

The Role of Diffusion Weighted MR Imaging in Assessment of Hepatic Malignancy after Radiofrequency Ablation

Thesis

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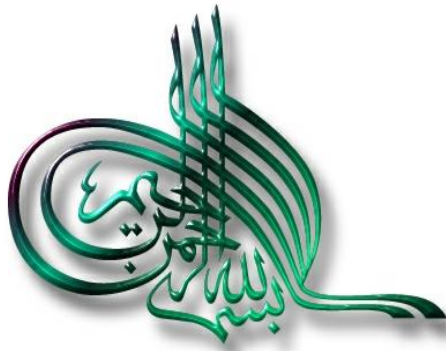
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وَقُلْ اَعْمَلُوا فَسَيَرَى اللّٰهُ
عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ

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Abstract

Keywords: MRI-RFA-DWI-ADC

DWI measures the ADC values, which relate to the movement of water molecules in vivo and indirectly reflect tissue micro-structural characteristics. The use of DWI in liver is relatively new, but very promising for the detection and differentiation of benign and malignant lesions before treatment and on follow-up after treatment. Besides, DWI is thought to be capable of evaluating the response to therapy of malignant tumors. In our study we concluded that DWI together with conventional imaging is a promising tool in the evaluation of the post RFA malignant liver tumors.

Finally we could recommend a cut-off value $1.233 \times 10^{-3} \text{mm}^2/\text{sec}$, with t values below this level, express viability of the malignancy. After RF ablation, the ADC values increase above this limit.

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List of Abbreviations

3D	Three Dimensional.
ADC	Apparent Diffusion Co-Efficient.
AFP	Alpha Fetoprotein.
APA	Arterio-Portal Anastomoses.
ASR	Ablation Site Recurrences.
BH	Breath Hold.
CCA	Cholangiocellular Carcinoma.
CE	Contrast Enhanced.
CNR	Contrast To Noise Ratio
CT	Computed Tomography.
CV	Central Venule.
DD	Differential Diagnosis.
DW MRI	Diffusion Weighted Magnetic Resonance Imaging.
DW	Diffusion Weighted.
DWI	Diffusion-Weighted Imaging.
EHE	Epithelioid Heamangioendothelioma.
EPI	Echo Planar Imaging.
FFE	Fast Field Echo.
Fig	Figure
FISP	Fast Imaging With Steady-State Precession.
FLASH	Fast Low-Angle Shot.
FLC	Fibrolamellar Carcinoma.
FLL	Focal Liver Lesions.
FNH	Focal Nodular Hyperplasia.
FNH	Focal Nodular Hyperplasia.

FS	Fast Spin.
FSE	Fast Spin Echo.
GB	Gall Bladder.
Gd	Gadolinium.
Gd-DTPA	Gadolinium Diethyl Enetriamine Pentaacetic Acid.
GI	Gastrointestinal.
GRAPPA	Generalized Auto- Calibrating Partially Parallel Acquisition.
GRASS	Gradient-Recalled Acquisition In Steady State.
GRE	Gradient Echo.
H& E	Hematoxylin And Eosin
HA	Hepatic Artery.
HBV	Hepatitis B Virus.
HCC	Hepatocellular Carcinoma.
HCV	Hepatitis C Virus.
HMS	Hepatic Microvascular Subunits.
IVC	Inferior Vena Cava.
LFT	Liver Function Tests
LHV	Left Hepatic Vein.
LPV	Left Portal Vein.
MHV	Middle Hepatic Vein.
min	Minute.
MR	Magnetic Resonance.
MRI	Magnetic Resonance Imaging.
MRS	Magnetic Resonance Spectroscopy.
MSCT	Multislice Computed Tomography.
msec	Millisecond
NEX	Number Of Excitation.

No.	Number.
PET	Positron Emission Tomography.
PSA	Prostatic Specific Antigen.
PSC	Primary Sclerosing Cholangitis.
PV	Portal Vein.
RES	Reticulo-Endothelial System
RFA	Radiofrequency Ablation.
RHV	Right Hepatic Vein.
ROI	Region Of Interest.
RPV	Right Portal Vein.
RT	Respiratory Triggered.
SD	Standard Deviation
SE	Spin-Echo.
sec	Second.
SGE	Spoiled Gradient Echo
SI	Signal Intensity.
SNR	Signal To Noise Ratio.
SOR	Standard Of Reference.
SPAIR	Spectral Attenuated Inversion Recovery (Fat Suppression MRI Technique).
SPGR	Spoiled Gradient Recalled.
SPIO	Super Paramagnetic Iron Oxide.
SUV	Standardized Uptake Value
T	Tesla
T1	T1 Weighted Image.
T2	T2 Weighted Image.
TACE	Transcatheter Arterial Chemoembolization.
TE	Echo Time.

THRIVE	High Resolution Isotropic Volume Examination.
TR	Relaxation Time.
TSE	Turbo Spin Echo.
US	Ultrasonography.
VIBE	Volumetric Interpolated Breath Hold Examination.
WIs	Weighted Images.

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INTRODUCTION

Correct detection, classification, and characterization of focal hepatic lesions are of paramount importance as they may significantly affect the choice of therapeutic approach in many cases (**Holzapfel et al., 2010**).

Although liver resection continues to be the standard for curative care in patients with hepatic malignancies, most patients are not candidates for surgical therapy. Therefore, minimally invasive strategies have gained increased attention as therapeutic options for both primary and metastatic hepatic malignancies. These loco-regional therapies include tissue ablation and chemoembolization procedures (**Dodd et al., 2000**).

Ablative techniques can be classified to either chemical or thermal physical (**Befeler, Di Bisceglie, 2002**). Chemical ablation refers to the use of ethanol and acetic acid, whereas Thermal ablation is achieved by using heat (radiofrequency ablation, microwave ablation, laser ablation); or cold (cryoablation) (**Braga et al., 2005 & Goldberg et al., 2003**).

Among all the ablative techniques, radiofrequency ablation (RFA) is the most widely used for both primary and secondary malignancies of the liver but all techniques produce coagulation necrosis (**Braga et al., 2005 & Lencioni et al., 2003 & Howard et al., 2008**).

RFA is accepted as an established local treatment of malignant hepatic tumors improving the survival rates of patients with unresectable liver metastases or being curative for patients with hepatocellular carcinoma (**Solbiati et al., 2001 & Goldberg et al., 2005**).

The rationale for the use of percutaneous ablation techniques is based on some relevant advantages: to destroy the tumor avoiding the loss or the damage of non-tumoral liver parenchyma, as occurs with resection and arterial chemoembolization; the low risk of complication associated with the procedure; the possibility to easily repeat the treatment in case of recurrent lesions; and finally, to be easily available and relatively inexpensive (*McWilliams et al., 2011*).

Assessment of tumor response after loco regional therapies is important in determining treatment success and in guiding future therapy. Several monitors of tumor response have been used, including histology, tumor markers and imaging. However, histologic evaluation using tissue biopsy can only be conclusive when it shows viable malignancy. Therefore, repeated negative biopsies do not exclude the presence of residual tumor. Tumor markers solely are of limited use in assessing tumor response (*Vossen et al., 2006*).

For several years magnetic resonance imaging (MRI) has been used for the evaluation of treatment response in malignant liver lesions.

Magnetic resonance imaging is preferred when further characterization of these masses is needed. MRI has many advantages (e.g., high contrast resolution, the ability to obtain images in any plane, lack of ionizing radiation and the safety of using particular contrast media rather than those containing iodine) that make it a favored modality (*Demir et al., 2007*).

However, after certain loco-regional treatments such as RFA, the assessment of tumor response remains difficult. The usual morphological criteria primarily based on the maximal lesion size cannot be used with

confidence, as the induced ablation zones comprise the tumor and its margin (**Lu et al., 2012**).

Although dynamic contrast enhanced examinations have become a routine component of abdominal imaging, the high cost/benefit ratio and risk of contrast media side effects remain an issue (**Hosny, 2010**).

Residual contrast enhancement may also be difficult to appreciate, since some types of secondary tumors (e.g. colorectal metastases) are hypovascular without strong contrast medium enhancement (**Lu et al., 2012**).

Furthermore, focal liver lesions treated by RF ablation often contain a hypersignal on T1-weighted MR sequences, corresponding to coagulation necrosis, which makes any residual tumoral contrast enhancement difficult to be differentiated (**Bruix et al., 2001**).

Diffusion-weighted MRI (DWI) has then been introduced into abdominal imaging, representing a supplementary tool for detecting and characterizing hepatic lesions (**Lee et al., 2011 & Bruegel, Rummeny, 2010**).

DWI is now increasingly used to evaluate tumors' response to various treatments (**Gourtsoyianni et al., 2008**). It provides unique insight into tissue cellularity, tissue organization, integrity of cells and membranes, as well as the tortuosity of the extracellular space, which can be helpful for detecting malignant diseases, and for distinguishing tumor tissues from non-tumor tissues (**Thoeny, De Keyser, 2007**).

In addition, DWI can help characterize focal hepatic lesions by enabling measurement of lesion apparent diffusion coefficient (**Parikh et al., 2008**).

DWI evaluates the random diffusion of water molecules. Restriction of this diffusion depends on the extracellular matrix and the cellularity of the tissue. It is reported that diffusion and its quantitative representation, the apparent diffusion coefficient (ADC), may increase in hepatic lesions after successful treatment (**Kamel et al., 2006**).

This response seems to reflect the passage of water molecules from the intracellular compartment to the extracellular matrix, due to the induced tumoral cell necrosis. Thus, ADC may be used to assess metabolic tumor response after loco-regional treatment. Additionally, some authors have tried to determine whether the intra lesion measurement of the lowest ADC might be helpful in monitoring tumor recurrence, because this value could reflect the persistence of viable and residual tumor cells (**Lu et al., 2010**).

Diffusion weighted technique should be used as an additional sequence to supplement conventional MRI protocol studies for proper characterization of focal liver lesions (**Vergara et al., 2010**).

The main purpose of this study was to evaluate the primary and secondary hepatic malignancies, before and after treatment by RF ablation, using DWI.