Original Article

Morphologic abnormalities of diffuse liver diseases at triphasic CT exam

Amjad Sattar, Binish Rasheed, Naureen Farhan, Mahnoor Hafeez, Saba Mughal

Dow Institute of Radiology, DUHS, School of Public Health, Karachi, Pakistan

Objective: To analyze the morphological abnormalities on Triphasic CT scan in patients with diffuse liver disease (DLD).

Methodology: All patients who underwent the Triphasic CT study comprised the study population. Demographics, size and density of the liver, caudate-right lobe ratio (CRL) was noted. Biliary-hepatic vascular patency, hepatic venous outflow tract obstruction (HVOT), parenchymal abnormality, liver contour abnormalities, Right Posterior Hepatic Notch (PHNS) Sign, Peri-Portal Space (PPS) widening and liver segmental/lobar atrophy, if present was recorded.

Results: The study had 270 participants. Chronic liver disease (CLD) was seen in 52.6%, Budd-Chiari syndrome (BCS) in 3.3% and hepatic steatosis (HS) in 4.8%. Patients who had heterogeneous or nodular liver texture, irregular or nodular margins and segmental/labor atrophy were more likely to have CLD. A statistically significant association of PPS widening and PHNS) with the CLD group of DLD compared to other groups (p=<0.001) and HS with the female gender (p=0.011). One-way ANOVA showed the highest mean liver size (18.44cm) for BCS and lowest mean liver size (15.10cm) for CLD.

Conclusion: All the morphological abnormalities were well depicted at Triphasic CT exam. Chronic liver disease accounted for more than 4/5th of DLDs. (Rawal Med J 202;46:765-769).

Keywords: Liver diseases, hepatic steatosis, liver cirrhosis, biliary tract diseases.

INTRODUCTION

The liver has multiple segments, dual blood supply and biliary pathways.[1,2] In Pakistan, around 12.5 million people are infected with hepatitis B and C viruses.[3] Diffuse parenchymal hepatic diseases can be categorized as storage, vascular, and inflammatory diseases.[4] In our experience, in Pakistan, Triphasic CT becomes the first-line modality for liver imaging because of its cost effectiveness. Percutaneous liver biopsy is the standard means of diagnosing liver diseases, but it has potentially serious complications including hemorrhage, infection, and bile leak.[5] Vascular disorders and biliary drainage abnormalities leading to lobar atrophy can be evaluated.

The normal ranges of the liver segments and lobes sizes have been described to classify liver diseases particularly, liver cirrhosis. Linear measures, most notably the caudate-to-right-lobe (CRL) ratio, have been applied to cross-sectional images in an attempt to quantify these changes.[6,7] The triphasic CT study has dual benefits; it characterizes liver lesions and is non-invasive.[8] The current study determines the morphological abnormalities of liver on Triphasic CT scan in patients with DLD.

METHODOLOGY

In this retrospective analysis, all in patients above 18 years of age that underwent Triphasic CT study at our institute from July to December 2020 were included. Data with incomplete information and blurring artifacts were excluded. Using OpenEpi Version 3, frequency of CLD in the population (p): 68.3%, confidence limits: 5%, design effect (for cluster surveys-DEFF): 1, Confidence Level: 90%, Sample size (n) = 235 [DEFF*Np (1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)].[9] The IRB exemption was sought for the study (Ref: IRB: 1672/DUHS/Approval/2020/).

CT cases were done on HITACHI 16-slice, SIEMENS 16-slice, GE 64-slice scanners. Triphasic CT examination is a multi-phasic acquisition of the abdomen, including non-contrast phase, Arterial, portal, Venous and Equilibrium phases, done before contrast, 35 sec, 70 sec, 180 sec post contrast, respectively.

The electronic medical record (EMR) of patients from the database was retrieved via HMIS PACS system. Images were analyzed at DICOM viewer. The size and density of the liver, CRL ratio was measured. The density was assessed by placing the region of interest (ROI) cursor in 3 segments of liver at non-contrast phase, with an area of cursor 2cm.[2] Mean Liver attenuation <40 Hounsfield Unit (HU) signifies hepatic steatosis.[10] The size of the liver was measured at coronal CT section at the level of portal vein bifurcation from the diaphragm up to inferior margin of the right lobe in cranio-caudal dimension. During the study, PPS widening i.e. enlargement of the fat filled peri hepatic space between the anterior margin of right portal vein and segment IV of liver at the axial cross sectional imaging; and PHNS Sign is an indentation over the posterior margin of right hepatic lobe was recorded.[11] Biliary-hepatic vascular patency and HVOT, if present was recorded. Study of focal liver lesions was not the mandate of research. Parenchymal abnormality morphologically manifests as heterogeneity or nodularity of the liver tissue (Figure).

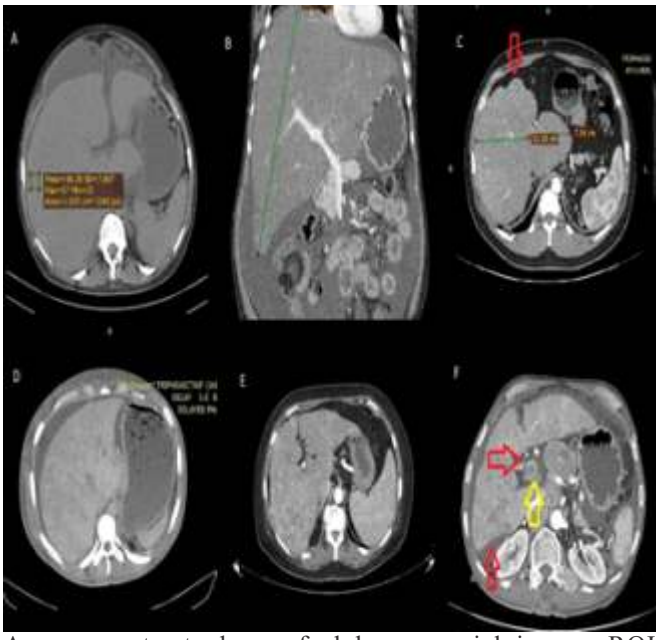
Statistical Analysis: Data were analyzed using SPSS version 21. The chi-square test and Fisher's exact test were run to check the association of morphological abnormalities of liver with the groups of patients. One way analysis of variance (ANOVA) was used to check mean differences of quantitative variables across the groups of patients. $p<0.05$ was considered statistically significant.

RESULTS

Out of 270 participants, 58.9% were males and 41.1% females. Mean age was 50.83±13.96 years. Patients with DLD were 60.7% and were sub divided into chronic CLD (52.6%), BCS (3.3%) and HS (4.8%) (Table 1). The miscellaneous group included pancreatico-biliary pathology causing biliary obstruction seen in 27(10.1%) patients, focal hepatic lesions in 22(8.1%), and gall bladder pathology in 6(2.2%) cases. It was noted that liver texture, margins, segmental/labor atrophy, PPS widening and PHNS were positively significantly associated with the DLD group of patients ($p<0.001$) (Table 2).

One-way ANOVA revealed that mean age was significantly different among all groups of patients and normal participants ($p<0.001$). Mean liver size and liver density was also found to be significantly different among all groups ($p<0.001$), with lowest density recorded for HS (33.23±7.61). However, no significant mean difference of caudate to right lobe (CRL) ratio was found across the groups (Table 3).

Fig. Morphologic abnormalities of diffuse liver diseases at triphasic CT exam.



A: non contrast phase of abdomen; axial image- ROI attenuation cursor shows density of liver. B: Coronal image- Portal venous phase shows cranio-caudal dimension of liver. C: Hepatic surface nodularity (Red arrow) and Caudate to Right Lobe (CRL) ratio. D: Delayed phase- Nutmeg liver in BCS. E: Arterial phase represents heterogenous parenchyma. F: thrombosed portal vein (yellow arrow), posterior hepatic notch sign and peri- portal space widening (red arrows).

The lowest mean age (29.89±7.00) and highest mean liver size (18.44±3.41) were found in patients with BCS and lowest mean liver size (15.10±2.67) were found in patients with CLD. Mean liver size and liver density was also found to be significantly different among all groups ($p<0.001$), with lowest density recorded for HS (33.23±7.61). However, no significant mean difference of CRL ratio was found across groups (Table 3).

Table 1. Distribution of morphological abnormalities of liver in patients (n=270).

Variables	Total	Normal (n=36)	CLD (n=142)	Budd-Chiari (n=9)	Hepatic steatosis (n=13)	Miscellaneous group (n=70)
		n (%)				
Gender						
Male	159	16 (10.1)	94 (59.1)	6 (3.8)	4 (2.5)	39 (24.5)
Female	111	20 (18.0)	48 (43.2)	3 (2.7)	9 (8.1)	31 (27.9)
Hepatomegaly						
No	113	12 (10.6)	79 (69.9)	0 (0)	3 (2.7)	19 (16.8)
Yes	157	24 (15.3)	63 (40.1)	9 (5.7)	10 (6.4)	51 (32.5)
Liver texture						
Smooth	141	36 (25.5)	30 (21.3)	3 (2.1)	11 (7.8)	61 (43.3)
Heterogeneous	110	0 (0)	96 (87.3)	6 (5.5)	2 (1.8)	6 (5.5)
Nodular	19	0 (0)	16 (84.2)	0 (0)	0 (0)	3 (15.8)
Margins						
Smooth	122	36 (29.5)	6 (4.9)	3 (2.5)	12 (9.8)	65 (53.3)
Irregular	34	0 (0)	25 (73.5)	6 (17.6)	0 (0)	3 (8.8)
Nodular	114	0 (0)	111 (97.4)	0 (0)	1 (0.9)	2 (1.8)
Segmental/lobar atrophy						
No	168	35 (20.8)	56 (33.3)	0 (0)	13 (7.7)	64 (38.1)
Yes	102	1 (1.0)	86 (84.3)	9 (8.8)	0 (0)	6 (5.9)
Location atrophied lobe						
No	168	35 (20.8)	56 (33.3)	0 (0)	13 (7.7)	64 (38.1)
Caudate and right	18	0 (0)	16 (88.9)	0 (0)	0 (0)	2 (11.1)
Right and segment IV	56	0 (0)	56 (100.0)	0 (0)	0 (0)	0 (0)
Left lobe	19	1 (5.3)	14 (73.7)	0 (0)	0 (0)	4 (21.1)
Peripheral	9	0 (0)	0 (0)	9 (100.0)	0 (0)	0 (0)

Table 2. Morphological abnormalities of liver with groups of patients (n=234).

Variables	Total	DLD (n=164)	Miscellaneous group (n=70)	P value*
		n (%)		
Gender				
Male	143	104 (72.7)	39 (27.3)	0.269
Female	91	60 (65.9)	31 (34.1)	
Hepatomegaly				
No	101	82 (81.2)	19 (18.8)	0.001
Yes	133	82 (61.7)	51 (38.3)	
Liver texture				
Smooth	105	44 (41.9)	61 (58.1)	<0.001
Heterogeneous	110	104 (94.5)	6 (5.5)	
Nodular	19	16 (84.2)	3 (15.8)	
Margins				
Smooth	86	21 (24.4)	65 (75.6)	<0.001
Irregular	34	31 (91.2)	3 (8.8)	
Nodular	114	112 (98.2)	2 (1.8)	
Segmental/lobar atrophy				
No	133	69 (51.9)	64 (48.1)	<0.001
Yes	101	95 (94.1)	6 (5.9)	
Periportal space widening				
No	118	51 (43.2)	67 (56.8)	<0.001
Yes	116	113 (97.4)	3 (2.6)	
Posterior hepatic notch sign				
No	121	52 (43.0)	69 (57.0)	<0.001
Yes	113	112 (99.1)	1 (0.9)	
*p-values have been calculated using Chi-square test.				

Table 3. Mean comparison of different characteristic of liver (n=270).

Variables	Normal	CLD	Budd-Chiari	Hepatic steatosis	Miscellaneous group	p-value*
Age (years)	45.81±14.49	54.22±12.05	29.89±7.00	46.15±14.64	50.10 ± 14.67	<0.001
Liver size (cm)	16.49 ± 2.36	15.10 ± 2.67	18.44±3.41	17.59 ± 3.17	17.34 ± 3.22	<0.001
Liver density (HU)	55.50 ± 8.57	53.08 ± 9.03	42.00±3.57	33.23 ± 7.61	54.80 ± 9.91	<0.001
CRL†	0.86 ± 0.78	0.88 ± 0.61	0.61 ± 0.13	0.86 ± 0.65	0.93 ± 0.71	0.767

*p-values have been calculated using One way ANOVA. †CRL=Caudate to right lobe ratio.

DISCUSSION

DLD are common clinical entities in our clinical practice including liver cirrhosis/CLD, BCS and fatty liver.[12] Liver surface nodularity was the frequent finding, seen in up to 67% of the diseased livers. These are a response to liver injury, seen not only CLD in patients but also in BCS. In our study, it was only seen in CLD patients. Hepatic nodules can also be evaluated using MRI.[13,14]

Fat accumulation has common patterns that include diffuse fat accumulation, diffuse fat accumulation with focal sparing, and focal fat accumulation in an otherwise normal liver.[15] In one recent study, the prevalence of HS in Canadian population was 24.7%, in US was 33.6%.[16] In our study, it was quite low, up to 4.8%.

There has been a misconception among the radiologists regarding HS whether it needs to be reported. It's a need because HS or NAFLD can lead to Nonalcoholic steato-hepatitis (NASH), which is the leading cause of cryptogenic cirrhosis.[17] Our institute is a major tertiary care center for liver diseases. The global prevalence of cirrhosis is around 4.5-9.5% in general population. Prevalence rates of 26%, 46% and 75.5% in cases of CLD have been reported from India, Ethiopia and Egypt, respectively.[18]

In a seven year study, Khokhar et al has reported 68.3% of CLD in Pakistan, whereas in our study, it was 52.6%.[11] Early grades of cirrhosis are difficult to assess on CT Abdomen. In these cases, the depiction of enlarged PPS and PHNS signs are a valuable aid in diagnosis of CLD. A measurement more than 10mm for PPS has an accuracy of 92%, and PPV of 91% for a diagnosis of cirrhosis. PHNS sign has been found in 71.8% patients with liver cirrhosis on MRI.[18,19]

The hypertrophy of caudate lobe and right lobe atrophy secondary to fibrosis accounts for pathophysiology of altered CRL in cirrhosis.[20] Increased CRL has a sensitivity, specificity and an accuracy of 84%, 100% and 94% for liver cirrhosis.[21] CRL of >0.73 indicates liver cirrhosis and normal liver has likely CRL of <0.6. Liver lobar and segmental atrophy is a common phenomenon following benign bile duct strictures, chronic biliary (BO) and/or portal venous obstruction (PVO).[22] The peripheral segmental atrophy was seen in 100% cases of BCS.[13]

CONCLUSION

All the qualitative and quantitative morphological abnormalities were well depicted at Triphasic CT exam. Chronic liver disease had the highest prevalence, accounting for more than 4/5th proportion of diffuse liver diseases.

Author Contributions:
Conception and design: Amjad Sattar
Collection and assembly of data: Binish Rasheed, Naureen Farhan
Analysis and interpretation of data: Saba Mughal
Drafting of the article: Mahnoor Hafeez
Critical revision of article for important intellectual content: Mahnoor Hafeez
Statistical expertise: Saba Mughal
Final approval and guarantor of the article: Amjad Sattar
Corresponding author email: Mahnoor: mahnoor.hafeez@yahoo.com
Conflict of Interest: None declared
Rec. Date: May 20, 2021 Revision Rec. Date: Aug 24, 2021 Accept Date: Aug 31, 2021

REFERENCES

1. Tortora, Gerard J.; Derrickson, Bryan H. Principles of Anatomy and Physiology (12th ed.). John Wiley & Sons. p. 945.
2. Kapoor VK. Liver Anatomy. 2017. Retrieved from URL. https://emedicine.medscape.com/article/1900159-overview.
3. Hussain T. October 14, 2008. Pakistan faces liver disease pandemic. Retrieved from URL. https://www.thenational.ae/world/asia/pakistan-faces-liver-disease-pandemic-1.546547.
4. Boll DT, Merkle EM. Diffuse liver disease: strategies for hepatic CT and MR imaging. Radiographics

2009;29:1591-14.
5. Bravo AA, Sheth SG, Chopra S. Liver biopsy. N Engl J Med 2001;344:495-500.
6. NN Chavan, RN Wabale. Morphological study of caudate lobe of liver. Indian J Med Res 2014;3:204-11.
7. Furusato Hunt OM, Lubner MG, Ziemlewicz TJ, Muñoz Del Rio A, Pickhardt PJ. The Liver Segmental Volume Ratio for Noninvasive Detection of Cirrhosis: Comparison with Established Linear and Volumetric Measures. J Comput Assist Tomogr 2016;40:478-84.
8. Hafeez S, Alam MS, Sajjad Z, Khan ZA, Akhter W, Mubarak F. Triphasic computed tomography (CT) scan in focal tumoral liver lesions. J Pak Med Assoc 2011;61 :571-5.
9. Danrad R, Martin DR. MR imaging of diffuse liver diseases. Magn Reson Imaging Clin 2005;13:277-93.
10. Hamer OW, Aguirre DA, Casola G, Lavine JE, Woenckhaus M, Sirlin CB. Fatty liver: imaging patterns and pitfalls. Radiographics 2006;26:1637-53.
11. Khokhar N. Spectrum of chronic liver disease in a tertiary care hospital. J Pak Med Assoc 2002;52:56-7.
12. Hanna RF, Aguirre DA, Kased N, Emery SC, Peterson MR, Sirlin CB. Cirrhosis-associated hepatocellular nodules: correlation of histopathologic and MR imaging features. Radiographics 2008;28:747-69.
13. Brancatelli G1, Federle MP, Grazioli L, Golfieri R, Lencioni R. Large regenerative nodules in Budd-Chiari syndrome and other vascular disorders of the liver: CT and MR imaging findings with clinicopathologic correlation. Am J Roentgenol 2002;178:877-83.
14. Hamer OW, Aguirre DA, Casola G, Lavine JE, Woenckhaus M, Sirlin CB. Fatty liver: imaging patterns and pitfalls. Radiographics 2006;26:1637-53.
15. Wells MM, Li Z, Addeman B, McKenzie CA, Mujoomdar A, Beaton M, et al. Computed Tomography Measurement of Hepatic Steatosis: Prevalence of Hepatic Steatosis in a Canadian Population. Can J Gastroenterol Hepatol 2016;2016:4930987.
16. Thuluvath PJ, Kantsevoy S, Thuluvath AJ, Savva Y. Is cryptogenic cirrhosis different from NASH cirrhosis?. J Hepatol 2018;68:519-25.
17. Ilione T, Ohagwu CC, Ogolodom MP. Computed Tomography Evaluation of the Caudate-to-Right Lobe Ratio in Patients with Liver Cirrhosis and Subjects with Normal Liver in Benin City, Edo State, Nigeria. J Res Health Sci 2019;13:1-7.
18. Khan TS, Rizvi F, Rashid A. Hepatitis C seropositivity among chronic liver disease patients in Hazara, Pakistan. J Ayub Med Coll Abbottabad 2003;15:53-.5.
19. Harbin WP, Robert NJ, Ferrucci JT. Diagnosis of cirrhosis based on regional changes in hepatic morphology: a radiological and pathological analysis. Radiology 1980;135:273-83.
20. Lubner MG, Pickhardt PJ. Multidetector computed tomography for assessment of hepatic fibrosis. Clin Liver Dis 2018;11:156-9.
21. Giorgio A, Amoroso P, Lettieri G, Fico P, de Stefano G, Finelli L, et al. Cirrhosis: value of caudate to right lobe ratio in diagnosis with US. Radiology 1986;161:443-5.
22. Czerniak A, Soreide O, Gibson RN, Hadjis NS, Kelley CJ, Benjamin IS, et al. Liver atrophy complicating benign bile duct strictures. Surgical and interventional radiologic approaches. Am J Surg 1986;152:294-300.