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Sonographic Comparison of Congestive Index of Portal Vein with and Without Chronic Liver Parenchymal Disease

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Abstract

Background Chronic liver disease is an oncogenic disease, and if not treated, it will most likely lead to hepatocellular carcinoma or death. In the past 30 years, major progress in the knowledge and management of liver disease has been observed. Cirrhosis and primary liver cancer represent the end-stage of chronic liver disease and thus are indicative of the burden of this disease. Objectives: To determine the sonographic comparison of the congestive index of portal vein with and without the chronic liver parenchymal disease. Methods: The study was carried out in Gilani Ultrasound Center Lahore, & Nishtar Hospital Multan, Pakistan, for the duration of Six months with two hundred patients (100 patients with chronic liver disease and 100 normal subjects) selected using non-probability convenient sampling technique. Results: Mean age of the patients was 40.78±0.40 vs. 40.42±0.46 years respectively in group A and B. There were [57(57%) vs. 40(40%)] male subjects in group I and II respectively, and [43(43%) vs. 60(60%)] female subjects in group I and II respectively. In our study, significantly increased congestion index was observed in Group I as compared to Group II (p=0.0000185). Conclusion: Congestion index was higher (almost doubled) in Chronic Liver Disease as compared to the control group.

Keywords: Congestion Index, Chronic Liver Disease, Portal Vein

Introduction

Chronic liver disease (CLD) is an oncogenic disease and lead to hepatocellular carcinoma (HCC) or death if not treated. CLD is a global public health disease affecting millions of people (Marinho RT, Giria J, & Moura MC, 2007). Cirrhosis and primary liver cancer represent the end-stage of CLD and thus are indicative of the burden of this disease (Blachier M, Leleu H, Peck-Radosavljevic M, Valla D-C, Roudot-Thoraval F, 2013). The most probable outcome of cirrhosis is HCC, which is the fifth most common cause of cancer. Developing countries like Egypt (22%), Pakistan (4.8%), and China (3.2%) are affected with hepatitis C virus chronically (Shepard CW, Finelli L, & Alter MJ, 2005). There are 14−26 new cirrhosis cases per 100,000 inhabitants per year or an estimated 170,000 deaths per year (McGlynn & London, 2005). Four leading causes of cirrhosis are chronic alcohol consumption, chronic viral hepatitis B, chronic viral hepatitis C and non-alcoholic fatty liver disease (NAFLD). If detected in time, each of these causes is responsive to treatment. CLD is characterized by a silent

and asymptomatic phase, and its solution is early detection and staging (Sherlock & Dooley, 2002). The developing of medical technology and more strong techniques of computer vision and machine learning are now creating new algorithms to assess liver disease, clustered in what is now known as translational medicine (Sporea I, Popescu A, & Sirli R, 2008). Ultrasound (US) is the first line diagnostic imaging modality in most of the abdominal exams, including the liver, because it is non-ionizing, non-invasive, non-expensive and it is available in almost all medical facilities. US image formation process is based on the interaction of acoustic waves with tissues.

Therefore, changes in textural characteristics of the US images may reveal pathological conditions in the microarchitectural and acoustic interfaces of the tissues. The evolution of CLD is characterized by different stages, each one with particular pathological characteristics and outcomes. Initial stages are usually steatosis or hepatitis, which can have several causes (World Health Organization[WHO], 1998). The end-stage of any liver disease is cirrhosis which typically precedes and empowers the development of HCC. This last pathological condition is one of the most frequent malignant tumors in the world, being the third cause of death from cancer in men (Maeda K, Utsu M, & Kihaile PE, 1998). Late detection is a key problem on CLD treatment because of its silent beginning (asymptomatic), causing globally high morbidity and mortality rates. A cirrhotic patient with clinical complications, such as ascites, has only 40% rate of survival in 2 years (Lee CH, Choi JW, Kim KA, Seo TS, Lee JM, & Park CM, 2006). Early detection of CLD is important. LB is not suited for use as a simple, fast and easy screening tool for CLD, since it is highly invasive, with low patient acceptance. This leads to the design of novel non-invasive approaches including portal vein maximum velocity (Vmax), portal vein minimum velocity (Vmin), portal blood flow volume, congestive index, and portal venous index (VPI). The World Health Organization (WHO) refers that US image modality is safe, effective, and highly flexible, providing clinically relevant information in a rapid and cost-effective fashion (WHO, 1998, Yeh WC, Jeng YM, Li CH, Lee PH, & Li PC, 2005). Portal vein velocimetry could be done with Doppler ultrasound in case of portal hypertension portal vein diameter increases while mean velocity decreases. It is therefore justified to determined portal vein congestive index in chronic liver parenchymal disease (Arena U, Vizzutti F, Corti G, Ambu S, Stasi C, Bresci S, et al., 2008). Congestion index was defined by Moriyasu et al. in 1986 as the ratio of cross-sectional area to portal flow velocity (Moriyasu F, Nishida O, Ban N, Nakamura T, Sakai M, Miyake T, et al., 1986). This index has been shown to be more sensitive and more specific in the diagnosis of portal hypertension than measurements of portal velocity (Haag K, Rössle M, Ochs A, Huber M, Siegerstetter V, Olschewski M, et al, 1999), although it was also found to have a critical limitation in that it needed a very skillful operator (Buonamico & Sabbá, 1991). For simplicity, the author set up a new index, the portal hypertension index, calculated as the ratio of the main portal vein dimension (D, mm) at the porta hepatis to the mean portal velocity (Vmean, cm/s) at the same site (Wu CC, Yeh YH, & Hwang MH, 1994), to detect portal hypertension in an easier way. Both the congestion index and the portal hypertension were recently demonstrated to be valuable in differentiating between chronic viral hepatitis and compensated early-stage cirrhosis (Iliopoulos P, Vlychou M, Margaritis V, Tsamis I, Tepetes K, Petsas T, et al., 2007, Iliopoulos P, Vlychou M, Karatza C, Yarmenitis SD, Repanti M, Tsamis I, et al, 2008).

Methods:

It was a cross-sectional study carried out in Gilani Ultrasound Center Lahore, & Nishtar Hospital, Multan, Pakistan for six months during the period of 1st May 2018 to 31st October 2018. Two hundred subjects, i.e. 100 individuals with liver parenchymal disease (Group I) and 100 individuals without liver disease (Group II) were selected by convenient sampling. Subjects including both male and female gender, age 13-80 years were included.

Patients with hepatic transplant and gastric varices were excluded. The ultrasound machines of Mindray Z5 and Toshiba xario 100 with convex transducer probe of 3-5 MHz were used to evaluate the patients. The study was started after informed consent. Descriptive statistics were calculated for patient's age, PV congestive index, PV mean velocity, PV Diameter. Frequencies and percentages were calculated for gender, clinical findings in both groups. Post-stratification t-test was applied taking $p \leq 0.05$ as significant.

Results:

Mean age of the patients was 52.66±1.25 vs. 36.28±1.62 years respectively in group I and II. Mean PV diameter was 1.02±0.08 vs. 1.11±0.03 in group I and II respectively. Mean congestion index was 0.14±0.02 vs. 0.05±0.00 in group I and II respectively.

There were [1(1%) vs. 14(14%)] subjects of the age of 1–20 years in group I and II respectively. There were [10(10%) vs. 57(57%)] patients of the age of 21–40 years in group I and II respectively. There were [59(59%) vs. 18(18%)] subjects of the age of 41–60 years in group I and II respectively and there were [30(30%) vs. 11(11%)] subjects of the age of 61–80 years in group I and II respectively as shown in Table No.1.

There were [57(57%) vs. 40(40%)] male subjects in group I and II respectively, and [43(43%) vs. 60(60%)] female subjects in group I and II respectively. In Group I, 6(6%) patients were diagnosed to have chronic liver disease on ultrasonography, 81(81%) had coarse liver, 3(3%) had a coarse liver with ascites, 2(2%) had focal liver lesion, hepatocellular carcinoma was evident in 4(4%) patients, 2(2%) had mixed solid echogenic lesion and 2(2%) had portal hypertension. In our study, mean congestive index was 0.05±0.00 in Group II while it was 0.14±0.02 in Group II (almost 2 times higher). Post-stratification, T-test revealed significantly increased congestion index in Group I as compared to Group II patients (p=0.0000185).

Table 1: Age Distribution of the Patients Presented with & Without Chronic Liver Disease

Age (in years)	No. of Patients in Group I	No. of Patients in Group II
1 — 20	1(1%)	14(14%)
21 — 40	10(10%)	57(57%)
41 — 60	59(59%)	18(18%)
61 — 80	30(30%)	11(11%)
Total	**100(100%)**	**100(100%)**

Table 2: Gender Distribution of the Patients Presented with & Without Chronic Liver Disease

Sex	No. of Patients in Group I	No. of Patients in Group II
Male	57(57%)	40(40%)
Female	43(43%)	60(60%)
Total	**100(100%)**	**100(100%)**

Table 3: Clinical Findings on Ultrasound of the Patients Presented with & Without Chronic Liver Disease

Findings	No. of Patients in Group I	No. of Patients in Group II
CLD	6(6%)	0(0%)
Coarse liver	81(81%)	0(0%)
Coarse liver with ascites	3(3%)	0(0%)
Focal liver lesion	2(2%)	0(0%)
HCC	4(4%)	0(0%)
Mixed echogenic solid lesion	2(2%)	0(0%)
portal hypertension	2(2%)	0(0%)
Normal (no liver disease)	0(0%)	100(100%)
Total	**100(100%)**	**100(100%)**

Table 4: Descriptive Statistics

Variables	Mean ±S.E.M. in Group I	Mean ±S.E.M. in Group II
Age of Patients (years)	52.66±1.25	36.28±1.62
PV Diameter (cm)	1.02±0.08	1.11±0.03
PV Mean velocity (m/s)	11.94±0.39	20.68±0.49
PV congestion index (cmxsec)	0.14±0.02	0.05±0.00
Total	**100(100%)**	**100(100%)**

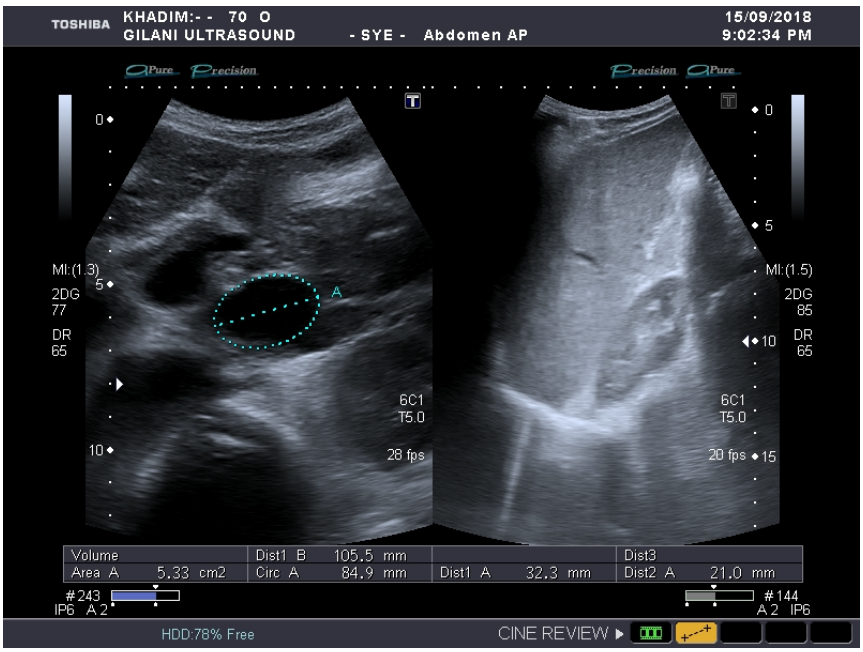

Figure 1: Ultrasound image showing normal portal vein diameter with fatty fibrotic liver parenchyma.

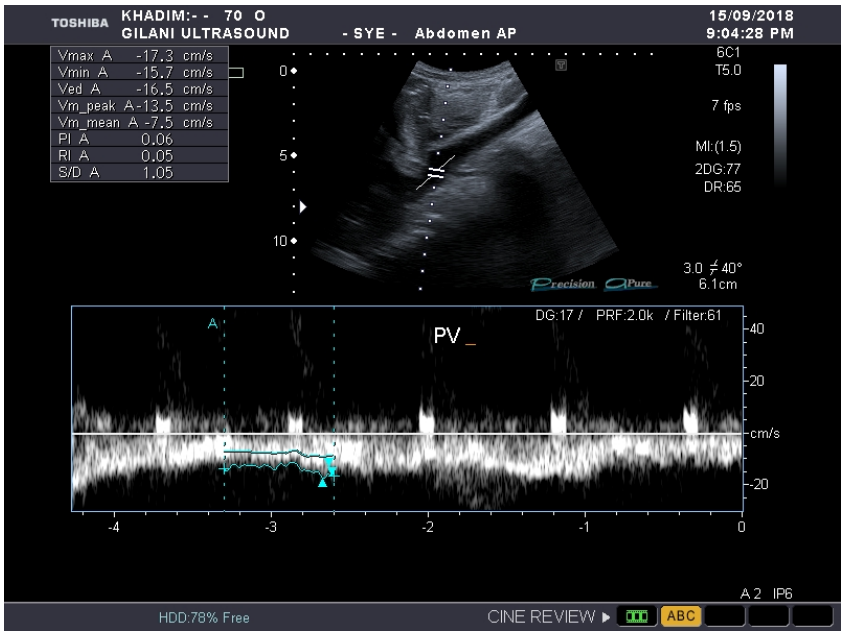

Figure 2: Ultrasound image showing a normal congestive index of the portal vein.

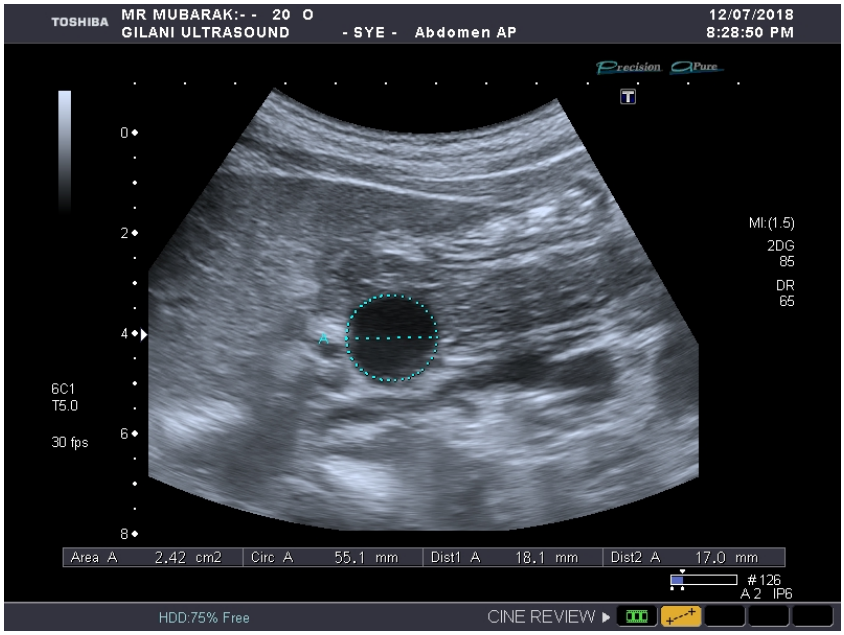

Figure 3: Ultrasound image showing the increased diameter of the portal vein in CLD.

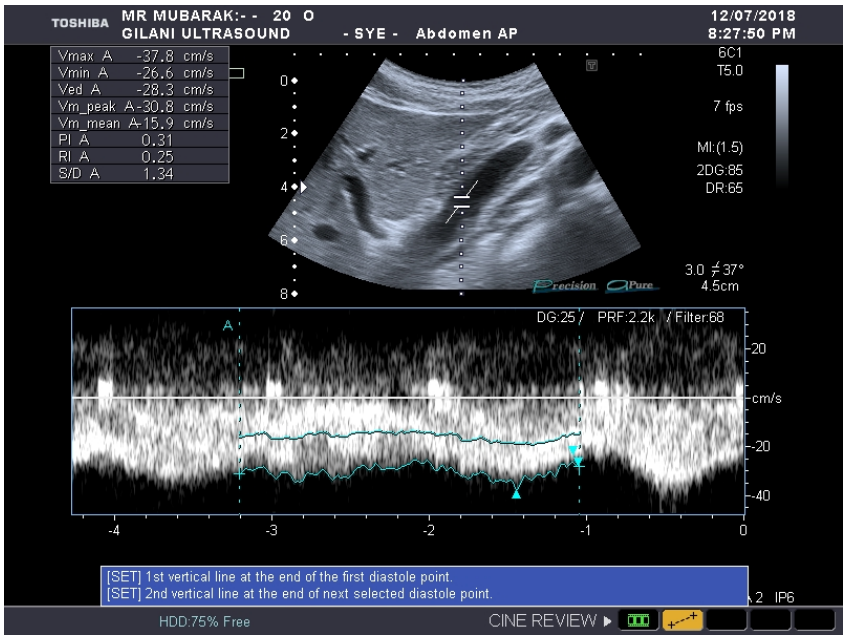

Figure 4: Ultrasound image showing an increased congestive index of the portal vein in CLD.

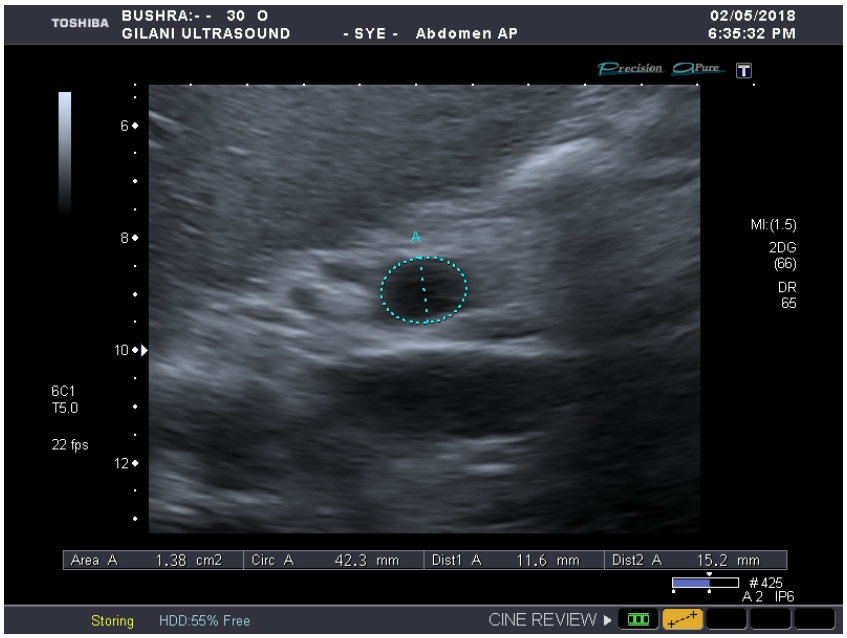

Figure 5: Ultrasound Image showing increased portal vein diameter in CLD.

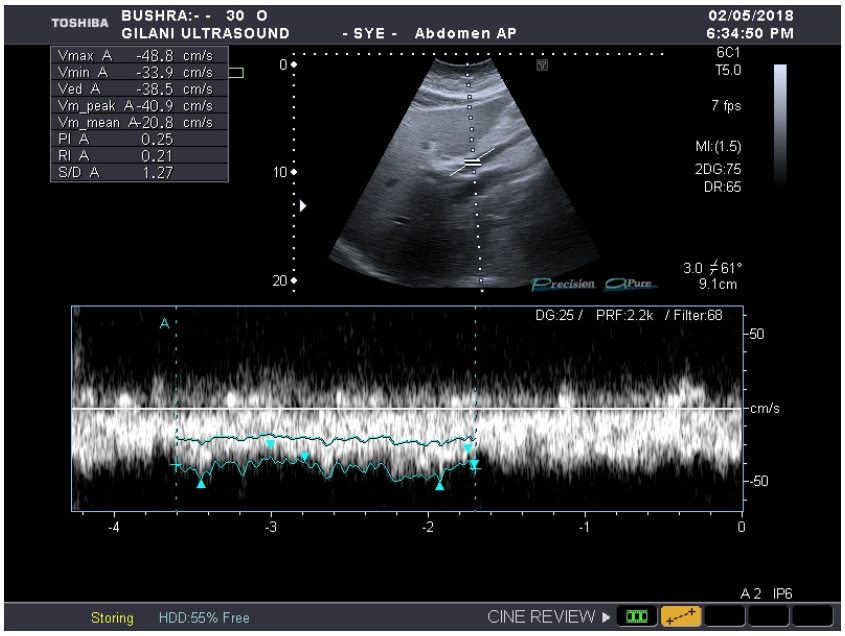

Figure 6: Ultrasound image showing an increased congestive index of the portal vein.

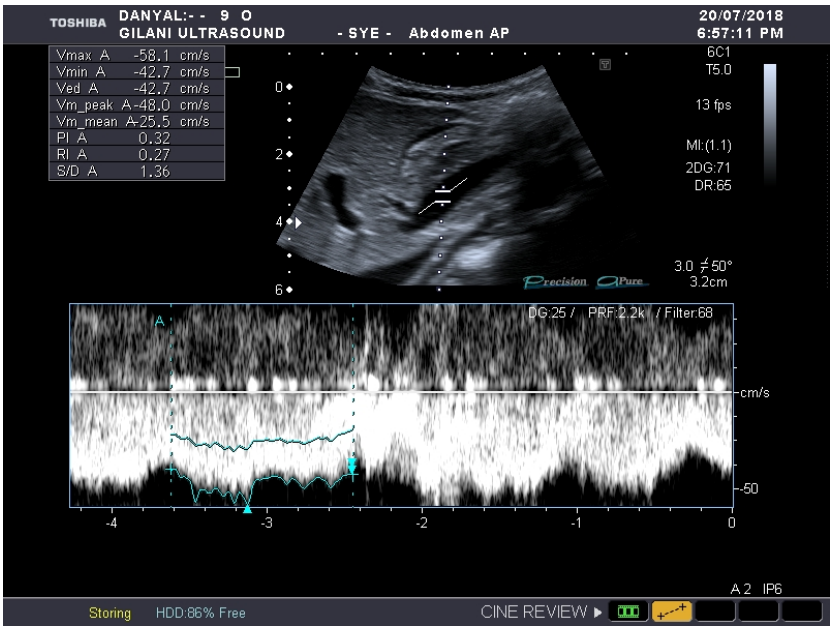

Figure 7: Ultrasound image showing an increased congestive index of the portal vein.

Discussion:

Doppler ultrasound is non-invasive and has no patient discomfort. It is a fast and easily reproducible technique that can study the hemodynamic alterations in the liver, especially in the portal vein. Congestion index is definitely a good predictor of the presence of liver cirrhosis with several authors reporting higher congestion index in alcoholic patients with de-compensated cirrhosis. Congestion index can also be evaluated as a parameter to predict the severity of liver disease in patients diagnosed with alcoholic cirrhosis. Also, it can be used to stage the disease as early or late cirrhosis. Further analytical studies may confirm the use of congestion index as a significant prognostic factor in the evaluation of several liver diseases (Yin XY, Lu MD, Huang JF, Xie XY, Liang LJ, 2016, Kayacetin E, Efe D, & Doğan C, 2016, Mahmoud HS, Mostafa EF, & Mohammed MAW, 2016).

Congestion index is a reliable indicator to differentiate between chronic viral hepatitis and alcoholic cirrhosis. Previous studies have evaluated the congestion Index for many different clinical applications in diseases involving the liver. Congestion index is a simple, inexpensive, noninvasive and accurate tool to differentiate alcoholic cirrhosis, NAFLD and viral hepatitis as an alternative to liver biopsy.

This study aimed to compare the congestion index in normal and diseased patients of the liver. Significantly increased congestion index was observed in patients with liver disease as compared to normal subjects (0.14±0.02 vs. 0.05±0.00) in the present study.

Moriyasu et al. 1986, have determined indices in normal subjects as 0.070±0.029 cmxsec whereas in acute hepatitis 0.071±0.014 cmxsec; chronic active hepatitis 0.119±0.084 cmxsec; cirrhosis 0.171±0.075 cmxsec; and idiopathic portal hypertension 0.180±0.107 cmxsec. There was a statistically significant difference between the congestion indices from the normal subject group and indices obtained from patients with chronic hepatitis, cirrhosis, and idiopathic portal hypertension.

Anup Chakravarthy et al. have recorded a congestion index of 0.02-0.03 in most of the normal subjects in their study while median congestion index in NAFLD -0.027. A significant difference was found in the congestion index present between the normal subjects and patients with NAFLD ($p=0.006$). Median congestion index in chronic viral hepatitis was -0.050. A significant difference in congestion index was present between the normal subjects and patients with chronic viral hepatitis ($p<0.001$). Median congestion index in patients with alcoholic cirrhosis was -0.060. A significant difference in congestion index was present between the normal subjects and

patients with alcoholic cirrhosis ($p<0.001$) (Chakravarthy AJ, Thomas S, Mohanan K, Puthussery PV, Resmi S, Raini KP, 2017).

Iliopoulos P et al. 2007 have revealed portal vein congestion index in controls as 0.05±0.02 and in compensated liver cirrhosis as 0.09 ± 0.07 in their study in differentiation between chronic viral hepatitis and compensated early-stage cirrhosis.

Mortada HF El-Shabrawi and Associates have obtained congestion index 4.61±5.75 in controls while 9.50±1.60 in children with established cirrhosis (5 of metabolic etiology and 8 viral hepatitis C or B) ($p < 0.01$) and congestion index 4.97±1.14 in chronic hepatitis and no cirrhosis (5 children with viral hepatitis C or B and 7 autoimmune) (Mortada HF El-Shabrawi, Maissa El-Raziky, Maha Sheiba, Hanaa M El-Karaksy, Mona El-Raziky, Fetouh Hassanin, et al., 2010).

Conclusion

Our data shows that congestive index of the portal vein is a significant indicator and increased in CLD as compared to normal individuals.

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