ORIGINAL RESEARCH

Triphasic Evaluation of Focal Hepatic Lesions on Contrast MDCT Study

Aseem Kaushal[1], Prabh Preet Singh[2], Nitin Goyal,[3] Ajay Kumar[4], Surya Rana[5]

[1]Assistant Professor, Department of Radiology, Adesh Medical College and Hospital, Haryana

[2]Assistant Professor, Department of Radiology, Adesh Medical College and Hospital, Haryana

[3]Associate Professor, Department of Radiology, Adesh Medical College and Hospital, Haryana

[4]Post graduate resident, Department of Radiology, Adesh Medical College and Hospital, Haryana

[5]M.B.B.S Second Year, Adesh Medical College and Hospital, Haryana

ABSTRACT

Background: In this study, we wanted to study the role of triphasic contrast multi detector computed tomography (MDCT) scan in diagnosis of focal hepatic lesions and enhancement patterns of various focal hepatic lesions on triphasic contrast MDCT scan.

Methods: This was a hospital based prospective study conducted among 96 patients who presented with suspected focal hepatic lesions or those suspected or diagnosed with other imaging modalities to the Department of Radiology, Adesh Medical College and Hospital, Mohri, over a period of 6 months from 1st March 2022 to 31st August 2022 after obtaining clearance from Institutional Ethics Committee and written informed consent from the study participants.

Results: Male preponderance (57.2 %) was seen compared to females (42.8 %) with a sex ratio of 1.3 : 1. 57 (59.3 %) were malignant and 39 (40.7 %) were benign. 47.4 % of the hemangiomas were seen in age group of 30 - 39 years, out of the total 19 cases. Male preponderance was seen in hepatocellular carcinoma (HCC) (85.7 %), metastases (55 %), cholangiocarcinoma (66.7 %), simple hepatic cyst (53.8 %) and abscess (60 %). Female preponderance was seen in haemangioma (63.2 %). Out of the total 345 lesions, 213 were hypo vascular lesions accounting for 61.8 % of the cases and 132 were hyper vascular lesions accounting for 38.2 % of the lesions. Out of the 213 hypo vascular lesions, benign lesions included cysts (28.6 %), abscess (5.7 %) and haemangioma (3.8 %). Malignant hypo vascular lesions included metastases (61.9 %). Out of the 132 hyper vascular lesions, benign lesions included haemangioma (47.8 %). Malignant lesions included HCC (50 %) and intrahepatic cholangiocarcinoma (2.2 %). The most common primary site for hepatic metastases was gall bladder (50 %) followed by lung (25 %) and colorectal carcinoma (7.5 %). No visible enhancement was seen in simple hepatic cysts on hepatic arterial phase (HAP, PVP) and delayed phase and the lesions remained hypo dense in all the phases.

Conclusion: Focal hepatic lesions are not uncommon in daily radiological practice. Triphasic contrast MDCT substantiates to be a helpful modality in the diagnosis of focal hepatic lesions by studying their pattern of enhancement in hepatic arterial, portal venous and delayed phase and hence facilitates in better characterization of the lesion. Furthermore, the better lesion to liver parenchymal attenuation difference achieved with different phases on post contrast CT also helps in increasing the conspicuity of lesions. On hepatic arterial phase, hyper vascular lesions are better delineated with

hypo vascular lesions being more definable on portal venous phase. Delayed phase is very helpful in detection of haemangioma which shows characteristic peripheral globular enhancement with progressive centripetal filling. It also has a crucial role in detecting cholangiocarcinoma. Moreover, MDCT decreases scanning time and consequently diminishing respiration artefacts. MDCT also enables enhanced spatial resolution and 3D reconstructions. Acquisition of very thin collimation scan provides improved detection rate of small liver lesions.

Keywords: Triphasic Evaluation, Focal Hepatic Lesions, Contrast MDCT.

Corresponding Author: Dr Aseem Kaushal, Assistant Professor, Department of Radiology, Adesh Medical College and Hospital, Haryana

INTRODUCTION

A focal hepatic lesion is defined as any discrete lesion in the liver with or without causing structural and functional abnormality. Differentiating the lesion primarily into benign and malignant and then further characterization is vital, with there being a broad list of differential diagnosis. Complex diffuse diseases like cirrhosis and chronic viral infections also affect it. An understanding of the classic imaging appearances of focal hepatic lesions allows more definitive diagnosis and shortens the diagnostic work up. A pre-operative diagnosis can be reached with an imaging technique which would have high sensitivity, high specificity and accessibility. This is necessary as many lesions are benign non-surgical lesions, like simple hepatic cyst or haemangioma. Moreover, with advanced imaging techniques, high frequency of focal hepatic lesions is being detected. Thus, it is essential to characterize the lesions into those that need further evaluation/treatment and those that do not. The technique of imaging liver with a CT protocol in three phases of hepatic arterial phase, portal venous phase and delayed phase is hence valuable. Triphasic evaluation of focal hepatic lesions on contrast MDCT has become the primary imaging modality for detection and characterization. Detection and evaluation of lesions with triphasic protocol is done by observing enhancement in different phases and also noting the phase of maximum difference in attenuation between the lesion and normal parenchyma. Besides with MDCT, there is faster scanning, which decreases respiration artefacts and improves imaging. MDCT also permits improved spatial resolution, allowing high quality multiplanar reconstructions and 3D reconstructions. Acquisition of very thin collimation scan provides improved detection rate of small liver lesions. This grants MDCT an advantage over MRI. The purpose of this study is to assess the role of MDCT in detecting and characterization of focal hepatic lesions depending on their pattern of enhancement on post contrast studies.

Aims and Objectives

To study the role of triphasic contrast MDCT scan in diagnosis of focal hepatic lesions.
To study the role of triphasic contrast MDCT scan in differentiation of focal hepatic lesions.
To study the enhancement patterns of various focal hepatic lesions on triphasic contrast MDCT scan.

MATERIALS AND METHODS

This was a hospital based prospective study conducted among 96 patients who presented with suspected focal hepatic lesions or those suspected or diagnosed with other imaging modalities to the Department of Radiology, Adesh Medical College and Hospital, Mohri, over a period of 6 months from 1st March 2022 to 31st August 2022 after obtaining clearance from Institutional Ethics Committee and written informed consent from the study participants.

Inclusion Criteria
Patients of any age group having clinical suspicion of focal liver disease.
Patients of any age group with suspected or proved focal liver lesions with non-specific appearance by other imaging modalities.

Exclusion Criteria
All pregnant women with suspected liver disease.
All patients with hypersensitivity to contrast agents.
All patients in whom CT is contraindicated due to any other reason.

Statistical Methods
Data was entered in MS Excel and analyzed using Statistical Package for Social Sciences (SPSS) software. Results were presented as tables**.**

RESULTS

Table 1: Demographic Distribution

	Age Group	**No. of Cases**	**Percentage (%)**
Age distribution of patients	10 - 19 years	03	3.2
	20 - 29 years	01	1.0
	30 - 39 years	14	14.6
	40 - 49 years	13	13.6
	50 - 59 years	23	23.9
	60 - 69 years	22	22.9
	70 - 79 years	13	13.5
	80 - 89 years	07	7.3
	Total	96	100
Gender distribution of patients	Gender	Number	Percentage
	Male	55	57.2 %
	Female	41	42.8 %
	Total	96	100 %

Table 2: Spectrum of Focal Hepatic Lesions – Benign vs Malignant

Diagnosis	**Number of Cases**	**Percentage**
Abscess	05	5.4 %
Metastases	40	41.6 %
Haemangioma	19	19.8 %
HCC	14	14.6 %
Simple cyst	13	13.5 %
Hydatid cyst	02	2 %
Cholangiocarcinoma	03	3.1 %
Total	96	100
Spectrum of Focal Hepatic Lesions		
Nature of Lesion	Number of Lesions	Percentage
Benign	39	40.7 %
Malignant	57	59.3 %
Total	96	100 %

The most common age group was in the range 50 - 59 years (23.9 % cases). This was followed by the age range of 60 - 69 years (22.9 % cases). Male preponderance (57.2 %) was seen compared to females (42.8 %) with a sex ratio of 1.3: 1. The most common malignant lesion was metastases accounting for 40 cases (41.6 %), however the most common primary malignant lesion was HCC, accounting for 14 (14.6 %). Intra-hepatic cholangiocarcinoma was seen in 3 (3.1 %) patients. The most common benign lesion was haemangioma, comprising 19 (19.8 %) of the total lesions, followed by simple hepatic cyst, accounting for 13 (13.5 %) of the cases. Abscess was seen in 5 (5.4 %) cases and hydatid cyst was seen in 2 (2 %) cases. Out of 96 cases, 57 (59.3 %) were malignant and 39 (40.7 %) were benign. The malignant lesions included metastases, hepatocellular carcinoma and intrahepatic cholangiocarcinoma. The benign lesions included abscess, simple hepatic cyst, haemangioma, and hydatid cyst.

Table 3: Distribution of Benign and Malignant Hyper-vascular Lesions

Lobe Involved	**Number (n = 96)**	**Percentage**
Right lobe	38	39.6 %
Left lobe	07	7.3 %
Both lobes	51	53.1 %
Lobar Distribution of Lesions		
Characteristic	Number	Percentage
Hypo vascular lesions	213	61.8 %
Hyper vascular lesions	132	38.2 %
Total	345	100 %
Distribution of Hyper-vascular vs Hypo-vascular Lesions of the Total Liver Lesions		
Hypo-vascular Lesions	Number	Percentage
Abscess	12	5.7 %
Haemangioma	08	3.8 %
Cysts	61	28.6 %
Metastases	132	61.9 %
Total	213	100 %
Distribution of Benign and Malignant Hypo-vascular Lesions		
Hyper-vascular Lesions	Number	Percentage
Haemangioma	63	47.8 %
HCC	66	50 %
Cholangiocarcinoma	3	2.2 %
Total	132	100 %

Focal hepatic lesions are grossly divided into hyper-vascular lesions and hypo-vascular lesions, based on the enhancing pattern in hepatic arterial phase. Out of the total 345 lesions, 213 were hypo-vascular lesions accounting for 61.8 % of the cases and 132 were hyper-vascular lesions accounting for 38.2 % of the lesions. Out of the 213 hypo-vascular lesions, benign lesions included cysts (28.6 %), abscess (5.7 %) and haemangioma (3.8 %). Malignant hypo-vascular lesions included metastases (61.9 %). Out of the 132 hyper-vascular lesions, benign lesions included haemangioma (47.8 %). Malignant lesions included HCC (50 %) and intrahepatic cholangiocarcinoma (2.2 %).

Table 4: Distribution of Hyper-vascular Lesions on Each PhaseRrelative to the Size of the Lesions

Hypo-vascular Lesions (n = 213)	**NECT**			**HAP**			**PVP**		
	NV	WV	EV	NV	WV	EV	NV	WV	EV
< 1cm (n = 66)	29	37	00	23	42	01	00	54	12
1 - 3cm (n = 102)	30	70	02	20	82	00	00	12	90
3cm (n = 45)	00	45	00	00	28	17	00	39	06
Distribution of Hypo-vascular Lesions on Each Phase Relative to the Size of the Lesions									
Hyper-vascular Lesions (n = 132)	NECT			HAP			PVP		
	NV	WV	EV	NV	WV	EV	NV	WV	EV
< 1cm (n = 27)	22	05	00	00	02	25	12	15	00
1 - 3 cm (n = 64)	34	30	00	00	00	64	10	34	20
3cm (n = 41)	00	41	00	00	00	41	00	30	11
NECT: Non enhanced contrast CT, HAP: hepatic arterial phase, PVP: portal venous phase. NV: not visualized, WV: well visualized, EV: excellent visualisation									
NECT: Non enhanced contrast CT, HAP: hepatic arterial phase, PVP: portal venous phase. NV: not visualized, WV: well visualized, EV: excellent visualisation									

Among the hypo-vascular lesions, a noteworthy difference was seen in number of lesions that were identified between PVP and other phases when the lesions were < 1cm and 1 – 3 cm in size. However, lesions > 3cm in size were visualised on all phases. The conspicuity of hypo-vascular lesions was higher on PVP than on other phases when the lesions were < 1cm and 1 - 3cm in size. No significant difference was noted when the lesions were > 3cm in size.
Among hyper-vascular lesions, a large number of lesions were seen on HAP than other phases when the lesions were < 1 cm and 1 - 3cm. However, lesions > 3cm in size were visualised on all phases. The conspicuity of hyper-vascular lesions was higher on HAP than on other phases when lesions were < 1 cm and 1 - 3 cm in size.

Table 5: Primary Sites for Metastases

Site of Primary	**No. of Patients (n = 40)**
Gall bladder	20 (50 %)
Pancreas	2 (5 %)
Stomach	1 (2.5 %)
Ca ovary	1 (2.5 %)
Colorectal carcinoma	3 (7.5 %)
Cholangiocarcinoma	1 (2.5 %)
Lung	10 (25 %)
Unknown	2 (5 %)

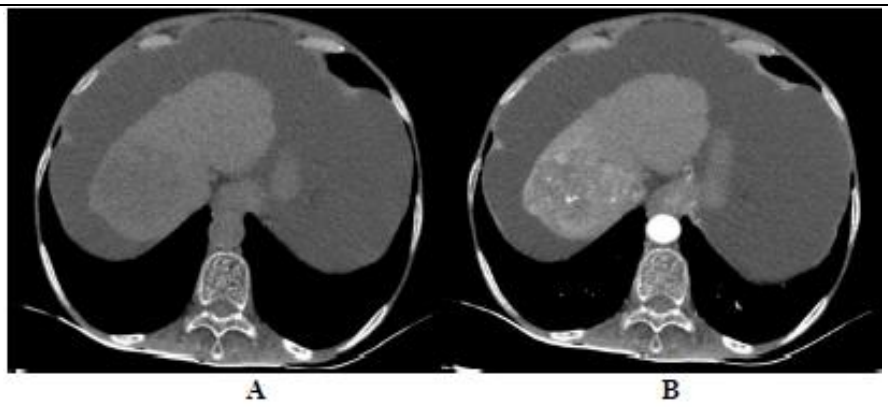
The most common primary site for hepatic metastases was gall bladder (50 %) followed by lung (25 %) and colorectal carcinoma (7.5 %).

Table 6: Enhancement Pattern in Simple Hepatic Cyst

Phase	**Hypo Dense**	**Hyper Dense**			**Iso Dense**	**Total**
		Homogeneous	**Heterogeneous**	**Peripheral**		
HAP	0	2 (14.3 %)	12 (85.7 %)	0	0	14
PVP	6 (42.8 %)	0	4 (28.6 %)	2 (14.3 %)	2 (14.3 %)	14
Enhancement Pattern of HCC on HAP and PVP						
Phase	Iso	Hypo	Uniformly	Peripheral	Peripheral	Total

			Hyper	Globular		
HAP	-	-	-	17 (89.4 %)	02 (10.6 %)	19
PVP	-	-	1 (5.1 %)	18 (94.9 %)	-	19
Delayed	-	-	19 (100 %)	-	-	19
Enhancement Pattern of Haemangioma						
Phase		Hypo Dense	Hyper Dense	Iso Dense	Total	
HAP		13 (100 %)	-	-	13	
PVP		13 (100 %)	-	-	13	
Delayed		13 (100 %)	-	-	13	

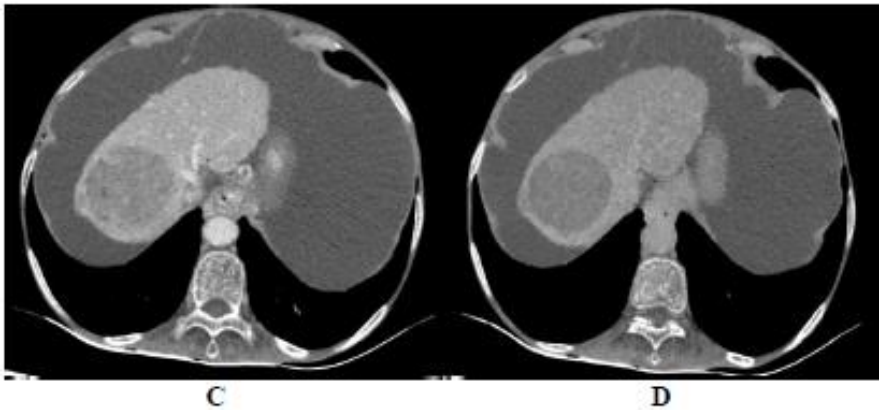
All the lesions (100 %) showed enhancement in HAP and 6 lesions showed enhancement in PVP (42.9 %). All the lesions appeared hypo-dense to liver parenchyma on delayed phase. No visible enhancement was seen in simple hepatic cysts on HAP, PVP and delayed phase and the lesions remained hypo-dense on all phases.



A B

A) NECT: Well defined hypodense lesion in a cirrhotic liver

B) HAP: Heterogeneous enhancement of the lesion

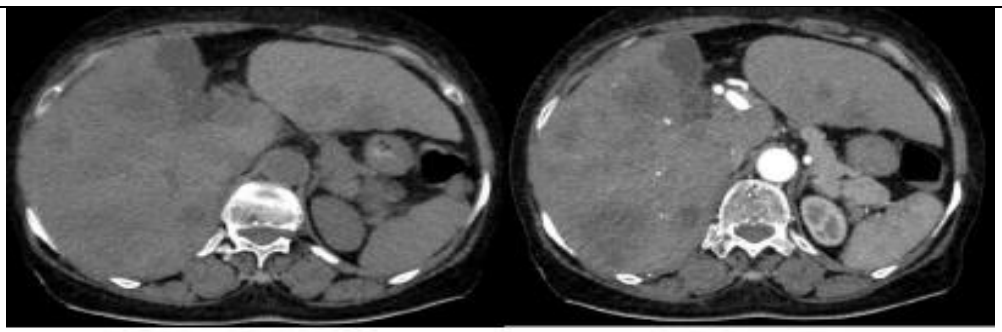


C D

C) PVP: Contrast washout with lesion hypodense to liver

D) Delayed: Lesion hypodense to liver parenchyma

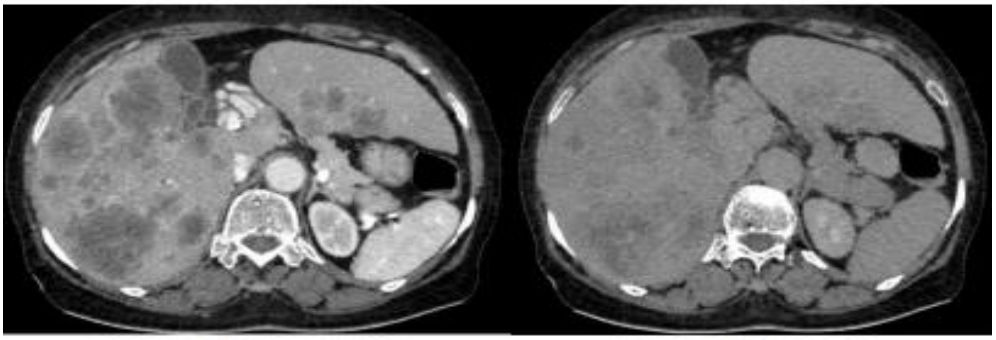
Figure :Hepatocellular carcinoma



A B

A) NECT: Multiple hypodense lesions involving both lobes

B) HAP: Faint peripheral enhancement

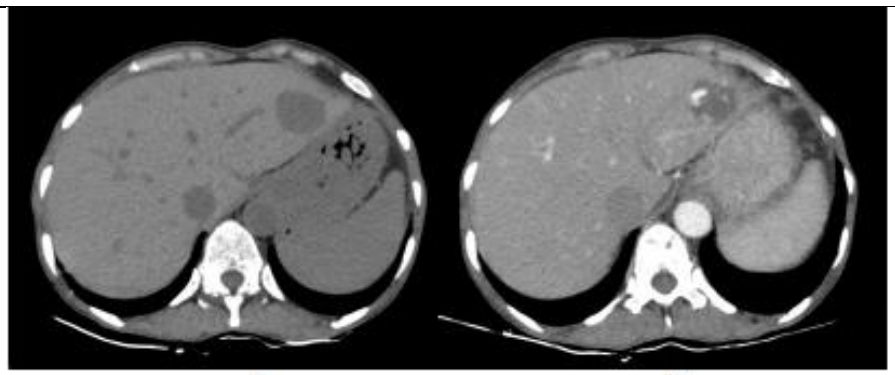


C D

C) PVP: Peripheral enhancement of lesions with central hypodensity

D) Delayed: All lesions hypodense to liver parenchyma

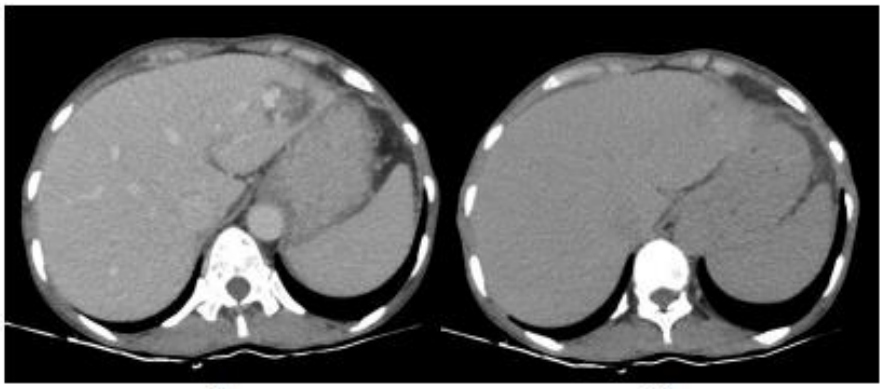
Figure 2:Metastases



A B

A) NECT: Well defined hypodense lesion in left lobe of liver

B) HAP: Peripheral globular enhancement



C D

C) PVP and D) Delayed: Progressive central fill-in with lesion appearing isodense on delayed phase. Note the isoattenuation of the lesion enhancement to aorta in all phases.

Figure 3:Hemangioma

DISCUSSION

The most common lesion in our study was metastases which accounted for 41.6 % of the cases. The second most common lesion was haemangioma comprising 19.8 % of the cases followed by HCC which constituted 14.6 % of the total 96 cases. A study conducted by Leeuwen et al. (1996),[1] on 104 patients showed that metastases was the most common lesion accounting for 37 %, followed by haemangioma which accounted for 32 % of the cases. The spectrum of lesions encountered in our study thus correlated with his observations. In the present study, malignant lesions were more common constituting 59.3 % of the total cases with benign causes being 40.7 %. Similar incidence of distribution of pathologies was noted in studies by Ji Hyun Yauk et al. and Hong Ding et al. who also found more incidences of malignant lesions as compared to benign. In the present study, involvement of both lobes was present in 53.1 % of cases (51 out of 96). Rest of the 46.9 % of cases were noted involving

either lobe, among which 39.6 % (38 out of 96) were involving right side and 7.3 % (07 out of 96) involving left side. In the study by Dr. Divya Bagoria et al. (2017),[2] both lobes were involved in 42 % of the cases, left lobe in 20 % of the cases and right lobe in 38% of the cases. In the present study, out of the total 345 lesions, 61.8 % were hypo-vascular and 38.2 % were hyper-vascular. A study conducted by Leeuwen et al. (1996) on 326 focal hepatic lesions also revealed more hypo-vascular lesions (61 %). Miller et al. (1998),[3] in their study showed more hypo-vascular lesions (84.9 %) as compared to hyper-vascular lesions (15.1 %). In the present study, which included 213 hypo-vascular lesions, the most common were metastases (61.2 %). Leeuwen et al. (1996) and Miller et al. (1998) also showed metastases to be the most common hypo-vascular lesions. The study by Miller et al. (1998) on 88 hyper-vascular lesions, showed metastases from hyper-vascular malignancies to be the most common lesion. This disagreement is possibly due to a shorter period of our study. Miller et al. (1998) conducted a study on suspected or known cases of focal malignant lesions and grouped the lesions as < 1 cm, 1 - 2 cm, 2 – 3 cm and > 3 cm. They depicted a notable difference in visualization of hypo-vascular lesions between PVP and other phases when the size of the lesion was < 2 cm. It was also seen that the conspicuity of the hypo-vascular lesions was higher on the PVP than on other phases when the lesions were < 3 cm. In patients with hyper-vascular lesions, the lesions were more conspicuous on the HAP than in other phases when the lesions were < 2 cm. This outcome correlated with our study. Soyer P et al. (2004),[4] in their study on 32 proven cases of metastases revealed that portal venous phase depicted more hypo-vascular metastases. Isaac R. Francis et al. (2003),[5] did a study on 52 patients with known or suspected hepatic tumours which demonstrated that maximal tumour-to-parenchyma differences for hypo-vascular lesions are achieved on PVP images. The above mentioned studies are in consonance with our findings. In our study, the size of HCC ranged from 2.2 – 14 cm with a mean of 5.9 cm. Matilde et al. (2000),[6] in their study found lesions that ranged from 1 - 14.3 cm with a mean of 5.2 cm, which correlates with our study. K.H.Y Lee et al. (2004),[7] in their study on HCC, found lesions ranging from 1 - 17.7 cm with a mean of 7.5 cm. In a study by Choi et al. (1996),[8] on 48 patients, the mean size of the lesion was 3 cm with a range of 5 – 125 mm. The difference in findings is likely due to short period of study time. In the present study, all of the lesions were hyper-dense on hepatic arterial phase. June Cho Sik et al. (1996) in their study which included 84 HCCs showed 87 % of the lesions were hyper-dense, 6 % were hypo-dense and 7 % were iso-dense on hepatic arterial phase, which is in concordance with our study. In our study comprising of 14 cases of HCC, 42.8 % of the cases showed hypo-density on portal venous phases, 42.9 % and 14.3 % were hyper-dense and iso-dense respectively. June Cho Sik et al. (1996) also has reported that around 39 % of tumours are hypo-dense though he reported larger percentage of tumours which were iso-dense on portal phase. While evaluating for enhancement pattern of metastases on hepatic arterial phase, the lesions were categorized as hypo-dense, showing homogeneous enhancement, mixed, peripheral enhancement and iso-dense to the liver parenchyma. Most common pattern that we came across was hypo-dense lesions which accounted for 75 %, followed by peripheral enhancement which comprised 25 % of the cases. This pattern correlated with study conducted by Honda et al. (1992),[9] who found 60.9 % of the lesions hypo-dense and 28.6 % showing peripheral enhancement. In our study, 55 % of the lesions were hypo-dense on portal venous phase followed by 25 % which showed peripheral enhancement. According to Honda et al. (1992), 57.2 % were hypo-dense which the most common pattern was. In our study, out of the 40 cases of metastases, the most common primary site was gall bladder (50 %), followed by lung (25 %) and colorectal carcinoma (7.5 %). Matilde et al. (2000) conducted a study on 53 cases of metastases which showed that the most common primary site was colorectal carcinoma (32 %) followed by

pancreas (20.7 %). Leeuwen et al. (1996) in their study showed colorectal carcinoma (62 %) to be the most common primary site with second most common site being pancreas (5.1 %). In our study, the size of haemangioma ranged from 2 – 9 cm with a mean of 4.4 cm. Quinn et al. (1992),[10] in their study revealed haemangioma in 21 patients with size ranging from 1.5 – 11 cm with a mean of 4.6 cm. Matilde et al. (2000) in their study found lesions that ranged from 1 - 14.3 cm with a mean of 5.2 cm. Leslie et al. (1995),[11] in their study on haemangioma, found lesions ranging from 1 – 20 cm with a mean of 4 cm. Thus the above mentioned studies correlate with our study. In our study of 19 cases of haemangioma, most common pattern of enhancement on hepatic arterial phase was found to be peripheral globular enhancement (89.4 %). This correlated with the study of Honda et al. (1992), who in their study of 39 cases of haemangioma found peripheral globular enhancement to be the most common pattern in 56.6 % of cases. Matilde et al. (2000) conducted a study on 9 cases of haemangioma to find peripheral globular enhancement pattern being most common and seen in 88.9 % of cases. In our study on 3 cases of intrahepatic cholangiocarcinoma, the age range of patients was between 41 - 55 years with a mean age of 48 years. In a study conducted by LacomisJM et al. (1997),[12] the mean age was 56.5 years with a range of 30 - 81 years. In another study conducted by N Fujita et al. (2017),[13] the mean age was 64.6 years with a range of 39 - 82 years, which is higher than the mean age in our study group. In our study of 13 cases of simple hepatic cyst, no internal or wall enhancement was noted on HAP, PVP and delayed phases involving all the lesions. Leeuwen et al. (1996) in their study on 13 cases depicted a hypo/hypo/hypo pattern of enhancement which signified no enhancement on all three phases. Dr. DivyaBhagoria et al. (2017) in their study showed that simple cysts appear as non-enhancing hypo-dense lesions with smooth margins. D. Mathieu et al. (1985),[14] did a study on 38 patients with liver abscess. In 36 patients (94.7 %), the abscess had a central hypo-dense area surrounded by a peripheral enhancing ring. In 12 out of the 36 patients (33.3 %), there was poorly defined hypo-dense area surrounding the enhancing peripheral ring. Murphy BJ et al. (1989),[15] in their study stated that pyogenic abscess shows “double target sign” which consists of an inner enhancing ring within the lesion and a second, outer ring of greater attenuation than the normal liver surrounding the abscess cavity. BaeJu Kwon et al. (2001),[16] studied 26 cases of liver abscess and found that the characteristic enhancement feature of liver abscesses is three or four layers during the arterial and portal phases, with reduction to two layers during the delayed phase. In the present study, we got 2 cases of hydatid cyst of age 27 years and 70 years. Both patients were male. Both patients underwent CT due to indications not related to the hepatic lesion. De Diego Choliz J et al. (1982),[17] in his study on 50 cases with hydatid cyst had 21 males and 29 females, who aged 15 - 77 years with a mean age of 46 years. Naik S et al. (2017),[18] reported four cases of hydatid cyst in patients ranging from 11 - 43 years with a mean age of 28.2 years. 3 of the 4 patients were males and 1 was female. Sarwagi AK et al. (2018),[19] studies 25 patients ranging from 14 - 72 years old with maximum number of patients in age group of 31 - 40 years (32 %). 14 patients were males (56 %) and 11 were females (44 %). In the present study, both lesions were hypo-dense on NECT and showed peripheral rim calcification. No enhancement was noted on HAP, PVP and delayed phases in both cases. Murphy BJ et al. (1989) in their study found the attenuation of hydatid cysts less than liver. 50 % of the lesions showed peripheral calcifications. 100 % of the lesions showed no contrast enhancement, which is similar to our study. J de Diego Choliz et al. (1982) found calcification in 11 cases (22 %). He depicted a hyper-vascular border surrounding all the lesions which increased their conspicuity. Cicero G et al. (2017),[20] reported a case of hydatid cyst in a 68 year old male. CT findings of the case revealed a hypo-dense lesion showing wall calcification.

CONCLUSION

Focal hepatic lesions are not uncommon in daily radiological practise. Triphasic contrast MDCT substantiates to be a helpful modality in the diagnosis of focal hepatic lesions by studying their pattern of enhancement in hepatic arterial, portal venous and delayed phase and hence facilitates in better characterization of the lesion. Furthermore, the better lesion to liver parenchymal attenuation difference achieved with different phases on post contrast CT also helps in increasing the conspicuity of lesions. On hepatic arterial phase, hyper-vascular lesions are better delineated with hypo-vascular lesions being more definable on portal venous phase. Delayed phase is very helpful in detection of haemangioma which shows characteristic peripheral globular enhancement with progressive centripetal filling. It also has a crucial role in detecting cholangiocarcinoma. Moreover, MDCT decreases scanning time and consequently diminishing respiration artefacts. MDCT also enables enhanced spatial resolution and 3D reconstructions. Acquisition of very thin collimation scan provides improved detection rate of small liver lesions.

REFERENCES

1. Van Leeuwen MS, Noordzij J, Feldberg MA, Hennipman AH, Doornewaard H. Focal liver lesions: characterization with triphasic spiral CT. Radiology 1996;201(2):327-36.
2. Bagoria D, Mathur R, Gupta A, Choudhary S, Pamnani J. Role of triphasic CT in evaluation of focal liver lesions. Int J Curr Res 2017;9(03):48075-8.
3. Miller FH, Butler RS, Hoff FL, Fitzgerald SW, Nemcek AA, Gore RM. Using triphasic helical CT to detect focal hepatic lesions in patients with neoplasms. Am J Roentgenol 1998;171(3):643-9.
4. Soyer P, Poccard M, Boudiaf M, Abitbol M, Hamzi L, Panis Y, et al. Detection of hypovascular hepatic metastases at triple-phase helical CT: sensitivity of phases and comparison with surgical and histopathologic findings. Radiology 2004;231(2):413-20.
5. Francis IR, Cohan RH, McNulty NJ, Platt JF, Korobkin M, Gebremariam A, et al. Multidetector CT of the liver and hepatic neoplasms: effect of multiphasic imaging on tumor conspicuity and vascular enhancement. Am J Roentgenol 2003;180(5):1217-24.
6. Nino-Murcia M, OlcottEW, Jeffrey RB, LammRL, Beaulieu CF, Jain KA. Focal liver lesions: pattern-based classification scheme for enhancement at arterial phase CT. Radiology 2000;215(3):746-51.
7. Lee KHY, O'Malley ME, Haider MA, Hanbidge A. Triple-phase MDCT of hepatocellular carcinoma. Am J Roentgenol 2004;182(3):643-9.
8. Cho JS, Kwag JG, Oh YR, Han SD, Song CJ. Detection and characterization of hepatocellular carcinoma: value of dynamic CT during the arterial dominant phase with uniphasic contrast medium injection. J Comput Assist Tomogr 1996;20(1):128.
9. Honda H, Matsuura Y, Onitsuka H, Murakami J, Kaneko K, Murayama S, et al. Differential diagnosis of hepatic tumors (hepatoma, hemangioma, and metastasis) with CT: value of two-phase incremental imaging. Am J Roentgenol 1992;159(4):735-40.
10. Quinn SF, Benjamin GG. Hepatic cavernous hemangiomas: simple diagnostic sign with dynamic bolus CT. Radiology 1992;182(2):545–8.
11. Leslie DF, Johnson CD, Johnson CM, IlstrupDM, HarmsenWS. Distinction between cavernous hemangiomas of the liver and hepatic metastases on CT: value of contrast enhancement patterns. Am J Roentgenol 1995;164(3):625-9.
12. LacomisJM, Baron RL, Oliver JH, Nalesnik MA, Federle MP. Cholangiocarcinoma: delayed CT contrast enhancement patterns. Radiology 1997;203(1):98-104.

13. Fujita N, Asayama Y, Nishie A, Ishigami K, Ushijima Y, Takayama Y, et al. Mass-forming intrahepatic cholangiocarcinoma: enhancement patterns in the arterial phase of dynamic hepatic CT - correlation with clinicopathological findings. EurRadiol 2017;27(2):498-506.
14. Mathieu D, Vasile N, Fagniez PL, Segui S, Grably D, Lardé D. Dynamic CT features of hepatic abscesses. Radiology 1985;154(3):749-52.
15. Murphy BJ, Casillas J, Ros PR, Morillo G, Albores-Saavedra J, Rolfes DB. The CT appearance of cystic masses of the liver. Radiogr Rev PublRadiolSoc N Am Inc 1989;9(2):307-22.
16. Kwon BJ, Kim YS, Rhim HC, KohBH, Cho OK, Kim BS, et al. Three-phase dynamic CT Findings of liver abscess: related factors with multiple layering enhancement pattern. J Korean RadiolSoc 2001;44(1):69-75.\
17. De Diego Choliz J, LecumberriOlaverriFJ, Franquet Casas T, OstizZubieta S. Computed tomography in hepatic echinococcosis. AJR Am J Roentgenol 1982;139(4):699-702.
18. Naik S, Yadav N, Alam F, Khandarpa A. A hepatic hydatid cyst: four case reports. IntSurg J 2017;4(10):3557-60.
19. Sarawagi AK, Kumar R, Choudhary S. Evaluating hydatid cyst disease of liver by ultrasound and CT scan. Journal of Evolution of Medical and Dental Sciences 2018;7(5):556-9.
20. Cicero G, Blandino A, Ascenti G, D'Angelo T, Frosina L, Visalli C, et al. Super infection of a dead hepatic echinococcal cyst with a cutaneous fistulization. Case Reports in Radiology 2017;2017:1-5.