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Characterisation of Hypervascular and Hypovascular Metastases on Triphasic Computed Tomography Based on Enhancement Pattern

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Abstract:
OBJECTIVE. Our purpose was to determine the value of triphasic helical CT (unenhanced, hepatic arterial, and portal venous phases) in the detection and characterization of focal hypervascular and hypovascular metastases.
MATERIALS AND METHODS. Thirty seven patients with known or suspected liver metastases underwent triphasic CT. The number and conspicuity of lesions were evaluated on each phase.
RESULTS. One hundred and eight lesions were detected in 37 patients. Patients with hypovascular malignancies had more lesions detected on the portal venous phase with increased conspicuity than on the other phases. Patients with hypervascular malignancies had lesions best detected on the hepatic arterial phase, which revealed small lesions that were not seen on the other phases.39 lesions were detected on the unenhanced phase that were seen on the other phases. However, arterial phase images introduced new diagnostic dilemmas because not all lesions seen on the arterial phase alone were caused by metastases, even in patients with known malignancies.
CONCLUSION. The unenhanced phase is not routinely necessary for the detection of metastases or hepatomas. Hypovascular malignancies are best evaluated during the portal venous phase. Small lesions due to hypervascular metastases are best evaluated and may be detected only during the hepatic arterial phase, which should be used routinely in these patients. New dilemmas may develop from the increased sensitivity of the hepatic arterial phase for lesions. However, the hepatic arterial phase is of limited value with hypovascular malignancies.
Keywords– *Hypervascular, Hypovascular, Triphasic CT.*

I. INTRODUCTION

Multi-detector row CT (MDCT) has become the most commonly used modality in the preoperative diagnosis, staging, treatment planning, and follow-up of patients with known or suspected hepatic tumors. With the recent advent of MDCT scanners, substantial anatomic volumes can be acquired within a short scan time, with submillimeter section thickness and virtually no penalty in increased radiation dose. Clinically, these technologic advances have led to image acquisition during peak vascular enhancement, with almost uniform enhancement along the entire scanned volume, reduced motion artefacts, and the capability to generate high-resolution reformations in any desired plane. In a single examination, MDCT provides detailed morphologic and hemodynamic information on the number, size, distribution, and vascularity of liver lesions, all of which are vital in guiding the clinical decision making and therapeutic plan(1,2,3)

Unlike hepatic parenchyma, predominantly fed by the portal vein, liver tumors receive blood supply from the hepatic arterial system. Most tumors are best seen during the hepatic venous phase (HVP), when the maximal difference in attenuation is attained between the vividly enhancing hepatic parenchyma and hypoattenuating lesions. For evaluation of hypervascular metastases, the HVP of imaging must be preceded by a contrast-enhanced acquisition during the hepatic arterial dominant phase (HAP). This phase is crucial in the detection of hypervascular liver metastases that receive abundant arterial supply. During the HAP, these lesions manifest as hyperattenuating foci relative to adjacent, poorly enhanced hepatic parenchyma but might not be detected during the HVP as a result of progressive liver enhancement from the portal vein.(4-7)

II. II MATERIALS AND METHODS

The present study was conducted at PES Institute of Medical Sciences and Research, Kuppam during the years October 2013 and November 2015. 65 consecutive patients suspected of having hepatic metastases were referred to our hospital for preoperative assessment. Patients were included in the study if they were suspected of having hepatic metastases at US or suspected or known primary hepatic neoplasms or extra hepatic primary malignancies that could metastasize to the liver or increased levels of carcinoembryonic antigen(CEA).

The patients age ranged from 38-84yrs with mean age being 58yrs and sex incidence Male:Female ratio 1:8. (68.3%) males and (31.6%) females.

Out of the 65 patients, 37 patients had lesions and confirmation. The primary malignancies in these 37 patients were; colon (n =10), gastric (n = 6), rectal (n = 3), breast (n = 3), uterine cervical (n = 3), endometrial (n =2),pulmonary(n=2), renal cell (n = 2), esophageal (n =1), ovarian (n = 1), prostate (n = 1), pancreatic (n = 1), urinary bladder (n = 1) or soft tissue sarcoma(n = 1) carcinoma.

For purpose of this study hyper vascular metastases are those that typically originate from renal cell carcinomas, carcinoids, pancreatic islet cell carcinomas, sarcomas, pheochromocytomas, melanomas, thyroid carcinomas, and choriocarcinomas. Remaining metastases were grouped with the hypovascular malignancies.

III. IMAGEACQUISITION

- Patients were kept nil orally 4 hrs at least prior to the CT scan to avoid complications while administrating contrast medium. Risks of contrast administration were explained to the patient and consent was obtained prior to the contrast study.
- Routine anteroposterior and lateral topogram of the abdomen was initially taken in all patients in the supine position with brief breath held.
- Scanning parameters used were spiral mode with slice thickness of 5mm and collimation 6 x 2.5 mm, pitch: 1.4; kVp: 130; mAs: 80. Field of view from top of diaphragm till symphysis pubis. Delayed scans were obtained with the same parameters wherever necessary.For contrast enhancement, 18G Vasofix (indwelling catheter) was placed in antecubital vein and dynamic injection at a rate of about 3-4ml/second a total volume of 60-80cc of non ionic contrast material(Omnipaque; 300mg iodine/ml) was given. Sections were taken in arterial phase (25-40s), portal venous phase(50-60s) and delayed (3-5mins) phases in craniocaudal direction from the superior margin to the inferior border of the liver. Post study reconstructions were done at 2.5 mm. Saggital and coronal reconstructions were made wherever necessary.

IV. IMAGE INTERPRETATION

Dynamic viewing of all reconstructed images was done. First the unenhanced, HAP, and PVP images were reviewed for presence of focal liver lesions. Second the CT appearance of each lesion in each phases (unenhanced, HAP, PVP and delayed images) were characterised based on enhancement patterns and its attenuation compared with that of the liver parenchyma in that phase.The contour and size of the liver was studied. Enhancement pattern of the tumours in the arterial, portal venous and delayed phases were evaluated. Masses were categorized as hypervascular- hyperdense relative to the surrounding parenchyma or hypovascular or hypodense compared with the surrounding parenchyma.

Out of the 65 patients, 37 patients had lesions and confirmation. No lesions were found in 21 patients. Seven patients were excluded because of lack of follow up.

V. RESULTS

TABLE 1: Depicting size of lesions

Size of lesion	Number
<1cm	22
2-3cm	56
>3cm	107
Total	185

Of the 185 lesions seen in 37 patients. The size of lesions ranged from 0.8 to 13.5 cm (mean, 4.8 cm). Most of the lesions in our study are found in poral venous phase constituting one hundred and five hypovascular lesions were found in 22 patients. Hypovascular lesions included metastases from typically hypovascular primary tumors i.e metastases from colorectal carcinoma(n=10) uterocervical (n=3), breast (n = 2), endometrial(n =2), lung(n = 2), prostate(n=1) ovarian(n=1)and urinary bladder(n=1).

Hypervascular lesions (Fig 1)were seen in 15 patients with a total of 80 lesions. The malignant hypervascular lesions were metastases from generally hypervascular malignancies. The hepatic arterial phase showed small lesions that were not seen on the portal venous phase. Lesions seen on only the arterial phase are gastric tumors (n = 6), pancreatic neuroendocrine tumors (n = 2), and colorectal carcinomas (n = 3), renal cell carcinoma(n=2)sarcoma(n=1) and breast(n=1). In the hypervascular malignancies the lesion detection was increased with combination of all three phases with additional seven lesions on the hepatic arterial phase, and six lesions on the portal venous phase that were not detected when the phases were evaluated independently. There is significant difference in detection of lesions when the lesions are less than 1cm compared to lesions

which are 2-3cm size and more than 3cm size. If the lesions were more than 3cms in size there is no much significant difference in detection of lesions on arterial and venous phases.
Among 37 hepatic metastases, unenhanced, arterial-dominant, and portal-dominant phase helical CT imaging depicted 39, 80, and 105 metastases, respectively. Arterial phase imaging depicted significantly more hypervascular metastases and portal-dominant phase imaging depicted significantly more hypovascular hepatic metastases than did unenhanced.

A study by Hiromitsu Onishi et al[2] concluded that contrast-enhanced CT improved the sensitivity for the detection of hepatic metastases. The mean sensitivity of CT was significantly greater than that of SPIO-enhanced MR imaging for lesions larger than 1 cm in diameter and greater but not significantly greater than that of SPIO-enhanced MR imaging for all lesions and for lesions 1 cm in diameter or smaller. A study of Philippe Soyer et al[10] – in a Prospective study on 32 patients with 59 surgically and histopathologically proved Hypo vascular hepatic metastases underwent Triphasic CT of the liver. Carlos Valls et al[1] showed the use of helical CT as the only preoperative imaging technique in the assessment of colorectal cancer metastases allowed accurate.

VI. DISCUSSION

The liver is second only to regional lymph nodes as a site for metastatic disease. It is far more common than primary liver cancer. The colon, stomach, pancreas, and breast are the common primary sites. Metastases are more common in the right lobe of the liver. Although the presence of liver metastases is a poor prognostic factor, the use of aggressive regimes in some subgroups can result in a better outcome. Over the past decade there has been increasing acceptance of liver resection as the best treatment for colorectal metastases. Successful outcome depends on knowledge of the size, number and location of the tumor burden and accurate radiological assessment is essential to identify the subset of patients who would benefit from aggressive management. These individuals are eligible for a variety of potentially curative therapies, including hepatic resection and percutaneous tumor ablation techniques (eg,radiofrequency, laser, or alcohol ablation)(3,8,9,10)
The advent of helical and multi-detector CT has led to a lot of flexibility but has also added complexity to the imaging protocols for liver evaluation. Advantages include significant reduction in scan time, elimination of respiratory misregistration, improved Z axis resolution, better multiplanar and 3D reformats and it allows a more precise timing for evaluation of liver in different phases of contrast enhancement. It also helps in demonstration of a vein close to a lesion as this determines the response to radiofrequency ablation. Lesions in proximity to a vessel have higher chances of recurrence. Since most metastases are hypovascular the usual protocol is to scan in the portal venous phase of enhancement. Dual phase scanning may be useful for detection of metastases from hypervascular primaries such as renal cell carcinoma and islet cell tumors. Although breast carcinoma metastases can be hypervascular, studies have not shown any added benefit of biphasic CT over portal phase CT for this indication.

In our study, we compared the respective sensitivities of unenhanced, arterial dominant, and portal-dominant phase helical CT in the preoperative depiction of hypovascular hepatic metastases by using a combination of intraoperative and histopathologic findings as the standard of reference. We found that both arterial and portal dominant phase imaging was significantly more sensitive in the depiction of hypervascular and hypovascular hepatic metastases respectively.

During the hepatic arterial phase of enhancement hypervascular lesions are readily identifiable against the background of the minimally enhanced normal liver parenchyma. During the portal venous phase, most hepatic tumors are perceived as hypodense lesions highlighted by the strongly enhancing normal liver parenchyma. Depending on the vascularity, a liver lesion will be more conspicuous during either the portal venous or the hepatic arterial phase. Most metastases to the liver are hypovascular and consequently are best detected during the portal venous phase. Hypervascular primary malignancies(fig2) (e.g., hepatocellular carcinomas) and certain metastases (e.g., pancreatic islet cell carcinomas, carcinoids, melanomas, pheochromocytomas, choriocarcinomas, and sarcomas) have a proportionately greater hepatic arterial blood supply and, as a result, enhance earlier than does the remainder of the liver. Hypovascular neoplasms were best seen on the portal venous phase.

A greater number of lesions were identified with greater lesion conspicuity on the portal venous phase than on the other phases, especially when the masses were less than 3 cm in size. When lesions were greater than 3 cm, no statistically significant difference was seen between the portal venous and hepatic arterial phase images(Fig 3), but a significant difference persisted between the contrast enhanced (portal venous and hepatic arterial phase images) and unenhanced images(12-17).

VII. CONCLUSION

Triphasic CT scan todate is the primary modality in the preoperative assessment and follow-up of oncology patients and is a good non-invasive tool. Benign lesions like haemangioma can be reliably differentiated from malignant liver lesion; therefore unnecessary biopsies can be avoided. It is also particularly useful for hypervascular lesions which can be easily missed on routine CT scanning.

REFERENCES

[1.] Carlos Valls et al. Hepatic Metastases from Colorectal Cancer: Preoperative Detection and Assessment of Resectability with Helical CT.Radiology 2001; 218:55–60.

[2.] Onishi et al. Hepatic Metastases: Detection with Multi–Detector Row CT, SPIOenhanced MR Imaging, and Both Techniques Combined. Radiology 2006; 239:131–138

[3.] Kanematsu et al. Portal Venous-Phase CT of the Liver in Patients without Chronic Liver Damage: Does Portal-Inflow Tracking Improve Enhancement and Image Quality? OJRad, 2013, 3, 112-116.

[4.] Daniele Marin, Alessandro Furlan,Michael P. Federle, Massimo Midiri,Giuseppe Brancatelli. Imaging Approach for Evaluation of Focal Liver Lesions. Clinical Gastroenterology And Hepatology 2009;7:624–634.

[5.] FrankH.Miller, ReniS.Butler, FrederickL.Hoff, StevenW.Fitzgerald, AlbertA. Nemcek,Jr. RichardM. Gor. UsingTriphasic Helical CT to Detect Focal Hepatic Lesions in Patients with Neoplasms. AJR1998;171:643-46.

[6.] Oliver 111III, BaronRL. Helical biphasic contrast enhancedCT of theliven technique, indications, interpretation and pitfalls. Radiology 1996;201-14

[7.] Von LeeuwenMS, NoordzijJ, FeldbergMAM, Hennipman AH, Doornewaard H. Focal liver Iesions: characterizationwith triphasic spiral CT Radiology 1996;201:327-336.

[8.] Hollet , Jeffrey RB Jr. Nino-Murcia M, JorgensenMJ, Harris DP. Dual-phase helical CT of the liver: value of arterial-phase scans in the detection of small (<I .5 cm) malignant hepatic neoplasms. AJR 1995;164:879 -884

[9.] Bressler EL, Alpern MB, Glazer GM, Francis IR, EnsmingerWD. Hypervascularhepatic metastasis: CT evaluation.Radiology1987;162:49-51

[10.] PattenRM, ByunJY, FreenyPC. CTof hypervascular hepatic tumors: are unenhanced scans necessary for diagnosis?AiR 1993;16l:979 -984.

[11.] Oliver JH, Baron RL, FederleME Jones BC, Sheng R.Hypervascular livrer metastases Do unenhanced and hepatic arterial phase CT images affect tumor detection? Radiology 1997;205:709-715.

[12.] DuBrow RA, David CL, Libshitz HI, Lorigan JG. Detectionof hepatic metastases in breast cancer: role of nonenhanced and enhanced CT scanning.JComputAssist Tomogr 1990;l4:366 -369.

[13.] KopkaL, RodenwaldtJ, FischerU, MuellerDW, Oestmann fly, Grabbe E. Dual-phase helical CT of the liver effects of bolus tracking and different volumes of contrast material. Radiology 1996;20l:321-326

[14.] Baron RL. Understanding and optimizing use of contrast material for CT of the liver. Am J Roentgenol 1994;163:323–331.

[15.] Foley WD, Mallisee TA, Hohenwalter MD, et al. Multiphase hepatic CT with a multirow detector CT scanner. Am J Roentgenol 2000;175:679–685.

[16.] Murphy-Lavallee J, Jang HJ, Kim TK, et al. Are metastases really hypovascular in the arterial phase? The perspective based on contrast-enhanced ultrasonography. J Ultrasound Med 2007;11: 1545–1556.

[17.] Philippe Soyer et al. Detection of Hypovascualar Hepatic Metastases at Triple-phase helical CT: Sensitivity of phases and Comparison with Surgical and Histopathologic Findings. Radiology 2004; 231:413-20

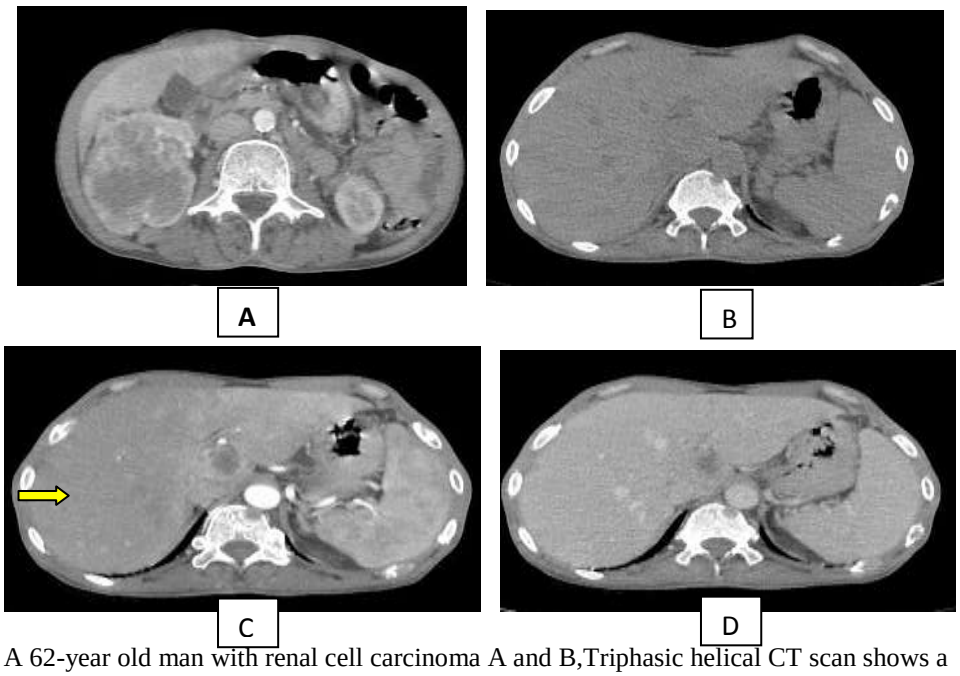

Fig 1: A 62-year old man with renal cell carcinoma A and B,Triphasic helical CT scan shows a lesion (arrowsA,)that was not visible on or unenhancedphase(B) and was visible only during hepatic arterial phase(C) and not during portal venous phase(D)

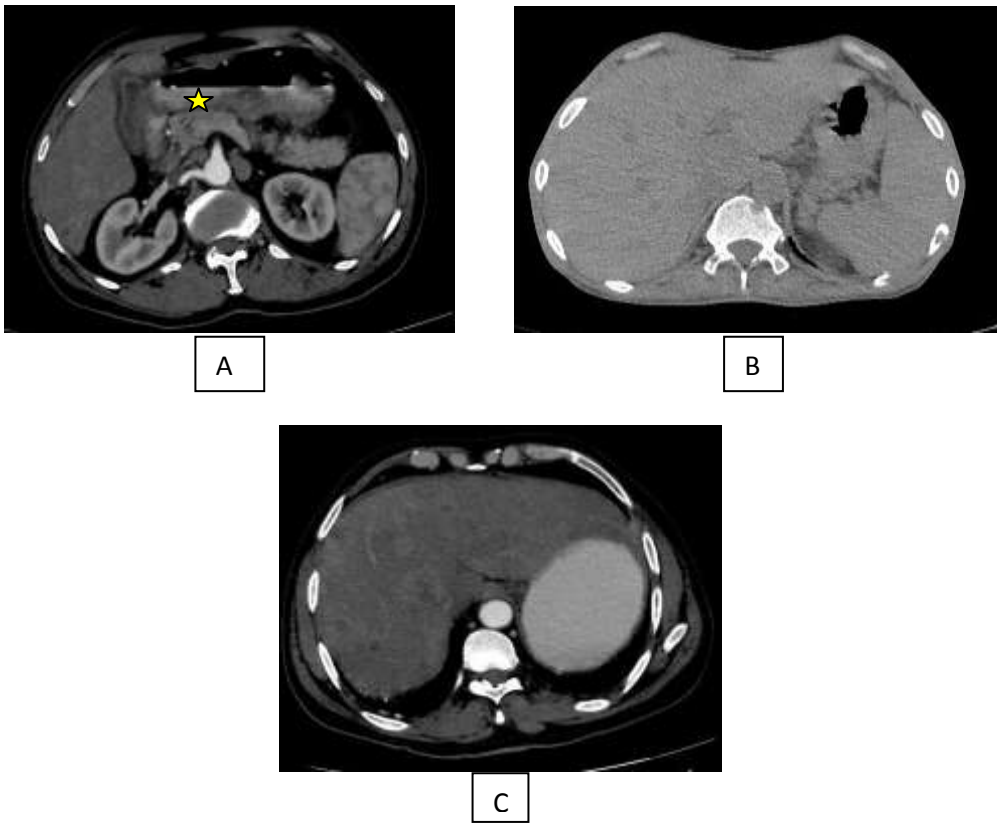

Fig 2 : A 55yr old female with gastric carcinoma (A)reveals multiple small enhancing lesions in arterial phase (C)which were not seen on plain unenhanced phase(B).

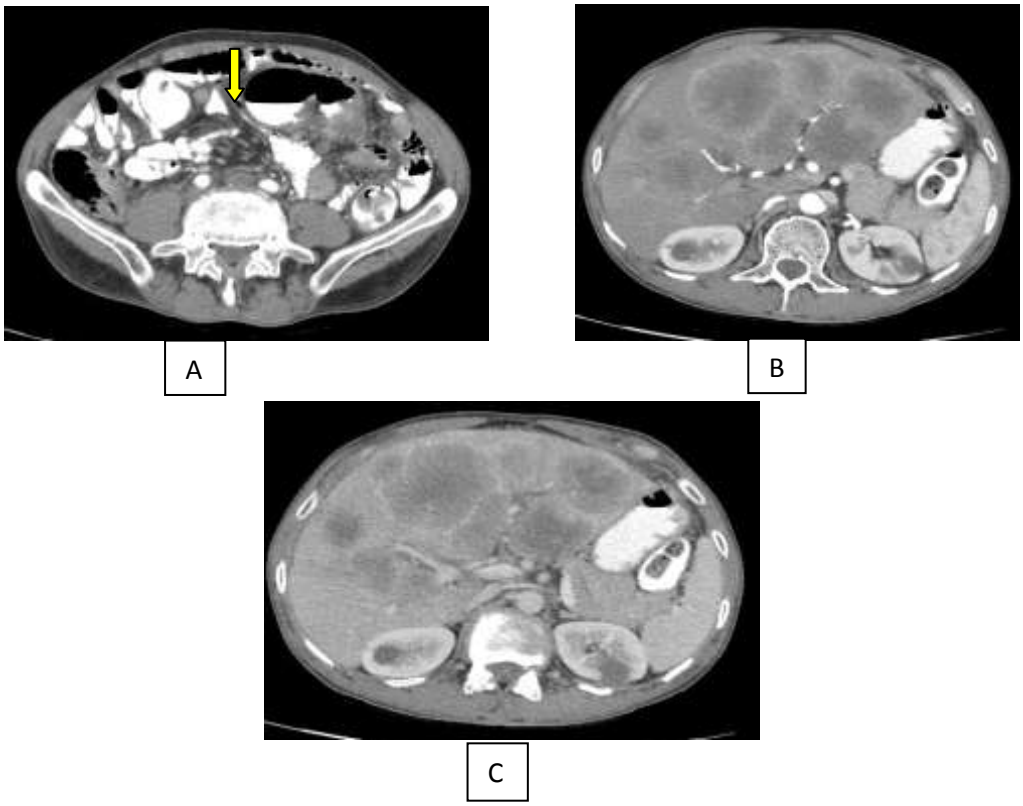

Fig 3: A 62yrs old male with carcinoma sigmoid colon (A) reveals multiple peripheral enhancing lesions on arterial (B) and portal venous phase(B). There is no significant difference seen on arterial and portal venous phase in this patient