Original Article

Comparison of Resistive Index, Pulsatility Index, and Arterial Waveform at the Site of Hepatic Artery Bifurcation in Patients with and without Nonalcoholic, Non-Diabetic Fatty Liver

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Abstract

Background: Nonalcoholic fatty liver disease (NAFLD) is common. Noninvasive methods to assess fibrosis stage are limited, and biopsy remains the gold standard. We aimed to compare the Doppler ultrasound indices (resistive index (RI), pulsatility index (PI), and arterial waveform) at the place of division of the hepatic artery in patients with and without nonalcoholic non-diabetic fatty liver.

Materials and Methods: This cross-sectional study involved patients with fatty and normal liver. For this purpose, 50 patients with fatty liver with a grade higher than II and confirmed and 50 patients without signs of fatty infiltration in sonography were examined by standard Doppler sonography from the location of the hepatic artery. The patients' waveform, RI, and PI were investigated based on this. The evaluated indicators were analyzed as the average of three consecutive measurements. Finally, the results obtained in the two groups were compared using SPSS statistical software.

Results: One hundred patients were equally divided into two groups with and without NAFLD. The two groups were similar in age, sex, and body mass index (BMI) (all P-values > 0.05). In the case group, the average RI was 0.5 ± 0.08; in the control group, it was 0.63 ± 0.04 (P-value<0.001). PI was 0.5 ± 0.08 in the case group and 0.63 ± 0.04 in the control group (P-value<0.001). In the case group, 74% of the subjects showed a Tardus parvus wave pattern, while in the control group, 100% had a normal wave pattern (P-value<0.001).

Conclusion: RI, PI, and arterial waveform at the site of division of the hepatic artery can be used to diagnose these patients who need a biopsy. They reduce the liver.

Keywords: Nonalcoholic fatty liver, Ultrasound, Resistive index, Pulsatility index

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Introduction

Nonalcoholic fatty liver disease (NAFLD) is a metabolic disorder characterized by histopathological or imaging evidence of diffuse lipids that usually occurs in the presence of metabolic risk factors (such as hypercholesterolemia and/or diabetes) and without an

identifiable cause of liver disease[1]. NAFLD is common worldwide, and its prevalence is estimated at 25-30% in the general population, while its incidence varies based on the population, from 29/100,000 to 86/100,000[2,3]. Two groups of NAFLD can be distinguished: NAFLD with no evidence of hepatocellular fibrosis and nonalcoholic steatohepatitis (NASH), in which inflammation with hepatocellular injury predominates, with or without fibrosis. It is important to distinguish between these two diseases because NASH patients are at higher risk of liver failure, cirrhosis, and hepatocellular carcinoma[4]. Liver biopsy is the gold standard method for early detection of liver fibrosis, but it is an invasive procedure. In the past years, some clinical and laboratory tests have been developed to evaluate the risk of this disease progressing to cirrhosis and the need for biopsy in these patients[7-5].

Although ultrasonography (US) is an excellent diagnostic technique for demonstrating diffuse fatty liver disease, it is neither sensitive nor specific for revealing fibrosis except in advanced stages when signs of cirrhosis are evident. Previous studies have shown that the resistance index (RI) of the hepatic artery changes significantly in patients with NAFLD, and a significant decrease in this parameter is associated with an increase in the severity of diffuse fatty liver disease[8,9]. Recently, Baikpour et al. described the portal vein pulsatility index (PI) as a useful tool for diagnosing high-risk NAFLD. Doppler ultrasound evaluation of the main portal vein is a part of liver ultrasound for many clinical indications[10]. Studies have been conducted to determine the utility and importance of venoportal PI in liver diseases. PI may be lower in chronic liver disease compared to healthy individuals. However, studies in this area are still limited[11,12]. In this study, we aimed to compare the Doppler ultrasound indices (RI, PI, and arterial waveform) at the site of bifurcations of the hepatic artery in patients with and without non-diabetic NAFLD.

Methods

This study was a cross-sectional study conducted in Imam Hossein Hospital on patients with fatty liver with a grade higher than II, with confirmation of the diagnosis of this disease in 2023. In this study, after obtaining the ethical code from the ethical committee of Shahid Beheshti Medical University and obtaining the informed consent of the patients, people with definitive diagnostic criteria for fatty liver were included in the study[13].

The inclusion criterion of the case group was fatty liver involvement with a grade higher than II based on diagnostic criteria, and the exclusion criteria confirmed vascular anomalies and a lack of consent to participate in the study. The inclusion criterion of the control group did not have fatty liver disease, and the exclusion criteria confirmed vascular anomalies and a lack of consent to participate in the study.

At first, verbal consent was obtained from the selected patients, and then these patients were evaluated based on the study objectives. The background information, including age, gender, and body mass index, was recorded. In the case group, the grade of fatty liver disease was determined and recorded, so the patients, after 8 hours of fasting with a 3-5MHZ convex probe in the supine position, were evaluated by ultrasonography for fatty liver and classified for NAFLD. Then, the patients were evaluated by Doppler ultrasound of the hepatic artery in terms of wave shape, RI, and PI.

Statistical analysis: Mean and standard deviation were used to describe quantitative data, and frequency and percentage were used for qualitative variables. Fisher's exact statistical test, Chi-square, and T-test were used to evaluate the frequency of indices among the groups. All analyses were done using SPSS 26 software. A P-value less than 0.05 was considered statistically significant.

Ethical consideration: This research received the code of ethics from the ethical committee of Shahid Beheshti Medical University (IR.SBMU.MSP.REC.1402.383).

Results

RI, PI, and arterial waveform at the site of hepatic artery bifurcation were compared between people with and without NAFLD. In Table 1, the patients' basic data are seen. In Table 2, the indices of hepatic artery Doppler ultrasound ultrasound were investigated. In Table 3, the distribution of the wave pattern and

Table 1. Basic characteristics of participants with and without NAFLD**.**

		Total N (%)	Groups		P-Value
			Case N (%)	Control N(%)	
Gender	Male Female	50 (50.0%) 50 (50.0%)	25 (50.0%) 25 (50.0%)	25 (50.0%) 25 (50.0%)	0.9
Age		54.86 ± 2.22	54.5±2.11	55.22±2.3	0.1
BMI		21.93 ± 1.62	21.96±1.67	21.90±1.59	0.8

P-value based on Chi-square and T-test

Table 2. Comparison of the results of RI and PI in the case and control groups**.**

	Total	Groups		P-value
		Case	Control	
RI	0.56 ± 0.09	0.5 ± 0.08	0.63 ± 0.04	0<0.001
PI	0.56 ± 0.09	0.5 ± 0.08	0.63 ± 0.04	0<0.001

P-value based on T-test

degree of fatty liver in the case and control groups were assessed and compared.

Discussion

The present study, which was conducted to compare Doppler ultrasound indices at the site of hepatic artery bifurcation in patients with and without non-diabetic NAFLD, RI, PI, and arterial waveform indices, were investigated. One hundred patients were equally divided into two groups with and without NAFLD. The two groups were homogeneous regarding age, sex, and BMI. This homogeneity is important in the study design because it can help reduce possible biases caused by demographic differences. Also, this homogeneity between groups can increase the study's internal validity and allow more accurate inferences about the effects of the intervention or the investigated factors[14]. The average RI in the all-study population was 0.56 ± 0.09. In the case group, the average RI was 0.5 ± 0.08; in the control group, it was 0.63 ± 0.04. the difference between the two groups was significant. The average PI in the whole population was 0.56 ± 0.09. PI was 0.5 ± 0.08 in the case group, and 0.63 ± 0.04 in the control group, and this difference was statistically significant. In the case group, 74% of the subjects showed a tardus parvus wave pattern, while in the control group, 100% had a normal wave pattern, and this difference between the two groups was significant. Yu et al. investigated the relationship between NAFLD and arterial stiffness with brachial-ankle pulse wave velocity (baPWV) in a young and middle-aged non-obese, non-hypertensive, and non-diabetic Chinese population. Subjects were classified into two groups based on the presence of NAFLD and divided into two groups based on baPWV. NAFLD patients had a higher

Table 3. Distribution of wave pattern and degree of fatty liver in case and control groups**.**

		Total N (%)	Groups		P-value
			Case N (%)	Control N (%)	
Wave shape	Normal	63 (63.0%)	13 (26.0%)	50 (100.0%)	0<0.001
	Tardis	37 (37.0%)	37 (74.0%)	0 (0.0%)	
Fatty liver grade	0	50 (50.0%)	0 (0.0%)	50 (100.0%)	0<0.001
	1	1 (1.0%)	1 (2.0%)	0 (0.0%)	
	2	30 (30.0%)	30 (60.0%)	0 (0.0%)	
	3	19 (19.0%)	19 (38.0%)	0 (0.0%)	
	4	0 (0.0%)	0 (0.0%)	0 (0.0%)	

P-value based on Chi-square and Fisher exact test

level of baPWV than controls. The incidence of NAFLD in the increased baPWV group was higher than the normal baPWV group, and the incidence increased with the increase of the quartile of baPWV in the normal range and the severity of arterial stiffness. The presence of NAFLD was positively and independently associated with baPWV[15]. One of the differences between the current study and Yu et al.'s study was that Yu et al. evaluated baPWV. However, the current study investigated RI, PI, and waveform in hepatic vessels. Based on both studies, it can be concluded that NAFLD is also effective in the state of vascular elasticity because, in the current study, it was seen that RI, PI, and the waveform in patients with NAFLD were significantly different from normal people. In the current study, it was seen that the parameters related to the condition of the liver vessels, which can be easily evaluated with ultrasound during abdominal ultrasound, can be used as a diagnostic parameter for patients.

Norouzi et al. investigated the effects of different NAFLD degrees and increased liver enzyme levels (AST/ALT) on portal vein hemodynamics. 54 NAFLD patients and 54 healthy adults were investigated as a control group. Venous PI (VPI), mean portal velocity (MPV), and portal diameter (PD) values were 0.3931±0.09, 10.44±1.65 cm/s, and 9.5±1.65 cm/s in patients with NAFLD and the control group, these values were 0.68±0.06, 17.09±1.72 cm/s and 9.3±1.6 cm, respectively. These parameters were significantly lower in the NAFLD group. It was concluded that VPI and MPV are significantly lower in patients with NAFLD compared to the control group, resulting from damage to vascular compliance due to fat deposition in hepatocytes[16]. In the current study, MPV was not investigated, but it was seen that in NAFLD patients, VPI was significantly lower than in the control group. In this sense, the current study's findings were similar to those of Nowrozi et al.

Tana et al.'s study aimed to investigate hepatic artery resistive index (HARI) and NAFLD fibrosis score in NAFLD patients. NAFLD patients with different disease severity levels and healthy individuals were included in the study. HARI in NAFLD patients was significantly lower than in the control group. There was a difference between the HARI of NAFLD patients with different NAFLD fibrosis scores compared to the control group's HARI, with a positive correlation between the NAFLD fibrosis score and HARI. It was concluded that the diagnosis of HARI greater than 0.9 in NAFLD patients, regardless of the severity of steatosis, may suggest biopsy to predict the risk of progression to steatohepatitis and accumulation of fibrous tissue. Low HARI values may indicate a low risk that does not require a biopsy[17]. In the current study, it was seen that HARI was significantly lower in patients with NAFLD, and this issue was similar in the two studies. Based on Tana et al.'s study and the current study, it can be said that HARI can be a diagnostic parameter in patients with NAFLD and reduces the need for biopsy in these patients.

Baikpour et al.'s study aimed to evaluate the accuracy of VPI as a noninvasive diagnostic tool for high-risk NAFLD. Of the 123 subjects studied, 33 (26.8%) were high-risk NAFLD and were found to have a lower VPI than the other 90 subjects. VPI, NAFLD fibrosis score, Fibrosis-4 (FIB-4), and AST to platelet ratio index (APRI) were statistically significant values for diagnosing high-risk NAFLD. VPI had the highest adjusted AUC (VPI, 0.84; NAFLD FS, 0.74; FIB-4, 0.81; APRI, 0.73). Adding the VPI to any of the four scoring systems significantly improved the diagnostic value of the score for high-risk NAFLD[10]. In the current study, the diagnostic accuracy of RI, PI, and waveform was not investigated, which is one of the current study's limitations. However, it was seen that RI was significantly lower in patients with NAFLD than in normal subjects, one of the advantages of the current study. This study aimed to investigate hepatic vascular indices exclusively and measure their diagnostic effect regardless of age, gender, and BMI. The present study's findings were similar to those of the Baikpur study regarding the value of RI for diagnosing NAFLD.

Lu et al.'s study aimed to evaluate whether the portal venous pulsatility index (VPI) could be used as a predictor of high-risk NAFLD for liver transplantation. No significant correlation was found between VPI and NAFLD risk or correlation between VPI and degree of steatosis[18]. The findings of this study were different from those of previous studies. Our study showed that VPI had a significant relationship with NAFLD disease, and in this respect, these two studies were different. Studies with larger sample sizes are needed to evaluate the association of liver vascular indices with NAFLD.

One of the advantages of the current study was that the waveform was also examined in our study and that the Tardus parvus waveform is significantly related to the diagnosis of NAFLD, which, based on our investigations, was not evaluated in previous studies.

Conclusion

It is concluded that vascular indices are useful for diagnosing NAFLD and reduce the need for biopsy to diagnose NAFLD. Our findings showed that in patients with NAFLD, the levels of RI and PI are significantly lower than in normal people, and most of these patients have a tardus parvus waveform in color Doppler ultrasound evaluations of liver vessels.

Acknowledgment

None.

Conflict of interest

The authors further declare that they have no conflict of interest.

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