International Journal of Biomedicine 13(1) (2023) 84-90
http://dx.doi.org/10.21103/Article13(1)_OA10

INTERNATIONAL JOURNAL OF BIOMEDICINE

ORIGINAL ARTICLE

Radiology

Characterization of Incidental Liver Lesions: Comparison of Multidetector CT versus Ultrasonography

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Abstract

Background: Due to recent advancements in imaging techniques, as well as the widespread use of routine medical exams and screenings, incidental liver lesions are now more frequently discovered by ultrasound (US). Physicians must decide whether to simply follow up when incidental liver lesions are discovered in the US or to order additional imaging tests for lesion classification. The goal of our study was to identify liver lesions using multidetector computed tomography (MDCT) and US.

Methods and Results: A total of 50 participants were selected from a variety of male and female patients with abdominal pain and suspected liver diseases, and received a CT triphasic scan and US at the Royal Care International Hospital, Ibn Alhaitham Diagnostic Center, Alfaisal Specialized Hospital, and the Department of Diagnostic Radiology in the CT department of Sudan from April 2018 to May 2020.

The results of the ultrasound scanning (liver lesions and related findings) performed on patients before the CT scanning indicated that ascites + liver lesions was predominant (48.6%). The incidental liver lesions that take peripheral nodular enhancement by MDCT when contrast media is injected, were liver metastases (30%), hemangioma (14%), and hepatocellular carcinoma (10%). Liver cysts represent 10(20%) of the total cases of lesions that were non-enhanced by CT, with a few cases of liver cirrhosis (2%), hepatosplenomegaly (2%), and cyst + hepatitis (2%). We found a significant relationship between peripheral nodular enhancement for liver lesions by MDCT and non-enhancing liver lesions (P=0.001).

Conclusion: The US and CT scan findings have a statistically significant relationship (P≤0.017). Contrast-enhanced CT performs better at diagnosing liver lesions than does standard US.(**International Journal of Biomedicine. 2023;13(1):84-90.**)

Keywords: liver lesions • multidetector computed tomography • ultrasonography • contrast-enhanced computed tomography

For citation: Osman HE. Characterization of Incidental Liver Lesions: Comparison of Multidetector CT versus Ultrasonography International Journal of Biomedicine. 2023;13(1):84-90. doi:10.21103/Article13(1)_OA10

Abbreviations

CT, computed tomography; **CM**, contrast media; **DP**, delayed phase; **EAP**, early arterial phase; **HCC**, hepatocellular carcinoma; **MDCT**, multidetector computed tomography; **MRI**, magnetic resonance imaging; **PVP**, portal venous phase; **US**, ultrasound.

Introduction

With technological advancements in ultrasound (US), multidetector computed tomography (MDCT), and magnetic resonance imaging (MRI), we are now better able to identify low-contrast lesions and small hepatic lesions that would have gone undetected a few years ago.[1,2]

A significant contribution to the assessment of patients with liver illness has been made by multiphasic, contrast-enhanced dynamic computed tomography (CT) of the entire liver. Any lesion in the liver that is not part of the normal parenchyma and that causes structural or functional abnormalities in the hepatobiliary system is referred to as a *focal liver lesion*.[3]

MDCT has entered clinical use over the past few years. Compared to standard abdominal X-rays, CT scans of the liver and biliary tract can offer more detailed information about the liver, gallbladder, and related structures. This can help reveal more about injuries and/or diseases of the liver and biliary

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tract. The placement of needles during liver biopsies or the aspiration (extraction) of fluid from the area of the liver and/or biliary tract may also be visualized using CT scans of the liver and biliary tract.[4]

Ultrasonography is noninvasive, reasonably priced, and widely available. Many clinicians request it as the initial imaging modality for assessing the upper abdomen, including the liver, to quickly and efficiently narrow the differential diagnosis. Ultrasonography is particularly helpful in differentiating between cystic and solid lesions.[5,6]

The liver has two blood supplies, and it is known that the time between the start of the contrast inflow from the portal vein and the start of the contrast inflow from the arteries defines the duration of the virtual hepatic arterial phase. Contrast agents can help characterize and detect localized liver lesions more accurately than US. Since diagnosing these lesions depends mostly on contrast resolution, a good contrast-to-noise ratio is crucial for successful lesion detection. The contrast is dependent on both the liver parenchyma and the CT attenuation of the localized lesion. The most popular imaging technique to identify and characterize hepatic metastasis is MDCT.[7]

Materials and Methods

The investigation was carried out concurrently at the Royal Care International Hospital, Ibn Alhaitham Diagnostic Center, Alfaisal Specialized Hospital, and the Department of Diagnostic Radiology in the CT department of Sudan from April 2018 to May 2020. A total of 50 participants were selected from a variety of male and female patients with abdominal pain and suspected liver diseases, and received a CT triphasic scan and US.

Inclusion and exclusion criteria

All patients who underwent abdominal CT and sonography aged between 25-85 years with abdominal pain and suspected liver diseases were included. Children, hepatectomy patients' and normal patients after sonogram were excluded from the study.

Patient position and techniques

Alfaisal Specialized Hospital. The patient was in the supine position with feet-first scanning. We used Toshiba Asteion-4, a 4-slice CT scanner with 120 KVP, and 200 MAS. A triphasic protocol A triphasic protocol (sure start protocol) was started after obtaining a scout view of one slice above the liver before starting the scan's early arterial phase (EAP), portal venous phase (PVP), and delayed phase (DP) with an automatic injection flow rate of 4ml/sec and an 18-gauge needle for injection.

The Royal Care International Hospital. The triphasic protocol was used with a Toshiba 64-slice (Aquilion) CT scanner (120 KVP, 125 MAS) and automatic injection of 70-100 ml Omnipaque contrast medium at a flow rate of 3.5 ml/sec. The scans were taken in the EAP, PVP, and DP. After the injection, the scan starts instantly, and the DP is performed 10 minutes later. Slice thickness is 5mm per slice, the patient position is supine, and each water bottle contains 10ml of the oral contrast medium (500 ml total).

The Ibn Alhaitham Diagnostic Center. The triphasic protocol was used with a Toshiba 4-slice CT scanner (Japan), using120 KVP, 125 MAS. A triphasic protocol starts with an EAP scan (20 seconds after injection), a PVP scan (40 seconds after injection), and a DP scan (5-10 minutes after injection). The scans are taken at each phase automatically using 75 ml of Omnipaque contrast medium (40-50 ml for pediatric, according to weight). After the injection, the scan starts immediately, and the DP is performed 10 minutes later. Slices are 10 mm thick, and each water bottle contains 10 ml of the 500 ml oral contrast medium. The coronal region is the first slice, followed by the plain film without contrast medium and triphasic protocol scanning with contrast medium.

The Antalya Medical Center. The patient was supine with feet-first scanning from the sternal angle to the symphysis pubis. The CT machine (USA) was an 8-slice, bride-speed model (120 KVP, 165 MAS). The triphasic protocol is also used, starting with the automatic injection of 75 ml of Omnipaque contrast medium for adults at a flow rate of 3.5 ml/sec, followed by scans of the EAP, PVP, and DP. The scan immediately starts with a slice thickness of 5mm, and the reconstruction method takes 2.5 mm.

According to the triphasic protocol, the first scan is without contrast medium on plain film, followed by the scout (coronal section). Phased array transducers that operate between 3MHz and 5MHz are used to perform abdominal US.[8]

Statistical analysis was performed using statistical software package SPSS version 23.0 (Armonk, NY: IBM Corp.). Group comparisons were performed using chi-square test with Yates correction. A probability value of $P<0.05$ was considered statistically significant.

Ethical approvals were obtained from the Radiologic Sciences Program, Batterjee Medical College (Jeddah, Saudi Arabia). The data was only used for study purposes without individual details identifying the participant.

Results

By convenient sampling, we selected 50 patients (22 men and 28 women), who underwent CT triphasic scans. The age distribution of the study sample participants was as follows: 25-34 years [3(6%)], 35-54 years [12(24.0%)], 55-64 years [18(36%)] and ≥65 years [17(34%)], with a mean age of 59.28±12.67 years, minimum age of 27 years and maximum age of 85 years (Fig. 1).

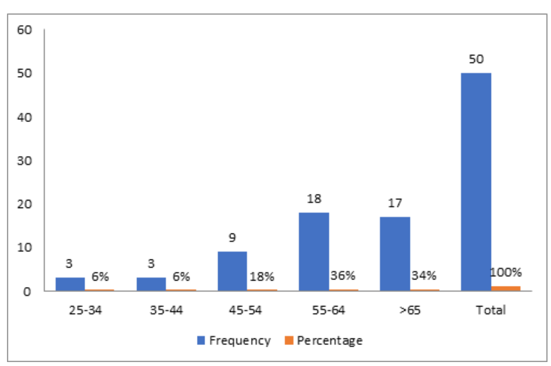

Fig. 1. The age distribution of the study sample participants.

The results of the ultrasound scanning (liver lesions and related findings) performed on patients before the CT scanning indicated that ascites+ liver lesions was predominant (48.6%) (Table 1).

Table 1.
The US scanning findings.

Diagnosis	Percentages (%)
Ascites + liver lesions	48.0
Liver lesions + hepatosplenomegaly	6.0
Multiple focal subdiaphragmatic + subcapsular lesions+ multiple mesenteric and para-aortic lymphadenopathies	6.0
Liver lesion + pancreatic tumor	6.0
Liver cyst	4.0
Liver mass	4.0
Hydatid liver cyst	2.0
Abdominal and pelvic mass + bilateral ovarian dermoid cysts	2.0
Liver lesions + prostate cancer	2.0
Fatty liver	2.0
HCC	2.0
Liver lesions + adnexal mass	2.0
Liver lesions + hemoperitoneum	2.0
Liver lesions + old TB granuloma	2.0
Liver lesions + sigmoid tumor	2.0
Hepatosplenomegaly + portal hypertension	2.0
Liver metastases	2.0
Liver mass+ right inguinal hernia	2.0
Liver lesions + right renal stone	2.0
Total	100.0

The incidental liver lesions characterized by CT were liver metastases (30%), liver cyst (20%), liver hemangioma (14%) and HCC (10%) (Table 2).

Table 2.
CT scanning results (liver lesions and associated findings).

Diagnosis	Percentages (%)
Liver metastases	30.0
Cyst	20.0
Hemangioma	14.0
HCC	10.0
HCC + liver cirrhosis	8.0
Liver abscess	6.0
Cyst + hepatitis	2.0
Hemangioma + old calcified granuloma	2.0
Hepatosplenomegaly	2.0
Liver cirrhosis	2.0
Liver metastases + hepatosplenomegaly	2.0
Liver metastases + lymphoma	2.0
Total	100.0

The incidental liver lesions that take peripheral nodular enhancement by MDCT when CM is injected, were liver metastases (30%), hemangioma (14%), and HCC (10%) (Table 3 A). Liver cysts represent 10(20%) of the total cases of lesions that were non-enhanced by CT, with a few cases of liver cirrhosis (2%), hepatosplenomegaly (2%), and cyst + hepatitis (2%) (Table 3B). We found a significant relationship between peripheral nodular enhancement for liver lesions by MDCT and non-enhancing liver lesions (P=0.001). When the US and CT scan findings were compared, a statistically significant relationship ($P \leq 0.017$) was found (Table 4).

Table 3A.
Peripheral nodular enhancement for liver lesion by MDCT.

CT (diagnosis)	Peripheral nodular enhancement
Hemangioma	7
	14.0%
Hemangioma + old calcified granuloma	1
	2.0%
HCC	5
	10.0%
HCC + liver cirrhosis	4
	8.0%
Liver abscess	3
	6.0%
Liver metastases	15
	30.0%
Liver metastases + hepatosplenomegaly	1
	2.0%
Liver metastases + lymphoma	1
	2.0%
Total	36
	72.0%

Table 3B.
Non-enhance liver lesions characterized by MDCT

CT (diagnosis)	Non-enhance enhancement
Cyst	10
	20.0%
Cyst + hepatitis	1
	2.0%
Hepatosplenomegaly	1
	2.0%
Liver cirrhosis	1
	2.0%
Liver metastases	1
	2.0%
Total	14
	28.0%

Table 4.

Ultrasonographic findings cross-tabulated with CT scanning diagnosis.

US Report (Diagnosis)	CT Report (Diagnosis)											Total
	Cyst	Cyst + hepatitis	Hemangioma + old calcified granuloma	HCC	HCC+ liver cirrhosis	Hepatosplenomegaly	Liver abscess	Liver cirrhosis	Liver metastases	Liver metastases + hepatosplenomegaly	Liver metastases + lymphoma	
Abdominal and pelvic mass + ovarian dermoid cysts/adnexa	-	-	2.0%	-	-	-	-	-	2.0%	-	-	4.0%
Ascites/ hepatic lesion	12.0%	2.0%	8.0%	8.0%	4.0%	-	4.0%	-	10.0%	-	-	48.0%
Liver lesions + prostate cancer	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
Fatty liver	-	-	-	-	-	2.0%	-	-	-	-	-	2.0%
HCC	-	-	2.0%	-	-	-	-	-	-	-	-	2.0%
Hepatic lesion + hemoperitoneum	-	-	2.0%	-	-	-	-	-	-	-	-	2.0%
Hepatic lesion + hepatosplenomegaly	-	-	2.0%	-	-	-	-	-	2.0%	2.0%	-	6.0%
Hepatic lesion + old TB gra-nuloma	-	-	-	2.0%	-	-	-	-	-	-	-	2.0%
Hepatic lesion + sigmoid tumor	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
Hepatosplenomegaly + portal hypertension	-	-	-	-	2.0%	-	-	-	-	-	-	2.0%
Hydatid liver cyst	2.0%	-	-	-	-	-	-	-	-	-	-	2.0%
Liver cyst	2.0%	-	-	-	-	-	2.0%	-	-	-	-	4.0%
Liver mass	-	-	-	-	-	-	-	-	4.0%	-	-	4.0%
Liver metastases	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
Multiple focal subdiaphragmatic + subcapsular lesions, multiple mesenteric + para-aortic lymphadenopathies	-	-	-	-	2.0%	-	-	2.0%	-	-	2.0%	6.0%
Pancreatic tumor + multiple hepatic lesion	4.0%	-	-	-	-	-	-	-	2.0%	-	-	6.0%
Right inguinal hernia + liver mass	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
RT renal stone+ hepatic lesion	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
Total	20.0%	2.0%	16.0%	10.0%	8.0%	2.0%	6.0%	2.0%	30.0%	2.0%	2.0%	100.0%
P-value	≤0.017											

Discussion

In patients with liver lesions, the aim of imaging is crucial to identify and characterize those lesions and to determine what is the most frequent lesion diagnosed by MDCT and US. CT scans are performed on patients with hepatic malignancies to rule out the presence of metastases and estimate the degree of local involvement. From our study, we found that a liver abscess is characterized by a thick, irregular wall, internal echogenicity or debris, and flow signals in the wall. Hemangioma is a homogeneous echogenic lesion with an echogenic peripheral rim and no or few peripheral or intralesional flow signals. Heterogeneous echogenic lesions, hypoechoic rims, and peripheral or internal artery flow signals are all characteristics of liver metastases. A heterogeneous echogenic lesion with a target sign, hypoechoic halo, and little to no peripheral flow signals is liver metastasis.[9]

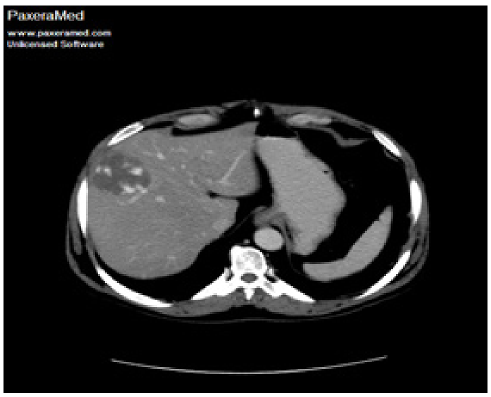

Image 1. *A 40-year-old male patient. Axial CT image arterial phase shows peripheral enhancement of hemangioma.*

In our study, by convenient sampling, we selected 50 patients (22 men and 28 women), who underwent CT triphasic scans. The age distribution of the study sample participants was as follows: 25-34 years [3(6%)], 35-54 years [12(24.0%)], 55-64 years [18(36%)] and ≥65 years [17(34%)], with a mean age of 59.28±12.67 years, minimum age of 27 years and maximum age of 85 years (Fig. 1).

Before getting a CT scan, patients had a US to check for liver lesions and other findings. In our cases (Table 1), liver lesions were found by ultrasonography and diagnosed following the above standards.[9] However, lesions were not specifically mentioned; rather, they were only reported as liver lesions. Table 2 displays the CT scan results of liver lesions and related findings.

Although it might be challenging to differentiate hepatic lesions based solely on imaging criteria, some focal liver lesions have well-defined ultrasonic and CT characteristics. It is crucial to stress that the main goal of imaging the liver is to differentiate between benign, metastatic, and initial malignant lesions. The best method for imaging the liver to detect localized liver disease is still debatable.[10]

Imaging is essential to diagnosing and treating HCC patients. Dynamic cross-sectional CT imaging techniques have also been used for HCC diagnosis and staging, although ultrasound is currently the primary diagnostic imaging tool for HCC. The use of CT is supported by recent technological developments in CT that relate to reducing radiation exposure, optimizing tissue characterization, and developing targeted contrast agents in various enhancement phases. The liver cirrhosis and HCC enhancement patterns are shown in Table 3 (A&B), respectively. We found a significant relationship between peripheral nodular enhancement for liver lesions by MDCT and non-enhancing liver lesions (P=0.001).

Until proven differently, a liver mass in a cirrhotic liver should be considered an HCC. Malignant and benign lesions are both diagnosed as liver masses in cirrhotic livers. Ultrasound was used to identify a hepatic mass, and contrast-enhanced MDCT was used to define the mass. The hepatic lesion and cirrhosis are described differently by each modality, depending on the presence of certain nodules and other elements. The characteristics of the liver masses and lesions in the cirrhotic and non-cirrhotic liver were demonstrated in the current study. HCC occurs as a supplementary improvement. Although ultrasound is the main surveillance imaging tool for HCC, dynamic contrast-enhanced CT and MRI are used primarily for diagnosis and staging of HCC.[11]

Regarding the cysts, similar descriptions were given in the study by P. Kar and J. Rajat,[12] which stated that on CT, cysts appear as a well-defined intrahepatic lesion with water attenuation (0-15 HU), round or oval with smooth thin walls and homogeneous appearance with no internal structures. Cases with cysts appear as non-enhanced in 11(22.0%) cases as hypo-dense non-enhancing focal lesions and no enhancement after contrast administration.

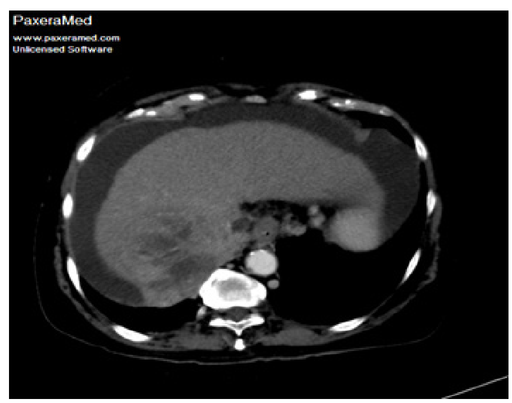

Image 2. *A 85-year-old male patient. Axial abdominal contrast-enhanced CT shows HCC with liver cirrhosis*

The liver abscess in the current study has been described as a peripheral nodular enhancement and rounded hypo-dense localized hepatic lesion in 3(6%) of the cases. According to prior research, the most effective approach for detecting liver abscesses is CT.[12,13] There are limitations to the CT diagnosis of liver abscess. Sometimes, the CT's appearance is neither specific nor diagnostic. In the series described from our study, abscesses ranged in appearance from fluid-filled cavities with clean margins to ill-defined masses with densities somewhat lower than the liver's surrounding tissue. Similar findings were described in the series of Rubinson et al.,[14] where the appearance of a hyperdense rim on a CT scan following contrast enhancement is thought to be evidence of an abscess, as in our study findings. Rubinson with colleagues showed that CT scanning of the abdomen in 50 patients evaluated for suspected intraabdominal abscess resulted in an overall accuracy of 92 percent.[14]

The most widely used method for imaging the liver in Sudan is US, which is also the main method for looking for liver metastases in many nations. US diagnosis has a smaller role in the United States due to the relative accessibility of CT and less physician engagement in US performance. When there is little to no suspicion of metastases, US frequently finds liver masses in patients. The screening for metastases is done less often with US. Studies comparing US to other imaging modalities show that it has higher specificity but lower sensitivity. Metastases can be hypoechoic, hyperechoic, cystic, or diffuse when detected by US. Normal hepatic arteries are commonly displaced by metastases.[15]

When the US and CT scan findings were compared, a statistically significant relationship ($P \leq 0.017$) was found (Table 4). This indicates that liver lesions can be detected and identified via ultrasonography. Due to its superior spatial and contrast resolution, ultrasonography can provide information about the liver and liver masses without the need for contrast agents, unlike CT scans. Liver cysts were found and confidently diagnosed, and a variety of solid mass manifestations pointed to a particular diagnosis. An echogenic or isoechoic liver mass with a hypoechoic halo or rim suggested that it was likely cancerous. This was also mentioned in earlier studies, and masses with this morphologic characteristic prompted confirmatory imaging with CT scans, some of which revealed the same findings and others with different results.

The small sample size of our study, particularly for benign lesions, is one of its limitations. Further, there was no calculation of interobserver agreement for CT picture interpretation. The diagnosis in cases of localized lesions was dependent on the radiologist's judgment and the CT/US diagnostic criteria rather than a biopsy. Another potential drawback is that multiple CT scanners of various makes were used for the scans.

Conclusion

Anatomical normality, pathologic alterations, and relationships to neighboring structures can all be seen using the highly spatially resolved MDCT technology. Additionally, the speed of MDCT scanning has improved, enabling quick and precise multiphasic imaging with brief breath-holding intervals. The accuracy of the presentation of enhancement and through-plane resolution of multiphasic liver imaging have both been greatly enhanced by the combination of MDCT and optimized administration of the contrast-agent. We can find tiny lesions by using thinner slices. Finally, contrast-enhanced CT performs better at diagnosing liver lesions than does standard US. However, an abdominal MDCT exposes the patient to a large amount of radiation. Consequently, the number of required scans and the use of reduced collimation should be precisely adhered to for each patient, with regard to the individual clinical concern and history.

Acknowledgments

I would like to express my special appreciation and thanks to the staff at the Sudan University of Science and Technology, College of Medical Radiological Science and Radiology Department in Alfaisal Specialized Hospital, Ibn Alhaitham Diagnostic Centre, Antalya Medical Centre, and Royal Care International Hospital for their help in data collection.

Competing Interests

The author declares that there is no conflict of interest in this work.

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