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Clinical Impact of Hepatitis C Virus in Patients with B-Cell Non-Hodgkin Lymphoma

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ABSTRACT

Background: In Egypt, the elevated incidence of hepatitis C infection is associated with several subtypes of B-cell non-Hodgkin lymphomas (B-NHL). Hepatitis C may hinder liver functioning, resulting in diminished tolerance to chemo-immunotherapy, inadequate responses, and unfavorable clinical results.

Objectives: This study aimed to examine the clinicopathological features and clinical outcomes of B-NHL cases in hepatitis C-positive and negative groups to find out the impact of hepatitis C infection on these cases.

Patients and methods: The retrospective study involved B-NHL cases with established hepatitis C virus status, determined by ELISA and/or polymerase chain reaction techniques who attended to the Clinical Oncology and Nuclear Medicine Department at Menoufia University from January 2020 to December 2021.

Results: The study includes 221 cases with B cell non-Hodgkin lymphoma, of whom 121 (54.8%) were hepatitis C-negative and 100 (45.2 percent) were Hepatitis C-positive. The average age was 45.46±13.44 for HCV-negative cases and 57.19±10.91 for HCV-positive cases, with a significant value ($p < 0.001$). Cases living in rural areas represented sixty-two percent of HCV-positive cases, whereas they accounted for just 40.5 percent of hepatitis C-negative cases (p-value equal 0.001). Cases who were tested positive for HCV exhibited a more advanced stage (III and IV) in around sixty seven percent of cases, compared to 52.9 percent of hepatitis C-negative cases, with a statistically significant distinction ($p=0.03$). Additionally, B symptoms were more prevalent in sixty-nine percent of hepatitis C-positive cases, in contrast to 40.5 percent in hepatitis C-negative cases.

Conclusions: Within Egypt, a significant proportion of B cell lymphoma cases are positive for hepatitis C and hepatitis C-positive lymphoma is associated with more advanced stages, increased B symptoms, elevated IPI scores, and reduced time to progression.

Keywords: HCV, B cell non-Hodgkin lymphoma, Clinical outcome, Progression-free survival, Egypt.

INTRODUCTION

Non-Hodgkin lymphomas include a variety of malignancies within the lymphoid system, distinguished by varying morphological and molecular features, as well as differing clinical courses [1]. Non-Hodgkin lymphoma is the most prevalent hematological malignancy and ranks as the fourth most prevalent tumor in Egypt, accounting for 5.4 percent of all new cases of cancer, as stated by Globocan 2020 [2]. Hepatitis C is regarded as a main risk factor to chronic liver disease globally, with a prevalence rate of roughly three percent [3].

In Egypt, the prevalence of hepatitis C was fifteen percent of the population in 2013, with an anticipated annual incidence of 125,000 viremic persons each year [4], a rate regarded as one of the highest globally. Hepatitis C is an RNA virus that is both hepatotropic and lymphotropic, replicating within B cells and inducing lymphomagenesis [5].

The lymphomagenesis associated with Hepatitis C results in malignant transformation through various pathways, involving antigenic stimulation, interactions with the infected environment, and the inflammatory effects of cytokines induced by viral proteins [6]. Hepatitis C proteins can have a direct oncogenic effect, leading to chronic antigenic stimulation that serves as the basic stimulus for lymphoma growth [7].

The potential theories clarifying the cause of lymphoma include the persistent activation of external lymphocyte receptors through viral antigens, leading to their proliferation; subsequent mediation of oncogenic effects via intracellular hepatitis C proteins; as well as the "hit and run" theory, which suggests irreversible damage to B-cells induced by the intracellular virus (such as mutations in tumor suppressor genes) [8]. Considering the etiological diversity among B-NHL subtypes[9], numerous studies have shown a greater frequency of hepatitis C in B-NHL cases compared to controls [10,11].

Around eight percent of non-Hodgkin lymphoma cases worldwide may be associated with hepatitis C[12].

The heightened probability of NHL may be especially obvious in groups with elevated prevalence of hepatitis C [13].

In Egypt, the high prevalence of hepatitis C has been correlated with a subset of B-NHL [4]. This study aimed to analyze the clinicopathological features, treatment tolerance, as well as clinical outcomes of B-cell non-Hodgkin lymphomas cases in hepatitis C-positive versus negative groups to find out the influence of hepatitis C infection on these cases.

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PATIENTS AND METHODS

This retrospective analysis involved 221 cases diagnosed with B-cell non-Hodgkin lymphoma. Cases were selected from the Clinical Oncology and Nuclear Medicine Department, Faculty of Medicine, Menoufia University, from January 2020 to December 2021. Patients have been categorized into 2 groups regarding their HCV status depending on the absence or presence of anti-hepatitis C antibody, **Group A;** Comprised 121 patients with HCV negative B-NHL, and **Group B;** 100 patients with HCV positive B-NHL. Diagnosis of HCV status was based on (ELISA and/or RT-PCR). Those patients who were presented with an incomplete paper file or an unknown hepatitis C status have been excluded from this examination.

All cases had their diagnoses confirmed through histopathological examination, as well as classification was performed based upon the World Health Organization criteria. Information have been collected concerning medical history, physical examination, and laboratory investigations, which included age, gender, residence, comorbidities, complete blood count, liver enzyme levels, performance status, B symptoms, lactate dehydrogenase levels, and bone marrow infiltration. All cases were staged depending on the Ann Arbor staging system [14]. and the International Prognostic Index. The IPI scoring index categorizes cases into 4 risk stratification groups: low, low-intermediate, high-intermediate, and high [15].

Cases were treated in accordance with the established institutional protocol. Treatment protocols included the following, Chemoimmunotherapy, Chemotherapy and Radiotherapy, Radiotherapy alone or follow up. Chemoimmunotherapy regimens were addition of the monoclonal antibody rituximab to chemotherapy as follows: R-CVP, R-CHOP, R-CHOP and Triple intrathecal therapy, R-CHOEP, Hyper CVAD-R or CNS lymphoma protocol.

For stages I–II, cases underwent three to six cycles of chemotherapy and immunotherapy, with or without involved site radiotherapy targeting the initial bulky sites. For stages III–IV, cases had six cycles of chemo-immunotherapy accompanied by involved site radiotherapy to both the initial bulky sites and areas of extranodal involvement. The median monitoring duration for the cases has been approximated at fifty-three months, and responses have been categorized according to the Lugano categorization response criteria [16]. Cases have been monitored, and their outcomes (response, progression-free survival) were documented.

The response has been measured using positron emission tomography-computed tomography (PET-CT) or computed tomography every three to six months based on response criteria [16].

Liver toxicity has been measured via the Common Terminology Criteria for Adverse Events (CTACE), version 5 [17]. PFS has been determined from the date of diagnosis to the date of progression or mortality. Follow up was done for 60 months.

Ethical approval:

The study has been reviewed and allowed by the Faculty of Medicine Menoufia University Ethical Committee, with approval No-7/2024 onco8. Each participant completed a permission form when all information was received. Throughout its implementation, the study complied with the Helsinki Declaration.

Statistical analysis

Case characteristics among HCV-positive and HCV-negative groups have been examined utilizing IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics were presented as frequency and percentages and averages with standard deviation (SD). The student's t-test was utilized to assess statistically significant variations in continuous variables, while the chi-square test or Fisher's exact test were applied to categorical variables. Progression-free survival has been assessed utilizing the technique of Kaplan–Meier (Log rank test). Variables having a p-value below 0.05 in the univariate analysis of progression-free survival were then analyzed by a Cox regression model in a multivariate model. A p-value less than 0.05 was deemed statistically significant.

RESULTS

Statistically significant distinction has been observed among both groups according to age. It was older in group B with statistically insignificant variation among them regarding sex. Statistically significant variation has been found among the 2 groups regarding residence with 59.5% from urban areas in group A, however 62% were from rural areas in group B. The presence of comorbid conditions was noted to be more in hepatitis C-positive than hepatitis C-negative patients (Table 1).

A significant raise has been observed in performance status (PS) score in group B compared to A. PS 0 represented 96.7% vs 63% in group B and group A respectively. In aggressive lymphoma, cases with a high (high intermediate and high) IPI score who were hepatitis C-positive exhibited a prevalence of 72 percent compared to 39.7 percent in hepatitis C-negative cases, with the difference being highly significant (Table 1).

In comparison to group A cases, group B cases exhibited increased levels of LDH and ESR, as well as a low platelet count, with a statistically significant distinction among both groups. Statistically insignificant value was seen among both groups concerning the rise of B2 microglobulin and hemoglobin (Table 1).

Table (1): The demographic and clinical and laboratory data of HCV positive and negative lymphoma cases.

	The studied cases N = 221					
	HCV negative (group A) N = 121		**HCV positive (Group B) N = 100**		**Test of Sig.**	P value
Age (years)						
Mean ±SD	45.46±13.44		57.19±10.91		7.16	**<0.001**
Range	16 – 64		17 – 78			
Sex						
Male	69	57.0	57	57.0	0.0	1.0
Female	52	43.0	43	43.0		
Residence						
Urban	72	59.5	38	38.0	10.13	**0.001**
Rural	49	40.5	62	62.0		
Comorbidity						
No	89	73.6	44	44.0		
HTN	0	0.0	6	6.0		
DM	17	14.0	32	32.0		
CLD	0	0.0	19	19.0	57.34	**<0.001**
Cardiac	0	0.0	1	1.0		
Multiple	0	0.0	12	12.0		
Psychiatric	0	0.0	1	1.0		
Performance status						
0	117	96.7	63	63.0		
1	0	0.0	14	14.0	43.15	**<0.001**
2	4	3.3	14	14.0		
3	0	0.0	9	9.0		
IPI; international prognostic index						
Low risk (1,2)*	73	60.3	28	28.0	23.06	**<0.001**
High risk (3,4)**	48	39.7	72	72.0		
Lactate dehydrogenase (LDH)						
Elevated	93	76.9	90	90.0	6.64	**0.01**
Erythrocyte sedimentation rate ESR						
Elevated	79	65.3	80	80.0	5.87	**0.01**
B2 microglobulins						
Elevated	75	62.0	69	69.0	1.19	0.28
Hemoglobin concentration						
Low	16	13.2	12	12.0	0.07	0.79
Platelets						
Low	0	0.0	27	27.0	8.14	**0.01**

*Low risk: low and low intermediate, ** High: high intermediate and high

A statistically insignificant distinction has been observed among both groups according to the presence of bulky disease. B symptoms were significantly common in group B cases than A patients. Spleen and liver involvement was significantly higher in group B compared to A patients. However, bone marrow and extranodal involvement were statistically insignificantly different. Regarding the tumor staging, more advanced stages (stage III and IV) were detected in group B cases. The predominant histological subtype among hepatitis-positive cases was DLBCL (81%) and DLBCLs was the most frequent in HCV-negative patients (86.8%). A statistically insignificant distinction has been observed among both groups in treatment protocols and chemoimmunotherapy regimens (Table 2).

Table (2): Clinical presentations and treatment protocols among the studied patients

	The studied cases (N = 221)					
	HCV negative cases (N = 121)		**HCV positive cases** (N = 100)		**Test of Sig.**	**P value**
	No	%	No	%		
Bulky disease	16	13.2	14	14.0	0.03	0.87
B symptoms	49	40.5	69	69.0	17.88	**<0.001**
BM involvement	4	3.3	4	4.0	0.076	0.783
Spleen involvement	12	9.9	25	25.0	8.93	**0.003**
Liver involvement	4	3.3	17	17.0	11.94	**0.001**
Extranodal	41	33,9	36	36.0	0.11	0.74
Stage						
stage 1 and 2	57	47.1	33	33.0	4.51	**0.03**
stage 3 and 4	64	52.9	67	67.0		
Histological subtype						
Marginal zone lymphoma (MZL)	4	3.3	12	12.0		
SLL/CLL	4	3.3	2	2.0	12.48	**0.03**
Follicular lymphoma (FL)	8	6.6	2	2.0		
Diffuse large B cell lymphoma.	105	86.8	81	81.0		
Analgesic large cell	0	0.0	2	2.0		
MALT lymphoma	0	0.0	1	1.0		
Treatment protocol						
Chemoimmunotherapy	81	66.9	77	77.0		
Chemo and radiotherapy	32	26.4	15	15.0	8.24	0.08
Radiotherapy	4	3.3	1	1.0		
Follow up	4	3.3	5	5.0		
BSC	0	0.0	2	2.0		
Chemotherapy regimen						
No	8	6.6	8	8.0		
R-Cvp	8	6.6	14	14.0		
R-Chop	97	80.2	72	72.0	10.58	0.10
R-Chop and TiT	0	0.0	2	2.0		
R-Choep	0	0.0	1	1.0		
R-Hyper c vad	4	3.3	0	0.0		
CNS lymphoma protocol	4	3.3	3	3.0		

Low grades: small lymphocytic, follicular small, MALT, High grades**:** follicular large, diffuse large, analgesics large.

The treatment response differed significantly as well as higher relapse rate has been found in group B compared to group A. The liver toxicity presented in higher liver enzymes was detected in 25 percent of cases of group B vs 3.3 percent in group A (Table 3).

Table (3): Treatment outcomes and liver toxicity among the studied patients

	The studied cases (N = 221)					
	HCV negative cases (N = 121)		**HCV positive cases** (N = 100)		**Test of Sig.**	**P value**
	No	%	No	%		
Response						
Complete response	68	56.2	45	54.0		
Partial response	0	0.0	11	11.0	40.75	**<0.001**
Stable disease	0	0.0	3	3.0		
Under follow up from the start	4	3.3	6	6.0		
Lost follow up before evaluation	17	14.0	30	30.0		
Refractory	32	26.4	5	5.0		
Response						
Complete remission	68	56.2	45	45.0	2.75	0.09
All others	53	43.8	55	55.0		
Relapse						
No relapse	115	95.0	74	74	19.57	**<0.001**
Relapsed	6	5.0	26	26.0		
Elevated liver enzymes during treatment						
Grade III and IV	4	3.3	25	5	12.31	**<0.001**

The mean PFS was significantly longer in hepatitis C virus-negative lymphoma cases than in HCV-positive cases (Table 4 and Figure 1).

Table (4): Progression free survival among HCV positive and HCV negative lymphoma cases

Grouping.	**Mean**				**Log rank test (p value)**
	Estimate	**SE**	**95% Confidence Interval**		
			Lower Bound	**Upper Bound**	
HCV negative	56.35	0.69	54.99	57.71	
HCV positive	43.66	2.60	38.56	48.77	31.02
Overall	52.41	1.25	49.97	54.85	**(<0.001)**

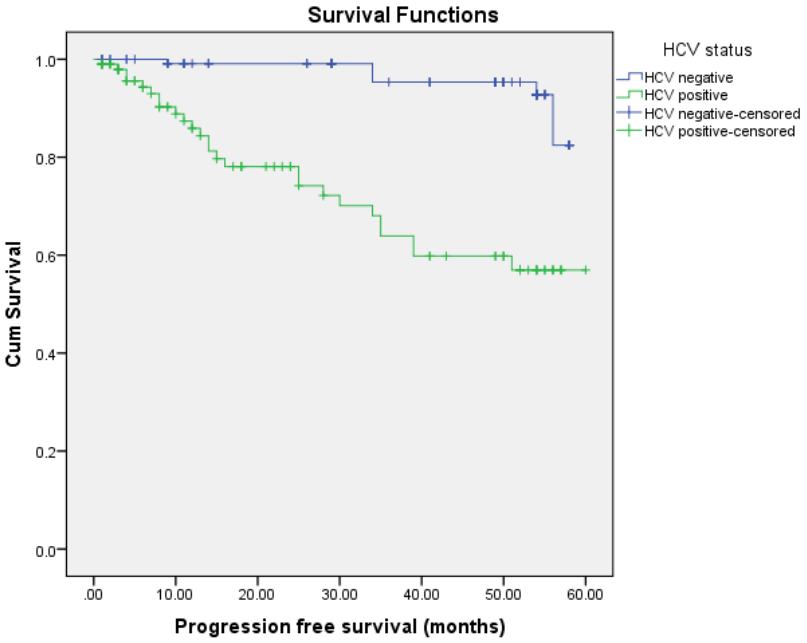

Figure (1): Progression free survival among HCV positive and HCV negative lymphoma cases.

Interpreting risk association of different parameters and PFS between hepatitis C virus positive and negative lymphoma patients in the univariate analysis showed that the stage of disease, bone marrow, spleen, liver involvement, and response were considered risk factors (Tables 5).

Table (5): Univariate analysis of factors affecting progression free survival among HCV positive and HCV negative lymphoma cases.

Variables	Mean				Log rank test (p value)
	Estimate	SE	95% Confidence Interval		
			Lower	Upper	
Sex					0.23
Male	44.1	2.0	40.1	48.2	(0.63)
Female	47.9	2.1	43.7	52.0	
Bulky disease					0.60
No	46.7	1.6	43.6	49.7	(0.44)
Yes	41.8	4.5	33.1	50.6	
B symptoms					0.03
No	47.0	1.9	43.2	50.8	(0.88)
yes	45.3	2.4	40.6	50.1	
Stage					11.4
1 and 2	52.8	1.8	49.3	56.3	**(0.001)**
3 and 4	40.9	2.1	36.8	45.1	
Histological grade					1.34
Low	38.0	4.5	29.2	46.8	(0.25)
Intermediate	47.4	1.6	44.3	50.5	
BM involvement					11.83
No	47.6	1.5	44.6	50.5	**(0.001)**
Yes	20.8	7.4	6.2	35.3	
Spleen involvement					5.3
No	48.2	1.6	45.1	51.3	**(0.02)**
Yes	37.8	4.1	29.7	45.8	
Liver involvement					12.05
No	48.0	1.5	45.0	51.0	**(0.001)**
Yes	29.9	5.3	19.5	40.3	
Extranodal					0.006
No	45.8	1.8	42.2	49.4	(0.94)
Yes	47.0	2.6	41.9	52.0	
Histological subtype					0.33
Low grade	45.0	4.9	35.5	54.5	(0.57)
High grade	46.4	1.6	43.2	49.5	
Treatment protocol					1.89
Chemotherapy	45.9	1.6	42.8	49.0	(0.16)
No	52.1	3.3	45.7	58.5	
Response					62.1
Cr	56.5	1.0	54.5	58.5	**(<0.001)**
All others	33.8	2.5	28.9	38.6	

The response rate was the only independent risk factor affecting PFS between hepatitis C virus positive and negative lymphoma patients in multivariate Cox regression analysis (Table 6).

Table (6): Multivariate Cox regression analysis for independent factors affecting progression free survival.

Variables	SE	Wald	P value	Hazard ratio	95.0% CI for Exp(B)	
					Lower	Upper
Stage	0.21	3.13	0.08	1.44	0.96	2.15
BM. involvement	0.72	1.11	0.29	0.47	0.12	1.92
Spleen involvement	0.29	2.21	0.14	0.65	0.37	1.15
Liver involvement	0.43	.04	0.84	1.09	0.47	2.56
Response	0.23	4.0	**0.04**	**1.58**	1.01	2.49

DISCUSSION

Hepatitis C infections in B-cell non-Hodgkin lymphoma correlate with increased prevalence and unique characteristics and clinical outcomes, particularly in marginal zone lymphoma (MZL) and diffuse large B-cell lymphoma (DLBCL), according to recent epidemiological research [18].

Besides liver damage, chronic hepatitis C virus infection can lead to several extrahepatic symptoms, involving hematological disorders. The hematological symptoms of hepatitis C might differ from benign cytopenia to malignant lymphoproliferative diseases [19].

In the present study, 45.2 percent of non-Hodgkin lymphoma cases tested positive for hepatitis C virus, which aligns with prior research on the malignant complications of chronic hepatitis C virus infection in Egypt, as well as studies examining the correlation between NHL and HCV, indicating a prevalence of HCV from forty percent to fifty percent among non-Hodgkin lymphoma cases [20-21-22]. The elevated prevalence rate seen in the Delta region may be attributed to the extensive hepatitis C among the Egyptian population in this area. A meta-analysis of fifteen investigations regarding the correlation among hepatitis C virus, infection and non-Hodgkin lymphoma revealed a combined relative risk of lymphoma of 2.5 (confidence interval: ninety five percent, 2.1–3.1) in hepatitis C-infected cases in 2006 [23]. Conversely, research by **Coppola *et al.*** [24] in Italy revealed that hepatitis C virus prevalence in non-Hodgkin lymphoma cases did not reach 22%. In regions with low hepatitis C prevalence, like Scandinavia, the United Kingdome, or Canada, a minimal or nonexistent correlation has been observed, potentially due to the limited number of infected cases; conversely, in the United States of America, a modest yet significant association is identified [25].

Comparing both study groups, we observed significant differences regarding age, it was older in HCV positive patients (the mean age was 57.19 verses. 45.46, p-value < 0.001), this was consistent with **Tsai *et al.*** [18] who observed that patients who were HCV-positive were older (mean age 67.23 ± 17.13 versus. 61.24 ± 15.27, p-value 0.088) and with **Ennishi *et al.*** [26] who observed that before treatment, patients with HCV-positive were older (the mean age was70.4 vs. 64.3, P < .001), while **Abu-Taleb *et al.*** [21] reported no significant difference. We observed no significant difference regarding sex, bone marrow involvement, hemoglobin level, levels of Beta-2 microglobulin, and the percentage of receiving management among 2 groups; this agreed with **Tsai *et al.*** [18]**, Ennishi *et al.*** [26] **and Marignani *et al.*** [27]**.**

Regarding residence, we observed higher HCV positive NHL in rural areas than urban (62% vs. 40.5% respectively). This can be described by the greater occurrence of hepatitis C virus in rural dwellers compared to individuals living in urban areas [28].

Elevated levels of LDH as well as low platelet count were found in HCV positive NHL. Elevated LDH, which, at least in part, is due to concomitant hepatitis [29,30]. Low platelets counts were like that observed by **Tsai *et al.*** [18] in which hepatitis C virus-positive cases appeared to have a significantly decrease platelet count (186.7 ± 68.8 × 103/microliters verses C virus-negative cases 236.2 ± 102.9 × 103/microliters, p-value 0.029) and this could be explained by HCV-related thrombocytopenia [30].

In the present study the International Prognostic Index score was high/high intermediate in 72% of hepatitis C virus positive cases vs 39.7% in hepatitis C-negative patients with p-value < 0.001. **Saleh *et al.*** [31] reported similar results in study conducted in Egypt; the International Prognostic Index score was high/high intermediate in 78% of hepatitis C virus positive cases with p=0.006 as we have the same demographic and clinical features related to hepatitis C virus infection in lymphoma cases while **Abu-Taleb *et al.*** [21] observed a non-significant variance among both groups.

Liver and spleen involvement were significantly higher in hepatitis C virus positive cases; however, bone marrow and extranodal involvement were statistically insignificant, similar results were reported by **Tsai *et al.*** [18] in Taiwan while **Ennishi *et al.*** [26] in a Japanese multicenter analysis observed spleen and extranodal involvement were significantly higher in HCV positive cases whereas liver and bone marrow were statistically insignificant. **Arcaini *et al.*** [32] stated that a common feature of hepatitis C virus associated B-NHL is more frequent extranodal disease presentation.

HCV positive studied patients presented by advanced Ann Arbor stage III–IV 67% like that was reported by **Tsai *et al.*** [18] **and Saleh *et al.*** [31]. Both advanced stages and high IPI score for hepatitis C virus positive studied cases confirmed the role of hepatitis C in progress of lymphoma and aggressiveness.

In our study, most hepatitis C-positive individuals were diagnosed with diffuse large B-cell lymphoma (81%), subsequently marginal zone lymphoma (12 percent). The non-Hodgkin lymphomas distribution we stated aligns with other discoveries in Egypt [20], indicating diffuse large B-cell lymphoma proportions of fifty-five percent to seventy-six percent among hepatitis C-positive related non-Hodgkin lymphomas, while marginal zone lymphoma proportions remain below ten percent [6]. Our findings corroborate with additional studies indicating a correlation between HCV and diffuse large B-cell lymphoma, and MZL [11,23]. In Western countries, most cases with hepatitis C-associated NHLs are diagnosed with MZL and diffuse large B-cell lymphoma, which often undergo transformation from low-grade to high-grade lymphomas [6]. The varying distribution can be attributed to variations in environmental context and access to healthcare.

The present study indicated that hepatitis C-positive non-Hodgkin lymphomas cases exhibited poorer survival outcomes, with a trend of reduced progression-free survival (PFS) of 43.66 months compared to 56.35 months for hepatitis C-negative patients ($p < 0.001$). **Saleh *et al.*** [31] observed that the median overall survival (OS) for the HCV positive group was thirteen months compared to twenty-six months for the hepatitis C-negative cases ($p=0.22$). The impact of hepatitis C on survival in B-NHL cases remains contentious. The research by **Ennishi *et al.*** [26] indicated comparable results in hepatitis C-positive diffuse large B-cell lymphoma patients relative to hepatitis C-negative cases (3-year overall survival seventy-five percent in HCV-positive versus eighty-four percent in hepatitis C-negative, $p = 0.07$). Conversely, several researchers revealed a poor result in HCV-positive cases [18,33,34].

Our analysis identified advanced stage, bone marrow, liver, and spleen involvement, as well as response, as the primary risk factors predicting progression-free survival. **Tsai *et al.*** [18] identified poor performance status, advanced stage, liver damage, and fewer cycles of chemotherapy as the primary risk variables influencing overall survival and progression-free survival. **Chen *et al.*** [34] identified additional independent indicators that predicted overall survival: lower albumin levels (<3 g/dL vs. ≥3 g/dL, p-value = 0.001), presence of hepatitis C infection (HCV-positive versus. HCV-negative, $p = 0.005$), and poor International Prognostic Index risk (high versus. low, $p = 0.031$).

We observed increased liver toxicity grade 3 and 4 in hepatitis C-positive patients, with an incidence of twenty-five percent compared to 3.3 percent in HCV-negative patients, consistent with **Tsai *et al.*** [18] who reported elevated liver toxicity rates (86.4% vs 45.1%) and a greater prevalence of > grade 3 liver toxicity in the hepatitis C-positive population.

This study had numerous limits: it was a retrospective analysis with a limited cohort of HCV patients, it did not concentrate on types of B-cell non-Hodgkin lymphomas, and HCV viral load wasn't consistently monitored throughout the data collection interval. Consequently, we lacked thorough data regarding hepatitis C viral load in certain HCV-positive cases and their receipt of antiviral therapy.

CONCLUSIONS

The majority of B cell lymphoma percentage of cases is positive for hepatitis C. Hepatitis C-positive lymphoma cases typically present with more advanced stages, increased B symptoms, elevated IPI scores, and reduced time to progression. Therefore, significant efforts are necessary for early identification and management of hepatitis C, with the establishment of prospective studies to find out whether early hepatitis C treatment can mitigate the risk of NHL in individuals with chronic hepatitis C, particularly in endemic regions with high hepatitis C prevalence, such as the Delta region of Egypt.

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