Role of magnetic resonance with Gd-BOPTA in the detection and size assessment of hepatic metastasis: comparison with contrast-enhanced 64-slice CT

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Authors: A. Pecchi, M. De Santis, M. C. Gibertini, F. Di Benedetto, G. E. Gerunda, P. Torricelli; Modena/IT
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Purpose

Metastasis are the most common malignant liver lesions, occurring about 18-40 times more than primary liver tumors and representing the most frequent indication for hepatic imaging.

Historically, diagnosis of focal liver lesions has been accomplished at histopathologic analysis following excisional or percutaneous biopsy. During the last two decades, the necessity for biopsy of liver lesions has diminished: with the newest improvements in CT and MRI technologies, focal liver lesions can be detected and characterized noninvasively with a high degree of accuracy.

It has been established that complete surgical resection of liver metastasis prolongs survival in eligible surgical candidates. Hence, detection, absolute quantification and localization of liver metastasis are crucial as the findings change the clinical outcome of the disease and patient management. Metastasis are vascularised to varying degrees and designations regarding the vascularity of a lesion, such as hypervascular or hypovascular, are relative to the degree of enhancement of the liver parenchyma.

During the last decade, a variety of liver contrast agents have been developed for MRI of the liver, which are designed to overcome the limitations of unspecific tissue uptake by extracellular low molecular gadolinium chelates.

Gadobenate dimeglumine (Gd-BOPTA; MultiHance, Bracco, Milan, Italy) is a gadolinium-based paramagnetic contrast agent that combines the properties of a conventional extracellular fluid contrast agent with those of a liver-specific contrast agent. In addition, due to the property of weak binding to serum proteins, it has an inherently twofold higher T1 relaxivity than conventional gadolinium chelates.

Gd-BOPTA has been shown to improve the detection and characterization of liver lesions, in fact 3-5% of the injected dose of Gd-BOPTA is taken up into functioning hepatocytes and excreted in the bile: this has been shown to produce a marked and long-lasting enhancement of the normal liver parenchyma, that results in significantly increased sensitivity for liver lesion detection, particularly of small (<1cm) metastasis, when T1-weighted MR images are acquired between 40 and 120 min after administration.

The purpose of our study was to compare the diagnostic performance of contrast-enhanced-64 slices-CT (ceCT) and Gd-BOPTA-enhanced-MRI in detection and size assessment of liver metastasis.
Methods and Materials

From January '09 to August '09, we enrolled 26 cancerous patients (10 M, 16 F, average age 59): the primary tumors were colon carcinoma \((n=22)\), cholangiocarcinoma \((n=2)\), rhabdomyosarcoma \((n=1)\), melanoma \((n=1)\). All patients were previously evaluated by 64-scan-ceCT, then underwent abdominal 1,5 T-MRI with hepatobiliary contrast medium injection (Gd-BOPTA, 0,1 mL/Kg).

CT was performed by using sixty-four-detector scanners (LightSpeed VCT; GE Medical Systems, Milwaukee, Wis). A triphasic liver protocol with standard delays was used during the arterial (30 seconds after injection) and portal venous (60 seconds after injection) phases. Iomeprol (Iomeron; Bracco SpA, Milan, Italy) at 300 mg of iodine per milliliter or iodixanol (Visipaque; Amersham Health, Princeton, NJ) at 270 mg of iodine per milliliter were used as intravenous contrast agent, with 2mL/kg injected at 3 mL/sec up to 200 mL. Reconstruction was performed with a standard algorithm, with section thickness of 2,5 mm.

MRI imaging was performed by using 1,5-T system (Achieva, Philips medical System, The Netherlands), and a phased array coil. T1 and T2-weighted sequences with and without fat suppression were acquired in the pre-contrastographic phase with the following parameters:

- Axial sDUAL FFE T1-w (TR 241,58; TE 2,30 e 4,60; FOV 38 x 38 cm, slice thickness 5 mm; FA 80).
- Axial SS T2-w (TR 429; TE 80; FOV 38 x 38 cm; slice thickness 5 mm; FA 90).
- Coronal SS T2-w (TR 756; TE 80; FOV 37,5 x 37,5 cm; slice thickness 5 mm; FA 90).
- Axial SE T2-w (TR 432; TE 80; FOV 38 x 38 cm; slice thickness 5 mm; FA 90) with fat-sat

Triphasic dynamic study with 3D T1-weighted fat-suppressed sequences has been performed before and after injection of contrast agent (Gd-BOPTA, Multihance, Bracco SpA, Milan, Italy) and completed by T1-w sequence acquired in the hepatobiliary phase (60 minutes delayed), as follows:

- Axial T1W 3D THRIVE (TR 3,74; TE 1,77; FOV 39x39 cm; slice thickness 2,5 mm; FA 10) performed at nonenhanced imaging and during the arterial (15 seconds after injection), portal venous (50 seconds after injection), and delayed (85 seconds after injection) phases.
Axial T1W TFE (TR10; TE 4,60; FOV 39×39 cm; slice thickness 8 mm; FA 15) after 45-90 min from the injection of Gd-BOPTA, for the hepatobiliary phase.

Twenty patients underwent surgery, so number and size of liver metastasis detected in the MRI hepatospecific phase and in ceCT in the portal phase were compared with intraoperative US and surgical specimen: size measure of liver lesions assessed with ceCT and MRI has been considered as correct when a difference # 3 mm was found in comparison with its histopathologic diameter.

Six patients required percutaneous endovascular treatment of liver metastasis and number and size of hepatic lesions were compared with angiography during chemioembolization procedures.

Accuracy and sensibility of ceCT and MRI in detecting liver metastasis were calculated and the percentage of liver metastasis size evaluation in comparison with gold standard were also formulated for each radiologic techniques.
Results

38 metastatic liver lesions (size range 5-41mm) were detected with ceCT, and 44 (size range 8-90mm) with MRI in the hepatospecific phase.

In 16 patients ceCT and MRI assessed the same number of hepatic metastatic lesions, confirmed by gold standard.

In 10 cases there was discordance between ceCT, MRI and gold standard (surgical specimen and angiography) for the detection of the number of hepatic lesions:

- In 4 cases, MRI was able to identify a larger number of hepatic lesions than ceCT, with exact correlation with the gold standard.
- In 4 cases ceCT and MRI detected the same number of hepatic lesions, with discordance with the gold standard. In 2 cases ceCT and MRI showed two lesions, whereas the gold standard revealed multiple diffuse metastasis.
- In two cases ceCT and MRI detected two lesions, and intraoperative ultrasonography one isolated lesion.
- In 2 cases, MRI revealed lesions not confirmed by the gold standard.

The accuracy and sensitivity in detecting liver metastasis were respectively 69% and 72% for 64-slices-ceCT, 79% and 92% for MRI.

In comparison with intraoperative US, anatomical evaluation and angiography, MRI enabled a correct size evaluation of hepatic metastasis in 20/26 cases (77%), whereas 64-slices-ceCT in 10/26 cases (38,5%). 6/26 lesions (23%) and 16/26 lesions (61,5%) were respectively underestimated by MRI and 64-slices-ceCT.
Fig. 0: Fig.1 a-e. A 51-year-old man with colon cancer and liver metastasis. CeCT and MRI detected one isolated focal lesion in the right lobe (red arrows). Its diameter was 22 mm. After wedge resection, the histologic diameter was 20 mm with good correlations with both radiologic techniques.

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**Fig. 0:** A 62-year-old woman affected by cholangiocarcinoma: ceCT assessed 2 focal hepatic lesions (2a, 2d, white arrows), with maximum diameter of 19 mm, whereas MRI detected 3 lesions (2b-c, 2e-f, red arrows), whose diameters were 8, 22 and 18 mm respectively. Fig 2g. Angiography performed after catheterization of the right hepatic artery demonstrated the presence of 3 focal lesions (red arrows), in agreement with results of MRI.

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**Fig. 0:** Fig 3. A 65-year-old man affected by colorectal cancer, with evidence of one isolated metastatic lesion in the right lobe (arrows). Its diameter was 39 mm for ceCT (3 a) and 47 mm for MRI (3b-e). After surgery, the histologic diameter was 48 mm with good agreement with MRI imaging.

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Conclusion

Our data show that Gd-BOPTA enhanced MRI enabled a better detection and size assessment of liver metastasis: this is in good agreement with data in literature. A study recently published by Lee demonstrated that MRI showed better diagnostic accuracy and sensitivity than ceCT for lesion detection or characterization. The advantages of MR images over CT images regarding lesion characterization may be attributed to the variety of different soft tissue contrasts achieved through implement of multiple sequences, and the greater contrast resolution by Gd-BOPTA. Gadobenate dimeglumine has a two-fold T1 relaxivity over conventional gadolinium chelates and is effective not only in the dynamic phase of contrast enhancement after bolus administration, but also in a more delayed phase when uptake into functioning hepatocytes of 3-5% of the injected dose results in a marked and long-lasting enhancement of the signal intensity of normal liver parenchyma and a corresponding increased sensitivity of MR imaging for the detection of focal metastatic lesions. Regarding lesion detection, Gd-BOPTA enhanced MRI showed greater sensitivities than those of MDCT.

Regarding size assessment of hepatic metastatic lesions, MRI sequences in the hepatospecific phase after administration of Gd-BOPTA enable a more accurate size assessment of hepatic lesions according to histopathologic diameters and permit a correct planning of surgical intervention.

If our results will be confirmed by large series we suppose that Gd-BOPTA enhanced MRI should be mandatory in pre-surgical evaluation of liver metastasis.
References

A. Pecchi*, M. De Santis, M. C. Gibertini*, F. Di Benedetto¹, G. E. Gerunda¹, P. Torricelli*

*Department of Radiology, University of Modena and Reggio Emilia, Modena, Italy

¹Liver and Multivisceral Transplant Center, University of Modena and Reggio Emilia, Modena, Italy