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ASPARTATE AMINOTRANSFERASE AND GAMMA-GLUTAMYL TRANSFERASE: INTRIGUING CLINICAL BIOMARKERS IN DISCRIMINATION OF HEPATIC LESION BETWEEN HEPATITIS C INFECTED PATIENTS AND HEALTHY CONTROLS

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SUMMARY – Over 1.5 million new cases of chronic hepatitis C virus (HCV) infection occur each year, infecting an estimated 58 million people worldwide. We aimed to find differences in peripheral blood count, liver enzymes and degradation products between HCV infected and healthy controls, and their impact on detection of the disease and discrimination of the diseased from non-diseased subjects. We performed laboratory testing for peripheral blood count, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (γ-GT) and bilirubin in 40 HCV patients and 40 healthy controls. There were statistically significant differences in leukocytes (p=0.001), ALT (p<0.0001), AST (p<0.0001), ALP (p<0.0001), γ-GT (p<0.0001), total bilirubin (p<0.018) and indirect bilirubin (p<0.030) between the HCV infected and control groups. On multiple regression, the independent variables of HCV titer (p=0.5091), granulocytes (p=0.7061) and total bilirubin (p=0.2022) showed no impact on liver lesion estimated by a dependent variable of γ-GT. On logistic regression, only AST [p=0.0112, odds ratio (OR)1.2161, area under the curve (AUC) 0.887] and γ-GT (p=0.0283, OR 1.1041, AUC 0.815) showed a statistically significantly positive predicting value when discriminating healthy subjects and diseased patients. In conclusion, HCV titer, granulocytes and total bilirubin did not show a statistically significant impact on hepatic lesion expressed by γ-GT, whereas only AST and γ-GT showed a statistically significant positive predicting value to discriminate infected patients from healthy controls. Each unit increase in AST and γ-GT resulted in 21.6% and 10.4% higher possibility of HCV infection, respectively.

Key words: *Hepatitis C virus (HCV); Aspartate aminotransferase; Gamma-glutamyl transferase; HCV titer; Liver enzymes*

Introduction

In affluent nations, hepatitis C virus (HCV) is the most prevalent blood-borne infection, and 60% of new HCV infections are caused by injecting drugs[1]. Elevated liver enzymes that mainly include alanine amino-

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transferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyl transferase (γ-GT) are widely observed in patients suffering from HCV infection[2]. Aminotransferases are most present and concentrated in the liver. AST is an enzyme that, in addition to hepatocytes, is also present in the skeletal muscles, heart, brain, kidneys, and red blood cells, while ALT has low concentrations in the kidneys and skeletal muscles[3]. This leads to a conclusion that ALT is more specific for liver injury. In the liver, the localization of ALT is only in the cell cytoplasm, while AST can be cytosolic and mitochondrial with about 80% of the total liver activity[4]. Sinusoidal cells in the liver carry out ALT and AST elimination[3,4]. The enzyme γ-GT is present in the cell membrane of the heart, seminal vesicles, kidneys, bile duct, spleen and gallbladder[5], and it is traditionally considered a predictive marker for liver dysfunction, bile duct ailments, and alcohol consumption[6]. While γ-GT measurement may not be useful in the diagnosis of specific types of liver disease, it is one of the best predictors of overall liver mortality[7].

Hepatitis C is a viral infection that targets the liver and causes inflammation. An increase in serum γ-GT levels is seen in approximately 30% of patients with chronic HCV infection; γ-GT levels will peak in the second or third week of illness and may remain elevated for up to six weeks[8]. It is necessary to establish the correlation between HCV and liver enzymes. Liver enzymes have a pivotal role in the control of various hepatic complications in patients. It is said that liver enzyme correlation is necessary to be identified in chronic HCV patients suffering from virus infection fibrosis progression[9]. There is a need for adequate follow-up of the patients infected with HCV to improve the understanding of chronic HCV infection and clinical consequences associated with the infection. The process of necroinflammation is associated with the presence of liver enzymes, including ALT and AST. When the liver damage starts, ALT is released in the bloodstream. The progression of fibrosis and the concentration of aminotransferases in the blood have no significant relationship[10,11]. Therefore, ALT is considered as a significant sign of liver inflammation; however, it does not reflect the progression of liver fibrosis[10]. The majority of HCV infected patients do not experience liver related complications in the initial years of developing infection because HCV is considered as a slowly progressive chronic disease. Determining hepatic decompensation, the rate at which liver fibrosis develops and potential mediators of the condition are acknowledged as being serious risk factors and effects of chronic HCV that result from liver disease[11,12]. The ALT levels are used for the diagnosis of acute condition of hepatitis. The ALT levels remain elevated for one-two months after the onset of HCV infection. However, because ALT typically returns to its normal level in approximately 3-6 months, the levels of ALT are not increased in patients with chronic hepatitis[11]. Any liver damage, acute or chronic, eventually results in an increase in serum aminotransferase concentrations.

The aims of this study were to find differences in clinical parameters of HCV infected patients and control group; to determine the potential predictive impact of HCV titer, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), granulocytes and total bilirubin on hepatic lesion expressed by γ-GT; and to find the importance of the predictive value of AST, ALT, alkaline phosphatase (ALP), γ-GT, total bilirubin, and granulocytes in the detection of the disease and discrimination of the HCV infected patients from non-diseased subjects.

Methods

Patients

Retrospective blood test results from 40 HCV patients with positive tests and 40 subjects included as controls were examined. The median age was 37.5 years in the HCV group and 58.0 years in the control group. The percentage of male was 82.5% in the HCV group and 47.5% in the control group. The mean value and standard deviation (SD) of the HCV titer was 14.41±4.96.

Assessment

This research was conducted at Dr Trifun Panovski Clinical Hospital in Bitola, which includes Departments of Medical Biochemistry and of Infectious Diseases. Complete blood counts [white blood cell (WBC), neutrophil, lymphocyte, granulocyte and platelet counts] were measured in EDTA-anticoagulated blood samples using Sysmex XP 300/Sysmex XN 550 analyzer (Sysmex). Following that, NLR and PLR values were computed for each patient.

According to the manufacturer's recommendations, Abbott Alinity CI analyzer was used for biochemical and immunologic examinations. ALP, ALT, AST, total bilirubin, direct bilirubin, γ-GT, and anti-HCV II were determined.

Statistical analysis

On statistical analysis, SPSS for Windows, version 28.0, was used (IBM Corp., Released 2021; IBM SPSS Statistics for Windows, Armonk, NY, USA). The results were expressed as number, percentage, mean and standard deviation (SD), median and 25th to 75thpercentile. We used the mean as a measure of the central tendency for data with symmetric distribution. An appropriate test for difference between the groups was used, i.e., t test for paired data, Wilcoxon matched pair test and χ^2-test. Multiple regression analysis was used to find the determinant of γ-GT in infected patients. Logistic regression was used to predict the factor influencing a disease. Analysis of the Receiver Operating Characteristic (ROC) curve was used as a discriminating model for identifying subjects with and without disease. The level of statistical significance was set at p<0.05 (two-sided).

Results

Descriptive statistics

Demographic and clinical characteristics of both study groups (infected patients and healthy subjects), a total 80 subjects, mean age 37.5 years (HCV group) and 58.0 years (control group) are presented in Table 1.

There was a statistically significant difference in age (p=0.0004), sex (p 0.0011), WBC (p=0.001), ALT (p<.0001), AST (p<0.0001), ALP (p<0.0001), γ-GT (p<0.0001), total bilirubin (p<0.018) and indirect bilirubin (p<0.030) between HCV infected patients and control group. The mean, median and their confidence

Table 1. Demographic and clinical parameters of infected patient group and control group, and their differences

	HCV infected (N=40)	Control group (N=40)	Tests (t, Z, χ2)	p
Age (years)	37.5 (34.0-43.0)	58.0 (46.0-68.5)	-3.515	**0.0004**
Sex (male, n, %)	33 (82.5)	19 (47.5)	10.635	**0.0011**
HCV (S/CO)	14.41±4.96	/	/	/
RBC (x10^{12}/L)	4.87±0.47	4.79±0.47	-0.843	0.404
Hemoglobin (g/L)	143.07±15.49	144.0±10.78	0.336	0.738
WBC (x10^9/L)	9.34±3.64	7.07±1.68	-3.574	**0.001**
Serum iron (μmol/L)	17 (10.75-22.65)	/	/	/
Lymphocytes (x10^9/L)	2.88±1.14	2.44±1.22	-1.534	0.133
Granulocytes (%)	0.580±0.146	0.566±0.108	0.552	0.584
NLR	1.70 (1.09-2.50)	1.63 (1.24-2.21)	0.605	0.545
PLR	77.4 (63.24-108.56)	121 (84.47-144.94)	-1.411	0.158
Platelets (x10^9/L)	239.52±4.57	247.55±57.79	0.482	0.633
ALT (U/L)	44 (30.5-81.0)	18.5 (14.5-22.5)	4.886	**<0.0001**
AST (U/L)	41 (25.0-55.0)	19 (16.5-22.0)	5.027	**<0.0001**
ALP (U/L)	85.5 (65.5-97.0)	62.0 (48.0-75.5)	3.804	**<0.0001**
γ-GT (U/L)	36 (26.0-58.0)	21.5 (16.0-26.0)	4.812	**<0.0001**
Total bilirubin (μmol/L)	11.75 (10.05-18.55)	5.8 (4.75-8.0)	-2.474	**0.018**
Direct bilirubin (μmol/L)	4.65 (3.4-6.3)	3.8 (3.45-5.2)	1.333	0.183
Indirect bilirubin (μmol/L)	6.95 (5.55-12.15)	5.8 (4.75-8.0)	-2.257	**0.030**

HCV = hepatitis C virus; t = test for paired data; Z = Wilcoxon paired samples test; χ^2-test=Chi-squared test; RBC = red blood cell; WBC = white blood cell; NLR = neutrophil-to-lymphocyte ratio; PLR = platelet-to-lymphocyte ratio; ALT = alanine aminotransferase; AST = aspartate aminotransferase; ALP = alkaline phosphatase; γ-GT = gamma-glutamyl transferase; results are presented as n (number), % (percent), mean and standard deviation (SD), median and 25th to 75th percentile

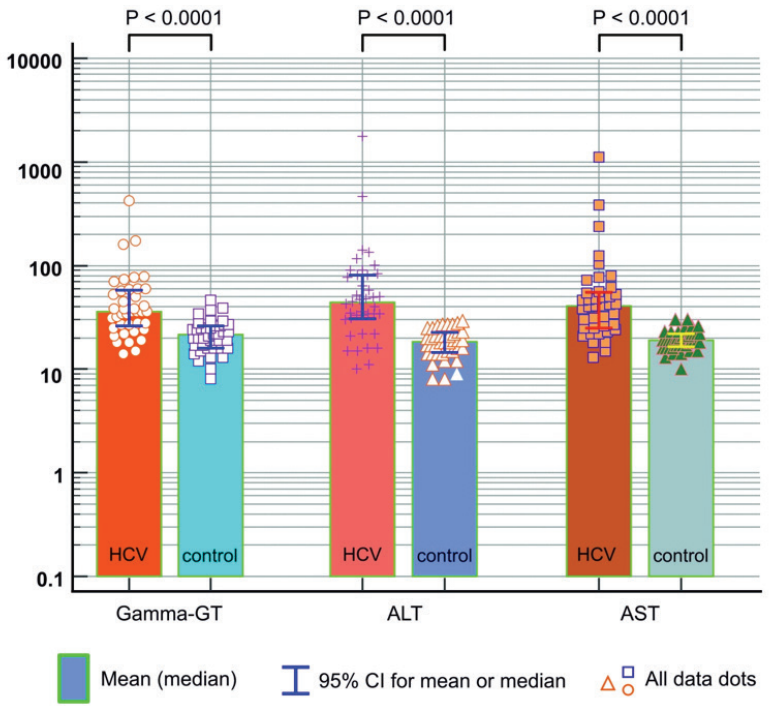

Fig. 1. The box-and-whisker diagram of γ-GT, ALT and AST in HCV infected patients and control group, and their differences.

HCV = hepatitis C virus; γ-GT = gamma-glutamyl transferase; ALT = alanine aminotransferase; AST = aspartate aminotransferase

interval (CI) for γ-GT, ALT and AST in both study groups and their differences are presented by the box-and-whisker diagram in Figure 1.

Multiple regression analysis

We used multiple regression analysis to find predictable values of independent variables (HCV titer, NLR, PLR, granulocytes and total bilirubin) on the dependent variable γ-GT as a measure of hepatic lesion. Assessments (standardized coefficient, standard error, t, p, r partial, r semipartial and variance inflation factor (VIF)) on the independent predictor of determinants for hepatic lesion increase in infected patients after stepwise multiple regression analysis are shown in Table 2.

There was no statistical significance in the predictable values of the independent variables of HCV titer (p=0.5091), NLR (p=0.5193), PLR (p=0.4969), granulocytes (p=0.7061) and total bilirubin (p=0.2002) for the hepatic lesion estimated by γ-GT as a dependent variable. The coefficient of determination (0.08416) showed that only 8.416% of total variability was explained with linear relation between γ-GT and HCV, or that 8.416% from γ-GT was dependent on HCV, but it was not statistically significant. Multiple correlation coefficient (0.2901) is a measure of how well a given variable (γ-GT) can be predicted using a linear function of a set of other variables (HCV titer, NLR, PLR, granulocytes and total bilirubin). The variables mentioned above cannot be used to predict the degree of hepatic lesion in HCV infected patients.

Logistic regression

The results of stepwise binary logistic regression [where the target variable "existence of the disease" is binary, that is, it can take only two values (disease, 1; health, 0)] are presented in Table 3.

We inserted the variables of ALT, AST, γ-GT, total bilirubin, ALP and granulocytes in the logistic regression model to find the possibility of predicting the disease [dependent "Y": disease (1), health (0)]. Only AST (p=0.0112) and γ-GT (0.0283) had a statistically significant positive predicting value when discriminating healthy from diseased subjects. Based on the odds ratio coefficients, the probability of the patients being infected

Table 2. Multiple stepwise regression analysis of determinants of γ-GT in HCV infected patients

Dependent Y	γ-GT						
Least square multiple regression							
Method	Backward						
Enter variable if p<	0.05						
Remove variable if p>	0.8						
Sample size	40						
Coefficient of determination R^2	0.08416						
R^2-adjusted	-0.05053						
Multiple correlation coefficient	0.2901						
Residual standard deviation	69.7101						
Regression Equation							
Independent variables	Coefficient	SE	t	p	$r_{partial}$	$r_{semipartial}$	VIF
(Constant)	75.0787						
HCV	-1.5795	2.3671	-0.667	0.5091	-0.1137	0.1095	1.106
NLR	-5.1099	7.8473	-0.651	0.5193	-0.111	0.1069	6.439
PLR	0.1881	0.2739	0.687	0.4969	0.117	0.1127	4.953
Granulocytes	-1.8296	4.8114	-0.38	0.7061	-0.0651	0.06241	2.007
Total bilirubin	0.2482	0.19	1.306	0.2002	0.2186	0.2144	1.142
Analysis of Variance							
Source	DF	Sum of squares	Mean square				
Regression	5	15182.06478	3036.41296				
Residual	34	165223.0352	4859.50104				
F-ratio	0.62484						
Significance level	p=0.6819						

HCV = hepatitis C virus; γ-GT = gamma-glutamyl transferase; NLR = neutrophil-to-lymphocyte ratio; PLR = platelet-to-lymphocyte ratio; SE = standard error; DF = degrees of freedom; VIF = variance inflation factor

was 1.2161 (1.1041) times higher at elevated AST (γ-GT) values, respectively. This binary model showed statistical significance in detecting the illness based on χ^2 (57.654) and p-value (<0.0001), and can be used for prediction. The investigated variables (AST and γ-GT) can be used to distinguish the diseased from healthy subjects.

Receiver operating characteristic analysis

The results of discrimination model to distinguish between subjects with and without disease (hepatitis C) by γ-GT and ASTas predictors are shown in Figure 2. The A and B points presented the maximal sensitivity/specificity pair for AST (80.00%/87.50%) and γ-GT (65.00%/90.00%), respectively. The area under the curve (AUC) for AST and γ-GT was 0.887 (CI=0.796 to 0.947, p<0.001) and 0.815 (CI=0.713 to 0.893, p<0.0001), respectively.

There was no statistical difference in AUCs for AST and γ-GT (z statistic=1.205, p=0.0713). Both predictor variables of AST and γ-GT were equal in distinguishing healthy from diseased participants. The Youden index "J" for AST (0.675) and associated criterion (AC) >23 U/L and J for γ-GT (0.550) and AC >29 U/L were significant statistical parameters confirming them in distinguishing between diseased patients and healthy subjects. The AC serves as a stand-in for a cut-off value to identify the measuring scales dividing the paths, which are used to classify test findings into distinct groups (i.e., diseased *vs*. healthy).

Discussion

We aimed to find differences in the clinical parameters (NLR, PLR, granulocytes, and liver enzymes) between 40 HCV infected patients and 40 control

Table 3. Binary logistic regression in disease prediction by analysis of multiple factors influencing negative/positive outcome

Logistic regression				
Dependent Y	Disease (1), Health (0)			
Method	Stepwise, Enter variable if p<0.05			
Sample size	N=80	Positive cases 40 (50.0%)		
Overall Model Fit				
Null model -2 Log Likelihood	110.904			
Full model -2 Log Likelihood	53.249			
Chi-squared	57.654			
DF	3			
Significance level	p<0.0001			
Coefficients and standard errors				
Variable	Coefficient	SE	Wald	p
ALT	-0.003251	0.049637	0.00429	0.9478
AST	0.19561	0.077129	6.432	0.0112
γ-GT	0.099036	0.045169	4.8074	0.0283
Constant	-7.58659	1.9109	15.7623	0.0001
Variables not included in the model: total bilirubin, alkaline phosphatase, granulocytes.				
Odds ratios and 95% confidence intervals				
Variable	Odds ratio		95% CI	
ALT	0.9968		0.9043 to 1.0986	
AST	1.2161		1.0454 to 1.4145	
γ-GT	1.1041		1.0106 to 1.2063	

DF = degree of freedom; ALT = alanine aminotransferase; AST = aspartate aminotransferase; γ-GT = gamma-glutamyl transferase; CI = confidence interval

group subjects, and their impact on the detection of the disease and discrimination of the diseased from non-diseased subjects. Laboratory tests yielded statistically significant differences in WBC, ALT, AST, ALP, γ-GT, total bilirubin and unconjugated bilirubin between HCV infected patients and control group. Age and gender differences between the two groups were found as well.

The HCV-infected group showed significantly higher WBC, ALT, AST, ALP, γ-GT, total and unconjugated bilirubin. This group was more likely to have high WBC and granulocytes, low platelet counts and low PLR[14]. Our study showed no significant difference in granulocytes, platelets and PLR, only in WBC count, but not in its differential (lymphocytes, granulocytes) as established systemic inflammatory markers. Although assumed to be prognostic factors in many diseases such as inflammatory diseases, cancer and cardiovascular disease, NLR and PLR did not show relevant significance in distinguishing the HCV and control group[15]. Despite the fact that PLR is closely related to HCV severity, we did not find statistical significance in this ratio between the two groups (p=0.158). Streiff *et al.* found significant peripheral blood count abnormalities such as low platelet counts and high WBC, but not anemia, which partially matches the results of our study. Infected patients in our study showed no signs of thrombocytopenia and anemia, nor significant intergroup differences in hemoglobin level or red blood cell count.

The major abnormalities in HCV patients that differed significantly were the results of liver enzyme activities (ALT, AST, ALP and γ-GT) and degradation products of hemoglobin (total bilirubin and in-

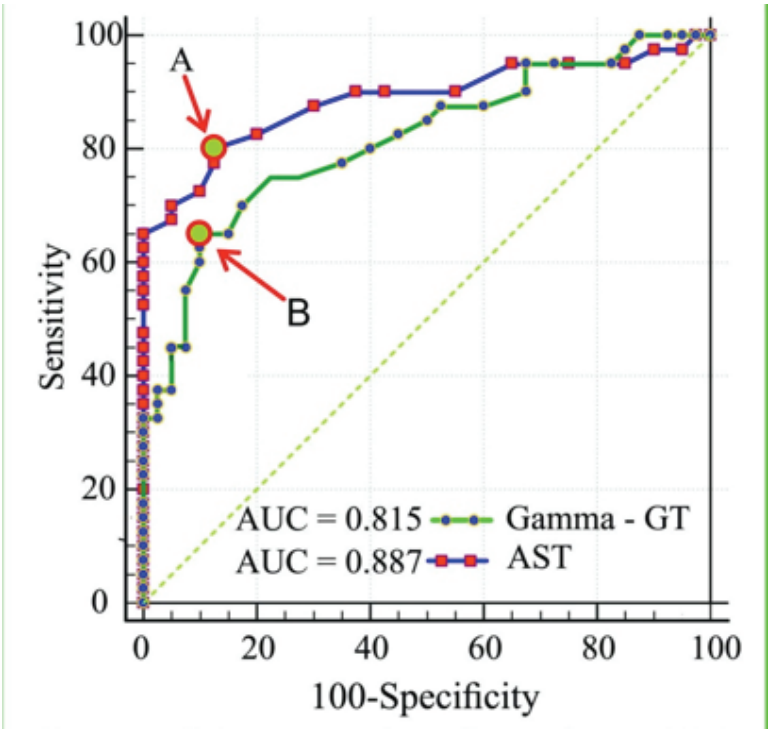

Fig. 2. Receiver operating characteristic curves for γ-GT and AST as predictors of HCV infection.
HCV = hepatitis C virus; γ-GT = gamma-glutamyl transferase; AST = aspartate aminotransferase; AUC = area under curve

direct bilirubin). Practitioners should screen people with unexplained neutropenia and thrombocytopenia for HCV infection, as is currently advised for patients with increased liver enzyme levels because these behaviors are frequently not adequately diagnosed[16].

Looking for the predictive value of the independent variables (HCV titer, NLR, PLR, granulocytes and total bilirubin) on the dependent variable γ-GT as a measure of hepatic lesion, using multiple regression analysis, we found that none of the variables mentioned above could predict the degree of hepatic lesion in HCV patients. Due to negative result of the predictive value in multiple regression, we applied logistic regression, where we assigned binary values for the diseased HCV group (1) and control group (0). The results of logistic regression showed that only AST and γ-GT had a statistically significant positive predicting value to discriminate healthy subjects and infected HCV patients. The patients with increased AST had by 21.6% higher possibility to be infected; and those with increased γ-GT had by 10.4% higher possibility to be infected with HCV. This confirmed and emphasized the importance of the liver enzymes AST and γ-GT in the assessment of hepatic lesions, thus their possibility to be useful in distinguishing the diseased from healthy subjects. Silva *et al.* found that grading of inflammatory activity and staging of histologically confirmed and graded fibrosis in HCV patients were associated with elevated γ-GT levels[17]. Although γ-GT is a marker of liver function, many studies demonstrated it to be associated with other morbidity and mortality causes independently of liver disease, including cardiovascular disease[18,19]. It was found that elevated serum γ-GT levels were linked to an increased risk of myocardial infarction and cardiac mortality in those with coronary heart disease[19].

In HCV liver parenchymatous lesions, this enzyme seems to be helpful as a marker of more severe liver disease[17]. It can be concluded from the findings of several studies that both liver enzymes (AST and ALT) showed elevated expression in HCV patients, with ALT being more pronounced than AST[20], which is similar to our study results. The logistic regression results in our study highlight the importance of AST over ALT when assessing a liver lesion. The histopathologic changes in the liver were correlated more significantly with AST, however, no significant correlation was observed between ALT and pathologic

status of the liver[21]. Despite the predominant importance of AST over ALT in liver lesions, which was demonstrated by the results of our study, Karmen *et al.* report that ALT is a better indicator of parenchymal liver damage than AST which is present in cardiac and skeletal muscle. Since ALT is primarily found in the cytosol of the liver, with minor amounts present elsewhere, it is more specific[22-24].

The results of ROC curves (AUC, J and AC) for AST and γ-GT, with high sensitivity and specificity confirming them to distinguish the diseased and healthy individuals, suggested that the liver enzymes AST and γ-GT could be used to distinguish the diseased from healthy subjects and to raise suspicion of a liver lesion, not only in HCV but also in other parenchymatous diseases of the liver, including hepatic steatosis, metabolic diseases, and fibrosis.

Conclusions

We conclude that significant differences in demographic and laboratory parameters between the HCV group and control group were found in age, sex, WBC, ALT, AST, ALP, γ-GT, total bilirubin and indirect bilirubin. The HCV titer, NLR, PLR, granulocytes and total bilirubin did not show a statistically significant impact on hepatic lesion expressed by γ-GT. Of all examined laboratory parameters, only AST and γ-GT showed a statistically significant positive predicting value to discriminate the diseased from healthy controls. Each unit increase in AST and γ-GT over their corresponding AC resulted in 21.6% and 10.4% higher possibility to be infected with HCV compared with healthy control group, respectively.

Study limitations

A small number of participants was the major limitation of the study, along with age and gender inhomogeneity of the participants in both groups, as well as the lack of additional demographic parameters such as body mass index, alcohol consumption, smoking status, etc. Another limitation of this study was variability of laboratory analyses depending on the stage of the disease, i.e., when the infection had occurred, since the test becomes positive 2-3 months later. Future studies should include some of the acute-phase proteins (serum iron, C-reactive protein, hepcidin, ferritin, fibrinogen, ceruloplasmin, serum albumin and leptin) in the analysis of the HCV disease prediction[24,25]

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Sažetak

ASPARTAT AMINOTRANSFERAZA I GAMA-GLUTAMIL TRANSFERAZA: INTRIGANTNI KLINIČKI BIOLOŠKI BILJEZI ZA RAZLIKOVANJE JETRENOG OŠTEĆENJA IZMEĐU BOLESNIKA ZARAŽENIH VIRUSOM HEPATITISA C I ZDRAVIH KONTROLNIH OSOBA

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Svake godine u svijetu se bilježi više od 1,5 milijuna novih slučajeva infekcije virusom hepatitisa C (HCV), odnosno procjenjuje se da ova zaraza zahvaća 58 milijuna ljudi. Cilj ovog istraživanja bio je utvrditi razlike u perifernoj krvnoj slici, jetrenim enzimima i degradacijskim produktima između osoba zaraženih HCV-om i zdravih osoba te njihov utjecaj na otkrivanje bolesti i razlikovanje oboljelih od nezahvaćenih osoba. Proveli smo laboratorijske testove periferne krvne slike, alanin aminotransferaze (ALT), aspartat aminotransferaze (AST), alkalne fosfataze (ALP), gama-glutamil transferaze (γ-GT) i bilirubina kod 40 bolesnika s infekcijom HCV i 40 zdravih ispitanika. Utvrđena je statistički značajna razlika u leukocitima (p=0,001), ALT (p<0,0001), AST (p<0,0001), ALP (p<0,0001), γ-GT (p<0,0001), ukupnom bilirubinu (p<0,018) and indirektnom bilirubinu (p<0,030) između skupine bolesnika s infekcijom HCV i skupine zdravih ispitanika. Multipla regresija nije pokazala nikakav utjecaj neovisnih varijabla titra HCV (p=0,5091), granulocita (p=0,7061) i ukupnog bilirubina (p=0,2022) na oštećenje jetre procijenjeno ovisnom varijablom γ-GT. Logistička regresija pokazala je statistički značajnu pozitivnu prediktivnu vrijednost u razlikovanju zdravih osoba i bolesnika zareaženih HCV-om samo za AST [p=0,0112, OR 1,2161, AUC 0,887] i γ-GT (p=0,0283, OR 1.1041, AUC 0,815). Zaključuje se da titar HCV, granulociti i ukupni bilirubin nisu pokazali statistički značajan učinak na jetreno oštećenje izraženo pomoću γ-GT, dok su samo AST i γ-GT pokazali statistički značajnu pozitivnu prediktivnu vrijednost u razlikovanju oboljelih od zdravih kontrolnih osoba. Porast razina AST i γ-GT za svaku mjernu jedinicu povećalo je mogućnost HCV infekcije za 21,6% odnosno 10,4%.

Ključne riječi: *Virus hepatitisa C (HCV); Aspartat aminotransferaza; Gama-glutamil transferaza; Titar HCV; Jetreni enzimi*