Evaluation of Carotid Intima- Media Thickness, Left Ventricular Mass and Left Atrium Diameter in Chronic Liver Diseases

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Abstract: Background: Cardiovascular disease is a common co-morbid disease process in individuals with chronic liver disease. Chronic liver disease is associated with abnormalities in cardiac geometry and function. The relationship between chronic liver disease and coronary atherosclerotic burden remains largely unknown. **Aim**: We aimed to evaluate the risk of atherosclerosis by measuring carotid intima-media thickness (CIMT) and to assess cardiac abnormalities in patients with chronic liver diseases (post hepatitis virus C infection liver cirrhosis and non alcoholic fatty liver disease NAFLD). **Methods:** Eighty patients with post hepatitis C liver cirrhosis (group 1), 20 patients with NAFLD (group 2) and 20 age and sex matched normal volunteers (controls) underwent echo-Doppler study for evaluation of left ventricular (LV) hypertrophy and mass, left atrium and left ventricular dimensions and EF%. Ultrasonographic measurement of CIMT, abdominal ultrasound and laboratory evaluation were done to all subjects. **Results:** There was a statistically significant increase in interventricular septum thickness (IVST), posterior wall thickness (PWT) and left ventricular mass (LVM) in both groups compared to the controls (P<0.01). IVST (1.01±0.17 in group1, 1.02±0.16 in group2 and 0.9±0.12 cm in the control group). PWT (1.03±0.12 in group 1, 1.03±0.15 in group 2 and 0.91±0.12 cm in the control group). LVM (186.89±52.18 in group 1, 195.57±65.46 in group 2 and 149.6±37.65 gm in the control group).There was also significant increase in left atrium diameter in group 1 compared to the controls (P <0.05) and significant increase in left ventricular end systolic diameter (ESD) in group 2 compared to the controls (P <0.05). Left atrium diameter (38.14±5.09 in group 1, 38.05±4.68 in group 2 and 35.8±3.79 mm in the control group) and ESD (3.10±0.58 in group 1, 3.36±0.75 in group 2, 2.89±0.43 cm in control group). CIMT was significantly increased in both groups compared to the control group (P <0.01) and in group 2 compared to group 1 (P <0.01). CIMT (1.03±0.11 in group 1, 1.17±0.1 in group 2 and 0.72±0.14 mm in the control group). **Conclusion:** Liver cirrhosis and NAFLD are associated with left ventricular hypertrophy (LVH), increased LVM and increased CIMT independently of classical cardiovascular risk factors. Also, patients with liver cirrhosis have increased left atrium size. Patients with NAFLD have increased left ventricular ESD diameter which may be a predictor of subclinical left ventricular dysfunction. Patients with liver cirrhosis or NAFLD having increased CIMT, which is indicator of atherosclerosis, should be evaluated for cardiovascular disease (CVD) risk and could be candidates not only for aggressive treatment of the liver disease, but also for aggressive treatment of underlying CVD risk factors; this would help to modify and potentially decrease the global CVD risk of these patients.

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1. Introduction

Liver cirrhosis is one of the mysteries especially in developing countries where it affects a sizable portion of people mostly due to high prevalence of hepatitis C virus (HCV) infection. It is associated with a wide range of cardiovascular abnormalities including hyperdynamic circulation, cirrhotic cardiomyopathy, and pulmonary vascular abnormalities. The pathogenic mechanisms of these cardiovascular changes are multifactorial and include neurohumoral and vascular dysregulations [(1)]. *Matsumori et al.,* detected hepatitis C virus in the hearts of patients with myocarditis or dilated cardiomyopathy [(2)].

There is considerable evidence that HCV infection and the atherosclerotic process are related, but the role of infection in the pathogenesis of atherosclerosis remains controversial [(3)]. Some researches demonstrated that HCV seropositivity lead to carotid artery plaque and carotid intima-media thickening independent of other risk factors and these studies found that HCV seropositivity is an independent predictor for coronary artery disease (CAD) [(4,5)].

Carey et al., concluded that cirrhotic individuals particularly those with nonalcoholic liver disease (HCV and cholestatic liver disease), have a higher rate of CAD than that had been expected based upon the earlier autopsy and clinical observation made almost exclusively in the alcoholic population [(6)]. However, *Marchesini et al.,* reported that the incidence of atherosclerosis and subsequent coronary and cerebro-vascular diseases, which are major causes of morbidity

and mortality, is low in cirrhotics even in comparison with general population [7]. *Kalaitzakis et al.,* concluded that Liver cirrhosis, per se, does not seem to confer a protective effect against CAD [8].

Ultrasonographic measurement of carotid intima-media thickness (CIMT) is a noninvasive method for demonstrating subclinical atherosclerosis. Increased CIMT is associated with the presence and severity of coronary atherosclerosis and cardiovascular disease [9,10].

In most studies of patients with cirrhosis, the heart mass has been found to be within the normal range [11]. However, some have reported an increased left ventricular mass (LVM) [12]. Also, *Bernal et al.* reported increased LV mass index in the cirrhotic patients with higher values of left atrium diameter, interventricular septum thickness, and posterior wall thickness compared to controls [13]. In an experimental study of portal hypertensive rats, left eccentric hypertrophy was found to correlate directly with the degree of hyperdynamic circulation [14]. *De Marco et al.*, found that Patients with severe liver disease have LVM values exceeding the compensatory needs to sustain hemodynamic overload [15].

In echocardiographic studies, *Kelbæk et al.,* [16] and *Rector et al.,* [17] found the size of the left ventricle to be normal and that of the left atrium enlarged in liver cirrhosis [18].

These structural and functional changes in liver cirrhosis may be due to a hyperdynamic circulation status and a decreased diastolic compliance of the left ventricle, which may result in elevated left ventricular end diastolic diameter (LVEDD) and ventricular pressure, compensatory left ventricular enlargement and increased pressure in the left atrium [19].

Left atrium enlargement which reflects one aspect of increased cardiac output in patients with liver cirrhosis is an indirect marker of intra pulmonary right to left shunt [20].

Nonalcoholic fatty liver disease (NAFLD), a highly prevalent condition [21] is a feature of metabolic syndrome and characterized by excessive accumulation of fat in the liver cells [22, 23]. Patients with NAFLD have a higher mortality rate than the general population [24].

NAFLD is strongly associated with cardiovascular risk factors, such as obesity, dyslipidemia, type 2 diabetes mellitus, and insulin resistance [25]. From previous published data, it is obvious that coronary heart disease mortality rates in patients with NAFLD are close to those associated with cirrhosis [26].

In recent years, case-control studies have shown a relationship between NAFLD and the presence of early manifestations of atherosclerosis indicated by CIMT measurement [27]. Other studies have shown only a relationship between NAFLD and advanced atherosclerosis, such as carotid plaque [28, 29]. *Afshin et al.,* concluded that NAFLD may be an independent risk factor for developing atherosclerosis. Therefore, NAFLD without other cardiovascular risk factors can be associated with increased CIMT and increased risk of cardiovascular events [30].

Goland et al., found increased thickness of the interventricular septum, posterior wall and larger LV mass and LV mass/ height in NAFLD group compared to normal controls (31). Fallo et al., found that Patients with NAFLD had similar prevalence of left ventricular hypertrophy compared to patients without NAFLD (32).

In the present study, we aimed to evaluate the risk of atherosclerosis in two groups of patients with chronic liver diseases (post hepatitis virus C infection liver cirrhosis and NAFLD) and comparing them to normal controls. We used the ultrasonographically measured carotid intima-media thickness as a noninvasive method for demonstrating subclinical atherosclerosis.

We also evaluated left ventricular hypertrophy, left ventricular mass, left atrium and ventricular dimensions in the same groups of patients and comparing them to normal controls, to assess cardiac abnormalities in these groups.

2. Subjects and Methods:

The present study was conducted on 120 subjects from inpatients and outpatients services of Theodor Bilharz Research Institute Hospital, selected to represent 3 groups:

Group (1) included 80 patients with liver cirrhosis (all of them post hepatitis C virus infection)

Group (2) included 20 patients with NAFLD, matched for age and sex and

Group (3) included 20 apparently healthy volunteers as control group matched for age and sex and with normal liver ultrasonography , normal liver function tests and negative hepatitis markers.

Subjects with heart disease, diabetes mellitus, hypertension (blood pressure >130/85 mmHg), hyperlipidemia, acute or chronic kidney disease, any malignancy, alcohol consumption, pregnancy, liver masses, anemia with hemoglobin less 10 gm% or taking any medication with adverse effects on liver or cardiovascular system were excluded.

All patients were provided by informed consent, and the ethical committee of hospital approved this study.

All patients and normal volunteers were subjected to:

Thorough history taking and physical examination.

Blood sampling for blood picture including hemoglobin percent, liver function tests, renal function tests, serum electrolytes, cholesterol, triglyceride, HBs antigen and HCV antibody.

Twelve lead surface resting ECG.

Abdominal ultrasound scanning was performed in all participants by one trained radiologist who was blinded to all clinical and laboratory data, using a Toshiba Memo 30 scanner equipped with a 3.5 mHz linear transducer.

Liver cirrhosis was diagnosed based on the results of laboratory tests (low serum concentrations of albumin, high INR and low platelet count) and abdominal ultrasonographic findings (irregularity of the liver surface).

Hepatic steatosis was diagnosed by a characteristic liver echo pattern (diffuse hyperechogenicity of liver compared with right kidney) and negative hepatitis markers.

Echo-Doppler study:

All echocardiographic measurements were performed according to the recommendations of the American Society of Echocardiography ([33]) by a member of the study team in a blinded manner.

M-mode, Two dimensional echocardiography and Doppler ultrasound studies (pulsed, continuous wave and color flow imaging) were made using a high resolution (ALT 5000 HDI) Toshiba Memo 30 scanner equipped with a 2.5 mHz transducer.

With M-mode, measurements of interventricular septum (IVS) and left ventricle posterior wall (PWT) thicknesses separately at diastole and systole were done and left ventricle end-diastolic (LVED) and end systolic (LVES) diameters were determined.

Left ventricular mass was calculated according to Devereux and associates convention: LVM gm = 1.04 x $\{(LVED + IVST + PWT)^3 - LVED^3\} \times 0.8 + 0.6$ (34) where LVED was the left ventricular end diastolic diameter, IVST is the interventricular septum thickness, and PWT was the left ventricular posterior wall thickness.

The size of the left atrium is determined from the parasternal long axis view at end systole.

Left ventricular ejection fraction EF% was measured from M-mode dimentions using Teichholz formula [(35)].

With Doppler echocardiography accompanied by electrocardiogram, Flow characteristics and rates of mitral, tricuspid, aortic and pulmonary valves were evaluated .

High resolution B mode ultrasonography of both the common and internal carotid arteries was performed using an ultrasound machine (Toshiba Memo 30 scanner) equipped with a 7.5 mHz high resolution transducer. Patients were examined in the supine position with the head tilted backwards. After the carotid arteries were located by transverse scans, the probe was rotated to 90° to obtain and record a longitudinal image of the common carotid arteries.

The maximum CIMT was measured at the posterior wall of the common carotid artery, 2 cm before the bifurcation, as the distance between the first and second echogenic lines of the anterior and posterior arterial walls. The image was focused on the posterior wall of the common carotid artery, and gain settings were used to optimize image quality. Measurement was performed vertical to the arterial wall for accurate measurement of CIMT. Three CIMT measurements were taken at and the average measurement was used. All of the CIMT measurement sonograms were obtained by a member of the study team in a blinded manner to the results of abdominal sonography and the clinical and laboratory data for cases and control subjects.

Statistical Analysis:

Statistical analysis was performed using SPSS version 16. Data were expressed as the mean ± standard deviation (SD) for numerical variables. $P \leq 0.05$ was considered to be statistically significant.

3. Results:

The demographic data of group 1 and group 2 patients and controls revealed mean ages 43.5±9.95years, 41.55±10.53years and 43.9±8.8years respectively. In group 1 patients, 60 were males (75%) and 20 females (25%), in group 2 patients, 13 were males (65%) and 7 were females (35%) and in control group 14 were males (70%) and 6 were females (30%) Table (1).

Thirty two patients (40%) in group 1 had early cirrhosis and 48 (60%) has coarse shrunken pattern. The etiology of liver disease were HCV in all cases. The portal vein was dilated in 70 patients (87.5%), the spleen was enlarged in 57 patients (71.25%). Ascites was found in 61 patients (76.25 %); 21 (2.25%) with mild ascites ,33(41.25%) with moderate ascites and 7 patients (8.75) with marked ascites. The spleen was normal in both group 2 and the control group with no ascites. The liver span was decreased in group 1 compared to both groups, However the portal vein was increased in group 1 compared to both groups (P <0.01) Table (2).

The echocardiographic data showed a statistically significant increase in IVST, PWT and LVM in group 1 and group 2 compared to the controls (P<0.01, P<0.05 respectively) and significant increase in left atrium diameter in group 1 compared to the controls (P <0.05).There was also significant increase in left ventricular end systolic diameter (ESD) in group 2 compared to the control group (P <0.05).

Also, there was significant increase in CIMT in both groups compared to the controls (P<0.01) and significant increase in CIMT in group 2 compared to group 1 (P <0.01) Table (3).

Plasma levels of Na was significantly decreased and that of K was significantly increased in group 1 compared to group 2 and the controls (P <0.01), together with a statistically significant increase in ALT, AST, total bilirubin and direct bilirubin in both groups

compared to the controls and significant increase in AST, total bilirubin, direct bilirubin and INR in group 1 compared to group 2. However there were a statistically significant decrease in albumin, hemoglobin and platelets count in both groups compared to the controls and also a statistically significant decrease in group 1 compared to group 2 (Table4).

Table (1) Demographic data of the studied groups.

	Group 1(n=80)	Group 2 (n=20)	Group3(n=20)
Age	43.5±9.95	41.55±10.53	43.9±8.8
Gender Male Female	 60(75%) 20(25%)	 13(65%) 7(35%)	 14(70%) 6(30%)

Table (2) Comparison between liver span and portal vein diameter of the studied groups.

	Group 1(n=80)	Group 2 (n=20)	Group3(n=20)
Liver cm	12.5±1.8**##	16.25±0.9**	14.6±0.5
Portal vein mm	14.5±1.6**##	7.55±0.6**	6.44±0.5

* Group 1 or Group 2 vs Control # Group 1 vs group 2

P < 0.05= significant (*, #) ***P*** < 0.01= highly significant (**, # #)

Table (3)Echocardiographic &Duplex finding of the studied groups.

	Group 1(n=80)	Group 2 (n=20)	Group3(n=20)
IVST cm	1.01±0.17**	1.02±0.16**	0.9±0.12
PWT cm	1.03±0.12**	1.03±0.15**	0.91±0.12
LVM gm	186.89±52.18**	195.57±65.46**	149.6±37.65
EDD cm	4.95±0.65	5.06±0.6	4.77±0.47
ESD cm	3.10±0.58	3.36±0.75*	2.89±0.43
EF%	66.55±7.87	62.9±10.89	68.0±6.53
LA mm	38.14±5.09*	38.05±4.68	35.8±3.79
CIMT cm	1.03±0.11**# #	1.17±0.1**	0.72±0.14

* Group 1 or Group 2 vs Control # Group 1 vs group 2

P < 0.05= significant (*, #) *P* < 0.01= highly significant (** , # #)

IVST: interventricular septum thickness, PWT: posterior wall thickness, LVM: left ventricular mass, EDD: end diastolic dimension, ESD: end systolic dimension, EF: ejection fraction, LA: left atrium dimension, CIMT: carotid intima-media thickness.

Table (4) Laboratory data of the studied groups.

	Group 1(n=80)	Group 2 (n=20)	Group3(n=20)
Na mEq/L	131.96±4.74**# #	139.95±5.44	141.55±2.04
K mEq/L	4.78±0.56**# #	4.14±0.22	4.05±0.24
ALT U/L	31.78±33.85**	41.65±20.29**	13.85±2.06
AST U/L	61.96±77.76**#	43.8±16.89**	13.65±4.04
T bil. mg/dL	3.12±3.79**# #	1.46±1.56*	0.51±0.11
D bil. mg/dL	1.5±2.33**# #	0.56±0.92 *	0.12±0.02
Albumin g/dL	2.47±0.69**# #	3.71±0.43**	4.21±0.1
Hb g/dL	10.58±1.24**# #	12.39±1.14 *	13.09±0.62
Platelets count 10^9/L	62.6±17.3**# #	161.2±32.7**	224.7±58.7
INR %	1.69±0.5**# #	1.03±0.03	1.02±0.03
LDL mg/dL	96.4±58.5	117.6±29.5	109.6±30.4
HDL mg/dL	40.0±14.3	46.2±21.6	48.8±14.8
Total Choles. mg/dL	161.2±71.3	176.5±37.9	167.7±36.2
TG mg/dL	90.6±50.5	131.9±57.7	122.3±56.5

* Group 1 or Group 2 vs Control # Group 1 vs group 2

P < 0.05= significant (*, #) *P* < 0.01= highly significant (**, # #)

Na: serum sodium, K: serum potassium, ALT: alanine aminotransferase, AST : aspartate aminotransferase, Hb : hemoglobin, INR : international normalized ratio

T bil. : total bilirubin, D bil.: Direct bilirubin, LDL: low density lipoprotein, HDL: high density lipoprotein, Total Choles.: Total cholesterol, TG: triglycerides.

4. Discussion:

Chronic liver disease comprises a number of progressive disorders which culminate in liver cirrhosis. Liver cirrhosis is associated with a wide range of cardiovascular abnormalities including hyperdynamic circulation, cirrhotic cardiomyopathy, and pulmonary vascular abnormalities. The pathogenic mechanisms of these cardiovascular changes are multifactorial and include neurohumoral and vascular dysregulations [1]. Also,There is considerable evidence that HCV infection and the atherosclerotic process are related [2].

Plotkin et al. reported a higher rate of cardiac morbidity and mortality in cirrhotic patients with angiographic evidence of CAD than in those without such findings [36].

Nonalcoholic fatty liver disease which is excessive accumulation of fat in hepatocytes is associated with a range of pathologic lesions, ranging from simple steatosis to nonalcoholic steatohepatitis and cirrhosis. NAFLD is now considered to be a hepatic manifestation of the metabolic syndrome and may have a potential role in the development and progression of atherosclerosis [37]. Some investigators suggest that the outcome in patients with NAFLD is more dependent on cardiovascular events than on the progression of liver disease [38].

In this study, we evaluated atherosclerosis by measuring CIMT as an indicator of atherosclerosis and cardiovascular risk in two groups of patients having chronic liver disease (post hepatitis C liver cirrhosis and NAFLD). Our study revealed significant increase in CIMT in both groups compared to controls (P<0.01). There was also significant increase in CIMT in group 2 compared to group 1. The mean value of CIMT was 1.03±0.11 in group 1, 1.17±0.1 in group 2 and 0.72±0.14 in the controls.

Our results showed that fatty liver disease is a highly significant marker of increased CIMT. As regards a possible link between fatty liver disease and increased CIMT and cardiovascular risk, it has been suggested that fatty liver disease might contribute to accelerated atherosclerosis through increased oxidative stress, chronic subclinical inflammation, and decreased liver production of cytokines with antiatherogenic properties [39].

In consistent with our study *Ramilli et al.,* and *Afshin et al.,* studies showed that pure NAFLD without metabolic syndrome is strongly associated with increased CIMT [40,30].

In our study the increased CIMT in patients with post hepatitis C liver cirrhosis compared to the controls is in agreement of the studies of *Ishizaka et al.,* and *Vasalle et al.,* who demonstrated that HCV seropositivity lead to carotid artery plaque and carotid intima- media thickening independent of other risk factors and these studies found that HCV seropositivity is an independent predictor for coronary artery disease [4,5]. Also, *Kalaitzakis et al*., concluded that Liver cirrhosis, per se, does not seem to confer a protective effect against CAD [8].

Interestingly, O'Leary *et al.,* have previously reported that a carotid IMT value ≤0.86 mm carries a low risk of developing CVD, whereas an IMT value ≥1.10 carries a high risk of developing CVD [41]. Thus, our findings might have important clinical and public health implications. Our data further emphasize the importance of evaluating the CVD risk in patients diagnosed with NAFLD or liver cirrhosis. Patients with liver cirrhosis or NAFLD having increased carotid IMT could be candidates not only for aggressive treatment of the liver disease, but also for aggressive treatment of underlying CVD risk factors; this would help to modify and potentially decrease the global CVD risk of these patients.

Regarding the echocardiographic data , Our study revealed statistically significant increase in IVST,PWT and LVM in group 1 (post hepatitis C liver cirrhosis) compared to the control group (P<0.01). These findings are supported by the results of *Wong et al.* and *De Marco et al.* [12, 15]. Also, *Bernal et al*., demonstrated a high prevalence of LV hypertrophy in cirrhotic patients as compared to controls [13]. LV hypertrophy has been described in autopsies and living cirrhotic patients of any etiology, with or without ascites [42- 44]. It is thought to be secondary to volume expansion and activation of various neurohormonal systems (renin-angiotensin system, endothelin-1, sympathetic stimulation) commonly observed in these patients [45]. The prognostic value of echocardiographically detected LV hypertrophy has been unequivocally demonstrated by the Framingham Heart Study [46].

Also, our study revealed a statistically significant increase in IVST, PWT and LVM in group 2 (NAFLD) compared to the control group. This findings is similar to that of *Goland et al*., who found increased thickness of the interventricular septum, posterior wall and larger LVM and LV mass/height in NAFLD group compared to normal controls and they suggest that factors associated with insulin resistance perse have a pivotal role in the development of cardiac abnormalities in patients with NAFLD and the clinical implications of early changes in LV structure and function may have relevance for prevention and treatment of overt cardiac abnormalities and apparent heart failure in this population [31].

Mantovani et al., on their study on patients having NAFLD reported that NAFLD is associated with LVH independently of classical cardiovascular risk factors and other potential confounders [47]. *Fotbolcu et al.,* found mild abnormalities in the LV structure, including increased LVM, LVM index and LV wall thickness in normotensive, non-diabetic patients with NAFLD and they attributed this to higher

levels of BP recordings, higher BMIs (but they did not have morbid obesity), and higher levels of insulin resistance than the controls [48].

In the present study, left atrium diameter was significantly higher in group 1 compared to the controls ($P<0.05$). Our results agreed with that of *Kelbaek et al.*, [16], *Soyoral et al.,* [49] and *Bernal et al.*, [13] as they demonstrated increased left atrium diameter in patients with liver cirrhosis compared to the controls.

Zamirian et al., concluded that in cirrhotic patients, left atrium enlargement, which reflects one aspect of increased cardiac output, is an indirect marker of intrapulmonary shunt (IPS) and greater left atrium dimension is associated with the presence of intrapulmonary right-to-left shunt [20].

In our study, there was insignificant increase in the mean value of left ventricular end diastolic dimension (EDD) in patients with post hepatitis C liver cirrhosis compared to the controls and there was no significant difference in ejection fraction between the two groups. In accordance to our study, *Kelbæk et al.,* reported that significant left ventricular dilatation does not occur in cirrhotics presumably as a consequence of the reduced systemic vascular resistance in these patients but Left atrium dilatation has been reported [16].

In our study there was no significant difference in the mean values of left atrium diameter between patients with NAFLD and the controls, although left atrium diameter tends to be more in NAFLD group. Also, left ventricular EDD tends to more and Left ventricular ejection fraction (EF%) tend to be less in NAFLD patients than the control group but the difference is statistically insignificant. In consistent with our study, *Fotbolcu et al.,* found no significant difference in left ventricular EDD, left atrium size and ejection fraction between NAFLD group and the controls [48]. Also, *Bonapace et al.,* on their study on diabetic patients with NAFLD found the same results [50].

In our study, There was significant increase of end systolic diameter (ESD) in NAFLD group compared to the controls ($p<0.05$). According to the study of *Ramachandran et al.,* an increase in echocardiographic left ventricular internal dimensions (EDD or ESD) is a risk factor for the development of congestive heart failure and the knowledge of left ventricular dimensions improves predictions of the risk of congestive heart failure made on the basis of traditional risk factors, perhaps by aiding in the identification of people with subclinical left ventricular dysfunction [51]. Also, *Sandvik et al.* and *Lauer et al.* concluded that cardiac enlargement is associated with increased morbidity and mortality among healthy middle-aged and elderly people [52, 53].

So, in our study, the increased ESD in patients having NAFLD may be a predictor of subclinical left ventricular dysfunction and a risk factor for the development of congestive heart failure and increased morbidity and mortality. This is in consistent with the study of *Fotbolcu et al.,* who found that Patients with NAFLD have impaired LV systolic function even in absence of morbid obesity, hypertension, or diabetes [48].

Conclusion:

Liver cirrhosis and NAFLD are associated with LVH, increased LV mass and increased CIMT independently of classical cardiovascular risk factors. Also, patients with liver cirrhosis have increased left atrium size. Patients with NAFLD have increased left ventricular ESD which may be a predictor of subclinical left ventricular dysfunction. The clinical implications of early changes in LV structure and function may have relevance for prevention and treatment of overt cardiac abnormalities and apparent heart failure in this population.

Patients with liver cirrhosis or NAFLD having increased CIMT, which is an indicator of atherosclerosis, should be evaluated for CVD risk and could be candidates not only for aggressive treatment of the liver disease, but also for aggressive treatment of underlying CVD risk factors; this would help to modify and potentially decrease the global CVD risk of these patients.

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