

To Investigate Prevalence of Diabetes Type 1 and Type 2 in HCV Infected Individuals

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Abstract

This study was aimed to investigate the prevalence of diabetes mellitus type 1 and 2 in patients infected with hepatitis C virus. This study was conducted in blood collection Centre at Nuclear Medicine Oncology and Radiotherapy Institute (NORI) situated in Islamabad, Pakistan. The duration of study was from March 2014 to June 2014 twice a week. Randomly selected 112 HCV infected patients were included in this study. Patient information form was used to collect information from patients. In addition to this, about 51 patients were tested for random blood glucose levels, by strip based glucose testing method. Our control group consisted of 80 non HCV infected individuals of same age group. The results of the present study showed 7/112 (6.25%) diabetic patients in HCV infected group and 9/80 (11%) in non-infected. Statistical analysis does not support association of diabetes type 2 with HCV infection (OR=0.5926, 95% of CI=0.2116 to 1.6594, P=0.3193). Similarly, when we analyzed diabetes type 1 separately, 3.57% were suffering from type 1 in HCV infected patients, contrary to that there was not a single person was suffering from type 1 diabetes. Statistically, it is insignificant with p value 0.2050. Although insulin resistance is often reported in HCV infection, however, association of diabetes type 2 with HCV seems rare event. Type 1 Diabetes mellitus is reported to be linked with antiviral therapy, but our results show insignificant association.

Keywords: Diabetes mellitus; Random blood glucose; Insulin resistance; Hyperglycemia; Glucose intolerance

Introduction

Hepatitis C virus (HCV) causes hepatitis C infection and is known as one of the leading cause of damages liver. This infection is asymptomatic and may remain over years without diagnosis. In case of chronic infection, liver disfigurement occurs eventually leading to liver fibrosis and liver cirrhosis. Even liver cirrhosis may remain unnoticed for number of years and finally develops into liver failure or liver carcinoma, or sometimes into esophageal and gastric abnormality [1].

About 3 percent of the world population is known to be suffering from this infectious disease in chronic form [2,3]. Studies show that approximately 3 to 4 million people get infected by HCV every year and above 350,000 people pass away per year due to hepatitis C infection and its complications [2].

There are a number of extra hepatic manifestations associated with HCV infection which include cryoglobulinemia (inflammation of small blood vessels) [4], associated Sjogren's syndrome (autoimmune disease), thrombocytopenia, skin diseases, insulin resistance, diabetes mellitus; diabetic nephropathy, autoimmune thyroiditis and B-cell lymphoproliferative disorders [5].

Metabolic disorders involving hyperglycemia due to some defect in accomplishment of insulin or due to abnormal amount of insulin secretions or both problems occurring simultaneously is known as diabetes mellitus. Unrelieved hyperglycemia is known to be linked with prolonged functional deficiency and often leads to defect and malfunctioning of different organs, like nerves, heart, blood vessels, kidneys and eyes [6].

It is estimated that above 285 million people are living with the lifelong progressive diabetes mellitus (DM) worldwide [7]. Approximately, 6.4% of the total world's population is known to be affected by DM; about 5-10% accounts for DM type 1, while rest of 90-95% accounts for DM type 2 [7].

Epidemiological surveys' in as early as 1994 showed that HCV infection is somehow related with onset of diabetes in HCV infected patients. This conclusion was based on information obtained from approximately entire prior epidemiologic learning, incorporated a combination of patients infected with HCV, those with liver cirrhosis and those without liver cirrhosis [8]. Hepatitis C virus infection and type 2 diabetes being major health problems have a wide range of complications and their mortality rates are continuously increasing. HCV infection prompts diabetes. Cirrhosis and hematomas caused by HCV infection cause glucose intolerance and insulin [9].

Based on early clinical observation, type II diabetes mellitus (DM) was suggested to be another potential extrahepatic manifestation of HCV infection, with excess risk postulated to be due to either direct viral involvement or secondary to HCV-induced liver damage. However, even a small increase in DM risk in HCV-infected patients may be clinically important, as available pharmacotherapy for HCV are less effective with concomitant DM and progression of liver disease has been shown to be worsened [8].

The association between HCV infection and type 2 diabetes appears to be often linked, at least in predisposed individuals (older and overweight). The virus itself and not the liver disease may be the culprit by interfering with insulin signaling [10]. Clinically, long-standing insulin resistance, hyperglycemia and diabetes may worsen liver fibrosis. Whether it also reduces the efficacy of anti-viral treatment remains to be studied but this may be the case as overweight

and steatosis associated with a lower response. Preliminary data suggest that correction of insulin resistance might help achieve higher response rates with anti-viral treatment [11].

Combined pegylated interferon (PEG-IFN) + ribavirin (RBV) therapy has been used as a primary treatment for chronic hepatitis C. However, IFN-induced autoimmune disease, including type 1 diabetes mellitus, has been highlighted as one of the problems with this therapy. A case study was conducted, in which patient developed DM 1 as a result of combined pegylated interferon + ribavirin therapy. It was treated by intensive insulin dosage initially and after completion of therapy, the dosage of insulin was gradually reduced from 22 U/day to 6 U/day. Prediction of onset of type 1 diabetes mellitus on the basis of baseline measurement of pancreas-associated auto antibodies is difficult. Therefore, it would be advisable to consider the possibility of onset of type 1 diabetes mellitus in all patients receiving IFN+RBV therapy [12].

Keeping in view above discussion this study is designed to investigate, at pilot scale, the association of Type-1 and Type-2 diabetes in HCV infected patients in our local population.

Materials and Methods

This is an epidemiological study to investigate prevalence of diabetic manifestation of HCV infection in Pakistan. This study was approved by Internal Control Board of NORI.

Institute/diagnostic lab

This study has been conducted in blood collection centre at Nuclear Medicine Oncology and Radiotherapy Institute (NORI) situated in Islamabad, Pakistan. This study is done from March 2014 to June 2014 twice a week.

Study group

Experimental group

Inclusion criterion: HCV positive, HBV negative, HIV negative.

Exclusion criterion: People without HCV infection.

Control group

Inclusion criterion: 25 years to 60 years.

Exclusion criterion: HCV positive, HBV positive, HIV positive.

Patient information and consent form

The patient information and consent form is attached in appendix. Our patient information and consent form included questions i.e., patient's age, gender, duration of HCV diagnosis, diabetes, antiviral therapy and viral load.

Data collection

Randomly selected 112 patients who were coming to NORI blood collection centre for HCV diagnosis test were included in this study. These patients were in age range of 20 years to 60 years. History was taken from these patients to find out diabetic prevalence in HCV infection in Pakistan. Patient information form was designed according to study requirements and was used to collect information

from patients. In addition to this, about 51 patients were tested for random blood glucose levels, by strip based glucose testing method.

Statistical analysis

Data analysis is done by using Odds Ratios software (Figure 1).

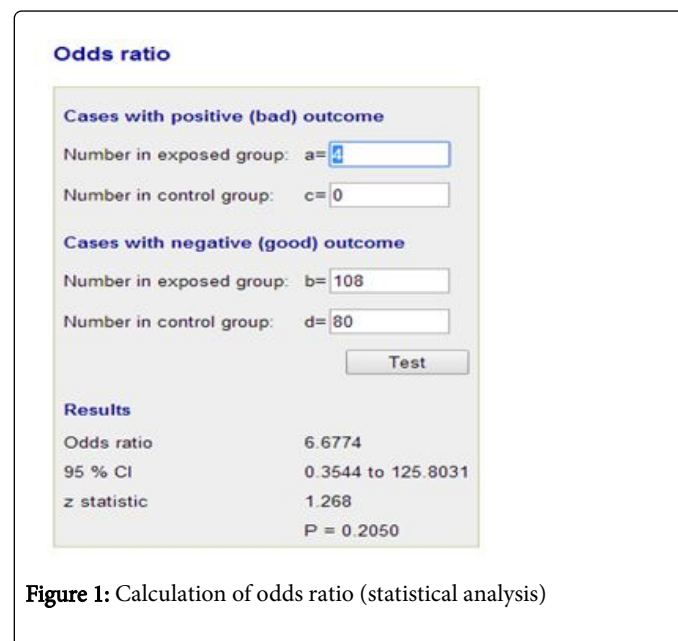


Figure 1: Calculation of odds ratio (statistical analysis)

Formula

The odd ratio is the ratio of odds of the outcome in the two groups.

$$= (a / c) / (b / d)$$

$$= (a \times d) / (b \times c)$$

Where,

Cases with positive outcome:

Number of cases in exposed group = a

Number of cases in control group = c

Cases with negative outcome:

Number of cases in exposed group = b

Number of cases in control group = d

Confidence Interval:

Confidence interval (for 95%) is calculated using this formula:

$$\text{Upper limit for 95\% CI} = e^{\ln(\text{OR}) + 1.96 \sqrt{[(1/a+1/b+1/c+1/d)]}}$$

$$\text{Lower limit for 95\% CI} = e^{\ln(\text{OR}) - 1.96 \sqrt{[(1/a+1/b+1/c+1/d)]}}$$

Results

All the data collected through patient's information was arranged in a Table [Table 1] with the help of which relation between HCV infection and diabetes was calculated. Further, prevalence of diabetic manifestations in HCV infected patients was determined. Out of 112 HCV infected patients, 12 patients were found to be diabetics. Out of 12 diabetic patients, 5 were those who had diabetes before HCV

diagnosis. 6 patients developed diabetes after diagnosis of HCV infection. Out of these 64 patients developed diabetes after undergoing antiviral therapy (Interferon) for 6 months. Thus it may be diabetes mellitus type 1.

Sr. No.	PRN No.	Viral load	Age/Gender	Diagnosis	Treatment	Diabetes
1	011667/14	<3,000	40/Female	2 years	Injection (1 year)	No
2	011963/14	<3,000	30/Female	5-6 years	6 months	No
3	012611/14	2.1×10^5	30/Male	Recent	No	No
4	011958/14	6.4×10^4	45/Female	1 year	No	No
5	011942/14	<3,000	18/Male	2 years	4 months	No
6	011933/14	2.5×10^5	62/Male	2 months	No	No
7	011929/14	1.4×10^4	40/Male	1 year	No	No
8	009004/13	<3,000	23/Male	5 years	6 months	No
9	01168/14	8.9×10^4	30/Male	4 years	No	No
10	011198/13	<3,000	46/Female	7 years	6 months	No
11	011671/14	7.6×10^5	50/Female	3 years	6 months	No
12	012559/14	<3,000	48/Female	3-4 months	Injection	No
13	012573/14	1.5×10^5	40/Female	4 years	No	No
14	009496/13	<3,000	41/Female	1 year	6 months	No
15	009589/12	<3,000	42/Male	1 year	No	No
16	012599/14	1.5×10^6	55/Female	2-3 years	No	No
17	012572/14	1.3×10^6	39/Male	1 month	No	No
18	012598/14	5.8×10^5	28/Male	3 months	No	No
19	013024/14	1.1×10^5	26/Female	Not yet	No	No
20	013046/14	4.1×10^6	53/Female	5 years	6 months	No
21	006718/14	28	41/Female	1 month	4 injection	No
22	023138/12	<3,000	46/Female	4 years	Injections	No
23	013067/14	1.0×10^5	60/Female	3-4 years	No	No
24	003445/12	3.6×10^5	37/Female	4 years	1 year	No
25	009565/11	9.0×10^4	26/Female	2 years	2 times	Yes
26	013338/14	1.6×10^6	20/Male	2 years	No	No
27	024484/13	<3,000	40/Female	1 year	Injection	No
28	013342/14	2.7×10^5	35/Female	1 year	No	No
29	013350/14	<3,000	42/Male	7 years	Injection	No
30	013339/14	1.0×10^5	52/Female	recent	No	No
31	013347/14	2.9×10^4	45/Female	recent	No	Yes
32	023177/13	6.3×10^5	40/Female	1 year	No	No
33	013351/14	7.4×10^4	25/Female	3 years	Started	No
34	013344/14	6.4×10^5	53/Female	13 years	Injection	No

35	013365/14	8.3×10^4	42/Male	Recent	No	No
36	007415/14	<3,000	35/Female	3 years	No	No
37	007408/14	4.1×10^5	16/Female	1 month	No	No
38	007429/14	5.6×10^5	43/male	1 year	Injection	No
39	007431/14	<3,000	54/Female	4-5 years	60 Inj.	Yes
40	007420/14	5.9×10^4	45/Female	1/1.5 year	No	No
41	007444/14	3.9×10^4	27/Male	4 year	No	No
42	025271/09	<3,000	43/Female	7 years	Inj. 1 year	No
43	008107/14	<3,000	47/Female	1 year	6 month	No
44	005503/12	1.3×10^4	52/Female	2 years	No	No
45	008134/14	1.0×10^4	34/female	recent	No	No
46	008150/14	7.9×10^4	64/Male	1 year	No	No
47	008810/14	1.8×10^5	48/Female	5-6 months	No	No
48	008815/14	6.1×10^4	48/Female	6 months	Inj.	No
49	004313/13	7.4×10^3	31/Female	1 year	No	No
50	008829/14	4.9×10^5	43/Male	1 year	No	No
51	008842/14	<3,000	35/Male	1 year	Inj.	No
52	008849/14	<3,000	28/Male	2 years	Inj.	No
53	008139/09	<3,000	52/Male	4-5 years	6 months	Yes
54	004931/11	9.3×10^5	37/Male	5 years	No	No
55	008857/14	1.1×10^5	25/Female	recent	No	No
56	008864/14	9.9×10^3	55/Female	8 years	No	No
57	008865/14	<3,000	44/Male	7 years	6 months	No
58	008026/13	<3,000	38/Female	1 year	6 months	No
59	008866/14	2.0×10^5	39/Male	5-6 years	No	No
60	008873/14	2.5×10^4	40/Female	2 months	No	Yes
61	008876/14	8.7×10^3	60/Female	8 years	Inj.	No
62	029644/12	<3,000	37/Female	2 years	Inj.	No
63	027047/12	1.2×10^4	51/Female	6 months	Inj.	No
64	013107/14	1.5×10^4	35/Male	2 months	No	No
65	013834/14	1.4×10^6	46/Male	Recent	No	No
66	013827/14	2.6×10^5	Female	2-3 years	No	No
67	013839/14	1.7×10^5	45/Male	recent	No	No
68	013840/14	2.5×10^6	47/Female	2 years	72 inj.	No
69	013853/14	3.7×10^6	35/Male	Recent	No	No
70	011334/12	<3,000	30/Female	2 years	6 months	No

71	013850/14	1.4×10^6	20/Male	Recent	No	No
72	013860/14	<3,000	55/Female	4 years	6 months	Yes
73	013883/14	<3,000	60/Female	5-6 months	Started	No
74	014069/14	<12	54/Male	3 months	14 inj.	Yes
75	014078/14	2.8×10^5	39/Male	recent	No	No
76	014077/14	7.3×10^6	19/Male	recent	No	No
77	002628/14	3.1×10^6	50/Male	1 year	Medicine	Yes
78	014079/14	5.2×10^4	38/Female	Recent	No	No
79	009718/12	8.2×10^6	27/Female	2 years	24, 72 inj.	No
80	014080/14	2.5×10^6	42/Female	recent	No	No
81	014087/14	1.0×10^6	40/Female	7 years	6 months	Yes
82	014092/14	5.2×10^3	22/Female	4-5 months	No	No
83	014120/14	<3,000	40/Female	6 years	72 inj.	No
84	014108/14	3.5×10^6	34/Male	1 year	No	No
85	006736/14	<3,000	30/Male	6 months	72 inj.	No
86	014106/14	<3,000	49/Female	3 months	36 inj.	No
87	014110/14	1.9×10^6	27/Female	1 month	No	No
88	014118/14	2.2×10^5	36/Male	Recent	No	No
89	014120/14	1.4×10^6	43/Male	2 months	4 inj.	No
90	014085/14	2.9×10^6	42/Male	recent	No	No
91	014769/13	<3,000	40/Male	4 years	72 inj.	No
92	001172/14	3.9×10^4	10/Male	5 months	No	No
93	004751/12	4.7×10^6	55/Female	3-4 years	72 inj.	yes
94	014125/14	<3,000	36/Female	3-4 years	Medicine	No
95	001236/08	<3,000	51/Female	8 years	No	yes
96	021819/12	3.2×10^6	54/Male	4 years	No	No
97	003634/14	6.4×10^4	35/Female	1 year	No	No
98	001155/10	<3,000	52/Female	3 years	72 inj.	No
99	000449/10	3.9×10^6	54/Male	3 years	2 times	No
100	014577/14	<3,000	49/Female	6-7 years	6 months	No
101	014588/14	1.6×10^5	24/Female	6-7 months	No	No
102	014582/14	7.2×10^6	40/Female	10 months	No	No
103	014587/14	3.9×10^5	50/Female	recent	No	No
104	014592/14	6.0×10^6	30/Female	4 years	No	No
105	007716/13	<3,000	43/Female	8 years	No	No
106	031328/13	<3,000	30/Male	4-5 years	Inj.	No

107	N.A	9.9×10^3	28/female	1 month	No	No
108	N.A	4.4×10^5	26/male	1 year	No	No
109	N.A	<3,000	45/female	1 year	6 month	No
110	N.A	<3,000	24/female	1 year	72 inj.	No
111	N.A	7.5×10^5	55/male	8 years	72 inj.	No
112	N.A	<3,000	32/female	1 year	No	Yes

Table 1: Data showing patient information such as age, gender, viral load, duration of HCV infection diagnosis, treatment history: Red color indicates data of diabetic patients.

During this study, 51 patients random glucose test was also performed in order to find the difference between glucose levels of those patients who were only HCV positive and those who were diabetic in addition to HCV infection. Out of 51 such patients, 6 patients were diabetic, and 2 were in pre diabetic state.

In order to make comparison of having diabetes between non-HCV infected and HCV infected individuals, control group of 75 healthy (non-HCV) individuals 25 to 60 years of age were included. In control group, 9 out of 75 individuals were having diabetes.

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Statistical Analysis

Odds Ratios software was used for statistical analysis of the collected data.

Diabetes mellitus type 2

Odds Ratio=0.5926

95 % CI=0.2116 to 1.6594

Z statistics=0.996

P value=0.3193

Result is statistically insignificant.

Diabetes mellitus type 1

Odds Ratio=6.6774

95% CI=0.3544 to 125.8031

Z statistics=1.268

P value=0.2050

Result is statistically insignificant.

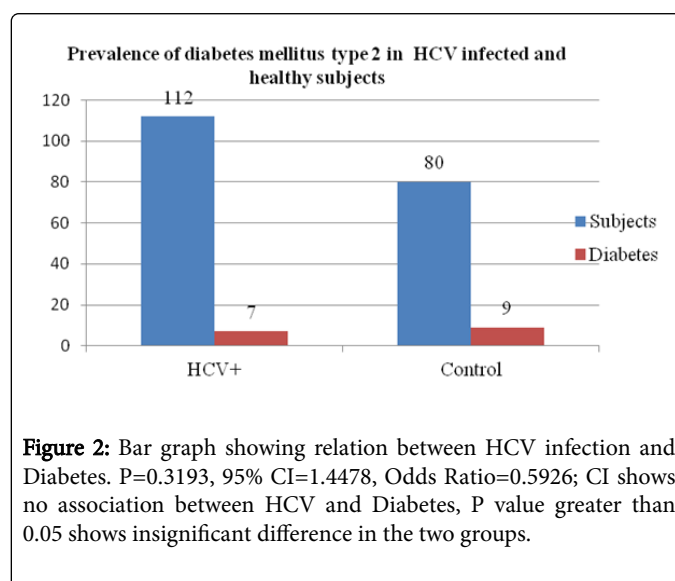


Figure 2: Bar graph showing relation between HCV infection and Diabetes. P=0.3193, 95% CI=1.4478, Odds Ratio=0.5926; CI shows no association between HCV and Diabetes, P value greater than 0.05 shows insignificant difference in the two groups.

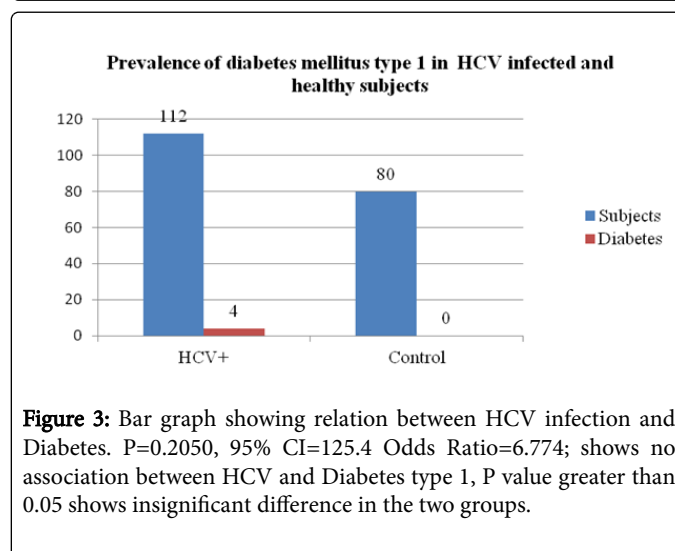


Figure 3: Bar graph showing relation between HCV infection and Diabetes. P=0.2050, 95% CI=125.4 Odds Ratio=6.774; shows no association between HCV and Diabetes type 1, P value greater than 0.05 shows insignificant difference in the two groups.

Discussion

Many studies have shown the association of HCV infection with diabetes. 30% occurrence of diabetes in HCV infected patients have been reported [13].

Allison first time reported this link between HCV infection and diabetes, since then, several studies have been conducted in order to figure out the exact process behind this association [14].

Some mechanisms have been proposed to be responsible for this association like Insulin resistance, interference in signaling pathways and increased production of proinflammatory cytokines like TNF and IL-6 causing oxidative stress [15].

The results of the present study showed 7/112 (6.25%) (Table 2) diabetic patients in HCV infected group and 9/80 (11%) (Table 2) in healthy individuals comprised almost of the same group. In this study the observed frequency of diabetes type 2 was very less in HCV infected than in non-infected group.

Statistical analysis does not support association of diabetes type 2 with HCV infection. Odds ratio of diabetes/non diabetes in HCV/non HCV group being less than 1 does not support association between HCV infections. The observed P value for diabetes type 2 was 0.3193, which indicates no association.

This association of occurrence of diabetes due to HCV infection is not established; some studies proposed that HCV infection might be responsible of diabetes development in HCV infected individuals however, contradictory results are not uncommon.

Presence of HCV markers were not responsible for increased odds of diabetes but elevated liver enzyme activities were might be associated with increased odds of diabetes [16].

S No.	PRN No.	Viral load	Age/ Gender	Diagnosis of HCV	Treatment	Diabetes	Diabetes before/ after HCV	Diabetes type
1	009565/11	9.0 × 10 ⁴	26/Female	2 years	2 years	Yes	After	Type 1
2	013347/14	2.9 × 10 ⁴	45/Female	Recent	No	Yes	After	Type 2
3	007431/14	<3,000	54/Female	4-5 years	60 Inj.	Yes	After	Type 1
4	008139/09	<3,000	52/Male	4-5 years	6 months	Yes	Before	Type 2
5	008873/14	2.5 × 10 ⁴	40/Female	2 months	No	Yes	Before	Type 2
6	013860/14	<3,000	55/Female	4 years	6 months	Yes	Before	Type 2
7	014069/14	<12	54/Male	3 months	14 inj.	Yes	Before	Type 2
8	002628/14	3.1 × 10 ⁶	50/Male	1 year	Medicine	Yes	Before	Type 2
9	014087/14	1.0 × 10 ⁶	40/Female	7 years	6 months	Yes	After	Type 1
10	004751/12	4.7 × 10 ⁶	55/Female	3-4 years	72 inj.	Yes	After	Type 1
11	001236/08	<3,000	51/Female	8 years	No	Yes	After	Type 2
12	N.A	<3,000	32/female	1 year	No	Yes	After	Type 1

Table 2: Data showing information of diabetic patients: red color, green color, yellow Colors represent type-1, type-2 and pretreatment type-1 respectively.

A recent report from America concluded no association of diabetes with HCV infection. Previous studies that reported associations between HCV infection and diabetes can be attributed to elevated levels of liver enzymes. However another Recent report from Pakistan showed Very high association of diabetes with HCV infection at liver cirrhotic stage (P=0.01) and no association at chronic non cirrhotic stage of infection (OR=2.005, 95% CI: 1.15, 3.43). Most of our patients were either chronic or the disease stage information was not clear, possibly the selection of chronic HCV patient had led to our results showing no association [15].

Similarly, when we analyzed diabetes type 1 separately, 3.57% was suffering from type 1 in HCV infected patients, contrary to that there was not a single person was suffering from type 1 diabetes. In HCV infection population slight increased. Statistically, it is insignificant with p value 0.2050. Our results are not in accordance with the previous reports which clearly designate association of Type 1 diabetes as side effect of the treatment [12]. However, this is a small scale study and the data presented is not conclusive. HCV positive patients (n=51) were tested for their random glucose level, 6 patients were diabetic and 2 patients random glucose level was in pre-diabetic range (Table 4).

Sr. No.	Age	Gender	Diabetes
1	30	Female	No
2	30	Female	No
3	32	Male	No
4	38	Male	No

5	29	Female	No
6	35	Female	No
7	25	Male	No
8	52	Male	Yes
9	57	Male	Yes
10	45	Female	No
11	49	Female	Yes
12	56	Female	No
13	55	Male	No
14	45	Female	No
15	55	Female	Yes
16	57	Male	No
17	59	Male	No
18	49	Female	No
19	40	Female	No
20	49	Male	No
21	45	Female	Yes
22	51	Male	No
23	30	Male	No
24	40	Female	No
25	32	Female	No
26	30	Female	No
27	32	Male	No
28	32	Female	No
29	30	Male	No
30	34	Male	No
31	41	Male	No
32	32	Male	No
33	33	Male	No
34	30	Female	No
35	60	Male	No
36	51	Female	No
37	55	Female	No
38	43	Male	No
39	34	Female	No
40	55	Male	No

41	50	Female	No
42	30	Male	No
43	30	Male	No
44	53	Male	No
45	48	Female	No
46	50	Male	Yes
47	42	Female	No
48	50	Male	No
49	46	Male	No
50	35	Female	No
51	30	Female	No
52	30	Female	No
53	51	Female	No
54	53	Female	No
55	48	Female	No
56	58	Male	yes
57	51	Male	No
58	33	Male	No
59	49	Female	No
60	30	Female	No
61	32	Female	No
62	31	Female	No
63	30	Female	No
64	58	Male	No
65	52	Female	Yes
66	34	Male	No
67	32	Male	No
68	30	Male	No
69	30	Female	No
70	30	Female	No
71	63	Male	No
72	45	Female	Yes
73	50	Male	No
74	47	Female	No
75	40	Female	No
76	40	Male	Yes

77	31	Female	No
78	30	Male	No
79	28	Female	No
80	32	Female	No

Table 3: Data showing age, and diabetes status for control group, highlighted data shows diabetes condition (N=80).

Serial no.	PRN no.	Age/Gender	Date of diagnosis	Viral load	Glucose	Diabetes
1	013024/14	26/female	Recent	1.1×10^5	118 mg/dl	No
2	013046/14	53/Female	5 years	4.1×10^6	89 mg/dl	No
3	013056/14	27/Female	Not yet	<3,000	81 mg/dl	No
4	006718/14	41/Female	1 month	28	137 mg/dl	Yes
5	023138/12	46/Female	4 years	<3,000	81 mg/dl	No
6	013067/14	60/Female	3-4 years	1.0×10^5	95 mg/dl	No
7	003445/12	37/Female	4 years	3.6×10^5	103 mg/dl	No
8	009565/11	26/Female	2 years	9.0×10^4	66 mg/dl	No
9	013338/14	20/Male	2 years	1.6×10^6	84 mg/dl	No
10	024484/13	40/Female	1 year	<3,000	84 mg/dl	No
11	013342/14	35/Female	1 year	2.7×10^5	83 mg/dl	No
12	013350/14	42/Male	7 years	<3,000	84 mg/dl	No
13	013339/14	52/Female	Recent	1.0×10^5	71 mg/dl	No
14	013347/14	45/Female	Recent	2.9×10^4	201 mg/dl	Yes
15	023177/13	40/Female	1 year	6.3×10^5	95 mg/dl	No
16	013351/14	25/Female	3 years	7.4×10^4	96 mg/dl	No
17	013344/14	53/Female	13 years	6.4×10^5	142 mg/dl	Pre-diabetic
18	013365/14	42/Male	Recent	8.3×10^4	75 mg/dl	No
19	013834/14	46/Male	Recent	1.4×10^6	123 mg/dl	No
20	013827/14	Female	2-3 years	2.6×10^5	91 mg/dl	No
21	013839/14	45/Male	Recent	1.7×10^5	216 mg/dl	Pre-diabetic
22	013840/14	47/Female	2 years	2.5×10^6	113 mg/dl	No
23	013841/14	36/Male	2 months	<3,000	72 mg/dl	No
24	013853/14	35/Male	recent	3.7×10^6	68 mg/dl	No
25	011334/12	30/Female	2 years	<3,000	93 mg/dl	No
26	013850/14	20/Male	recent	1.4×10^6	84 mg/dl	No
27	013876/14	45/Female	Recent	<3,000	85 mg/dl	No
28	013860/14	55/Female	4 years	<3,000	347 mg/dl	Yes
29	013883/14	60/Female	5-6 months	<3,000	133 mg/dl	No

30	014069/14	54/Male	3 months	<12	162 mg/dl	Yes
31	014078/14	39/Male	recent	2.8×10^5	85 mg/dl	No
32	014077/14	19/Male	recent	7.3×10^6	74 mg/dl	No
33	002628/14	50/Male	1 year	3.1×10^6	225 mg/dl	Yes
34	014079/14	38/Female	Recent	5.2×10^4	83 mg/dl	No
35	009718/12	27/Female	2 years	8.2×10^6	101 mg/dl	No
36	014080/14	42/Female	recent	2.5×10^6	85 mg/dl	No
37	014087/14	40/Female	7 years	1.0×10^6	219 mg/dl	Yes
38	014092/14	22/Female	4-5 months	5.2×10^3	88 mg/dl	No
39	014102/14	40/Female	6 years	<3,000	102 mg/dl	No
40	014108/14	34/Male	1 year	3.5×10^6	77 mg/dl	No
41	006736/14	30/Male	6 months	<3,000	92 mg/dl	No
42	014106/14	49/female	3 months	<3,000	84 mg/dl	No
43	014110/14	27/female	1 month	1.9×10^6	114 mg/dl	No
44	014118/14	36/Male	Recent	2.2×10^5	76 mg/dl	No
45	014120/14	43/Male	2 months	1.4×10^6	75 mg/dl	No
46	014085/14	42/Male	Recent years	2.9×10^6	84 mg/dl	No
47	014769/13	40/Male	4 years	<3,000	79 mg/dl	No
48	001172/14	10/Male	3-4 months	3.9×10^4	73 mg/dl	No
49	004751/12	55/female	3-4 years	4.7×10^6	212 mg/dl	Yes
50	014125/14	36/Female	3-4 years	<3,000	84 mg/dl	No
51	021819/12	54/male	4 years	3.2×10^6	90 mg/dl	No

Table 4: Data showing random glucose levels of HCV patients (N=51): pink color indicates diabetic condition and blue color represents pre-diabetic condition.

Conclusion

Although insulin resistance is often reported in HCV infection, however, association of diabetes type 2 with HCV seems rare event. In present study, there is no significant association between HCV infection and diabetes mellitus type 2. It remains to be determined whether HCV infection leads to diabetes type 2 or vice versa. Type 1 diabetes mellitus is reported to be linked with antiviral therapy, but our results show insignificant association. However, this is a small scale study and the data presented is not conclusive.

Future Prospects

We further intend to evaluate insulin resistance in non-diabetic pathway in detail. We recommend studying type 1 diabetes marker in HCV patients, so that some alternative therapy could be recommended for predisposed patients. It is necessary to screen and control earlier for the presence of type 1 and type 2 diabetes mellitus.

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