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ORIGINAL ARTICLE

Diastolic myocardial dysfunction does not affect survival in patients with cirrhosis

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Summary

Left ventricular diastolic dysfunction (DDF) has been considered as a component of cirrhotic cardiomyopathy. The clinical significance of DDF in cirrhotics has not been clarified. We prospectively evaluated the echocardiographic-Doppler, tissue-Doppler (TDI) findings of left ventricular function and survival in cirrhotics with or without DDF. Seventy-six cirrhotics without endogenous heart disease were included. DDF was diagnosed by mitral inflow Doppler parameters and diastolic myocardial velocities. Assessments of demographics, liver dysfunction, laboratory, echocardiographic systolic/diastolic indices, TDI of mitral annular motion and M-mode echocardiography were recorded. Patients were followed-up for a median of 25 months (15–40). DDF was diagnosed in 51 (67%) patients. Patients with compared with those without DDF had significantly older age and higher pulse rate as well as more frequently severe ascites, greater aortic root diameter and interventricular septal thickness. There was no difference in systolic myocardial function between two groups. Patients with DDF had a trend for worse survival (long rank, $P = 0.094$). A multivariate analysis showed that age, MELD and sodium but no DDF were predictive of death. DDF is prevalent in advanced cirrhosis and is associated with severe ascites. Systolic myocardial function and mortality do not seem to be strongly affected by the presence of DDF.

Introduction

Diastolic left ventricular (LV) myocardial dysfunction is present in a large number of patients with cirrhosis especially in those with ascites [1]. It is attributed to abnormal relaxation and/or increased stiffness of the left ventricle leading to impaired filling during diastole [2]. Diastolic dysfunction seems to be associated with fluid overload common in decompensated cirrhosis as it is ameliorating after paracentesis of ascites [3].

The condition is subclinical and becomes symptomatic after transjugular intrahepatic portosystemic shunt (TIPS) [4]. TIPS may rapidly increase cardiac preload and cause heart failure in a less compliant heart. The clinical significance of diastolic dysfunction in cirrhosis remains to be further investigated since symptoms of heart failure are usually absent before but may be manifested soon after liver transplantation [5,6]. In patients with diastolic dysfunction, the ratio of early to late diastolic filling is decreased, while the deceleration and isovolumetric relaxation times are prolonged on conventional Doppler echocardiogram [2,3].

The aim of this prospective study was to investigate whether diastolic dysfunction is related to (i) severity and aetiology of liver disease and (ii) survival and specific causes of death in patients with cirrhosis.

Material and methods

Study population

All patients with cirrhosis admitted to the 2nd Department of Internal Medicine of our hospital from May 2008 to May 2010 were prospectively included in the

study, unless they had an exclusion criterion. Specifically, patients with coronary disease, systolic dysfunction (ejection fraction <50%), heart valve stenosis or regurgitation, atrial fibrillation or other cardiac arrhythmias, diabetes mellitus, arterial hypertension, body mass index (BMI) >30 kg/m^2 (on dry weight), active haemorrhage or infection were excluded. No patient had been treated with TIPS or any other posto-systemic shunt.

The diagnosis of cirrhosis was based on liver histological findings and/or imaging, endoscopic or clinical findings. Cirrhosis was considered to be decompensated in patients with history of ascites, variceal bleeding, hepatic encephalopathy and jaundice of nonobstructive cause (bilirubin >3 mg/dl for noncholestatic and >10 mg/dl for cholestatic causes of cirrhosis). The study protocol was approved by the Hospital Ethical Committee. All patients provided a written informed consent before their inclusion in the study.

Clinical data

Demographic and clinical data (such as age, gender, BMI, cause of liver cirrhosis, heart rate, systolic and diastolic blood pressure) as well as laboratory parameters (including biochemical and clotting profile) were prospectively recorded on admission. Based on these data, liver-specific prognostic scores (Child-Pugh class and score, MELD) were evaluated.

Echocardiographic examinations

All echocardiographic examinations were performed using a Hewlett Packard 5500 Sonos Ultrasound System with a multifrequency transducer (2.5–4 MHz), equipped with TDI technology. Echocardiograms were recorded with patients in left lateral decubitus position. The evaluation was made through parasternal long axis, parasternal short axis and apical four-chamber views, according to the recommendations of the American Society of Echocardiography Committee [7]. Thirty-three echocardiographic variables were evaluated.

Left ventricular diameter at end-systole and end-diastole (LVEDD) and left atrial and aortic root diameters were measured from M-mode echocardiogram in the parasternal long axis. LV posterior wall thickness and interventricular septal thickness were measured by 2D method in the parasternal long axis. LV outflow tract was measured by 2D method in the parasternal long and short axis respectively. Left atrial volume (LAV) was calculated using the HP Sonos Ultrasound system's in-build software, using the method of discs or Simpson's rule at end-systole (maximum) and end-diastole (minimum).

Conventional Doppler techniques were used for flow-related calculations and estimations of left and right ventricular filling patterns. Implementing standard pulsed-wave Doppler, mitral inflow velocity was recorded, at the tip of the mitral valve leaflet (E- and A-waves, cm/s). Mitral E-wave deceleration time (defined as the time between the peak E velocity and the point where the slope encounters the baseline) was measured. Isovolumic relaxation time (IVRT) (defined as the time distance from aortic valve closure to mitral valve opening) was measured as well. Systolic pulmonary artery pressures were calculated, by addition of approximately 5–15 mmHg (value expressing approximately the right atrial pressure, based on inferior vena cava diameter and respiratory variations) to the tricuspid valve systolic pressure gradient, as it is extracted from the modified Bernoulli equation $\Delta P = 4 \times$ Tircuspid regurgitation velocity $(TRV)^2$.

The TDI techniques (which use a modified wall filter and reduced gain to display myocardial velocity while avoiding blood flow detection) were deployed as well. From the apical four-chamber view, a 10-mm sample volume was placed at the lateral mitral annulus, and spectral TDI was recorded, with the mitral annulus motion parallel to the TDI cursor. The pulsed TDI measurements included the myocardial systolic velocity and the diastolic velocity (expressed in cm/s), acquired from the interventricular septum and left lateral wall at valve annulus level.

Flow propagation of mitral valve (defined as the propagation velocity of the wavefront of the E-wave as it enters the left ventricle, measured in cm/s) was calculated from colour M-mode imaging.

Left ventricular output was calculated using the equations $LV_{output} = \pi \times (LVOT/2)^2 \times VTI_{LVOT}$ ($\pi \sim 3.14$, LVOT: left ventricular outflow track, VTI_{LVOT}: velocity-time integral at LVOT). LV Ejection Fraction (LVEF) was calculated with the single plane Simpson's method in the apical 4-chamber view, using the equation [LVEDV-LVESV/LVEDV] $\times$ 100 (LVEDV: LV end-diastolic volume, LVESV: LV end-systolic volume). Left atrial ejection fraction (LAEF) was similarly calculated using the equation $[LAV_{max} - LAV_{min})/LAV_{max}] \times 100$ (LAV_{max}: Maximum left atrial volume – at T, LAV_{min}: Minimum left atrial volume – at R).

Diastolic function was classified according to severity into four categories on the basis of mitral inflow Doppler parameters and diastolic myocardial velocities (E' and A') [8]. (i) Normal filling pattern: peak early mitral inflow velocity (E-wave)/peak atrial filling velocity (A-wave) ratio between 1 and 2 and deceleration time (DT) >140 and ≤240 ms, (ii) Abnormal filling pattern of impaired relaxation (mild diastolic dysfunction): E-wave/A-wave ratio <1 and E'mv/A'mv <1 and DT >240 ms, (iii) Pseudonormal filling pattern (moderate diastolic dysfunction): E-wave/A-wave ratio between 1 and 2 and E'mv/A'mv <1 and DT >140 ms and <240 ms (iv) Restrictive

filling pattern (severe diastolic dysfunction): E-wave/A-wave ratio >1.5 and DT <140 ms.

Statistical methods

All data were analysed using the statistical package SPSS (version 17.0; SPSS Inc., Chicago, IL, USA). Variables with normal distribution were expressed as mean ± SD and variables with abnormal distribution as median values (range). Corrected chi-squared test, *t*-test or Mann–Whitney test was used for univariate analyses, when appropriate. Survival rates were evaluated by Kaplan–Meier curves and were compared between groups by the long-rank test. The Cox proportional-hazards model was used to identify factors associated with an increased risk of death. Factors associated with mortality with a *P*-value of <0.10 in the univariate analysis were entered in the multivariate model and nonsignificant factors were removed by a backward selection process.

Results

Patient characteristics

In total, 76 consecutive patients with cirrhosis were included. There were 57 (75%) men and 19 (25%) women, whereas their mean age was 60.5 ± 13.8 years. The cause of cirrhosis was chronic hepatitis B or C in 41 (54%), alcohol abuse in 20 (26.3%) and other in 15 (19.7%) of patients. Cirrhosis was decompensated in 65 (85.5%) of the patients, while the mean Child-Pugh, and MELD scores on admission were 9.2 ± 2.7 and 17 ± 7 respectively. Diastolic dysfunction was diagnosed in 51 (67.1%) of the 76 patients. The diastolic filling pattern was as follows: 37 had mild, 11 moderate and 3 severe DDF.

Follow-up

The median follow-up was 25 months (range: 15–40). Of the 76 patients, 75 were followed until the end of the study, 44 (57.9%) died and one (1.3%) was lost to follow-up. The leading cause of death was hepatic failure in 16 (36.5%), followed by hepatocellular carcinoma, sepsis, hepatorenal syndrome and gastrointestinal bleeding in 14 (31.4%), 9 (20.5%), 2 (4.5%) and 3 (6.8%), respectively. The leading cause of death did not differ significantly between patients with or without DDF.

Patients with versus without diastolic dysfunction

Patients with compared with those without diastolic dysfunction were older (62.4 vs. 53.4, $P = 0.04$), had higher

Table 1. Main and laboratory characteristics of cirrhotic patients with and without diastolic dysfunction (DDF).

Variable	With DDF (*N* = 51)	Without DDF (*N* = 25)	*P*
Gender, males (%)	39 (76.5)	18 (72)	0.6
Age (years)	62.4 ± 12.7	53.4 ± 16.5	0.04
Aetiology of liver disease, *n* (%)			
Alcoholic	14 (27.4)	6 (24)	0.95
Viral	27 (52.9)	14 (56)	
Others	10 (19.6)	5 (20)	
Child class, *n* (%)			
A	6 (11.7)	5 (20)	0.61
B	19 (31.4)	9 (36)	
C	26 (51)	11 (44)	
Child score	9.2 ± 2.6	9 ± 2.8	0.77
MELD score	15.5 ± 6.5)	14.3 ± 5.7)	0.5
Severe ascites, n (%)	14 (27.5)	1 (4)	0.016
Body mass index (kg/m^2)	24 ± 3.8	24.1 ± 3.6	0.28
Body surface area (m^2)	1.9 ± 0.2	1.8 ± 0.3	0.35
Systolic artery pressure (mmHg)	110 (100–140)	110 (100–130)	0.86
Diastolic artery pressure (mmHg)	65 (60–80)	80 (60–90)	0.19
Pulse rate/min	76.7 ± 9.5	72.5 ± 8.2	0.03
Haemoglobin	11.1 ± 1.8	11.2 ± 2.1	0.8
Prothrombin time (s)	15.4 (11.1–29)	16 (12.1–26.6)	0.7
Sodium (mEq/l)	134.7 ± 5.1	137.3 ± 4.1	0.15
Total bilirubin (mg/dl)	1.9 (0.4–38.7)	1.9 (0.5–8.4)	0.75
AST (IU/l)	75 (19–618)	77 (17–165)	0.81
ALT (IU/l)	36 (14–469)	61 (15–103)	0.84
Albumin (g/dl)	3.4 ± 0.5	3.3 ± 0.7	0.57
Creatinine (mg/dl)	0.9 (0.3–2.8)	0.9 (0.5–1.8)	0.66

MELD, Model for End-Stage Liver Disease.
Quantitative variables are expressed as mean ± SD or median (range) values.

Table 2. Conventional echocardiographic characteristics of cirrhotic patients with and without diastolic dysfunction (DDF).

Variable	With DDF (N = 51)	Without DDF (N = 25)	P
Ejection fraction (%)	60 (30–60)	60 (50–65)	0.86
Left ventricular end-diastolic diameter (mm)	48 ± 6.9	46.8 ± 5.7	0.8
Left ventricular end-systolic diameter (mm)	31.3 ± 8.5.	30.9 ± 6.8	0.82
Left ventricular outflow tract (mm)	20.8 ± 3.4	20.9 ± 2.6	0.99
Left atrial diameter (mm)	40.4 ± 7.6	39 ± 5.4	0.38
Left atrial volume (ml)	47 (20–137)	45 (36–90)	0.41
Aortic root diameter (mm)	34.1 ± 4.86	31.6 ± 4.5	0.03
Interventricular septal thickness (mm)	9.7 ± 1.3	8.7 ± 1.5	0.006
Left ventricular posterior wall thickness (mm)	9.3 ± 1.4	8.9 ± 1.3	0.11

Variables are expressed as mean ± SD or median (range) values.
Normal values: Ejection fraction >55%; Left ventricular end-diastolic diameter (mm) 39–53; Left atrial diameter (mm) 27–38; Left atrial volume (ml)22–52; Aortic root diameter (mm) 23–38; Interventricular septal thickness (mm) 6–9; Left ventricular posterior wall thickness (mm) 6–9 [30].

Table 3. Conventional Doppler and Tissue-Doppler (TD) measurements of cirrhotic patients with and without diastolic dysfunction (DF).

Variable	With DDF (n = 51)	Without DDF (n = 25)	P
Isovolumic relaxation time (ms)	102 ± 17.7	95 ± 28.1	0.19
TD S wave (systolic) at the left lateral wall / mitral annulus (Smv) (cm/s)	12 ± 3.6	12.9 ± 3.3	0.9
E/E'mv (mitral valve)	6.2 ± 1.8	6.1 ± 1.9	0.9
Mitral flow propagation (cm/s)	28.6 ± 13.1	31.1 ± 13.1	0.48
Left ventricular output (ml)	77.3 ± 33.7	81.9 ± 32.3	0.27
Left atrial ejection fraction (%)	63 ± 7	55 ± 12	0.29
Left ventricle ejection fraction (%)	66 ± 24	70 ± 19	0.12
Systolic pulmonary artery pressure (mmHg)	35 (20–54)	28 (12–40)	0.28

Quantitative variables are expressed as mean ± SD or median (range) values.

pulse rate (76.7 vs. 72.5 years, $P = 0.03$) and more frequently severe ascites (27.5% vs. 4%, $P = 0.016$) (Table 1). Other parameters of the severity of liver disease, such as Child-Pugh class and score, MELD score and prothrombin time, albumin or bilirubin were not statistically different between the two groups (Table 1). The diastolic dysfunction was not associated with cirrhosis aetiology and was not more prevalent in alcoholic cirrhosis.

In echocardiography, Doppler and tissue-Doppler echocardiography (Tables 2 and 3), patients with compared with those without diastolic dysfunction had significantly greater aortic root diameter (34.1 vs. 31.6 mm, $P = 0.03$), interventricular septal thickness (9.7 vs. 8.7 mm, $P = 0.006$), lower E-wave velocity of mitral valve during early diastole (72.3 vs. 88.2 cm/s, $P < 0.001$), lower E/A ratio (0.96 vs. 1.4, $P < 0.001$) and higher deceleration time (256 vs. 201 ms, $P < 0.001$). In tissue-Doppler imaging, patients with compared with those without diastolic dysfunction had lower E' wave (early diastolic period) at the left lateral wall / mitral annulus (12 vs. 14.9 cm/s, $P < 0.001$), higher A' wave (atrial systole) at the left lateral wall / mitral annulus (16.3 vs. 11.7 cm/s, $P < 0.001$) and lower E'mv/A'mv ratio (0.74 vs. 1.4, $P < 0.001$) (Table 4).

Kaplan–Meier analysis showed that patients with diastolic dysfunction had a nonsignificant trend for worse survival compared with those without diastolic dysfunction (Fig. 1). In particular, the survival rates for patients with and without diastolic dysfunction were 51% and 76% at 6 months, 45% and 60% at 12 months and 37% and 52% at 24 months respectively (long rank, $P = 0.094$).

In Cox univariate analysis, variables that had at least a trend ($P < 0.10$) for association with survival included age ($P = 0.078$), MELD score ($P < 0.001$), Child-Pugh score ($P = 0.013$), haemoglobin ($P = 0.038$), INR ($P = 0.006$), creatinine ($P = 0.038$), total bilirubin ($P = 0.033$), sodium ($P < 0.001$), diastolic dysfunction ($P = 0.094$), ejection fraction ($P = 0.029$) and LV posterior wall thickness ($P = 0.046$). In multivariate Cox regression analysis, age [Hazard ratio (HR): 1.029, 95% confidence interval (CI): 1.003–1.055; $P = 0.027$)], MELD score (HR: 1.074, 95% CI: 1.008–1.145; $P = 0.027$) and sodium (HR: 0.891, 95% CI: 0.834–0.953; $P = 0.001$) but not diastolic dysfunction were found to be independently associated with survival (Table 5).

Table 4. Echocardiographic characteristics included in the definition of DDF of cirrhotic patients with and without diastolic dysfunction (DF).

Variable	With DDF (n = 51)	Without DDF (n = 25)	P
Velocity during early diastole E-wave (Mitral valve) (cm/s)	72.3 ± 20	88.2 ± 17.8	<0.001
Velocity during atrial contraction A-wave (Mitral valve) (cm/s)	83.6 ± 26.6	64.6 ± 14.8	<0.001
E/A ratio (mitral valve)	0.96 ± 0.5	1.4 ± 0.4	<0.001
E deceleration time (ms)	256 ± 31.2	201 ± 31.2	<0.001
TD E-wave (early diastolic period) at the left lateral wall / mitral annulus (E'mv) (cm/s)	12 ± 3.4	14.9 ± 3	<0.001
TD A-wave (atrial systole) at the left lateral wall / mitral annulus (A'mv) (cm/s)	16.3 ± 3.8	11.7 ± 3.5	<0.001
TD E'mv/A'mv	0.74 ± 0.2	1.4 ± 0.5	<0.001

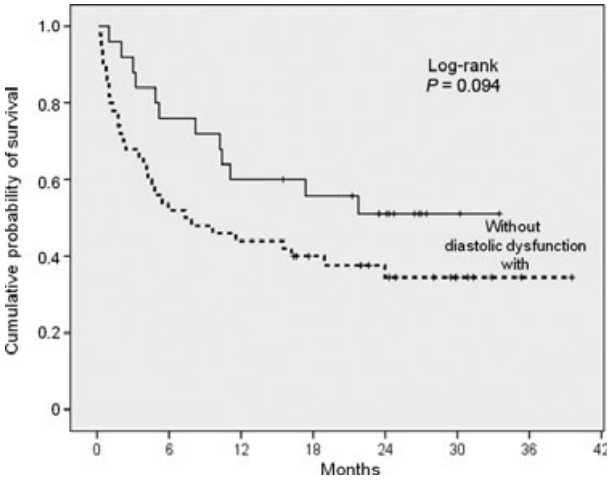

Figure 1 Probability of survival in patients with or without diastolic dysfunction.

Discussion

Cirrhosis induces a hyperdynamic circulation characterized by high cardiac output and increased cardiac work which may be latent clinically because of decreased afterload (reduced systemic vascular resistance). Cardiac failure may become clinically overt under strain or vasoconstrictors. This type of cardiac dysfunction is termed cirrhotic cardiomyopathy [9]. Krag *et al.* recently demonstrated a significant relation between the degree of systolic and renal dysfunction/survival in patients with decompensated cirrhosis [10]. The presence of cirrhotic cardiomyopathy may be revealed by different surgical interventions such as liver transplantation [5,6]. Recently, Saner *et al.* [11] reported two deaths from cardiogenic shock within 3 days after transplantation despite a normal preoperative cardiac work-up. They supported therefore that no preoperative cardiac assessment may predict a cardiac decompensation and a liver transplant procedure may unmask cirrhotic cardiomyopathy.

Diastolic dysfunction in cirrhosis has been recognized as a determinant of cirrhotic cardiomyopathy and it was proposed to precede systolic disturbances [12–14]. Patients with diastolic dysfunction had a lower probability of ascites disappearance and survival after TIPS insertion [4,15–18]. TIPS leads to an acute increase in the right cardiac preload, worsening of the hyperdynamic state with further increase in cardiac output, stroke volume and left and right diastolic volumes and a decrease in the systemic vascular resistance [19]. It may therefore unmask a silent cirrhotic cardiomyopathy. However, the clinical

Table 5. Factors associated with mortality.

Factor	Univariate analysis HR (95% CI)	P	Multivariate analysis HR (95% CI)	P
Age	1.021 (0.998–1.046)	0.078	1.029 (1.003–1.055)	0.027
MELD score	1.093 (1.040–1.149)	<0.001	1.074 (1.008–1.145)	0.027
Child-Pugh score	1.175 (1.034–1.336)	0.013	–	NS
INR	2.889 (1.351–6.177)	0.006	–	NS
Creatinine	1.633 (1.026–2.598)	0.038	–	NS
Total bilirubin	1.036 (1.003–1.070)	0.033	–	NS
Haemoglobin	0.857 (0.741–0.991)	0.038		NS
Sodium	0.873 (0.824–0.924)	0.046	0.891 (0.834–0.953)	0.001
Diastolic dysfunction	1.749 (0.902–3.399)	0.094	–	NS
Ejection fraction	0.949 (0.905–0.995)	0.029	–	NS
Left ventricular posterior wall thickness	1.249 (1.004–1.554)	0.046	–	NS

HR, hazard ratio; CI, confidence interval; NS, nonsignificant.

significance of diastolic dysfunction in common haemodynamic conditions without any surgical interventions including TIPS, as in the presented group of patients, needs further investigation.

Ventricular filling is biphasic. The integrity of diastolic relaxation is dependent on the ratio between early diastolic filling phase (E) and late filling phase during atrial contraction (A). Both phases are measured using pulsed-wave Doppler of the mitral valve inflow. Most ventricular filling occurs during the E-early phase and therefore the rate of filling is determined by the degree of diastolic relaxation. Consequently, a fall in E/A ratio reflects a decrease in diastolic compliance. Since conventional Doppler transmitral velocities are load-dependent [20], the findings of conventional doppler ultrasound may be confusing because of the increased plasma volumes in cirrhotic patients. To avoid this effect, tissue-Doppler measurements that are less load-dependent and more indicative of cardiac muscle structural changes seem to provide more information about myocardial function [8].

In the present study, tissue-Doppler imaging was added to conventional Doppler to evaluate the diastolic dysfunction. We have excluded patients with obesity, diabetes mellitus, primary heart disease and arterial hypertension, to avoid the above factors known to be associated with diastolic dysfunction [21–23] and thus evaluate only diastolic dysfunction associated with cirrhosis.

Diastolic dysfunction was frequent involving more than half of the patients in our study. Of them, more than half presented with an abnormal filling pattern suggesting mild diastolic dysfunction. Regarding severity of liver disease, the number of patients with Child class A cirrhosis was too small for any conclusion. However, it was evident that diastolic dysfunction was very common (70%) in patients with decompensated cirrhosis (Child class B or C). No correlation was demonstrated between aetiology of liver disease including alcohol-induced and diastolic dysfunction.

The clinical differences detected in patients with compared with those without diastolic dysfunction included significantly older age, more prevalent severe ascites and higher heart rate. Advanced age is a factor previously shown to be correlated to diastolic dysfunction [24]. Patients with diastolic dysfunction had a more prominent hyperdynamic circulatory state as indicated by higher heart rate. Regarding severe ascites, a negative correlation between plasma aldosterone levels and the E/A ratio has been previously reported in cirrhotics [25] indicating that the worse the portal hypertension the more severe the diastolic dysfunction. In addition, ascites has been previously shown to negatively affect the cardiac function [3,26].

Cardiac structural changes may be detected in patients with decompensated cirrhosis [27] and can regress after liver transplantation [6]. The morphological changes found by echocardiography in our patients consisted of an increase in the left aortic root diameter and intraventricular septal thickness in patients with compared with those without diastolic dysfunction. These changes could be accounted for by cardiac adaptation to an increase of blood volume and retention of blood in left ventricle, since these patients were characterized by a thickened and less compliant heart with impaired relaxation.

Despite signs of cardiac hypertrophy in patients with diastolic dysfunction suggesting cirrhotic cardiomyopathy, no significant decrease either in ejection fraction or peak systolic tissue velocity in mitral valve was observed. The above finding suggested lack of systolic myocardial dysfunction at rest in patients with compared with those without diastolic dysfunction. In a recent study a significant decrease in peak systolic tissue velocity and systolic strain rate in the absence of pharmacological or physical stress was found by tissue-Doppler imaging [8]. However, the design of that study was different and the main comparison was between cirrhotics and controls.

In the multivariate analysis, age, liver function as assessed by MELD score and serum sodium levels emerged as independent predictors of death. Cardiovascular complications were not evident in patients with diastolic dysfunction during the follow-up period and no patient died because of a cardiac event. Causes of death did not differ between patients with compared with those without diastolic dysfunction. Survival was worse in patients with diastolic dysfunction, but the difference did not reach statistical significance, which might seem to be in contrast to the significant findings of a smaller report by Cazzaniga *et al.* [15]. The absence of the association of survival with diastolic dysfunction might be because of the small number and/or the large proportion of our patients with mild diastolic dysfunction and therefore the low power of our study to detect such an effect. In addition, the effect of diastolic dysfunction on survival might be more evident in patients with TIPS, like the 32 patients included in the report by Cazzaniga *et al.* [15], and less evident in patients with decompensated cirrhosis but without porto-systemic shunts like the 76 patients in our study.

Nasr *et al.* [28] showed that diastolic dysfunction was not a predictor of circulatory dysfunction in patients with massive ascites who underwent large volume paracentecis and previous investigators have shown that paracentesis of ascites rather ameliorated diastolic myocardial function [3]. There are reports on immediate reversal of diastolic dysfunction after liver transplantation [29]. Furthermore, some investigators believe that some degree of diastolic dysfunction is present in virtually every patient with

cirrhosis [12]. All the above argue against a structural myocardial disorder in cirrhotic patients and are in favour of a functional condition associated with fluid overload, possibly representing the early stage of cirrhotic cardiomyopathy.

In conclusion, diastolic dysfunction is frequent in patients with decompensated cirrhosis especially those with severe ascites. Diastolic dysfunction does not seem to have strong effects on survival and the causes of death in patients without porto-systemic shunts. Larger, adequately powered studies are required to definitely detect or exclude an effect of diastolic dysfunction on survival.

Authorship

AA: designed study, draft of the paper. PS: performed study. RL: collected data. CC: designed the study, analysed data. PG: intellectual input, analysed data, edited the paper. PD: intellectual input, edited the paper.

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