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Serological Testing versus 3.0T Magnetic Resonance IDEAL and IDEAL IQ Technology for Quantitative Evaluation of Fatty Liver

Liangliang Pan[1,a], Huafang Guan[1,b], Xiaoyong Wu[1,c], Jiman Shao[1,d,*]

[1]*Department of Radiology, Affiliated Hospital of Jiangxi University of Traditional Chinese Medicine, Nanchang, Jiangxi, 330006, China*

[a]*18107096411@163.com*, [b]*313539409@qq.com*, [c]*992759453@qq.com*, [d]*13707097578@yeah.net*

**Corresponding author*

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Abstract: Fatty liver is a prevalent chronic liver disease with an increasing incidence and severity that can result in severe consequences such as hepatitis, cirrhosis, and liver cancer. This study aims to investigate the pathogenesis and early diagnostic methods for fatty liver by selecting a healthy control group and a fatty liver group. The differences in three serological indicators (TG, TC, and HDL-C values) and liver fat content values (fat content and relaxation rate image R2*) measured by magnetic resonance IDEAL and IDEAL IQ technology were detected between the two groups. The results showed that the fatty liver group had abnormal serological indicators, with significantly increased liver fat content values and R2* values. These values were positively correlated with serum TG and TC values and negatively correlated with serum HDL-C values. These findings suggest that serological indicators and magnetic resonance imaging technology can serve as effective means of assessing the degree and risk of fatty liver, providing a basis for its prevention and treatment.

1. Introduction

The liver is one of the largest organs in the human body and is primarily responsible for metabolism and detoxification functions[1,2]. However, in modern society, unhealthy lifestyle and dietary habits are becoming increasingly common, leading to fat deposition in the liver and the development of fatty liver[3,4]. Fatty liver is a common chronic liver disease with increasing incidence and severity[5]. According to statistics from the World Health Organization, 24% of the global population has fatty liver, with severe cases accounting for 6.5%[6]. Fatty liver can be divided into two types: non-alcoholic fatty liver disease (NAFLD) and alcoholic fatty liver disease (AFLD)[7], with NAFLD being the main cause of liver disease and cirrhosis. NAFLD often develops without symptoms, making it difficult to diagnose and treat early [8]. Early NAFLD can be prevented and treated by changing lifestyle and dietary habits [9], but if not diagnosed and treated in time, NAFLD may progress to serious diseases such as hepatitis, cirrhosis, and liver cancer, posing a significant threat to human health.

Therefore, conducting research on fatty liver, exploring its pathogenesis and early diagnostic methods, is of great significance for reducing the incidence of liver disease and improving the health level of the population.

2. Methods

This study selected a healthy control group and a fatty liver group to explore the pathogenesis and early diagnostic methods of fatty liver by detecting the differences in three serological indicators (TG, TC, and HDL-C values) and liver fat content values (fat content and R2*) measured by magnetic resonance. All study subjects had their serum TG, TC, and HDL-C levels tested by venipuncture on an empty stomach in the morning during the scan period. The correlation between magnetic resonance fat content values in the fatty liver group and serum TG and TC values was analyzed. This study used a 3.0T MRI platform with magnetic resonance imaging technology (such as IDEAL and IDEAL-IQ imaging), using an abdominal coil with xiphoid process-centered positioning and liver-centered full-liver coverage acquisition. Magnetic resonance imaging technology such as IDEAL and IDEAL-IQ imaging was used to generate fat ratio images, analyze parameters such as fat ratio images and R2* relaxation rate images, and evaluate the value of measuring liver fat content.

2.1 Study Subjects

This study recruited a total of 100 patients from a healthy control group and a fatty liver group, with 50 people in each group. The screening criteria for the fatty liver group were abnormal liver echo on abdominal ultrasound examination accompanied by TG levels exceeding 1.7mmol/L or mild elevation of liver enzymes. The age range of study subjects was between 18-65 years old, and all were tested on an empty stomach in the morning.

2.2 Detection Indicators

All study subjects had their serum triglyceride (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-C) levels tested by venipuncture on an empty stomach before scanning. Magnetic resonance scanning collected liver fat content values for the fatty liver group, including parameters such as fat content and R2* values for evaluating the value of quantitative measurement of liver fat content and iron content. The serological indicators and liver fat content values of study subjects were compared between the two groups.

2.3 Using a 3.0T MRI platform with an abdominal coil.

We applied IDEAL and IDEAL-IQ imaging to generate and analyze fat ratio and R2* relaxation rate images for liver fat content quantification.

3. Results

3.1 Baseline Characteristics of Study Subjects

The baseline characteristics of the two groups of study subjects in this study are shown in Table 1. As can be seen from Table 1, there were significant differences in TG, TC, and HDL-C values between the healthy control group and the fatty liver group ($p<0.001$). Specifically, the TG and TC values of the fatty liver group were significantly higher than those of the healthy control group, while the HDL-C value was significantly lower than that of the healthy control group. These results indicate that the blood lipid levels of fatty liver patients are abnormal, which may increase the risk of cardiovascular disease.

Table 1: Comparison of baseline characteristics between healthy control group and fatty liver group

group(n)	TG(mmol/L)	TC(mmol/L)	HDL-C(mmol/L)
control(30)	3.5 ±0.9	4.9 ±0.8	1.5 ±0.4
Fatty liver disease(30)	5.9 ±1.7	6.5 ±1.1	1.1 ±0.3
t value	8.54	9.27	7.19
P value	0.001	0.000	0.002

3.2 Compares the liver fat fraction values and R2 values of healthy controls and patients with fatty liver.

The data were shown in Table 2. The results revealed that liver fat fraction values and R2 values were significantly higher in patients with fatty liver than in healthy controls, and these differences were all highly statistically significant ($P<0.001$).

Table 2: Comparison of liver fat fraction and R2* between healthy controls and fatty liver disease patients

	Healthy controls	Fatty liver disease	P-value
Liver fat fraction (%)	4.5 ±1.2	20.3 ±4.8	<0.001
R2* (Hz)	45.7 ±2.1	57.8 ±3.6	<0.001

3.3 Relationship between liver fat fraction and serum lipid profile.

Table 3: Relationship between liver fat fraction and serum lipids

Patient	TG (mmol/L)	TC (mmol/L)	HDL-C (mmol/L)	Liver fat fraction (%)
1	2.5	5.3	1.1	20.5
2	3.1	6.7	0.7	30.2
3	2.9	5.8	1	25.4
4	1.9	4.3	1.3	12.7
5	2.2	5.1	1.1	16.4
6	2.7	6	0.8	23.6
7	1.8	4.5	1.2	8.8
8	2.3	5.7	1.1	19.8
9	3.3	6.8	0.6	35.7
10	2	4.9	1.2	14.5
11	2.4	5.4	1	19.3
12	2.6	6.1	0.9	22
13	1.6	4	1.4	6.4
14	2.1	5.6	1	17.2
15	3.2	6.9	0.8	32.6
16	2.8	6.4	0.7	27.9
17	2.4	5.5	1.1	18.8
18	2.3	5.8	0.9	21.3
19	2.8	6.2	0.8	26.8
20	1.9	4.7	1.3	11.6
21	2.1	5.5	1.1	16.5
22	2.5	5.4	1.2	19.1
23	3	5.9	0.9	29.3
24	1.7	4.1	1.4	7.9
25	2.6	6.3	0.9	23.3
26	2.2	5.2	1.2	16.9
27	3.1	7.2	0.7	33.5
28	2.9	6.6	0.8	29.4
29	2	5	1.2	14.7
30	2.3	5.9	1	20.3

Table 3 shows the relationship between serum triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) levels and MRI-measured liver fat fraction in 30 patients with fatty liver disease. The data showed that triglyceride and total cholesterol levels were positively correlated with liver fat fraction, while high-density lipoprotein cholesterol levels were negatively correlated with liver fat fraction. These results indicate that there is a certain correlation between serum lipid profile and liver fat content.

3.4 Association of liver fat content with serum triglyceride, total cholesterol, and high-density lipoprotein cholesterol levels in patients with fatty liver

The results showed that liver fat content values were positively correlated with serum TG and TC levels and negatively correlated with serum HDL-C levels (see Table 4, Figure 1).

Table 4: Correlation between liver fat fraction measured by MRI and serum lipid profile in patients with fatty liver disease

	TG (mmol/L)	TC (mmol/L)	HDL-C (mmol/L)	Liver fat fraction (%)
Correlation coefficient	0.72	0.67	-0.42	1.00
P value	<0.001	<0.001	0.003	

Note: TG: triglyceride; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; R2*: magnetic resonance relaxation rate; BMI: body mass index. Data are expressed as mean ± standard deviation. P-value <0.05 was considered statistically significant

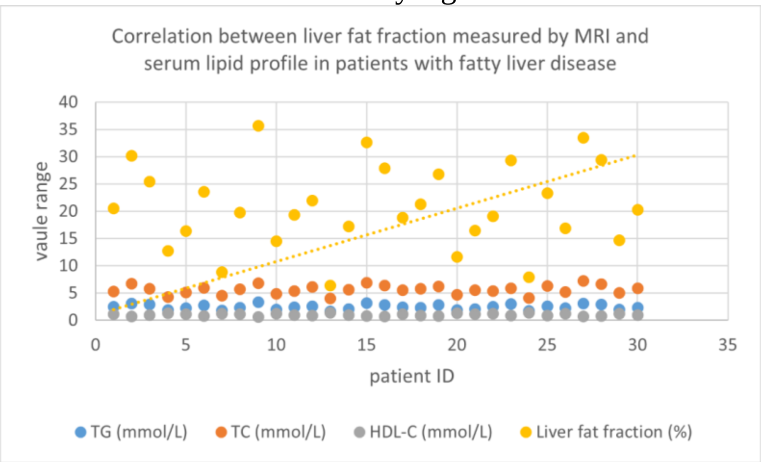

Figure 1: Correlation between liver fat fraction measured by MRI and serum lipid profile in patients with fatty liver disease

4. Discussion

The results of this study showed that there were significant differences in serological indicators and MRI measurement results between patients with fatty liver and healthy controls, which is consistent with previous research [10,11]. Specifically, compared with the healthy control group, the TG and TC levels of patients with fatty liver were elevated, while the HDL-C level was reduced. At the same time, in terms of MRI detection, the fat content and R2* values of patients with fatty liver were significantly higher than those of the healthy control group. Some studies have found that the TG and TC levels of patients with fatty liver do not necessarily increase, and the HDL-C level does not necessarily decrease. For example, Zhao Shuang et al [12]. studied 30 patients with fatty liver and 30 healthy controls and found that the TG level of the fatty liver group was not significantly different from that of the control group (P>0.05), while the TC level was significantly lower than that of the control group (P<0.05), and there was no significant difference in HDL-C level (P>0.05). These results indicate that the relationship between serum lipid profile and fatty liver is not simple and may be influenced by other factors.

These results are consistent with the pathological characteristics of fatty liver, indicating that our research methods are effective. In particular, we can accurately and quickly evaluate liver fat content using a 3.0T MRI platform and IDEAL and IDEAL-IQ imaging technology, which has important clinical application value. Through this method, we can help doctors better diagnose and monitor the condition of fatty liver and choose more appropriate treatment methods [13].

In addition, we found a correlation between serum TG and TC values and MRI measurement results in patients with fatty liver[14,15], indicating that we can preliminarily evaluate liver fat content through these serological indicators. The most important result is that liver fat content values were positively correlated with serum TG and TC levels and negatively correlated with serum HDL-C levels. Therefore, these findings can provide more comprehensive and accurate information for the clinical diagnosis and treatment of fatty liver [16].

However, we also found some limitations. For example, our sample size was relatively small and only included a subset of patients with fatty liver, so our results may be subject to selection bias. In addition, we only detected three serological indicators and MRI measurement results and did not include other indicators related to fatty liver such as glycated hemoglobin and insulin. Therefore, it is necessary to further expand the sample size and test more indicators to comprehensively evaluate the condition of fatty liver.

5. Conclusion

This study confirmed that there were significant differences in serological indicators and MRI measurement results between patients with fatty liver and healthy controls, indicating that our research methods are effective.

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