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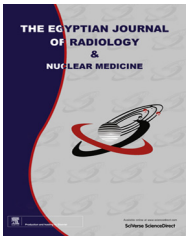

ORIGINAL ARTICLE

MDCT assessment of HCC patient after radiofrequency ablation among Egyptian population: Preliminary experience

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KEYWORDS

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Abstract *Purpose:* Evaluate the role of multi-detector computed tomography (MDCT) in follow up HCC patients after radiofrequency ablation.
Materials and methods: A prospective study was used to assess patients who underwent radiofrequency ablation for treatment of HCC nodules using MDCT. MDCT was done immediately after procedure to asses treatment success, then after one month for decision making; either good ablation or reablation for residual tumor if present. Three and six months follow up for detection of marginal growth or newly developed HCC nodules. One year MDCT follow up for true technical success.
Results: MDCT findings were as follows: immediate evaluation showed good ablation in 29 patients (96.7%), and one patient showed residual tumor tissue reablated at the same session. In one month follow up nodular marginal enhancement denoting residual tumor was seen in 2 patients (6.7%). In three months follow up no residual tumor or recurrence (100%); in six months follow up recurrence was seen in one patient (3.4%) and another patient (3.4%) showed a new HCC focus. In one year follow up marginal recurrence was seen in three patients (10%).
Conclusion: RF ablation is an internationally approved treatment for HCC. MDCT should be the corner stone method for follow to achieve better results and improve the survival rate via early detection and immediate interference with any new or recurrent lesions.

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1. Introduction

Hepatocellular carcinoma is the most common primary malignant liver tumor and one of the most common causes of cancer mortality in the world. It usually arises on top of cirrhotic liver. It has high incidence rate above 40 years with male to female ratio about 8:1 with more than 90% mortality rate. It

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is estimated that HCC is responsible for more than 600,000 deaths annually worldwide (1,2).

Tumor resection is the definitive treatment for HCC. Unfortunately only 20% of patients are candidates for surgical resection. Advanced liver cirrhosis or multicentricity makes surgery impossible. Furthermore, recurrence is frequent even after apparently curative resection (3).

In past decades a variety of minimally invasive therapies have been used as an alternative to hepatic resection such as trans-catheter arterial chemoembolization (TACE), ethanol injection, cryosurgery, microwave ablation, laser photocoagulation and radio-frequency (RF) ablation.(4–9) Among locoregional treatments for hepatocellular carcinoma (HCC), radiofrequency ablation (RFA) has been accepted as the most popular alternative to curative transplantation or resection, and it shows an excellent local tumor control rate and acceptable morbidity (10–13).

The fact that, HCC has a very rich arterial neovascularization, makes it better detected in triphasic MDCT examination during hepatic arterial dominant phase. This also makes MDCT, the most accepted imaging modality for evaluation of therapeutic response to RF ablation. It helps in making decision whether the patient is completely cured or will be amenable for treatment repetition (14–17).

2. Patient and methods

Thirty patients were studied in a prospective study conducted between August 2010 and September 2011. They were presented at the radiology department, El-Minia University Hospital. All of them underwent radiofrequency ablation for HCC on top of liver cirrhosis after approval from the ethics committee of our institution and written consent from each patient was obtained. Follow up MDCT examination was done for all of them at 1, 3, 6 and 12 months interval.

2.1. Inclusion criteria for RF ablation

- Patients with HCC diagnosed by US as a hypo-echoic hepatic lesion on top of cirrhotic liver with coarse parenchyma. The lesion confirmed by triphasic CT as intensely enhanced lesion in the arterial phase. Alpha feto protein (AFP) was done to all for confirmation.
- Tumor size not greater than 5 cm.

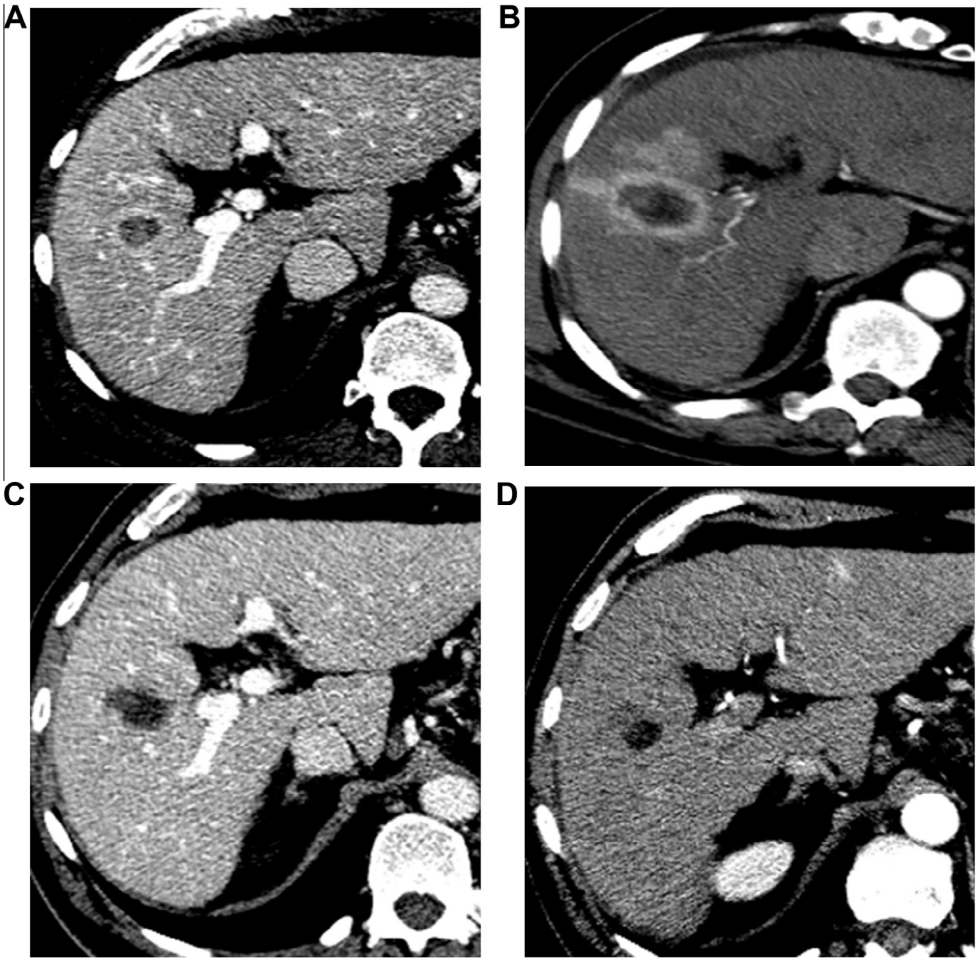

Fig. 1 (A) Small sized HCC with marginal enhancement. (B) Immediate post RF showed good ablated lesion with marginal hyperemic zone, no residual tumor. (C) 3 months follow up showed good ablated lesion, no recurrence. (D) 6 months follow up showed reduction in the size of the ablated lesion, no recurrence and no distant spread.

Table 1 MDCT findings in 30 patients with HCC immediately after RF ablation.

CT findings	Number
Hypo-attenuated coagulation zone	27 (90%)
Gas bubbles	24 (80%)
Marginal hyperemic zone	24 (80%)
Immediate complication	3 (10%)
Tumor residual	1 (3.3%)

- Patent portal vein and no ascites in both ultrasound and MDCT (Child Pugh class A or B).

2.2. Exclusion criteria from the study

- Patients not amenable for RF ablation e.g. patients with PV thrombosis, metastasis, severe coagulation disorders, lesions larger than 5 cm and multi-centric tumors.

2.3. Imaging protocol

1. *Abdominal ultrasonography:* Using logic pro General Electric machine with curved array transducer, and frequency ranging from 3.5 to 11 MHz. Any focal lesion detected was evaluated as regards site, size, characteristics and any associated pathyology e.g. portal vein thrombosis or ascites. Any solid lesion on top of cirrhosis was considered to be malignant and sent for MDCT and AFP.
2. *Abdominal MDCT:* Using 16-detector MDCT scanner (Bright Speed 16; GE Medical Systems) after oral abdominal preparation. Contrast material was injected with a power injector (Medrad, Stellate) through an 18–20 gauge catheter into the antecubital vein. The injection rate was 4 mL/s. A total of 90 mL of nonionic contrast material was used. Imaging protocol was: Arterial phase at (30–35 s), portal (70–75 s), and equilibrium (>3 min) phases. The acquisition parameters were 120 kVp, 440 mAs, a helical pitch of 1.375:1, 16×1.25 mm detector configuration, 5.3 s total exposure time, 1.25 mm helical slice thickness, and 0.625 mm reconstruction interval with a large FOV. For image reconstruction, the axial source images were transferred to an Advantage Workstation Volume Share 2 (GE Healthcare). Multiplanar reformatted images (MPR) were obtained in the coronal and sagittal planes to evaluate anatomic relations of lesions. MIP reconstruction was used to evaluate hepatic arteries and curved planner traces the portal vein.
3. *Radiofrequency Ablation procedure:* For all patients was done under general anesthesia. RF generator used was RITA Medical Systems, Inc., Mountain View, Calif. with

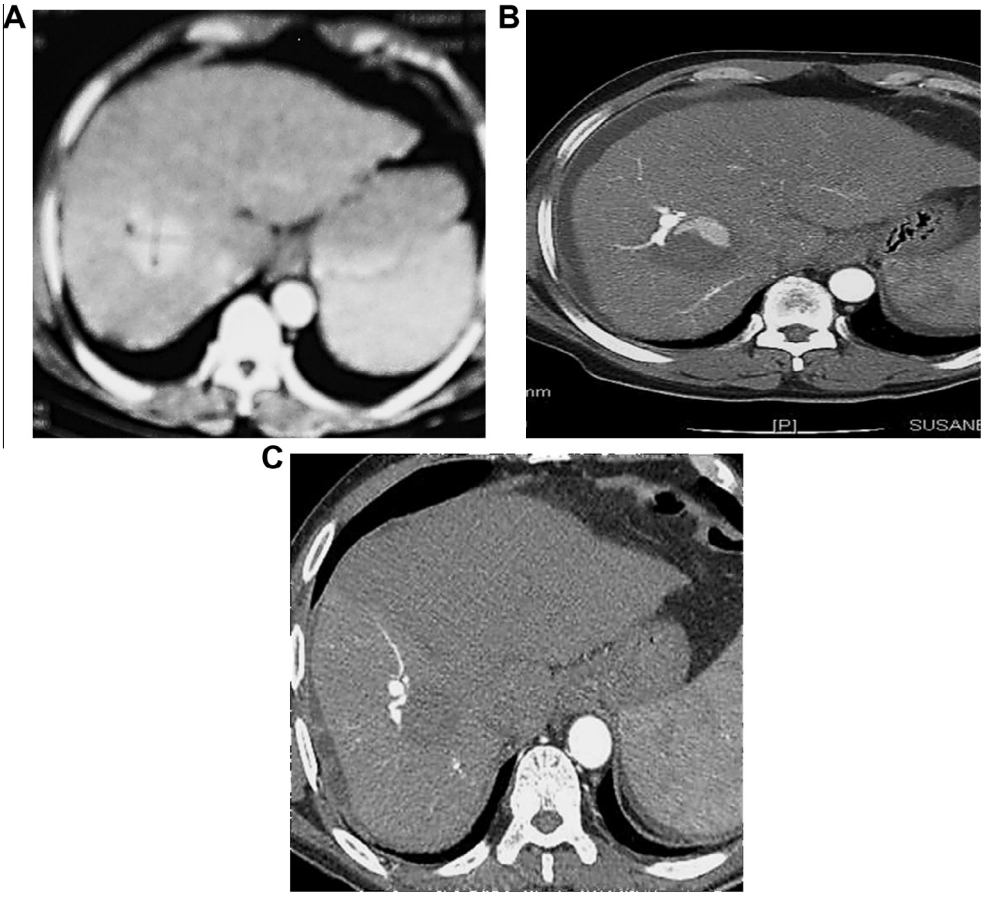

Fig. 2 (A) Medium sized HCC post RF ablation with good ablated central zone and its surrounding hyperemia. (B) One month follow up showed local marginal recurrence presented as intensely enhanced marginal nodule at the periphery of the lesion. (C) The lesion after second RF ablation session with complete ablation.

umbrella type electrodes that cover a range 2–6 cm in diameter. The technique was done either under US, CT guided or combination of both techniques according to tumor location and accessibility. Immediately post RF ablation MDCT was done to assess RF coverage; presence of residual and need for reablation; detection of immediate complications; assessment of marginal hyperemia and to confirm a tumor-free margin (at least 5 mm).

4. *Follow up MDCT protocol was done as follows:*
   - 1 month follow up for evaluation of residual tumor or delayed complication.
   - 3 and 6 months follow up to determine any recurrence or newly developed HCC nodules.
   - One year follow up for evaluation of true technical success.

2.4. MDCT image analysis

- Ablation was considered to be complete when no enhancement was seen within the ablated lesion. Peripheral enhancement immediately post RF was considered perifocal reactive hyperemia.
- Nodular or irregular enhancement at the arterial phase was considered to be viable tumor (residuals or recurrence) according to the time of assessment.
- New HCC enhancing nodules were considered with respect to ablated lesions.
- Post RF ablation complications were recorded including; major complications (hemoperitoneum, bowel or gastric perforation, pneumothorax, hemothorax, hydrothorax and AVF) and minor complications (infection, sub capsular hematoma and biloma).

3. Results

In our study we recruited thirty patients who underwent RF ablation for HCC nodules. They were 23 males (76.6%) and 7 females (23.3%). Their ages ranged between 54 and 64 with mean age of 59 ± 5 years.

All patients underwent baseline pre-ablation high quality multiphasic MDCT for assessment of site, size and number of lesions. 24 patients (80%) had HCC nodules at the right hepatic lobe and 6 patients (20%) at the left hepatic lobe. Regarding the tumor size; it was ranging from 2.5 to 4.5 cm (mean 3.5 cm).

In MDCT 25 lesions were hypervascular in the arterial phase, while 5 lesions were hypo vascular and confirmed with alpha-feto-protein.

Immediate post ablation triphasic MDCT study was performed for all patients and reviewed immediately before recovery from anesthesia to confirm complete ablation of the tumor. The ablated area appeared as hypo attenuation area relative to the surrounding liver with no enhancement (29/30) patients. One patient showed enhancing marginal nodule in the arterial phase denoted residual tumor tissue that is reablated in

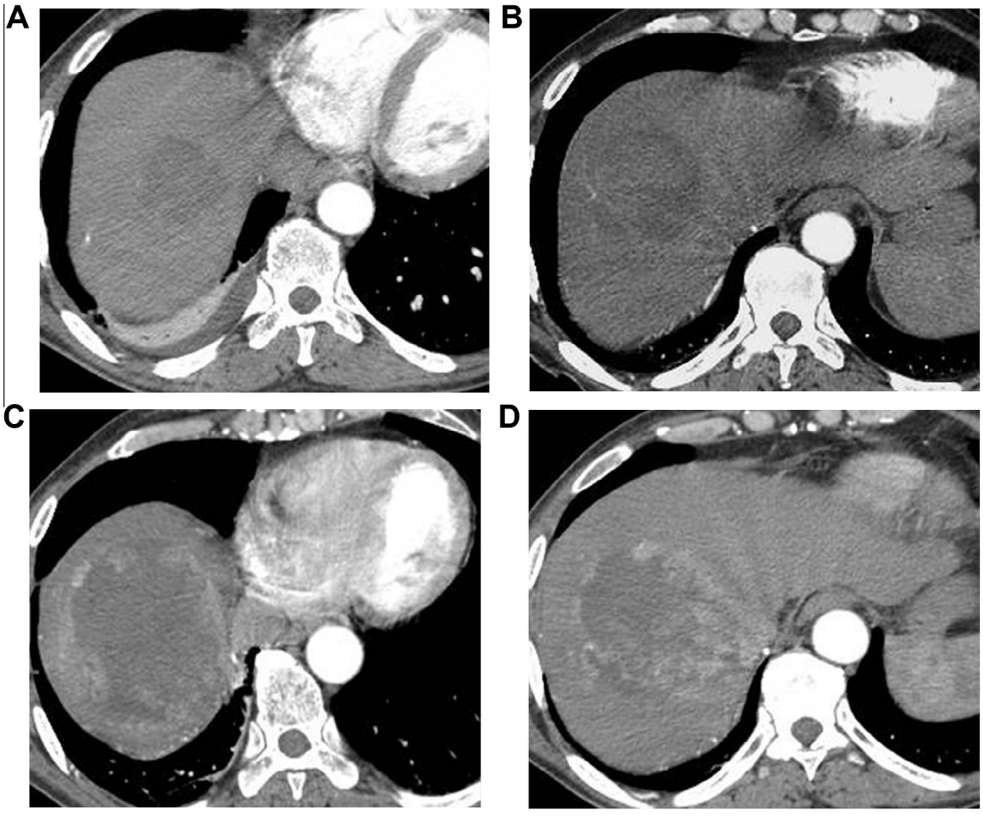

Fig. 3 (A) Large sized HCC 1 month after RF ablation showing complete ablation. Mild Rt. basal consolidation and minimal pleural effusion were detected. (B) 3 months follow up showed no enhancement. (C) and (D) 6 months follow up showed increase in the size of the lesion and circumferential irregular nodular marginal enhancement denoting local tumor recurrence which required a session of chemoembolization.

the same session. All patients showed bright zone around the ablated lesions denoted reactive hyperaemia (Fig. 1) (Table 1).

MDCT follow up was done at 1, 3, 6 and 12 months. In all our follow ups gas bubbles and the hyperemic zone disappeared in all studies. In one month follow up nodular marginal enhancement denoted residual tumor was seen in 2 patients (6.6%) (Fig. 2) while hypo attenuation zone denoted good ablation was seen in 28 patients (93.4%). Three months follow up showed the hypo attenuation zone with no contrast enhancement either marginal or in any site of the hepatic parenchyma (100% of patients) confirming no residual tumor or recurrence. Six months follow up showed recurrence in one patient as enhancing marginal nodule (3.3%) (Fig. 3) and another one (3.3%) showed a new focus at the left hepatic lobe which is also ablated immediately after detection (Fig. 4). One year follow up showed enhancing marginal nodules denoted marginal recurrence in three patients (10%) that need reablation. Meaning that early good results do not assure high rate of success (Table 2).

Multiple post RF complications were detected in our study. They included major complications such as intra peritoneal hemorrhage, biloma and A-V shunt that were seen in one patient for each. Minor complications also encountered are shown in Table 3.

4. Discussion

In the last decade there was an extensive use of ultrasound surveillance, in patients with hepatic cirrhosis. This made HCC diagnosis increasing at an early asymptomatic stage which includes Child A and B categories. Ultrasound represented a very satisfactory diagnostic tool, approved to have high sensitivity approaching 90% in detection of HCC nodules. However, its role as a follow up method after RF ablation was not satisfactory, because it only provides morphological assessment of the lesions with no sufficient information about tissue viability (18).

Precise assessment of post RF treatment needed a new tool that can provide a dynamic study, assess coagulated (dead) tissue and the possibility of any residual or recurrent viable tumor tissues. After recent advances in the era of MDCT, now it is considered the modality of choice to assess treatment response for ablated hepatic focal lesions.

In our study we enrolled 30 patients with small and medium sized HCC to evaluate the efficiency of high quality MDCT in follow up of post RF ablation patients. Immediate MDCT study showed successfully ablated lesion as hypodense area with no contrast enhancement in the arterial phase which is believed to represent necrosis of ablated tumor tissue. Residual viable tumor tissue was seen as enhancing irregular marginal nodule in the arterial phase. This agreed with what described before in many reports (12,13,17,19).

Peripheral thin rim of enhancement with uniform thickness seen in 56.6% of our patients in immediate post RF study represented reactive hyperemia and disappear at one month follow up study. This agreed with what reported by Lim et al. (2001) who detected the same feature in 79% of his patients (17).

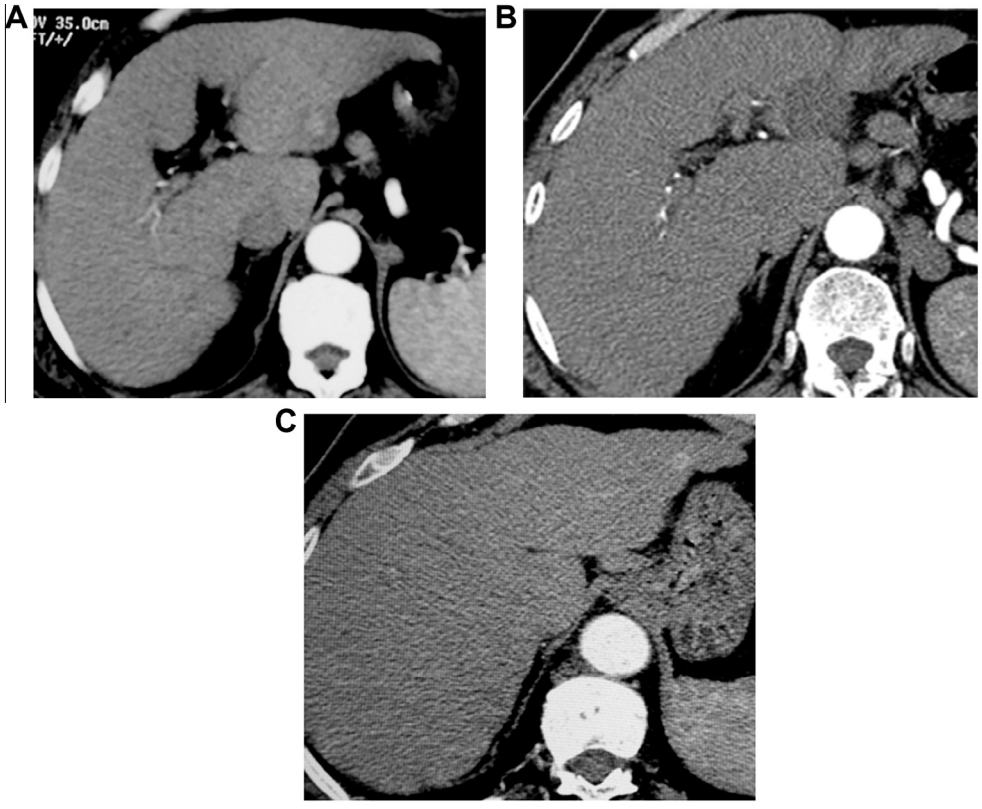

Fig. 4 (A) Axial CT image showing a small HCC nodule at segment II with mild enhancement in the arterial phase. (B) 3 months follow up after RF ablation showing good ablation, no residual. (C) Six months follow up; the ablated area with no enhancement but there is a newly developed enhancing small HCC nodule at segment II away from ablated zone. The new lesion ablated in another setting.

Table 2 MDCT findings in follow up of 30 patients post RF ablation of HCC nodules.

MDCT findings	One month	Three month	Six month	One year
Hypo-attenuation zone denoting good ablation	28 (93%)	30 (100%)	28 (93%)	27 (90%)
Marginal enhancing nodules denoting local recurrence	2 (6.6%)	0	1 (3.3%)	3 (10%)
Newly developed enhancing nodule denoting distant spread	0	0	1 (3.3%)	0
Late complication	4 (13%)	2 (6.6%)	1 (3.3%)	1 (3.3)

Table 3 Post RF complications.

Complication	Number	Percent
Pleural effusion	2	6.6
Rt. basal consolidation	2	6.6
Sub-capsular hematoma	2	6.6
Biloma	1	3.3
Arterio-venous shunt	1	3.3
Intraperitoneal hemorrhage	1	3.3

In one month follow up we had a high rate of success (93.3%) compared with previous reports such as Lim et al. (2001). However, we found in our study that good results in early MDCT did not assure successful treatment. There was no evidence of any enhancing tumor tissue in six months follow up however, later in one year follow up we had 3 patients (10%) with enhanced tumor regrowth at the periphery of the ablated lesions. This was concordant with previous studies such as Gazelle et al. (2000) and Lim et al. (2001) who stated that rates of local tumor recurrence have been reported to vary from 1.8% to 34%. This may be attributed to the inability to identify the residual tumor within the hyperaemic zone that often present after ablation (13,17).

This problem necessitates the use of other facilities of imaging such as CT perfusion or other functional imaging such as contrast enhanced MRI or PET CT to reduce the rate of recurrence in delayed follow up and increase the rate of technical success. This agreed with Ippolito et al. (2013) who stated that CT perfusion enables the assessment of vascularity of lesions after RF ablation, by adding the quantitative information about the presence of any residual vessels within viable tissue. Also agreed with Park et al. (2008) who stated that functional modality may be an important diagnostic method for early detection of residual tumor tissue and local progression (20,21).

However MDCT can detect many complications after the procedure. Two of them only were major; intraperitoneal hemorrhage and A-V shunt. This was considered accepted rate of complications regarding what was reported in other studies such as that of Livraghi et al. (2003) and Mulier et al. (2002) where they reported that the rate of complication of RFA ranged from 2.4% to 8.9%. On contrary to the study of Lim et al. (2001) that included 40 patients and arterio-venous shunt was detected in 10 of them (17,22,23).

5. Conclusion and recommendation

RF ablation is proved to be relatively safe, non invasive treatment for HCC nodules. Strict MDCT follow up must be applied for early detection of local recurrence or distant spread that allowed complete control of the disease and improved the technical rate of success. However, addition of other functional imaging methods such as CT perfusion, PET CT or contrast enhanced MRI may increase the accuracy of procedure evaluation and increase the rate of technical success.

Conflict of interest statement

None.

References

(1) Laghi A et al. Hepatocellular carcinoma: detection with triple-phase multi-detector row helical CT in patients with chronic hepatitis. Radiology 2003;226(2):543–9.
(2) Ishikawa T. Strategy for improving survival and reducing recurrence of HCV-related hepatocellular carcinoma. World J Gastroenterol 2013;19(37):6127–30.
(3) Shiina S, Tateishi R, Arano T, Uchino K, Enooku K, Nakagawa H, et al. Radiofrequency ablation for hepatocellular carcinoma: 10-year outcome and prognostic factors. Am J Gastroenterol 2012;107(4):569–77.
(4) Gervais DA, Goldberg NS, Brown DB, Soulen MC, Millward SF, Rajan DK. Society of interventional radiology position statement on percutaneous radiofrequency ablation for the treatment of liver tumors. J Vasc Interv Radiol 2009;20:S342–7.
(5) Peng ZW, Lin XJ, Zhang YJ, Liang HH, Guo RP, Shi M, et al. Radiofrequency ablation versus hepatic resection for the treatment of hepatocellular carcinomas 2 cm or smaller: a retrospective comparative study. Radiology 2012 Mar;262(3):1022–33.
(6) Murakami R, Yoshimatsu S, Yamashita Y, Matsukawa T, Takahashi M, Sagara K. Treatment of hepatocellular carcinoma: value of percutaneous microwave coagulation. AJR Am J Roentgenol 1995;164:1159–64.
(7) Vogl TJ, Muller PK, Hammerstingl R, et al. Malignant liver tumors treated with MR imaging–guided laser-induced thermotherapy: technique and prospective results. Radiology 1995;196:257–65.
(8) Haddad FF, Chapman WC, Wright JK, Blair TK, Pinson CW. Clinical experience with cryosurgery for advanced hepatobiliary tumors. J Surg Res 1998;75:103–8.
(9) Sutherland LM, Williams JA, Padbury RT, Gotley DC, Stokes B, Maddern GJ. Radiofrequency ablation of liver tumors: a systematic review. Arch Surg 2006;141(2):181–90.
(10) Rhim H, Lim HK. Radiofrequency ablation of hepatocellular carcinoma: pros and cons. Gut Liver 2010;4:S113–8.
(11) Lin SM. Local ablation for hepatocellular carcinoma in Taiwan: different points between Japan, Asia and West. Oncology 2010;78:102–6.
(12) Lim HK. Radiofrequency thermal ablation of hepatocellular carcinomas. Korean J Radiol 2000;1:175–84.
(13) Gazelle GS, Goldberg SN, Solbiati L, Livraghi T. Tumor ablation with radio-frequency energy. Radiology 2000;217:633–46.
(14) Rhim H, Lim HK, Choi D. Current status of radiofrequency ablation of hepatocellular carcinoma. World J Gastrointest Surg 2010;2(4):128–36.
(15) Silverman PM, Szklaruk J. Controversies in imaging of hepatocellular carcinoma: multidetector CT (MDCT). Cancer Imaging 2005;5(1):178–87.

(16) Lim HK, Han JK. Hepatocellular carcinoma: evaluation of therapeutic response to interventional procedures. Abdom Imaging 2002;27:168–79.
(17) Lim HK, Choi D, Lee WJ, et al. Hepatocellular carcinoma treated with percutaneous radio-frequency ablation: evaluation with follow-up multiphase helical CT. Radiology 2001;221: 447–54.
(18) Chen MH, Liu JB, Yan K, et al. Ultrasound guided radiofrequency ablation of malignant hepatic tumors. Chin J Ultrasonogr 2001;10:404–7.
(19) Solbiati L, Goldberg SN, Ierace T, Dellanoce M, Livraghi T, Gazelle GS. Radio-frequency ablation of hepatic metastases: post procedural assessment with a US micro bubble contrast agent—early experience. Radiology 1999;211:643–9.
(20) Ippolito D, Bonaffini PA, Capraro C, Leni D, Corso R, Sironi S. Viable residual tumor tissue after radiofrequency ablation treatment in hepatocellular carcinoma: evaluation with CT perfusion. Abdom Imaging 2013;38(3):502–10.
(21) Park M, Rhim H, Kim Y, Choi D, Lim HK, Lee WJ. Spectrum of CT findings after Radiofrequency ablation of hepatic tumors. Radiographics 2008;28:379–90.
(22) Livraghi T, Solbiati L, Meloni MF, et al. Treatment of focal liver tumors with percutaneous radiofrequency ablation: complications encountered in a multicenter study. Radiology 2003; 226:441–51.
(23) Mulier S, Mulier B, Ni Y, et al. Complications of radiofrequency coagulation of liver tumors. Br J Surg 2002;89:1206–22.