【 ORIGINAL ARTICLE 】

The Albumin-bilirubin Score Detects Changes in the Liver Function during Treatment for Budd-Chiari Syndrome: A Retrospective Observational Study

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Abstract:
Objective Mapping the long-term prognosis of Budd-Chiari syndrome (BCS) is difficult, as the prognosis is associated with changes in the liver function. The present study evaluated the time course changes in the liver function in a treatment group with percutaneous old balloon angioplasty (POBA) and a non-treatment group using the albumin-bilirubin score (ALBI) and Child-Pugh score during long-term follow-up.
Methods In this retrospective study, 13 consecutive patients diagnosed with BCS at our hospital between 2007 and 2020 were categorized into a treatment group (n=8), which received POBA, and a non-treatment group (n=5). Differences in the liver function in the ALBI and Child-Pugh scores between the initial visit and one- and three-year follow-up were calculated and statistically evaluated. We investigated the changes in the liver function during the long-term follow-up, including events such as re-stenosis and re-treatment.
Results While the Child-Pugh scores in the treatment group did not differ significantly between the initial visit and 1- or 3-year follow-up, the ALBI scores in this group improved significantly between the initial visit and the 1- or 3-year follow-up visit (p=0.0078 and 0.0156, respectively). The liver function according to the ALBI score in the treatment group showed gradual improvement from the initial value but gradual worsening in the non-treatment group. The ALBI scores also revealed that the liver function varies according to re-stenosis and re-POBA in BCS patients.
Conclusion Unlike the Child-Pugh score, the ALBI score was able to capture changes in the liver function of BCS patients during the long-term course of BCS.

Key words: ALBI score, angioplasty, Budd-Chiari syndrome, Child-Pugh score, liver

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Introduction

Budd-Chiari syndrome (BCS) is characterized by an obstructed hepatic venous flow in the suprahepatic inferior vena cava (IVC) or hepatic veins, resulting in an increased hepatic sinusoidal pressure and hepatic congestion (1, 2). Obstruction of the hepatopetal flow causes portal hypertension, subsequently leading to liver failure, abdominal pain, ascites, esophageal varices, and hepatocellular carcinoma (HCC) (3, 4). BCS is managed by a number of therapies, including thrombolytic therapy, angioplasty, transjugular intrahepatic portosystemic shunt (TIPS), surgical shunting, and liver transplantation, among others (5). Controlled trials of therapies for BCS have been performed for only therapeutic arms (6). Due to the increasing availability of therapeutic options, the most recently published studies have reported 5-year overall survival rates of over 90% (7-11). However, medical therapy alone offers a shorter survival than intensive interventional and surgical therapies (6, 8-11).

No cohort studies have examined untreated BCS patients; therefore, the natural history of BCS is not well-

known (12, 13). Mapping the long-term prognosis of BCS is difficult. To verify the long prognosis of BCS, large-scale cohort studies spanning a few decades that compare treated and untreated patients are required. However, such studies are impractical and difficult to conduct. It is important to capture the short-term changes in the liver function instead of tracking the long-term prognosis of BCS based on the finding of a long-term study. While a few reports have demonstrated the changes in the liver function of BCS patients after intensive treatments, none have described the liver function in untreated patients (8, 14, 15).

The Child-Pugh score is most commonly used for the evaluation of the liver function. However, there are some concerns associated with it (16). For example, the Child-Pugh score uses categorical variables, which makes capturing slight changes in the liver function difficult. Ascites and encephalopathy are subjective factors in the Child-Pugh score, while albumin and ascites are similarly evaluated. The prothrombin time, which is part of the Child-Pugh score, is affected by anticoagulants prescribed to BCS patients after percutaneous old balloon angioplasty (POBA) therapy. The albumin-bilirubin (ALBI) score is gaining popularity in the evaluation of liver cancer (16). Slight changes in the liver function can be captured using continuous variables.

We hypothesized that the ALBI score could capture changes in the liver function in both treated and untreated BCS patients and that treated patients who had experienced re-stenosis and re-POBA would show changes in the liver function. Therefore, the present study determined whether the ALBI score or Child-Pugh score was more useful for evaluating the liver function changes during the long-term course of BCS.

Materials and Methods

Study participants

This retrospective study was approved by the institutional review board committee on human investigation. Informed consent was obtained from all individual patients included in this study. We retrospectively analyzed 18 consecutive patients diagnosed with BCS at our hospital between January 2007 and January 2020.

Group division

Of the 18 patients analyzed, 5 were excluded, including 1 who underwent liver transplantation, 2 who could not be observed after POBA during follow-up, and 2 who were diagnosed with acute on-set BCS. Of the remaining 13 patients, 8 were assigned to the treatment group with POBA therapy, while 5 were assigned to the non-treatment group.

Diagnoses

BCS was diagnosed from the medical history, symptoms, laboratory data, and contrast-enhanced computed tomography (CT) scans that directly detected a focal obstruction in the IVC or the hepatic veins. X-ray venography also visualized a focal obstruction. Renal and cardiac failure were excluded by renal and cardiac examinations. To exclude cases of sinusoidal obstruction syndrome (SOS) and confirm BCS, the medical history regarding chemotherapy, radiation therapy, and transplantation was investigated.

Indication of treatment

First, the patients with symptomatic BCS were indicated for POBA therapy. Second, a focal obstruction was identified by X-ray venography just before POBA. We treated patients who met two criteria: symptoms due to BCS and a focal obstruction (Table 1).

Treatment

Two 4-Fr catheters (RC-09; MEDIKIT, Tokyo, Japan; Impress STR or Pig-tail; Merit Medical, South Jordan, USA) were inserted either into the IVC distal to the occlusion site via a transfemoral approach or into the right atrium proximal to the occlusion site via a transjugular approach. The pressure at both sites was measured using the catheters as above. Mono or dual venography was performed using one or two catheters, respectively. For treatment, a 0.035-inch guidewire (Radifocus; Terumo, Tokyo, Japan) was first advanced to the occlusion site. If passage through the occlusion site was not possible due to severe stenosis, a needle (Rösch-Uchida Transjuglar Liver Access Kit; COOK, Bloomington, USA) was inserted to penetrate the occlusion site, as described previously (17). When the puncture succeeded, the 4-Fr catheter was advanced along the needle to enter from the other side. A small amount of contrast media was injected through the catheter to confirm that it was in a vessel. A 0.035-inch stiff guidewire (Amplatz; COOK) was replaced with a 4-Fr catheter for POBA. A balloon catheter (Armada, Abbott, Abbot Park, USA; MAXI LD, Cordis, Fermont, USA) was inserted over the wire via the jugular or femoral vein to perform angioplasty at the occlusion site, and the balloon was inflated manually a few times for one minute each. After dilation, venography was performed to confirm the expansion of the occluded vessels. After the procedure, heparin (10,000 units/day) was administered for 2 days, followed by oral anticoagulant drugs.

For cases with hepatic vein stenosis, POBA was performed as described above. Transhepatic puncture of hepatic veins was initially performed under sonography guidance to insert a 5-Fr sheath (Supersheath; MEDIKIT), 0.035-inch guidewire, and 4-Fr catheter. At the end of the procedure, the sheath was removed while embolizing the transhepatic track using a gelatin sponge (Spongel; Astellas, Tokyo, Japan).

Follow-up

Technical success was defined as the restoration of the venous flow in the IVC and/or the hepatic vein to the right atrium on venography and drops in both the distal pressure and the pressure gradient just after POBA. Clinical success

Table 1. Summary of Patients.

Case	Sex	Age (years)	Medical history	Stenosis site	Initial visit			Treatment	One-year follow-up			Three-year follow-up		Five-year follow-up		Ten-year follow-up		Overall survival† (days)	Primary patency (days)	Re-POBA
					Symptoms	CP score	ALBI score		Symptoms	CP score	ALBI score	CP score	ALBI score	CP score	ALBI score	CP score	ALBI score			
1	F	31	Diabetes	IVC	Varicosis, leg edema	6	-2.17	Y	Resolved	5	-2.77	5	-2.56	7	-2.86	NA	NA	2,623	175	Y
2	F	40	Esophageal varix	HV	Abdominal distension, ascites	7	-1.94	Y	Resolved	6	-2.62	5	-2.68	6	-2.74	NA	NA	1,986	574	Y
3	F	46	NA	HV	Abdominal distension, ascites	10	-1.47	Y	Resolved	6	-2.70	6	-2.56	NA	NA	NA	NA	1,440	1,440	N
4	M	81	Gastric varix	IVC	Leg edema, abdominal distension	6	-2.09	Y	Unresolved	6	-2.22	7	-2.17	6	-2.27	NA	NA	2,315	2,315	N
5	M	37	NA	IVC	Varicosis, leg edema, ascites	9	-1.82	Y	Resolved	9	-2.01	8	-1.88	8	-1.86	NA	NA	2,558	2,558	N
6	F	50	NA	IVC	Abdominal distension, leg edema, ascites	7	-2.65	Y	Resolved	5	-3.20	5	-3.2	NA	NA	NA	NA	1,713	357	Y
7	M	49	NA	IVC	Abdominal distension, leg edema	6	-2.98	Y	Resolved	5	-3.03	5	-3.19	NA	NA	NA	NA	1,188	1,188	N
8	F	30	NA	IVC	Leg edema	5	-2.81	Y	Resolved	5	-2.98	NA	NA	NA	NA	NA	NA	376	376	N
9	M	57	NA	IVC	None	5	-2.68	N	NA	5	-2.50	5	-2.73	5	-2.62	5	-2.64	4,331	NA	NA
10	M	51	NA	IVC	None	5	-2.40	N	NA	5	-2.19	NA	NA	NA	NA	NA	NA	978	NA	NA
11	M	26	NA	IVC	None	5	-3.17	N	NA	5	-2.79	5	-2.68	5	-2.77	5	-2.87	4,163	NA	NA
12	F	22	NA	IVC	None	5	-3.38	N	NA	5	-3.24	5	-2.82	5	-2.93	5	-2.7	4,387	NA	NA
13	F	73	NA	IVC	Varicosis, leg edema	5	-2.62	N	Unchanged	5	-2.23	5	-1.96	5	-1.82	NA	NA	2,622	NA	NA

†Overall survival indicates the number of survived days within the observation periods. CP: Child-Pugh, ALBI: albumin-bilirubin, POBA: percutaneous old balloon angioplasty, F: female, M: male, IVC: inferior vena cava, HV: hepatic vein, N: no, Y: yes, NA: not applicable

Table 2.   Comparison between the Treatment Group and the Non-treatment Group.

	Total=13 cases	Treatment (n=8)	Non-treatment (n=5)	p value
Sex (Male, Female)	6, 7	3, 5	3, 2	0.592[†]
Age (median, interquartile range) (years)	46, 31-51	43, 38.5-49.25	51, 26-57	0.974[‡]
Stenosis site (IVC, HV)	11, 2	6, 2	5, 0	0.487[†]
Albumin, g/dL (median, interquartile range)	4.0, 3.5-4.4	3.55, 3.3-4.1	4.2, 4.2-4.8	0.060[‡]
Total bilirubin, mg/dL (median, interquartile range)	1.3, 0.9-1.5	1.4, 1.1-1.75	1.3, 0.9-1.4	0.699[‡]
Prothrombin time, % (median, interquartile range)	76, 69-84	71.5, 56.75-75.25	88, 80-97	0.006[*‡]
Platelet count, $\times10^4$/μL, (median, interquartile range)	12.1, 10.5-15.1	13.8, 9.85-17.15	12.0, 11.8-12.1	0.622[‡]
ALBI score (median, interquartile range)	-2.62, -2.81--2.09	-2.13, -2.69--1.91	-2.68, -3.17--2.62	0.041[*‡]
Child-Pugh score (median, interquartile range)	6, 5-7	6.5, 6-7.5	5, 5-5	0.012[*‡]
Follow-up period (median, interquartile range) (days)	2,315; 1,440-2,623	1,986; 1,576.5-2,436.5	4,163; 2,622-4,331	0.083[‡]
1-year ALBI score (median, interquartile range)	-2.70, -2.98--2.23	-2.74, -2.99--2.52	-2.50, -2.79--2.23	0.678[‡]
1-year Child-Pugh score (median, interquartile range)	5, 5-6	5.5, 5-6	5, 5-5	0.184[‡]
3-year ALBI score (median, interquartile range)	-2.68, -2.77--2.36 (n=11)	-2.56, -2.93--2.36 (n=7)	-2.70, -2.75--2.50 (n=4)	0.900[‡]
3-year Child-Pugh score (median, interquartile range)	5, 5-5 (n=11)	5.5, 5-6.5 (n=7)	5, 5-5 (n=4)	0.201[‡]

*p value<0.05, [†]Fisher's exact test, [‡]Mann-Whitney's *U*-test. IVC: inferior vena cava, HV: hepatic vein. The number of patients is different between the bottom 2 lines and the above.

was defined as the resolution of symptoms, representing treatment efficacy of POBA. Operative and post-operative complications were evaluated during follow-up. Primary patency was defined as the number of days between the first POBA and the first appearance of stenosis/occlusion as detected by CT. The one-year patency rate was defined as the rate of patency at one year after POBA. If re-occlusion was suspected due to recurrence of clinical symptoms, CT was performed to confirm occlusion or stenosis. POBA was repeated for patients who experienced re-occlusion or restenosis. The overall patency was defined as the number of days between the first POBA and the latest follow-up, including re-POBA cases. The overall patency rate was defined as the patency rate at the latest follow-up, regardless of whether or not POBA had been repeated.

Laboratory examinations were performed one, three, and six months after POBA and once or twice a year during follow-up. In addition, CT was performed when re-occlusion was suspected. The ALBI and Child-Pugh scores were obtained by calculation using data from the laboratory examination and by the concordance of the evaluation of two observers with 10 years' experience concerning ascites and encephalopathy in order to determine the patient's liver status. The overall survival was evaluated as the period from treatment to the last clinical visit or confirmation of the patient's survival by phone. The above data were analyzed at the time when a laboratory examination was performed.

Statistical analyses

Data were analyzed using the GraphPad Prism software program, version 8.00 (GraphPad Software, La Jolla, USA). The patients' characteristics are summarized as medians and interquartile ranges for continuous variables and as frequencies and percentages for categorical variables. Wilcoxon's signed-rank test was used for drawing pair-wise comparisons between data from the initial visit and one-year follow-up. The unpaired Mann-Whitney's *U*-test was used to compare two independent samples. The categorical parameters were analyzed using Fisher's exact test. A value of p<0.05 was considered statistically significant.

Results

Patients' characteristics

The patients' characteristics are summarized in Tables 1 and 2. The 13 enrolled patients included 6 men and 7 women with a median age of 46 (interquartile range: 31-51) years old. While 11 patients had IVC occlusion or stenosis, the other 2 had hepatic vein stenosis. Of the 13 BCS cases studied, 9 were symptomatic, while 4 were asymptomatic. Four cases had ascites, and none had encephalopathy.

Treatment

POBA was performed in eight symptomatic BCS cases. The remaining five patients did not undergo any interventional therapies: technical difficulties due to calcified stenosis were observed in one symptomatic case, while four were asymptomatic. POBA was technically successful in all 8 patients (100%). Venography demonstrated the significant improvement of the IVC or hepatic venous outflow in all patients just after POBA. All eight patients also showed a drop in the distal pressure and the pressure gradient after treatment. Seven cases (87.5%) showed resolution of the symptoms immediately after treatment; one case did not show any resolution. No operable complications were identified in any cases.

Follow-up

The median follow-up for the 13 patients was 2,315 (range: 1,440-2,623) days. As of the last follow-up, all 13 patients were still alive. Even the three restenosis cases and the five non-treatment cases were also still alive during the follow-up period. All 13 patients were in a good general
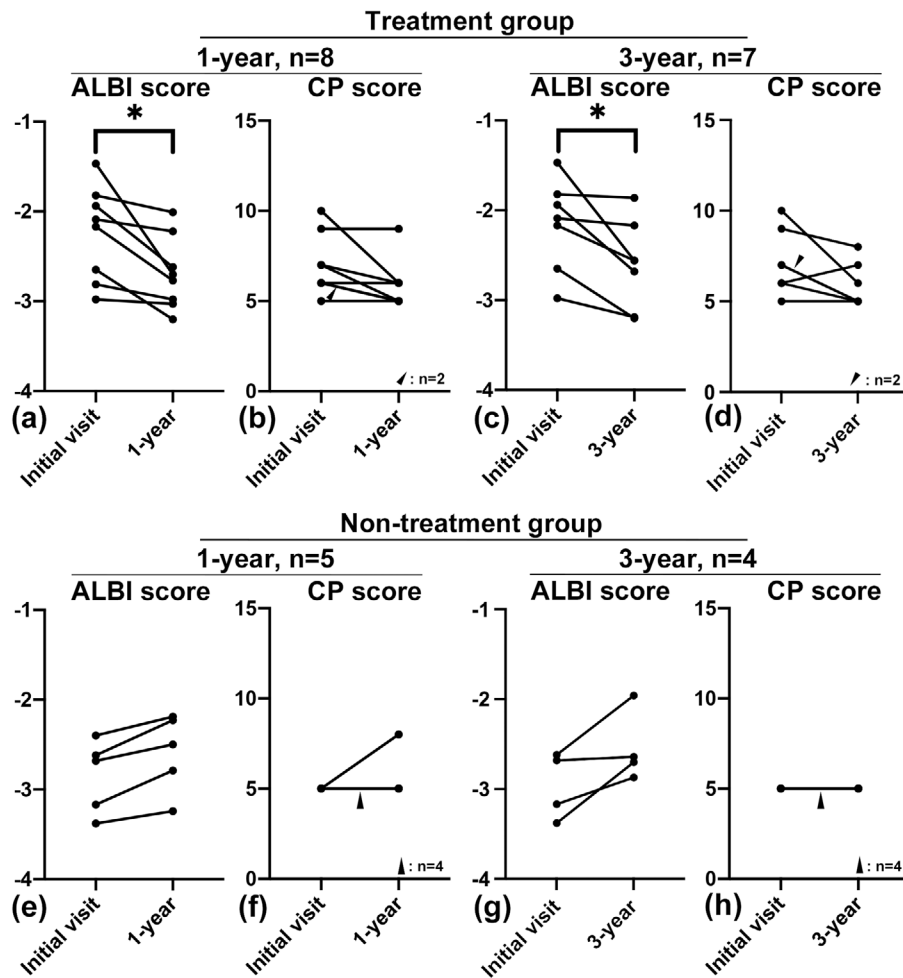
Figure 1.   Differences in ALBI score and Child-Pugh score in the treatment and non-treatment groups between the initial visit and one- or three-year follow-up. *p value<0.05. For overlapping data, the number of cases is indicated by black arrows. (a) p value=0.0078. (b) p value=0.0625. (c) p value=0.0156. (d) p value=0.125. (e) p value=0.0625. (f) p value>0.99. (g) p value=0.125. (h) NO p value.

condition and did not develop HCC during the follow-up period. The primary patency was 730.5 (interquartile range: 311.5-1,202.75) days, while the 1-year patency rate was 75.0% (6/8). Restenosis was detected by CT in three patients during follow-up; therefore, POBA was repeated in these patients. Re-POBA was successful in these three patients and did not cause any complications. The median overall patency time was 2,315 (range: 1,440-2,623) days, while the overall patency rate was 100% (8/8) at the latest follow-up.

Changes in the liver function

The ALBI and Child-Pugh scores at the initial visit and 1-, 3- 5-, and 10-year follow-up are summarized in Table 1. The median ALBI scores in the treatment group at the initial visit and 1- and 3-year follow-up were -2.13 (range: -2.69--1.91, n=8), -2.74 (range: -2.99--2.52, n=8), and -2.56 (range: -2.93--2.37, n=7), respectively. The median Child-Pugh score in the treatment group at the initial visit and 1- and 3-year follow-up were 6.5 (range: 6-7.5, n=8), 5.5 (range: 5-6, n=8), and 5 (range: 5-6.5, n=7), respectively. While the

Child-Pugh scores in the treatment group did not differ significantly between the initial visit and 1- or 3-year follow-up, the ALBI scores in the treatment group improved significantly at 1- and 3-year follow-up visits compared to the initial visit (p value=0.0078 and 0.0156) (Fig. 1a-d). The ALBI scores and Child-Pugh scores in the non-treatment group did not differ significantly between the initial visit and 1- or 3-year follow-up visits (Fig. 1e-h). The albumin and total bilirubin levels in the treatment and non-treatment groups did not show significant differences at the one- or three-year follow-up compared to the initial visit, except in one case (Supplementary material 1). Only the total bilirubin level in the treatment group improved significantly between the initial visit and the 3-year follow-up visit (p Value= 0.047).

No significant differences in the sex, age, stenosis site, albumin, total bilirubin, platelet count, or follow-up period were observed between the treatment and the non-treatment groups at the initial visit, although the prothrombin time did differ between the two (Table 2). The ALBI score and Child-Pugh score at the initial visit showed significant inter-
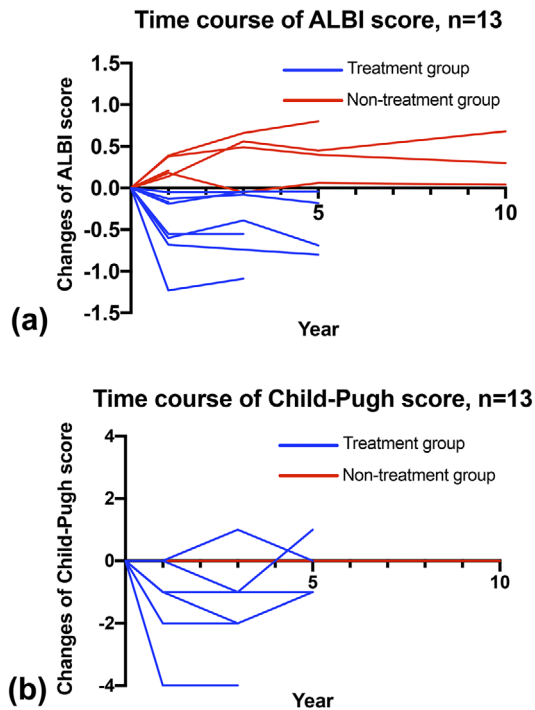
Figure 2. The changes in the ALBI and Child-Pugh score during the entire follow-up period in 13 patients with Budd-Chiari syndrome. The changes in the scores in the treatment group are indicated by blue lines, and those in the non-treatment groups are indicated by red lines.

group differences (p value=0.041 and 0.012) (Table 2). However, the significant intergroup differences in both scores had disappeared at the one- and three-year follow-up visits (Table 2). These results implied that the liver function improved in the treatment group and deteriorated in the non-treatment group.

As shown in Fig. 2a, the ALBI score in the non-treatment group captured the deterioration of the liver function during the entire follow-up period. However, the Child-Pugh score showed no marked changes in the liver function (Fig. 2b). All eight patients in the treatment group showed an improving trend in the liver function according to the ALBI score (Fig. 2a).

Unlike the Child-Pugh score, the ALBI score can detect slight changes in the liver function of BCS patients. In the non-treatment group, changes in the liver function were captured using the ALBI score, even though the Child-Pugh score remained at 5 points throughout the entire follow-up period (Fig. 3a, b). The untreated patients showed a progressively worsening liver function. Regarding the treated patients, the ALBI score successfully visualized changes in the liver function due to steep drops in the score following POBA (Fig. 3c). Four treated patients (Cases 1, 4, 7, and 8) had a good liver function with a Child-Pugh score of 5 or 6. Even in these four cases, there was an improvement in the ALBI score during the post-treatment follow-up (Fig. 3d, Supplementary material 2). Three out of 8 patients had restenosis after POBA therapy and underwent re-POBA during the follow-up period. As indicated in Figs. 3e and 3f, the patients showed a worse liver function in the ALBI score when they had either stenosis or restenosis. Furthermore, the liver function according to the ALBI score improved after POBA and re-POBA.

Discussion

This study revealed that the treatment group showed a significant improvement in the ALBI scores at one- or three-year follow-up compared to pre-therapy; however, no such differences in the Child-Pugh score were observed. The ALBI score captured the recovery of the liver function post-therapy and the deterioration of the liver function in untreated patients and those with restenosis. However, the Child-Pugh score was unable to clarify whether or not patients had suffered restenosis, as it could not detect slight changes in the liver function.

There have been no reports concerning the poor prognosis and deterioration of the liver function in untreated BCS patients; thus, the need for BCS treatment could not be verified. Reports on the long-term prognosis of BCS for treatment arms indicate that the prognosis of BCS is basically good (6), with a 5-year prognosis of each treatment group at around 90% (7-11). Some studies have reported changes in the liver function of BCS patients following intensive therapies (14). Tang et al. showed that the Child-Pugh score, serum alanine transferase level, and portosystemic shunting appeared to be prognostic indicators of BCS patients (15). Murad et al. demonstrated that encephalopathy, ascites, prothrombin time, and bilirubin were independent determinants of the survival (8). The present study revealed that the untreated patients had slight changes in their liver function according to the ALBI score, unlike the Child-Pugh score. In untreated cases, the Child-Pugh score did not change, even over the course of 5 to 10 years (Fig. 2b). However, the ALBI score indicated that the liver function gradually worsened during follow-up despite an asymptomatic condition. This proved that treatment is required for BCS patients in order to prevent liver cirrhosis, regardless of symptoms, as the scores changed over time. If the liver function worsens, patients will eventually develop cirrhosis and HCC (18). Therefore, treatment should be considered even in asymptomatic BCS patients. To determine the need for treatment for BCS, evaluating the liver function based on the ALBI score is a suitable approach.

Most patients with HCC have chronic liver diseases, the severity of which have been widely assessed by the Child-Pugh grade (16). The ALBI score offers a simple, evidence-based, objective, and discriminatory method of assessing the liver function in HCC and has been extensively tested in an international setting (16). The ALBI score has been reported to be a better prognostic tool than the Child-Pugh score among Child-Pugh grade A HCC patients receiving radiotherapy (19). It is a new model for assessing the severity of liver dysfunction (20) and it may be a better prognostic indi-
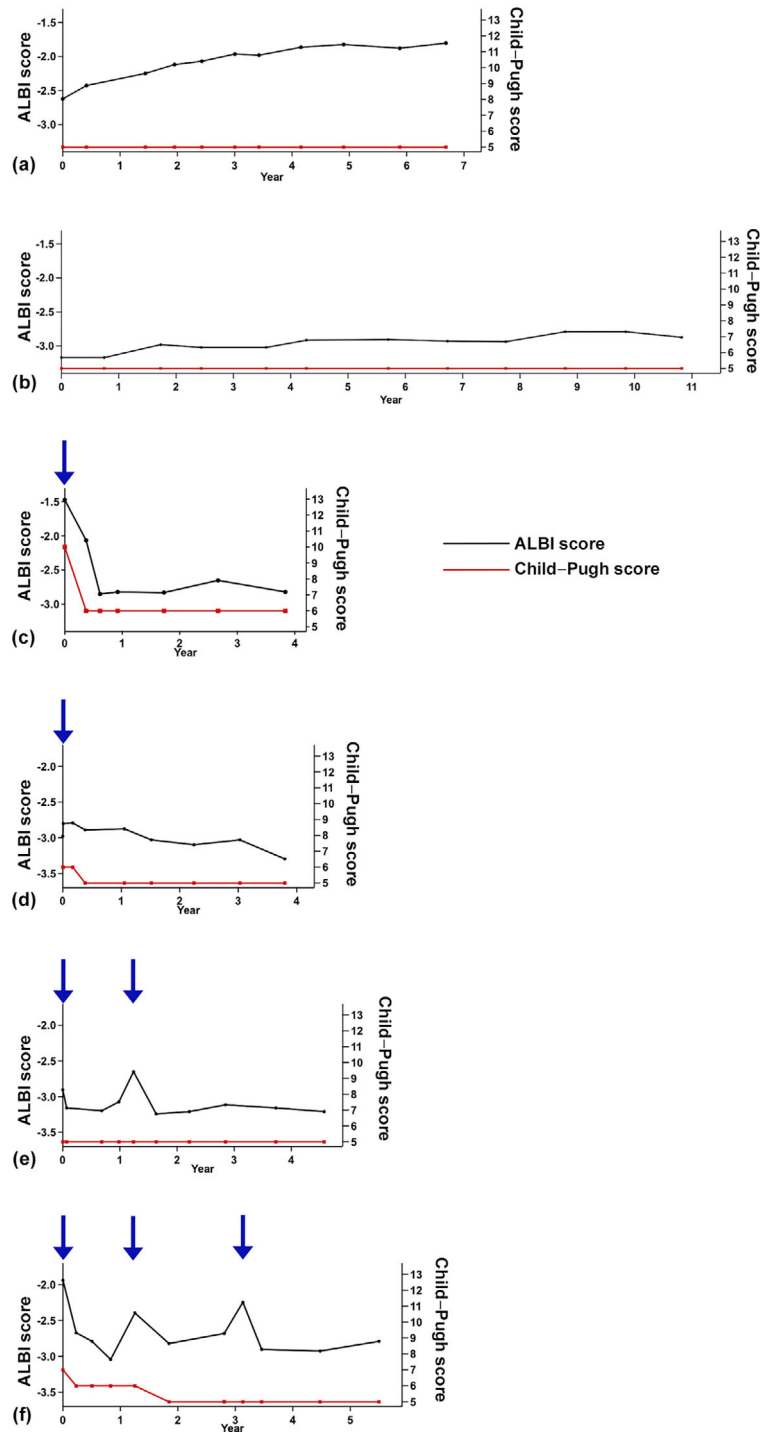
Figure 3. Five representative cases showing changes in the liver function during the long-term follow-up. The ALBI score is indicated with a black line, and the Child-Pugh score is indicated with a red line. The left X-axis shows the scale of the ALBI score, and the right X-axis shows the scale of the Child-Pugh score. (a) Untreated patient in Case 13. (b) Untreated patient in Case 11. (c) Treated patient in Case 3. The ALBI score shows steep drops following POBA therapy. The treatment day is indicated by a blue arrow. (d) Treated patient with a good liver function in Case 7. The ALBI score shows gentle drops during the follow-up period. The treatment day is indicated by a blue arrow. (e) Treated patient in Case 2. The ALBI score shows steep drops following POBA therapy and a steep rise when restenosis appears. The treatment days are indicated by blue arrows. (f) Treated patient in Case 6. The ALBI score shows steep drops following POBA therapy and a steep rise when restenosis appears. The treatment days are indicated by blue arrows.

cator of mortality in cirrhosis than the Child-Pugh score. Given its simplicity, it can function as a substitute for the Child-Pugh, model for end-stage liver disease (MELD), and MELD-Na scores (21). Among noninvasive markers, the ALBI score best correlates with the hepatic venous pressure gradient and is associated with short-term outcomes in cirrhotic patients (22). In our study, the liver function improved in the treatment group but deteriorated in the non-treatment group. Furthermore, changes in the liver function according to the ALBI score were associated with the appearance or disappearance of stenosis in this study. Generally, albumin has a greater effect on the calculation of the ALBI score than total bilirubin does (16). In our study, the albumin level did not differ significantly during the follow-up period in the treatment or non-treatment group (Supplementary material 1). Even the total bilirubin level barely showed a significant difference between groups. Although a previous study showed that total bilirubin was a major prognostic factor with significant differences in BCS, albumin was also a secondary prognostic factor (8). Mukund et al. compared two groups of patients with BCS who underwent recanalization of the IVC or hepatic veins and TIPS (14). The group with recanalization showed significant biochemical improvements with a decrease in total bilirubin levels and increase in albumin levels after intervention. The other group that received TIPS did not show any significant differences. We speculate that both albumin and total bilirubin influence the ALBI score in patients with BCS. Therefore, the liver condition based on the ALBI score in BCS patients is expected to predict the long-term prognosis.

A previous study revealed that percutaneous transluminal angioplasty led to a remarkable improvement in the liver function (14). We also found that POBA improves the liver function. POBA for BCS is safe with a low risk of complications. Since balloon dilatation therapy was first performed in 1974, the choice of therapies has largely shifted toward radiological intervention in patients with BCS (1). The patency rates at 5 to 10 years following therapy with POBA were over 90% (1, 4). The survival of patients who received POBA was shown to be better than that of patients who underwent surgical therapy and TIPS (4, 23). Endovascular management has resulted in lower morbidity and mortality rates than surgical therapies (2). Although restenosis or obstruction following POBA has remained a major concern, repeated POBA achieved overall patency in the present study as well as other studies.

Several limitations associated with the present study warrant mention. First, this study included only a small number of cases. Because of the small number of cases, we were able to follow the treatment history of each case individually. In each case, we carefully captured slight changes in the liver function using the ALBI score. However, further investigations are required in order to enhance the validity of our results. Second, this was a retrospective, single-center study. It is therefore necessary to accumulate further case data over time. Multicenter research is also important.

In conclusion, changes in the liver function during the course of BCS can be detected by the ALBI score, regardless of whether or not therapy is administered.

The authors state that they have no Conflict of Interest (COI).

References

1. Lee BB, Villavicencio L, Kim YW, et al. Primary Budd-Chiari syndrome: outcome of endovascular management for suprahepatic venous obstruction. J Vasc Surg **43**: 101-108, 2006.
2. Copelan A, Remer EM, Sands M, Nghiem H, Kapoor B. Diagnosis and management of Budd Chiari syndrome: an update. Cardiovasc Intervent Radiol **38**: 1-12, 2015.
3. Tripathi D, Macnicholas R, Kothari C, et al. Good clinical outcomes following transjugular intrahepatic portosystemic stent-shunts in Budd-Chiari syndrome. Aliment Pharmacol Ther **39**: 864-872, 2014.
4. Ding PX, Zhang SJ, Li Z, Fu MT, Hua ZH, Zhang WG. Long-term safety and outcome of percutaneous transhepatic venous balloon angioplasty for Budd-Chiari syndrome. J Gastroenterol Hepatol **31**: 222-228, 2016.
5. Menon KN, Shah V, Kamath PS. The Budd-Chiari syndrome. N Engl J Med **350**: 578-585, 2004.
6. Qi X, Ren W, Wang Y, Guo X, Fan D. Survival and prognostic indicators of Budd-Chiari syndrome: a systematic review of 79 studies. Expert Rev Gastroenterol Hepatol **9**: 865-875, 2015.
7. Rössle M, Olschewski M, Siegerstetter V, Berger E, Kurz K, Grandt D. The Budd-Chiari syndrome: outcome after treatment with the transjugular intrahepatic portosystemic shunt. Surgery **135**: 394-403, 2004.
8. Murad SD, Valla DC, De Groen PC, et al. Determinants of survival and the effect of portosystemic shunting in patients with Budd-Chiari syndrome. Hepatology **39**: 500-508, 2004.
9. Plessier A, Sibert A, Consigny Y, et al. Aiming at minimal invasiveness as a therapeutic strategy for Budd-Chiari syndrome. Hepatology **44**: 1308-1316, 2006.
10. Perelló A, García-Pagán JC, Gilabert R, et al. TIPS is a useful long-term derivative therapy for patients with Budd-Chiari syndrome uncontrolled by medical therapy. Hepatology **35**: 132-139, 2002.
11. Eapen CE, Velissaris D, Heydtmann M, Gunson B, Olliff S, Elias E. Favourable medium term outcome following hepatic vein recanalisation and/or transjugular intrahepatic portosystemic shunt for Budd Chiari syndrome. Gut **55**: 878-884, 2006.
12. DeLeve LD, Valla DC, Garcia-Tsao G. Vascular disorders of the liver. Hepatology **49**: 1729-1764, 2009.
13. Martens P, Nevens F. Budd-Chiari syndrome. United European Gastroenterol J **3**: 489-500, 2015.
14. Mukund A, Mittal K, Mondal A, Sarin SK. Anatomic recanalization of hepatic vein and inferior vena cava versus direct intrahepatic portosystemic shunt creation in Budd-Chiari syndrome: overall outcome and midterm transplant-free survival. J Vasc Interv Radiol **29**: 790-799, 2018.
15. Tang TJ, Batts KP, De Groen PC, et al. The prognostic value of histology in the assessment of patients with Budd-Chiari syndrome. J Hepatol **35**: 338-343, 2001.
16. Johnson PJ, Berhane S, Kagebayashi C, et al. Assessment of the liver function in patients with hepatocellular carcinoma: a new evidence-based approach - the ALBI grade. J Clin Oncol **33**: 550-558, 2015.
17. Kageyama K, Yamamoto A, Jogo A, et al. Usefulness of venous pressure measurement in endovascular treatment of Budd-Chiari syndrome: a retrospective cohort study. Intern Med **58**: 2923-2929, 2019.

18. Ren W, Qi X, Yang Z, Han G, Fan D. Prevalence and risk factors of hepatocellular carcinoma in Budd-Chiari syndrome: a systematic review. Eur J Gastroenterol Hepatol **25**: 830-841, 2013.

19. Ho CH, Chiang CL, Lee FA, et al. Comparison of platelet-albumin-bilirubin (PALBI), albumin-bilirubin (ALBI), and Child-Pugh (CP) score for predicting of survival in advanced hcc patients receiving radiotherapy (RT). Oncotarget **9**: 28818-28829, 2018.

20. Chen B, Lin S. Albumin-bilirubin (ALBI) score at admission predicts possible outcomes in patients with acute-on-chronic liver failure. Medicine (Baltimore) **96**: e7142, 2017.

21. Fragaki M, Sifaki-Pistolla D, Orfanoudaki E, Kouroumalis E. Comparative evaluation of ALBI, MELD, and Child-Pugh scores in prognosis of cirrhosis: is ALBI the new alternative? Ann Gastroenterol **32**: 626-632, 2019.

22. Hsieh YC, Lee KC, Wang YW, et al. Correlation and prognostic accuracy between noninvasive liver fibrosismarkers and portal pressure in cirrhosis: role of ALBI score. PLoS One **13**: e 0208903, 2018.

23. Tripathi D, Sunderraj L, Vemala V, et al. Long-term outcomes following percutaneous hepatic vein recanalization for Budd-Chiari syndrome. Liver Int **37**: 111-120, 2017.