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ORIGINAL ARTICLE

ROLE OF ULTRASONOGRAPHY AND CT IN THE EVALUATION OF ABDOMINAL MASSES

D. Harinath[1], B. Suresh[2], Smrita Swamy[3], Kiran K. U. V[4]

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ABSTARCT: BACKGROUND: Investigators have stressed the ability of CT and US to image abdominal masses and have touted them as first-line imaging modalities. MRI may be used to evaluate complex lesions not definitely characterized by US or CT. We want to evaluate the utility of US and CT for evaluating abdominal masses in our rural India setup, wherein the study has to be appropriately utilized and tailored to the clinical need and also according to the socioeconomic situation. **MATERIALS AND METHODS:** This is a prospective observational study done in Department of Radiodiagnosis, PES Institute of medical sciences, Kuppam, between November 2011 to June 2013 in 30 patients with suspicious of abdominal masses and referred to the Department of Radio diagnosis and Imaging, for ultrasound and CT scan of abdomen. **RESULTS:** Ultrasound and CT has 73% and 100% sensitivity respectively for identifying the site of origin in abdominal and retroperitoneal masses when compared with surgical findings. Ultrasound is less sensitive for the detection of fat and characterization of retroperitoneal masses compared to CT. By combining the ultrasound and CT findings we can able to give the histopathological diagnosis in 83% cases of abdominal mass lesions. **CONCLUSION:** We conclude that ultrasound and CT has additive role in the evaluation of abdominal masses and their management.

KEYWORDS: Ultrasonography, Computed Tomography, Magnetic Resonance Imaging, Abdominal masses.

INTRODUCTION: Much has been written about the use of imaging in evaluating abdominal masses since the 1980s. Newer reviews and case reports have focused on evaluation of specific masses using Computed Tomography (CT), Ultrasound (US), and Magnetic resonance imaging (MRI).

CT, MRI, and US are complementary imaging modalities for evaluation of a palpable abdominal mass. US is the first-line imaging modality when ionizing radiation from CT is of particular concern (eg, pediatric or pregnant patients and when the mass is superficial.[1]

US are limited by bowel gas in cases of dilated bowel or by body habitus. US is also partly operator dependent, however likely to a lesser extent with directly palpable abnormalities. As expected, attempts to predict the pathologic diagnosis of masses based on imaging findings are less successful. In several studies US findings correctly predicted the pathologic diagnosis in 77% to 81% of cases, while CT findings suggested the diagnosis in 88% of cases.[2,3,4]

CT imaging, which is relatively more costly and involves ionizing radiation, may then be reserved for cases requiring further problem solving secondary to indeterminate US findings or for detecting lesions not visible on US due to body habitus and/or overlying bowel gas. One study

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demonstrated that, compared with strategies not using CT, the use of CT can result in saving the time for diagnosis and overall cost of hospitalization. Accordingly, when US findings are indeterminate, CT imaging should be obtained in a timely manner. Ultrasound still remains more appropriate as first-line imaging in this radiosensitive population because of its high sensitivity (90% to 99%), specificity (97% to 100%), and lack of ionizing radiation.[2,5,6]

MRI may be used to evaluate complex lesions not definitely characterized by US or CT.[7] MRI lacks ionizing radiation and demonstrates cross-sectional and multiplanar capability similar to that of US and multi detector CT. MRI also excels in specifically characterizing fat, protein, fluid, blood products and metal. Hence, MRI may demonstrate distinct advantages in radiation-sensitive patient populations when the US findings are non-diagnostic.

We would like to restrict our study to Ultrasound and Computed Tomography evaluation of the abdominal masses. We want to evaluate the utility of these modalities for evaluating abdominal masses in our rural India setup, wherein the study has to be appropriately utilized and tailored to the clinical need and according to the socioeconomic situation. To our knowledge we did not come across any such study in the literature.

AIMS AND OBJECTIVES:

1. To study CT morphological characteristics of various abdominal masses.
2. To study Sonographic morphological characteristics of various abdominal masses.
3. To compare CT and USG findings with the Surgical or Histopathological findings.
4. To evaluate sensitivity and specificity of CT scan and Ultrasonography in assessment
5. Of the abdominal masses.

MATERIALS AND METHODS: This is a prospective observational study done in Department of Radio diagnosis, between November 2011 to June 2013 in 30 patients with suspicious of patients with abdominal masses referred to the Department of Radio diagnosis and Imaging, for ultrasound and CT scan of abdomen in PES Institute of medical sciences, Kuppam.

All the patients were undergone abdominal Ultrasonography and Computed Tomography with Philips (HD 11 XE) USG and GE Bright Speed Ct Machine 16 Slice.

Inclusion Criteria:

1. Patients above 1 yrs and below 80yrs.
2. All positive CT & USG studies with abdominal masses and in which histopathological or surgical confirmation (either FNAC / Biopsy or surgical HPE) is available.

Exclusion Criteria:

1. Patients below 1yr and above 80 yrs.
2. Cases without histopathological / surgical confirmation.
3. Patients who are allergic to contrast.

All male and female patients between 1yr and 80 yrs. referred with complaints suggestive of abdominal mass are imaged with both US and CT scan. Patients were scanned using with C5-2 and L12-3 probes. Both gray scale and color Doppler images are acquired as per requirement.

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CT scan will be done employing Non Contrast Enhanced Study and Contrast Enhanced Study including oral, rectal and intravenous contrast. Oral and rectal contrast may be positive or negative. All cases will also have Ultrasonography done. All cases will be followed up for Operative / FNAC or Biopsy results for the final diagnosis.

All positive CT & USG studies with abdominal masses and in which Histopathological (FNAC / Biopsy) or surgical confirmation is available are included in the study. Patients below 1 yr and above 80 yrs and cases without Histopathological / surgical confirmation are excluded from the study.

Institutional review board approval has been taken for the study.

RESULTS: A Correlation clinical radiological study consisting of 30 patients is undertaken to study the correlation of findings of USG and CT diagnosis with surgical/Histopathological diagnosis. Total numbers of patients are 40. USG study was not done in 4 cases, CT images were not available for 4 patients, and histopathology reports were not available in 6 cases.

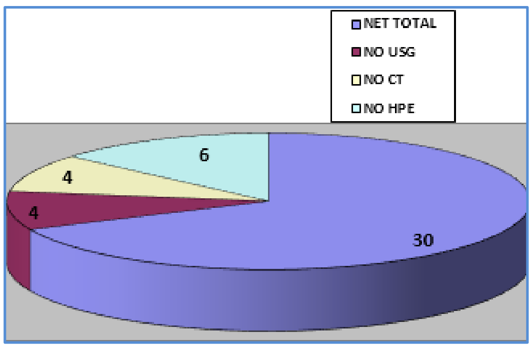

Fig. 1: Pie chart showing Net sample size (n)

Net Total Sample Size is 30.

Total number (n) is 30. Males – 19, Females – 11.

Majority of patients are seen in the age group of 41-50 yrs. Minimum age is 28 yrs and maximum age is 90 yrs. Average age is 59 yrs.

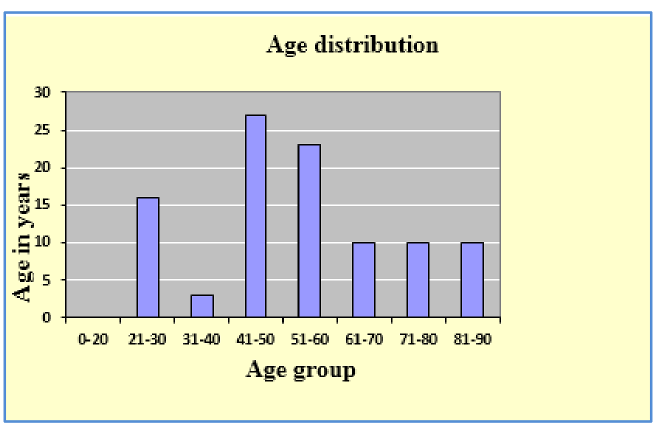

Fig. 2: Simple bar graph showing age distribution of the cases studied

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Age in years	Number	%
Up to 20	0	0
21-30	5	16
31-40	1	3
41-50	8	27
51-60	7	23
61-70	3	10
71-80	3	10
81-90	3	10

Table 1: Age distribution of patients studied

Presenting Complaints	Number (n=30)	%
GIT	11	37
URINARY	4	13
NON SPECIFIC	8	27
RESPIRATORY	1	3
HPB	6	20

Table 2: Showing presenting complaints of the patients in the study

Majority of the patients presented with GIT symptoms followed by non-specific symptoms.

Site of origin:

Site of origin	Number (n=30)	%
Retro peritoneum(RP)	4	13
Peritoneum(PE)	4	13
Kidneys(K)	4	13
Urinary bladder(UB)	1	3
Pancreas (PA)	3	10
Liver (LI)	3	10
Duodenum (DU)	2	6
Gall bladder (GB)	1	3
Colon (CO)	3	10
Stomach (ST)	5	16

Table 3: Showing site of origin of the mass (Surgical)

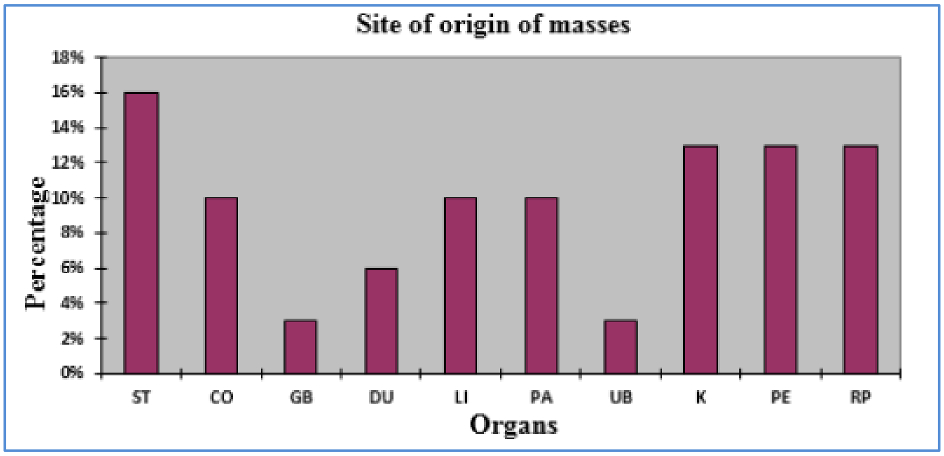

Fig. 3: Simple bar diagram showing site of origin of the masses on surgery

Comparison of site of origin of the masses on USG and CT with surgical/histopathology.

Surgical/ Histopathological Site	Correctly identified on USG	Sensitivity	Correctly identified on CT	Sensitivity
30	22	73%	30	100%

Table 4: Showing comparison between USG and CT

Out of 30 cases ultrasound is able to correctly in 22 cases and CT in 30 cases.

USG AND CT MORPHOLOGICAL FEATURES:

1. Echo pattern of the abdominal masses: Majority of the abdominal masses studied are hypoechoic on ultrasound followed by hyperechogenicity.

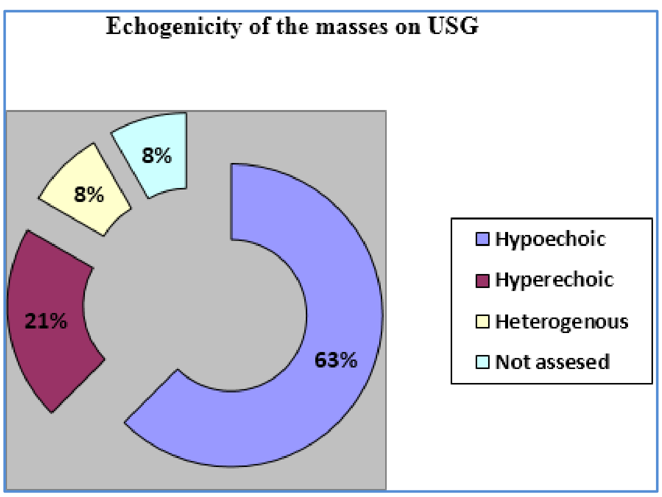

Fig. 4: Simple Doughnut showing echogenicity of the masses studied

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2. Density of the masses on CT:

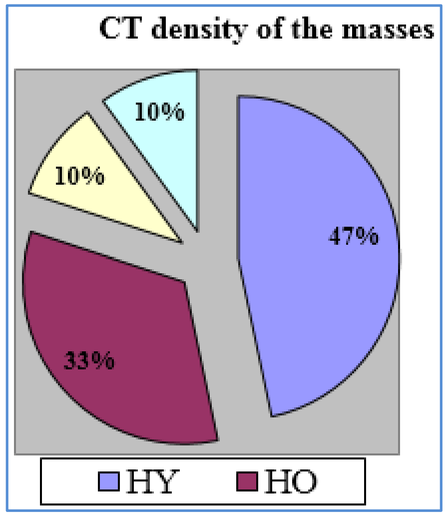

Fig. 5: 3D pie chart showing density of the masses studied on CT

HY: Hyperdense HO: Homogenous IS: Isodense. MIX: Mixed density.

3. Vascularity of the masses on USG:

Vascularity (Doppler)	Number (n=30)	Percentage (%)
Mild (MI)	12	42
Moderate(MOD)	4	13
Absent (AB)	13	45

Table 5: Showing Vascularity of the Masses on USG

Majority of the abdominal masses showed mild vascularity, followed by absent vascularity on Doppler application.

4. Comparison of combined diagnosis of USG and CT with surgical/histopathology.

USG and CT Diagnosis	Surgical and Histopathology Diagnosis
Renal cell carcinoma	Renal cell carcinoma (clear cell)
Ca.stomach	Adenocarcinoma of stomach
Renal cell carcinoma	Renal cell carcinoma
Lymphoma/sarcoma	Non-Hodgkin's lymphoma
Pancreatic carcinoma	Adenocarcinoma of pancreas
Carcinoma colon	Adenocarcinoma of colon
GIST	Gastrointestinal stromal tumor
GIST/retroperitoneal sarcoma	well differentiated liposarcoma

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Synchronous malignancy of colon	Adenocarcinoma of colon
Liposarcoma	Myxoid Liposarcoma
Ca.descending colon	Adenocarcinoma of colon
Multifocal HCC	Hepatocellular carcinoma
GIST	Gastrointestinal stromal tumor
Ca.stomach	Lymphoma of stomach
Lymphoma	Non-Hodgkin's lymphoma
Periampullary carcinoma	Adenocarcinoma
Gall bladder carcinoma	Poorly differentiated adenocarcinoma
Hepatoma	Hepatocellular carcinoma
Ca. stomach	Adenocarcinoma of stomach
Solid papillary tumour/soft tissue sarcoma	Solid papillary tumor
Periampullary carcinoma	Adenocarcinoma
Renal cell carcinoma	Clear cell carcinoma
Ca.stomach	Adenocarcinoma of stomach
Retroperitoneal leiomyosarcoma	Poorly differentiated leiomyosarcoma
Transitional cell carcinoma of bladder	High grade Transitional cell carcinoma
Renal cell carcinoma	Renal cell carcinoma
Ca. stomach	Adenocarcinoma of stomach
Liposarcoma	Liposarcoma
Carcinoma stomach	Adenocarcinoma of stomach

Table 6: Showing comparison of USG and CT diagnosis with Surgical and histopathology findings

Correlation	Number (n=30)	%
Number correlated (C)	25	83
Number not correlated(NC)	5	17

Table 7: Showing Correlation of combined USG and CT diagnosis with Surgical /Histopathology diagnosis

Combined diagnosis of Ultrasound and CT is correlated with histopathology in 83% of cases.

HPE Diagnosis	Number (n=30)	%
Awaited	5	16
Liposarcoma(LS)	2	6
Gastrointestinal stromal tumor(GIST)	2	6
Renal cell carcinoma(RCC)	2	6
Transitional cell carcinoma of bladder(TCC)	1	3
Adenocarcinoma of pancreas(ACP)	3	10

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Hepatocellular carcinoma(HCC)	2	6
Leiomyosarcoma(LI)	1	3
Adenocarcinoma of gall bladder(ACG)	1	3
Adenocarcinoma of colon(ACC)	3	10
Adenocarcinoma of stomach(ACS)	3	10
Solid papillary tumor(SPT)	1	3
Haemangioma of liver(HL)	1	3
Non – Hodgkin's lymphoma(NHL)	2	6
Lymphoma of stomach(GL)	1	3

Table 8: Showing histopathological diagnosis of masses studied

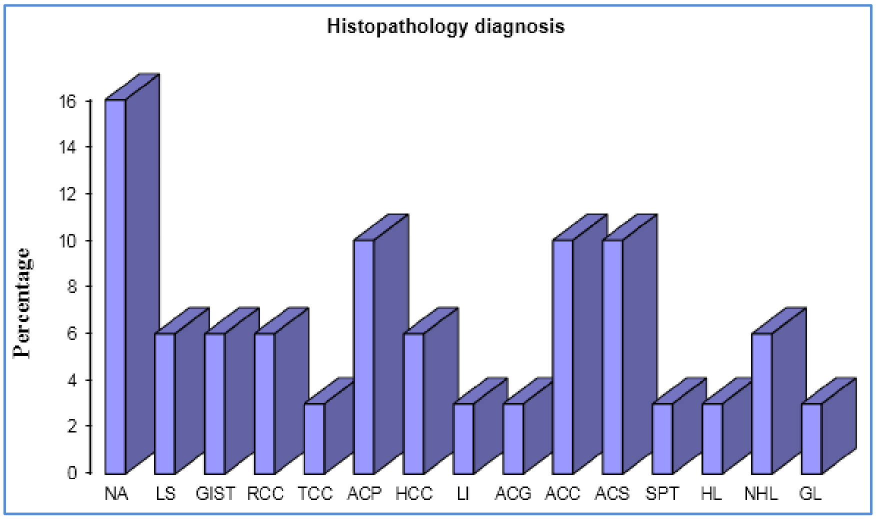

Fig. 6: Simple Bar chart showing HPE diagnoses of abdominal masses

USG MORPHOLOGY OF MASSES

Image 1a

Image 1b

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Image 1: Bowel wall thickening: Transabdominal ultrasound images (a) with high frequency linear transducer, (b) convex transducer showing bowel thickening demonstrating 'pseudo kidney sign'.

Image 2a

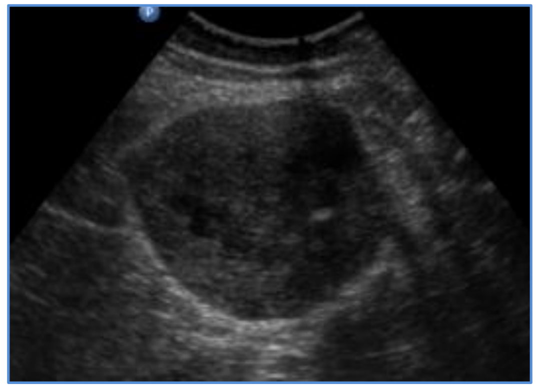

Image 2b

Image 2: Necrosis: Transabdominal images (a) showing necrosis in a case of GIST. (b) Calcification: Transabdominal images showing calcification in another case of gastrointestinal stromal tumor

CT MORPHOLOGY OF MASSES:

Image 3a

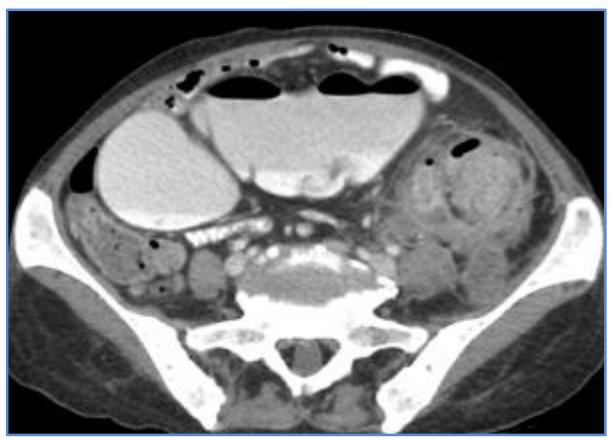

Image 3b

Image 3: (a) Lymphadenopathy: Axial CECT image in late arterial phase at the level of kidneys showing paraaortic lymphadenopathy. (b) Bowel wall thickening: Axial CECT image in venous phase showing symmetric circumferential thickening of the descending colon.

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Image 4a

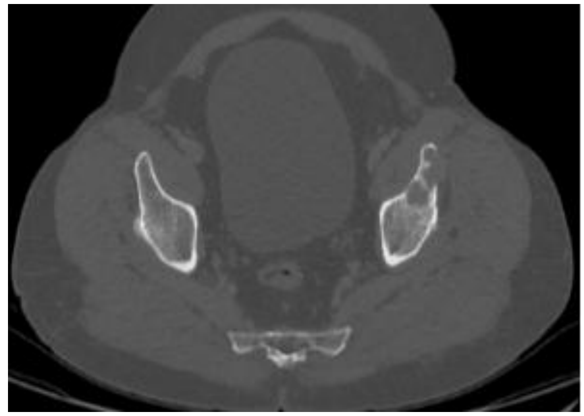

Image 4b

Image 4: (a) Metastasis: Axial CECT image at the liver in arterial phase showing multiple liver metastases. Axial CT image (b) in bone window showing lytic metastasis in the iliac bone.

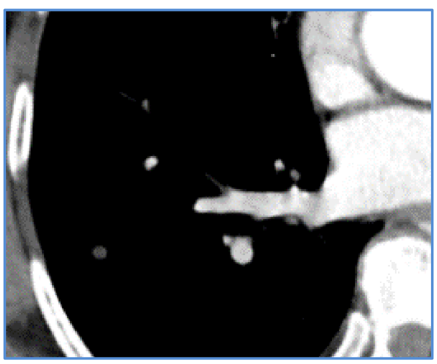

Image 5a

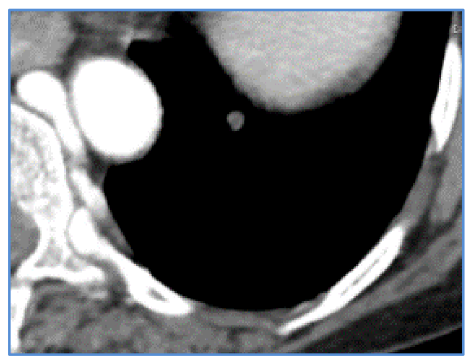

Image 5b

Image 5: Lung metastasis: Axial CECT of thorax magnified images shows rounded nodule in keeping with pulmonary metastasis in a case of retroperitoneal sarcoma.

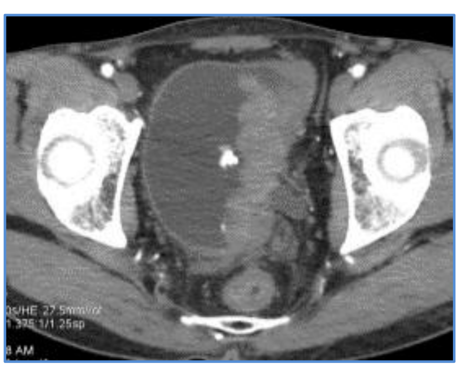

Image 6a

Image 6b

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Image 6: (a) Calcification: Axial CECT image showing calcification in the bladder mass. (b) Necrosis: Axial post contrast CT image showing non-enhancing area in retroperitoneal mass suggesting necrosis

Image 7

Image 7: Fat: Axial CECT image in venous phase showing retroperitoneal mass showing increased amount of fat around the displaced left kidney suggestive of liposarcoma.

CASE 1:

Image 8a

Image 8b

Image 8c

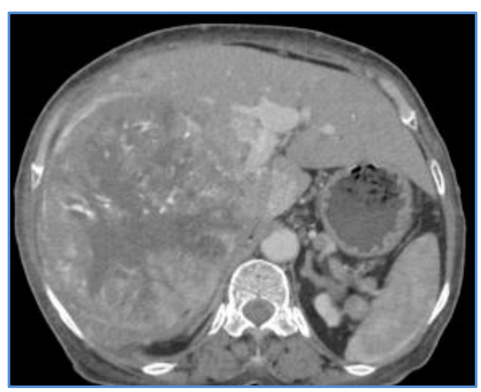

Image 8d

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Image 8: Hepatocellular carcinoma: Transabdominal axial ultrasound images(a) & (b) of the liver showing a well-defined hyperechoic mass in the superior segment of the liver with multiple hypoechoic areas in the rest of the liver. Axial CECT images at the level of liver in the arterial phase showing multiple well defined enhancing masses in segment VII/VIII and a large heterogeneous enhancing mass in the right lobe.

CASE 2:

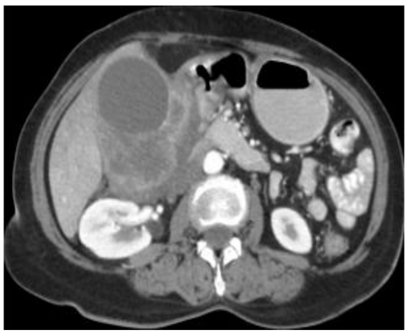

Image 9a

Image 9b

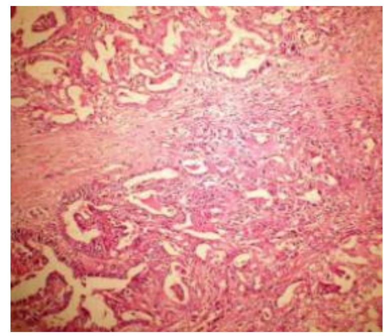

Image 9C

Image 9: Gall bladder carcinoma: Axial (a) and Coronal reformatted (b) CECT images showing enlarged gall bladder with heterogeneous enhancing mass around the neck. Histopathology slide (c) showing adenocarcinoma.

CASE 3:

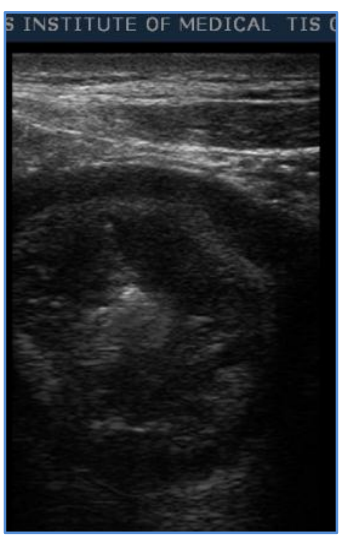

Image 10a

Image 10b

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Image 10c

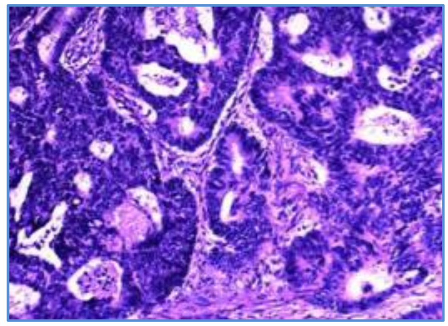

Image 10d

Image 10: Colon carcinoma: Transabdominal ultrasound images (a) & (b) acquired with linear high frequency transducer showing circumferential thickening of descending colon. Axial CECT image showing thickened and enhancing descending colon. Histopathological picture (d) showing atypical cells with increased nuclear to cytoplasmic ratio.

CASE 4:

Image 11a

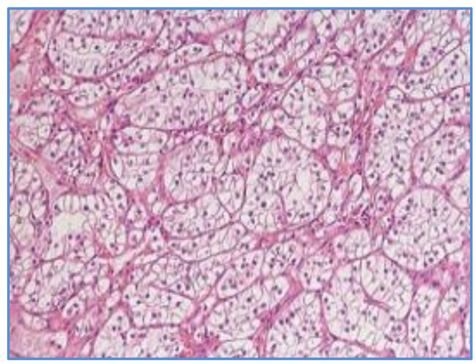

Image 11b

Image 11c

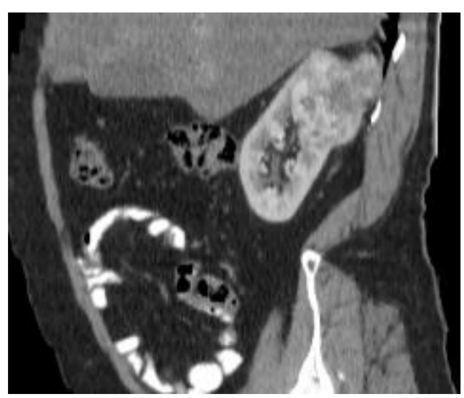

Image 11d

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Image 11: Renal cell carcinoma: Transabdominal ultrasound image (a) showing heterogenous mass lesion with central necrosis and mild internal vascularity in the upper pole of right kidney. (b) Histopathological picture showing sheets of clear cells suggesting clear cell carcinoma. Coronal and sagittal reformatted CECT images (c) & (d) showing heterogenously enhancing mass arising from the upper pole of right kidney.

CASE 5 :

Image 12a

Image 12b

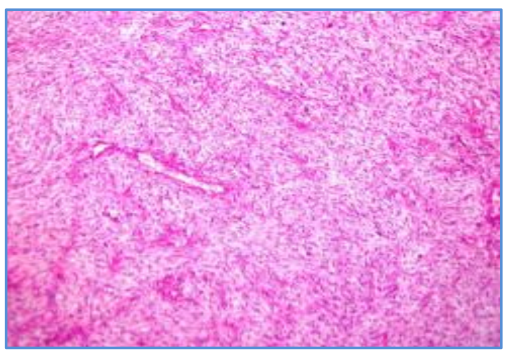

Image 12c

Image 12: Gastrointestinal stromal tumor: Transabdominal ultrasound image (a) showing a large hypoechoic mass lesion with internal necrotic areas. Corresponding CECT image (b) shows enhancing mass with extensive necrosis. Histopathology slide (c) shows spindle cells suggesting spindle cell tumor.

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CASE 6:

Image 13a

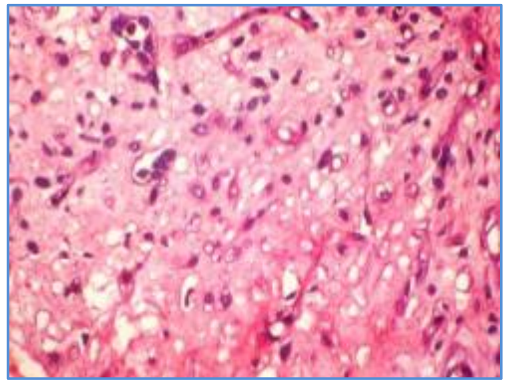

Image 13b

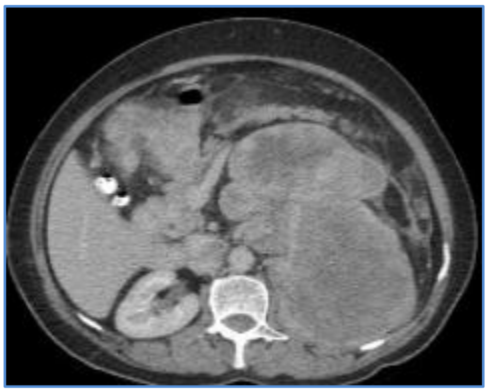

Image 13c

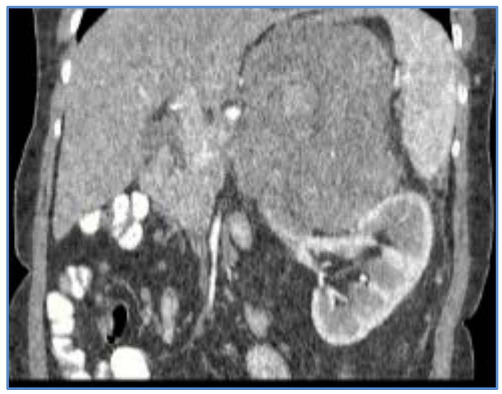

Image 13d

Image 13: Retroperitoneal liposarcoma: Transabdominal ultrasound image (a) showing large well defined hypoechoic mass in the retroperitoneum. (b) Histopathological slide showing large number of myxoid cells. Axial and oblique coronal reformatted images (c) & (d) of the same patient confirming the retroperitoneal location, and fat content in the mass at the periphery. The mass is displacing the kidney antero-inferiorly and renal vessels anteriorly.

DISCUSSION: The radiologist often is challenged to identify the origin and specific tissue composition of the imaged neoplasms. When the radiologic findings are combined with patient information and clinical data, the correct diagnosis may be made in many cases. Upper abdomen organs are closely connected with each other and correct imaging localization of a large mass in this region is not easy. Ultrasonic scanning is the method of choice in evaluating patients with a palpable abdominal mass. Abdominal CT is more sensitive than other imaging modalities in clarifying organ relationships and the origin of masses in the left upper quadrant.

Our study comprised of 30 cases, after excluding 14 cases. Ultrasound report is not available in 4 patients, CT is not available in 4 patients and histopathology report in 6 patients. The majority of the patients are males comprising of 63%. Maximum patients are in the age group of 41-50 yrs, followed by 51 to 60 and then 21 to 30 years. The mean age is 53 yrs.

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The commonest complaints being Gastrointestinal in 37 %(n-11), followed by non – specific complaints in 27 %(n-8), followed by hepatobiliary and urinary complaints 20% and 13% respectively. One patient (3%) presented with respiratory symptoms.

In our study of 30 patients majority of the abdominal masses are arising from the stomach 16%(n-5) followed by kidneys, peritoneum and retro peritoneum with equal number of 13%(n-4). Other common sites are liver, pancreas and colon comprises of 10% each (n-3). Three masses were arising from duodenum (6%), one mass from gall bladder (3%) and one mass from urinary bladder (3%).

Ultrasound was able to correctly identify the site of origin in 22 cases compared to surgical findings (sensitivity of 73%). Computed tomography has identified the organ of origin correctly in all the 30 cases (100% sensitivity).

In our study we have studied the morphological characteristics of abdominal masses on ultrasound and CT. Ultrasound characteristics includes echogenicity, vascularity, calcifications, necrosis and presence or absence of fat in the mass. Computed tomography characteristics assessed are density of the mass, enhancement pattern on post contrast study, calcifications, necrosis and presence or absence of fat.

On ultrasound majority of the abdominal masses studied are hypoechoic in 63% of cases, followed by 21% masses showed hyperechogenicity. Other masses showed heterogenous echopattern (8%). Echogenicity was not assessed in 2 cases due to smaller size of the masses.

The vascularity of the masses studied as follows. 40% of (n=12) cases showed mild vascularity on Doppler application followed by moderate vascularity in 4 cases (13%). Majority of the masses do not show vascularity on Doppler (47%). In our study majority of the abdominal masses were hyperdense to the organ of origin on CT, which was seen in 47% of cases followed by 33% masses which are hypodense. Mixed density is seen in 3 cases (10%). Three masses were isodense to the organ of origin.

All the masses showed enhancement following intravenous administration of contrast. Stomach and Colon masses showed homogenous enhancement without mural stratification. Liver and Gall bladder masses showed heterogenous enhancement. Pancreatic and Duodenal masses showed homogenous enhancement. Peritoneal and retroperitoneal masses showed heterogenous enhancement. Renal masses were enhancing less than the normal renal parenchyma. All the masses showed enhancement in the arterial phase or in the venous phase after I.V contrast administration.

Other morphological characteristics are calcifications, necrosis and presence or absence of fat in the masses. In our study we found that CT is superior to the ultrasound in demonstration of the above characteristics. Ultrasound was able to demonstrate calcification in 10% of cases (n-3) whereas CT demonstrated in 20% cases (n-20).

Necrosis is a feature of malignancy and is due to outgrowth of tumor of its blood supply.[8] Ultrasound showed necrosis in 23% cases compared to CT which detected in 36% of cases.

Presence of fat in the mass is diagnostic of its lipomatous origin.[9] In our study fat component was detected in 2 cases on CT which were reported as liposarcomas and confirmed on histopathology of the same.

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Ultrasound was able to demonstrate the infiltration only in 10% of the cases whereas CT demonstrated in 50% of cases. Lymph nodal involvement was demonstrated in 26% of cases on ultrasound compared to CT which demonstrated in 40% of cases. Metastasis was detected in 20% of cases compared to CT which detected in 33% of cases.

Finally we compared the combined ultrasound and CT diagnosis with surgical findings or histopathological diagnosis. Histopathology reports were not available in 5 cases in which diagnosis was correlated with surgical findings only. Ultrasound and CT diagnosis was correlated in 83% of cases (n-25) when compared to the surgical findings /histopathology.

Ultrasound and CT has 73% and 100% sensitivity respectively for identifying the site of origin in abdominal and retroperitoneal masses when compared with surgical findings. Ultrasound is less sensitive for the detection of fat and characterization of retroperitoneal masses compared to CT.

By combining the ultrasound and CT findings we can able to give the histopathological diagnosis in 83% cases of abdominal mass lesions. Finally we conclude that ultrasound and CT has additive role in the evaluation of abdominal masses and their management.

Our study results are nearly comparable with previous study done by Dixon AK, Fry IK, Kingham JG[1] et al both US and CT usually demonstrate the organ from which a mass arises. The accuracy of US in determining the organ of origin has been 88%–91%, whereas CT has fared slightly better at 93%. In several studies US findings correctly suggested the pathologic diagnosis in 77%–81% of cases,[2,3,4] whereas CT findings correctly suggested the diagnosis in 88% of cases[1].

CONCLUSION: In this study of 30 patients with abdominal masses we conclude that CT is more sensitive than US in demonstrating the morphological features of abdominal masses like echogenicity, vascularity, density, contrast enhancement characters, tumoral necrosis, calcifications, presence or absence of fat, regional lymphadenopathy, infiltration into the adjacent structures and distant metastases.

Plain Computed tomography with is more sensitive for detection of calcifications and fat than ultrasound. Contrast enhanced CT is more sensitive than ultrasound for detection of tumoral necrosis, infiltration into the surrounding organs/structures, regional lymphadenopathy and distant metastases.

Ultrasound and CT has 73% and 100% sensitivity respectively for identifying the site of origin in abdominal and retroperitoneal masses when compared with surgical findings. Ultrasound is less sensitive for the detection of fat and characterization of retroperitoneal masses compared to CT. Ultrasound elastography and Contrast enhanced ultrasound will further improve the diagnostic efficacy of ultrasound.[10,11] We have not assessed these recent techniques as the facilities are not available in our rural set up. Ultrasound also have certain advantages over CT like it can be performed multiple times without radiation especially in children, follow up of tumors and evaluation of treatment response.

By combining the ultrasound and CT findings we can able to give the histopathological diagnosis in 83% cases of abdominal mass lesions. Finally we conclude that ultrasound and CT has additive role in the evaluation of abdominal masses and their management.

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There are some limitations in our study. First is the number of case are less, as we have included only those patients with ultrasound, CT, surgical and histopathology reports are available. So most of the patients were excluded from the study. Second limitation is we have not evaluated the abdominal masses with recent techniques in ultrasound as these advanced set up is not available in our rural set up.

We have restricted our study to gray scale and color Doppler Ultrasound and Contrast Enhanced Computed Tomographic evaluation of the abdominal masses. We want to evaluate the utility of these modalities for evaluating abdominal masses in our rural India setup, wherein the study has to be appropriately utilized and tailored to the clinical need and according to the socioeconomic situation.

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AUTHORS:
1. D. Harinath
2. B. Suresh
3. Smrita Swamy
4. Kiran K. U. V.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department Of Radiodiagnosis, Kurnool Medical College, Kurnool.
2. Assistant Professor, Department Of Radiodiagnosis, Kurnool Medical College, Kurnool, Andhra Pradesh.
3. Professor, Department of Radiodiagnosis, PESIMS&R, Kuppam, Chittoor, Andhra Pradesh.
4. Professor, Department of Radiodiagnosis, PESIMS&R, Kuppam, Chittoor, Andhra Pradesh.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:
Dr. D. Harinath,
Assistant Professor,
Department of Radiodiagnosis,
Kurnool Medical College,
Kurnool-518001, Andhra Pradesh.
E-mail: drharinath83@gmail.com

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