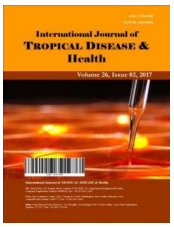

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Correlation of Small Dense Low Density Lipoprotein, Tumour Necrosis Factor - alpha with Liver Enzymes in Chronic Hepatitis B Patients

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Authors' contributions

This study was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study investigated the relationship between small dense low density lipoprotein (sdLDL), tumour necrosis factor-alpha (TNF-α), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) in chronic hepatitis B patients.
Duration of Study: June 2018- March 2019.
Subjects and Methods: Sixty (60) participants were recruited for this cross sectional study. They comprised thirty (30) clinically diagnosed chronic hepatitis B virus (HBV) infected patients attending clinic at a tertiary hospital in Osogbo, Osun state, Nigeria. Thirty (30) apparently healthy volunteers were recruited as control subjects after fulfilling the inclusion criteria. Anthropometric measurements were performed using standard method. About 6mL of venous blood was collected from each study participant, serum was extracted and kept at -80^{o}C until time of analysis. Small dense LDL, TNF-α, AST, ALT and ALP were determined using enzyme linked immunosorbent assay and colorimetric method as appropriate. Data analysis was done using Student's t-test for

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comparison of variables and Pearson's correlation was used to determine the relationship between variables. *P*–value less than 0.05 was considered significant.
Results: SdLDL, TNF-α, AST and ALT were significantly elevated in HBV patients when compared with the control subjects (*P*<0.05). SdLDL had a significant positive correlation with TNF-α (*P*=0.03), AST (*P*=0.01), ALT (*P*=0.00). TNF-α had a significant positive correlation with AST (*P*=0.02) and ALT (*P*=0.00).
Conclusion: This study revealed a noteworthy positive relationship between sdLDL, TNF-α and hepatic aminotransferases in chronic hepatitis B patients.

Keywords: Hepatitis B virus; tumour necrosis factor alpha; liver enzymes; small dense low density lipoproteins.

1. INTRODUCTION

Viral hepatitis is now recognized as a major public health challenge that requires an urgent response [1]. In 2015, about 325 million people were living with chronic hepatitis infections worldwide and it was reported that approximately 1.34 million people died of hepatitis globally [2]. This global mortality is comparable to deaths caused by tuberculosis and human immunodeficiency virus (HIV). While deaths resulting from tuberculosis and HIV appear to be declining, deaths from hepatitis are on the increase.

Hepatitis B viral infection has been described as one of the leading causes of mortality worldwide with about 650,000 annual deaths [2]. Hepatitis B viral infection poses a major threat to human health and it is highly prevalent in developing countries [3]. The prevalence of Hepatitis B infection is about 12% in Nigeria [4].

Hepatitis B virus has the potential to affect the functional integrity of the liver of an infected host. Liver as a homeostatic organ plays a pivotal role in lipid metabolism. Thus, the circulating levels of lipids in plasma depend greatly on the functionality of the liver. In the setting of acute or chronic hepatic dysfunction circulating lipids and lipoproteins are altered with respect to quantity as well as pattern of their electrophoretic mobility [5].

Previous studies documented diverse reports about the alterations of serum lipids in patients suffering from acute hepatitis due to the actions of hepatotropic viruses [6-8]. Additionally, it has been reported that chronic HBV infection is associated with elevated levels of low density lipoprotein (LDL), which is known to be a predictor of atherosclerotic cardiovascular disease risk [9-13].

Low-density lipoprotein consists of several subclasses of particles with different sizes and densities and they include the large buoyant, intermediate and small dense (sd) LDL particles. It is well documented that sdLDL cholesterol (sdLDL-C) proportion is a better marker for prediction of cardiovascular disease than total LDL-C [14,15].

Furthermore, activation of the immune response during viral hepatitis leads to the production of many pro-inflammatory cytokines that act as mediators of disease activity [16]. These pro-inflammatory cytokines particularly interleukin-6 (IL-6), interleukin-1 (IL-1) and tumour necrosis factor-alpha (TNF-α) appear to accentuate lipogenesis [17].

Even though previous studies have documented that viral hepatitis might interfere with lipid metabolism, however, the link between sdLDL, TNF-α and liver enzymes in individuals with hepatitis B patients has not been fully elucidated. The present study therefore aimed to determine the association between sdLDL, TNF-α, AST, ALT and ALP in chronic hepatitis B patients visiting a tertiary hospital in the south-western part of Nigeria.

2. MATERIALS AND METHODS

2.1 Subject Selection

A total of sixty (60) subjects were recruited for this analytical cross-sectional study. The test group comprised thirty (30) clinically diagnosed chronic hepatitis B virus (HBV) infected patients attending clinic at the Department of Gastroenterology, Ladoke Akintola University of Technology Teaching, Osogbo, Osun state, Nigeria. These patients continuously tested positive for HBsAg for more than one year during their periodic visit to the clinic and they had one

or more of these features; pallor, jaundice and liver enlargement. The control group comprised thirty (30) age matched apparently healthy HBV seronegative individuals.

A short structured questionnaire was administered to each study participant to obtain information on age, alcohol use, drug use, smoking habits, medications and established diseases. Persons diagnosed with dyslipidemia and other metabolic conditions, record of alcoholism, smoking, usage of medications that affect lipid status and pregnant women were excluded from this study.

2.2 Blood Pressure and Anthropometric Measurement

The blood pressure was measured using mercury sphygmomanometer with appropriate cuff size. Korotkoff phases 1 and 5 were used. Body weight in kilogram (kg) was measured using a standard weighing scale and height (m) was measured using stadiometer. Body mass index (BMI) was calculated as the ratio of body weight (kg) to the square of height (m^2).

2.3 Sample Collection and Assay Methodology

About 6 milliliters (mL) of venous blood was collected from each participant and dispensed into plain bottles to obtain serum which was aliquoted into a small vial and stored at -80^{o}C until time of analysis for the determination of small dense low density lipoprotein (sdLDL), tumour necrosis factor-alpha (TNF-α), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP).

2.3.1 Detection of hepatitis B surface antigen (HBsAg)

The serum samples of subjects were screened to detect the presence of hepatitis B surface antigen. Fifty microliter (50µL) of serum was added vertically into the hole on the cassette and the result was read after 15 minutes (Melsin Medical Co., Limited, China). Appearance of two distinct red lines; one line at the control region (C) and the other at the test region (T) indicated positive test. Whereas appearance of only one red line, at the control region (C) indicated negative test. The result was invalid when the line at the test region appeared but the control region failed to appear.

2.3.2 Determination of liver enzymes

The serum activities of ALT and AST were determined colorimetrically using Randox reagents (Randox Laboratories, UK) as described by Adelakun et al. [18]. The serum activities of ALP were determined colorimetrically using Randox reagents (Randox Laboratories, UK) as described by Airaodion et al. [19].

2.3.3 Determination of sdLDL

Small dense LDL (sdLDL) was analyzed based on the principle of solid phase enzyme linked immunosorbent assay (ELISA) using a unique monoclonal antibody directed against distinct antigenic determinant on sdLDL molecule immobilized on microtitre wells with kits supplied by ElabScience, Biotech, Ltd (USA). The standard working solution, biotinylated detection ab working solution and HRP conjugate working solution were prepared according to the manufacturer's instruction.

One hundred microliter (100µL) of sdLDL standards, samples and controls were added to appropriate wells. One hundred microliter (100µL) of biotinylated detection ab, solution was added to each well, they were mixed thoroughly and then incubated at 37ºC for 60 minutes, after which the wells were washed 3 times. One hundred microliter (100µL) of HRP conjugate was then added to each well and was incubated at 37ºC for 30 minutes after which the wells were washed 5 times. Ninety microliter (90µL) of substrate reagent was added to each well and was incubated at 37ºC for 15 minutes after which 50µL of stop solution was added to each well to stop the reaction. Absorbance was read at 450nm with a microtitre well reader. The grades of standard were used to plot a curve of absorbance against concentration for the calculation of sdLDL concentration.

2.3.4 Determination of TNF-alpha

Tumour necrosis factor-alpha(TNF-alpha) was analyzed based on the principle of solid phase enzyme linked immunosorbent assay (ELISA) using a unique monoclonal antibody directed against distinct antigenic determinant on TNF-alpha molecule immobilized on microtitre wells with kits supplied by ElabScience, Biotech, Ltd (USA). The standard working solution, biotinylated detection ab working solution and

HRP conjugate working solution were prepared according to the manufacturer's instruction.

One hundred microliter (100µL) of TNF-alpha standards, samples and controls were added to appropriate wells. One hundred microliter (100µL) of biotinylated detection ab. solution was added to each well, they were mixed thoroughly and then incubated at 37ºC for 60 minutes, after which the wells were washed 3 times. One hundred microliter (100µL) of HRP conjugate was then added to each well and was incubated at 37ºC for 30 minutes after which the wells were washed 5 times. Ninety microliter (90µL) of substrate reagent was added to each well and was incubated at 37ºC for 15 minutes after which 50µL of stop solution was added to each well to stop the reaction. Absorbance was read at 450nm with a microtitre well reader. The grades of standard were used to plot a curve of absorbance against concentration for the calculation of TNF-alpha concentration.

2.4 Statistical Analysis

Data analysis was done using SPSS version 21.0. All values were expressed as mean±standard deviation for test and control groups. Comparison of variables was done using Student's t-test and Pearson's correlation was used to determine the relationship between variables. $P < 0.05$ was considered to be statistically significant.

3. RESULTS

The age, anthropometric and biochemical parameters of the study participants are summarized in Table 1. The mean age, BMI and blood pressure of the case and control subjects were not statistically significant ($P >0.05$). The mean levels of sdLDL, TNF-α and mean activities of AST, ALT were significantly elevated in hepatitis B patients compared with control. ($P < 0.05$).

Table 2 shows the correlation between sdLDL and other biochemical parameters in HBV patients. Small dense LDL had significant positive correlation with TNF-α (P=0.03), AST (P=0.01) and ALT (P=0.00). There was also positive correlation with ALP but not significant ($P > 0.05$).

Table 3 shows the correlation between TNF-α, AST, ALT and ALP in HBV patients. TNF-α had significant positive correlation with AST (P=0.02) and ALT (P=0.00) but not with ALP ($P > 0.05$).

Table 1. Age, anthropometric and biochemical parameters of the study participants

Parameters	HBV	Control	*P*-value
Age (years)	35.6±8.7	32.3±6.4	0.64
BMI (kg/m^2)	23.7±3.9	24.8±4.3	0.14
SBP (mmHg)	128.4±12.5	125.2±8.4	0.34
DBP (mmHg)	78.2±7.4	75.6±5.9	0.22
AST (IU/L)	56.8±33.5	28.2±12.5	0.00*
ALT (IU/L)	46.2±23.2	21.1±14.3	0.00*
ALP (IU/L)	65.3±23.7	58.2±16.8	0.16
SdLDL(nmol/mL)	67.9±23.8	29.8±15.9	0.00*
TNF-α (pg/mL)	29.2±13.5	15.7±10.5	0.01*

**Statistically significant at P<0.05. Results are expressed as mean±standard deviation. BMI-Body mass index; SBP-systolic blood pressure; DBP- diastolic blood pressure; AST-aspartate aminotransferase; ALT- alanine aminotransferase; ALP-alkaline phosphatase; sdLDL-small dense low density lipoprotein; TNF-α- tumour necrosis factor-alpha*

Table 2. Correlation between sdLDL, AST, ALT, ALP and TNF-α

Parameters	R	P-value
AST§	0.929	0.01*
ALT§	0.745	0.00*
ALP§	0.294	0.16
TNF-α§	0.813	0.03*

**Statistically significant at P<0.05 (2-tailed). AST§= correlation between sdLDL and AST ALT§= correlation between sdLDL and ALT. ALP§= correlation between sdLDL and ALP. TNF-α§= correlation between sdLDL and TNF-α*

Table 3. Correlation between TNF-α, AST, ALT and ALP

Parameters	R	P-value
AST†	0.835	0.02*
ALT†	0.665	0.00*
ALP†	0.440	0.14

**Statistically significant at P<0.05 (2-tailed). AST† = correlation between TNF-α and AST ALT† = correlation between TNF-α and ALT. ALP† = correlation between TNF-α and ALP*

4. DISCUSSION

Liver is an important homeostatic organ that is mainly responsible for the synthesis of lipids. Moreover, the synthesis of key enzymes for lipid metabolism takes place in the liver [20]. Liver also regulates the catabolism of various plasma lipoproteins via hepatic cellular surface receptors which help to maintain the levels of lipids and lipoproteins in humans [21]. Thus, these processes depend upon the integrity of the cellular function of liver. Hepatocellular damage or injury can interfere with these processes, thereby leading to alterations of lipids and lipoprotein patterns.

Small dense LDL is a major component of LDL-cholesterol and it is believed to be a very promising biomarker for the prediction of cardiovascular event because it possesses more atherogenic potential than other fractions of LDL-cholesterol and it has the profound ability to exhibit prolonged residency in the sub endothelial space [22-24]. Additionally, sdLDL particles have reduced affinity to the liver LDL receptor, consequently they stay longer in the circulation [25,26].

Experimental evidence suggests that most proinflammatory cytokines especially TNF-α plays an important role in liver injury induced by hepatitis B virus and may also be associated with persistent HBV infection and severity [27,28].

The present study revealed that both sdLDL and TNF- alpha are significantly elevated in chronic HBV patients when compared with control subjects ($P < 0.05$). Additionally, we observed a significant positive correlation between sdLDL and TNF-α in HBV patients. The underlying mechanism for this association is not entirely clear but one possible explanation is that TNF-alpha has the ability to modify the activities of hepatic lipase thereby causing it to increase the lipolysis of triglyceride-rich LDL with consequent increased formation of sdLDL [29-31].

The present study also demonstrated significantly higher levels of hepatic aminotransferases (AST, ALT) in HBV patients when compared with control subjects. This is consistent with finding of previous studies [8,13,32] and this has been attributed to a localized autoimmune reaction mediated by major histocompatibility complex-1-hepatitis B surface protein complex which results into the degeneration of hepatic tissue and during this process the cell membranes become more permeable, thereby leading to leakage of the hepatic aminotransferases into the blood stream [6,33].

Our findings also revealed a significant positive correlation with between sdLDL and hepatic aminotransferases. This agrees with findings of previous studies that reported significant rise in AST and ALT in proportion to raised LDL and triglycerides levels in patients with HBV infection [13,34-36].

Furthermore, the present study revealed that there is a significant positive correlation between TNF- alpha and hepatic aminotransferases and this is consistent with reports of previous studies [28,37,38]. The significant positive association that exists between TNF- alpha and hepatic aminotransferases, indicates the progression of inflammation and severity of injury induced by HBV infection [39].

5. CONCLUSION

The present study demonstrated that there is significant relationship between sdLDL, TNF-alpha and hepatic aminotransferases. Taken together, sdLDL and TNF- alpha can therefore serve as potential predictors of liver damage induced by HBV. Also based on our findings, HBV patients need to be closely monitored for signs of cardiovascular disease.

While results from cross sectional study on a larger scale would play significant role in understudying the observations reported in this study, longitudinal studies would also facilitate better understanding of the findings of this study.

CONSENT AND ETHICAL APPROVAL

All participants were recruited for this study after ethical clearance was obtained from the ethics committee of Ladoke Akintola University of Technology Teaching, Osogbo, Osun state, Nigeria. Written informed consent was obtained from each participants.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Health Organization. Hepatitis B: fact sheet; 2018. Available:http://www.who.int/news-room/fact-sheets/ detail/hepatitis-B.
2. World Health Organization. Hepatitis B: WHO Fact Sheet NO 204 Geneva, Switzerland: World Health Organization. 2013;204.
3. Ott JJ, Stevens GA, Groeger J, Wiersma ST. Global epidemiology of hepatitis B virus infection: new estimates of age-specific HBsAg seroprevalence and endemicity. Vaccine. 2012;30(12):2212-2219.
4. Adebola T. Olayinka, Akin Oyemakinde, Muhammad S. Balogun, Anthonia Ajadua, Patrick Nguku, Moses Aderinola, Abiodun Egwuenu-Oladejo, Simeon W Ajisegiri, Samuel Sha'aibu, Bolanle O. P. Musa, Saheed Gidado, Abdulsalami Nasidi. Seroprevalence of hepatitis B infection in Nigeria: A National survey. Am J Trop Med Hyg. 2016;95(4):902-907.
5. Ooi K, hiraki K, Sakurai Y, Morishita Y, Nobori T. Clinical significance of abnormal lipoprotein patterns in liver diseases. Int J Mol Med. 2005;15: 655–660.
6. Choi JS, Han KJ, Lee S, Chun SW, Kim DJ, Kim HC. Serum HBV surface antigen positivity is associated with low prevalence of metabolic syndrome in Korean adult men. J Epidemiol. 2015;25:74-79.
7. Kwarteng JK, Owusu L, Afihene M, Mica E, Opare-Sem O, Arthur FK. Lowered serum triglyceride levels among chronic hepatitis B-infected patients in Ghana. J Sci Technol. 2013;32:1-10.
8. Basavaraj Patil, Amareshwar M, Sreekantha, Avinash SS. Comparison of lipid parameters in acute viral hepatitis and normal individuals. Int J Clin BR. 2018; 6(1):105-110.
9. Krauss RM. Lipoprotein subfractions and cardiovascular disease risk. Current Opinion in Lipidology. 2010;21(4):305–311.
10. Wong VW, Wong GL, Chu WC, Chim AM, Ong A, Yeung DK, et al. Hepatitis B virus infection and fatty liver in the general population. J Hepatol. 2012;56:533-540.
11. Li WC, Lee YY, Chen IC, Sun C, Chiu FH, Chuang CH. Association between the hepatitis B and C viruses and metabolic diseases in patients stratified by age. Liver Int. 2013;33:1194-1202.
12. Janicko M, Senajová G, Drazilová S, Veselíny E, Fedacko J, Siegfried L, et al. Association between metabolic syndrome and hepatitis B virus infection in the Roma population in eastern Slovakia: A population-based study. Cent Eur J Public Health. 2014;22: S37-42.
13. Agbecha Ayu, Chinyere Adanna Usoro, Maisie Henrietta Etukudo. Serum lipids in chronic viral hepatitis B patients in Makurdi, Nigeria. Chrismed J Health Res. 2017;4:81-86.
14. Hirayama S, Miida T. Small dense LDL: An emerging risk factor for cardiovascular disease. Clinica Chimica Acta. 2012;414: 215–224.
15. Ekaterina A. Ivanova, Veronika A. Myasoedova, Alexandra A. Melnichenko, Andrey V. Grechko, Alexander N. Orekhov. Small dense low-density lipoprotein as biomarker for atherosclerotic diseases. Oxidative Medicine and Cellular Longevity. 2017;1-10.
Article ID 127304210.
16. Watashi K, Liang G, Iwamoto M, Marusawa H, Uchida N, Daito T. Interleukin-1 and tumor necrosis factor-alpha trigger restriction of hepatitis B virus infection via a cytidine deaminase activation-induced cytidine deaminase (AID). J Biol Chem. 2013;288:31715-31727.
17. Targher G, Marra F, Marchesini G. Increased risk of cardiovascular disease in non-alcoholic fatty liver disease: Causal effect or epiphenomenon? Diabetologia. 2008;51:1947–1953.

18. Adelakun Ayodele A, Adediji Isaac O, Motayo Babatunde, Akinwande Kazeem. Biochemical indices of liver functions in infected malaria patients in Nigeria. Int. J. Biomed. Res. 2015;6(3):177-180.
19. Augustine I. Airaodion, Emmanuel O. Ogbuagu, Adenike R. Adeniji, Aanu P. Agunbiade, Edith O. Airaodion. hepatoprotective effect of *Parkia biglobosa* on acute ethanol-induced oxidative stress in wistar rats. Int. Res. J. Gast & Hep. 2019;2(1):1-11.
20. Su TC, Lee YT, Cheng TJ, Chien HP, Wang JD. Chronic hepatitis B virus infection and dyslipidemia. J Formos Med Assoc. 2004;103(4):286–291.
21. Libo L, Xiangke P, Yongzhong W. Impaired plasma lipid profile in acute hepatitis. Lipids Health Disease. 2010;9:1-6.
22. Sancho-Rodriguez N, Aviles-Plazza FV, Granero-Fernandez E. Observational study of lipid profile and LDL particle size in patients with metabolic syndrome. Lipids Health Dis. 2011;10(162):1-8.
23. Nishikura T, Koba S, Yokota Y, et al. Elevated small dense low density lipoprotein cholesterol as a predictor for future cardiovascular events in patients with stable coronary artery disease. Atheroscler Thromb. 2014;21(8): 755-767.
24. Liu Xia, Zhai Limin, Wang Li. Association of small dense low density lipoprotein cholesterol and D- two with coronary heart disease. Int J Lab Med. 2016;37(14): 2003-2009.
25. Petersen KF, Dufour S, Hariri A, et al. Apolipoprotein C3 gene variants in nonalcoholic fatty liver disease. New England Journal of Medicine. 2010;362 (12):1082–1089.
26. Lucero D, Zago V, L´opez GI, et al. Does non-alcoholic fatty liver impair alterations of plasma lipoproteins and associated factors in metabolic syndrome? Clinica Chimica Acta. 2011;412(7):587–592.
27. Katia Falasca, Claudio Ucciferri, Margherita Dalessandro, Pompea Zingariello, Paola Mancino, Claudia Petrarca, Eligio Pizzigallo, Pio Conti and Jacopo Vecchiet. Cytokine Patterns Correlate with Liver Damage in Patients with Chronic Hepatitis B and C. Annals of Clinical & Laboratory Science. 2006; 36(2);144-150.
28. Gyaneshwori Devi Salam, Ashok Kumar, Premashis Kar, Sarita Aggarwal, Akhtar Husain, Shashi Sharma. Serum tumor necrosis factor-alpha level in hepatitis E virus-related acute viral hepatitis and fulminant hepatic failure in pregnant women. Hepatology Research. 2013;43: 826–835.
29. Xiuping Chen, Keli Xuan, Lidian Chen, Yitao Wang. TNF alpha, a potent lipid metabolism regulator. Cell Biochem Funct. 2009;27:407-416.
30. Zina Valaydon, Marc Pellegrini, Alexander Thompson, Paul Desmond, Peter Revill and Gregor Ebert. The role of tumour necrosis factor in hepatitis B infection. Clinical & Translational Immunology. 2016; 5:e115.
DOI:10.1038/cti.2016.68.
31. Luo L, Pu X, Wang Y, Xu N. Impaired plasma lipid profiles in acute hepatitis. Lipids in Health and Disease. 2010;9(1):1-6.
32. Liu PT, Hwang AC, Chen JD. Combined effects of hepatitis B virus infection and elevated alanine aminotransferase levels on dyslipidemia. Metabolism. 2013;62: 220‑5.
33. Philip M, Libbrecht L. Wieland S, De Vos R, Habib N, Kramvis A, Roskams T, Leroux-Roels G. Immune suppression uncovers endogenous cytopathic effects of the hepatitis B virus. J. Virol. 2006;80(6): 2792-2807.
34. Li WC, Lee YY, Chen IC, Sun C, Chiu FH, Chuang CH. Association between the hepatitis B and C viruses and metabolic diseases in patients stratified by age. Liver Int. 2013;33:1194‑202.
35. Chen EQ, Wang ML, Zhang DM, et al. Plasma apolipoprotein AV predicts long-term survival in chronic hepatitis B patients with acute-on-chronic liver failure. Sci Rep. 2017;7:455-476.
36. Osbourne Quaye, Benjamin Godfried Amuzu, Samuel Mawuli Adadey, Emmanuel Ayitey Tagoe. Effect of Hepatitis B Virus (HBV) Infection on Lipid Profile in Ghanaian Patients. Virology: Research and Treatment. 2019;10:1–5.
37. Zhang W, Yue B, Wang GQ, Lu SL. Serum and ascites levels of macrophage migration inhibitory factor, TNF-alpha and IL-6 in patients with chronic virus hepatitis

B and hepatitis cirrhosis. Hepatobiliary Pancreat Dis Int. 2002;1:577–580.

38. Xu XW, Lu MH, Tan M. Association between tumour necrosis factor gene polymorphisms and the clinical types of patients with chronic hepatitis B virus infection. Clinical Microbiology and Infection. 2005; 11(1):52-56.

39. Tilg H, Wilmer A, Vogel W, Herold M, Nolchen B, Judmaier G, Huber C. Serum levels of cytokines in chronic liver disease. Gastroenterology. 2002;103:264–274.

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