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The Role of Diffusion Weighted MR Imaging in Assessment of Hepatocellular Carcinoma After Radiofrequency Ablation

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ABSTRACT

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy. Surgical resection and local ablative therapies represent the most frequent first lines therapies adopted when liver transplantation cannot be offered. **Aim of the work:** was to evaluate the feasibility of DWI and the corresponding ADC values to detect tumor response after radiofrequency ablation for hepatocellular carcinoma.

Materials and methods: MR examinations were done for 20 HCC patients post-RFA. Pre and postgadolinium enhanced images as well as DW sequences were performed. ADC values of ablation zones and liver parenchyma were assessed. ADC values of ablation zones and adjacent signal alterations identified in DWI were analyzed. **Results:** Residual or recurrent lesions were detected in 4 patients (20%). The mean ADC value of ablated zones differed significantly from that of normal liver parenchyma. The corresponding ADC values were significantly lower in patients with residual lesion than in patients without residual lesion. **Conclusion:** It could be concluded that DWI is a feasible follow-up tool for postablation liver contributing in detection of residual lesion.

Keywords:MR, Hepatocellular Carcinoma, Radiofrequency Ablation

INTRODUCTION

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy and is a leading cause of cancer-related death worldwide [(1)]. Surgical resection and local ablative therapies represent the most frequent first lines therapies adopted when liver transplantation cannot be offered[(2)]**.** Radiofrequency ablation has become the most widely used local thermal ablation method in recent years because of its minimally invasive nature[(3)]**.** After certain loco-regional treatments such as RFA, 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[(4)].

Diffusion-weighted imaging represents a promising non-invasive diagnostic tool for the evaluation of HCC treatment responses to loco regional therapies [(5)]. ADC value changes have been shown to occur early after treatment and correlate well with tumor necrosis [(5)].

The aim of the current study was to assess role of diffusion weighted MRI in evaluation of treatment response after radiofrequency ablation for hepatocellular carcinoma.

PATIENT AND METHODS

The study was conducted during the period between November 2016 and May 2017 at MRI unit at Ain Shams University Hospital on 20 patients (14 male and 6 female) treated by Radiofrequency ablation for hepatocellular carcinoma. **Exclusion criteria** included patients with MRI incompatible devices such as cardiac pacemaker, metallicvalves, hearing aids or aneurismal clips.

Documented consent must be obtained from each patient involved in the study.

1. MR protocol

Magnetic resonance imaging examinations were performed on a Philips InteraAchieva 1.5 T super conducting MR unit , with a 16- channel body coil

2. Pre-contrast imaging included

a) T1 weighted (T1W) images.
b) T2 weighted (T2W) images.
c) T2 SPAIR (Spectral Attenuated Inversion Recovery).
d) In phase and out phase gradient echo sequences.
e) Heavy T2 weighted images.

3. Dynamic study

Dynamic study was performed after bolus injection of 0.1mmol/kg bodyweight of Gadolinium - DTPA at a rate of 2ml/s, flushed with 20ml of sterile 0.9% saline solution from the antecubital vein. The injection of contrast media and saline solution was performed by automatic injector.

4. Diffusion study

Respiratory-triggered fat-suppressed single-shot echo planar DW imaging was performed in the transverse plane with tri-directional diffusion gradients by using different b values 0,300,600 sec/mm2 to increase sensitivity to cellular packing.

5. MR analysis

The morphological features of each lesion were recorded included size, shape, margin, signal characteristics and pattern of enhancement in the dynamic imaging as well as number and site of the detected focal lesions. Then provisional diagnosis was reported. Second, we reviewed the diffusion images with ADC values for final radiological characterization and detection of focal lesion.

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6. ADC calculation

We measured ADC values for each lesion by two different regions of interest. The first region of interest included the average of the whole lesion while the second included the visibly most restricted diffusion area on the ADC map (least ADC value / MRDA).

7. Subtraction images

Subtraction of multiphase contrast enhanced dynamic series were automatically acquired by software of the workstation. Software provided a new series by image –by –image subtraction of precontrast series from each post contrast series (arterial, portal, and delayed) of each patient. Finally, comparisons were hold between the pre and post RF ablation images as regard their ADC values.

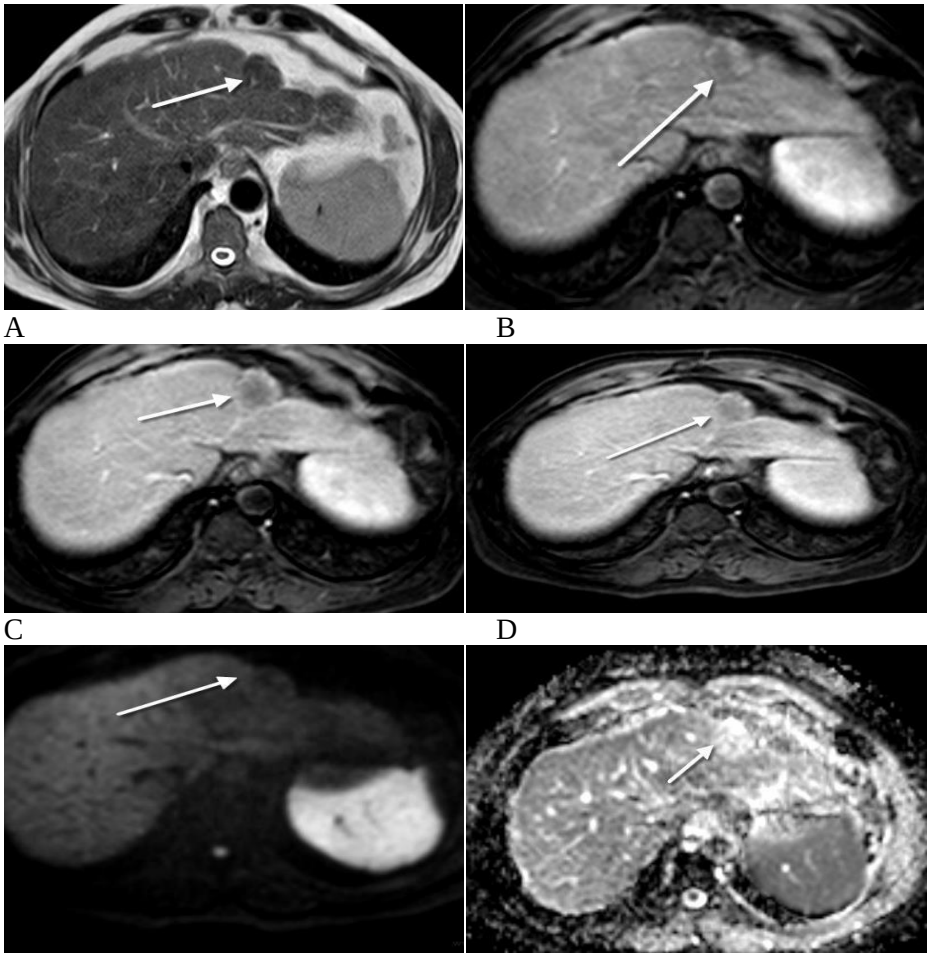
The study was done after approval of ethical board of Ain Shams university and an informed written consent was taken from each participant in the study.

RESULTS

This study included (20) patients, 14 male (70%) and 6 female (30%). their ages ranges from 42 to 73 years with the mean age 49.5 years.

Table(1): Frequencies according to final diagnosis.

1- no evidence of residual or recurrent lesions by MRI study	12	60%
2- no evidence of residual or recurrent lesions by MRI criteria yet MRI showed denovo lesions	3	15%
3-no evidence of residual or recurrent lesions by MRI criteria yet MRI showed multiple dysplastic nodules	1	5%
4-residual or recurrent lesions by MRI criteria.	4	20%



A B C D E F

Figure (1): MRI of the liver showing Well ablated hepato cellular carcinoma.

DWI and ADC values

DWI and ADC imaging can be used to investigate tumor viability at the cellular level after lecoregional therapy. ADC values of tumors treated with locoregional therapy increase after treatment, suggesting increasing cellular necrosis**.**

The mean ADC value of normal liver parenchyma was $1.175 \pm 0.\ 13 \times 10^{-3}$ mm^2/s while that for the ablation zones was $1.4 \pm 0.1 \times 10^{-3}$ mm^2/s. Regarding values in residual or recurrent lesions post loco regional therapy , it was $0.8+ 0.2x\ 10^{-3}$ mm^2/s

In our study, 16 patients showed completely treated lesions with significant rising changes regarding ADC values after RF ablation and no residual enhancement was detected on subtraction images. Of all cases, 4 patients have showed residual enhancement on subtraction images, where viable tumoral tissue appeared hyperintense with significantly lower ADC values (0.8 × 10-3 mm2/sec) than completely ablated necrotic tissue which appeared hypointense with higher ADC values (1.4 × 10-3mm2/sec).

Moreover, it has been shown in our study that the level of ADC may help us to recommend a cut-off value of 1.233×10−3mm2/s. The values below this level, express viability of the malignancy. After RF ablation, the ADC values increase above this limit.

DISCUSSION

It was suggested that MRI is considered more accurate than other imaging modalities not only in detection & characterization of hepatic focal lesions but also in post treatment follow up for the detection of residual or recurrent tumors after treatment, as well as for the depiction of post treatment complications as the early detection of residual or recurrent tumor is important for planning new intervention **[(8)]**.

The success of RFA is determined by the rate of ablation site recurrences (ASR), i.e. tumor recurrence as result of incomplete ablation. Close & careful follow-up is needed in patients who underwent treatment by RFA to detect ASR at an early stage **[(7)]**. The diagnostic management of the liver after RFA remains a challenging issue that is related to difficulties in accurately differentiating residual or recurrent vital tumor from non tumoral tissue changes following thermal therapy. DWI is increasingly applied in the evaluation of treatment effectiveness in the oncologic patient **[(9)]**. Different studies worldwide were established to determine the value of DW-MRI in evaluation of hepatic focal lesions and in assessment of malignant lesions response after loco regional therapy.

It was reported that ADC values of benign hepatic lesions were significantly higher than that of malignant hepatic tumors, with a P value < 0.05 **[(10)]**.

The current study results showed that ablation zones can be differentiated from surrounding liver parenchyma visually in the DW images and by means of ADC maps in all patients.

The present studyshowed the mean ADC of the well ablated lesion was 1.4 X 10^{-3} mm^2/sec and of the residual lesion 0.8 X 10^{-3} mm^2/sec with significant statistical difference between the residual viable tumor and the well ablated lesions.

CONCLUSION

Unlike treatment of other oncologic tumors, locoregional therapies are mainstay treatments of HCC with RFA becoming widely used. Treatment response assessment using imaging is a key factor in the management of patients with HCC. Conventional MRI is inconclusive in detecting viable tumor in postablation patients.

In conclusion, the present study demonstrates that DWI is a feasible follow-up tool for postablation liver providing more information regarding the viability of treated HCCs and contributing in detection of residual or recurrent lesion. Although no significant changes in ADC obtained from the entire ablation zones were detected over time, yet ADC-based evaluation of signal alterations in the periphery of the ablation zone may be helpful in differentiation between residual lesion and post treatment tissue changes.

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