Computed Tomographic Appearances of Colorectal Liver Metastases

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Background: *There are various computed tomographic appearances of liver metastases from colorectal cancer, but there is little data in Thailand*
Material and Method: *This was a retrospective, descriptive study of the CT appearances of 21 patients diagnosed with liver metastasis from colorectal cancer in Srinagarind Hospital, Khon Kaen, between January 2003 and December 2007. All of the patients were examined in the portovenous phases.*
Results: *Rim-enhancement was seen in 20 patients (95.2%). Irregular rim-enhancement was seen in 19 patients (90.5%) and smooth rim-enhancement in one (4.8%). Thin rim was seen in 16 patients (76.2%) and thick rim in four (19%). Internal heterogeneous enhancement was seen in 15 patients (71.4%). Irregular, thin rim-enhancement with internal heterogeneous enhancement was the most common combination seen in 12 patients (57.1%).*
Conclusion: *An enhancing rim could be seen in 95.2% of patients. Internal heterogeneous enhancement was shown in 71.4% of patients. Familiarity with the various CT appearances may help to facilitate the diagnosis of colorectal liver metastases.*

Keywords: *CT, Appearance, Colorectal, Liver metastases, Northeast Thailand*

J Med Assoc Thai 2011; 94 (7): 826-32
Full text. e-Journal: *http://www.mat.or.th/journal*

Colorectal cancer is the third most common malignancy worldwide, with over 1 million new cases reported annually. It is the second most common cause of cancer deaths in the developed world, because of distant metastasis. By the time of diagnosis, about 25% of patients have liver metastases (synchronous metastases) and another 25-30% will present hepatic lesions in the following two to three years (metachronous metastases)[1]. About 70% of colon cancer patients have liver metastases at autopsy[2].

The overall life expectancy in colorectal cancer is mainly determined by the progression of liver secondary disease and not by the primary carcinoma[1]. It is therefore important to recognize the computed tomographic appearances of liver metastases from colorectal primaries, as resection in a selected group may offer a 30 to 48% rate of five-year survival over against less than 5% with non-surgical management[2].

Helical and multidetector-row CT (MDCT) are the most commonly used imaging modalities for the detection and characterization of hepatic metastases[2]. The CT appearances of colorectal liver metastases and the frequency of the various findings have been described by Chiang et al in their original article[3]; however, there is to the authors' knowledge no peer-reviewed article on CT appearances of colorectal liver metastases in Northeast Thailand, where cholangiocarcinoma is endemic. The authors, therefore, set out to review the CT appearance of colorectal liver metastases seen at Srinagarind Hospital and to describe their various appearances and frequency of occurrences.

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Material and Method

Thirty-eight patients who had underlying colorectal cancer were diagnosed with liver metastases between January 2003 and December 2007 at Srinagarind Hospital, Khon Kaen, Thailand. The

inclusion criteria for the present study were known cases of colorectal cancer, the availability of a pre-treatment CT of the liver in the portovenous phase and any of the following:

(1) Pathologically-proven liver metastasis from adenocarcinoma.

(2) No pathologically-proven metastasis but at least one follow-up study which showed progression of the hepatic lesions.

(3) No pathologically-proven metastasis, no follow-up study but findings characteristic of liver metastasis.

Thirteen patients were excluded from the present study because of the unavailability of CT images of the liver. Additionally, three more patients were not included because the liver lesions mimicked benign lesions and another patient only had computed tomography of the chest which only partially revealed liver lesions on the arterial phase (*i.e.,* there was no portovenous phase available).

The final study group of 21 patients comprised 10 males (47.6%) and 11 females (52.4%). Their mean age was 56.3 years (range, 29 to 76 years). In two patients (9.5%), the pathology report regarding the primary tumor was not available. In the other groups, the primary tumor originated from the rectum in two patients (9.5%), the rectosigmoid junction in six (28.6%), the sigmoid colon in six (28.6%) and the other part of the colon in five (23.8%). Poorly-differentiated adenocarcinoma was found in one patient (4.8%) with primary colorectal tumor, in five (23.8%), it was moderately-differentiated, and in 10 (47.6%), it was well-differentiated. In another three patients (14.3%), the histological grading was not specified (Table 1).

All of the CT studies were performed using helical and MDCT techniques, on a Somatom Plus 4 (Siemens Medical Systems, Erlangen, Germany). Scans were acquired with 4-8 mm collimation, using a pitch of 1:1.6. The respective range of the tube current and tube voltage was 150-250 mA and 120-140 kV. Helical breath-hold began at 30 seconds for the arterial phase, 70-80 seconds for the portovenous phase and 6 minutes for the delayed phase.

All of the CT studies were performed with an intravenous contrast material using a non-ionic contrast. A total volume of 100 mL of contrast was administered for each patient. The contrast was delivered by a power injector at a rate of 2.5 mL/s for scans acquired in the portovenous phase. If the arterial phase was acquired, an injection rate of 2.5-3.0 mL/s was used.

The majority (81%) of scans were acquired in the arterial and portovenous phases. A single portovenous scan was performed in four patients (19%). Only one patient (4.8%) underwent an additional delayed phase scan. In the present study with a delayed phase, additional information on the patterns of enhancement, such as fading, increasing, or persistence of rim or central enhancement were recorded.

The CT images of the liver for all 21 patients were retrospectively evaluated by two radiologists in consensus reading using films, CD images and Picture Archival and Communications Systems (PACS). The following features were recorded for each patient: (1) location, (2) number, (3) size, (4) density of the lesion on pre-contrast images, (5) presence or absence of calcification, (6) characteristics of calcification, (7) presence or absence of rim, (8) rim thickness (*i.e.,* 'thick' if more than one-quarter of the largest lesional diameter and thin if less than one-quarter of the largest lesional diameter), (9) rim enhancement (*i.e.,* the rim of the lesion having a higher attenuation than the surrounding liver parenchyma),

Table 1. Histologic grading of primary tumor

Grading	Number of patients (n = 21)	Percentage
Well-differentiated	10	47.6
Moderately-differentiate	5	23.8
Poorly-differentiate	1	4.8
Not specified	3	14.3
No pathologic report	2	9.5

Table 2. Number, location and size of the metastatic lesions

	Number of patients (n = 21)	Percentage
Number of lesions		
Single	3	14.3
Few	6	28.6
Multiple	12	57.1
Location of lesion		
Right lobe	3	14.3
Left lobe	1	4.8
Both lobes	17	81.0
Size of lesion		
< 1 cm	0	0
1-5 cm	13	61.9
> 5 cm	8	38.1

(10) rim characteristics (*e.g.,* smooth or irregular) and (11) increased central attenuation (*i.e.,* the center of the lesion appearing denser than the overall background of the lesion).

Results

The respective frequency of the various CT appearances on the portovenous phase and the combination of CT appearances are summarized in Table 3 and 4. Of the 21 patients, three (14.3%) had only a single lesion, six (28.6%) had a few and twelve (57.1%) had multiple lesions. The respective lesion for three (14.3%), one (4.8%) and 17 (81%) of the patients was at the right, left, and both lobes of the liver. None of the patients had a lesion < 1 cm, 13 (61.9%) had lesions between 1 and 5 cm and eight (38.1%) had lesions > 5 cm. In the pre-contrast images, 20 patients (95.2%) had low-density liver lesions while the remainder had isodense lesions (Table 2). An absence of lesional calcification showed in 15 (71.4%) patients, while four patients (19%) had amorphous calcification (Fig. 1), one (4.8%) had well-defined calcification, and another one (4.8%) had faint calcification.

In the arterial phase, rim-enhancement was seen in 17 patients (81%) of whom 16 (76.2%) had irregular rim-enhancement and one (4.8%) had smooth rim-enhancement. In the remaining four patients (19%), no arterial phase scan was available. In the portovenous phase, 20 patients (95.2%) showed rim-enhancement of whom 19 (90.5%) showed irregular rim-enhancement while one (4.8%) showed smooth rim-enhancement (Fig. 5) and one patient (4.8%) showed no rim enhancement at all. Regarding rim

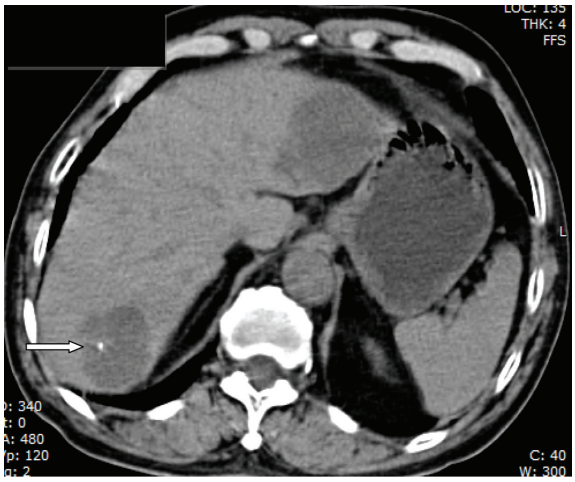

Fig. 1 A 76-year-old man with well-differentiated adenocarcinoma of the colon. Plain CT shows masses in right and left lobe of liver with amorphous calcification (arrow)

Table 3. CT characteristics of liver metastatic lesions

Characteristic	Number of patients	Percentage
Rim-enhancement	20	95.2
Irregular/smooth	19/1	90.5/4.8
Thin/thick	16/4	76.2/19
Internal heterogeneous enhancement	15	71.4
Target appearance	5	23.8
Enhancing mural nodule	1	4.8
Capsular retraction	2	9.5
Mildly dilated adjacent intrahepatic bile duct	4	19.0
Portal vein thrombosis	1	4.8

Table 4. Combination of CT appearances of metastatic lesions

Combination	Number of patients (n = 21)	Percentage
Irregular, thin rim-enhancement with internal heterogeneous enhancement	12	57.1
Irregular, thick rim-enhancement with internal heterogeneous enhancement	2	9.5
Irregular thin rim-enhancement with some target appearance	3	14.3
Irregular thick rim-enhancement with some target appearance	2	9.5

Fig. 2 A 52-year-old man with metastatic masses in liver and spleen (black arrow). In portal venous phase CT ,there are irregular, thin rim-enhancement with internal heterogeneous enhancement (white arrows)

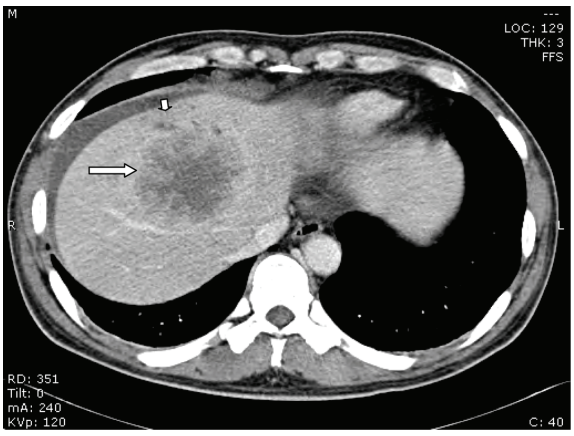

Fig. 3 A 46-year-old man with moderately-differentiated adenocarcinoma of the rectosigmoid colon. In portal venous phase CT, there are irregular, thick rim-enhancement with internal heterogeneous enhancement (long arrow) and mild dilatation of adjacent intrahepatic bile ducts (short arrow)

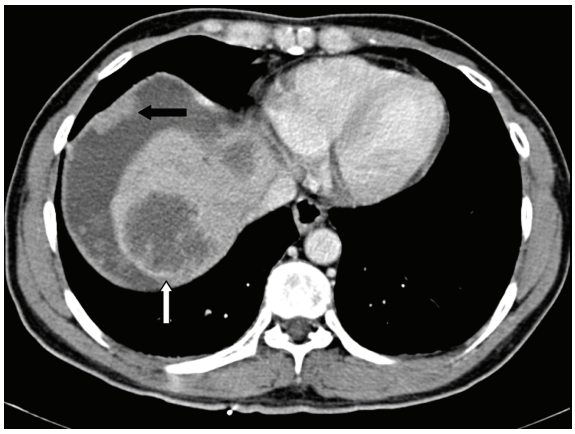

Fig. 4 A 59-year-old man with moderately-differentiated adenocarcinoma of the sigmoid colon. In portal venous phase CT, there are irregular, thin rim-enhancement with internal heterogeneous enhancement (white arrow) and intraperitoneal seeding (black arrow)

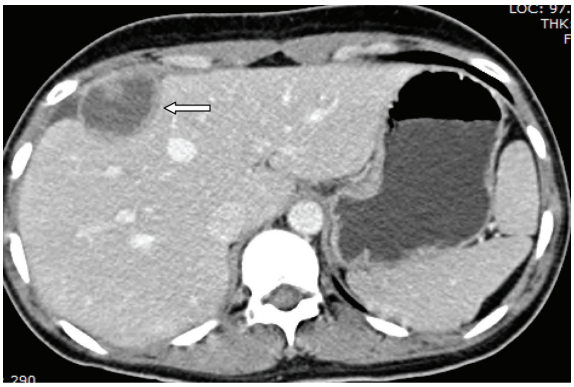

Fig. 5 A 29-year-old woman with well-differentiated adenocarcinoma of the colon. In portal venous phase CT,there are smooth rim-enhancement with enhancing mural nodule (arrow)

characteristics, 16 patients (76.2%) had thin rims and four (19%) had thick rims (Table 3).

Increased internal attenuation was seen in 15 patients (71.4%), all of which appeared as an internal heterogeneous enhancement. In the only patient who underwent an additional delayed phase, it showed progressive fill-in of the internal heterogeneous enhancement. Target appearance was seen in five patients (23.8%). One patient (4.8%) showed enhancing mural nodules (Fig. 5). Capsular retraction was seen in two patients (9.5%). Mild dilated intrahepatic bile ducts, adjacent to the hepatic lesions (Fig. 3), showed in four patients (19%). Portal vein thrombosis was seen in one patient (4.8%). The combinations of irregular, thin rim-enhancement and internal heterogeneous enhancement (Fig. 2, 4) were seen in 12 patients (57.1%). Irregular, thick rim-enhancement with internal heterogeneous enhancement (Fig. 3) was seen in two patients (9.5%). Irregular, thin rim-enhancement with some target appearance was seen in three patients (14.3%). Irregular thick rim-enhancement with some

target appearance was seen in two patients (9.5%) (Table 4).

Pulmonary, splenic (Fig. 2), pancreatic metastases and peritoneal seeding (Fig. 4) were seen in eight patients (38.1%), one patient (4.8%), one patient (4.8%), and two patients (9.5%), respectively. One patient (4.8%) had a nodule at the anterior abdominal wall and one (4.8%) para-aortic lymphadenopathy.

Four patients (19%) had ascites and one (4.8%) pleural effusion. Finally, ureteric stones, gall stones, and bowel dilatation were seen in one patient (4.8%).

Discussion

The liver is a highly vascularized organ that frequently hosts metastases in patients with colorectal adenocarcinomas. Pathologically, colorectal liver metastases are a heterogeneous group with different growth patterns depending on the fraction of immature blood vessels, proliferating endothelial cells and apoptotic tumor cells[4].

Sica et al[5] reviewed the CT and MR imaging appearances of hepatic metastases in general and found that most metastases exhibit low or iso-attenuation on CT. Irregular margins and areas of necrosis may be present depending on the size of the lesion, but margins can be sharp and well-defined. Calcification may be present with metastases from mucinous gastrointestinal tract tumors and other primaries.

Most liver metastases are hypovascular and show a complete ring of enhancement during the arterial phase. On the portovenous phase, a thickened rim enhances progressively.

Central low attenuation may be due to necrosis or cystic change. Some metastases may fill-in (*i.e.,* in a centripetal pattern) over time, similar to hemangiomas while some metastases may show peripheral areas of low attenuation surrounding an enhancing center on delayed images.

In the present study, the authors found that all patients showed low or isodense masses on the pre-contrast images. The most common pattern for colorectal liver metastases was an irregular rim-enhancement (in 19 patients, 90.5%). Increased central attenuation (internal heterogeneous enhancement) was seen in 15 patients (71.4%). In the one patient for whom the authors had delayed images, it showed progressive fill-in of the internal heterogeneous enhancement. Target appearance, which has central low attenuation, showed in five patients (23.8%). The most common combination was irregular, thin rim-enhancement with internal heterogeneous enhancement (in 12 patients, 57.1%). Based on the authors' observations, colorectal liver metastases should be included in the differential diagnosis of a lesion with internal heterogeneous enhancement or target appearance as it is known that metastatic colorectal cancer stimulates collagen synthesis by fibroblasts[6]. Thus, the internal heterogeneous enhancement in the present study was probably related to areas of collagen synthesis, though a radiological-pathological correlated study would be needed to confirm this.

Chiang et al[3] studied the CT appearance of colorectal hepatic metastases on the portovenous phase and found that an enhancing rim could be seen in 83.8% of lesions, which is similar to the present series. Notwithstanding, they found an increased central attenuation in 51.4% of the lesions and that the most common combination was thick enhancing rim with a non-enhancing center (in 20.3% of the lesions), which is dissimilar to the present study. The difference is possibly because most of their study population had moderately-differentiated adenocarcinomas while ours had well-differentiated ones.

Nino-Murcia et al[7] found that complete ring enhancement on the arterial phase has a high positive predictive value (82%) and specificity (80%) for metastases. Although not all of the patients in the present study underwent an arterial phase, 81% (17) did and all of them showed an enhancing rim.

Soyer et al[8] studied the prevalence and specificity of retraction of the adjacent liver capsule in hepatic tumors. They found that capsular retraction of the liver adjacent to hepatic tumors is an uncommon CT finding but specific for malignant hepatic tumors. This finding was never associated with benign tumors. In the present series, adjacent capsular retraction was seen in two patients (9.5%).

There are limitations to the present study. For one, the population is small. Therefore, the authors may not have exhaustively described all patterns of appearance. Moreover, not all of the presented patients had pathologically-proven liver metastases meaning that the authors lack confirmation of the pathology. In addition, about half of the presented cases had well-differentiated adenocarcinomas so that the appearance of moderately- and poorly-differentiated adenocarcinomas has been inadequately assessed. Only one patient in the present study underwent a delayed phase scan, so the additional findings based on this phase are not conclusive so further study is required.

Conclusion

The various CT patterns of colorectal liver metastases were described and the most common patterns were rim-enhancement and internal heterogeneous enhancement.

Acknowledgements

The authors wish to thank the Faculty of Medicine, Khon Kaen University for its support and Mr. Bryan Roderick Hamman for assistance with the English-language presentation of the manuscript.

Potential conflicts of interest

None.

References

1. Paschos KA, Bird N. Current diagnostic and therapeutic approaches for colorectal cancer liver metastasis. Hippokratia 2008; 12: 132-8.
2. Schima W, Kulinna C, Langenberger H, Ba-Ssalamah A. Liver metastases of colorectal cancer: US, CT or MR? Cancer Imaging 2005; 5 (Spec No A): S149-56.
3. Chiang SH, Thng CH, Teh CS, Tan AG, Poddar SL, Wong BS, et al. Computed tomographic appearance of colorectal hepatic metastases. Ann Acad Med Singapore 2003; 32: 191-5.
4. Vermeulen PB, Colpaert C, Salgado R, Royers R, Hellemans H, Van Den Heuvel E, et al. Liver metastases from colorectal adenocarcinomas grow in three patterns with different angiogenesis and desmoplasia. J Pathol 2001; 195: 336-42.
5. Sica GT, Ji H, Ros PR. CT and MR imaging of hepatic metastases. AJR Am J Roentgenol 2000; 174: 691-8.
6. Basso D, Mazza S, Greco E, Belluco C, Roveroni G, Navaglia F, et al. Metastatic colorectal cancer stimulates collagen synthesis by fibroblasts. Anticancer Res 2001; 21: 2665-70.
7. Nino-Murcia M, Olcott EW, Jeffrey RB Jr, Lamm RL, Beaulieu CF, Jain KA. Focal liver lesions: pattern-based classification scheme for enhancement at arterial phase CT. Radiology 2000; 215: 746-51.
8. Soyer P, Bluemke DA, Vissuzaine C, Beers BV, Barge J, Levesque M. CT of hepatic tumors: prevalence and specificity of retraction of the adjacent liver capsule. AJR Am J Roentgenol 1994; 162: 1119-22.

ลักษณะทางเอกซเรย์คอมพิวเตอร์ของการแพร่กระจายไปที่ตับจากโรคมะเร็งลำไส้ใหญ่และไส้ตรงในโรงพยาบาลศรีนครินทร์

นิตยา ฉมาดล, วัลลภ เหล่าไพบูลย์, นิชนันท์ เรืองวัฒนไพศาล, ณรงค์ ขันตีแก้ว, ชวลิต ไพโรจน์กุล

วัตถุประสงค์: *เพื่อศึกษารูปแบบของการแพร่กระจายไปที่ตับของโรคมะเร็งลำไส้ใหญ่และไส้ตรงด้วยเครื่องเอกซเรย์คอมพิวเตอร์ และศึกษาถึงความถี่ของแต่ละลักษณะที่พบ*

วัสดุและวิธีการ: *ทำการศึกษาข้อมูลย้อนหลังเกี่ยวกับรูปแบบของการแพร่กระจายไปที่ตับของโรคมะเร็งลำไส้ใหญ่และไส้ตรงด้วยภาพเอกซเรย์คอมพิวเตอร์ระหว่างเดือนมกราคม พ.ศ. 2546 ถึงธันวาคม พ.ศ. 2550 ของผู้ป่วยในโรงพยาบาลศรีนครินทร์จำนวน 21 ราย การศึกษาได้เก็บข้อมูลการเปลี่ยนแปลงความเข้มทางรังสีในการตรวจระยะปอร์ตัล*

ผลการศึกษา: *พบความเข้มบริเวณขอบของก้อนที่ตับสูงขึ้นในระยะปอร์ตัลหลังฉีดสารทึบรังสีในผู้ป่วย 20 ราย (ร้อยละ 95.2) โดยแบ่งเป็นขอบขรุขระ 19 ราย (ร้อยละ 90.5) และขอบเรียบ 1 ราย (ร้อยละ 4.8) พบขอบบาง 16 ราย (ร้อยละ 76.2) และขอบหนา 4 ราย (ร้อยละ19) พบว่ามีความเข้มขึ้นอย่างไม่สม่ำเสมอภายในก้อน 15 ราย (ร้อยละ 71.4) ลักษณะร่วมที่พบมากที่สุดคือ มีความเข้มขึ้นที่ขอบของก้อนที่ขรุขระและมีความเข้มขึ้นอย่างไม่สม่ำเสมอภายในก้อน 12 ราย (ร้อยละ 57.1)*

สรุป: *ผู้ป่วยโรคมะเร็งลำไส้ใหญ่และไส้ตรงที่มีการกระจายไปที่ตับพบความเข้มบริเวณขอบของก้อนที่ตับสูงขึ้นในระยะปอร์ตัลหลังฉีดสารทึบรังสีในผู้ป่วยร้อยละ 95.2 มีความเข้มขึ้นอย่างไม่สม่ำเสมอภายในก้อนร้อยละ 71.4 การตรวจพบลักษณะดังกล่าวจากภาพเอกซเรย์คอมพิวเตอร์จะช่วยในการวินิจฉัยโรคนี้ได้*