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ORIGINAL ARTICLE

Statin Use in Patients with Cirrhosis: A Retrospective Cohort Study

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Abstract
Background Statins reduce cardiovascular risk. Patients with cirrhosis have decreased hepatic clearance of statins and potentially increased risk for complications. No studies assess mortality in patients with biopsy-confirmed cirrhosis.
Aim Compare mortality in patients with cirrhosis on statins to those not on statins.
Methods A retrospective cohort study evaluated patients from 1988 to 2011 at Partners Healthcare Hospitals. The Partners Research Patient Data Registry identified patients with biopsy-proven cirrhosis on statins at biopsy and at least 3 months following. Controls were matched 1:2 by age, gender and Child–Pugh class. Decompensation was defined as ascites, jaundice/bilirubin >2.5 mg/dL, and/or hepatic encephalopathy or variceal hemorrhage. Primary outcome was mortality. Secondary outcome was decompensation in baseline-compensated patients. Chi-square and two-way ANOVA testing compared groups. Cox proportional hazards models for mortality controlled for age, Child–Pugh class, diabetes, coronary artery disease, non-alcoholic steatohepatitis and hepatocellular carcinoma. Kaplan–Meier curves graphed mortality.
Results Eighty-one statin users and 162 controls were included. Median follow-up: 36 months in statin users and 30 months in controls. 70.4 % of patients were Child–Pugh A. Model for End-Stage Liver Disease (MELD), albumin, varices and beta-blocker use were not significantly different between groups. Statin users had lower mortality on multivariate analysis (HR 0.53, $p = 0.01$), and Child–Pugh A patients had longer survival on Kaplan–Meier analysis. Cox multivariate analysis for decompensation showed lower risk of decompensation with statins while increased decompensation with low albumin, high MELD score and beta-blocker use.
Conclusions In patients with cirrhosis, statin therapy is not associated with increased mortality and may delay decompensation.

Keywords Statins · Cirrhosis · Decompensation · Child–Pugh

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Introduction

Cardiovascular disease is an important cause of morbidity and mortality in the general population, and patients with chronic liver disease are no exception. Cardiovascular risk has been shown to be greater in liver disease, specifically non-alcoholic fatty liver disease, hepatitis C infection and primary biliary cirrhosis [1–3]. A recent study also determined the prevalence of coronary artery disease in patients with cirrhosis to be 20 %, compared to 12 % in the general population [4]. A study specifically assessing coronary angiographic characteristics in liver transplant candidates

without known coronary artery disease showed 26 % of patients to have moderate to severe coronary narrowing [5]. The physiologic changes in cirrhosis, including increased cardiac output and compromised ventricular response to stress, may increase the risk for cardiovascular disease [6].

To reduce cardiovascular risk, lipid-lowering agents such as statins (3-hydroxy-3-methylglutaryl-coenzyme A reductase inhibitors) are standard therapy for the general population. Interestingly, statin therapy has also been associated with reduced mortality in a number of conditions irrespective of their effect on cardiovascular risk. Palmer et al. recently showed that statin therapy reduced mortality and cardiovascular events in chronic renal failure patients who were not on dialysis, and similar findings were also reported in renal transplant recipients [7, 8]. Frohlich et al. showed in patients who underwent heart transplantation, treatment with statins was associated with improved cancer-free and overall survival [9]. After an episode of pneumonia, survival was also improved in patients who were treated with statins compared with patients who did not receive the medication [10]. Additional studies have shown that statin therapy is associated with a reduced risk of mortality in a number of different cancers including prostate, breast, colon and hepatocellular carcinoma [11–16].

Statins undergo first-pass hepatic metabolism, generally through the cytochrome P450 system [17, 18], and have been associated with elevations in liver enzymes [19]. Given patients with chronic liver disease are at risk of decreased hepatic clearance, there is concern that this patient population may be at higher risk for complications from statin therapy [20, 21]. In particular, there has been concern that statins may trigger hepatic decompensation in patients with a known diagnosis of cirrhosis resulting in significant morbidity and mortality. However, recent studies suggest that patients do not have increased rates of hepatotoxicity from statins even when baseline liver enzymes are elevated [22]. Several studies have shown that statins are generally well tolerated in patients with chronic liver disease such as non-alcoholic fatty liver disease, primary biliary cirrhosis and hepatitis C [23–25]. Chalasani et al. compared cohorts of patients with elevated liver enzymes who did and did not receive a statin, showing that baseline elevation in liver enzymes did not increase the risk of hepatotoxicity [26]. A randomized controlled trial in which high-dose pravastatin was administered to patients with at least 6 months of compensated chronic liver disease for treatment of elevated levels of low-density lipoprotein (LDL) cholesterol also demonstrated that the drug was safe and well tolerated [27]. However, this study excluded patients with a Child–Pugh score greater than 5 and not all patients had biopsy-proven cirrhosis. Another retrospective study of lovastatin use in patients with any degree of compensated chronic liver disease further suggested safety of the drug [28]. Based on these studies, the current guidelines by the Liver Expert Panel for the National Lipid Association's Safety Task Force support the use of statins as a lipid-lowering agent in compensated cirrhosis [29]. In addition to being safe, a comprehensive review by Lewis summarized the beneficial effects of statins in patients with non-alcoholic fatty liver disease, hepatitis B, hepatitis C and hepatocellular carcinoma [30]. Recent studies in both animals and humans suggest that statins may also reduce portal hypertension, further adding to their benefit [31–33]. Atorvastatin has also been shown to reduce the pro-inflammatory effects of angiotensin II both in vivo and in vitro in the liver [34].

Despite the number of studies performed on statins, none have been published that specifically evaluate the effect of statin use on mortality in patients with documented cirrhosis. The objective of this study is to assess difference in mortality in patients with biopsy-proven cirrhosis who were and were not on statins.

Methods

The study was a retrospective cohort study to evaluate the effects of statin therapy in patients with cirrhosis. The Institutional Review Board at Partners Healthcare approved the study. A database was created by obtaining data from the Partners Research Patient Data Registry (RPDR). The RPDR is a centralized clinical data registry that gathers data from multiple hospitals within the Partners Healthcare Hospitals (which includes, but is not limited to, Brigham and Women's Hospital, Massachusetts General Hospital and Faulkner Hospital). The resulting data warehouse allows for user-defined queries to be performed to access both inpatient and outpatient data. Enrollment was limited to: (1) Adult patients (age > 18 years); (2) Patients with biopsy-proven cirrhosis; (3) Patients on statin therapy at time of biopsy and for at least 3 months after biopsy confirmation of cirrhosis; and (4) Patients that received care at the Partners Healthcare Hospitals.

The total number of subjects and sample size were determined by the RPDR query results. All study patients on statins were matched to a control group with biopsy-proven cirrhosis but no statin use.

Two groups were compared: the subjects using statins for a documented minimum of 3 months and the control subjects not using statins, using mortality as the primary endpoint. Patients on statin therapy were identified through commonly used ICD-9 codes for cirrhosis (query criteria included cirrhosis diagnosis codes 571.2 and 571.5, and statin use). After results from the query were obtained,

diagnosis and statin use for at least 3 months were confirmed by manual review of each chart. A 3-month duration of treatment was chosen based on a previous study showing the effect of statins on portal hypertension after 1 month of therapy [33]. Individuals with cirrhosis not on statin therapy were then identified by age, gender and Child–Pugh class matching to serve as a control group (1:2 matching was performed) from RPDR. Age was matched within 2 years. Matching was performed by Child–Pugh class in order to control for severity of liver disease. Data collection included demographics from the resulting queries, as well as measures of baseline characteristics (i.e., etiology of liver disease, non-selective beta-blocker use, Child–Pugh class, comorbidities and laboratory values).

Baseline covariates were first assessed comparing statin users to non-users. Etiologies of liver disease were also assessed. Because of the small number of subjects in the groups with less common causes (including primary biliary cirrhosis, alpha-1 antitrypsin deficiency, sarcoidosis, drug-induced liver disease, and hemochromatosis), an "other" category was created to facilitate analysis. As the majority of cryptogenic cirrhosis has been shown to be a long-term complication of non-alcoholic steatohepatitis (NASH), the cryptogenic group was combined with the NASH group for analysis. Child–Pugh class was divided into 2 categories, Child–Pugh class A or Child–Pugh class B and C. Categorical variables were compared between groups using the chi-square test and reported as number of subjects, and percent of total and continuous variables were compared using the two-way ANOVA and reported as mean and standard deviation.

Clinical outcomes included mortality and clinical decompensation in patients who were compensated at baseline. All patients were followed indefinitely in the initial assigned groups. For all analyses, patients were censored at last clinic visit or date of transplant. All data were collected by manual chart review and entered into a database without personal identifying information. Analysis was performed using the SAS 9.3 software. A p value <0.05 was considered statistically significant.

Initial univariate analysis on the effect of statin use on mortality was performed using a Cox proportional hazards model. This was graphically represented with plotting of Kaplan–Meier curves. Multivariate analysis was then performed to control for other comorbidities that may affect mortality. These potential confounders included Model for End-Stage Liver Disease (MELD) score, diabetes, coronary artery disease, NASH and hepatocellular carcinoma.

The secondary outcome was the occurrence of clinical decompensation in patients who were compensated at baseline. Decompensation was defined as the occurrence of hepatic encephalopathy documented by a gastroenterologist, variceal hemorrhage, clinically significant ascites requiring diuretic therapy and/or clinical jaundice or bilirubin >2.5 mg/dL.

A Cox proportional hazards model was created to perform univariate and multivariate analysis on possible predictors of decompensation in patients with compensated cirrhosis at baseline. Multivariate analysis controlled for albumin, beta-blocker use, MELD score, NASH and HCC at baseline.

Results

Patients were included from 1988 to 2011. The vast majority of patients (>95 %) started statin therapy after 1995. A total of 424 patients satisfied inclusion criteria per the RPDR query. Of these, 343 patients were excluded due to lack of biopsy-proven cirrhosis, lack of statin use, statin use for less than 3 months, follow-up time less than 3 months or inadequate documentation of data. Eighty-one patients remained with biopsy-proven cirrhosis and the use of statins at time of diagnosis and for a minimum of 3 months after diagnosis. A control group was matched 1:2 by age, gender and Child–Pugh class and consisted of 162 patients (Fig. 1). The statin group had 57 Child–Pugh class A patients, 23 Child–Pugh class B patients and 1 Child–Pugh class C patient. Median follow-up time in the statin group was 36 months with a range of 4–385 months and 30 months in the control group with a range of 4–220 months ($p = 0.237$). Median statin use duration was 25 months, with range of 3–184 months. The statins prescribed were simvastatin, atorvastatin, rosuvastatin, pravastatin, lovastatin and fluvastatin. Simvastatin was the most commonly used statin (49.4 %) followed by atorvastatin (29.6 %).

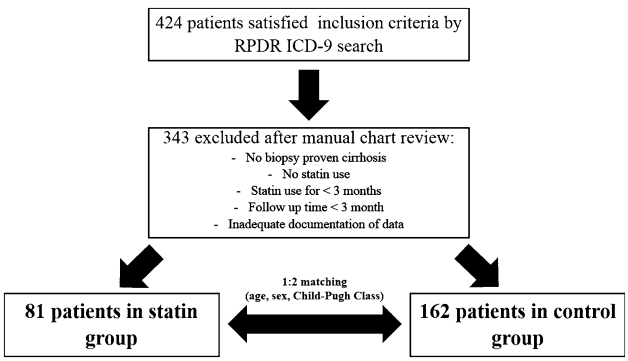


Fig. 1 Flowchart of inclusion process. 81 patients satisfied inclusion criteria after manual review of each chart returned from the RPDR search. The cohort was then matched by age, sex and Child–Pugh class to form the control group

Table 1 describes the baseline characteristics between the statin users and the control group. Of the covariates analyzed, the number of subjects on statins with a diagnosis of NASH was significantly different from the control group. Those on statins also had increased prevalence of diabetes mellitus and coronary artery disease.

Among patients who received statins, 30 died (37.0 %) and 2 (2.5 %) underwent liver transplantation, whereas in the control group, 82 died (50.6 %) and 29 (17.9 %) underwent liver transplantation. The median duration of statin use in patients who died was 2 years; 3.8 years in patients who were transplanted.

Initial univariate analysis of mortality with a Cox proportional hazards model, censoring at last clinic visit or date of transplant, demonstrated a trend toward lower mortality in patients on statins (HR 0.66, $p = 0.05$) (Table 2). Coronary artery disease, HCC and MELD score were significantly associated with higher mortality (HR 1.63, $p = 0.01$, HR 2.44, $p = 0.001$, HR 1.07, $p = 0.0001$, respectively), compared to diabetes and NASH which were not significantly associated with mortality. On Kaplan–Meier analysis, time to death trended toward being significantly longer for patients with cirrhosis who received statins compared to the

Table 1 Comparison of baseline characteristics between statin users and controls

Baseline characteristic	Statin users ($n = 81$)	Controls ($n = 162$)	p value
Cirrhosis	81 (100)	162 (100)	1.000
Gender			1.000
Male—No. (%)	44 (54.32)	88 (54.32)	
Female—No. (%)	37 (45.68)	74 (45.68)	
Age at diagnosis[a]—mean yrs (SD)	59.79 (10.91)	59.64 (10.60)	0.917
*Cause of liver disease**			
Hepatitis C—No. (%)	18 (22.22)	55 (33.95)	0.060
Alcohol—No. (%)	18 (22.22)	39 (24.07)	0.758
Hepatitis B—No. (%)	2 (2.47)	10 (6.17)	0.195
NASH[b]—No. (%)	35 (43.21)	41 (25.31)	0.004
Autoimmune hepatitis—No. (%)	3 (3.70)	6 (3.70)	1.000
Cardiac cirrhosis—No. (%)	4 (4.94)	6 (3.70)	0.655
Other[c]—No. (%)	8 (9.88)	16 (9.88)	1.000
Child–Pugh—mean score (SD)	6.14 (1.35)	6.26 (1.38)	0.508
Class A—No. (%)	57 (70.37)	114 (70.37)	1.000
Class B or C—No. (%)	24 (29.63)	48 (29.63)	1.000
Beta-blocker use[d]—No (%)	27 (33.33)	42 (25.93)	0.262
HCC at diagnosis—No. (%)	9 (11.11)	20 (12.34)	0.178
MELD—mean value (SD)	10.96 (4.02)	11.68 (4.61)	0.233
Albumin—mean value (SD)	3.49 (0.77)	3.41 (0.67)	0.416
Presence of endoscopic proven varices—No. (%)[e]	19 (36.54)	27 (35.06)	1.000
CAD—No. (%)	35 (43.21)	20 (12.35)	<0.0001
DM—No. (%)	45 (55.56)	50 (30.86)	0.0001
Cholesterol—mean (SD)			
Total	160.0 (48.20)	150.0 (56.36)	0.210
LDL	91.69 (38.79)	84.20 (37.41)	0.209

* In the statin group, 4 patients had alcoholic liver disease and hepatitis C, 2 had alcoholic liver disease and non-alcoholic steatohepatitis and 1 patient had alcoholic liver disease and cardiac disease as cause of cirrhosis. In the control group, 7 patients had alcoholic liver disease and hepatitis C, 2 had alcoholic liver disease and non-alcoholic steatohepatitis and 1 patient each had hepatitis C and non-alcoholic steatohepatitis and hepatitis C and hemochromatosis as the cause of liver disease

[a] Age at diagnosis is age at time of liver biopsy showing evidence of cirrhosis

[b] NASH = Non-alcoholic steatohepatitis + cryptogenic (18/35 in statin group, 24/41 in controls)

[c] Other categories include the following: primary biliary cirrhosis, alpha-1 antitrypsin deficiency, sarcoid, drug-induced liver disease and hemochromatosis

[d] Non-selective beta-blocker use only considered

[e] 129 patients had upper endoscopies performed (statin users = 52, controls = 77)

Table 2 Univariate and multivariate analysis of mortality in patients with cirrhosis treated with statins compared to the control group

Variable	Univariate hazard ratio	Multivariate hazard ratio	95 % Confidence interval
Statin	0.66^	0.53*	(0.334, 0.856)
Coronary artery disease	1.634*	1.79*	(1.14, 2.814)
Diabetes	0.96	0.87	(0.57, 1.31)
Hepatocellular carcinoma	2.44*	2.22*	(1.312, 3.752)
MELD	1.07*	1.07*	(1.034, 1.115)
NASH	1.42	1.77*	(1.125, 2.774)

*p value <0.05; ^ p value 0.05

controls ($p = 0.06$) (Fig. 2a). The median time to death was 6.3 years in the control group and 10.8 years in the statin group.

On multivariate analysis with a Cox proportional hazards model, when controlling for possible confounders of MELD score, coronary artery disease, diabetes, NASH and HCC, statin use became significantly associated with lower mortality (HR 0.53, $p = 0.01$), while coronary artery disease, higher MELD, HCC and NASH were associated with higher mortality (Table 2).

Subgroup analysis showed that Child–Pugh A patients with cirrhosis at baseline who had received statins had longer survival compared to the control group, $p = 0.005$ (Fig. 2b). The median time to death was 7.0 years in the control group and 14.4 years in the statin group.

The most common causes of death were infection and malignancy in both the statin group and the control group. There were no statistically significant differences for cause of death, including infection, malignancy, cardiovascular event, liver/renal failure and respiratory failure, between the statin group and the controls. However, cause of death was not documented in approximately one-third of each group.

Among patients who were compensated at baseline, the occurrence of decompensation on follow-up was 30.0 % (21/70) in the statin users compared to 40.5 % in the control group (49/121), $p = 0.04$.

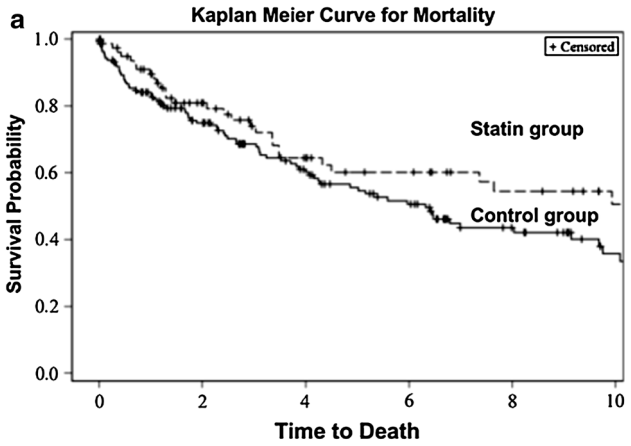
A Cox proportional hazards model was created to assess the association of statin use on hepatic decompensation, censoring patients at last clinic visit, date of transplant or death. On univariate analysis, statin use was not significantly associated with hepatic decompensation (HR 0.63, $p = 0.07$). On Kaplan–Meier analysis, the median time to decompensation was 8.1 years in the control group, while the statin group did not reach 50 % decompensation. Cox multivariate analysis was conducted controlling for baseline albumin, MELD score, baseline betablocker use and baseline hepatocellular carcinoma. In this model, statin use was associated with lower risk of decompensation (HR 0.58, $p = 0.04$), whereas a low baseline albumin (HR 0.43, $p = 0.001$), high MELD score (1.14, $p = 0.0001$) and baseline beta-blocker use (HR 2.32, $p = 0.001$) were found to be significantly associated with higher decompensation risk. In the same model when baseline HCC patients were excluded, there remained a trend of lower risk of decompensation with statin use, but this was not statistically significant, $p = 0.051$ (Table 3).

When comparing the decompensating events between the two groups, the statin group had a statistically significantly lower occurrence of ascites [statin 16 % ($n = 11/70$) vs. no statin 31 % ($n = 38/121$), $p = 0.017$] while variceal hemorrhage was significantly less likely to occur in patients not on statins [statin 11 % ($n = 8/70$) vs. no statin 2 % ($n = 3/121$), $p = 0.02$]. There was no statistically significant difference in the development of jaundice [statin 3 % ($n = 2/70$) vs. no statin 9 % (n = 11/121)] or hepatic encephalopathy [statin 19 % ($n = 13/70$) vs. no statin 20 % ($n = 24/121$)] between the statin group and the control group.

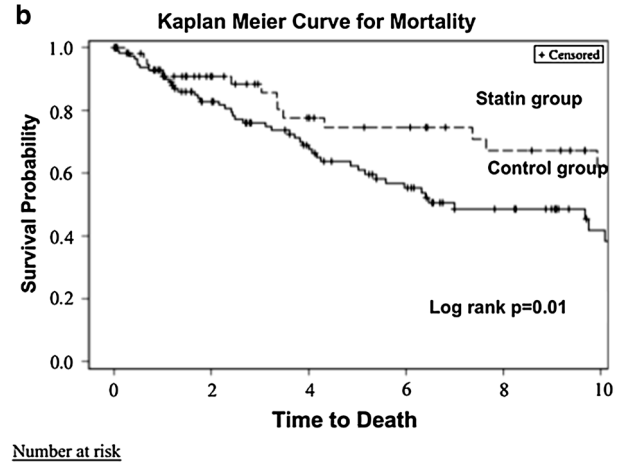
Discussion

Numerous studies have shown statins to be associated with reduction in mortality. Specifically, the cholesterol treatment trialists' collaborators have shown that LDL cholesterol reduction with statin therapy results in a reduction in all-cause mortality, specifically vascular mortality in high-risk populations [35]. In addition, landmark studies from the mid-1990s have shown statins to be efficacious in preventing death and cardiovascular morbidity when used as primary prevention in people at low cardiovascular risk [36]. Thus, statins have been extensively used for risk reduction of cardiovascular disease, with their benefits attributed to more than an alteration in cholesterol levels, as they have been shown to have anti-inflammatory effects as well [37]. Cardiovascular disease is also a significant source of morbidity and mortality in patients with liver disease, both before and after liver transplantation, and risk modification is likely to reduce its occurrence in cirrhosis.

Advertisements and the prescription literature for the use of statins in the treatment of dyslipidemia, however, specifically warn against their use in patients with liver disease, and therefore, practitioners have been reluctant to use statins in this patient population [38]. This is despite numerous studies showing statins to be safe in liver disease, including non-alcoholic fatty liver disease, hepatitis B, hepatitis C and hepatocellular carcinoma [24–28, 30]. An important limitation of previous studies that may influence provider practice patterns is the lack of



Year	0	1	2	3	4	5	6	7	8	9	10
Statins	81	66	49	39	33	27	26	21	19	18	12
Control	162	126	101	82	69	57	50	32	30	25	16



Number at risk

Year	0	1	2	3	4	5	6	7	8	9	10
Statins	57	49	40	33	28	25	24	20	18	17	12
Control	114	98	77	64	54	46	38	25	24	20	12

Fig. 2 **a** Mortality in patients who were treated with statins compared to a control group. The median time to death was 10.8 years in the statin group and 6.3 years in the control group ($p = 0.06$). **b** Mortality in Child–Pugh class A patients who were treated with statins compared to a control group. The median time to death was 14.4 years in the statin group and 7 years in the control group ($p = 0.01$)

conclusive data in prospective studies of statins in patients with cirrhosis.

The current study assessed all-cause mortality in patients with cirrhosis treated with statins, which was found to be reduced in patients who were statin users compared to the control group. The difference in survival between patients using statins and the control population

Table 3 Univariate and multivariate analysis of decompensation in patients with cirrhosis treated with statins compared to the control group

Variable	Univariate hazard ratio	Multivariate hazard ratio	95 % Confidence interval
Statin	0.63	0.58*	(0.34, 0.98)
Albumin	0.42*	0.43*	(0.29, 0.65)
MELD	1.14*	1.14*	(1.074, 1.211)
Hepatocellular carcinoma	1.90	1.11	(0.51, 2.43)
Beta-blocker	2.30*	2.30*	(1.41, 3.74)
NASH	1.06	1.13	(0.68, 1.87)
Excluding patients with HCC at baseline			
Statin	0.63	0.57	(0.33, 1.002)
Albumin	0.42*	0.33*	(0.22, 0.51)
MELD	1.14*	1.13*	(1.06, 1.21)
Beta-blocker	2.30*	2.62*	(1.561, 4.4)
NASH	1.06	1.07	(0.63, 1.80)

* $p < 0.05$

became statistically significant when controlling for potential confounders of coronary artery disease, diabetes, HCC, NASH and MELD score. Coronary artery disease, hepatocellular carcinoma and NASH were also associated with increased mortality. No significant difference in cause of death was observed between patients who were and were not on statin therapy. It is important to note though that in a third of patients in each group, cause for mortality was not documented. The collection of these findings supports the use of statin drugs in patients with cirrhosis.

To determine whether clinical decompensation in patients with cirrhosis may place them at higher risk of death, additional subgroup analysis was performed. Of the 191 patients compensated at the time of liver biopsy, the occurrence of clinical decompensation was less in patients on statins compared to those who were not. On univariate analysis, statin use alone was not associated with clinical decompensation. However, with multivariate analysis, statin use was associated with a lower risk of decompensation. Additional analysis was carried out eliminating patients with HCC at baseline, and statin use trended towards reduced risk of clinical decompensation in this group. The lack of statistical significance may be a type II error due to the smaller size of the cohort analyzed without HCC who were compensated at baseline.

These findings could suggest that the lower mortality in statin patients may be related to the reduced clinical decompensation of cirrhosis. Both animal and human studies have shown statins to reduce portal hypertension, offering a potential explanation for the mechanism [31–

33]. Further prospective studies are needed to determine if statins reduce the risk of decompensation in cirrhosis.

On further analysis, baseline beta-blocker use was shown to be associated with an increased risk of clinical decompensation. However, the data on beta-blocker use were only collected at baseline. Whether patients remained on beta-blockers on follow-up, were adequately dosed or remained compliant in taking the drug is not known. In addition, beta-blockers may have been added to the therapeutic program during follow-up, and therefore, it is difficult to make any conclusions with regard to their use.

Previous reports have shown that statin therapy in patients with chronic liver disease is well tolerated, but most of these studies have not focused on patients with documented cirrhosis [26–28]. The Liver Expert Panel currently states that there is marginal confidence that statins are safe to use in patients with compensated cirrhosis [29]. The findings from the current study provide additional evidence that the use of statins in patients with compensated cirrhosis does not increase the risk of death and may potentially be beneficial.

There are a number of limitations to the current study. It was conducted retrospectively which subjects the study to reporting bias. However, each chart was manually reviewed by the investigators. It also includes a very heterogeneous patient population with varied duration and potentially different indications of statin use, responses to statins and risk of decompensation. There may be a selection bias in the prescription of statins for patients by practitioners with the statin users having less comorbidities, although NASH, coronary artery disease and diabetes were more prevalent in the statin group, all of which have been associated with higher mortality. These comorbidities were also controlled for in an attempt to account for any confounding. The population is also primarily composed of compensated patients with cirrhosis, making it difficult to provide reliable conclusions and recommendations in Child–Pugh class B and C patients with cirrhosis. Given the retrospective design of the study, compliance with statin use cannot be adequately assessed. Another important limitation is that the effect of active alcohol use, tobacco use, non-steroidal anti-inflammatory medication use and/or obesity as a predictor of decompensation or mortality cannot be assessed due to the lack of sufficient data. Obesity has been recently associated with clinical decompensation in cirrhosis which may be an important factor to consider [39].

In conclusion, the use of statins in cirrhosis is not associated with increased all-cause mortality. The occurrence of clinical decompensation may be less in patients with compensated cirrhosis who have been on statins. Based on these findings, statins can be used in patients with cirrhosis. Prospective studies are still needed, however, to validate the role of statins in the management of cirrhosis.

Conflict of interest None.

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