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Computed tomography findings of portal hypertension in non-alcoholic fatty liver disease

Dr. Gayatri Patil

Assistant Professor, D.Y.Patil Medical College, Navi Mumbai
Corresponding author email: drgpsatil@gmail.com

Dr. Amolkumar Patil

Consultant Urologist, Apollo Hospitals, Navi Mumbai

Dr. Madan Manmohan

HOD, Radiology Department, D.Y.Patil Medical College, Navi Mumbai

Abstract---To evaluate radiologic findings of portal hypertension at computed tomography (CT) of patients with non-alcoholic fatty liver disease for early diagnosis. Images of 200 cases who underwent non-enhanced abdominal CT were reviewed. The patients with the difference between hepatic and splenic attenuation (CT L-S) > 10 were enrolled in hepatosteatorosis group. The remaining formed control group. The relationship between two groups about diameters of portal and splenic veins, craniocaudal (CC) span of liver, splenic index, caudate lobe/right lobe (C/RL) ratio was analyzed statistically by Mann-Whitney U Test and Student's t-test. Total 200 cases, as hepatosteatorosis (n= 120) and control (n= 80) groups, were involved in this study. Liver CC span, splenic index and C/RL ratio between two groups were found to be statistically significant ($p < 0.01$). The splenic index and C/RL ratio are important findings of portal HT and fibrosis. CT imaging can be beneficial for diagnosis and treatment of NAFLD patients.

Keywords---hepatosteatorosis, portal hypertension, fatty liver, cirrhosis.

Introduction

Untreated nonalcoholic fatty liver disease (NAFLD) encompasses a wide spectrum of pathologic conditions, from simple steatosis to nonalcoholic steatohepatitis, which may progress to liver cirrhosis, and is associated with hepatocellular

carcinoma.¹⁻⁵ To prevent this progression, diagnosis of NAFLD and early initiation of therapy is important.

Liver specimens from patients with NAFLD show pericellular fibrosis around the central vein in the early stages of the disease, with gradual progression to fibrosis connecting the central veins in neighbouring lobules. In patients with chronic hepatitis, portal tract damage with pathologic changes to the portal vein generally precedes central vein involvement. The lumina of portal veins in the portal tracts tend to be preserved in the noncirrhotic stage of nonalcoholic steatohepatitis.⁶ This raises the concern that factors that contribute to the development of portal hypertension in patients with NAFLD may differ from those in patients with chronic viral hepatitis. Mendes et al⁷ reported that portal hypertension could occur in some patients with NAFLD who show only mild or no fibrosis. Evaluation of splenic elasticity is superior to other methods for the estimation of portal hypertension.⁸

Early detection of NAFLD is necessary to prevent progression. Percutaneous liver biopsy is required for accurate diagnosis of NASH; however, imaging studies can be helpful in avoiding unnecessary biopsies.⁹⁻¹¹ After exclusion of viral hepatitis and alcoholic liver disease with laboratory findings and history, diagnosis of NAFLD including NASH, can be done by imaging modalities.¹²⁻¹⁴ Our study was performed to investigate the role of CT on detection of development of portal HT in NAFLD patients. For this reason, we evaluated the CT images of NAFLD patients for portal HT findings based on quantitative measurements.

Materials and Methods

Between June 2020 and June 2021, 250 consecutive patients who underwent non-enhanced abdominal CT with nonspecific symptoms, were reviewed at a single institution from PACS (Picture Archiving and Communications System). The exclusion criteria for this study were as follows: (a) the patients with liver mass; (b) the positive laboratory findings for viral hepatitis; (c) the patients with history of alcohol consumption. The remaining 200 cases were included in our study. The patients who had hepatosteatosi, constituted the study group. The patients without hepatosteatosi were evaluated as the control group. The CT images were examined by a radiologist. All CTs were performed at a multi-slice helical scanner (Somatom Sensation 40, Siemens Medical Solutions, Erlangen, Germany). Scanning parameters for non-enhanced CT images were as follows: tube voltage, 120 kVp; tube current, 20 mAs, helical thickness, 2.5 mm, interval, 2.5 mm, pitch, 1.5 and reconstruction slice thickness 1.25 mm.

For detection of hepatosteatosi, the difference of hepatic and splenic attenuation (CT L-S) was used.¹⁴ The region of interest (ROI) measurements at five segments of liver (segments V, VI, VII, VIII from right lobe and segment IVb from left lobe) and at splenic zones (superior, middle, inferior) were performed. The mean attenuation values were estimated. For each measurement, a 200 mm² circle ROI was used. ROIs were measured from parenchymal area without vascularity, calcifications, visible biliary system, and artifacts. The patients with CT L-S >10 was enrolled in our study group, and the remainings were reported as the control group. For assessment of progression to portal HT, diameters of portal and splenic

veins, craniocaudal (CC) span of liver, splenic index, and caudate lobe/right lobe (C/RL) ratio were estimated. The portal and splenic venous measurements were done at the level of liver hilum and splenic hilum, respectively.

Splenic index was calculated by the formula of longitudinal length x anterior posterior (AP) diameter x mediolateral diameter. The mediolateral diameter was measured at the level of splenic hilus. C/RL ratio was estimated by using technique previously described.¹⁵ C/RL <0.65 is accepted as normal. Statistical analyses were performed using Number Cruncher Statistical System (NCSS) 2007 and the Power Analysis and Sample Size (PASS) 2008 Statistical Software (Utah, USA). Mann-Whitney U Test or Student's t-test was used, where appropriate, and $p < 0.05$ was used to determine statistical significance.

Results

Total 200 cases, as study (n= 120) and control (n =80) groups, were involved in this study. Of 200 patients, 60% (n= 120) were women and 40% (n = 80) were men. In study and control groups, the mean age was 49 and 52 years, respectively. The mean age of control group was a little higher, but not statistically significant ($p > 0.05$).

Table 1

The mean values of measurements of the study and control groups were shown.

There were statistically significant differences between two groups about liver span, C/RL ratio and splenic index

Parameters	Study Group	Control Group	p
Liver span (mm)	190	178	0.001
Splenic index	496	430	0.026
Portal venous diameter (mm)	12	12	0.310
Splenic venous diameter (mm)	8	9	0.16
C/RL ratio	0.32	0.28	0.001

The mean liver CC spans in the study and control groups, were 190 mm and 178 mm, respectively. Despite high meanliver spans in both groups, there was a statistically significant difference between two groups ($p < 0.01$). All C/RL ratios were within normal limits in both groups. The mean C/RL ratios were estimated 0.32 and 0.28 in the study and control groups, respectively. The mean C/RL ratio of study patients was significantly higher than that of the control group ($p < 0.01$). The mean splenic indexes in the study and control groups were 496 cc and 430 cc, respectively. The mean splenic index was statistically higher in the study group ($p < 0.05$). The splenic index that can be calculated accurately at CT, is an important indicator of portal HT. The mean diameters of portal and splenic veins were found to be 8 mm and 9 mm, respectively, in both study and control groups ($p > 0.05$), which showed no significant difference between two groups. The distribution of mean values and statistically relationships between groups are shown in Table 1.

Discussion

Patients with NAFLD and advanced fibrosis may progress to portal hypertension. Mendes et al.⁷ reported a 25% incidence of portal hypertension in patients with NAFLD, and portal hypertension can occur in patients without cirrhosis. The present study was an evaluation of hepatic blood flow changes that resulted from portal hypertension, and we identified those histologic parameters that correlated with hemodynamic changes in patients with NAFLD. If the fibrosis stage of NAFLD is advanced, the platelet count is known to decrease. In patients with NAFLD who have fibrosis, the platelet count is typically higher than 200 000/ μ L.¹⁶

NAFLD is a common disease and defined as hepatosteatosis without history of alcohol consumption.¹³ NAFLD can be seen without symptoms or with elevated liver enzymes or more severe forms such as fibrosis, liver failure, cirrhosis or HCC.^{17,18} The accurate diagnosis is done by percutaneous liver biopsy. Because it is an invasive method, we hypothesized that CT can be used as a non-invasive method for early diagnosis of portal HT in NAFLD. The imaging findings such as coarse echogenicity of liver, blunt liver edge, surface nodularity, caudate lobe hypertrophy, shrunken right lobe, increased diameters of portal and splenic veins, splenomegaly, ascites, varices are accepted as advanced fibrosis.¹⁸ CT is an effective method for detection of these findings with quantitative measurements.

In previous studies, Boyce et al. and Saadeh et al. reported that CT can be used as a screening tool for identifying hepatosteatosis.^{19,20} But, in contrast to our study, the evaluation of progression to steatohepatitis and cirrhosis was not investigated. The imaging features of portal HT were not assessed. In the study by Oliva et al., CT findings of 68 patients with NASH were analyzed. Of 68, 12 patients underwent liver biopsy. As a result, NASH patients had statistically higher CC liver span ($p < 0.05$) and C/RL ratio ($p < 0.05$) than those of the controls ($n = 9$). The similar results were achieved, but, additionally, the splenic indexes were also higher in NAFLD patients in our study. The number of patients was smaller compared to our study group.²¹

In NAFLD patients, the splenic index is accepted as an essential feature of portal HT. Our study is the largest series that investigated the portal HT findings in NAFLD patients at CT. There was statistically significant difference between groups according to CC liver span, splenic index, C/RL ratio ($p < 0.05$). The higher CC liver span, splenic index and C/RL ratio were noted as the findings of portal HT in the study group. Therefore, the portal HT findings at CT imaging in NAFLD patients can lead to biopsy for diagnosis of NASH. Unnecessary procedures may be prevented. The limitation of this study was the lack of histopathological results of NAFLD patients. Further investigations proven by biopsy are needed.

Conclusion

NAFLD is a common and severe disease which may cause portal HT and fibrosis. The early diagnosis of portal HT is important. The splenic index and C/RL ratio that are crucial signs of portal HT can be easily measured on CT in NAFLD

patients. So, as a non-invasive modality CT has an important role for diagnosis and treatment of these patients additional to clinical findings.

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