2 Relationship between the grade of liver fibrosis and indexes

	Good prognosis group (*n*=51)				Poor prognosis group (*n*=37)			
	F1 group (*n*=13)	F2 group (*n*=21)	F3+F4 group (*n*=17)	*P* value	F1 group (*n*=10)	F2 group (*n*=13)	F3+F4 group (*n*=14)	*P* value
ALT	176 (111, 275)	175 (86, 260)	137 (86, 265)	0.542	143 (61, 199)	171 (82, 288)	159 (119, 277)	0.388
AST	236 (154, 330)	220 (159, 340)	249 (151, 301)	0.441	225 (151, 245)	265 (126, 306)	386 (224, 482)	0.104
GGT	386 (238, 834)	368 (325, 554)	651 (306, 889)	0.324	588 (386, 818)	439 (319, 548)	209 (118, 334)	**0.038**
ALB	36 (33, 40)	37 (34, 39)	36 (33, 39)	0.731	37 (32, 40)	37 (35, 39)	36 (32, 39)	0.639
TBIL	209 (152, 287)	198 (161, 236)	177 (136, 263)	0.634	187 (169, 254)	176 (162, 220)	217 (154, 277)	0.800
DBIL	121 (98, 191)	129 (97, 151)	114 (87, 151)	0.257	107 (95, 134)	109 (88, 161)	134 (98, 162)	0.691
TBA	128 (84, 139)	122 (102, 141)	105 (95, 127)	0.791	88 (77, 111)	105 (89, 121)	122 (95, 132)	0.169
ALP	509 (383, 800)	630 (439, 704)	640 (468, 831)	0.950	528 (361, 766)	480 (401, 657)	491 (399, 805)	0.905
PLT	462 (369, 552)	448 (324, 526)	407 (342, 479)	0.722	349 (274, 565)	443 (355, 552)	319 (235, 489)	0.563
APRI	1.07 (0.89, 1.54)	1.15 (0.73, 1.55)	1.25 (0.83, 2.09)	0.715	1.75 (0.99, 2.87)	1.29 (1.13, 1.98)	2.36 (1.38, 4.25)	0.264
FIB-4	0.11 (0.06, 0.13)	0.09 (0.07, 0.14)	0.09 (0.07, 0.15)	0.892	0.12 (0.06, 0.19)	0.12 (0.08, 0.15)	0.19 (0.10, 0.34)	0.163

Items in bold in the table indicate $p<0.05$
ALB, albumin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APRI, Aspartate Aminotransferase-to-Platelet Ratio Index; AST, aspartate aminotransferase; DBIL, direct bilirubin; FIB-4, Fibrosis-4 score; TBA, total bile acid; TBIL, total bilirubin.

ascending state, but there was no significant difference between the groups (all $p>0.05$, table 2).

Predictive value of various indexes for short-term prognosis of children with BA after KPE

ROC curve analysis showed that the preoperative APRI level had the highest predictive values for the prognosis of children with BA, with an AUC of 0.667 (95% CI: 0.553 to 0.781). The optimal cut-off value was 1.190, with a Youden index of 0.299, and sensitivity and specificity of 73.0% and 56.9%, respectively. The AUC for preoperative FIB-4 in predicting the prognosis of children with BA was 0.642 (95% CI: 0.523 to 0.761), and when the critical value of FIB-4 was 0.102, its sensitivity and specificity were 67.6% and 56.9%, respectively (figure 2, table 3).

Predictive value of APRI and FIB-4 combined with biochemical indexes for short-term prognosis after KPE

ROC curve analysis showed that the prediction efficiency of APRI and FIB-4 combined with biochemical indexes was improved compared with using them individually. The highest prediction efficiency was observed with the combination of APRI and ALT, with an AUC of 0.733 (95% CI: 0.622 to 0.845). Moreover, the AUCs of APRI combined with ALT, AST, TBA, ALP, and FIB-4 combined with AST and TBA for prediction were all greater than 0.7 (figure 3).

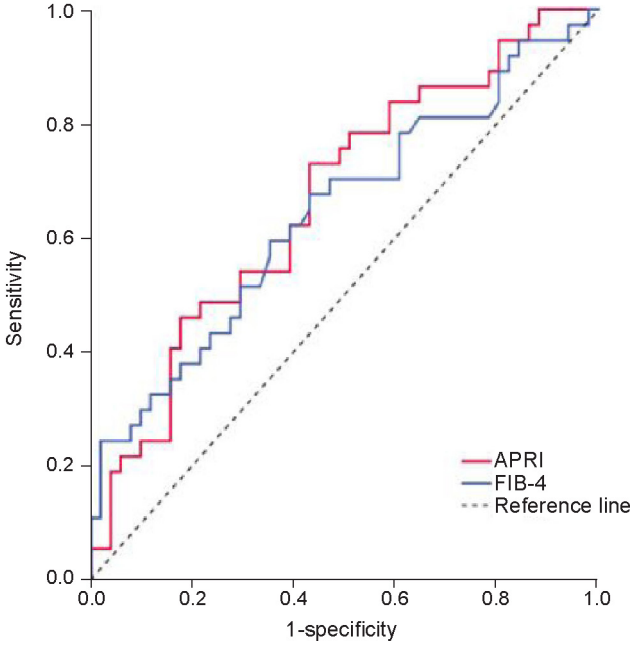

Figure 2 Receiver operating characteristic curves of preoperative APRI and FIB-4 in predicting short-term prognosis after KPE. APRI, Aspartate Aminotransferase-to-Platelet Ratio Index; FIB-4, Fibrosis-4 score; KPE, Kasai portoenterostomy.

Table 3 Predictive performance of preoperative indexes for prognosis after KPE in children with BA

Indicators	AUC	95% CI	Sensitivity	Specificity	Youden index
ALT	0.524	0.401 to 0.647	0.412	0.730	0.142
AST	0.552	0.428 to 0.676	0.757	0.451	0.208
GGT	0.595	0.473 to 0.716	0.765	0.432	0.197
ALB	0.511	0.388 to 0.635	0.902	0.189	0.091
TBIL	0.521	0.399 to 0.643	0.811	0.314	0.125
DBIL	0.516	0.393 to 0.640	0.647	0.486	0.133
TBA	0.598	0.477 to 0.718	0.353	0.838	0.191
ALP	0.573	0.449 to 0.697	0.608	0.649	0.257
PLT	0.591	0.467 to 0.715	0.725	0.541	0.266
APRI	**0.667**	**0.553 to 0.781**	**0.730**	**0.569**	**0.299**
FIB-4	0.642	0.523 to 0.761	0.676	0.569	0.245

Items in bold in the table indicate $p<0.05$
ALB, albumin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APRI, Aspartate Aminotransferase-to-Platelet Ratio Index; AST, aspartate aminotransferase; AUC, area under the curve; AUC, area under the curve; BA, biliary atresia; DBIL, direct bilirubin; FIB-4, Fibrosis-4 score; GGT, gamma-glutamyl transpeptidase; KPE, Kasai portoenterostomy; PLT, platelet; TBA, total bile acid; TBIL, total bilirubin.

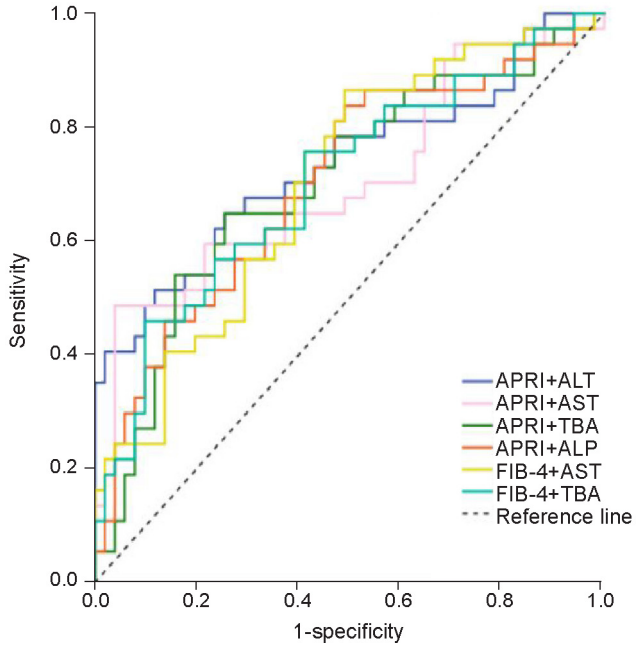

Figure 3 Receiver operating characteristic curves of APRI and FIB-4 combined with biochemical indicators to predict prognosis of children with BA. ALP, alkaline phosphatase; ALT, alanine aminotransferase; APRI, Aspartate Aminotransferase-to-Platelet Ratio Index; AST, aspartate aminotransferase; BA, biliary atresia; FIB-4, Fibrosis-4 score; TBA, total bile acid.

DISCUSSION

BA is a severe pediatric cholestasis disorder that causes neonatal jaundice. Without timely intervention, affected patients often develop liver failure within a year and typically die by the age of 2.[13 2] Therefore, early and accurate assessment of liver fibrosis degree in children with BA is of great importance for predicting KPE prognosis. Currently, liver biopsy is considered the gold standard for assessing the severity of liver fibrosis. However, it has several drawbacks, including its invasive nature, the potential for sampling errors, and risks of complications such as abdominal pain, hypotension, biliary tract bleeding, and intraperitoneal hemorrhage.[14] Additionally, 10%–30% of single liver biopsy samples may fail to detect cirrhosis due to the uneven distribution of fibrosis in the liver tissue.[15] As a result, except in cases of Kasai surgery or LT, liver biopsy is rarely performed in children with BA.

Our study found that the key threshold for predicting postoperative outcomes in children with BA using APRI was 1.19, with an AUC of 0.667, sensitivity of 73.0%, and specificity of 56.9%. For FIB-4, the critical threshold was 0.102, with an AUC of 0.642, sensitivity of 67.6%, and specificity of 56.9%. Both measures demonstrated low predictive accuracy when assessed individually. However, when combined with other liver biochemical markers, the predictive accuracy of APRI alongside ALT improved to 0.733. These findings offer insights into the prognosis of Kasai, providing important decision-making support for both parents and doctors.

APRI is a non-invasive indicator first proposed by Wai to assess the degree of liver fibrosis in patients with chronic hepatitis C.[11] It is now increasingly used in children with BA and has been used as a tool to predict long-term survival after KPE.[16] FIB-4 is another non-invasive method for assessing liver fibrosis in chronic liver disease patients, proposed by Sterling *et al.*,[12] relying on simple indicators such as ALT, AST, PLT, and patient age. FIB-4 is suitable for use in primary care hospitals and patient follow-up. Given that children with BA need lifelong monitoring, the use of non-invasive indicators for assessment is particularly valuable.[17] In this study, we evaluated the prognostic value of preoperative APRI and FIB-4 in children with BA

undergoing KPE, aiming to provide an early basis for clinical decision-making.

Several studies have indicated that APRI is effective in distinguishing different grades of liver fibrosis. Mo *et al*.[5] found that there was a significant difference in APRI between METAVIR fibrosis scores of F2 and F4, as well as F3 and F4. Similarly, Lampela *et al*.[18] reported a strong positive correlation between APRI and METAVIR F4 in children with BA. Kim *et al*.[19] observed a significant correlation between APRI and degree of liver fibrosis in 35 children with BA, with AUC values of 0.92 and 0.91 for evaluating METAVIR F3 and F4, respectively, suggesting that APRI is a useful tool for evaluating liver fibrosis severity. While APRI measured within 3 days before surgery can provide some indication of the level of liver fibrosis at the time of the procedure, this study found that APRI was not adequate for clearly differentiating between METAVIR grades, consistent with the findings of Lind *et al*.[20] They suggested that this limitation may arise because APRI is calculated using standard serological markers (AST, PLT), which do not directly indicate liver fibrosis but rather reflect the extent of liver damage. Additionally, the small sample size and the upper limit of the normal AST range may have influenced the results of this study.

While APRI was not effective in accurately distinguishing between liver fibrosis grades in this study, it did show some potential in predicting postoperative outcomes in children with BA (AUC=0.667, with an optimal cut-off value of 1.190). Previous research has indicated that postoperative APRI values can help predict NLS in children with BA. For instance, Ihn *et al*.[21] found that APRI is more effective in predicting 5-year NLS rates in these children, with those having an APRI greater than 0.605 at 4 months showing poorer prognoses. Additionally, a study by Grieve *et al*. [22]found that an APRI above 1.22 could indicate the development of liver cirrhosis, and the NLS rate was significantly lower in that patient group. In our research, we also used preoperative indicators to compute APRI and FIB-4 to forecast the short-term outcomes of KPE. A study by Muntean *et al*.[16] confirmed that preoperative APRI can independently predict 5-year NLS, supporting the results of our study. From these findings, we conclude that children with BA who have low APRI levels experience a notably higher rate of NLS and a more favorable prognosis than those with elevated preoperative APRI levels.[21]

FIB-4 has been widely used in adults with chronic liver disease to assess the degree of liver fibrosis. This indicator combines age, AST, ALT, and PLT to provide a comprehensive approach to the assessment of liver fibrosis. Compared with APRI, FIB-4 additionally incorporates ALT and age, which makes it potentially more sensitive in the assessment of liver fibrosis, especially in pediatric populations. However, due to the young age of children with BA, the predictive value of FIB-4 may be affected by age. In this study, age was calculated in months, which could result in lower FIB-4 values. Nagi expanded the FIB-4 value by multiplying it by 100 and suggested that the cut-off value for FIB-4 to predict the degree of liver fibrosis in children with BA was 9.82.[23] Although FIB-4 is rarely used in children with BA, this study shows that it holds some predictive value. However, further research is needed to validate its applicability and accuracy in this population.

Although this study found that preoperative APRI and FIB-4 have certain predictive value in the short-term prognosis after KPE, it is important to consider the potential impact of postoperative biliary drainage on the progression and prognosis of liver fibrosis. Even in cases with high intraoperative liver fibrosis, adequate bile drainage may improve prognosis by reducing cholestasis and inhibiting fibrosis progression. Previous studies have shown that bile flow after KPE is positively correlated with NLS, and effective drainage can slow liver fibrosis and reduce the risk of portal hypertension. While APRI and FIB-4 can reflect the underlying liver condition before surgery, their predictive performance is limited by the effects of postoperative bile drainage. This study found that the jaundice clearance rate in the good prognosis group was significantly higher than in the poor prognosis group. Even among children with F3+F4 liver fibrosis, the jaundice clearance rate in the good prognosis group was significantly higher than that in the poor prognosis group (p=0.036). This suggests that even if the intraoperative hyperfibrosis was graded, the prognosis of children with effective bile drainage can still improve. This finding aligns with that of Gad,[13] in which 45% of children with good postoperative bile secretion experienced a reversal of liver fibrosis during follow-up, suggesting that bile drainage has a dynamic regulatory effect on fibrosis. In this study, the value of preoperative APRI and FIB-4 in predicting prognosis was moderate (AUC=0.667 and 0.642), and their predictive performance was affected by the effect of postoperative bile drainage, but it could still reflect the status of preoperative liver fibrosis to a certain extent. Although the outcome of postoperative bile drainage affects prognosis, preoperative APRI and FIB-4 can assist clinicians in identifying children at high risk of liver fibrosis prior to surgery. Even if biliary drainage is successful after surgery, these patients require closer follow-up to monitor the progression of liver fibrosis. Therefore, preoperative indicators should be combined with postoperative management rather than serving as a substitute for dynamic monitoring. In conclusion, the success of postoperative biliary drainage may significantly affect the degree of liver fibrosis, highlighting the importance of clinicians closely monitoring postoperative bile secretion and adjusting treatment strategies as needed to optimize the long-term prognosis of children.

This study has several limitations. First, the low incidence of BA and inconsistent follow-up resulted in the exclusion of some children, reducing the sample size and potentially leading to selection bias. Second, as a retrospective study, the data may be influenced by various confounding factors. Unlike earlier studies that assessed

APRI and FIB-4 postoperatively, this research used laboratory markers at the time of admission. However, the prognosis for children is affected by multiple factors, such as postoperative medications, home care, and cholangitis. Although we aimed to maintain a consistent treatment approach during sample inclusion, discrepancies may still exist, limiting the ability of this study to predict children's prognosis. Future research should adopt a large-scale, multicenter design that incorporates postoperative evaluation metrics to enhance the predictive accuracy of short-term postoperative outcomes for children with BA undergoing KPE. Such studies would provide a more comprehensive understanding of the factors influencing prognosis and offer better guidance for clinical decision-making.

In conclusion, this research demonstrates that preoperative FIB-4 and APRI can predict the outcomes of KPE, with elevated APRI and FIB-4 typically signifying a worse prognosis and providing moderate predictive capability. Although the predictive value of APRI and FIB-4 in combination with liver function indexes is better than that of a single indicator, clinical decision-making still should be based on a comprehensive evaluation. Therefore, exploring additional meaningful predictors is needed to improve predictive accuracy among children with BA.

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ORCID iD

Bingliang Li http://orcid.org/0009-0004-0905-7414

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