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Tissue Doppler Imaging Assessment of Left Ventricular Function in Diabetic Patients with Hepatitis C Virus (HCV)

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Abstract: *Background & Purpose:* Hepatitis C virus (HCV) is the motive of many distinctive kinds of heart illnesses globally. Up till now, few cardiologists are aware of (HCV) as an etiology of heart sickness and its treatment. It has been nicely documented that the presence of diabetes mellitus (DM) changed into carefully connected to cardiovascular disorder. The aim of this work was to evaluate the left ventricular function in diabetic patient with hepatitis C (HCV) using tissue Doppler imaging "TDI". *Study design:* Comparative study. *Setting:* Menofia hospitals, Police Academic Hospital and Kafr El-Sheikh hospital from October 2016 to November 2018. *Subjects:* We included 50 adult HCV patients, allocated into 2 groups with BMI, age and sex matching. Group A: 25 patients below 50 years old who were diabetic (DM), and infected with HCV. Group B: 25 patients below 50 years old with HCV without Dm. *Methods:* All patients were subjected to Echocardiographic analysis, Doppler tissue imaging, ECG, blood sugar investigations and PCR for HCV. *Results:* In the studied population, we found that, comparative study between the 2 groups revealed; significant increase in LA mass index, in DM & HCV group ($p = 0.035$). Non-significant difference as regards all the remaining Echocardiographic variables ($p > 0.05$). Regarding correlations among DM & HCV cases; Mitral E had a highly significant positive correlation with HCV-PCR ($p < 0.01$). E/E' ratio and isovolumic relaxation time had a significant positive correlation with HCV-PCR ($p < 0.05$ respectively). It also shows that; septal mitral E' had a highly significant negative correlation with HCV-PCR ($p = 0.004$). And also shows that; the remaining Tissue Doppler Echocardiographic parameters, had non-significant correlation with HCV-PCR ($p > 0.05$). *Conclusion:* To conclude, our data suggests that, HCV infection had a significant impact on Lt ventricular diastolic function without any other predisposing factors probably due chronic inflammatory reaction and mild fibrosis of the heart muscle, previous studies did not follow strict inclusion and exclusion criteria that confirm the independence role of (HCV) infection to cause diastolic dysfunction. also, the presence of DM in addition to HCV infection add no more adverse effect on cardiovascular outcomes.

Keywords: Tissue Doppler Imaging, Left Ventricular Function, DM, HCV

1. Introduction

Hepatitis C virus (HCV) is the motive of many distinctive kinds of heart disease globally. Up till now, few cardiologists are aware of (HCV) as an etiology of many heart sickness and its treatment. HCV infection is seen globally, and is regularly undetected and therefore untreated. the burden of HCV-derived heart diseases is international, with higher incidence in Asia, Africa, and occasional- and mid-income international locations. Egypt has greatest incidence of HCV within the globe, reputedly because of preceding mass parenteral anti-schistosomal therapy [1]." HCV derived coronary heart illnesses are persistent, chronic, and devastating sicknesses [2]."

The myocardium can be the goal of several kinds of viral infections. these days, the significance of hepatitis C virus

(HCV) infection has been noted in patients with hypertrophic cardiomyopathy, dilated cardiomyopathy, myocarditis and left ventricular (LV) diastolic dysfunction [3, 4]."

It has been nicely documented that the presence of diabetes mellitus (DM) changed into carefully connected to cardiovascular disorder. DM actually portends cardiac morbidity and mortality [5–7]." even within the absence of danger elements which include ischemic, valvular, or hypertensive coronary heart disorder [8, 9]."

Histological and necropsy reviews are, however, conflicting at the presence, extent, and significance of atherosclerosis and diabetic microvascular involvement of the coronary stream. If there may be a particular diabetic sickness of the myocardium there have to be a robust relation between the degree of clinical microvascular disorder and left ventricular function, and the frequency and severity of abnormalities need to increase with the length of diabetes [8]."

In this study we try to assess the effect of hepatitis C (HCV) And diabetes in left ventricular function.

2. Aim of the Study

The primary outcome of the study is to evaluate the left ventricular function in diabetic patient with hepatitis C (HCV) using tissue Doppler imaging "TDI".

3. Patients and Methods

Our study is comparative study at 50 adult HCV patient, 25 patient of them has also diabetes mellitus at Menofia hospitals, Police Academic Hospital and Kafr el Shikh hospital from October 2016 to November 2018.

3.1. Study Design

Comparative study.

3.2. Setting

Menofia hospitals, Police Academic Hospital and Kafr El-Shikh hospital from October 2016 to November 2018.

A total of 50 adult HCV patients enrolled in the study.

Patients randomized into two matched groups.

1. Group A: included 25 patients below 50 years old who are diabetic (DM), and infected with hepatitis C virus (HCV).
2. Group B: included 25 patients below 50 years old with hepatitis C (HCV) infection without DM.

Eligible patients will be selected according to the following inclusion and exclusion criteria:

3.2.1. Inclusion Criteria

Group A;

i. Diabetic patients.
ii. HCV Patients.
iii. Age below 50 years.
iv. Body Mass Index (BMI) 18.5 kg/m^2-30 kg/m^2.

Group B;

i. HCV patient.
ii. Age below 50 years.
iii. Body Mass Index (BMI) 18.5 kg/m^2-30 kg/m^2.

3.2.2. Exclusion Criteria

Group A;

i. Any risk factors including ischemic, valvular, or hypertensive heart disease.
ii. Congenital heart, hypertrophic cardiomyopathy, restrictive cardiomyopathy or myocarditis.
iii. Smokers or those over 50 years of age.
iv. BMI below 18.5 kg/m^2 or over 30 kg/m^2.

Group B;

i. Diabetic patient.
ii. Any risk factors including ischemic, valvular, or hypertensive heart disease.
iii. Patients with congenital heart disease or valvular heart disease, restrictive cardiomyopathy, hypertrophic cardiomyopathy, pericardial constriction or myocarditis were excluded.
iv. Smokers or those over 50 years of age.
v. BMI below 18.5 kg/m^2 or over 30 kg/m^2.

3.3. Methods

Patients were subjected to the following:

1) Thorough medical history include age, sex, Body Mass Index (BMI), anti-diabetic treatment and co-morbidities.
2) Echocardiographic analysis:
   i. Each patient will have a complete two-dimensional echocardiography study.
   ii. Mitral inflow velocities were obtained.
   iii. Mitral E and A wave velocities and deceleration time were also obtained.
   iv. The *E*/*A* ratios were calculated.
3) Doppler tissue imaging:
   i. Pulsed wave Doppler tissue imaging velocities will be obtained.
   ii. The peak early diastolic mitral annular velocities (Ea, cm/s) and peak late diastolic mitral annular velocities (Aa, cm/s) were also obtained.
   iii. The lateral E/Ea ratio, a measure of LV filling pressure, was calculated.
4) Surface 12 leads ECG interpretation.
5) Fasting blood sugar.
6) 2-hrs post prandial blood sugar.
7) Random blood sugar.
8) PCR.

Ethical approval:

Approval had been obtained from Menofia University.

Statistical analysis:

Data entry, processing and statistical analysis was carried out using MedCalc ver. 18.2. (MedCalc, Ostend, Belgium). Tests of significance (t test, Chi square test and Spearman's correlation coefficient) were used.

Inferential statistics carried out using (Chi square, independent student's t test, and Spearman correlation coefficient).

4. Results

Comparative studies:

The 50 HCV patients were classified according to presence or absence of DM into 2 independent groups:

1. Group A: included 25 patients below 50 years old who are diabetic (DM), and infected with hepatitis C virus (HCV).
2. Group B: included 25 patients below 50 years old with hepatitis C (HCV) infection without DM.

Comparative studies are shown in the following tables and figures;

Comparative study between the 2 groups revealed non-significant difference as regards age, BMI and sex of the patients ($p > 0.05$).

Regarding hypoglycemic treatment, we found that, 56% of DM & HCV group of patients had insulin treatment, while 44% had oral hypoglycemic treatments.

Also (Table 1), showed that, comparative study between the 2 groups revealed; significant increase in LA mass index, in DM & HCV group; compared to HCV group ($p = 0.035$).

Comparative study between the 2 groups revealed non-significant difference as regards all the remaining 2D Echocardiographic variables ($p > 0.05$).

Table 1. *Comparison between two studied groups as regarding 2D Echo.*

2D Echo	Studied groups		t- test
	Diabetic& HCV group (n=25)	HCV group (n=25)	
	Mean±SD	Mean±SD	
Mitral E (cm/s)	74.40±10.39	70.65±10.57	1.29
Mitral A (cm/s)	77.28±17.22	72.92±18.08	0.87
Deceleration time (msec)	239.80±45.38	228.64±45.82	0.86
E/A ratio	0.99±0.23	1.01±0.20	0.29
Ejection fraction %	63.48±3.04	63.83±3.93	0.36
Tricuspid regurge velocity (m/s)	2.76±0.16	2.70±0.19	1.21
LA mass index (mm/m^2)	35.12±1.81	33.84±2.32	2.17

Also, Table 2 showed that, comparative study between the 2 groups revealed non-significant difference as regards all Tissue Doppler Echocardiographic variables ($p > 0.05$).

Also Figure 1 showed that, comparative study between the 2 groups revealed; highly significant increase in PCR in DM & HCV group; compared to HCV group ($p < 0.001$).

Correlation studies:

Correlation between PCR of with either of 2D Echo and Tissue Doppler Echo among the studied diabetic& HCV cases (n=25) (Figures 2-4).

Table 2. *Comparison between two studied groups as regarding Tissue Doppler Echo.*

Tissue Doppler Echo	Studied groups		t- test	P value
	Diabetic& HCV group (n=25)	HCV group (n=25)		
	Mean±SD	Mean±SD		
Septal mitral annulus:				
E'(cm/s)	5.64±0.63	5.68±0.69	0.21	0.832 NS
A'(cm/s)	9.96±1.48	10.36±1.75	0.87	0.388 NS
S(cm/s)	8.28±1.27	8.40±2.17	0.23	0.813 NS
Lateral mitral annulus:				
E'(cm/s)	7.64±0.70	7.40±0.64	1.26	0.214 NS
A'(cm/s)	12.36±1.52	12.96±1.36	1.46	0.150 NS
S(cm/s)	8.76±123	8.68±1.65	0.2	0.842 NS
Anterior mitral annulus:				
E'(cm/s)	6.04±0.78	5.72±0.73	1.48	0.145 NS
A'(cm/s)	10.06±2.09	9.80±1.68	0.44	0.657 NS
S(cm/s)	9.04±2.35	8.28±1.56	1.34	0.185 NS
Inferior mitral annulus:				
E'(cm/s)	6.68±0.94	6.96±0.72	1.18	0.243 NS
A'(cm/s)	11.24±1.83	11.96±1.56	1.49	0.142 NS
S(cm/s)	8.72±1.13	8.08±1.35	1.81	0.076 NS
E/E'	11.62±1.54	10.91±1.53	1.64	0.108 NS
Isovolumic relaxation time (msec)	93.04±2.68	92.16±3.15	1.06	0.294 NS

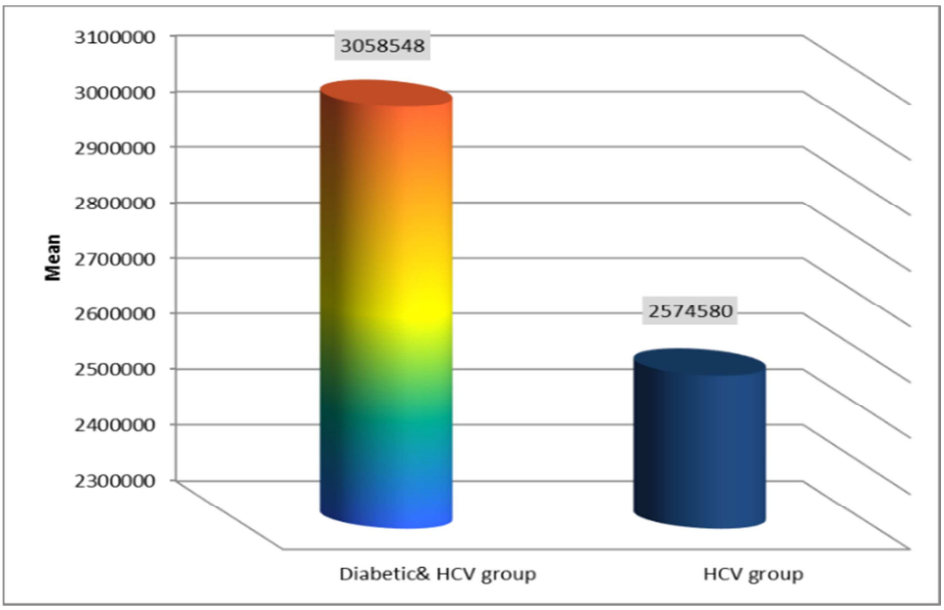

Figure 1. *PCR among the studied groups.*

Regarding 2D Echo;

Spearman's correlation analysis shows that; Mitral E had a highly significant positive correlation with HCV-PCR, in DM & HCV group ($p < 0.01$).

It also shows that; the remaining 2D Echocardiographic parameters, had non-significant correlation with HCV-PCR, in DM & HCV group ($p > 0.05$).

Regarding Tissue Doppler Echo (Figures 2-5);

Spearman's correlation analysis shows that the E/E' ratio and isovolumic relaxation time had a significant positive correlation with HCV-PCR, in DM & HCV group ($p < 0.05$ respectively).

It also shows that; septal mitral E' had a highly significant negative correlation with HCV-PCR, in DM & HCV group ($p = 0.004$).

And also shows that; the remaining Tissue Doppler Echocardiographic parameters, had non-significant correlation with HCV-PCR, in DM & HCV group ($p > 0.05$).

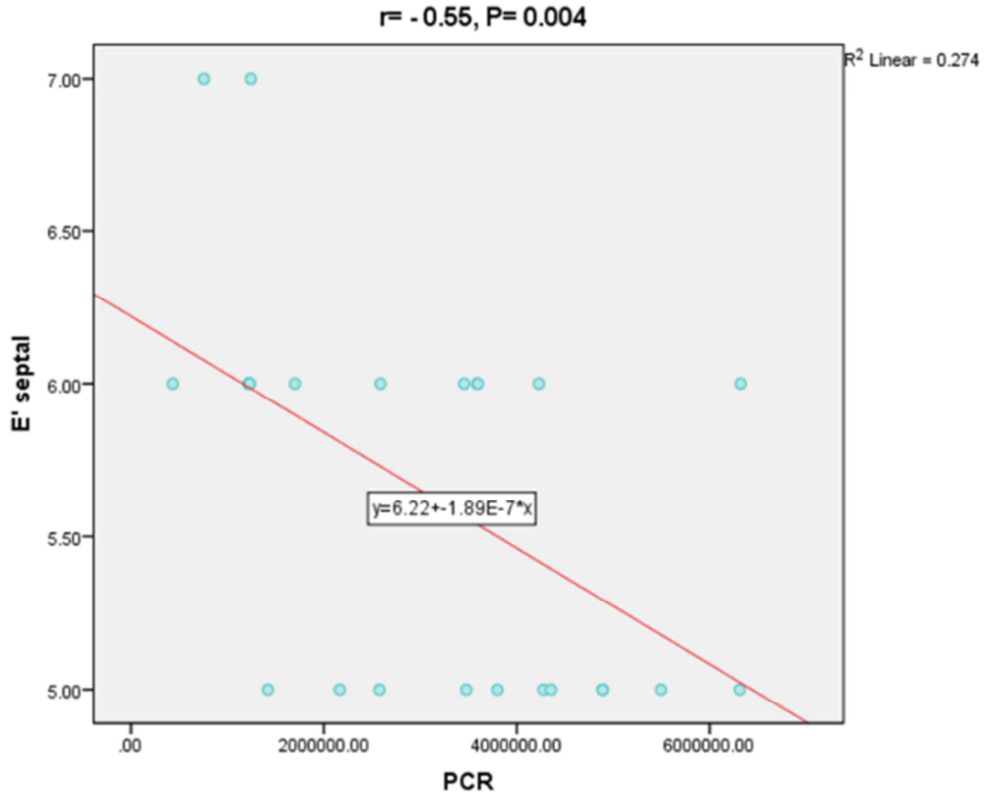

Figure 2. *Correlation between PCR and E' septal among studied diabetic& HCV cases.*

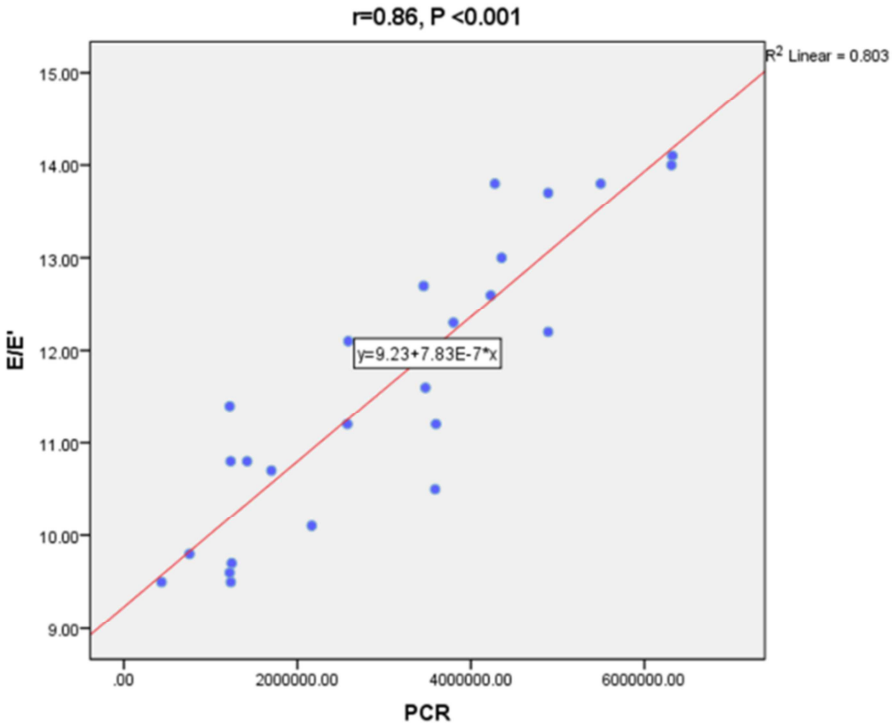

Figure 3. *Correlation between PCR and E/E' among studied diabetic& HCV cases.*

Correlation between PCR of with either of 2D Echo and Tissue Doppler Echo among the studied HCV cases (n = 25) (Figures 5, 6).

Regarding 2D Echo;

Spearman's correlation analysis shows that; Mitral E and A had a highly significant positive correlation with HCV-PCR, in HCV group ($p < 0.01$ respectively).

And also show that the remaining 2D Echocardiographic parameters, had non-significant correlation with HCV-PCR, in HCV group ($p > 0.05$).

Regarding Tissue Doppler Echo;

Spearman's correlation analysis shows that the E/E' ratio and isovolumic relaxation time had a highly significant positive correlation with HCV-PCR, in HCV group ($p < 0.01$ respectively).

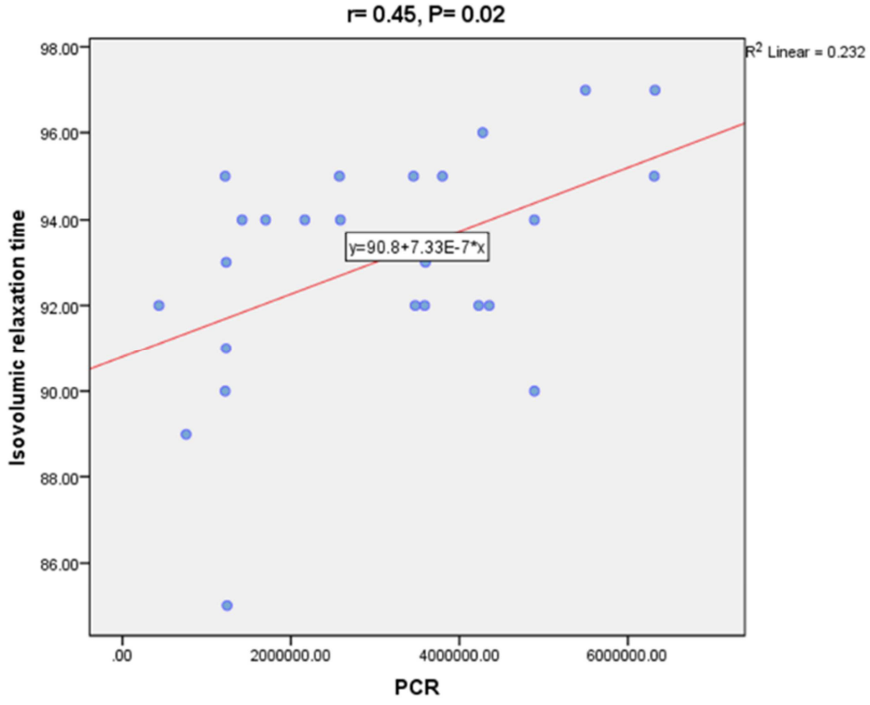

Figure 4. *Correlation between PCR and Isovolumic relaxation time among studied diabetic& HCV cases.*

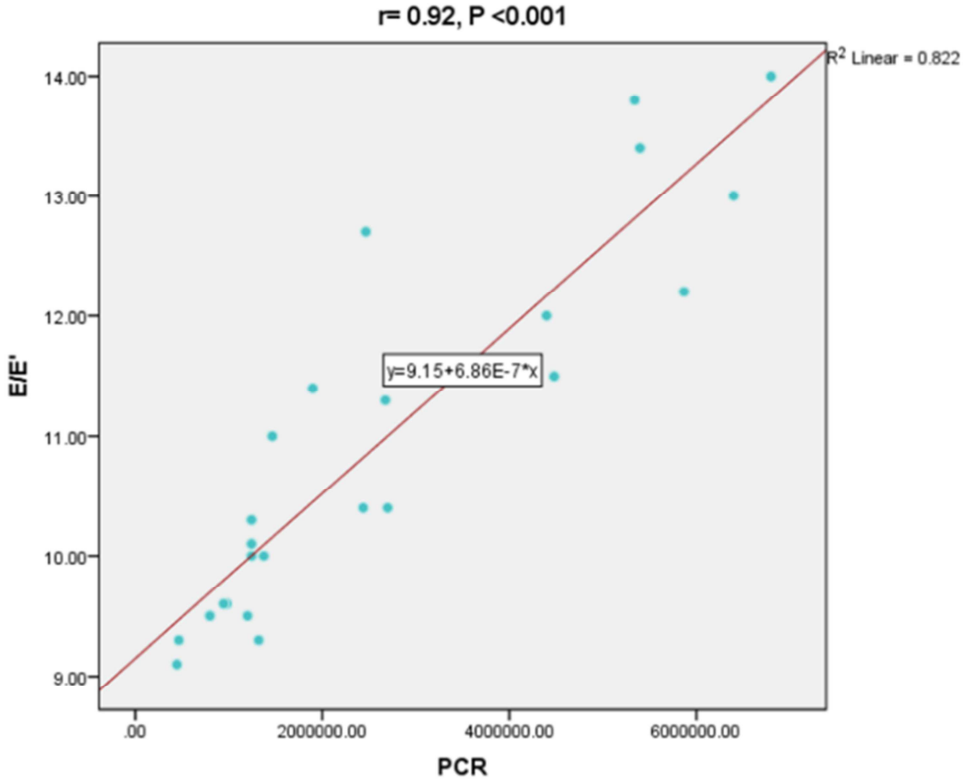

Figure 5. *Correlation between PCR and E/E' among studied HCV cases.*

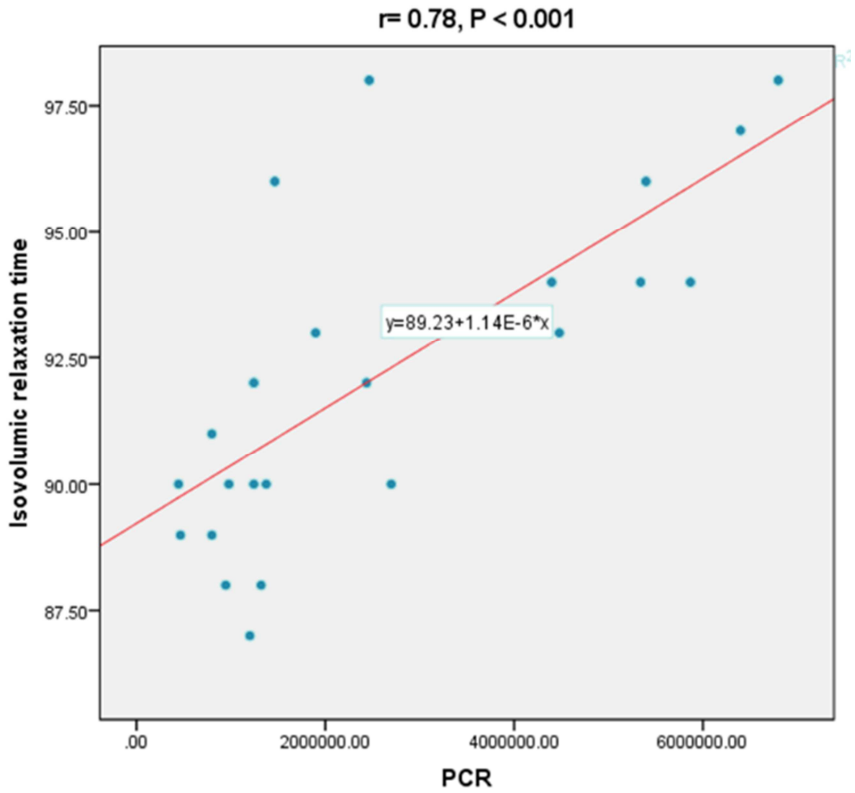

Figure 6. *Correlation between PCR and Isovolumic relaxation time among studied HCV cases.*

Also shows that; septal mitral E' had a significant negative correlation with HCV-PCR, in HCV group ($p = 0.035$).

While the remaining Tissue Doppler Echocardiographic parameters and analysis had non-significant correlation with HCV-PCR, in HCV group ($p > 0.05$).

5. Discussion

The myocardium can be the target of several sorts of viral infections. Currently, the importance of hepatitis C virus (HCV) infection has been referred to in sufferers with hypertrophic cardiomyopathy, dilated cardiomyopathy, myocarditis and left ventricular (LV) diastolic dysfunction [3, 4]."

This was a comparative study conducted on 50 adult HCV patients, to assess the left ventricular function in diabetic patient with hepatitis C (HCV) using tissue Doppler imaging "TDI".

A total of 50 adult HCV patients, recruited from the department of cardiology menofia University, Police academic hospital and kafr el sheikh hospital.

Patients were allocated into two groups with body mass index, age and sex matching; *Group A:* included 25 patients below 50 years old who are diabetic (DM), and infected with hepatitis C virus (HCV), and *Group B:* included 25 patients below 50 years old with hepatitis C (HCV) infection without DM.

Regarding demographic and anthropometric characteristics of the studied groups, comparative study between the 2 groups revealed non-significant difference as regards age, BMI and sex of the patients ($p > 0.05$). These results came in agreement with *Nazar et al., 2013*, who studied Lt ventricular function assessed by echocardiography in hepatic cirrhosis, and reported that, age and sex had no correlation with systolic nor diastolic dysfunction in HCV patients [10].

Bender, 2019, and *Haas et al., 2019*, who conducted their research on linking coronary microvascular and cardiac diastolic dysfunction in diabetes, and sex differences in coronary microvascular function in individuals with type 2 diabetes and found that, ladies had a better rest myocardial blood flow (MBF), decrease coronary flow reserve (CFR), and worse diastolic characteristic as compared to guys. moreover, relaxation MBF turned into undoubtedly correlated with worse diastolic characteristic in women [11, 12]."

Regarding hypoglycemic treatment, we found that, 56% of DM & HCV group of patients had insulin dependent, while 44% had oral hypoglycemic treatments. These results came in agreement with *Huynh et al., 2019*, who studied comparison of outcomes in patients with diabetes mellitus who are insulin dependent + heart failure with preserved left ventricular ejection fraction (From the TOPCAT Study), and reported that, 40.2% of his patients had insulin dependent, while the rest had oral hypoglycemic treatment [13]."

Regarding the link between HCV infection and cardiovascular disease *Onoue and Saito, 2018* found that, chronic infection with certain organisms is likewise thought to promote systemic inflammation and consequent atherosclerosis. certainly, chronic HCV infection has been shown to induce pro-inflammatory cytokines, which include interleukin (IL)-6, tumor necrosis factor (TNF)-α, C-reactive protein, and fibrinogen, which affect most effective the coronary arteries, ensuing in CVD, but also the pulmonary vasculature, resulting in pulmonary high blood pressure, each of which conditions should cause heart failure (HF). Portocardiac shunt-precipitated pulmonary high blood pressure is some other reason of HF in patients with continual HCV infection, mainly inside the advanced degree complicated with the aid of cirrhosis [14]."

The opportunity of an immediate affiliation between HCV contamination and myocardial harm, ensuing in myocarditis or cardiomyopathy, has been reported by *Matsumori et al., 2006* who found a higher prevalence of anti-HCV antibodies in patients with cardiomyopathies and myocarditis than in the general population and detected the minus strand of HCV-RNA from cardiac tissue suggesting replication of the virus, both of which indicate a direct association between HCV and cardiac injury through its proliferation [2]."

In our study we compare both groups to analyze the effect of HCV infection on diabetic cardiovascular patients.

Regarding 2D Echocardiographic data, comparative study between the 2 groups revealed; significant increase in LA mass index, in DM & HCV group; compared to HCV group ($p = 0.035$). It is due to the chronicity and severity of both HCV and diabetes that may affect the heart and increase LA mass and cardiac muscle.

Comparative study between the 2 groups also revealed non-significant difference as regards all the remaining 2D Echocardiographic variables ($p > 0.05$).

This also came in agreements with *Pritchett et al 2005* who found that in the general population, atrial remodeling as assessed by LAVI is closely associated with the severity of diastolic dysfunction. However, LAVI does now not reliably predict milder but prognostically crucial levels of diastolic disorder and the severity of diastolic disorder is most predictive of future death [15]."

In a study of *Teo et al 2009* who also came in agreement with our study who reported that LA remodeling occur in patients with LV diastolic dysfunction and LA volume expressed the severity of diastolic dysfunction. Initially, the LA compensates for changes in LV diastolic properties by augmenting active atrial contraction. As the severity of diastolic dysfunction increase, this compensatory mechanism fails as atrial mechanical dysfunction sets in, resulting in lower total atrial emptying volume [16]."

Chew et al., 2017, also reported that, relationships between cardiac abnormalities detected by MRI/MRS and systolic and diastolic function, including associations between myocardial fibrosis and diastolic dysfunction and LV mass and systolic dysfunction [17]."

Regarding Tissue Doppler Echocardiographic data, it shows decrease in both Ea and Aa and Aa is more than Ea and increase in E/Ea ratio in the two groups. Comparative study between the 2 groups revealed non-significant difference as regards all Tissue Doppler Echocardiographic variables ($p > 0.05$).

In a study of, *Saleh et al., 2011*, who reported that, the first direct evidence that HCV infection causes diastolic dysfunction without any other predisposing factors, probably

due to chronic inflammatory reaction with mild fibrosis in the heart. Previous studies did not follow strict inclusion and exclusion criteria that confirm the independent role of HCV to cause diastolic dysfunction [18].

Also, *Saleh et al., 2011*, reported that, Tissue Doppler was more sensitive to diagnose diastolic dysfunction than conventional Doppler [18]."

Regarding HCV-(PCR*)*, comparative study between the 2 groups revealed; highly significant increase in PCR in DM & HCV group; compared to HCV group ($p < 0.001$) This may be due to the presence of diabetes as risk factor and decrease in immunity in diabetic patients or may be due to the selected group of patients.

These results came in agreement with *Younossi et al., 2013* who reported that, in multivariate analysis, in addition to known risk factors for insulin resistance, chronic hepatitis C (HCV) was independently associated with the presence of insulin resistance, DM and hypertension. Independent predictors of cardiovascular diseases included older age, presence of obesity and smoking. chronic hepatitis C was independently associated with congestive heart failure subtype of cardiovascular diseases but not ischemic heart disease and stroke [19]."

Also, *Younossi et al., 2013* reported that, chronic hepatitis C virus infection is independently associated with presence of metabolic conditions (insulin resistance, type 2 diabetes mellitus and hypertension) and congestive heart failure [19]."

In our study the results show that the number of patients that show diastolic dysfunction were 23 patients in group A (HCV and DM) and 21 patients in group B (HCV) so there's no statistical difference.

In a study of *Saleh et al., 2011* show that there was diastolic dysfunction in 18 patients in the (HCV) group and non in the normal control group that the study was compering between (HCV) group patients and another control normal group of patients that show diastolic dysfunction in the HCV group patient and none in the control group [18]."

In our study it shows normal systolic function in all patient on the two groups due to strict exclusion of any disease or risk factor can affect the heart.

In the study of *(Konno et al., 2018).* it shows the prevalence of reduced systemic ventricular ejection fraction (SVEF) <50% was significantly higher in the HCV antibody-positive group compared with the HCV antibody-negative group (17 vs. 5.4%, P=0.014) [20]."

Regarding correlation between PCR of with either of 2D Echo and Tissue Doppler Echo among the studied diabetic & HCV cases, we found that;

Regarding 2D Echo; Spearman's correlation analysis showed that; Mitral E had a highly significant positive correlation with HCV-PCR, in DM & HCV group ($p < 0.01$).

Spearman's correlation analysis also showed that; the remaining 2D Echocardiographic parameters, had non-significant correlation with HCV-PCR, in DM & HCV group ($p > 0.05$). These results came in agreement with *Younossi et al., 2013* [19]."

Also *Petta et al., 2016*, who conducted a large meta-analysis, and stated that, compared to uninfected individuals (controls), HCV infected patients had increased risks of CVD-related mortality (*P*=.02), carotid plaques (*P*<.001), and cerebro-cardiovascular events (*P*=.002). Significant heterogeneity was observed in the risk of cerebrocardiovascular disease among individuals with HCV infection. The effect of HCV infection on cerebrocardiovascular disease was stronger in populations with a higher prevalence of diabetes (>10%) or hypertension (>20%) (*P*<.001) [21]."

Regarding Tissue Doppler Echo; Spearman's correlation analysis showed that the E/E' ratio and isovolumic relaxation time had a significant positive correlation with HCV-PCR, in DM & HCV group ($p < 0.05$ respectively).

Spearman's correlation analysis also showed that; septal mitral E' had a highly significant negative correlation with HCV-PCR, in DM & HCV group ($p = 0.004$).

Spearman's correlation analysis also showed that; the remaining Tissue Doppler Echocardiographic parameters, had non-significant correlation with HCV-PCR, in DM & HCV group ($p > 0.05$). These results came in agreement with *Younossi et al., 2013* [19]."

In a meta-analysis of published studies, individuals with HCV infections were found to be at increased risk for CVD-related morbidity and mortality, especially those with DM [21]."

Regarding correlation between PCR of with either of 2D Echo and Tissue Doppler Echo among the studied HCV cases, we found that;

Regarding 2D Echo; Spearman's correlation analysis showed that; Mitral E and A had a highly significant positive correlation with HCV-PCR, in HCV group ($p < 0.01$ respectively).

Spearman's correlation analysis also showed that; the remaining 2D Echocardiographic parameters, had non-significant correlation with HCV-PCR, in HCV group ($p > 0.05$). These results came in agreement with *Konno et al., 2018*, who reported that hepatitis C virus (HCV) antibody positivity adversely affects cardiac function. As the screening for HCV began in 1992, we hypothesized that HCV antibody-positive rate would be high in adult congenital heart disease (ACHD) patients who underwent heart surgery before 1992 and adversely affected cardiac function and long-term prognosis [20]."

Regarding Tissue Doppler Echo; Spearman's correlation analysis showed that the E/E' ratio and isovolumic relaxation time had a highly significant positive correlation with HCV-PCR, in HCV group ($p < 0.01$ respectively).

Spearman's correlation analysis also showed that; septal mitral E' had a significant negative correlation with HCV-PCR, in HCV group ($p = 0.035$).

Spearman's correlation analysis also showed that; the remaining Tissue Doppler Echocardiographic parameters, had non-significant correlation with HCV-PCR, in HCV group ($p > 0.05$). These results came in agreement with

Huang et al., 2019 [22].

In *Huang et al., 2019* recent study, there were 29 members inside the control group and eighty sufferers within the liver cirrhosis group. 27.8% of cirrhotic patients presented with ordinary systolic but abnormal diastolic features and QTc prolongation that had been compatible with Cirrhotic Cardiomyopathy (CCM). 34.2% of cirrhotic sufferers presented with diastolic disorder in resting country evaluating to 24.1% in control group. Systolic features did no longer show conspicuous distinction between cirrhosis and control group nor between compensated and decompensated cirrhosis [22]."

After adjustment for demographic and clinical factors, HCV remained significantly associated with an increased risk for heart failure events [23]."

Also, *Tsui et al., 2009* reported that, HCV seropositive participants had higher rates of death, CV events, and heart failure hospitalizations during follow-up. After adjustment for CV risk factors, HCV seropositivity remained independently associated with risk for heart failure events [23]."

6. Conclusion

To conclude, our data suggests that, HCV infection had a significant impact on Lt ventricular diastolic function without any other predisposing factors probably due chronic inflammatory reaction and mild fibrosis of the heart muscle, previous studies did not follow strict inclusion and exclusion criteria that confirm the independence role of (HCV) infection to cause diastolic dysfunction. Also, the presence of DM in addition to HCV infection add no more adverse effect on cardiovascular outcomes.

Conflict of Interest

The authors declared that there is no conflict of interest.

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