ROLE OF ULTRASONOGRAPHY AND CONTRAST ENHANCED CT IN DETECTION OF FOCAL LIVER LESIONS IN A RURAL SOUTH INDIAN POPULATION

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ABSTRACT

BACKGROUND

Focal liver lesions are frequently encountered by radiologists mostly during routine ultrasonography and then are usually evaluated further by contrast enhanced CT. Dedicated triple phase CT helps in studying the nature of the lesion by the timing and pattern of enhancement. For instance, metastasis shows early arterial enhancement and early washout in contrast to Haemangioma which shows delayed wash out following portal phase enhancement. This further narrows the diagnosis which can then be confirmed histopathologically in cases where biopsy is indicated. This study aims at understanding the aptness of USG as first line of imaging in detecting focal hepatic lesions and comparing the findings with CECT and histopathology. The objectives of the study were-
1. To determine the diagnostic accuracy and role of ultrasonography in evaluation of focal liver lesions.
2. To compare the findings with contrast enhanced CT.
3. To compute sensitivity, specificity and accuracy of ultrasonography in detecting focal hepatic lesions.

MATERIALS AND METHODS

This prospective study spanned over three years. 106 patients who were detected sonographically with focal liver lesions were selected. Patient details including relevant clinical history were recorded. The sonographically detected lesions were subjected to contrast enhanced CT of abdomen, follow up USG and in few cases, with histopathology, to reach confirmatory diagnosis.

RESULTS

Of the 106 patients, incidence of focal liver lesions was found to be more in males in the ratio of 1.4: 1. Most patients were 41 - 50 years (24.5%) of age. Right lobe showed predominant involvement - 2.9: 1 and both lobes were involved in 26% cases. Contrast enhanced CT was done in all cases and biopsy was done in 24 patients. USG was repeated in 18 cases.

Ultrasonography showed: Sensitivity - 93.9%, Specificity–98.5% Accuracy– 98.4%

CONCLUSION

Ultrasonography has advantages like accessibility, speed, non-invasiveness, low cost and good specificity. Adjuvant Doppler gives USG the added advantage of studying vascularity. Study shows that in spite of higher specificity and better role as confirmatory investigation in case of CECT, the reliability of Ultrasonography is still comparable and is hence, considered as first line modality.

KEYWORDS

Hepatic, Ultrasonography, Prospective, Focal Lesions, Doppler.

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BACKGROUND

Noninvasive imaging of liver and hepatic lesions using sonography and CT (Computed Tomography) has been preferred as mainstay in imaging for various clinical settings, such as neoplasm screening, portal hypertension work up, suspected cases of portal or hepatic venous thrombosis and also in pre- and post-operative assessment in liver surgeries. MRI is the alternative noninvasive modality which assists in study of hepatic vasculature without contrast agents. Sonography offers additional advantages like easy availability, portability, cost effectiveness and complementary Doppler mode for vascular study, hence, advocating for sonography as the first line noninvasive imaging modality in imaging liver and its vasculature.1

Recent advances in Ultrasonography have improved resolution and signal-to-noise ratio and so, it is now possible to gather information regarding texture as well as contour of liver.2

The advent of ultrasonography as routine imaging tool has enabled prompt detection of focal liver lesions. For lesions larger than 1.5 cm, USG is superior to CT in their
detection. For lesions smaller than 1.5 cm in size, conventional CT plays a less important role, but sonography still has the ability to detect them and characterize them as cystic or solid.

Detection of multiple small low-density lesions in CT imaging is correlated with sonography findings to arrive at an accurate diagnosis. The high sensitivity and relative specificity of sonography makes it the modality of choice for detecting liver lesions. First line differentiation of benign versus malignant lesions is made possible by ultrasonography. Small sized HCCs are usually incidentally picked on routine sonography which has higher accuracy than AFP (Alpha fetoprotein) screening, when compared to smaller lesions which may not correlate with AFP levels.

Ultrasonography is effective in guiding biopsy needles for sampling hepatic secondaries which are 1.5 cm or smaller along with the added advantage of guiding the needles along non-axial planes as well.

**Aims and Objectives**
1. To assess the sensitivity, specificity and accuracy of sonography in detection and evaluation of focal liver lesions.
2. To correlate the USG findings with CECT/ repeat USG or HPE (histopathological examination) or Lab findings or follow up to supplement the diagnosis of focal liver lesions depending on each case.
3. To detect and characterize most common and least common focal liver lesions in the selected rural population.

**MATERIALS AND METHODS**
A group of 106 patients who presented to the hospital were worked up based on detailed history, physical examination and biochemical investigation and were then subject to routine Ultrasonography imaging. They were further worked up using plain and contrast enhanced CT imaging as indicated.

**Inclusion Criteria**
The study predominantly included asymptomatic/symptomatic patients with focal hepatic lesions incidentally detected during routine USG as well as patients detected with focal liver lesions in the backdrop of diffuse liver diseases like cirrhosis.

**Exclusion Criteria**
It was beyond scope to include all patients presenting with liver lesions and so, the study excluded locally spread conditions involving the liver. Acute traumatic contusions/lacerations of the liver were excluded. Asymptomatic lesions with diagnostic triple phase CECT features, where further treatment was not indicated, were not subjected to further biopsy. Patients with deranged renal function were excluded from contrast studies.

The imaging findings were correlated with CT/ Surgical /histopathological/ follow up imaging including repeat ultrasonography or CT following conservative management. Follow up was done between 2-6 months following the first visit.

**Instruments and Procedure**
Ultrasonography was done using LOGIC GE Q5 PRO scanner with a 3.5/ 5 MHz curvilinear and high frequency linear probes with patient in fasting state. The liver was scrutinized, and any focal abnormality was recorded. Doppler study was done and when indicated, CT was done using Spiral CT 8-slice multi detector HITACHI scanner before and after administration of IV and/or oral contrast agent. Oral contrast (20 ml) mixed with 1 litre of water was given 1 hour before the procedure. For the triphasic study, pressure injector was used where 60 ml of iodinated contrast was given at the rate of 1.2 ml/ sec using a pitch of 1.0 to 1.5 mm slice thickness were obtained.

On the basis of medical, surgical and histopathological follow up, we derived sensitivity, specificity and accuracy of ultrasonography in the diagnosis of focal lesions of liver. Further, Ultrasound – guided biopsy/FNAC/ Aspiration cytology was performed as indicated.

**RESULTS**
The study concluded that incidence of focal liver lesions was high in the elderly (Table 2). Right hepatic lobe was mostly affected (Fig. 2). Of the 106 cases, 122 different lesions were detected, wherein, 91 were benign and 31 were malignant (Table 3). The commonest malignant lesion encountered was metastasis whereas commonest benign lesions were haemangiomas and simple hepatic cysts (Table 3). The overall sensitivity of ultrasound is comparable to that of CT but lack of radiation exposure and easy accessibility makes USG the ideal first line imaging tool in detecting focal hepatic lesions (Table 7).

**Table 1. Sex Distribution of Patients**

| Sex     | No. of Cases | Percentage (%) |
|---------|--------------|----------------|
| Females | 44           | 41.5%          |
| Males   | 62           | 58.5%          |

**Figure 1. Incidence of Focal Liver Lesions in Males and Females**
The incidence of focal liver lesions was high among the elderly age group. More than 70% of the lesions occurred in patients above 40 years of age and 33% of patients were above the age of 60 years.

| Age Group (Years) | No. of Cases | Percentage (%) |
|-------------------|--------------|----------------|
| 0 – 10            | -            | -              |
| 11 – 20           | 1            | 0.94           |
| 21 – 30           | 9            | 8.49           |
| 31 – 40           | 17           | 16.03          |
| 41 – 50           | 26           | 24.51          |
| 51 – 60           | 18           | 16.98          |
| 61 – 70           | 19           | 17.9           |
| 71 – 80           | 12           | 11.38          |
| 81 – 90           | 4            | 3.77           |
| Total             | 106          | 100            |

Table 2. Age Wise Distribution of Patients with Focal Liver Lesions

Of the total 106 cases, 122 different lesions were recorded of which, 91 were benign (74.5%) and 31 were malignant (25.5).

Of 22 cases of metastasis, 19 had multifocal lesions and 3 had solitary lesion.

**Lesions** | **Histopathology Findings**
---|---
Liver abscess | USG guided aspiration was done in 6 patients. Four cases showed heavy inflammatory pus with neutrophilic infiltration; Two cases showed anchovy pus. No complication encountered other than blood tinged aspirate.
Liver metastasis | 21 cases – Biopsy was done from the primary. 2 cases – FNAC done from the liver lesion – proved to be metastatic adenocarcinoma with occult primary.
HCC | USG guided FNAC done in 4 cases which showed sheets of malignant hepatocytes with high nucleocytoplasmic ratio, prominent nucleoli and intranuclear inclusions. One case was inconclusive by HPE.

**Lesions** | **Follow Up Study**
---|---
Simple Cyst | Follow up study showed no increase in the size and confirmed the diagnosis
Liver abscess | Follow up done in 5 cases showed gradual decrease in size of the abscesses in the subsequent scans with positive response to therapy
Haemangioma | Follow up study showed no increase in the size of the lesion in the subsequent scan
Focal fat sparing | Follow up scan showed hyperechoic lesions with geographical margins and no mass effect which confirmed the earlier diagnosis
Focal fatty infiltration | After 2 weeks, study done in 2 cases showed persistence of the lesions

**Lesion** | **True Positive** | **True Negative** | **False Positive** | **False Negative**
---|---|---|---|---
Hepatic cyst | 34 | 65 | 2 | 1
Haemangioma | 17 | 83 | 2 | 1
Calcified granuloma | 20 | 78 | 1 | 1
HCC | 5 | 94 | 2 | 1
Metastasis | 21 | 79 | 1 | 1
FNH | 4 | 95 | 1 | 1
Focal fat sparing | 2 | 98 | 1 | 0
Abscess | 5 | 95 | 1 | 0

Table 3. Incidence of Benign and Malignant Focal Liver Lesions in 106 Patients

**Figure 2. Location of Focal Liver Lesions**

**Table 4. Histopathology Findings**

**Table 5. Follow-Up Findings**
Table 6. Predictive Value of Ultrasonography and CECT

| Liver Disease            | No. of Cases | Sensitivity (%) | Specificity (%) | Accuracy (%) |
|--------------------------|--------------|-----------------|-----------------|--------------|
| Hepatic cyst             | 35           | 97.1            | 97              | 97           |
| Haemangioma              | 17           | 94.4            | 97.6            | 97           |
| Calcified granuloma      | 22           | 95.2            | 98.7            | 98           |
| HCC                      | 6            | 83.3            | 97.9            | 97           |
| Metastasis               | 21           | 95.4            | 98.75           | 98           |
| FNH                      | 5            | 80              | 98.9            | 99           |
| Focal fat sparing        | 2            | 100             | 98.9            | 99           |
| Abscess                  | 5            | 100             | 98.95           | 99           |
| Regenerating Nodule      | 1            | 100             | 100             | 100          |

Table 7. Sensitivity, Specificity and Accuracy of Sonographically Diagnosed Lesions

Illustrated Cases

Image 1 - Liver shows coarsened echotexture with a large predominantly hypoechoic lesion in the right lobe with multiple satellite nodules surrounding it. The portal vein appears invaded by a satellite lesion with an intraluminal projection. Features suggestive of primary malignancy.

Image 2 - USG shows multiple satellite lesions with halos around or 'target' sign, suggestive of hepatic metastases. Associated right pleural effusion was also seen in this case.

Image 3 - Right lobe shows a single anechoic cyst with no internal echoes - suggestive of benign hepatic cyst. No similar cysts noted elsewhere.

Image 4 - Superior aspect of the right lobe shows a large lesion containing internal heterogeneous debris suggestive of hepatic abscess. Perisplenic fluid was noted in this case.
**Image 5**- An image of the interventional USG guided biopsy done in an attempt to retrieve biopsy sample for confirming the diagnosis.

**Image 6**- The portal vein with hyperechoic walls which helps in its identification shows an intraluminal echogenicity which causes luminal narrowing as is evident by the narrowing stream of Doppler uptake at the same point.

**Image 7**- An axial section of contrast enhanced CT showing an ill-defined hypodense lesion with minimal peripheral enhancement in the right lobe of the liver suggestive of liver abscess.

**Image 8**- Coronal section of unenhanced CT abdomen showing a hyperechoic speck in the right lobe of liver suggestive of haled calcified granuloma.

**Image 9**- Axial section of contrast enhanced CT in an asymptomatic patient showing hyperdense calcific foci with somewhat lobulated contour suggestive of calcified granulomata

**Image 10**- Axial section of plain CT abdomen showing well defined hypodense lesions in the liver involving multiple segments suggestive of benign hepatic cysts while cystic metastases should be considered as unlikely differential diagnosis.
Image 11- Sonography study of the liver shows an isodense lesion with surrounding halo in segment VIII with multiple similar lesions in the other segments as well. Features compliant with those of hepatic secondaries.

Image 12- Sonography study of the liver shows a well-defined solid lesion with heterogeneous internal appearance and mass effect on the surrounding anatomic structures. Lesion turned out to be hepatocellular carcinoma with secondaries.

DISCUSSION

Doppler study provides rapid, comprehensive and accurate evaluation of the hepatic as well as intra-lesional vascularity. Regular B-mode USG has excellent resolution and therefore gives complete assessment of hepatic contour and liver lesions without contrast agents.

This study included 106 patients with male to female ratio of 1.4:1. In a study by Wernicke et al the male to female ratio was 2.26:1. In a study by Kenneth J W Taylor et al, age group of the selected patient crowd ranged from 2 months to 92 years, whereas our study included patients aged 19 to 87 years with the mean age of 52.59 years.

Another study by Stephanie R Wilson et al showed mean age of 51 years.

58 cases (54.7%) involved the right hepatic lobe and left lobe was involved in 20 cases (18.86%) whereas bilateral lobe involvement was noted in 28 cases (26.4%). (Fig. 2)

Solitary lesions were observed in 64 cases and multifocal lesions observed in 42 cases. Benign focal lesions accounted for 85.85% and malignant lesions seen in 29.25% cases.

Simple liver cysts were seen in 36 cases (33.9%) and this was similar to the study by Ralph M Weaver et al. Our study recorded sensitivity of 97.1% and specificity of 979% in the sonological diagnosis of simple hepatic cysts. In the research by Richard S M et al, the positive predictive value of sonography in diagnosing hepatic cysts was 100%. (Table 7). Owing to the sensitivity and relative specificity of ultrasonography, it may be preferred as imaging modality of choice for detecting simple hepatic cysts.

In our research, haemangioma accounted for 19 cases (17.9%). 16 cases (15.09%) were hyperechoic, 2 were isoechoic (1.87%) and only one demonstrated heterogeneous form. These findings are same as those observed in the study by Hashemi et al which found incidence was 88%, 4.9% and 7.3% for hyperechoic, isoechoic and heteroechoic variety of haemangioma respectively. Similar observations were made in the study by Yuji et al. Complementary Color Doppler study showed no significant internal vascularity in most haemangiomas, similar to study by Hashemi et al. Similar observation was made by Srivasthava et al. 106 cases were subjected to CT contrast enhanced CT study. 11 cases subject to review sonography revealed no significant change in size or appearance. Sensitivity, specificity and accuracy of sonography for in diagnosing haemangioma was found to be 94.4%, 97.6% and 97% respectively, which is similar to the study by Yuji et al, who suggested that ultrasonography is superior for lesions less than 15 mm.

Of the cases with hepatic abscess, 80% were provisionally diagnosed. Hepatic abscess was noted in 6 cases (5.66%), the commonest site was right lobe (85%). Ultrasonography revealed sensitivity of 100% and specificity of 98.9% and accuracy of 99% in diagnosing liver abscess. False negative case was an abscess de novo mimicking an atypical haemangioma. Sonography-guided percutaneous drainage showed anchovy pus in all abscesses except one case and all, on subsequent imaging, showed reduction in size of the collections.

7 cases of hepatocellular carcinoma were detected, of which, 65% cases had cirrhotic backdrop. 85.7% (6 out of 7 cases) were detected in the right lobe. 42.8% (3 out of 7 cases) were multifocal and 57.2% (4 out of 7 cases) were discrete. Peripheral halo sign was noted in 60% in comparison to 27% (4 out of 15 cases) observed by Hashemi et al.

Portal vein seeding was seen in 42.8% cases (3 cases) of which, 28.5% (2 out of 7 cases) appeared thrombosed. Intralesional vascular uptake on Doppler was noted in 77% cases, whereas 80% hepatocellular carcinomas showed intra and perilesional vascular uptake as proved by Hashemi et al. Sensitivity and specificity of 80% and 80.8% respectively was noted for detecting HCC. Our study showed a sensitivity of 83.3%, specificity of 97.9% and accuracy of 97%. A study by Kenichi Takayasu et al showed that sonography has 84% sensitivity and sonography/CT and AFP together are useful in detecting small HCCs.

22 cases (20.7%) of metastatic deposits in liver were noted. 40.9% (9 out of 22) had associated hepatomegaly. 86.33% (19 out of 22) patients had known primary malignancy. In 50% (11 out of 22) cases, hyperechoic lesions were noted. In our study, target appearance was seen in 38.2% (13 in 34) cases in contrast to 17% (13 out of 36) by William Schieble et al and 38% (14 out of 37) by Hashemi et al. Intralesional vascularity was demonstrated in 17.6% cases (6 out of 34), while, research by Srivasthava showed intralesional vascularity in 33% cases.
Our study observed sensitivity and specificity of 95.4% and 98.75% respectively.

Hepatomegaly was observed in all cases with focal fat sparing, with sensitivity and specificity of 100% and 98.9% respectively.

Histopathological diagnoses were accepted as definitive. In 15 cases, validation of the sonographic results was based on follow up imaging as intervention wasn’t validated. No changes in size or appearance for a period of 2-6 months was considered as evidence that the lesion was benign.

CONCLUSION
Ultrasound, owing to its many advantages including high overall accuracy, plays a pivotal role as primary imaging modality in diagnosing focal hepatic lesions. Complementary Doppler study further adds to its role by assessing vascularity. Although CT and CECT has the higher overall sensitivity among routine imaging techniques, sonography is comparable to CT in detecting hepatic lesions. Another advantage of Ultrasonography includes its role in real time imaging and guided aspiration/biopsy thus, helps in definitive diagnosis.

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