

Computed Tomographic Appearance of Colorectal Hepatic Metastases

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Abstract

Introduction: This article reviews the various computed tomography (CT) appearances of hepatic metastases from colorectal primaries and assesses the frequency of occurrence of the various patterns. **Materials and Methods:** This is a retrospective study of the CT appearances of histologically proven colorectal hepatic metastases in a group of 52 patients who had undergone surgical hepatic resection between January 1994 and December 2001. A total of 74 hepatic metastatic lesions were reviewed. All lesions were examined in the portal venous phase. **Results:** A discernible rim was seen in 54 lesions (73%). Thick rim was present in 36 lesions (48.6%) and thin rim in 18 lesions (24.3%). Enhancement of the rim was present in 62 cases (83.8%). Increased central attenuation was seen in 38 lesions (51.4%). Of these, the centre was heterogeneous in 76.3% and scar-like in 23.7%. A non-enhancing rim was seen in 12 lesions (16.2%) which appeared as lesions with "bevelled edge". Thick enhancing rim with non-enhancing centre was the most common combination in 15 lesions (20.3%). **Conclusion:** An enhancing rim could be seen in 83.8% of lesions. Increased central attenuation was present in 51.4% of the lesions. Familiarity with the various CT appearances may facilitate identification and diagnosis of colorectal liver metastases.

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Key words: Colorectal cancer, Imaging features, Liver metastasis

Introduction

It is important to recognise the computed tomography (CT) appearance of hepatic metastases from colorectal primaries, as resection in a selected group may offer a 20% to 40% rate of five-year survival compared to 5% to 10% with non-surgical management.¹

The general CT appearances of liver metastases have been described by Sica et al in their review article.² However, the article described findings of hepatic metastases from a wide variety of primary lesions and not, specifically, colorectal hepatic metastases. Furthermore, the frequency of the various findings was not described.

Though the appearance of liver metastases is varied, we are unable to obtain studies published in the English language describing the frequency of various patterns.

Therefore, we set out to review the CT appearance of pathologically proven resected liver metastases from colorectal primaries to describe their various appearances and frequency of occurrence.

Materials and Methods

Ninety-five patients had liver resection for histologically confirmed colorectal liver metastasis between January 1994 and December 2001 at the National Cancer Centre (NCC) and Singapore General Hospital (SGH). The inclusion criteria for the study were availability of preoperative CT and no prior chemotherapy at the time of resection. Forty-one patients were excluded from the study because of unavailability of relevant preoperative CT images of the liver. In 1 patient, the earliest available CT study was

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performed after chemotherapy and was, therefore, excluded from the study. Another patient only had computed tomography arteriography and, thus, was not included in the study group. There were two patients who had previous liver resection for hepatic metastases presenting with recurrence of liver metastases at the time of the study. These patients were included in the study as no chemotherapy was given after the initial resection.

The final study group of 52 patients consists of 34 males and 18 females. Their mean age was 57.1 years (range, 24 to 75 years). The primary tumour originated from the rectum in 14 patients (26.9%), the recto-sigmoid junction in 10 patients (19.2%) and the colon in 28 patients (53.8%). Synchronous hepatic metastases were found in 18 patients (34.6%), while the rest of the lesions were metachronous. The mean time of discovery of the metachronous hepatic metastases from surgical resection of the primary colorectal tumour was 23.5 months (range, 3 to 60 months). Poorly-differentiated adenocarcinoma was found in 4 patients (7.7%) with primary colorectal tumour, while the rest were of intermediate grade. None of the patients in this study group had well-differentiated adenocarcinoma.

There was a total of 74 hepatic metastases in this study group. Thirty-five patients had only 1 lesion detected on the preoperative CT, 13 patients had 2 lesions, 3 patients had 3 lesions and 1 patient had 4 lesions.

The mean maximum diameter of the lesions was 4.2 cm (range, 0.7 to 15.3 cm). There were 23 lesions (31.1%) measuring less than 2 cm and 51 lesions (68.9%) measuring 2 cm or larger.

All CT studies were performed using helical CT techniques. A total of 52 sets of preoperative helical CT scans with 74 hepatic metastatic lesions were retrospectively analysed. Twenty-two cases were performed using helical CT scanners in SGH. Of these, 16 were scanned using the CT scanner HiSpeed Advantage (General Electric Medical Systems, Milwaukee, WI, USA) and 6 used the scanner Toshiba Xpress/SX (Toshiba Medical Systems, Tokyo, Japan). Thirty cases were performed using the CT scanner in NCC (Somatom Plus 4; Siemens Medical Systems, Erlangen, Germany). Scans were acquired with 8-mm collimation with the CT scanner in NCC and 7 mm for the two CT scanners in SGH, using a pitch of 1:1.2 to 1:1.5. The range of tube current was 150 mA to 250 mA, and that of tube voltage was 120 kV to 140 kV. Helical breath-hold acquisition began at between 60 and 70 seconds for the portal venous phase, and between 2 and 3 minutes for the delayed phase.

All studies were performed with intravenous contrast using non-ionic contrast, namely, Iohexol 300 (Omnipaque®; Nycomed, Cork, Ireland) or Iopamidol 300 (Iopamiro® 300; Bracco, Milano, Italy). A total volume of 100 mL to 120 mL of contrast was administered for each

patient. The contrast was delivered by a power injector at the rate of 1.5 mL/s to 2.5 mL/s for scans acquired in the portal venous phase. If the arterial phase was acquired, an injection rate of 3 mL/s was used.

The majority (78.8%) of the scans was acquired in a single portal venous phase, which constituted 57 lesions. Arterial and portal venous phase scans were performed in only 1 patient (1.9%) with 3 lesions shown. Portal venous and delayed scans were performed in 6 patients (11.5%), which constituted 8 lesions. The remaining 4 patients (7.7%) received scans in all the 3 phases, thereby contributing the remaining 6 lesions.

All lesions were shown in the portal venous phase. Only 9 lesions had an arterial phase and 14 lesions had a delayed phase.

The CT images of the liver for all 52 patients, with a total of 74 lesions, were retrospectively evaluated by 2 radiologists in consensus reading using Picture Archival and Communications Systems. The following features were recorded for each lesion: size, presence or absence of a rim, rim thickness (thick if more than one-quarter the largest lesional diameter, and thin if less than one-quarter the largest lesional diameter), rim enhancement (the rim of the lesion having higher attenuation than the surrounding liver parenchyma) and increased central attenuation (the centre of the lesion appearing denser than the overall background of the lesion). The pattern of increased central attenuation was further divided into linear scar-like or heterogeneous. All available phases of the CT liver study were reviewed. In studies with a delayed phase, additional information on the pattern of enhancement, such as fading, increasing or persistence of rim or central enhancement, was recorded.

There was a discrepancy in 2 patients with regard to the CT findings on the different phases of enhancement. One patient had a thin rim in the portal venous phase and thick enhancing rim in the delayed phase. For the purpose of statistical analysis, this patient was considered to have a thick rim. In another patient, no identifiable rim was noted in the portal venous phase, while on the delayed phase a thin rim was seen. For the purpose of statistical analysis, this patient was considered to have a thin rim.

Results

The frequency of the various appearances is summarised in Table I.

Of the 74 colorectal hepatic metastases, 36 (48.6%) showed an identifiable thick rim. Of these, 32 showed enhancement of the rim while 4 did not show rim enhancement. Among the thick-rimmed lesions, 17 showed increased central attenuation, of which a central scar-like area was seen in 5 and a heterogeneous pattern without specific patterns was seen in the remaining 12 (Fig. 1).

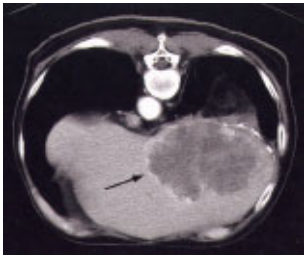


Fig. 1a. Thick enhancing rim showing no central enhancement. This is the most common pattern in 15 (20.3%) lesions in the entire series of this study. The attenuation of the rim is higher than the surrounding liver parenchyma.

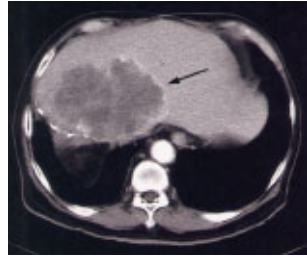


Fig. 1b. Thick enhancing rim with the centre showing non-specific heterogeneous enhancement.

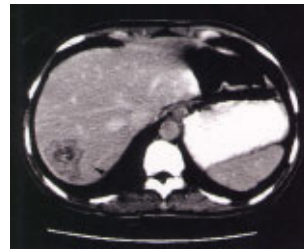


Fig. 1c. Thick enhancing rim with the centre showing linear scar-like enhancement.

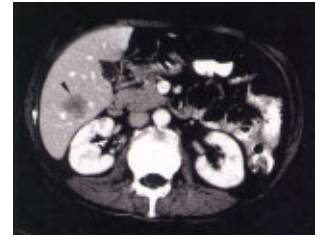


Fig. 1d. No rim enhancement is seen, as the rim does not appear to be of higher attenuation than the surrounding liver parenchyma. There is also no central enhancement noted in the portal venous phase.

Fig. 1. Examples of CT appearance of thick-rimmed colorectal hepatic metastases defined as rim thickness more than one-quarter the maximum lesional diameter.



Fig. 2a. Thin enhancing rim with no central enhancement.

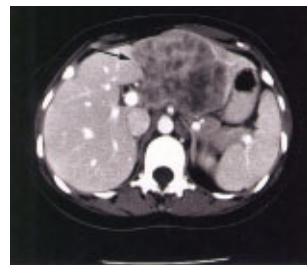


Fig. 2b. A large thin enhancing rim with non-specific heterogeneous central enhancement.



Fig. 2c. Thin enhancing rim with enhancing central scar.



Fig. 2d. Thin non-enhancing rim, which is seen in 1 lesion, mimicking a cyst.

Fig. 2. Examples of CT appearance of thin-rimmed metastatic lesions. The rim thickness of these lesions is less than one-quarter the maximum lesional diameter.

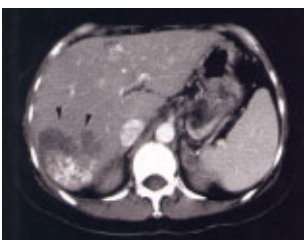


Fig. 3a. No discernible rim with heterogeneous central enhancement.



Fig. 3b. No discernible rim with enhancing central scar. This is seen only in 1 lesion.

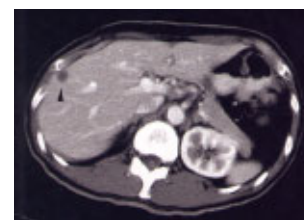


Fig. 3c. No discernible rim with no enhancement. This small lesion can look deceptively like a cyst.

Fig. 3. Examples of CT appearance of metastatic lesions with no discernible rim.

An identifiable thin rim was seen in 18 lesions (24.3%), with 17 demonstrating enhancement of the rim. One lesion did not show rim enhancement and mimicked a cyst. Eight lesions also demonstrated increased central attenuation, 3 of which were scar-like and the rest were heterogeneous. The remaining 9 enhancing, thin-rimmed lesions had a persistently low attenuation centre (Fig. 2).

Twenty (27%) colorectal hepatic metastases were low-density lesions with a barely noticeable rim. Twelve had

increased central attenuation with heterogeneous pattern, and only 1 had increased central attenuation with central scar-like pattern. The remaining 7 lesions did not show increased central enhancement (Fig. 3).

Increased central attenuation was seen in 38 (51.4%) metastatic lesions. Of these, 29 demonstrated heterogeneous pattern and the rest showed central scar. Thick rim was seen in 17 lesions, thin rim in 8 lesions and no distinct rim in 13 lesions.

TABLE I: APPEARANCE OF COLORECTAL HEPATIC METASTASES

Lesion Appearance	Number (n = 74) (%)	
Thick enhancing rim*		
No central enhancement	15	(20.3)
Heterogeneous central enhancement	12	(16.2)
Enhancing central scar	5	(6.8)
Thick non-enhancing rim*	4	(5.4)
Thin enhancing rim**		
No central enhancement	9	(12.2)
Heterogeneous central enhancement	5	(6.8)
Enhancing central scar	3	(4.1)
Thin non-enhancing rim**	1	(1.3)
No rim		
Heterogeneous central enhancement	12	(16.2)
Enhancing central scar	1	(1.3)
No enhancement	7	(9.4)

* Rim thickness of more than one-quarter the maximum lesional diameter.

** Rim thickness of less than one-quarter the maximum lesional diameter.

Regardless of rim thickness, enhancement of the rim was seen in 62 (83.8%) lesions. Lesions with thick enhancing rim comprised 43.2%, and thin enhancing rim 23%, of the entire series. The rest did not show a distinct rim.

Of the 23 lesions that were smaller than 2 cm, 12 (52.2%) did not have an identifiable rim, be it enhancing or non-enhancing. Seven lesions (30.4%) showed no sign of increased central attenuation. Hence, the lack of central enhancement or rim does not rule out the presence of metastasis in small lesions.

Discussion

Pathologically, colorectal liver metastases are a heterogeneous group with different growth patterns, differing in angiogenic parameters and in the degree of co-option of the liver stroma containing the sinusoids.³ Three patterns were recognised by Vermeulen et al.³ A “desmoplastic” growth pattern with a rim of desmoplastic stroma separating the metastases from the surrounding liver parenchyma was shown in 42% of their series. A “pushing” pattern with a compressed rim of liver plates, rather than a desmoplastic stroma surrounding the tumour, was shown in 46% of their series. A “replacement” growth pattern was seen in 12% of their series, in which the tumour replaced the hepatocytes conserving the reticulating network of the liver parenchyma with minimal angiogenesis. Microvascular density is higher with the “desmoplastic” and “pushing” types. Desmoplasia can potentially be imaged as it usually appears as areas of prolonged and delayed enhancement.⁴⁻⁶

Sica et al² described findings of hepatic metastases in general and not, specifically, colorectal hepatic metastases. The frequency of the various findings was also not described. They described most hepatic metastases as hypovascular low or isoattenuating masses that may show a complete

ring of enhancement in the arterial phase. In the portal venous phase, a thickened rim may be progressively enhanced. On delayed phases, metastases may appear to be of low attenuation. Some lesions will show peripheral areas of low attenuation surrounding an enhanced centre on delayed images. Depending on the lesion size, the margins tend to be irregular, though it can be sharp and well-defined. Central low attenuation may be the result of necrosis or cystic change. Calcifications can be present from mucinous gastrointestinal primaries.

The appearance of colorectal metastases is varied with no pathognomonic imaging finding. Valls et al,⁷ while assessing the preoperative detection of colorectal liver metastases, employed a practical definition of colorectal liver metastases as “nodular low-attenuating lesions without characteristic findings of benign lesions (cysts or haemangiomas)”. Though a common occurrence in clinical practice, we were unable to find literature in the English language describing the various patterns and frequencies of colorectal liver metastases.

In our study, we found that the most common pattern for colorectal liver metastases is that of a thick rim with no increased central attenuation in 15 (20.3%) lesions. The next most common appearances are that of an increased central attenuation in heterogeneous pattern with thick rim and no rim, both at 16.2%.

Nino-Murcia et al studied the pattern of arterial phase CT and found that a complete ring of enhancement has a high positive predictive value (82%) for metastases.⁸ Though only 9 of our patients have hepatic arterial phase scans, an enhancing rim, regardless of thickness, is found in 83.8% of portal venous phase scans in our study.

Several studies have analysed the significance of rim enhancement in colorectal metastases. Lunevicius et al⁹ found fibrotic capsules around colorectal metastases in 20% of cases, which were associated with a lower rate of initial recurrence in the remnant liver. Semelka et al studied post-gadolinium areas of perilesional enhancement on magnetic resonance imaging (MRI) with direct pathological correlation.¹⁰ The areas of perilesional enhancement correspond to peritumoral desmoplastic reaction, inflammatory cell infiltration and vascular proliferation. The actual tumour tissue seen is thinner than the area of enhancement due to areas of hepatic tissue reaction. Outwater et al¹¹ found that hypointense peripheral rims on T2-weighted scans in 25% of their series correlated to areas of compressed liver parenchyma, hepatocellular atrophy, fibrosis, inflammation and congested sinusoids. One limitation of our study is the lack of direct radiological and pathological correlation. It is likely that the thick or thin rims seen in our study correspond either to a fibrous capsule or to areas of peritumoral desmoplastic reaction,

inflammatory cell infiltration and vascular proliferation.

Increased central attenuation was seen in 38 lesions (51.4%) in our series. Of these, 29 (76.3%) were heterogeneous in nature while 9 (23.7%) were scar-like. It is likely that our increased central attenuation corresponds to areas of desmoplasia and fibrosis, though a radiological and pathological study is required to confirm this. It is known that metastatic colorectal cancer stimulates collagen synthesis by fibroblasts.¹²

In our study, scar-like enhancement was seen in 9 lesions (12.2%). Colorectal metastases should be included in the differential diagnosis of a lesion with an enhancing central scar. Further studies to determine if this is a useful discriminatory point and histological correlation to determine the nature of the scar-like areas of enhancement are required.

We found that a non-enhancing rim was discernible in 12 (16.2%) of the lesions, giving the lesions a “bevelled edge” appearance. Although the rims were non-enhancing in the portal venous phase on CT, it was unclear if they would enhance in the hepatic arterial phase or in the delayed phase as not all cases had these additional phases. It was also unclear if these cases would show enhancement with MRI, since MRI is generally considered a more sensitive modality for the detection of enhancement. However, as portal venous phase CT is a commonly encountered modality, familiarity with this appearance would alert the reporting radiologist to the possibility of colorectal liver metastases.

It is also noteworthy that 12 (52.2%) of the 23 small (<2 cm) lesions did not show an enhancing or non-enhancing rim. Therefore, these lesions may mimic cysts and radiologists should be alert to them. T2-weighted MRI scans may be useful to tell them apart.¹³

Our study suffers from several other limitations. Not all our studies have all the three phases. Arterial and delayed phases are often not available. It is possible that more cases may show central enhancement due to central desmoplasia had delayed scans been performed for all cases. The lack of pre-contrast scans also hampers the assessment of tumour calcifications. As this is our initial study describing the appearance of colorectal liver metastases, we did not assess the reproducibility of the descriptive patterns. We acknowledge that it may be difficult and subjective to classify appearances into broad groups, but we feel that such broad descriptive groups allow familiarity with the CT appearance of colorectal liver metastases. Most of our cases are moderately differentiated adenocarcinomas. The appearance of well-differentiated and poorly-differentiated adenocarcinomas is not adequately assessed. Our population is relatively small and, therefore, we may not have exhaustively described all patterns of appearance.

Conclusion

Common patterns of CT appearance of colorectal metastases are described. The most common patterns are thick enhancing rim and heterogeneous increase in central attenuation.

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