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Research Article

The importance of hemodynamic parameters in cirrhotic patients with portal hypertension

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Abstract. Ultrasound is successfully used in the assessment of patients with portal hypertension. The most common cause of portal hypertension is liver cirrhosis. Ultrasound employs several techniques and assesses liver and spleen parameters. Some indices are useful in evaluating patients with decompensated liver disease or in patients with hepatic encephalopathy. Other indices are useful in assessing the risk of rupture of esophageal varices. The purpose of the study is to evaluate the relationship between various portal hemodynamic parameters and the cause of the disease, the severity, possible complications, considering the nutritional status of patients. Material and methods. The study was conducted on 50 patients with liver cirrhosis in the Third Medical Clinic between January and May 2012. Nutritional status assessment was done using body mass index (BMI) and tricipital skinfold thickness (TST) measurements. Ultrasound examination focused on: liver size, presence of ascites, portal vein diameter and flow, mean portal vein velocity, congestion index of the portal vein, splenic venous flow, congestion index of the splenic vein. Results. The mean age of the study group was 56.20 years, with no differences in terms of gender distribution and area of origin, viral etiology was 48% followed by ethanol-related etiology 32%, with a slight predominance of Child-Pugh class A liver cirrhosis. Portal vein diameter under 15 mm was correlated with Child-Pugh class A liver cirrhosis ($p=0.008$ for the comparison with Child-Pugh class B, and $p<0.01$ for the comparison between A and B+C). There was a positive correlation between mean portal vein velocity over 15 mm and Child-Pugh class A liver cirrhosis ($p=0.03$ versus B+C). Malnutrition was present in 12% of patients when using BMI and 30% when using TST. Ethanol-related etiology was predominant (60%) in malnourished patients. There was a correlation between malnutrition and a portal vein velocity below 15 cm / sec ($p<0.001$) and the presence of ascites ($p<0.001$). There was a correlation between ascites and a portal vein velocity greater than 15 cm/sec ($p<0.001$) and the congestion index of the portal vein over 40 ($p=0.01$), but there was no correlation with the congestion index of the splenic vein ($p=0.08$). Conclusion. Ultrasound is useful in the assessment of portal hypertension. There was a direct correlation between portal vein diameter and the Child-Pugh score. There was an inverse correlation between portal vein velocity and the Child-Pugh score and hepatomegaly, and a direct correlation with malnutrition and the presence of ascites. Malnutrition correlated with ethanol-related etiology, reduced portal venous velocity and the presence of ascites.

Key Words: portal hypertension, ultrasound, Child-Pugh score, malnutrition.

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Introduction

Ultrasound is used to evaluate patients with portal hypertension (Tsochatzis et al 2014). The most common cause of portal hypertension is liver cirrhosis (Cavaşi et al 2004). There are various ultrasound techniques used for the assessment of the portal system in addition to B-mode, such as colour Doppler ultrasound, pulsed ultrasound, etc.

The most widely used parameters are: the diameter of the portal vein, of the splenic vein and of the superior mesenteric vein, maximum, mean and minimum velocity in the veins and arteries constituting the portal system, venous and arterial blood flow, the congestion index of the portal and splenic veins (Badea et al 1997; Badea et al 2000; Seitz et al 1998). A particular importance is also played by the pulsatility index and the resistivity index of the hepatic and splenic arteries (Zwiebel et al 1992; Al-Nakshabandi et al 2006; Bolond et al 1997). As it is well-known, the etiology of liver cirrhosis is diverse and various causes are associated with a higher rate of complications (viral etiology correlates with an increased risk of HCC). Ethanol-related etiology also seems to correlate with a more rapid deterioration of the nutritional status, mainly expressed by significant protein deficiency. The severity of cirrhosis is assessed according to certain parameters divided into various classes of severity. The more damaged the clinical and biological samples, the more severe the disease (Child-Pugh class A, B, C) (Cavaşi et al 2004).

This study aims to assess the existence of a relationship between various portal hemodynamic parameters and the cause of the disease, the degree of severity of cirrhosis, the clinical manifestation of hepatic encephalopathy, based on the nutritional status of patients with liver cirrhosis.

Material and methods

The study was conducted on 50 patients with liver cirrhosis hospitalized at the Third Medical Clinic between January and May 2012. They had been diagnosed with liver cirrhosis prior to their participation in the study. Patients were included in the study

regardless of etiology, Child-Pugh class, and nutritional status. The diagnosis of cirrhosis was based on clinical and laboratory data (biological tests, abdominal ultrasound, upper gastrointestinal endoscopy). Patients signed the informed consent form and the study protocol was approved by the Ethics Committee.
Exclusion criteria:
• Detection of hepatocellular carcinoma or other malignancies when performing ultrasound
• Previous diagnosis of hepatocellular carcinoma or another form of malignancy
• Personal conditions (large ascites, severe patients (coma) large abdominal scars with keloid, large hernias or incisional hernias) that did not allow the Doppler examination of the entire portal system
Body mass index (BMI) and tricipital skinfold thickness (TST) measurements were performed. The latter was assessed midway between the acromion and olecranon, on the non-dominant arm, by the same examiner and the result was expressed in millimetres. Normal values are between 9 and 15 mm. Measurements were performed using the standard adipometer manufactured by Jacques Logeais Laboratories, France. According to an international classification of the nutritional status, there are four groups defined as: underweight BMI <17.9; normal weight BMI = 18-24.9; overweight BMI = 25-29.9; obesity BMI >30. In what concerns the tricipital skinfold thickness parameter, values below 9 mm indicate an overweight status, between 9 and 15 mm normal weight, and over 15 mm obesity.
B-mode and Doppler ultrasound were performed in all patients. The examination was carried out by the same examiner and with the same equipment, in the morning, under fasting conditions. The equipment consisted of a GE Logiq 7 ultrasound machine and a convex variable frequency transducer (4.5-5.5 MHz).
The following parameters were measured: portal vein diameter and flow, mean portal vein velocity, congestion index of the portal vein, splenic venous flow, congestion index of the splenic vein. The congestion index of the portal vein is defined as the ratio between the cross-sectional area and the mean blood flow velocity of the portal vein. The congestion index of the splenic vein is defined as the ratio between the cross-sectional area and the mean blood flow velocity of the splenic vein. Measurements were made with the maximum Doppler window extent, without touching the walls of the vessel, at a correction angle of less than 45 degrees. Doppler indices were measured automatically after at least two cardiac cycles.
Data were analysed using Windows 2010 and Office 2016. Arithmetic means, frequencies, medians were calculated. Statistical significance was established using the chi square test in EPIINFO program. A p value <0.05 was considered statistically significant.

Results

The study group included 50 patients aged between 27 and 78 years with a mean age of 56.2 years, most of them between 50 and 60 years old.
In terms of gender distribution, there were no significant differences between men (48%) and women (52%).
In terms of area of origin, there were no significant differences: urban (56%) versus rural (44%).
In terms of patient distribution on classes of severity, there were 40% patients with class A cirrhosis, 32% with class B, and 28% with class C.
When analysing the relationship between different degrees of severity and a portal venous diameter of under 15 mm, there was a positive correlation with a p value of 0.008 (between Child-Pugh classes A and B), respectively between class A on the one hand and classes B and C on the other hand.
The relationship between the degrees of severity and mean portal venous velocity (over 15 cm/second) was assessed and resulted in a positive correlation for compensated cirrhosis (class A), compared to decompensated cirrhosis (classes B and C) (p=0.03).
The cause of cirrhosis was diverse, the most common being ethanol-related etiology (32%), followed by hepatitis C virus-related etiology (28%) and hepatitis B virus-related etiology (20%).
Malnutrition is a recognized risk factor in liver cirrhosis. This can be expressed after body mass index assessment. According to this criterion, there were 6 malnourished patients, with a prevalence of 12% in the study group.
Patients with liver cirrhosis suffer from significant salt retention, which changes their weight and their body mass index is higher. Tricipital skinfold thickness is an anthropometric index that does not consider fluid retention and can be applied in patients with orthostatic intolerance. According to this index, there was 30% prevalence of malnutrition in the study group.
The comparison between the two results determines that BMI understates the nutritional status compared to the TST, which is why the TST malnutrition assessment group will be used in order to compare various indices.
The etiology of the group of malnourished patients: 60% ethanol-related and 40% viral. Comparing these patients with normal weight patients based on the same etiology resulted in a positive correlation between the presence of malnutrition and ethanol-related versus viral etiology (p<0.008), as well as compared to other etiologies (p<0.001).
The correlation between the presence of malnutrition and mean portal venous velocity resulted in a positive correlation between the presence of malnutrition and a mean portal venous velocity below 15 cm/sec (p<0.001).
Hepatomegaly was present in 52% of patients.
The relationship between the presence of hepatomegaly and portal venous diameter was assessed. There was a positive correlation between a portal venous diameter under 15 mm and hepatomegaly (p=0.019).
Ascites was present, in varying degrees, in 60% of patients during examination.
The influence of the nutritional status on the presence of ascites was assessed. There was a positive correlation between the presence of ascites and malnutrition (p = 0.005).
The relationship between ascites and portal venous velocity was also assessed. There was a positive correlation between the presence of ascites and a portal venous velocity below 15 cm/sec (p<0.001).
When analysing the relationship between ascites and the congestion index of the splenic vein, even if 60% of patients with ascites had an index value of over 3.5 compared to 35% patients without ascites, results did not reach statistical significance (p=0.08).

The congestion index of the portal vein was assessed in relation to ascites. An index value above 40 was present in 66.66% of patients with ascites compared to 30% patients without ascites, indicating a strong positive correlation (p=0.01).
Hepatic encephalopathy (HE) was present in 60% of patients examined.
The relationship between the clinical manifestation of HE and portal venous velocity was assessed. A portal venous velocity below 15 cm/sec was present in 92.30% of patients with HE and absent in patients without clinical signs of HE, demonstrating a strong positive correlation (p<0.001).

Discussion

Ultrasound is used for the assessment of patients with portal hypertension, whose most common cause is liver cirrhosis (Cavaşi et al 2004).
The study group consisted of 50 patients with a mean age of 56.2 years, most of them aged between 50 and 60 years. In terms of patient distribution by area of origin, 56% of patients were from urban areas and 44% from rural areas, showing a relatively uniform distribution. Gender distribution is also uniform, with a slight predominance of women (52%) over men (48%).
The severity of liver disease is estimated by means of the Child-Pugh score. This is the main indicator of liver functionality, which is why we assessed the correlations between this score and various parameters. Child-Pugh classes A versus B were associated with a portal venous diameter of under 15 mm. There was also a statistically significant correlation of the portal venous diameter when comparing classes A versus B and C together. This is explained by the increase in portal venous diameter as the disease progresses towards decompensated cirrhosis (Mittal et al 2011; Shi et al 2005).
Portal blood flow velocity seems to weaken as the hepatic dysfunction becomes more accentuated (Berzigotti et al 2013). In this study we found that a decrease in portal vein velocity below 15 cm/sec is more common in classes B and C, while portal blood flow velocity is over 15 cm/sec in patients with class A cirrhosis in 70% of the cases.
Ethanol-related etiology was the most common (32%), followed by hepatitis C virus-related etiology (28%) and hepatitis B virus-related etiology (20%).
The differences in etiology in patients with different nutritional status were analyzed. Ethanol-related etiology was more prevalent in malnourished patients, which is statistically significant when compared to viral etiology or any other etiology. This study is consistent with the literature and emphasizes that patients with ethanol-related etiology present a poor nutritional status, much lower than in case of other etiologies (Franca et al 2001). This is primarily due to chronic inappetence and the tendency to replace food with ethanol, which cannot provide the necessary daily calories. Moreover, there is an inhibition of hunger due to the release of endorphins into the general circulation during ethanol consumption. This is partly the mechanism underlying chemical and physical addiction. Patients show no interest in anything other than ethanol. Their meals are fast, frugal, low in protein, which correlates with the degradation of the biological status, muscle loss, further leading to weight loss, mostly evidenced by the decrease in tricipital skinfold thickness. The decrease in body fat and muscle mass of the limbs associated with an enlarged abdomen causes the characteristic "amphibian" appearance of the cirrhotic patient.
Portal blood flow velocity is significantly lower in malnourished patients. This is explained by the increase in portal venous diameter (Martínez-Noguera et al 2002).
Hepatomegaly was present in 52% of patients. There is a statistically significant inverse correlation between this index and portal blood flow velocity. This is due to the initial decrease in portal blood supply to the liver cell due to an increase in intrahepatic resistance. This is due to liver fibrosis, which ultimately reduces its size. The portal vein tries to increase the blood flow to the liver by increasing the diameter and the flow, but this will ultimately lead to a lower velocity (Iranpour et al 2015).
Ascites was present in 60% of patients in the study. The presence of ascites was significantly correlated with malnutrition. Besides the mechanisms stated above, hypoalbuminemia is a factor in ascites development, maintenance and treatment-refractory (Iranpour et al 2015).
The reduced velocity in the portal vein (less than 15 cm/sec) correlates with the presence of ascites. The congestion index in the portal vein over 40 correlates with ascites, while the congestion index in the splenic vein over 35 does not correlate with ascites. These changes are consistent with the international literature (Moriyasu et al 1986) showing that liver vascular indices correlate with patient status and decompensated cirrhosis (damage to the hepatic parenchyma), while splenic vascular indices correlate with decompensated cirrhosis (damage to the vessels), especially with bleeding esophageal varices (Perisic et al 2005; Kayacetin et al 2004).
Clinical signs of hepatic encephalopathy (HE) were present in 60% of patients. It was significantly correlated with the reduction in portal venous velocity below 15 cm/sec, but with no correlation with the congestion index of the splenic vein, confirming once again the correlation between the hepatic (and not the splenic) parameters and decompensated cirrhosis with damage to the hepatic parenchymal (Moriyasu F et al 1986). The lower the portal venous velocity, the more blood can short-circuit the liver through collateral pathways opened as a result of portal hypertension. Thus, ammonia penetrates easier and in a greater amount into the cerebral circulation increasing the risk of hepatic encephalopathy (Mittal et al 2011).

Conclusion

B-mode ultrasound, colour Doppler, pulsed-wave Doppler are useful for the assessment of the portal venous system in cirrhosis. There was a direct correlation between the diameter of the portal vein and the Child-Pugh score. There was an inverse correlation between portal venous velocity and the Child-Pugh score and hepatomegaly, and a direct correlation with malnutrition and ascites. The congestion index of the portal vein correlated with ascites and encephalopathy, but there was no such correlation for the congestion index of the splenic vein.

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