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The role of diffusion-weighted imaging in the detection of hepatic metastases from colorectal cancer: A comparison with unenhanced and Gd-EOB-DTPA enhanced MRI

Stefano Colagrande[a,*], Alessandro Castellani[a], Cosimo Nardi[a], Chiara Lorini[b], Linda Calistri[a], Antonella Filippone[c]

[a] Department of Experimental and Clinical Biomedical Sciences, Radiodiagnostic Unit n. 2, University of Florence—Azienda Ospedaliero-Universitaria Careggi, Largo Brambilla 3, Florence 50134, Italy
[b] Department of Health Science, University of Florence, viale GB Morgagni 48, Florence 50134, Italy
[c] Departement of Neurosciences and Imaging, Section of Radiological Imaging, "G. d'Annunzio" University—Ospedale SS. Annunziata, Via dei Vestini, Chieti 66013, Italy

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ABSTRACT

Objectives: To compare the role of DWI vs. gadoxetic-acid-disodium enhanced MRI in the detection of colorectal hepatic metastases.
Methods: Fifty-four patients with 115 hepatic metastases were included in this retrospective study, approved by the Ethical Board. All patients underwent intraoperative-ultrasound and surgical resection within two weeks after MRI. Images were grouped in 4 sets, which were analyzed by two radiologists in different sessions: unenhanced T1-T2w (set A), set A plus DWI (set B), set A plus gadoxetic-acid-disodium (set C), set A plus DWI plus gadoxetic-acid-disodium (set D). For each set, metastases presence/size/site was reported. Interobserver agreement and statistical significance were assessed by Cohen's kappa and Mc-Nemar's test, respectively.
Results: Readers' agreement was always very good ($k > 0.80$). Mean sensitivity values were 84.3/92.1/95.6/97.3% for set A/B/C/D, respectively. Mean specificity, positive predicted, negative predicted, and accuracy values strongly and progressively increased in the various set too: from 62.5% (set A) to 85.0% as for specificity, from 92.8% to 97.3% as for positive predicted value, from 41.0% to 85.1% as for negative predicted value, and from 81.1% to 95.5% as for accuracy.
For each reader from set A to D, the number of false negatives progressively decreases.
Conclusions: For both readers, DWI improved all statistical parameters in the unenhanced examinations, as for nodules either smaller or greater than 1 cm, while in the EOB-enhanced examinations DWI prevalently increased specificity/negative predictive value.

1. Introduction

Patients with colorectal cancer develop liver metastases with a rate of around 50–60%. Metastases are the most common malignant liver tumors, and they are best diagnosed with gadolinium liver specific chelates [1]. The hepatic involvement significantly affects the clinical outcome, with a median survival of 3–20 months if left untreated [2]. Surgical resection and image-guided ablation therapies have demonstrated to increase the long-term survival [3]. Moreover, using preoperative chemotherapy, liver disease can downsize and downstage, increasing the resection rate by 13–20% in selected patients [4]. Therefore, the accurate assessment of number and location of hepatic metastases is a crucial issue for an adequate treatment planning and successfully therapy. Gd-EOB-

Abbreviations: DWI, diffusion weighted imaging; MR, magnetic resonance; MRI, magnetic resonance imaging; CA, contrast agent; Gd-EOB-DTPA, gadolinium ethoxybenzyl diethylenetriamine pentaacetic acid; IOUS, intraoperative ultrasound; IV, intravenous; ADC, apparent diffusion coefficient; FNH, focal nodular hyperplasia; FLL, focal liver lesion.

* Corresponding author at: Department of Experimental and Clinical Biomedical Sciences, Radiodiagnostic Unit n. 2, University of Florence—Azienda Ospedaliero-Universitaria Careggi, Largo Brambilla 3, Florence 50134, Italy.
E-mail addresses: stefano.colagrande@unifi.it (S. Colagrande), ale.andro@hotmail.it (A. Castellani), cosimo.nardi@unifi.it (C. Nardi), chiara.lorini@unifi.it (C. Lorini), linda.calistri@unifi.it (L. Calistri), a.filippone@rad.unich.it (A. Filippone).

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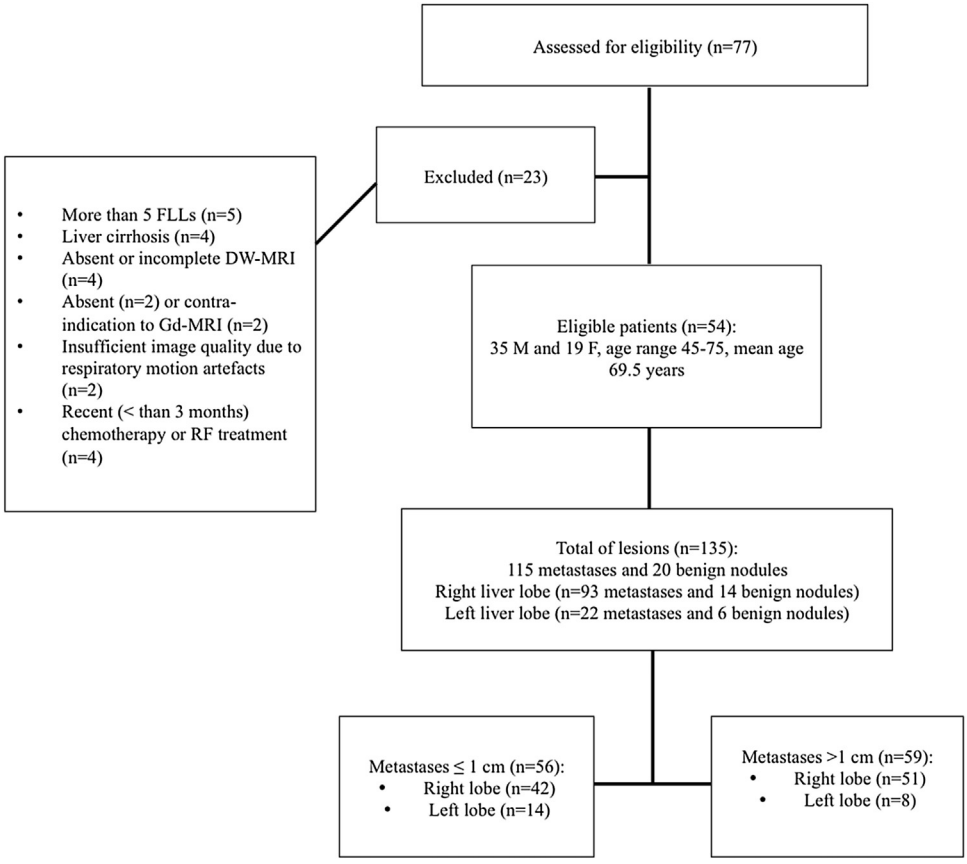

Fig. 1. Flow-chart for patient selection.

DTPA (EOB—gadoxetic acid disodium, Primovist, Bayer Schering Pharma AG, Berlin, Germany) is a dual-purpose gadolinium chelate liver-specific MR contrast agent (CA) [5]. The evaluation of vascular profile and hepatocyte-specific uptake enables accurate detection and characterization of liver metastases, as suggested by several recent studies [6–8]. Magnetic resonance (MR) diffusion weighted imaging (DWI) allows an evaluation of changes in the diffusion properties of water molecules in tissues, and can potentially add useful information to conventional imaging sequences. It can be quickly and easily added to existing protocols, without the use of intravenous (IV) CA administration, therefore it is repeatable and useful in patients with severe renal dysfunction at risk for nephrogenic systemic fibrosis [9–11]. Recent works have described that DW single-shot echo-planar imaging is useful for the detection of hepatic metastases, giving its high contrast resolution [9,11,12]. To the best of our knowledge, there are only few published studies comparing DWI and EOB enhanced MRI in the detection of hepatic metastases, with histologic confirmation, and until now there is not a clear consensus about the role of DWI in this setting which remains still challenging [12–17]. So, even if DWI is usually included in routine protocol, radiologists are still wondering if DWI can really contribute in hepatic metastases detection and if in this assessment it is superior in comparison to EOB-enhanced images.

Giving this background, the purpose of this retrospective study was to evaluate the role of DWI in the detection of colorectal hepatic metastases, either in unenhanced or in EOB-enhanced examination, in a series of patients with intraoperative ultrasound (IOUS) and histologic confirmation.

2. Materials and methods

2.1. Patients and standard of reference

The Ethics Committee of our institution approved this retrospective study (on 24 April 2014). In this study patients' privacy was maintained and patients' care was not impacted, so the informed consent of patients was not required. However, all patients had provided written informed consent to perform MRI examination with IV administration of CA according to the principles of the Declaration of Helsinki (revision of Edinburgh, 2000).

An initial study population was selected in our electronic database by the query "colorectal hepatic metastases" and "Gd-

Table 1
NA: not applicable; 3D: three-dimensional; THRIVE: volumetric interpolated breath-hold examination; AT: acquisition time (seconds).
[a]Axial T1-w 2D gradient echo in/out phase breath-hold sequence.
[b]T1-w 3D-GRE with volumetric interpolated breath-hold examination fat sat THRIVE sequences were performed before and repeated three times after the dynamic bolus injection of gadolinium chelate (artery, portal venous, and equilibrium) and at 20 min during hepato-biliary phase.
[c]Axial and coronal T2-w half-Fourier single-shot turbo spin-echo free-breath, intersection slice gap = 10%.

Sequence	TR/TE(ms) Flip Angle (degrees)	NSA	Matrix	FOV (mm, AP-RL)	Slice thickness (mm)/number	Bandwidth (Hz/pixel)	Sense	AT (s)
T1w in/out phase[a]	231-121/14.6-2.3/80	1	256 × 165	300 – 420	5/24	470	1,5	18
T1w (THRIVE)[b]	3.8/1.5/80	1	256 × 169	350 – 400	4/40	560	1,5	16
T2w single shot[c]	810/80/90	1	256 × 165	300 – 420	5/40	260	NA	120