Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2013; 1(6):1041-1059 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2013.v01i06.0085

Research Article

Evaluation of Focal Liver Lesions by Ultrasound as a Prime Imaging Modality

Dr. Vishwanath .T. Thimmaiah
Department of Radiodiagnosis, JSS Medical College,JSS University MG Road, Mysore-570004, Karnataka, India

***Corresponding author**
Dr.Vishwanath .T. Thimmaiah
Email: visgurad@gmail.com

Abstract: Liver diseases are amongst the common causes of morbidity and mortality in India, which are encountered frequently in day-to-day practice. To establish the correct diagnosis and treatment, a precise initial diagnostic imaging modality is needed. Following history and clinical examination, ultrasonography has become one of the first and most useful methods of investigation in patients with upper abdominal pain, jaundice and mass per abdomen. It is a testament to the importance of ultrasonography that almost 25% of all imaging studies worldwide are ultrasonographic examinations. Ultrasound is widely accessible, inexpensive, non-invasive, and portablewith high spatial and temporal resolution. Ultrasound is the first choice of investigation for screening of patients with suspected liver diseases. Focal liver lesions mainly comprise of liver abscess, cystic lesions, primary malignant neoplasms metastases, focal fatty infiltrations and hematoma. The signs and symptoms of such lesions are non-specific and biochemical tests have limitations in the diagnosis of these lesions. Real-time ultrasonography has got considerable application in diagnosis of focal liver lesions. It gives valuable information regarding other parameters such as site, size, number of lesions, nature of lesions and relation to surrounding structures. Ultrasonography has an important role in the detection and follow-up of focal liver lesions. It can be used as an imaging guide for FNAC and therapeutic drainage of abscesses. This study has been conducted to diagnose different types of focal liver lesions by ultrasonography as a prime imaging modality and to assess the validity of ultrasonographic diagnosis in relation to FNAC diagnosis.
Keywords: Ultrasonography, Primary malignant liver disease, metastasis, Fine needle aspiration cytology

INTRODUCTION

Ultrasounds are sounds with a frequency greater than 20000 cycles/ second. Medical sonography employs frequency between 1 megahertz to 20 megahertz[1]. The piezoelectric effect was discovered by Pierre and Jacques in the year 1880. In 1912 Richardson, a British physicist used ultrasound for detection of iceberg. Australian neurologist, Dussik became the first to use ultrasound as a medical procedure. Kossof, Robinson and Gorrett developed the first compound scanner in 1962. The same group introduced gray scale imaging in ultrasound in 1972.Ultrasonography has undergone dramatic changes since its inception three decades ago, the original cumbersome B-mode gantry system has evolved into a high resolution real-time imaging system. Thus ultrasound introduced in 1950s, developed slowly and only became a practical imaging tool in late 1960s, mainly in cardiology and obstetrics. Its use in radiology remained limited until the introduction of gray scale displays in early 1970s. Real-time imaging became available in late 1970s. The last 20 years have been an accelerated development with image quality improving dramatically year by year at a rate comparable to that of CT scanner and MRI.

Ultrasound has become established as a very important modality for tomographic imaging of soft tissue. With development of electronic scanning heads and high frequency transducer, ultrasound has found important applications in abdomen for imaging liver, spleen, kidney and other organs [2].Ultrasound has been used as a non-invasive imaging technique for detection, characterization and staging of various focal lesions. Ultrasonography allow full liver scanning and accurate detection of focal lesions of liver parenchyma.Ultrasound examinations are the most frequently used imaging method for evaluation of focal liver lesions [3]. Sonography has been ignored in most recent comparative imaging studies of focal hepatic lesion, which have usually focused on CT and MRI. Sonography exclusion is usually justified by allusion to studies performed nearly 20 years ago with equipment now four generations out of date. This seems curious given the relatively poor sensitivity of all imaging modalities, and evidence that modern sonography can perform well in detecting focal liver disease.Given the current insensitivity and imperfections of all modalities, it seems prudent to reject the idea that there is a single "best test" to image focal hepatic lesions.

Detecting and characterization of focal liver lesions is one of the most confusing and controversial challenges in imaging today. A major problem is that all standard non-invasive imaging modalities are less sensitive than generally perceived. These sensitivity problems are no surprise to radiologists experienced in hepatic imaging, since focal hepatic lesions are frequently missed with one modality, then detected with another [4].Hepatic sonographic main strengths include

its ability to characterize common benign lesions like cysts, Haemangiomas, its safety and low lost. Ultrasound is used as first line imaging investigation in patients with jaundice, right upper quadrant pain and hepatomegaly. USG is inexpensive and easily available excellent test to screen liver diseases [5].

Ultrasonography is preferred as the first examination to assess patients considered for resection of primary or metastatic liver tumors. Sonography, because of its ability to image in any oblique plane is equal or superior to CT and MRI in localizing lesions to an anatomic segment or sub segment of the liver. Sonography is unexcelled in showing the relationship of liver tumors to critical structures such as veins, bile ducts and arteries. In addition, sonography can be used for FNAC of these suspicious lesions that might obviate curative hepatic resection. If liver abscess is suspected clinically, sonography is the preferred screening modality. Hepatic sonography is an appropriate initial examination when metastases are suspected, but only if staging is not needed. Sonography often detects incidental liver lesions when performed for non-hepatic indications. When this occurs, it can guide further evaluation or management like percutaneous drainage, biopsy and additional imaging methods, depending upon the clinical settings and the sonographic findings. Sonography is often indicated to characterize focal liver lesions found with other modalities. When CT detects low attenuation lesions, sonography can generally determine whether they are cystic or solid.

Ultrasonography have been widely used in the diagnosis of liver diseases in the past 20 years, but the final definitive diagnosis of focal liver disease cannot be made only by imaging methods. Ultrasonography has been used in combination with FNAC in the diagnosis of liver disease since 1979 [6].Sonography can effectively guide for FNAC, an ability shared with CT, but an inability MRI and nuclear medicine techniques lack. For experienced users, sonographically guided liver FNAC is often quicker, easier and cheaper than CT guidance. It often allows real-time visualization of the needle tip as it moves towards the lesion, which makes biopsy of smaller lesions and lesions in unco-operative patients easier. If a lesion can be imaged, then FNAC is generally more efficient and cost effective using sonographic guidance, even when initially detected with some other modality.

EXPERIMENTAL SECTION(METHODOLOGY)

Objectives

- To study ultrasonography as a prime diagnostic imaging modality for patients with clinical features of focal liver disease.
- To study the validity of ultrasonographic diagnosis in relation to Fine Needle aspiration Cytology (FNAC) diagnosis.

One year Cross-sectional study was conducted,with 105 cases of focal liver lesions diagnosed by ultrasound followed by FNAC for confirmation of ultrasound diagnosis.

Inclusion criteria

Patients with Right upper quadrant pain, fever, jaundice, Hepatomegaly, mass per abdomen.Metastatic work up in patients presenting with primary neoplasm known to produce metastases in liver and congenital lesions involving liver.

Exclusion Criteria

Diffuse fatty infiltration, Storagedisorders, Cirrhosis of liverandDiffuseinfiltrative malignancies-lymphoma and leukemia

Patient preparation and scanning technique

Informed consent was taken prior to ultrasound examination, followed by detailed history and brief clinical examination. Patients were kept nil by mouth for few hours prior to ultrasound examination. In some cases clinical condition of patient demanded an ultrasound examination without prior preparation. Patients were examined in the supine position to begin with and then in decubitus (right or left) and sitting position if needed. Liver was scanned in various planes like sagittal, parasagittal, transverse, oblique, subcostal, intercostal and coronal planes. Comprehensive scanning of other upper abdominal organs were done.

Various ultrasonographic features of focal liver lesions were observed, which include:

Number of lesions – single or multiple,Location within liver – Lobar distribution (right lobe, left lobe, both lobes), segmental distribution,Echogenicity (by comparing with that of normal liver Parenchyma), hyperechoic, hypoechoic, anechoic or mixed echogenic.

Size, shape and margins: Exact size of lesion was measured with a note on shape of lesion like round, oval or irregular. Margins of lesion were studied whether well defined, poorly defined, regular or irregular.

Acoustic characteristics of lesions: Apart from the above observations related to lesion several other important observations were made which include overall assessment of liver size, portal and hepatic veins involvement, biliary tract and gall bladder, lymphadenopathy, aortic and its branches and ascites.FNAC of these ultrasonographically detected focal liver lesions were done.

FNAC of Focal Liver Lesions

FNAC of focal liver lesion was done to obtain cytological diagnosis in all ultrasound positive cases. FNAC was avoided initially in those patients with prolonged BT, CT, PT and decreased platelet counts

.After correction of these abnormalities, patients were subjected to FNAC.

Ultrasound localization of liver

While patients were breathing quietly, lesion was localized in longitudinal and transverse planes. Lesion was located with its borders marked on skin by skin marker and optimal puncture site at the center of marked area. The distance between lesion and skin surface was measured with electronic calipers and suitable needle length was selected.

Aspiration Equipment

22 gauge needle, sterile gloves, sponges, saline, spirit, local anesthetic (2% xylocaine) if needed.

Preparation

Patient was advised to fast overnight to minimize gas occurring over areas of interest and to prevent lung aspiration in cases of adverse reaction. Patient blood group was known. Emergency drugs and blood transfusion facilities were kept ready.

Technique

Skin was carefully scrubbed and field was draped in a sterile fashion. Puncture site was anaesthetized. Needle with stylet was inserted and firmly plunged in to desired depth. Stylet was then removed and 20 cc syringe was attached with patient in suspended respiration and aspirated material was smeared on slides. Procedure was repeated four or five times if required to ensure that adequate specimen was obtained. But in haemangiomas single pass technique was used. Tip of needle was confirmed to be present within lesion by USG.

The cells were stained and examined by cytopathologist. Fluid material obtained from cysts was centrifuged 2500 rpm for 15 minutes and sediments stained and examined.

After FNAC procedure the punctured site was washed and simple adhesive bandage was placed over puncture site. The patients were returned to their respective wards and observed for bleeding and sepsis as would be done after any interventional procedure. For the diagnosis of Hydatid lesion of liver, special precautions during FNAC procedure was taken. The procedure was done in intensive care unit, so as to take action immediately if at all any hypersensitivity reaction occurs. Before procedure, IV hydrocortisone and IV anti-histamine of suitable dose was given and then fine needle aspiration was done. Two cases showed allergic reactions, for which immediate medical treatment was given and later patient was kept for observation. Three other cases showed no adverse untoward reaction.

Statistical Tests applied

Sensitivity,Specificity,Positive predictive value,Negative predictive value, Chi-square test,Cross tab procedure (contingency coefficient)

RESULTS

The present study comprises of 105 cases of focal liver lesions studied by ultrasound for a period of one year conducted in the Department of Radiology. Patients with clinically suspected focal liver disease were referred to the Department of Radiology. These patients were subjected for ultrasonographic evaluation and later the findings were confirmed by FNAC. The following observations were made.

Table 1: Age distribution of focal liver lesion

Age group (years)	No. of Cases	Percentage
Below 10	5	4.8
11 – 20	8	7.6
21 – 30	10	9.5
31 – 40	20	19.0
41 – 50	39	37.1
51 – 60	17	16.2
More than 60	6	5.7
Total	**105**	**100.0**

The age range between 41 to 50 years had the maximum incidence with 39 cases and <10 years category showed the lowest incidence with 5 cases.

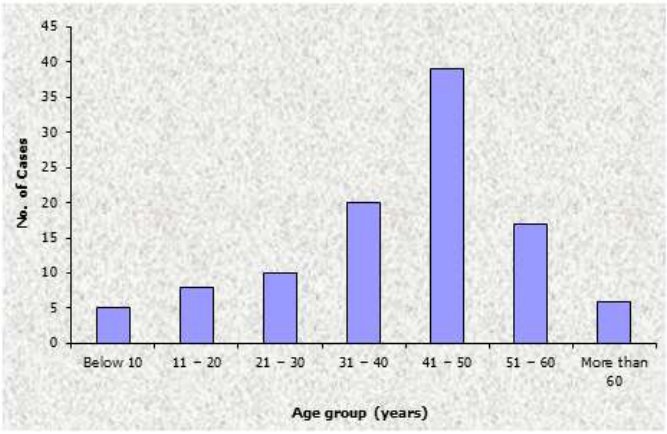

Fig. 4: Age distribution of focal liver lesions

Table 2: Sex distribution of focal liver lesion

Sex	No. of Cases	Percentage
Male	70	66.7
Female	35	33.3
Total	**105**	**100.0**

Males had increased predilection for focal liver disease with a male to female ratio of 2:1.

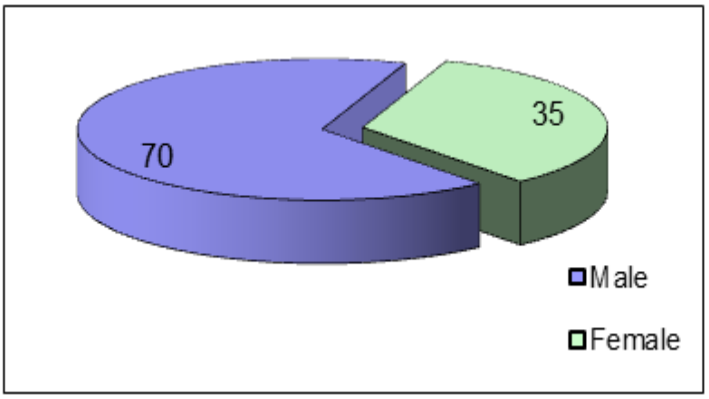

Fig. 5: Sex distribution of focal liver lesion

Table 3: Age and sex Cross Tabulation

Age group (years)		Gender		Total
		Male	Female	
Below 10	Count	4	1	5
	% within gender	5.7%	2.9%	4.8%
11 – 20	Count	6	2	8
	% within gender	8.6%	5.7%	7.6%
21 – 30	Count	8	2	10
	% within gender	11.4%	5.7%	9.5%
31 – 40	Count	12	8	20
	% within gender	17.1%	22.9%	19.0%
41 – 50	Count	27	12	39
	% within gender	38.6%	34.3%	37.1%
51 – 60	Count	11	6	17
	% within gender	15.7%	17.1%	16.2%
Above 60	Count	2	4	6
	% within gender	2.9%	11.4%	5.7%
Total	Count	70	35	105
	% within gender	100%	100%	100%

The maximum incidence were within the age range of 41-50 years constituting 37.1% of the total number of cases.

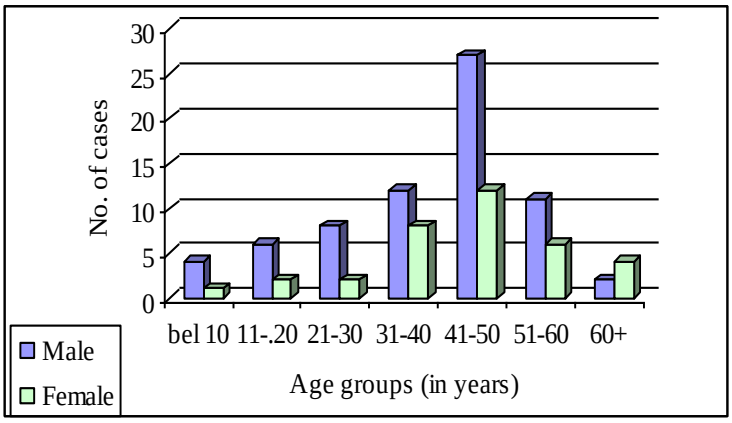

Fig. 6: Age and sex distribution of focal liver lesions

Table 4: Age distribution of Individual Focal Liver Lesions

Age group (years)	Liver abscess	PMLT	Metas-tatses	Hemangioma	Cystic lesion	Hydatidlesion	Total
Below 10	1	2	--	2	--	--	5
11 – 20	4	1	--	1	1	1	8
21 – 30	2	2	1	1	1	3	10
31 – 40	8	4	3	2	3	--	20
41 – 50	14	15	10	--	--	--	39
51 – 60	4	4	9	--	--	--	17
More than 60	--	3	3	--	--	--	6
Total	**33**	**31**	**26**	**6**	**5**	**4**	**105**

Liver abscess, primary malignant liver tumors and metastases have highest incidence in the age group of 41-50 years with 14, 15 and 10 cases respectively. The lowest incidence of liver abscess was in the age group of <10 years. Metastatic deposits in liver were not found below 20 years of age. Hemangioma and cystic lesions were noted up to the age of 40 years.

Table 5: Sex distribution of Individual Focal Liver Lesions

Sex	Liver abscess	PMLT	Metas-tases	Hemangioma	Cystic lesion	Hydatid lesion	Total
Male	24	18	16	5	3	4	70
Female	9	13	10	1	2	--	35
Total	**33**	**31**	**26**	**6**	**5**	**4**	**105**

In the present study, males were predominantly affected by focal liver lesions than females. In liver abscess, male to female ratio was 2.7:1 (24:9), whereas in primary malignant liver tumors and metastasis, the ratio was 1.4:1 (18:13) and 1.6:1 (16:10) respectively.

.

Table 6: Mean Age and Sex Distribution of focal liver lesions

Sex	No. of cases	Mean age	Minimum age	Maximum age
Male	70	38.96	6	69
Female	35	44.51	9	67
Total	105	41.74	6	69

Mean age incidence among males and females was 38.9 years and 44.5 years respectively.

Distribution of cases based on clinical symptoms

Table 7: Distribution of cases based on Pain

Pain	No. of Cases	Percentage
Present	60	57.20
Absent	45	42.8
Total	**105**	**100.0**

Out of 105 cases, 60 cases presented with clinical symptom of pain.

Table 8: Distribution of cases based on Fever

Fever	No. of Cases	Percentage
Present	28	26.7
Absent	77	73.3
Total	**105**	**100.0**

Only few cases (28) presented with clinical symptom of fever.

Table 9: Distribution of cases based on Hepatomegaly

Hepatomegaly	No. of Cases	Percentage
Present	40	38.1
Absent	65	61.9
Total	**105**	**100.0**

40 cases out of 105, had hepatomegaly clinically.

Table 10: Distribution of cases based on Jaundice

Jaundice	No. of Cases	Percentage
Present	7	6.7
Absent	98	93.3
Total	**105**	**100.0**

Minimum number of cases (7) presented with jaundice.

Table 11: Distribution of cases based on Tenderness

Tenderness	No. of Cases	Percentage
Present	22	20.9
Absent	83	79.1
Total	**105**	**100.0**

Only 22 out of 105 cases had tenderness in right upper quadrant of abdomen.

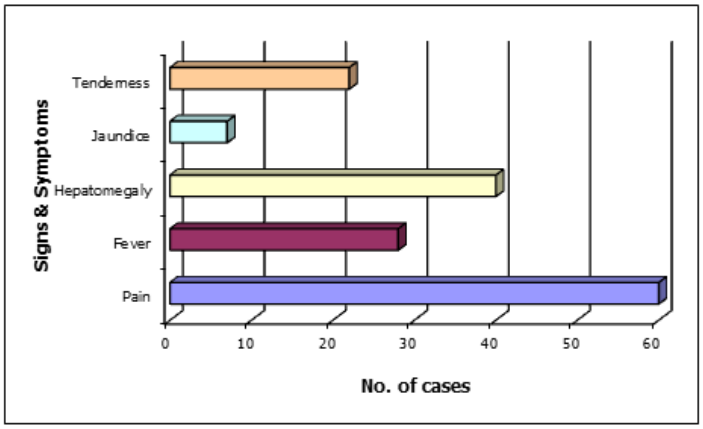

Fig.7: Distribution of cases based on clinical symptom

Distribution of cases based on numberof focal lesions

Table 12: Number of lesions detected on ultrasonography

Lesions	No. of Cases	Percentage
Solitary	65	61.9
Multiple	40	38.1
Total	**105**	**100.0**

Out of 105 cases, 65 cases had solitary liver lesions and 40 cases had multiple liver lesions.

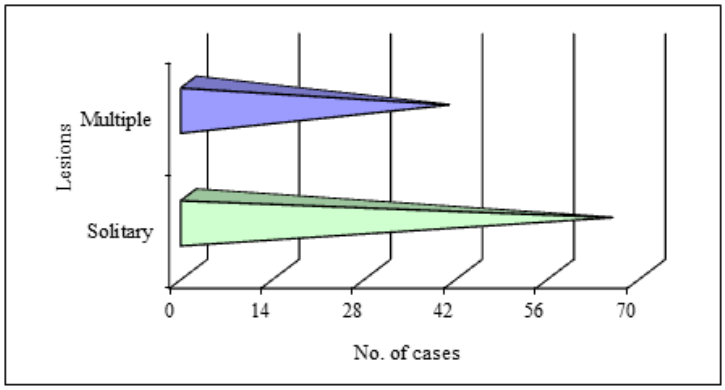

Fig. 8: Number of focal liver lesions

Distribution of cases based on lobar involvement

Table 13: Lobar involvement of focal liver lesion

Lobar	No. of Cases	Percentage
Right lobe	68	64.8
Left lobe	12	11.4
Both lobes	25	23.8
Total	**105**	**100.0**

Out of 105 cases studied 64.8% (68 cases) had right lobe involvement, 11.4% (12 cases) had left lobe involvement and both lobes were involved in 23.8% (25 cases) of cases.

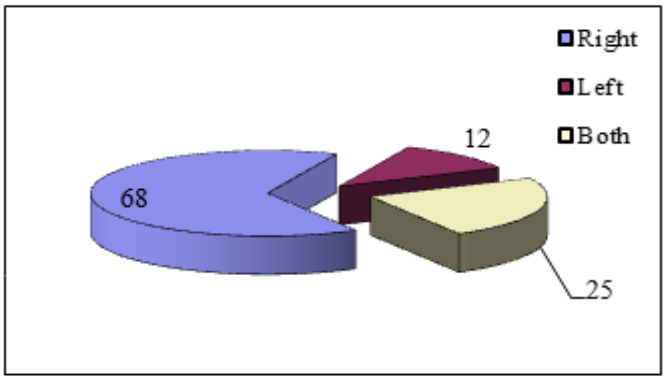

Fig. 9: Lobar involvement of focal liver lesion

Table 14: Echo Features of liver abscess

Echo pattern	No. of Cases	Percentage
Anechoic	6	17.2
Hypoechoic	28	80.00
Hyperechoic	1	2.8
Total	**35**	**100.0**

Out of 35 cases of liver abscess, majority of cases (28 cases) were hypoechoic, 6 cases were anechoic and one case was hyperechoic on ultrasound.

Table 15: Echo Features of Metastasis in liver

Echo pattern	No. of Cases	Percentage
Bull's eye lesion	5	19.2
Hypoechoic	10	38.5
Hyperechoic	5	19.2
Mixed	6	23.1
Total	**26**	**100.0**

Out of 26 cases, majorities (10 cases) werehypoechoic, 5 were hyperechoic, 5 showed bull's eye lesion and 6 showed mixed echogenic features.

Table16: Echo features of primary malignant liver tumor

Echo pattern	No. of Cases	Percentage
Hyperechoic	16	50.00
Hypoechoic	5	15.6
Mixed	11	34.4
Total	**32**	**100.00**

Out of 32 cases, majority i.e., 16 cases (50%) were hyperechoic, 5 cases (15.6%) were hypoechoic and 11 cases (34.4%) were mixed echogenic.

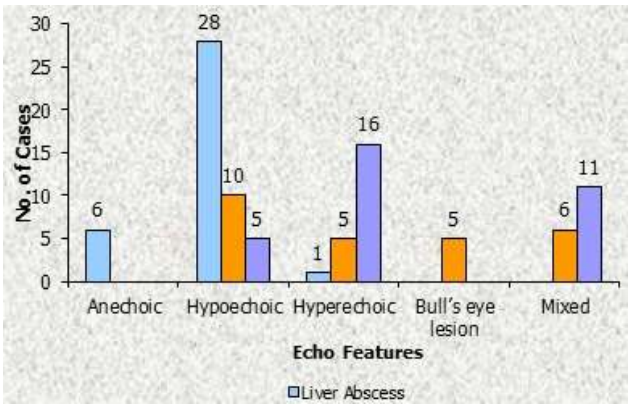

Figure 10: Echo features of focal liver lesions

Distribution of focal liver lesions

Table 17: Distribution of cases diagnosed by ultrasound

Ultrasound diagnosis	No. of Cases	Percentage
Liver abscess	35	33.3
Primary malignant liver tumors	32	30.5
Metastases	26	24.8
Hemangioma	4	3.8
Cysts	3	2.9
Hydatid lesion	5	4.8
Total	**105**	**100.00**

Out of the total 105 cases studied, ultrasound diagnosed 35 cases as liver abscess, 32 cases as primary malignant liver tumors, and 26 cases as liver metastases. 4 cases were diagnosed as hemangioma, 5 cases were diagnosed as hydatid lesion and the remaining 3 lesions were diagnosed as cysts other than hydatid.

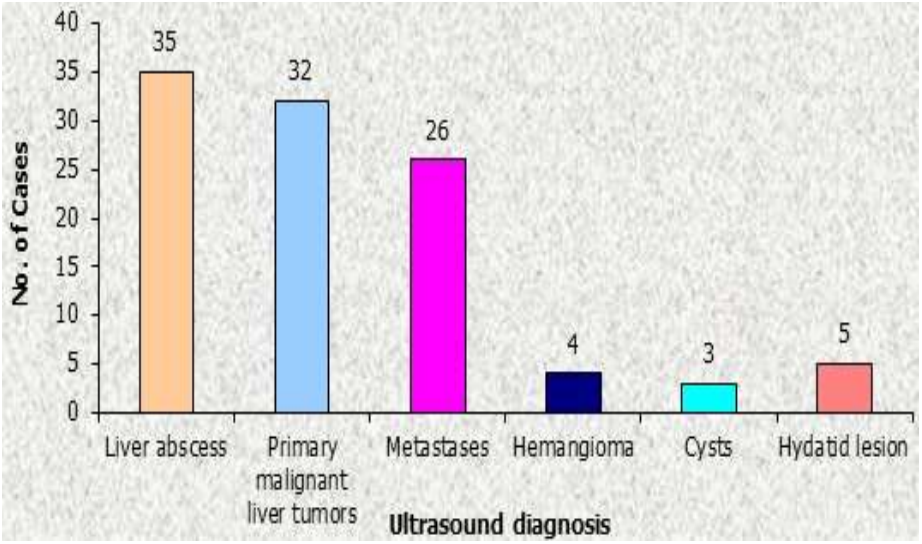

Fig. 11: Distribution of cases diagnosed by ultrasonography

These cases were referred to the Department of Pathology, for the confirmation of diagnosis by FNAC. FNAC was done on all the 105 cases and the results indicated 33 cases of liver abscess, 31 cases of primary malignant tumors, 26 cases of metastases, remaining diagnosed by FNAC were 6 cases of Hemangioma, 4 cases of Hydatid lesion and 5 cases were other cystic lesions.

Table 18: Distribution of focal liver lesion diagnosed by FNAC

FNAC diagnosed	No. of Cases	Percentage
Liver abscess	33	31.4
Primary malignant liver tumors	31	29.5
Metastases	26	24.7
Hemangioma	6	5.8
Cysts	5	4.8
Hydatid lesion	4	3.8
Total	**105**	**100.00**

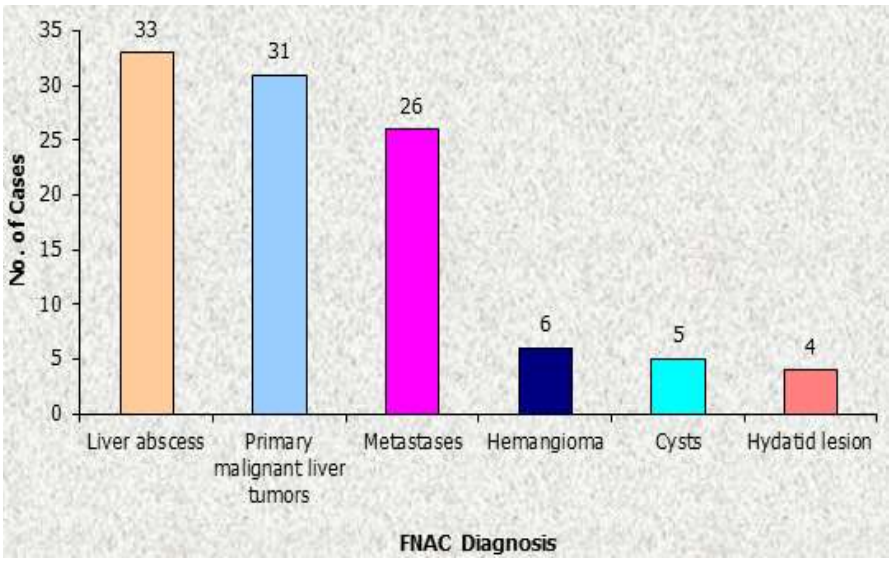

Figure 12: Distribution of cases Diagnosed by FNAC

Ultrasound and FNAC diagnosis of focal liver lesions

Table19: USG and FNAC cross-tabulation

		USG						Total
		Liver abscess	primary malignantLiver tumors	Metastases	Heman-gioma	Cystic lesions	Hydatid lesions	
FNAC	Liver abscess	30	2	--	--	--	1	33
		90.9 %	6.1%	--	--	--	3.0%	100.0%
	Primary malignant liver tumors	1	25	5	--	--	--	31
		3.2%	80.6%	16.1%	--	--	--	100.0%
	Metastases	1	4	20	1	--	--	26
		3.8%	15.4%	76.9%	3.8%	--	--	100.0%
	Heman-gioma	1	1	1	3	--	--	6
		16.7%	16.7%	16.7%	50.0%	--	--	100.0%
	cysts	2	--	--	--	2	1	5
		40.0%	--	--	--	40.0%	20.0&	100.0%
	Hydatid lesion	--	--	--	--	1	3	4
		--	--	--	--	25.0%	75.0%	100.0%
	Total	35	32	26	4	3	5	105
		33.3%	30.5%	24.8%	3.8%	2.9%	4.8%	100.0%

Chi-square test

	Value	df	Asymp Sig (2-sided)
Pearson chi-square	244.32	25	.000

Contingency Coefficient Test

	Value	Approximate significance
Contingency coefficient	0.836	.000

Out of the 35 cases diagnosed as liver abscess by ultrasonography, 30 cases were confirmed as liver abscess by FNAC. 5 cases were false positive on ultrasound, out of which FNAC proved one each as primary malignant liver tumor, hemangioma, metastasis and remaining two as cystic lesions. 32 cases were diagnosed as primary liver malignant tumors on ultrasonography, of which 25 cases were confirmed by FNAC. 6 were false negative on ultrasound, which were diagnosed by FNAC.26 cases were diagnosed as metastasis by ultrasound of which 20 were confirmed by FNAC as metastases, 6 were false positive by ultrasound.4 cases of hemangiomas were diagnosed by USG of which 3 cases were confirmed by FNAC and one case was false positively diagnosed. 3 cases of cystic lesions were diagnosed by ultrasound. FNAC confirmed 2 cases and one case was false positively diagnosed by ultrasound.5 cases of hydatid lesions were diagnosed by ultrasound. 3 cases were confirmed by FNAC. 2 cases were false positive, one each were liver abscess and cystic lesion.There is significant association between USG findings and FNAC findings (chi-square value = 244.329, $p<0.000$). Even contingency coefficient value of 0.836 was found to be highly significant ($p<0.000$).

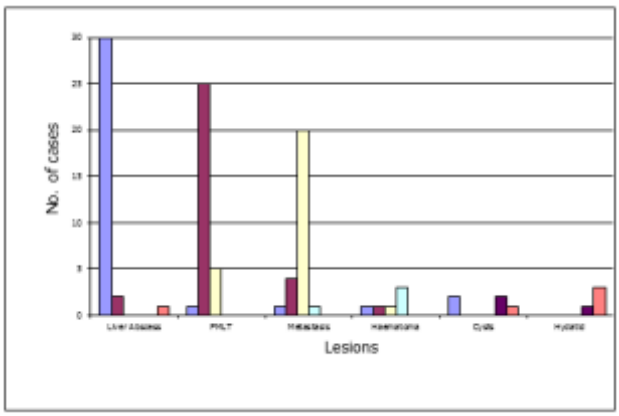

Figure 13: USG and FNAC cross-tabulation

Tests of Validity

$$\text{Sensitivity} = \frac{\text{True positive}}{\text{True positive + False negative}}$$

$$\text{Specificity} = \frac{\text{True negative}}{\text{True negative + False positive}}$$

$$\text{Positive predictive value} = \frac{\text{True positive}}{\text{True positive + False positive}}$$

$$\text{Negative predictive value} = \frac{\text{True negative}}{\text{True negative + False negative}}$$

Validity of ultrasonographic diagnosis of focal liver lesions in relation to FNAC diagnosis

Table 20: Cases diagnosed by USG and FNAC

		FNAC											
		Liver abscess		Primary malignant liver tumor		Metastases		Hemangioma		Cysts		Hydatid lesion	
		+	–	+	–	+	–	+	–	+	–	+	–
USG	Positive	30	5	25	7	20	6	3	1	2	1	3	2
	Negative	3	67	6	67	6	73	3	98	3	99	1	99

Table 21: Statistical Values of the Study

Lesions	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Liver abscess	90.9	93.0	85.7	95.7
Primary malignant liver tumors	80.6	90.5	78.1	91.7
Metastases	76.9	92.4	76.9	92.4
Hemangioma	50.0	98.9	75.0	97.0
Cysts	40.0	99.0	66.6	97.0
Hydatid lesion	75.0	98.0	60.0	99.0

Ultrasound was highly sensitive and specific in diagnosing liver abscess with a sensitivity of 90.9% and specificity of 93.0%. In diagnosing primary malignant liver tumors and metastasis, ultrasound showed sensitivity of 80.6%, 76.9% and specificity of 90.5% and 92.4% respectively. In diagnosis of hemangioma, cystic and hydatid lesions, ultrasound showed a specificity of 98.9 and 99.0% and 98.0%respectively.

DISCUSSION

Ultrasonography has been an accepted method for the diagnosis of focal liver lesions because of its rapidity of diagnosis and its high sensitivity.
Ultrasound features of focal liver lesions was studied and diagnosis was confirmed by fine needle aspiration cytology .FNAC was taken as gold standard in comparing the diagnosis made by ultrasonography.The various focal liver lesions encountered in the study were liver abscess, PMLT, metastasis, Haemangiomas, cystic and Hydatid lesions.

Ultrasonographic Features of Focal Liver Lesions

Amoebic Liver Abscess: Worldwide amoebic liver abscess are more common than pyogenic liver abscess.Many patients with amoebic liver abscess report no GI symptoms, instead present with right upper quadrant pain, hepatomegaly and fever.They are less ill compared to pyogenic liver abscess patients and the most common presenting complaint is pain, occurs in 99% of population, 80% of abscesses occur in right lobe due to streaming of portal venous blood from the more frequently and more heavily infected right side of colon and much greater volume of right lobe. 75% of cases are solitary. There is strong tendency for male preponderance and 3rd to 4th decade is the most vulnerable age group but any age can be affected.Sonographically these are symmetrical, oval or rounded lesions with well-defined margins. They are usually peripherally situated touching the liver capsule (subcapsular location) [7]. Lesions are primarily hypoechoic compared to normal liver parenchyma, hence almost always shows distal acoustic enhancement, a feature that is less consistent with pyogenic abscess. Whenever an abscess is discovered by ultrasound should be followed by aspiration.Some lesions may show bizarre sonographic appearance like irregular echogenicity, interspread with disorganized low level echoes. Ultrasonography can be used as a guide for aspiration in order to identify the causative organisms of liver abscess [8].

Pyogenic Liver Abscess: Ultrasound will usually show a spherical oval or slightly irregular echopoor lesions with distal enhancement. This pattern is present in 75% of cases. A significant number of abscesses can be higher in reflectivity than the adjacent normal liver. . They are located usually at the center and rarely touching hepatic capsules. In a ultrasonographic study of 39 cases of liver abscess, 33 cases were pyogenic and 6 cases were amoebic liver abscess. Mean patient age was 55 years for pyogenic liver abscess and 35 years for amoebic liver abscess, while male to female ratio was 2.3:1 for pyogenic abscess and 5:1 for amoebic abscess. Ultrasonography confirmed the diagnosis of liver abscess with accuracy of 82.05% and sensitivity of 86.60% [9].

Ultrasonography is the preferred initial method of imaging for liver abscess as it is non-invasive, cost effective and can be used to guide aspiration to identify the causative organisms [10].In a study of 32 cases of hepatic abscess, 16 cases were found to be pyogenic liver abscess and remaining 16 cases to be amoebic liver abscess. All the patients initially underwent ultrasonographic examination. The confirmation of ultrasonographic diagnosis was made by ultrasound guided percutaneous aspiration in 30 cases and laprotomy in 2 cases. The right lobe was involved in all cases. Pyogenic abscesses were multiple in 62.5% cases, while amoebic liver abscesses were double only in one case. Amoebic liver abscess were larger in size than pyogenic abscess. Three ultrasound aspects were found. Hypoechogenic aspect was the most frequent (76% of amoebic and 61% of pyogenic abscess). The heterogenous aspect was found in 21% of amoebic and in 36% of pyogenic abscess. The anechogenic aspect was found in only one case of pyogenic abscess. Irregular wall was found in 70% of ameobicabscesses and in 51% of pyogenic abscesses [11].

Cysts: Ultrasonographyis one of the most sensitive diagnostic modalities for the detection and characterization of cysts. Sonographically these cysts have thin well defined walls, are echo free and show distal acoustic enhancement. Morphologically they have smooth margins and essentially imperceptible walls and they lack septations [12]. The diagnosis of simple cyst was based on established ultrasonographic criteria like anechoic lesions, sharp smooth borders with strong posterior wall echoes, oval or spherical in shape and relative accentuation of echoes beyond the cyst compared to echoes at a similar depth.

Hydatid disease: Liver is the most frequently involved organ with more than 50% of cysts found in the liver. Cysts are multiple in 40% of cases and about in 25% of patients with liver disease also have lung cysts. Lesions may be purely cystic, solid or mixed. The cyst appears as a well-defined sonolucent mass with smooth borders and good posterior enhancement. Wall calcification may occur years after the initial infection. The presence of complete rim of calcification suggests as inactive lesion. Debris, consisting of sand and scolices may be present within the hydatid lesion. It may also be possible to discrene the two layers of the wall of hydatidlesion.Separation of the membrane producing an ultrasound 'Water Lilly" sign results from detachment of inner germinal layer from the exocyst. This gives characteristic appearance for the hydatid lesion. The collapsed germinal layer is seen as an undulating linear collection of echoes either floating in the cyst or lying in the most dependent portion.The development of daughter cysts from the lining germinal layer produces a characteristic appearance of `cyst within a cyst.' This appearance is extensively characteristic, producing 'cart-wheel' or 'honey comb' appearance. Another pattern is 'Rossette' pattern, which is also characteristic appearance of a hydatid with daughter cysts. Capsule is well outlined but the inner architecture show circular array of cysts and a solid centre[13]With heavy or continued infestation, multiple primary parent cysts may develop within the liver and will often produce hepatomegaly. Aspirated fluid from hydatid cyst is turbid and thick, fragments of the hyaline laminated cyst wall membrane are readily demonstrated. The diagnosis is confirmed by the demonstration of scolices or refractilehooklets [14].

Hemangiomas: Hepatic cavernous hemangiomas are the most common benign tumors of the liver with a frequency at autopsy of up to 7.3%. These tumors can be found at any age and it is estimated that 70-95% occur in women. They are usually solitary but are multiple in 10% of cases. They are typically located in the subcapsular region or near to a hepatic fissure. Size is usually less than 3 cm in diameter, but they may become very large. Large majority of liver hemangiomas will not change in size over a period of several years. Calcification or phleboliths are rare. Central thrombosis is common and leads to fibrosis. Hepatic hemangiomas are usually asymptomatic although larger tumors may cause liver enlargement and abdominal discomfort. They may enlarge during pregnancy.The spectrum of appearance on ultrasound is variable. However, the majority have a very distinctive pattern. This is of a sharply defined homogeneously hyperechoic round tumor without anhypoechoic peripheral border. The anatomic basis for the typical echogenic appearance of anhemangioma is thought to be due to multiple interfaces between the walls of cavernous sinuses and the blood contained within. A minority of hemangioma may present as an isoechoic or hypoechoic mass relative to the liver parenchyma. Hemangiomas larger than 2.5 cm are reported to show posterior acoustic enhancement.Somehemangiomas, especially if they are large (more than 5-6 cm in diameter) present a heterogeneous ultrasound echo pattern. The anatomical basis for this is thought to be due to thrombosis, fibrosis, degeneration or hemorrhagic necrosis. Atypical appearance makes distinction from other focal

lesions difficult.The confirmation of diagnosis is based on aspiration of profuse blood with correct positioning of needle within the lesion. When diagnostic cells are present they assume three-dimensional swather of endothelial cells surrounding cavernous spaces of endothelial cells.

Hepatocellular Carcinoma: HCC is the most common primary liver cancer comprising of 80% of primary liver malignancies. It is typically a disease of middle aged and elderly individuals. The advent of real-time ultrasound has increased the accuracy of diagnosis of focal lesions of liver and has significantly contributed to improve the early detection of HCC.

Sonography has been shown to be sensitive and integral part of screening for hepatocellular carcinoma in high risk countries like India.The sonographic appearance of HCC is variable. The masses may be hypoechoic complex or echogenic. Most small (< 5 cm) HCC are hypoechoic. A thin peripheral hypoechoic halo, which corresponds to a fibrous capsule, is seen most often in small HCC. With time and increasing size, the masses tend to become more complex and heterogeneous as a result of necrosis and fibrosis. Calcification is uncommon. Small tumors may appear diffusely hyperechoic, secondary to fatty metamorphosis or sinusoidal dilatation, making them indistinguishable from lipossis and hemangioma. The highly reflective pattern is most frequent, being present in about half of all cases. Vascular invasion is common and should suggest the diagnosis of Hepatocellular carcinoma. HCC invades portal vein, hepatic vein and IVC. Ultrasonographic screening and follow up of patients with chronic liver disease lead to the detection of a large number of small asymptomatic hepatocellular carcinomas, so that the changing appearance of this neoplasm during its natural history has now been recognized. Ultrasonography provides information on shape, echogenicity, growth pattern and vascular involvement of the neoplasm. Three different shapes may be identified, depending upon the size and the invasiveness of the neoplasms: nodular,massive and diffuse. The echogenicity is variable and the tumor mass may appear hypo, hyper or isoechoic in comparison with the surrounding liver tissue. A mixed pattern and/or a hypoehcoic ring may also be visualized. A tendency to change from allow echo pattern to a low periphery and finally to a massive pattern with increasing echogenicity has been shown in Japanese patients. The infiltrative growth pattern may be grossly distinguished from the expansive one on the basis of the aspect of the tumor boundary. Vascular invasion is easily recognizable as a mass with in a major portal branch or even in the portal trunk. Finally, ultrasound guidance allows puncture of intrahepatic nodules as small as 1cm. The sensitivity of this procedure in the diagnosis of focal liver lesions is very high, varying between 91% and95% with a specificity of 92%-100%[14].

Metastasis: The liver is one of the commonest site for metastasis and terminal involvement is the rule in all but CNS malignancies. This can be attributed to its large size, high rate of blood flow and double perfusion by the portal vein and hepatic artery. The route of tumor spread to the liver is more likely to be hematogenous rather than lymphatic, because for the most part of the liver's lymphatics are hepatofugal. The most common primary tumors are those of the gut, breast, lung and melanoma. Metastasis may be found in any part of the liver and are usually multiple.The wide ranges of appearances are encountered in liver metastatic disease. Focal lesions are commonest but the malignancy may also infiltrate widely. The commonest focal pattern is of echopoor masses. Highly reflective lesions may be surrounded by an echo-poor band which may be fine or a few millimeters thick. This is called Bull's eye pattern and is more often seen in larger lesions. Highly reflective and target lesions are typically of tumors originating in the gastrointestinal tract and urogenital tract. These are recognized by distal enhancement caused by them. They may contain clear fluid as may be produced by mucin secreting lesion (e.g., cancer pancreas/ ovary) but contain debris when the fluid represents tumor necrosis. These types tend to have shaggy walls and are less likely to be mistaken for simple cysts [15]. Calcified lesions have very intense echoes and may show shadowing if the foci are sufficiently large. Calcification commonly occurs in secondaries from colorectal and gastric carcinomas as well as neuroblastomas.A difficult differential diagnosis is that from hemangiomas which also have a variety of echo patterns. Definite differential diagnosis is not possible based on ultrasound alone. Colonic adenocarcinoma is the most common source of liver metastasis. The cytopathological pattern is characteristic showing malignant columnar epithelial cells in palisaded rows or microglandular groups with a background of necrotic debris.

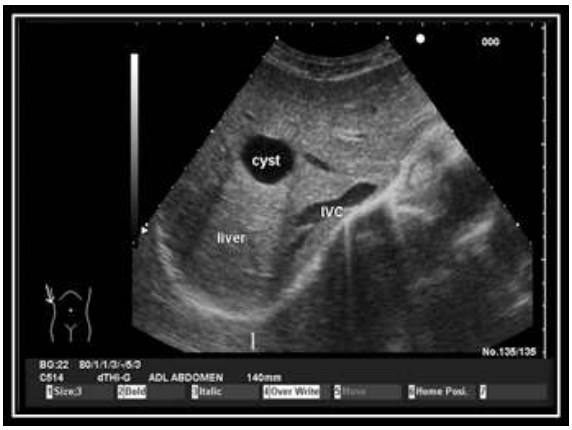

Figure 1:Solitary cystic lesion in right lobe of liver – Small well defined anechoic lesion measuring 2.2 x 1.8 cms in right lobe. Acoustic enhancement at the posterior margin of the cyst can be seen

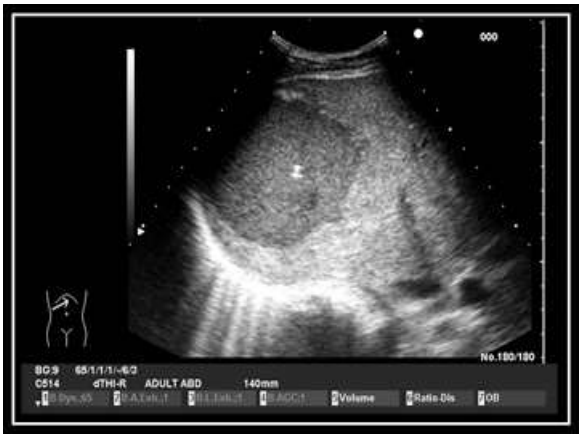

Fig. 2:Liver abscess with FNAC needle – Tip of the needle can be seen as highly Echogenic structure at the center of the lesion

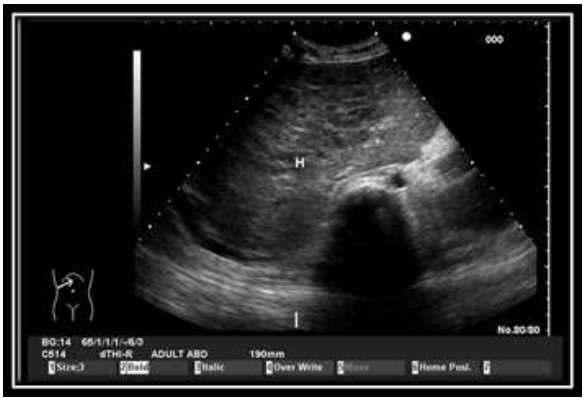

Fig. 3: Solitary Hemangioma in right lobe of liver – Large well defined. Predominantly hyperechoic lesions measuring 4.8 x 3.5 cms in right lobe of liver

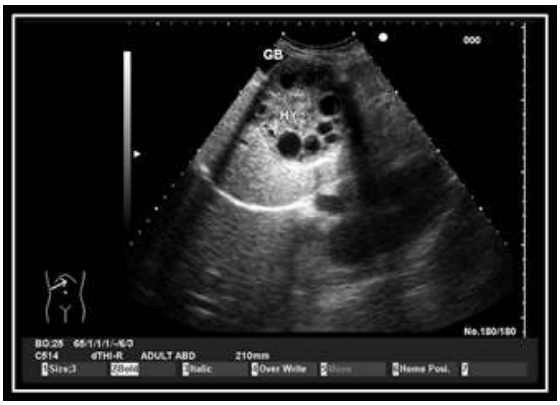

Fig. 4: Solitary Hydatid cyst in right lobe –Well defined lesion with multiple small cystic lesion (daughter cyst) within lesions are seen giving typical 'spoke wheel' appearance

Fig. 5: Solitary PMLT in right lobe of liver – Large ill-defined predominantly echogenic lesion measuring 8 x 6 cms in right lobe of liver

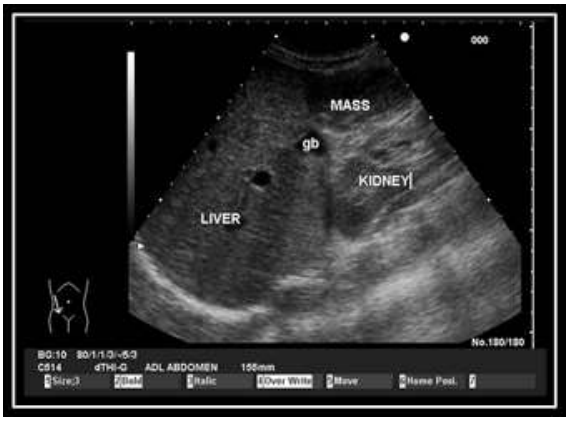

Fig. 6: PMLT in left lobe of liver-Hypoechoic lesion measuring 4 x 3.2 cms in left lobe of liver

Fig.7: Multiple Bull's eye metastatic lesions in both lobes of liver

Fig. 8: Solitary metastasis with central necrosis in right lobe of liver

Following tables shows comparison of Present study with various studies in literature

Table 22: Age incidence of focal liver lesions

	Author	Age range (years)	Mean age (years)
Focal liver lesions	Nggada HA *et al.*[16]	14 – 75	47.00
	Present study	06 –69	41.7
Liver abscess	Ramamohan et al [17]	31 – 50	
	Blanco QF et al [9] Azhar Jawaid Bhukari et al[26]	10 – 60 10-60	35.8 29.00
	Present study	8 – 60	37.1
PMLT	Gbesso RD et at [18]	24 – 76	47.4
	HsinlinTseui et al [19]	2 m – 15	10
	Present study	6 – 66	45.4
Metastasis	Ali Nawaz Khan et al [20]	50 – 70	
	Present study	30 – 70	52.2
Hemangioma	Gandolfie et al [21]	20 – 70	49.5
	Present study	08 – 60	24.3
Cystic lesion	Richard M Spigel et al[22]	5 – 75	
	Present study	8 – 60	29.2
Hydatid lesion	Mergen H et al [23]	18 – 85	42.0
	Dilip K Das [24]	28 – 60	34.5
	Present study	16 – 60	25.3

Table-23: Sex incidence of focal liver lesion

	Study group	No. of cases	No. of Males	No. of females	M:F ratio
Focal liver lesion	Mukul PA et al [25]	28	22	6	3.6:1
	Nggada HA et al [16]	47	38	9	4.2:1
	Present study	105	70	35	2:1
Liver abscess	AzharJawaidBhukari et al [26]	53	39	14	2.8:1
	Present study	33	24	9	2.7:1
PMLT	Dubbin et al [27]	32	27	5	5.2:1
	Present study	31	18	13	1.3:1
Metastasis	Ali Nawaz Khan et [20]	50	30	20	3:2
	Present study	26	16	10	1.6:1
Hemangioma	Gandolfie et al[21]	123	41	82	1:2
	Present study	6	5	1	5:1
Cystic lesion	Richard M speigal et al[22]	10	8	2	4:1
	Present study	5	3	2	3:2
Hydatid lesion	Mergen H et al[23]	73	38	53	1.6:1
	Dilip K Das et al[24]	8	2	6	1:3
	Present study	4	4	0	4:0

Table 24: Number of focal liver lesions

	Study group	Total No. of cases	Solitary (%)	Multiple (%)
Liver abscess	Ralls W et al [28]	106	83.00	17.00
	Ramamohan C et al[17]	22	66.70	33.30
	Present study	33	94.00	6.00
PMLT	Mario Cattone et al [29]	27	(18) 67.00	(9)33.00
	Present study	31	(20) 65.00	(11) 35.00
Heman-gioma	Gandolfie et al[21]	123	75.00	25.00
	Present study	6	(4) 66.60	(2) 33.40
Cysts	Richard MSpigel et al[22]	10	(5) 50.00	(5) 50.00
	Weaver roa et al [30]	8	(4) 50.00	(4) 50.00
	Present study	5	(3) 60.00	(2) 40.00
Hydatid lesion	Mergen H et al[23]	73	69.00	31.00
	Present study	4	(2) 50.00	(2) 50.00

Table 25: Lobar involvement of liver abscess

	AzharJawaidbukari et al		Present study	
	No. of cases (N=46)	%	No.of cases (N=33)	%
Solitary	38	82.6	31	94
Multiple	8	17.4	2	6
Right lobe	36	78.2	25	76
Left lobe	4	8.6	7	21
Both lobes	6	13.0	1	3

Table 26: Echo features of liver abscess

Study group	Echo features	
	Hypoechoic	Heterogeneous
Abdelauafi A[11]	76% (ALA) 61% (PLA)	21.0 (ALA) 36% (PLA)
Present study	80.0	Anechoic 17.2% / Hyper-echoic 2.8%

Table 27: Echo features of PMLT

Echo-pattern	Study group					
	Reuss J [31]		Mario Cottone et Al [32]		Present study	
	No. of cases	Percent	No. of cases	Percent	No. of cases	Percent
Hyperechoic	24	48.00	16	59.00	16	50.00
Hypoechoic	14	28.00	7	26.00	5	15.60
Mixed echogenic	12	24.00	4	15.00	11	34.40
Total No. of cases	50	100.00	27	100.00	32	100.00

Table-28: Echo features of metastases

Echo pattern	Study group		
	Jain AK et al [33](%)	Viscomi GN et al [34] (%)	Present study (%)
Hypoechoic	34.60	37.50	38.50
Hyperechoic	13.30	25.0	19.20
Bull's eye	14.60	--	19.20
Mixed	4.0	37.50	23.10
Others	33.5	--	--

Diagnostic Validity Test Results of Various Focal Liver Lesions

Blanco Quintana F et al studied [9] cases of liver abscess between 1980-1994. Mean patient age was 55.6 years. The most common presenting clinical symptom was fever in 71.9% of cases. Ultrasonography confirmed the diagnosis in 32 cases (82.05%) with a sensitivity of 86.6%.Sanchez Alvarez J et al[34]in their study of 20 cases of liver abscess, sensitivity of ultrasonography in the diagnosis of liver abscess was

found to be 78%. Donovan AJ et[35]al in their study found that hepatic abscess – amoebic or pyogenic can be diagnosed with great accuracy by ultrasonography. Ultrasound is the modality of choice with a high sensitivity and specificity of 90% and 93% respectively. In the present study of 35 cases of liver abscess diagnosed by USG, overall sensitivity and specificity was 90.9% and 93% respectively. The PPV and NPV were 85.7% and 95.7% .The higher sensitivity and specificity could be attributed to the higher number of liver abscesses found in the study.

Table 29: Diagnostic validity test results of ultrasonographic diagnosis invarious studies of liver abscess

Study group	Year	No. of Cases	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Sanchez Alverez J et al [35]	1988	20	78.00			
Donovan AJ et al [36]	1991		90.00	93.00		
Blanco Quintona F et al[9]	1995	39	86.6			
Present study	2007	35	90.9	93.0	85.7	95.7

Table 30: Diagnostic validity test results of ultrasonographic diagnosis invarious studies of PMLT

Study group	Year	No. of Cases	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Cottone M et al[29]	1983	100	90.00	93.00	84.4	95.00
Buscarini et al [37]	1987	67	95.00	100.00		
Zamannsn et al [38]	1990		78.00	93.00	93.00	
Colli A et al [39]	2006		60.00	97.00		
Present study	2007	32	80.60	90.50	78.10	91.70

Table 31: Diagnostic validity test results of ultrasonographic diagnosis in various studies of Metastases

Study group	Year	No. of Cases	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
TakanobuYashida et al [40]	2000	338	78.30	99.7	96.8	97.1
Nawaz Ali Khan et al[20]	2007	220	84.00	85.00		
Present study	2007	26	76.9	92.4	76.9	92.4

In the present study of 6 cases of Hemangioma, sensitivity, specificity, PPV and NPV were 50%, 98.9%, 75% and 97% respectively. Richard M Spiegel et al in his study of 10 cases of cystic lesions of liver found sensitivity of 77% with PPV of 100%. In the present study, 5 cases of cystic lesions were diagnosed by FNAC. The overall sensitivity and specificity was 40% and 99% respectively. The PPV and NPV were 66.6% and 97%. JouiniS et al [40] in their study of 88 cases of liver Hydatid lesion, ultrasonography showed a sensitivity of 92.3% and specificity of 98.3% in diagnosing the lesions. In the present study of 4 cases of Hydatid lesion, overall sensitivity and specificity was 75% and 98%.For above, Haemangiomas, cystic and Hydatid lesions, sensitivity, specificity, positive predictive value and NPV were calculated. Definitive diagnostic precision could not be attributed due to less number of cases enrolled in the study. However, USG with its typical sonological features can diagnose above lesions with high diagnostic accuracy, obviating needle confirmation in majority of cases.

Ultrasonography provides an accurate and safe imaging method in diagnosing various focal liver lesions. Majority of focal liver lesions constituted in the present study were liver abscess, PMLT and metastases.

Ultrasonography was able to diagnose almost accurately all these major focal liver lesions, in other lesions like Hemangioma, cysts and Hydatid also, ultrasound had good diagnostic capability. However for the accurate final diagnosis – FNAC examination is needed, as the tissue type cannot be detected by ultrasonography. On the other hand ultrasonography aid in proper localization of focal liver lesion such that FNAC can be done from appropriate site without much false negative results. Ultrasonography has become an indispensable component in the evaluation of focal liver lesions.

Even though CT may be More accurate and highly sensitive in detection of foal liver lesion, because of unavailability and cost, USG in still the best and most cost effective cross-sectional imaging method for evaluating focal liver lesion. It is simple, inexpensive, safe method and is worthy of consideration to be

included as a routine initial imaging modality for evaluation of focal liver lesions.

CONCLUSION

Ultrasound is a safe and effective method of detecting focal liver lesion. Its flexibility, easy availability and lack of dependence on organ function makes it most ideal for imaging the liver and also serves as an object of defining therapeutic decision quickly.

Ultrasonography when adopted as an initial imaging modality was seen as a method which reduced the cost and time to arrive at a diagnosis.By this rapid method, even small lesions with subtle difference in reflectivity can be detected. The liver can be scanned in multiple planes enabling us to know the exact location of lesions and study their echo pattern.Apart from detecting lesion, other valuable information like ascites, vessel involvement, primary source of malignancy in abdomen and pelvis can be easily obtained.

Ultrasonography is highly sensitive in diagnosing focal liver lesions such as Liver abscess, Primary malignant liver tumors and metastases which constituted majority of focal liver lesions in the present study, with a sensitivity of 90.9%, 80.6% and 76.9% respectively.Despite the minimum drawback, it is evident from this study that ultrasonography has a wide applicability in the diagnosis of focal liver lesion.Being a safe, simple, repeatable and without radiation exposure to the patient, it is worthy of being included in routine diagnostic work. In spite of the advent of newer diagnostic modalities, it still holds a unique status even in the current perspective.

Validity of ultrasonographic diagnosis in relation to FNAC diagnosis was done in 105 cases of focal liver lesions.Ultrasonography was highly sensitive in diagnosing liver abscess with a sensitivity of 90.9% and specificity of 93.0%. In diagnosing primary malignant liver tumors and metastases, USG showed sensitivity of 80.6%, 76.9% and specificity of 90.5% and 92.4% respectively. The PPV for liver abscess, primary malignant liver tumors and metastasis were 85.7%, 78.1% and 76.9% respectively. Negative predictive value for the same lesions were 95.7%, 91.7% and 92.4% respectively.There is a significant association between USG findings and FNAC diagnosis.

High degree of sensitivity and specificity of USG diagnosis in the present study confirms the value of ultrasonographic evaluation of focal liver lesions and suggests that it can be effectively used in the routine diagnostic work.

REFERENCES

1. Thomas S Curry, James E Dowdey, Robert C Murry JR. Ultrasound, Chapter-20 in: Christensen's Physics of Diagnostic Radiology. 4th Edition, Lea &Febiger, UK; 1990: 323-25.
2. Christopher J Harvey, James M Pilcher, Robert J Eckersley, Martin JK Bomley, David O Cosgrove. Advances in Ultrasound. ClinRadiol. . 2002; 57: 157-177.
3. Civardio, Vallisa, Befer, Lazzaron. Focal liver lesions in NHL – Investigation of their prevalence and clinical significance. Eur J Cancer. 2002; 38(18): 2382-2387.
4. Tchelepi, Hisham MD, Ralls W, Philip W. Ultrasound of focal liver masses. Ultrasound Quarterly 2004; 20(4): 155-169.
5. Salani V Duyshant, Saneev D Kalu. Imaging of liver. Oncology. 2004; 9(4): 385-395.
6. Jixiao-Long. Fine needle aspiration cytology of liver disease. World J Gastroenterol. 1999; 5(2): 95-97.
7. Kuligowska E, Noble J. Sonographic features of hepatic abscess. Semin Ultrasound. 1983; 4: 102-116.
8. Gossin KB. Intrahepatic focal liver lesions – Differential diagnosis. Am J Roentgenol. 1981; 137: 763-767.
9. Blanco Quintana F, Novella Arribas B, Sanchez Molini P, SanzSanz J. Descriptive studies of 39 cases of hepatic abscess of pyogenic and amoebic origin. An Med Interna. October 1995; 12(10): 477-84.
10. Shamsuzzanman SM, Haque R, Hasin SK, Petri WA, Hashiguchi Y. Socioeconomic status, clinical features, laboratory and parasitological findings of hepatic ameobiasis patients – A hospital based prospective study in Bangladesh. South Asian J Trop Med Health. 2000; 31: 399-404.
11. Abdelouafi A, Ousehal A, Vuzidane, Kadiri R. Ultrasonography in the diagnosis of liver abscesses – Apropes of 32 cases. Ann Radiol. (Paris). March 1993; 36(4): 286-92.
12. Edmonston HA, Peters RL . Tumors of the liver – Pathological features. Seminars inRoentgenology. 1983; 18(2): 75-83.
13. TareqSinan, Mehraj Sheik, Abdulla Behbdoni, Fayaz A Chisti, Zafar Sheik, PR Hira et al. Diagnosis of abdominal hydatid cyst: The role of ultrasound and ultrasound guided fine needle aspiration cytology. International Journal of Medical Principles and Practice. 2002; 11(04).
14. Bolandi L, Gaiani S, Benzi G, Zironi G, RigamontiA,Fuscorni F et al. Ultrasonography and guided biopsy in the diagnosis of hepatocellur carcinoma. Italian J of Gastroenterol. Jan. 1992; 24(1): 46-49.
15. Scheible W, Gosink BB, Leopold GR. Gray scale echographic patterns of hepatic metastatic disease Am J Roentgenol. 1977; 129: 983-987

16. Nggada HA, Ahidjo A, Ajavi NA, Mustapha SK, Pindiga UH, Jahir et al. Correlation between USG findings and USG guided FNAC in the diagnosis of hepatic lesion. Int. J of Gastroenterol. 1999; ISSN-1528: 8323.
17. Ramamohan C, Pramod Kumar Reddy, Manohar K. Sonographic evaluation of liver abscess. Ind J RadiolImag. 1989; 43(3): 312-215.
18. Gbesso RD, Athia A, Mahassadi, Kanga N, Yoman TN, Keita AK et al. Hepatocellular carcinoma observed in Abidjan – Aspects and role of ultrasonography. J Radiol. 1998; 79(5): 409-14.
19. Hsin Lin Tseui, Chin Su lie, Jai Waichin, Chou-Fu Wei. Hepatoblastoma and hepatocellular carcinoma in children. J Chin Med Assoc. 2004; 67: 83-88.
20. Nawaz Ali Khan, MacDonald S, Zahir A, Ajay Pankania, David Sherlock, Karai et al. http://: www.medicine.com/radio.topic.394
21. Gonaldolfi L, Leo P, Solmi L, Vitelli E, Verros G, Colecchia A. Natural history of hepatic haemangioma – Clinical and ultrasound study. Liver, Biliary &Pancreat Gut. 1991; 32: 677-680.
22. Richard M Spiegel, Donald L King, William M Green.. Ultrasonography of primary cysts of the liver. Am J Roentgenol. Aug. 1978; 131: 235-238.
23. Mergen H, Gen H, Tarus Bay C. Assessment of liver hydatid cyst case – 10 years experience in Turkey. Trop Doct. Jan 2007; 37(1): 54-56.
24. Das DK, Bhambani S, Chandras Pant CS. Ultrasound guided FNAC diagnosis of hydatid disease of the abdomen and thorax. DiagnCytopathol. 1995; 12(2): 173-176
25. Mukul P Agarwal, Ravi Kapoor, Madan M Shah. Ultrasonography and Scintigraphy in the diagnosis of extra hepatic space occupying lesion. Ind J RadiolImag, supplement to 1991: Issue part I.
26. AzharJawaidBukhari, Khali JavedAbid. Amoebic liver abscess: Clinical presentation and diagnostic difficulties. Kuwait Medical Journal. 2003; 35(3): 183-186.
27. Dubbins PA, Riordan DO, Mellor WM. Ultrasound in hepatoma – Can a specific diagnosis be made. Br J Radiol. 1981; 54: 307-311.
28. Philip W Ralls, Patrick M Colleti, Michael F Qinn. Sonographic findings in hepatic amoebic abscess. Radiology. 1982; 145: 123-126.
29. Mario Cottone M, PiaMarcena, AbertoMaringhini, Fortuna Rinaldi, GiuseppinaRuno, Elisociarrino et al. Ultrasound in the diagnosis of hepatocellur carcinoma associated with cirrhosis. Radiology; 1983; 147: 517-519.
30. WeanerRoaJr, Goldstein HM, Green B. Gray scale ultrasound evaluation of hepatic cystic disease. Am J Roentgenol. 1978; 130(5): 849-52.
31. Reuss J, Seiz K, Rettenmaier G. US diagnosis of Hepatocellular carcinoma. Bildgebung. March 1993; 60(1): 18-22.
32. Jain AK, NC Gupta, Ravi Kapoor, Madan M Shah. Sonographic spectrum of hepatic metastasis disease. Ind J RadiolImag. 1999; 44
33. Viscomi GN, Ganzalex R, TaylerKJW Histopathological correlation of ultrasound appearances of liver metastasis. J ClinGastroenterol. 1981; 3: 395-400.
34. Sanchez Alwarez J, BarberenaIriberria J, SaurasHerran MA, JimaneMedioro F, Perez Garcia C, CarillodeAlbornozmm. CT Computerized axial tomography, ultrasonography and percutaneous drainage in the diagnosis and treatment of pyogenic abscess of the liver. Rev Med Univ Navarra,1988;32(3):139-142.
35. Donovan AJ, Yellin AE, Ralls PW. Hepatic abscess. World J Surg. 1991; 15(2): 162-9.
36. Buscarini L, Sbolli G, Cavanna L, Civardi G, Rossi S, Distasi S. Clinical and diagnostic features of 67 cases of hepatocellular carcinoma. Oncology 1987; 44(2): 93-7.
37. Zaman SN, Johnson PJ, Willias R Silen. Silent cirrhosis in patients with HCC implication for screening in high incidence and low incidence area. Cancer. 1990; 65: 1607-10
38. Colli A, Fraquelli M, CasazzaG,Massironi S, Colluci A, Conte D et al. Accuracy of ultrasonography, spiral CT, magnetic resonance and Alpha-FP in diagnosing hepatocellular carcinoma – A systemic review. Am J Gastroenterol. 2006; 101(3): 513-23
39. Takanobu Yoshida, Histomatsu, Nobuookazaki. Preoperative ultrasonography screening for liver metastasis of patients with colorectal carcinoma. Japanese Journal of Clinical Oncology, 2000; 10(2): 112-115.
40. Jouinis S, Menif E, Sehilis S, Bensafta Z, Chaemak L, Belaid S et al. Value of ultrasonics in differential diagnosis of hydatid cyst of liver and other solid masses. J Radiol. Aug 1996; 77 (8): 563-9.