COMPARATIVE STUDY OF DIFFERENT GD-EOB-DTPA FLOWS AS A SOLUTION OF THE GIBBS ARTERIAL PHASE ARTIFACT IN LIVER MRI

SCAN ME

Curatolo Calogero[1], Santoro Vincenzo[2]

[1]*Dott. TSRM Ordine PSTRP TSRM Agrigento-Caltanissetta*
[2]*Dott. TSRM ASP Caltanissetta Ospedale S.Elia- UO di Risonanza Magnetica, Ordine TSRMPSTRP Agrigento-Caltanissetta*

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ABSTRACT

The purpose of this study was to compare three different injection rates to improve the quality of the arterial phase images in the MRI imaging of the liver with Gadoxetico Acid (Gd-EOB-DTPA) and, in particular, how these affect and/or mitigate Gibbs artifact.

INTRODUCTION

Disodium Gadoxetate (disodium Gd-EOB-DTPA) is a contrast medium (CM) primarily indicated for detection of focal hepatic lesions and provides informations on the nature of lesions in T1-weighted MRI images.
According to recent studies published in the literature, the sensitivity and specificity of MRI imaging, using Gd-EOB-DTPA, appear to be higher than those of Computed Tomography both for the diagnosis of hepatocellular carcinoma (HCC) and for the detection of small metastases in cancer patients. However, artifacts that occur when using the Gd-EOB-DTPA are well known, reducing image quality, especially the high frequency truncation artifact (Gibbs artifact).
The cause is to be found in the average variation between medium-high frequencies and low frequencies in the sampling of K-space during the single acquisition. The short duration of the injection of the CM, compared to the time of acquisition of the arterial phase, is responsible of a reduction of the homogeneity of the K space sampled during the arterial phase. The purpose of our work was to analyze three different rates of CM flow in the study and, in particular, how these affect and/or mitigate the Gibbs artifact.

MATERIAL E METHODS

In this study, 18 patients, aged between 43 and 65 years, with a diagnosis of HCC were analyzed with upper abdomen MRI with ev administration of CM (Gd-EOB-DTPA) for liver study, using a high-field MRI scanner 1.5 T with 33 m/m Amplitude and slew-rate from 150 mt/m. The standard MRI protocol for liver study included, in combination with the SS-FSE T2w sequences without and with fat suppression, Dual-Echo (in and out-phase) and EPI-SE DWI, the pre- and post-contrastographic GRE Rapid Acquisition Fid-dynamic sequenceSpoiled imaging with m-DIXON fat saturation technique. Dynamic imaging was conducted with a Repetition Time (TR) of 4.6ms, an Echo Time (TE) of 2.2ms, a Flip-angle (FA) of 10, BW 330 Hz, Pixel 1.75mm x 1.75mm at a thickness of 5mm (i2.5) and and a parallel imaging acceleration factor R=2 (SENSE). The acquisition time varied on the basis of patient's ability to hold his breath (range between 15-18 seconds).
For all studies, an 18-channel Phased-Array body coil was used.
The CM was administered by means of an automatic injector. Gd-EOB-DPTA (Primovist 0.25 mmol/ml, Bayer Shering Pharma, Berlin, Germany) was used with a dose of 0.1 ml per kilogram of body weight and three different types of flow were chosen, respectively at 0.7-1.0 and 1.5 ml/s, each one in 6 patients.
The delay of the arterial scanning phase has been fixed and calculated previously taking into account the different flow rates (Ttk0).
After the arterial phase imaging, the portal phase and equilibrium phase images were obtained respectively after 34 seconds from the arterial phase and after about 180 seconds from CM injection.
Finally, hepatobiliary imaging, useful for providing information on hepatocytic uptake is performed 20 minutes after injection of Primovist.

RESULTS

The images of the arterial phase of our study were evaluated by two Magnetic Resonance Specialists. The degree of Gibbs artifact, visual acuity and enhancement have been evaluated using a scale of values from 1 to 5 (see Table 1).

	GIBBS ARTIFACT (GA)	VISUAL ACUITY (VA)	ENHANCEMENT (E)
1	Severe	Insufficient	Inhomogeneous
2	Moderate	Sufficient	Slightly homogeneous
3	Low	Good	Sufficiently homogeneous
4	Very low	Very good	Homogeneous
5	No artifacts	Excellent	Perfectly Omogeneo

Tab.1 - *Scale of values for judgment on the Gibbs artifact, visual acuity and enhancement*

CM FLOW 0.7ml/s			*CM FLOW 1 ml/s*			*CM FLOW 1.5ml/s*		
AG	**AV**	**E**	**AG**	**AV**	**E**	**AG**	**AV**	**E**
4 +/-0.89	4.1 +/-0.75	3.6 +/-0.51	3.83 +/-0.40	3.83 +/-0.75	3.66 +/-0.81	3.33 +/-0.51	3.16 +/-0.40	3.83 +/-0.40
4 +/-0.63	3.66 +/-0.51	4 +/-0.63	3.8 +/-0.4	3.5 +/-054	4.1 +/-0.75	2.67 +/-0.52	3.1 +/-0.40	4 +/-0

Tab.2

In Table 2 arithmetic averages and +/- Standard Deviation of both observers' evaluations on the basis of the different flow rates used.
The analysis of our results showed, for both observers, the absence of statistically significant differences ($p>0.05$) in the evaluation of enhancement with the 3 different degrees of flow in the study. Instead, for observer 1 a statistically significant difference was found, in particular in the reduction of Gibbs artifacts, using a flow of 0.7 ml/s or 1 ml/s compared to a flow

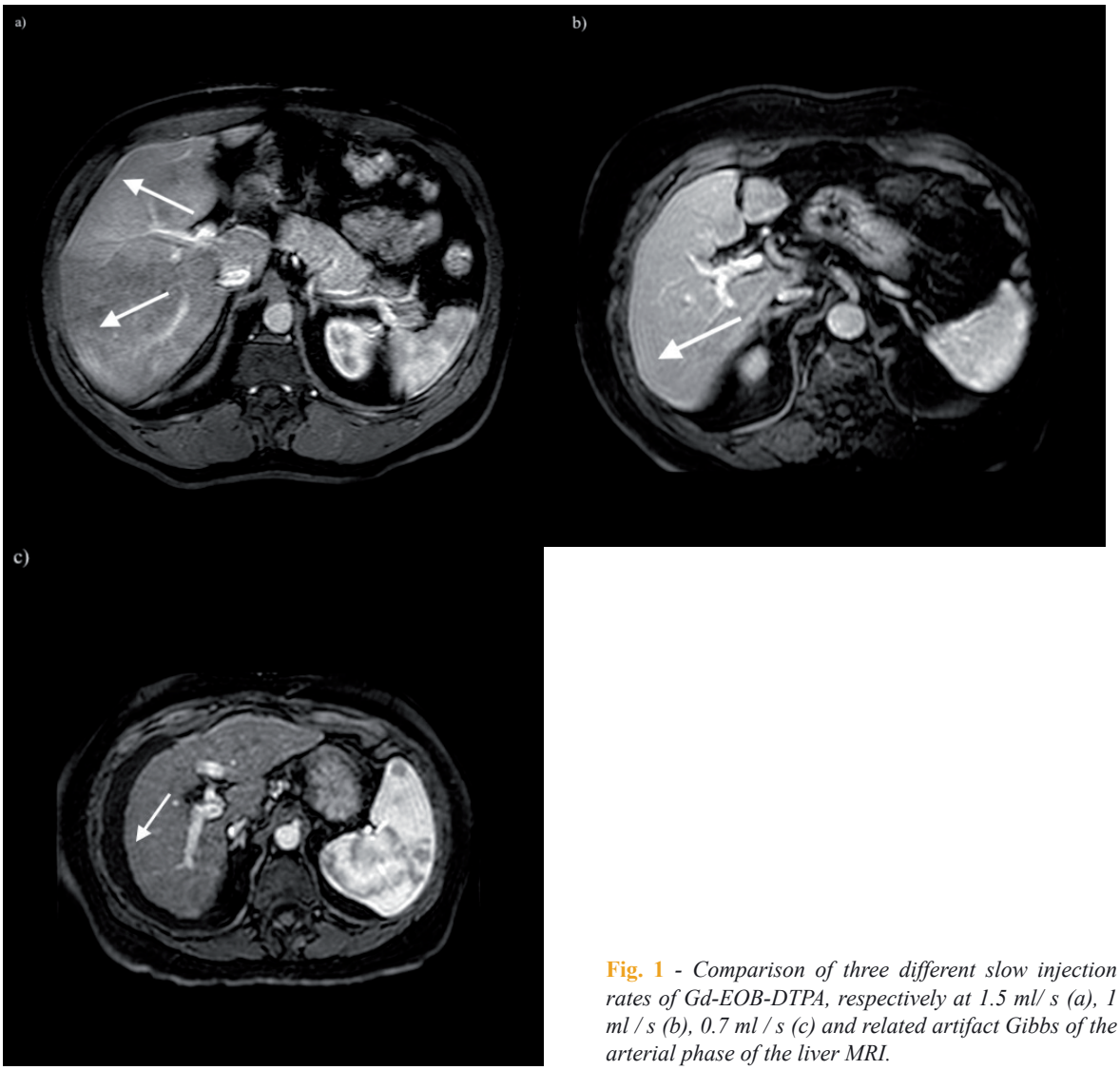

Fig. 1 - *Comparison of three different slow injection rates of Gd-EOB-DTPA, respectively at 1.5 ml/ s (a), 1 ml / s (b), 0.7 ml / s (c) and related artifact Gibbs of the arterial phase of the liver MRI.*

of 1.5 ml/s ($p=0.0029$ and $p=0.0018$ respectively). On the other hand, for observer 2 significant differences in visual acuity were detected using a flow of 0.7 ml/s compared to a flow of 1.5 ml/s ($p<0.05$)

Hepatocellular carcinoma is the most common neoplastic evolution in patients with cirrhosis of the liver. At the state of the art, the diagnosis of hepatocarcinoma is made thanks to the use of multiple imaging methods (ultrasound, computed tomography and magnetic resonance imaging); in particular, the study of the dynamic behavior of the lesion after ev. administration of contrast medium allows to highlight the typical behavior of the hepatocarcinoma. In MRI, the hepatobiliary phase (HBP) allows us to represent the majority of liver cancers since normal hepatocytic absorption by Gd-EOB-DTPA does not occur.
Considering the relative importance of optimizing the quality of arterial images in the study of focal liver lesions with MRI, flow velocity can play an important role in reducing the artifact of high frequency truncation, alleviating this problem. In this study, imaging was conducted at various flow rates. By analogy with other studies in the literature, we have shown that a slower flow and therefore a longer Gd-EOB-DTPA injection time leads to a reduction in truncation artifacts.
The explanation for this evidence is that the a smaller dose of contrast medium per second results in a minimal average variation, at sampling time, between the medium-high frequencies and the low frequencies during the single acquisition. The absence of significant differences in terms of enhancement, revealed in our study, in accordance with previous studies, is justified in the first hypothesis by the adjustment of Time to K0 to the different flow rate used.

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