VOLUME - 11, ISSUE - 04, APRIL - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Radio-Diagnosis

COLOUR DOPPLER EVALUATION OF COMMON ADULT HEPATIC TUMORS AND ITS CORRELATION WITH HISTOPATHOLOGICAL EXAMINATION AND CONTRAST ENHANCED COMPUTED TOMOGRAPHY IN TERTIARY CARE CENTER; A CROSS SECTIONAL STUDY

Dr. Prajwaleet Pratapsingh Gour — M.D. Radiodiagnosis, Professor, Department Of Radiodiagnosis, Government Medical College, Nagpur, India.

Dr. Pritam D. Sangma* — MBBS, M.D. Radiodiagnosis(Ongoing), Junior Resident, Department Of Radiodiagnosis, Government Medical College, Nagpur, India. *Correspondsing Author

Dr. Aarti Anand — M.D. Radiodiagnosis, Professor And Head Of The Department, Department Of Radiodiagnosis, Government Medical College, Nagpur, India.

ABSTRACT

Objective:A. To characterize the colour doppler ultrasonographic features of common adult hepatic tumours.

B. To correlate colour doppler findings with histopathological examination and contrast enhanced computed tomography.

C. To assess the sensitivity, specificity and accuracy of colour doppler ultrasound in differentiating HCCs, metastases and haemangiomas.

Materials and Methods: A Cross sectional study of 63 patients with 88 liver lesions >2 cm in size detected on gray scale ultrasound was done. They were subjected to Ultrasound, Colour Doppler USG, CECT and Histopathological examination. The histopathological diagnosis was taken as the gold standard for confirmation of Hepatocellular carcinoma and metastases and triphasic CECT was taken as the gold standard for confirmation of haemangioma. Only adult patients were included in the study. There were no limitations to study with respect to sex.

Results: Thirty-six (57.1%) patients were males and twenty-seven (42.9%) were females. Seven (11.1%) patients were between the ages of 20 and 40, 40 (63.5%) were between the ages of 40 and 60, and 16 (25.4%) were over the age of 60. On colour doppler examination, HCCs were found in 25 (39.7%) patients, while metastases were found in 15 (23.8%) others, and haemangiomas were found in 23 (36.5%) others. On CECT and HPE, 25 (83.3%) of the 30 HCCs were correctly diagnosed, 5 (16.7%) lesions were overlooked, and 3 lesions were incorrectly labelled as HCCs, which turned out to be two haemangiomas and one metastasis. Out of 32 metastases, 28 (87.5%) were accurately detected by doppler, four (12.5%) were missed, and one was misdiagnosed as a metastasis but later revealed to be HCC. 23 (88.5%) haemangiomas were successfully identified by doppler, three (11.5%) lesions were overlooked, and eight lesions were incorrectly diagnosed as haemangiomas but later revealed to be 5 HCCs and three metastases. Colour doppler sensitivity to distinguish HCC, metastases, and haemangioma is 83.3 percent, 87.5 percent, and 88.5 percent, respectively. The above lesions have a specificity of 94.8 percent, 98.2 percent, and 87.1 percent, respectively.

Conclusion: The colour doppler sonography is a readily available, reasonably inexpensive, well-tolerated, non-invasive technology with good diagnostic potential for distinguishing common adult hepatic tumours (HCCs, metastases, and haemangiomas) larger than 2 cm.

KEYWORDS : Colour doppler evaluation, adult hepatic tumours, HCC, Metastasis, Haemangioma, CECT, HPE.

INTRODUCTION

The liver is a big, homogeneous organ, various imaging techniques can be used to assess it. Adult liver tumours are a typical occurrence in clinical practice. Hepatocellular carcinoma, haemangiomas, and metastases are all common adult hepatic tumours.(1)

Hepatocellular carcinoma (HCC) is the leading cause of death in compensated cirrhosis, accounting for 5% of all malignancies. HCC is becoming more common over the world as the prevalence of HBV and HCV infection rises. HCC is responsible for 85 percent of all primary liver cancers. The majority of patients die within a year of being diagnosed. Survival is determined by the size of the tumour and the presence of accompanying disease at the time of diagnosis. As a result, early identification of HCC is critical for extending survival. HCC is more frequent in men between the ages of 30 and 60.(2–4)

Because of the abundant, dual blood supply as well as humoral substances that encourage cell proliferation, the liver provides good soil for metastases to thrive. (The liver's blood supply is only surpassed by the lung's in terms of blood flow per minute.) After lymph nodes, the liver is the most usually affected organ by metastatic illness. Almost any primary tumour can spread to the liver and cause metastases. Patients with any malignant neoplasm, particularly primary tumours of the colon, stomach, pancreatic, breast, lung, and eye, should have their ultrasounds closely monitored, and if a lesion is found, colour doppler can be used to diagnose and treat them early.(5,6)

The most prevalent benign liver tumours are haemangiomas. Hepatic haemangiomas are reported to occur in 2% of people. At necropsy, the incidence is as high as 7.4%. The majority of hepatic haemangiomas are discovered in people between the ages of 30 and 50, with females being more affected than males.(1)

The investigation of liver tumours is extremely difficult. In many circumstances, a preoperative diagnosis can be made using a combination of imaging modalities that are completely non-invasive. Because many individuals have benign nonsurgical hepatic tumours such as haemangiomas, this is critical.(1)

To evaluate focal liver lesions, a variety of imaging modalities are used, including plain radiographs, USG and doppler, CT, MRI, angiography, and nuclear medicine techniques. The first non-invasive, easily accessible modality to describe localised liver lesions is ultrasound and doppler, followed by CECT or MRI. Scintigraphy was completed for a few patients. Prior to embolization, an angiogram is performed.(7)

MATERIALS AND METHODS

ETHICS:

a. Approval from Institutional Ethics Committee (IEC) was sought. Informed written consent in Subject's vernacular

language was taken before enrolment for study.

SELECTION OF PATIENTS:
Samples are randomly selected from adult patients who come for abdominal ultrasonography to the Department of Radiodiagnosis and are found to have hepatic lesions of size more than 2 cm.

Inclusion And Exclusion Criteria:
Inclusion Criteria:
- All adult patients with liver tumour on gray scale ultrasound more than 2 cm in diameter who are willing to participate were included.

Exclusion Criteria:
- History of surgery.
- History of chemotherapy.
- History of FNAC / biopsy of liver lesion
- Very obese patients (non-visualization or poor colour flow visualization of hepatic artery due to deep location).

METHOD OF COLLECTION OF DATA:
Patients with suspected liver tumour referred to us were included in our study after written informed consent, explaining procedure in detail to the patient and obtaining clearance from ethical committee. Complete history was taken and clinical evaluation of the patient was done.

A Cross sectional study of 63 patients with 88 liver lesions detected on gray scale ultrasound was done. They were subjected to Ultrasound, Colour Doppler USG, CECT and Histopathological examination. The histopathological diagnosis was taken as the gold standard for confirmation of Hepatocellular carcinoma and metastases and triphasic CECT was taken as the gold standard for confirmation of haemangioma. Only adult patients were included in the study. There were no limitations to study with respect to sex.

ULTRASOUND IMAGING PROTOCOLS:
Patients were subjected to Gray scale and Colour Doppler sonography after history taking and clinical evaluation.

A) EQUIPMENT:
MACHINE- Aloka 3500 SSD series unit.
TRANSDUCER - 3.5 MHz curved array transducer.

B)PROTOCOL:
Gray scale image of liver was obtained in craniocaudal extent and also from medial to lateral extent. In all of the tests, the flow toward the transducer was assigned a red colour, while the flow away from the transducer was assigned a blue colour. Examinations were carried out at various flow settings, depending on the flow velocities, with threshold values adjusted to optimize sensitivity without excessive noise. Real-time colour photographs of the lesion were taken, followed by point spectral analysis. Multiple peritumoral and intratumoral arteries visible in two-dimensional images were used to compute velocity. After correcting for the angle of insonation, velocity measurements were taken at peak systole and end diastole. When possible, a Doppler angle of 0 to 60 degrees was used to reduce velocity computation mistakes. Only the highest systolic peak flow velocity recorded from each tumour was selected for statistical evaluation out of the 5 to 20 measurements collected from each tumour. At the level of the porta hepatis, measurements of the common hepatic artery flow and angle corrected PSV were collected. The hepatic tumour index was determined (defined as the ratio of the peak systolic velocity in the tumour to the peak systolic velocity in the hepatic artery).

C) ULTRASOUND BASED IMAGING CRITERIA:
On gray scale, the following parameters was taken for consideration: Lesion size, shape, margins, number, location (right or left lobe, segments), echogenicity, calcification, adjacent vessel involvement (portal vein thrombus), bile duct dilatation, liver echoes and architecture (cirrhotic liver), regional lymphadenopathy and ascites.

In Doppler, we evaluated intralesional flow pattern (pulsatile flow, continuous flow, basket pattern or spot pattern, central or peripheral flow), intralesional peak systolic velocity, common hepatic artery peak systolic velocity, tumour index (intralesional PSV / common hepatic artery PSV) and portal vein involvement.

CONTRAST ENHANCED COMPUTED TOMOGRAPHY (CECT):
The ultrasonography (USG) findings were compared with the findings of triple phase CECT.

HISTOPATHOLOGICAL EXAMINATION (HPE):
It was collected from follow-up study after the patients underwent biopsy of the lesions (HCC and metastasis). Data was collected from the pathology department.

Statistical Analysis
- Collected data was entered into Microsoft Excel software and coded.
- Descriptive data was presented in frequency and percentage.
- The correlation between USG findings, CECT and HPE findings was performed by Chi2 test.
- P value <0.05 was considered as statistically significant.
- Statistical software SPSS 19.0v was used for data analysis.

RESULTS
Gray scale ultrasonography and CDS were used on 63 individuals with 88 liver lesions who were referred by Gastroenterology and Surgery departments.

Demographic features are represented in Chart 1 and Chart 2.

In grey scale ultrasound, 15 HCC lesions had a mixed appearance (Figure 1), 9 lesions were hyperechoic, and 6 lesions were hypoechoic. Out of 32 metastases, 11 were hypoechoic (Figure 4), 9 were isoechoic, 5 were hyperechoic, 4 were calcified, and 3 had a mixed appearance. Twenty-one of the 26 haemangiomas show hyperechoic (Figure 6), while five appear mixed echogenic. (Chart 3)

Pulsatile intralesional flow, intralesional PSV greater than 40 cm/s (Figure 2), normal or moderately enhanced common hepatic artery flow (Figure 3), and a hepatic tumour index greater than or equal to one are all colour Doppler ultrasonography results that point to HCC. Pulsatile or continuous flow within the lesion with intralesional PSV less than 40 cm/s (Figure 4), high common hepatic artery flow (Figure 5), and a Tumour Index (TI) less than one are all CDS results that point to metastases. Minimal continuous flow with intralesional PSV less than 40 cm/s (Figure 6), normal common hepatic artery PSV (Figure 7), and TI less than one are CDS findings that imply haemangiomas.

On CDS, 27 of the 30 HCCs showed pulsatile flow (Figure 2), two showed continuous flow, and one lesion had no flow. In metastases, 15 of the 32 lesions had pulsatile flow, 14 had continuous flow (Figure 4), and three had no flow. There were 15 continuous flows, 6 no flows (Figure 6), and 5 pulsatile flows in haemangiomas. Pulsatile flow was detected at a considerably higher rate ($p<0.01$) in HCCs than in metastases and haemangiomas.

In 31 of the 88 lesions, the intralesional peak systolic velocity

(ILPSV) was 40 cm/s or higher. There were 25 HCCs, three metastases, and three haemangiomas among them. HCC has a mean peak systolic velocity of 75.1 cm/s, which is statistically significant ($p<0.01$) when compared to metastases (24.1 cm/s) and haemangioma (19 cm/s).

The mean peak systolic velocity obtained from metastases (108.4 cm/s) was substantially higher than that of HCCs (72.9 cm/s) and haemangiomas (58.1 cm/s) ($p<0.01$). (Chart 4)

The TI is computed by dividing the intralesional PSV by the PSV of the common hepatic artery. In 22 of 30 HCCs, one of 32 metastases, and two of 26 haemangiomas, the hepatic tumour index was equal to or greater than one. HCC had a substantially higher mean hepatic tumour index than metastases and haemangiomas ($p<0.01$ in both cases). (Chart 5)

There is 83.3 percent sensitivity, 89.7% specificity, and 87.5 percent accuracy when intralesional pulsatile flow with PSV more than 40 cm/s is combined with normal common hepatic artery flow velocity for identification of HCC. There is 87.5 percent sensitivity, 94.6 percent specificity, and 92.0 percent accuracy when continuous or pulsatile flow with PSV40 cm/s is combined with enhanced PSV of the common hepatic artery for metastasis identification. The detection of haemangiomas is 84.6 percent sensitivity, 93.5 percent specificity, and 90.9 percent accuracy when minimal continuous flow or no flow is combined with intralesional PSV40 cm/s, normal common hepatic artery PSV.

When intralesional flow, ILPSV, common hepatic artery PSV, and hepatic TI are combined, the sensitivity is 83.3 percent, specificity is 94.8 percent, and accuracy is 90.9 percent for HCCs, 87.5 percent sensitivity, 98.2 percent specificity, and 94.3 percent accuracy for metastases, and 88.5 percent sensitivity, 87.1 percent specificity, and 87.5 percent accuracy for haemangioma detection.

The hepatic tumour index was more than or equal to one in 25 lesions (22 HCCs, 1 metastasis, and 2 haemangiomas) and less than one in 63 lesions (8 HCCs, 31 metastases, and 24 haemangiomas), resulting in 88.0 percent sensitivity, 87.3 percent specificity, and 87.5 percent accuracy.

DISCUSSION:

HCCs were found in 25 patients, while metastases were found in 15 others, and haemangiomas were found in 23 others. On CECT and HPE, 25 of the 30 HCCs were correctly diagnosed, 5 lesions were overlooked, and 3 lesions were incorrectly labelled as HCCs, which turned out to be two haemangiomas and one metastasis. Out of 32 metastases, 28 were accurately detected by doppler, four were missed, and one was misdiagnosed as a metastasis but later revealed to be HCC. 23 haemangiomas were successfully identified by doppler, three lesions were overlooked, and eight lesions were incorrectly diagnosed as haemangiomas but later revealed to be 5 HCCs and three metastases.

Colour doppler sensitivity to distinguish HCC, metastases, and haemangioma is 83.3 percent, 87.5 percent, and 88.5 percent, respectively. The above lesions have a specificity of 94.8 percent, 98.2 percent, and 87.1 percent, respectively.

To summarise, colour doppler ultrasound with strong sensitivity and specificity can better describe and discriminate hepatocellular carcinoma, metastases, and haemangiomas larger than 2 cm.

When compared to the **Numata K, Tanaka K, Kiba T, Morimoto M. et al(8)** study in which in separating HCCs from hepatic metastases, a PSV of 40 cm/s or above was related with a sensitivity of 91 percent, specificity of 83 percent, and accuracy of 89 percent; our study demonstrated 83.3 percent sensitivity, 94.8 percent specificity, and 90.9 percent accuracy.

Wang WF, Zhang QP et al(9) studied the use of CDFI in characterization of liver tumours. Doppler flow signals were found in all hepatic carcinomas and 10 of 18 haemangiomas, with pulsatile flow in 41 of 42 lesions and 6 of 10 haemangiomas, with mean PSV clearly lower in haemangiomas (20.34 +/- 23.93) than HCCs (64.74 +/- 30.18). Color Doppler flow signals were found in 29 of 30 HCCs and 20 of 26 haemangiomas in our study. Pulsatile flow was found in 27 of the 30 HCCs and 5 of the 26 haemangiomas. HCCs have a mean PSV of 75.1 +/- 33.1, which is higher than haemangiomas, which have a mean PSV of 19.0 +/- 16.4.

Kudo M, Tochio H, Zhou P et al(10) study showed Maximum velocity was significantly lower in haemangiomas (15.0 +/- 16.0 cm/s) than in HCCs (34.0 +/- 26.7 cm/s) and metastases (37.9 +/- 17.4 cm/s). The mean velocity of haemangiomas (19.0 +/- 16.4), HCCs (75.1 +/- 33.1), and metastases (24.1 +/- 15) in our study.

When compared to **Nino-Murcia M, Ralls PW, Jeffrey RB Jr, Johnson M. et al(11)** in which internal vascularity was found in 76 percent of HCCs, 67 percent of metastases, and 75 percent of benign lesions. Flow was found in 96.7 percent of HCCs, 9.4 percent of metastases, and 11.4 percent of haemangiomas in our study.

Yashura K, Kimura K, Ohto M, Matsutani S et al(12) study identified pulsatile flow in 35 of 55 HCCs, 7 of 25 metastases, and continuous flow in 4 of 30 haemangiomas. Our study found pulsatile flow in 27 of 30 HCCs, 15 of 32 metastases, and 5 of 26 haemangiomas, as well as continuous flow in 2 HCCs, 14 metastases, and 15 haemangiomas when compared to theirs.

CONCLUSION:

Adult hepatic tumours larger than 2 cm, such as hepatocellular carcinoma, metastases, and haemangiomas, are particularly sensitive to colour doppler ultrasound.

HCCs are diagnosed by pulsatile intralesional flow with a peak systolic velocity more than 40 cm/s and a hepatic tumour index greater than or equal to one. Increased common hepatic artery PSV with hepatic tumour index less than one, intralesional pulsatile or continuous flow with intralesional PSV less than 40 cm/s, and intralesional PSV less than 40 cm/s are indicative of metastases. Haemangiomas can be identified with a reasonable degree of confidence with intralesional continuous flow or no flow, intralesional PSV less than 40 cm/s, normal common hepatic artery PSV, and hepatic tumour index less than one.

Finally, we conclude that colour doppler sonography is a generally available, reasonably inexpensive, well tolerated, non-invasive technology with good diagnostic potential for distinguishing common adult hepatic tumours (HCCs, metastases, and haemangiomas) larger than 2 cm.

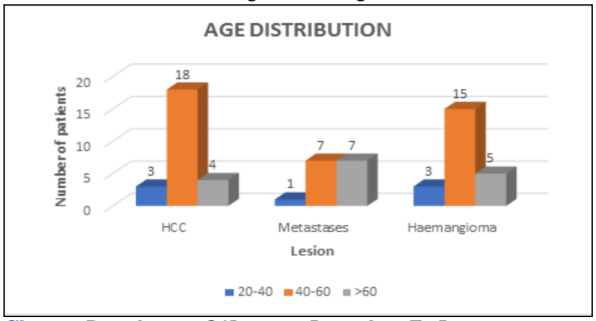


Chart 1: Distribution Of Lesions According To Age

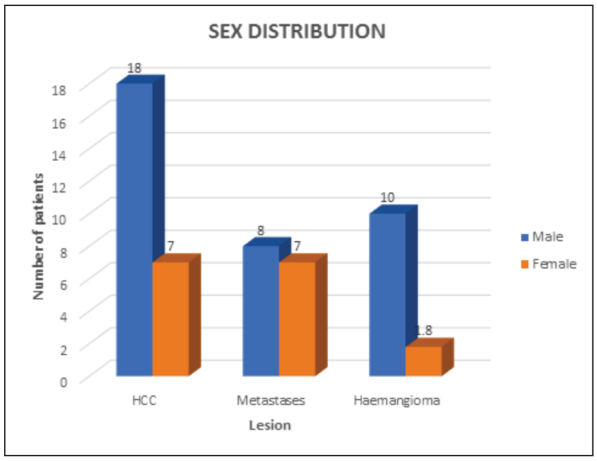


Chart 2: Distribution Of Lesions According To Sex

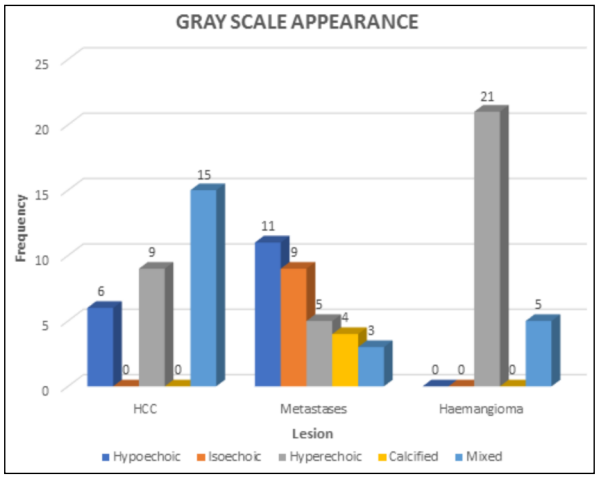


Chart 3: Distribution Of Lesions According To Gray Scale Appearance

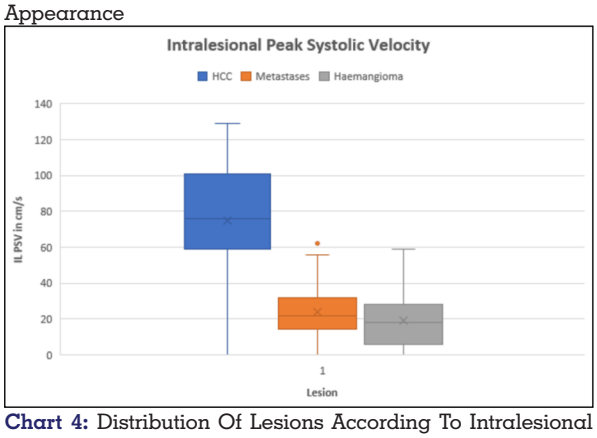


Chart 4: Distribution Of Lesions According To Intralesional Peak Systolic Velocity

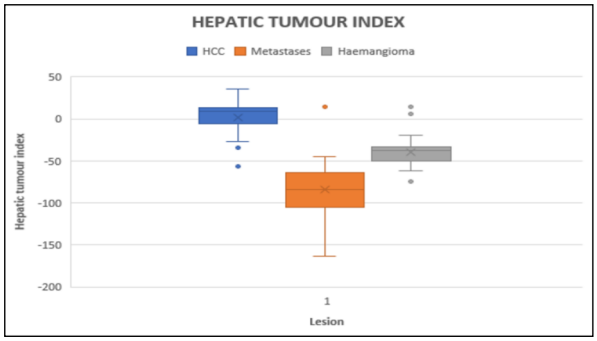


Chart5 : Distribution Of Lesions According To Hepatic Tumour Index

Differentiation Of HCC By Combining ILF, ILPSV, CHAPSV And TI

HCC	HPE		Total
	+	-	
Doppler +	25	3	28
Doppler -	5	55	60
Total	30	58	88

p=0.001, NS

PARAMETERS	%	CONFIDENCE LIMIT
Sensitivity	83.3	65-94%
Specificity	94.8	86-99%
Concordance	90.9	79-97%
Discordance	9.1	3-21%
Positive predictive value	89.3	72-98%
Negative predictive value	91.7	82-98%
False positive rate	5.2	1-14%
False negative rate	16.7	6-35%

Differentiation Of Metastases By Combining ILF, ILPSV, CHAPSV And TI

Metastases	HPE		Total
	+	-	
Doppler +	28	1	29
Doppler -	4	55	59
Total	32	56	88

p=0.001, NS

PARAMETERS	%	CONFIDENCE LIMIT
Sensitivity	87.5	71-97%
Specificity	98.2	91-100%
Concordance	94.3	91-100%
Discordance	5.7	1-15%
Positive predictive value	96.5	82-100%
Negative predictive value	93.2	84-98%
False positive rate	1.8	0-9%
False negative rate	12.5	3-29%

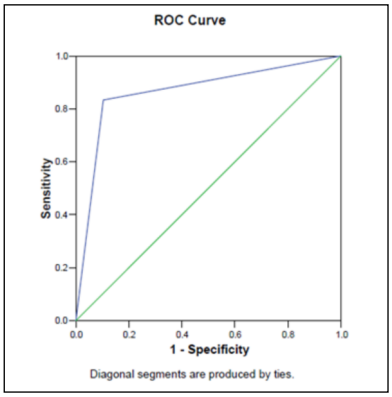
Differentiation Of Hemangioma By Combining ILF, ILPSV, CHAPSV And TI

Haemangioma	CECT		Total
	+	-	
Doppler +	23	8	31
Doppler -	3	54	57
Total	26	62	88

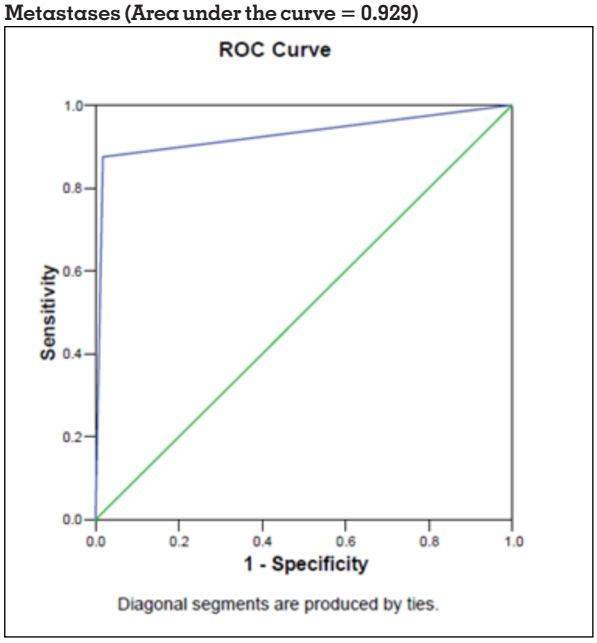
p=0.001, NS

PARAMETERS	%	CONFIDENCE LIMIT
Sensitivity	88.5	70-98%
Specificity	87.1	76-94%
Concordance	87.5	76-93%
Discordance	12.5	7-24%
Positive predictive value	74.2	55-88%
Negative predictive value	94.7	85-99%
False positive rate	12.9	6-24%
False negative rate	11.5	2-30%

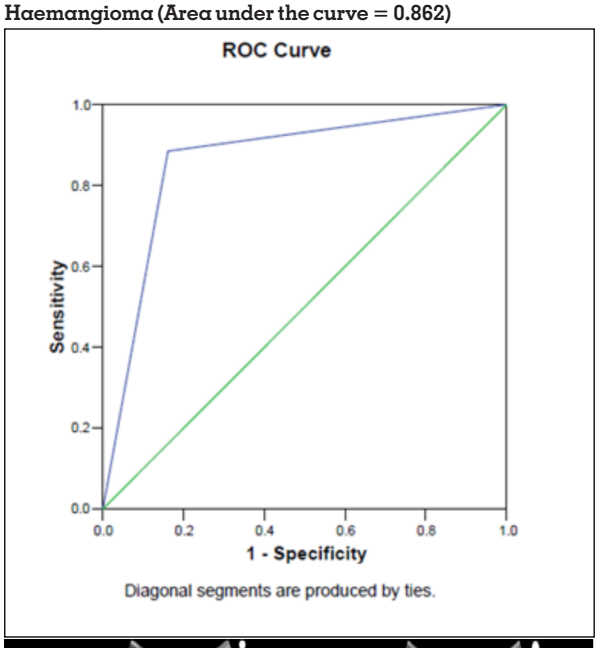
HCC (Area under curve = 0.891)



Metastases (Area under the curve = 0.929)



Haemangioma (Area under the curve = 0.862)



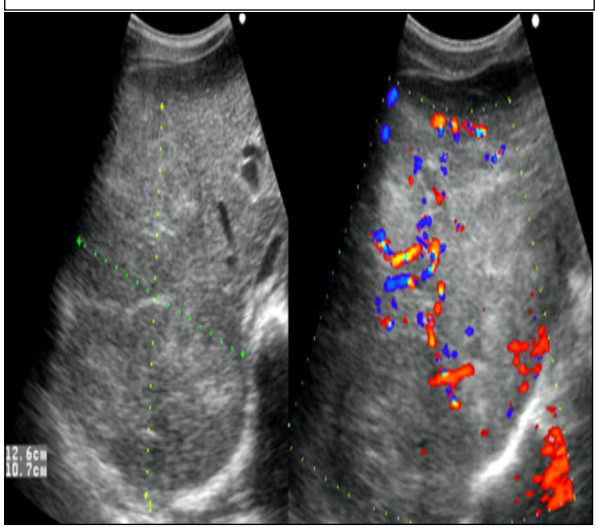


Figure 1: Large Mix Echogenic HCC With Increased Intralesional Flow

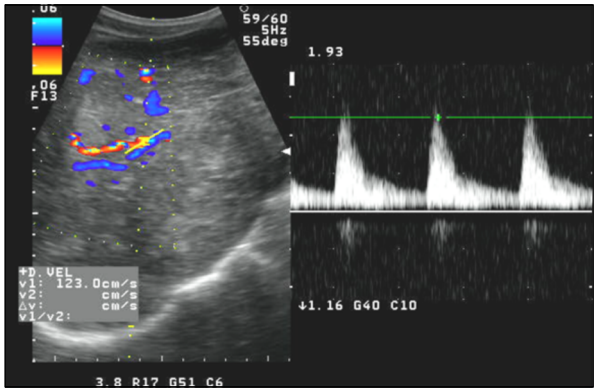


Figure 2: Pulsatile Intralesional Flow With ILPSV > 40 cm/s In HCC

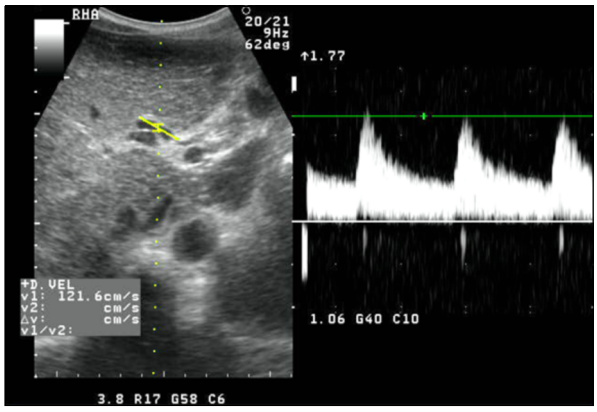


Figure 3: Increased CHA PSV But Less Than ILPSV In Same HCC Patient In Figure 2

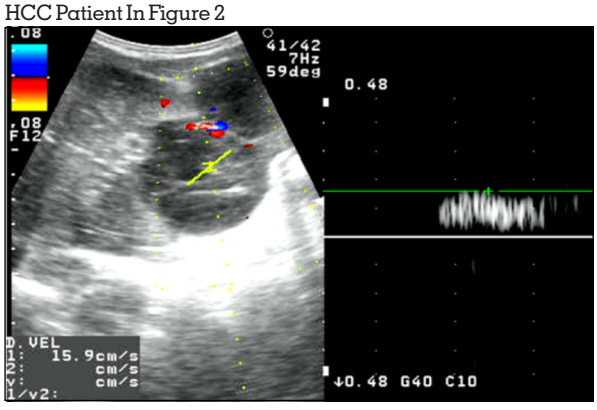


Figure 4: Minimal Continuous Intralesional Flow With PSV < 40 cm/s In Hypoechoic Hepatic Metastasis

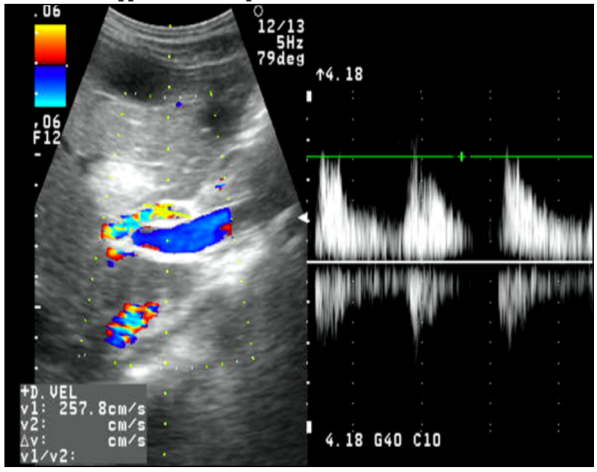


Figure 5: Highly elevated CHA PSV In Same Hepatic Metastasis Patient In Figure 4

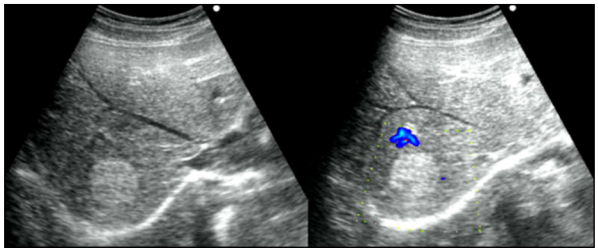


Figure 6: Hyperechoic Haemangioma With No Intralesional Flow

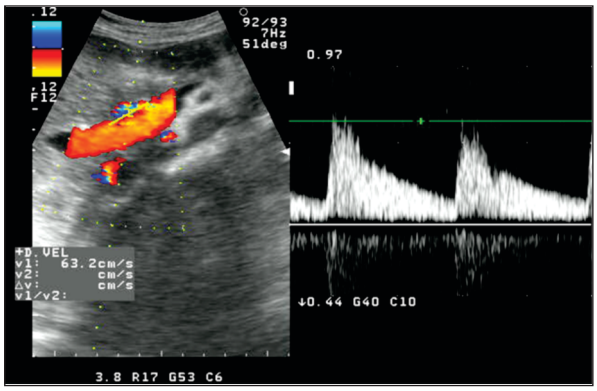


Figure 7: Normal CHA Colour Flow And Spectral Waveform In Same Haemangioma Patient In Figure 6.

Acknowledgments

1. Dept Of Radiodiagnosis, Government Medical College, Nagpur
2. Department Of Surgery And Pathology, Government Medical College, Nagpur
3. Department Of Gastroenterology, Super Speciality Hospital, Government Medical College, Nagpur

Conflicts Of Interest Statement: None

Funding: None

REFERENCES:

1. Low VHS. Textbook of Gastrointestinal Radiology, 2nd ed. Am J Roentgenol. 2001 Feb;176(2):392–392.
2. Di Bisceglie AM, Rustgi VK, Hoofnagle JH, Dusheiko GM, Lotze MT. NIH conference. Hepatocellular carcinoma. Ann Intern Med. 1988 Mar;108(3):390–401.
3. Sinha SN. Hepatocellular carcinoma--an update. P N G Med J. 1985 Jun;28(2):83–8.
4. Lemoine A, Azoulay D, Jezequel-Cuer M, Debuire B. [Hepatocellular carcinoma]. Pathol Biol (Paris). 1999 Nov;47(9):903–10.
5. Kinkel K, Lu Y, Both M, Warren RS, Thoeni RF. Detection of Hepatic Metastases from Cancers of the Gastrointestinal Tract by Using Noninvasive Imaging Methods (US, CT, MR Imaging, PET): A Meta-Analysis. Radiology. 2002 Sep;224(3):748–56.
6. Grace RH, Hale M, Mackie G, Marks CG, Bloomberg TJ, Walker WJ. Role of ultrasound in the diagnosis of liver metastases before surgery for large bowel cancer. Br J Surg. 1987 Jun 1;74(6):480–1.
7. Margulis AR, Burhenne HJ. Alimentary tract radiology. Fourth edition. 1989 Jan 1 [cited 2022 Mar 27]; Available from: https://www.osti.gov/biblio/5322452-alimentary-tract-radiology-fourth-edition
8. Numata K, Tanaka K, Mitsui K, Morimoto M, Inoue S, Yonezawa H. Flow characteristics of hepatic tumors at color Doppler sonography: correlation with arteriographic findings. AJR Am J Roentgenol. 1993 Mar;160(3):515–21.
9. Wang YF, Zhang QP. A study of blood supply of liver tumors using duplex Doppler ultrasound and color Doppler flow imaging. J Tongji Med Univ Tong Ji Yi Ke Xue Xue Bao. 1993;13(1):18–22.
10. Kudo M, Tochio H, Zhou P. Differentiation of hepatic tumors by color Doppler imaging: role of the maximum velocity and the pulsatility index of the intratumoral blood flow signal. Intervirology. 2004;47(3–5):154–61.
11. Nino-Murcia M, Ralls PW, Jeffrey RB, Johnson M. Color flow Doppler characterization of focal hepatic lesions. AJR Am J Roentgenol. 1992 Dec;159(6):1195–7.
12. Yasuhara K, Kimura K, Ohto M, Matsutani S, Ebara M, Tsuchiya Y, et al. Pulsed Doppler in the diagnosis of small liver tumours. Br J Radiol. 1988 Oct;61(730):898–902.