Original article

Integration of ALBI Score into Barcelona Clinic Liver Cancer (BCLC) Staging System

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Abstract

Background: Hepatocellular carcinoma (HCC) is a major world health concern with a high mortality rate. liver function assessment is important for appropriate staging and treatment strategy. The Albumin-Bilirubin (ALBI) score offers a simpler, more objective alternative to the Child-Turcotte-Pugh (CTP) score for assessing liver function in hepatocellular carcinoma (HCC) patients within the Barcelona Clinic Liver Cancer (BCLC) staging system. The study aims to evaluate the concordance between ALBI- and CTP based BCLC staging in HCC patients.

Material and Methods: A prospective study was conducted from September 2021 to February 2022 at the Centre for Liver and Digestive Diseases, Holy Family Hospital, Rawalpindi, Pakistan. 93 HCC patients, diagnosed via triphasic CT per EASL guidelines, were enrolled using convenience sampling. ALBI and CTP scores were calculated, and their integration into BCLC staging was compared using Cohen's kappa (κ). Data were analyzed with IBM SPSS Statistics v22.0.

Results: Among 93 patients (72% male, mean age 60.16 ± 8.47 years), 61% had multifocal lesions, and 88% had chronic hepatitis C. Cohen's κ showed near-perfect agreement between ALBI-based and CTP-based BCLC staging ($\kappa = 0.97$, $p < 0.001$), with disagreement in only two patients. ALBI's objectivity and simplicity enhanced its clinical utility.

Conclusion: This study concludes that ALBI score is a reliable, objective alternative to the CTP score in BCLC staging regarding liver function., offering comparable prognostic performance with greater ease of use. Larger, multicenter studies are needed to validate these findings and assess survival outcomes. The medical community, researchers, and research organizations might all benefit from these findings.

Keywords: Hepatocellular Carcinoma (HCC), Barcelona Clinic Liver Cancer (BCLC) Staging, Albumin-Bilirubin (ALBI) Score.

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Received 17 February 2025; Accepted 21 February 2025

1. Introduction

Hepatocellular carcinoma (HCC) is sixth most common cancer and the third leading cause of cancer related mortality globally 1]. The Barcelona Clinic Liver Cancer (BCLC) staging system, backed by the American Association for the Study of Liver Diseases (AASLD) and the European Association for the Study of the Liver (EASL), guides HCC management by integrating tumor characteristics, liver function, and performance status [2,3].

It is imperative to know the tumour load and liver function to decide on the further treatment and prognosis. Traditionally, the Child-Turcotte-Pugh (CTP) score assesses liver function, using five parameters: serum bilirubin, albumin, prothrombin time, ascites, and hepatic encephalopathy [4]. However, CTP's subjective components (ascites, encephalopathy) and arbitrary cut-offs limit its precision [5,6].

The Albumin-Bilirubin (ALBI) score, introduced by Johnson et al. in 2015, uses only serum albumin and bilirubin levels, offering a simpler, evidence-based alternative.[7]

Studies have shown ALBI's comparable or superior prognostic accuracy in HCC patients undergoing treatments like resection or radioembolization [8,9] Despite its capability, ALBI's integration into BCLC staging requires further validation in diverse populations [8]. This study aims to evaluate and compare the agreement between BCLC staging using ALBI and CTP scores and to assess the capacity of ALBI as a replacement for CTP in clinical practice.

2. Materials & Methods

A prospective cohort study was conducted from September 2021 to February 2022 at the Centre for Liver and Digestive Diseases, Holy Family Hospital, Rawalpindi, Pakistan, after ethical approval from the Institutional Research Forum, Rawalpindi Medical University. 93 HCC patients (aged 18–85 years, both genders) diagnosed via triphasic CT scan per EASL guidelines were enrolled using non-probability convenience sampling. Inclusion criteria included confirmed HCC with or without cirrhosis. Exclusion

criteria comprised obstructive jaundice, metastatic liver cancer, chronic kidney disease, or terminal illness. Written informed consent was obtained from all participants. Data were collected using a pre-designed questionnaire capturing socioeconomic demographics, clinical parameters (e.g., serum albumin, bilirubin, prothrombin time, alpha-fetoprotein), radiological findings (e.g., lesion number, vascular invasion), and Eastern Cooperative Oncology Group (ECOG) performance status. Only complete questionnaires were included to minimize missing data.

Scoring Systems: CTP Score; Calculated using serum bilirubin, albumin, prothrombin time, ascites, and hepatic encephalopathy, with scores ranging from 5–15 (Class A: 5–6, Class B: 7–9, Class C: >9) [4]. ALBI Score; Computed as (log10 bilirubin [μmol/L] × 0.66) + (albumin [g/L] × –0.085), with grades: Grade 1 (≤–2.60), Grade 2 (>–2.60 to ≤–1.39), Grade 3 (>–1.39) [7]. BCLC Staging; Patients were staged (0, A, B, C, D) using both CTP and ALBI scores, incorporating tumor characteristics and ECOG status [2].

Each patient was given the opportunity to provide informed consent before being enrolled, and information about each patient's complete medical history, clinical examination, laboratory investigations, including complete blood counts, liver function tests, serum albumin and bilirubin levels, prothrombin time, and the international normalization ratio, renal function test, alpha-Fetoprotein level, and serum sodium level, was recorded. Furthermore, the people suffering from HCC were recorded on both scoring systems (assessment by means of ALBI Scoring system and CTP scoring system) after a Triphasic CT abdomen in order to compare the two scoring systems.

Statistical data was examined by using IBM SPSS Statistics v22.0. Qualitative variables (such as gender, presence of ascites, encephalopathy, CTP class, and ALBI grade) were analyzed using frequencies and percentages, while quantitative variables (including age, serum albumin, serum bilirubin, prothrombin time [PT], alpha-fetoprotein [AFP], platelet count, CTP score, and ALBI score) were summarized using means and standard deviations. Cohen's kappa (κ) assessed agreement between ALBI-based and CTP-based BCLC staging, with $\kappa > 0.81$ indicating near-perfect agreement [10].

3. Results

Of 93 patients (67 male [72%], 26 female [28%]), the mean age was 60.16 ± 8.47 years (range: 41–83). Multifocal lesions were present in 57 patients (61.3%), and vascular invasion or extrahepatic spread in 46 (49.5%). Chronic hepatitis C was the primary comorbidity (88.2%), followed by hepatitis B (3.2%). Ascites was absent in 61 patients (65.6%), and hepatic encephalopathy in 79 (84.9%). The mean ALBI score was –1.85 (range: –3.46 to 0.261), and the mean CTP score was 6.94 (range: 5–13). ECOG status was predominantly 2 (42 patients, 45.2%). Treatments included sorafenib (40.86%), transarterial chemoembolization (TACE, 20.4%), and ablation (9.8%).

Table 1: Base-line patient Characteristics

Patient Factors		**n= 93 (%)**
Age	-	60.16 (41, 83)
Gender	Male	67 (72)
	Female	26 (28)
No. of lesions	One	27 (29)
	Two	6 (6.5)
	Three	3 (3.2)
	Multifactorial	57 (61.3)
HCC Treatment	Ablation	9 (9.8)
	Ablation/LT	5 (5.4)
	BSC	16 (17.2)
	Chemoembolization	1 (1.1)
	Radio Frequency ablation	1 (1.1)
	Resection	1 (1.1)
	RFA/LT	2 (2.2)
	Sorafenib	38 (40.86)
	Surgical resection/Ablation	1 (1.1)
	TACE	19 (20.4)
Vascular invasion/Extra hepatic spread	Present	46 (49.5)
	Absent	47 (50.5)
Ascites	None	61 (65.6)
	Mild	15 (16.2)

	Moderate	4 (4.3)
	Severe	13 (14)
Hepatic encephalopathy	None	79 (84.9)
	Mild	1 (1.1)
	Grade 2	11 (11.8)
	Grade 3	1 (1.1)
	Grade 4	1 (1.1)
Serum albumin (g/dl) (mean, range)	-	3.3 (1.10,4.60)
Bilirubin (mg/dl) (mean, range)	-	2.16 (0.28, 21.80)
Alpha-fetoprotein (ng/ml) (mean, range)	-	11820.10 (0.85, 447999)
Platelets (mean, range)	-	175023.44 (9000, 577000)
ALBI Accumulative score (mean, range)	-	-1.85 (-3.46, 0.261)
Comorbid	HCV-CLD	82 (88.2)
	HBV-CLD	3 (3.2)
	HCV-CLD/HBV-CLD	2 (2.2)
	HCV-CLD/T2DM	2 (2.2)
	HCV-CLD/T2DM//HTN	1 (1.1)
	HCV-CLD/HTN	3 (3.2)
ALBI Grade	Grade I	11 (11.8)
	Grade II	65 (69.9)
	Grade III	17 (18.3)
CP Accumulative score (mean, range)	-	6.94 (5, 13)
CTP score	Child Class A	56 (60.2)
	Child Class B	25 (26.9)
	Child Class C	12 (12.9)
BCLC/CTP	Stage 0	18 (19.4)
	Stage A	20 (21.5)
	Stage B	38 (40.9)
	Stage C	16 (17.2)
	Stage D	1 (1.1)
BCLC/ALBI	Stage 0	18 (19.4)
	Stage A	18 (19.4)
	Stage B	39 (41.9)
	Stage C	17 (17.2)
	Stage D	1 (1.1)
ECOG	0	3 (3.2)
	1	32 (34.4)
	2	42 (45.2)
	3	14 (15.1)
	4	2 (2.2)

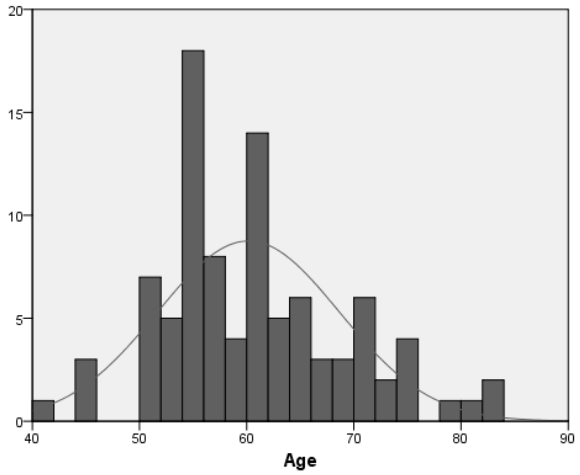

Fig 1: Age Distribution of sampled patient population

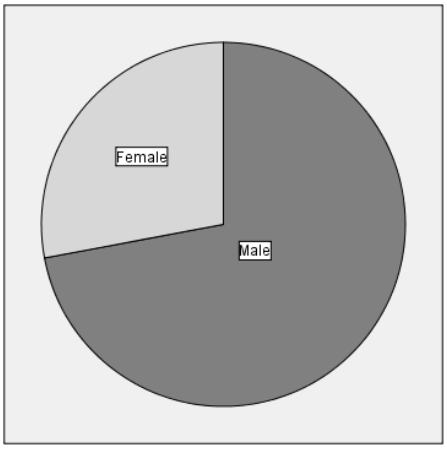

Fig 2: Gender ratio of sampled patient population

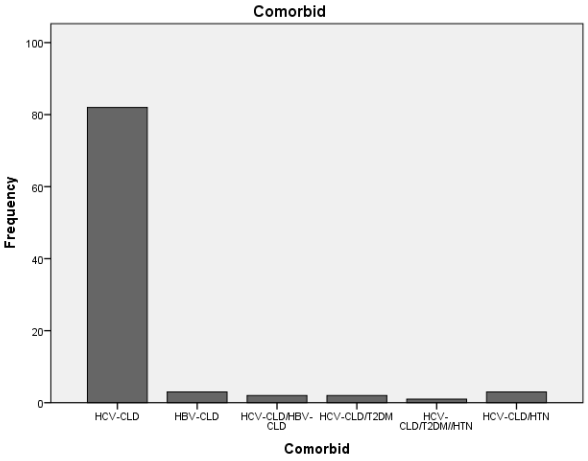

Fig 3: Frequencies of different Comorbid of sampled patient population

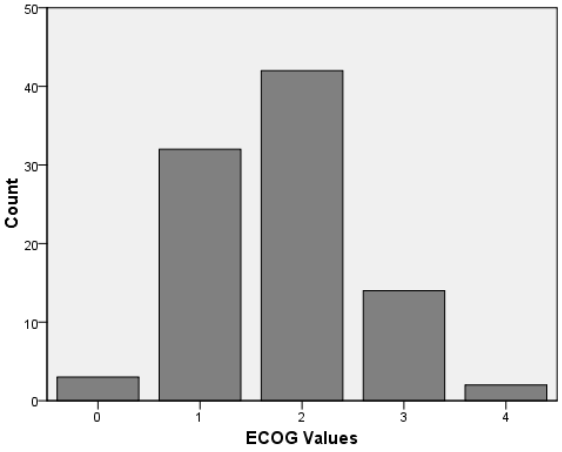

Fig 4: Frequencies of different ECOG status of sampled patient population

ALBI Score and CTP Score alone for HCC patients: The relative agreement between ALBI and CTP score has been illustrated through Fig 5.

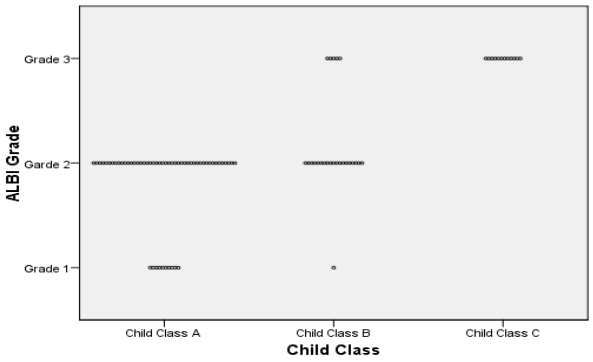

Fig 5: 2D-Dot Plot for ALBI vs. CTP

Kappa statistics were applied on the staging system of 93 patients using SPSS version 22.0, compares BCLC stages using ALBI and CTP scores. Cohen's κ revealed near-perfect agreement (κ=0.97, p<0.001). Disagreement occurred in two patients: BCLC/ALBI classified one as Stage C and one as Stage D, while BCLC/CTP classified both as Stage B. Table 2 and explained through Figure 6.

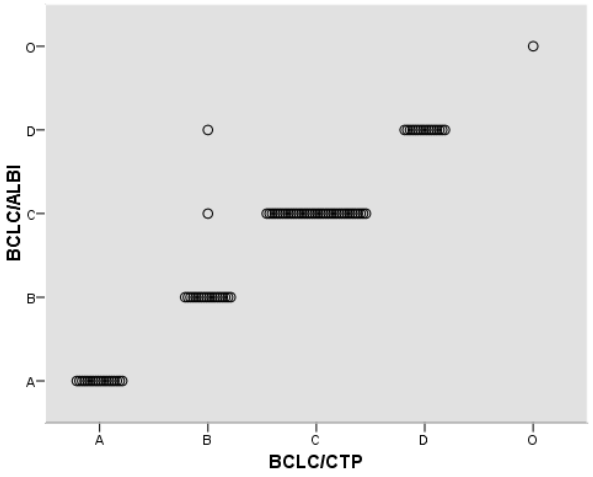

Fig 6: 2D-Dot Plot for BCLC/ALBI vs. BCLC/CTP

Table 2: Relative frequencies of BCLC stages of 93 patients by two scoring systems

		ALBI integration into BCLC							
		Stage 0	Stage A	Stage B	Stage C	Stage D	Total	*Cohen's κ*	*p-value*
CTP integration into BCLC	Stage 0	1	0	0	0	0	1		
	Stage A	0	18	0	0	0	18		
	Stage B	0	0	18	1	1	20	*0.97*	*<0.001*
	Stage C	0	0	0	38	0	38		
	Stage D	0	0	0	0	16	16		
	Total	1	18	18	39	17	93		

4. Discussion

High concordance suggests ALBI can reliably replace CTP in BCLC staging, enhancing clinical efficiency due to its ease of calculation and reduced subjectivity.
The ALBI score, utilizing only serum albumin and bilirubin, for assessment of liver function in HCC patients compared to the CTP score, which includes subjective parameters (ascites, hepatic encephalopathy) and arbitrary cut-offs [7,11]. This study demonstrates near-perfect agreement ($\kappa = 0.97$, $p < 0.001$) between ALBI-based and CTP-based BCLC staging in 93 HCC patients, with disagreement in only two cases.

ALBI's significance in HCC management lies in its applicability across treatment modalities. Studies like Antkowiak et al. (2019) found ALBI superior to CTP in predicting survival after yttrium-90 radioembolization, while Wang et al. (2016) reported better prognostic accuracy post-liver resection [9,12].

The male predominance in our cohort (72%, 67/93 patients) is consistent with the global epidemiology of hepatocellular carcinoma (HCC), where males exhibit a 2–4 times higher incidence due to risk factors such as chronic hepatitis B/C, alcohol consumption, and androgen-related pathways [1,13]. Our findings of near-perfect agreement ($\kappa = 0.97$, $p < 0.001$) between ALBI-based and CTP-based BCLC staging extend ALBI's utility to a Pakistani population with high hepatitis C prevalence (88.2%), Zhao et al. (2021) highlighted epigenetic mechanisms in HCV-induced HCC, underscoring its regional significance [18].

For instance, Wang et al. (2016) reported an 86.3% male cohort in their study of 1,243 HCC patients undergoing liver resection, demonstrating that the Albumin-Bilirubin (ALBI) score surpassed the Child-Turcotte-Pugh (CTP) score in predicting postoperative survival (hazard ratio 1.54 for ALBI Grade 2 vs. Grade 1, $p < 0.001$) [12]. Our findings of near-perfect agreement ($\kappa = 0.97$, $p < 0.001$) between ALBI-based and CTP-based BCLC staging extend ALBI's utility to a Pakistani population with high hepatitis C prevalence (88.2%), reinforcing its reliability across diverse HCC cohorts[12.]

In our cohort, where 40.86% received sorafenib and 20.4% underwent TACE, ALBI's simplicity could streamline staging and treatment planning. The high prevalence of hepatitis C (88.2%) aligns with regional epidemiology but may limit generalizability to populations with diverse HCC etiologies [13].

Compared to prior studies, our findings reinforce ALBI's robustness. Johnson et al. (2015) validated ALBI across global cohorts (e.g., Japan, UK, US), noting its prognostic accuracy in HCC [7]. Chan et al. (2016) reported improved survival prediction with ALBI-based BCLC staging in patients treated with sorafenib [14]. Our study extends these findings by demonstrating ALBI's concordance with a Pakistani cohort study where hepatitis C predominates.

Some studies provide indirect evidence by showing improved survival prediction or stratification with ALBI/BCLC, implying better treatment allocation. ALBI-based BCLC staging enhances survival prediction across treatments. Wang et al. (2016) and Zhang et al. (2018) found ALBI superior for post-resection survival in BCLC 0/A (median OS: 60.2 vs. 30.5 months, $p<0.001$; HR=2.1, $p=0.002$) [12,15]. Chan et al. (2016) reported better stratification with sorafenib (HR=1.45, $p<0.001$) [14], relevant to our 40.86% sorafenib-treated cohort. Su et al. (2019) showed ALBI's utility in SBRT (OS: 29.9 vs. 11.5 months, $p<0.05$) [16]. Similarly, Ho et al. (2020) found ALBI superior for survival prediction post-radiotherapy [19].

Another study like Antkowiak et al. (2019) found ALBI superior to CTP in predicting survival after yttrium-90 radioembolization, while Chan et al. (2016) reported improved survival prediction with ALBI-based BCLC staging in sorafenib-treated patients [9,14]. In our cohort, where 40.86% received sorafenib and 20.4% underwent TACE, ALBI's simplicity could streamline staging and treatment planning.

Kim et al. (2024) confirmed ALBI's superior prediction of long-term survival in HCC across treatments in a large, multi-center study, supporting its integration into the 2022 BCLC guidelines [17,2], Liu et al. (2016) further validated ALBI's prognostic accuracy across HCC stages [20].This reinforces ALBI's utility for our cohort, particularly for sorafenib (40.86%) and TACE (20.4%) patients.

Strengths

The strength of this study is that it includes a homogeneous sample of patients who received treatment at the Centre for Liver and Digestive Disease, Holy Family Hospital, Rawalpindi. The data for this study comes from a mature dataset that was developed through the consensus decision of hepatologists, transplant and hepatobiliary

surgeons, medical oncologists, and interventional radiologists.

Limitations include the small sample size (n=93), single-center design, and potential selection bias from convenience sampling and exclusion of incomplete questionnaires. The high hepatitis C prevalence (88.2%) may not reflect global HCC populations, and the lack of survival data limits prognostic evaluation. Future multicenter studies with larger cohorts and survival analyses are needed to validate ALBI's utility in BCLC staging and its impact on treatment outcomes.

Despite its prospective nature, this study has certain methodological limitations. Confounding variables unmeasured factors that can influence the outcome may still be present. These unknown influences were not accounted for in the analysis, potentially affecting the validity of the results. This study may be affected by selection bias, as only fully completed surveys were included in the analysis, while incomplete responses were excluded. This could limit the representativeness of the sample and contributed to the relatively small sample size (n = 93). A smaller sample reduces the statistical power of the study, increasing the risk of false-negative findings. However, the minimum required sample size for this research was 83, and all 93 participants were included with proper authorization and without any data manipulation.

Another limitation is that the study was conducted at a single center, which may not reflect broader patient populations. The sample also included only one patient at BCLC stage 0, and only two patients showed differing results between the two staging systems, making the findings potentially sensitive to statistical variation. Moreover, since 90% of participants were HCV-positive, the applicability of the results to patients with other risk factors for HCC is limited.

Given these limitations, further multicenter studies are recommended to validate these findings. Future research should also evaluate overall survival in relation to the ALBI grading system to better assess its prognostic value in HCC management.

5. Conclusion

The ALBI score is a reliable, objective alternative to the CTP score in the BCLC staging system for HCC, showing near perfect agreement ($\kappa = 0.97$) in this prospective study. Its simplicity and reduced subjectivity make it a practical tool for clinical practice, particularly for treatments like sorafenib and TACE. Further diverse research in larger cohorts is needed to confirm these findings and evaluate ALBI's prognostic impact on survival.

Acknowledgment

We thank the staff of the Centre for Liver and Digestive Diseases, Holy Family Hospital, and the patients for their participation. We acknowledge Prof. Dr. Muhammad Umer for his guidance.

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