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Role of Percutaneous Microwave Ablation in Treatment of Hepatocellular Carcinoma

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Abstract

Introduction: Hepatocellular carcinoma (HCC) is one of the most common malignancies worldwide with an annual occurrence of one million new cases. An etiologic association between HBV infection and the development of HCC has been established. Hepatitis C virus is also proving an important predisposing factor for this malignancy, the use of minimally invasive Percutaneous ablative technique (e.g. Radiofrequency (RF) and Microwave ablation (MW) has gained great momentum and because of the drawbacks of RF ablation, several groups have successfully proved the efficacious nature of Microwave ablation in the treatment of hepatocellular carcinoma.

Aim of the Work: The aim of this work is to highlight the role, the principles and the applications of percutaneous Microwave Ablation in Hepatocellular carcinoma.

Methods: The studied group included 30 patients (25 men and 5 women) with hepatocellular carcinoma. All patients underwent microwave ablation for the hepatocellular carcinoma.

Results: The results of the procedures will be assessed as regarding sizeand enhancement of the lesion (s) on triphasic CT abdomen before the procedure and at the follow up at one month as well as the Alpha fetoprotein levels.

Conclusion: MWA technique represents a safe, fast and efficacious way to perform hepatic ablation in patients with HCC. Initial results are encouraging; however, longer follow-up is needed for further classification of our results.

INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most common malignancies worldwide with an annual occurrence of one million new cases. An etiologic association between HBV infection and the development of HCC has been established. Hepatitis C virus is also proving an important predisposing factor for this malignancy.(1)

Given that most patients present initially with unresectable tumors, the use of minimally invasive Percutaneous ablative technique (e.g. Radiofrequency (RF) and Microwave ablation (MW) has gained great momentum and because of the drawbacks of RF ablation, several groups have successfully proved the efficacious nature of Microwave ablation in the treatment of hepatocellular carcinoma.(2)

The main advantages of microwave technology, when compared with existing thermo-ablative technologies, include consistently higher intra-tumoral temperatures, larger tumor ablation volumes, faster ablation times, and an improved convection profile.(2)

Recently newly developed antennas and techniques are used to increase efficiency of the microwave ablation as cooled-shaft microwave ablation antenna which enabled delivery of greater energy without concern about skin burns.(3)

THE AIM OF THE WORK

The aim of this work is to highlight the role, the principles and the applications of percutaneous Microwave Ablation in Hepatocellular carcinoma.

METHODS

This study will be conducted over a period of 3 years on 30 patients (25 men and 5 women) presenting with hepatocellular carcinomas. All patients should undergo triphasic CT scan before the procedure for better diagnosis and for follow up.

Patients included in our study will have one of the following criteria: Single nodular HCC lesions of 8 cm or smaller, Five or fewer

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multiple nodular HCC lesions with a maximum dimension of 6 cm or less in each nodule, Absence of portal vein thrombosis, Absence of extra-hepatic metastases, Prothrombin time of less than 25 seconds, HCC nodule at least 5 mm away from the main biliary duct of the hepatic hilum and the bowel and Presence of an appropriate route for percutaneous puncture under US guidance.

The patients with one or more of the following criteria will be excluded from the study: Liver dysfunction (impaired blood coagulation, low serum albumin level, ascites as sign of liver failure), Advanced age with chronic kidney or heart disease, Multiple lesions located in different hepatic segments, Obstructive jaundice due to the potential risk of bleeding and bile peritonitis

The results will be collected and statistically analyzed. The routine procedure that the patients would have is as follows: All the procedures will be done as inpatient procedures, Signed consent, Combined general and local anesthesia.

The lesion is well defined by ultrasound and the microwave needle will be inserted at the center of the lesion under ultrasound guidance, Simultaneous Activation Microwave Ablation System with Multiple Antenna Clusters will be used for all patients. Ablation of the entry track is done to avoid seeding of the tumor.

RESULTS

The study included all cases referred from hepatic surgery department between January 2011 and January 2014; that fulfilled the informed consent and inclusion criteria.

MW ablation was utilized to treat 38 hepatic tumor nodules in 30 patients and treated with ultrasound-guided percutaneous MWA. The study group included 25 male patients (83.3%) and 5 female patients (16.6%), with age ranging from 50 to 70yrs (mean age 60.4yrs).

Twenty five patients had a single tumor nodule while 3 patients had 3 nodules and 2 patients had two tumor nodules, with a mean size of 5.5cm. The locations of these tumors were evenly distributed for both the right and left lobes.

The mean age of study cases was 64.4±5.8yrs; males represented 83.3% of cases. HBV and HCV were present among 33.3% and 93.3% of cases respectively. About 67% of cases were Child A (Table 1).

Table (1): Description of personal and medical data among cases.

		Mean	±SD	Min.	Max.
Age		60.40	5.82	50.00	70.00
Sex	Male (n %)	25	83.3%		
	Female (n %)	5	16.7%		
HBV	Yes (n %)	10	33.3%		
	No (n %)	20	66.7%		
HCV	Yes (n %)	28	93.3%		
	No (n %)	2	6.7%		
Child classification	A (n %)	20	66.7%		
	B (n %)	10	33.3%		

The etiology of their liver disease was hepatitis C virus in 20 cases (66.6%), hepatitis B virus in 2 cases (6.6%) and hepatitis B and C virus in 8 cases (26.6%) (Fig. 1).

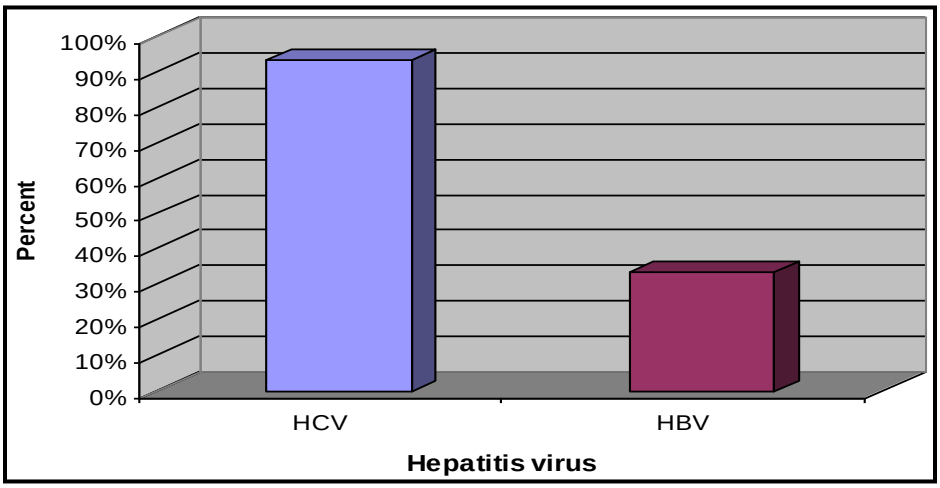

Fig. (1) : Bar chart showing etiology of liver disease by HCV and HBV.

Among the thirty patients, 20 patients were classified as Child-Pugh class A (66.6%) and 10 patients were classified as Child-Pugh class B (33.3%). patients C were excluded from the study (Fig. 2).

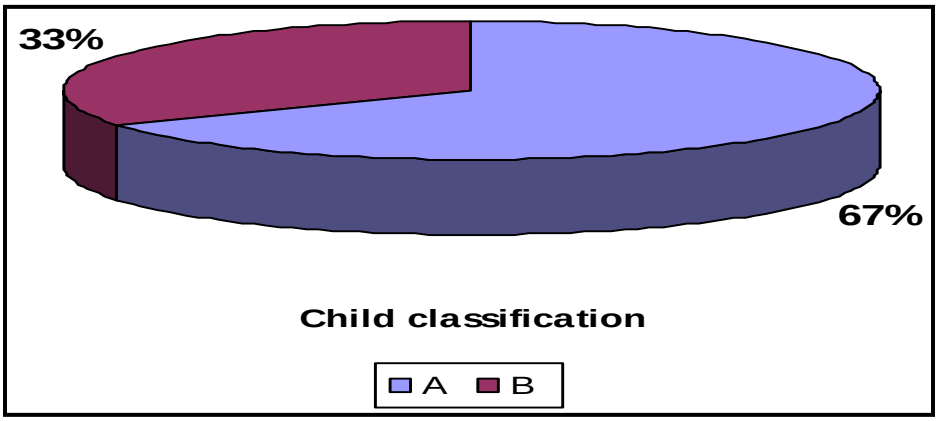

Fig. (2) : Pie chart showing child classification of patients in the study.

Diagnosis was made by typical computed tomography (CT) criteria of HCC by triphasic spiral CT with or without elevation of α-fetoprotein. The number of patients with single tumor nodule were 25 patients (83.3%); 20 of them had the lesion in the right lobe (66.6%) and 5 of them had the lesion in the left lobe (16.6%), with maximum lesion size up to 8cm., 15 patients of which had a lesion ranging from 3-5cm. (50%) and in 10 patients the lesion was ranging from 5-8cm. (33.3%). Those with multiple tumor nodules were 5 patients (16.6%) with a maximum size of each lesion of 5cm. Three patients of which had three lesions in the right lobe and two patients with two lesions each of them had one in the right and the other in the left lobe.

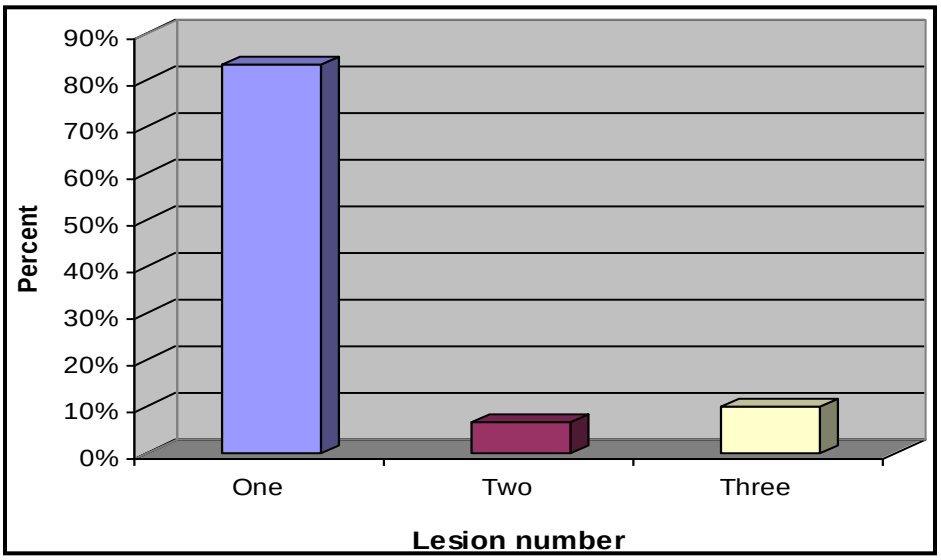

Fig. (3) : Bar chart showing the number of lesions before ablation.

Table (2) : Description of lesion characteristics among cases.

		N	%
Lesion site	Right	31	83.8%
	Left	6	16.2%
Lesion Number	One	25	83.3%
	Two	2	6.7%
	Three	3	10.0%
Lesion size	Mean ±SD	4.27±1.54	
	Range	2-8	

Twenty five patients (83.3%) of the 30 patients had an increased serum α-fetoprotein level (>200μg/L) and 5 patient had normal serum α-fetoprotein level (16.6%).

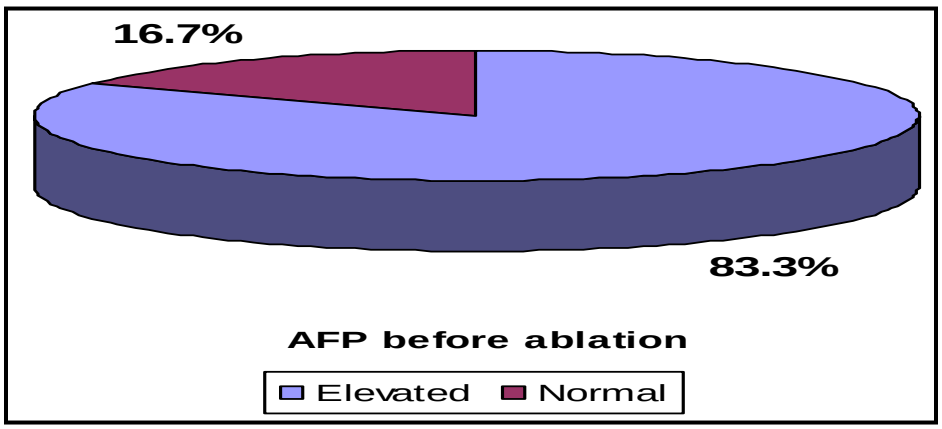

Fig. (4) : Pie chart showing percentage of AFP level in patients before ablation.

Right side lesions represented 83.8% of ablated lesions. The majority of cases (83.3%) had single lesion with a mean lesion size of 4.27±1.54cm.

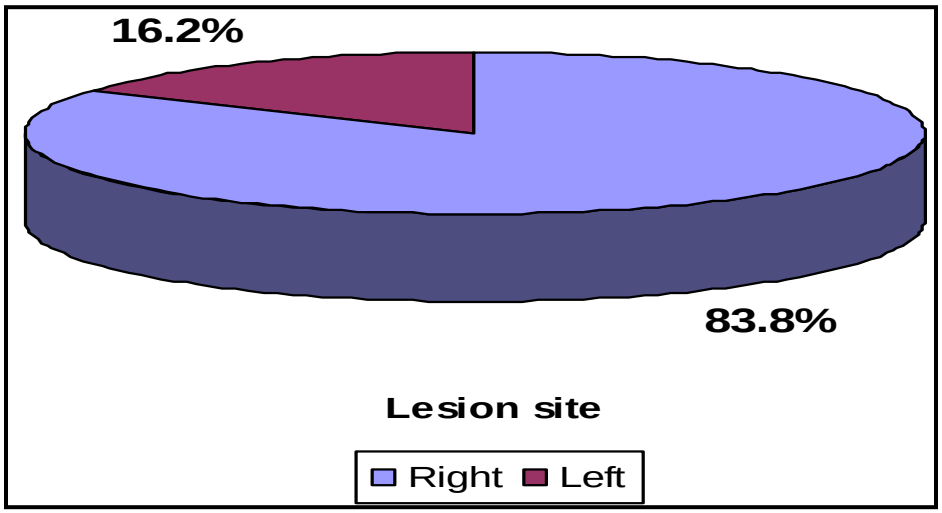

Fig. (5) : Pie chart showing the site of lesions weather right or left lobes.

All cases had CT enhancement before ablation (100%), with 83.3%had elevated AFP level.

Table (3): Description of CT enhancement and AFP before ablation among cases.

		N	%
CT enhancement before ablation	Yes	30	100.0%
AFP before ablation	Elevated	25	83.3%
	Normal	5	16.7%

All patients completed the procedure safely and the median ablation time was 10min (range: 5-15min).

Technical success, as determined at dynamic CT performed 1 month after percutaneous MWA, was achieved in 38 (100%) of 38 nodules.

Table (4): Description of CT enhancement and AFP after ablation among cases.

		N	%
CT enhancement after ablation	No	30	100.0%
AFP after ablation	Decreased	25	83.3%
	Normal	5	16.7%

All cases had No CT enhancement after ablation (100%), with 83.3%had decreases AFP level.

Follow-up for all cases extended for 6 months with a mean of 4 months (162 days ±81); including the first follow-up step at 1sth month after MWA then after 3-5 months; accordingly 10 (33.3%) patients were followed once, and 20 (66.6%) patients were followed twice. During this limited period, none of the patients died, no local recurrence was detected, however, new lesions at other sites of the liver occurred in 3 (10%) patients.

Alpha-fetoprotein (α-FP) was measured for all patients pre-operatively, mean α-FP was 317.9±235.1 (median= 231). Patients with values <200µg/L (n= 25) were excluded from follow-up with α-FP. Those patients were only evaluated by CT examination. Out of the 5 patients that had α-FP with values >200µg/L, 3 patients showed decreased level to within the normal range one month after ablation. The patient with increased α-FP showed a significant decrease in α-FP level at 4 month post-ablation, but was still above the normal range, then it dropped to the normal level at 7 months post-ablation (Table 2).

Comparison between preoperative versus follow-up a-fetoprotein values showed that values significantly decline by time (for 1m, 4m and 7m comparisons, respectively). Moreover, there was significant decline on comparing a-fetoprotein at 4m versus that at 7m.

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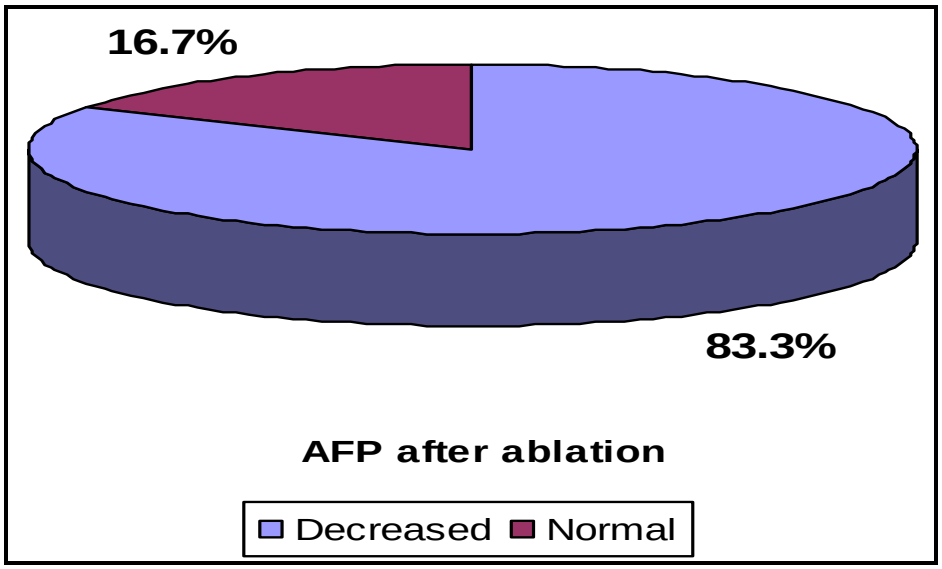

Fig. (6) : Pie chart showing percentage of AFP level in patients after ablation.

The mean INR of study cases was 1.08±0.17; the mean ablation time was 9.43±5.5.

Table (5): Description of INR and ablation time among cases.

	Mean	±SD	Minimum	Maximum
INR	1.08	0.17	0.80	1.40
Ablation time	9.43	5.50	3.00	16.00

In our study, no complication occurred related to the ablation procedure. After percutaneous MWA, one patients had mild pleural effusion. The effusion was relieved with the oral administration of analgesics and antibiotics and chest physiotherapy. One patient had small 2x2cm subcapsular hematoma that resolved on follow up after two weeks with n o treatment. Five (16.6%) patients had a mild fever, which lasted 1-3 days. No other clinically relevant complications were observed.

Table (6): Description of complication among cases

		N	%
Fever	Yes	5	16.7%
	No	25	83.3%
Hematoma	Yes	1	3.3%
	No	29	96.7%
Pleural Effusion	Yes	1	3.3%
	No	29	96.7%

About 17% of cases had fever, 3.3% had hematoma and 3.3% had pleural effusion.

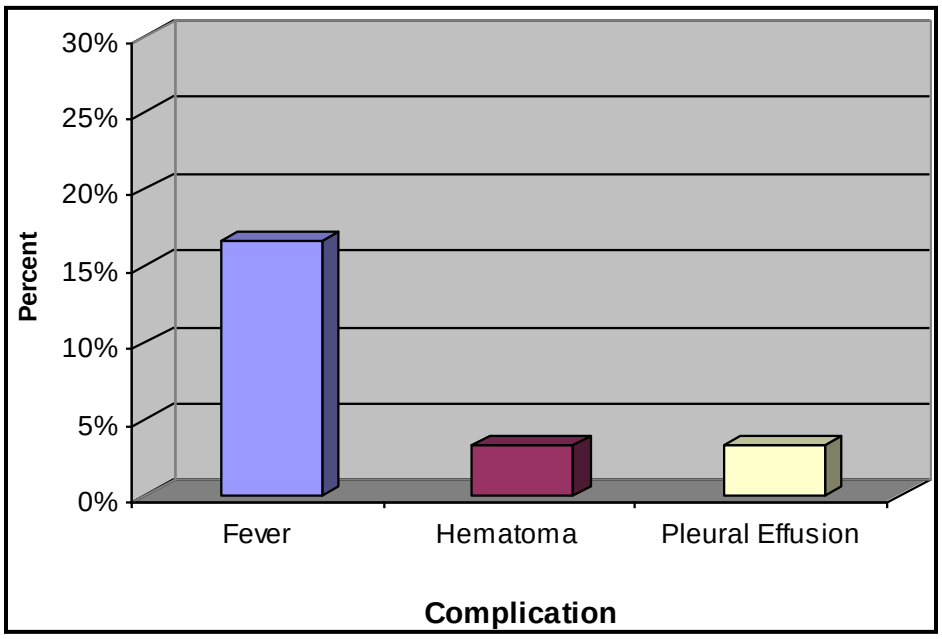

Fig. (7) : Bar chart showing the percentage of complications after ablation.

CASES

Case 1

A case of liver cirrhosis and a single focus of HCC on top of cirrhosis. Ultrasound showed a 4x5cm hypoechoic nodule in segment V and Power Doppler depicted liver vessels surrounding the lesion.

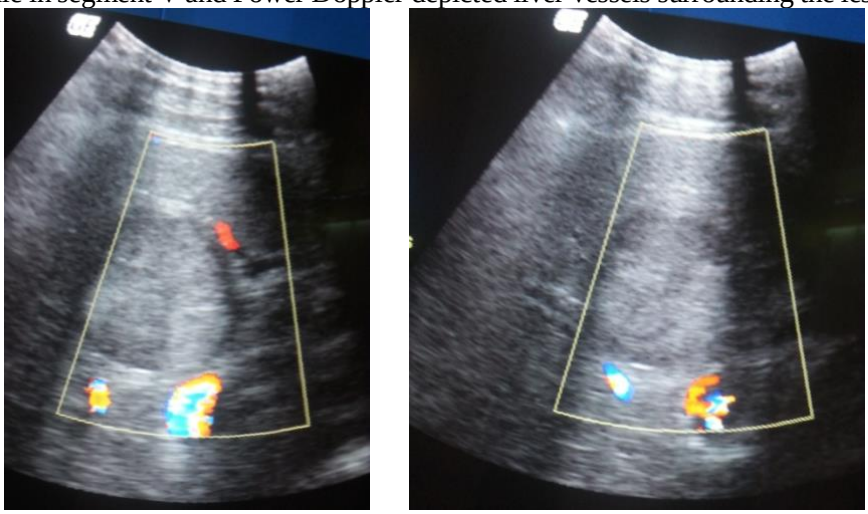

Fig. (8): Sonogram before microwave ablation shows a 4x4.5cm.

Pre-Microwave ablation tri-phasic CT study In the arterial phase the lesion showed contrast enhancement with wash-out in the further phases, after ablation by 1 moth, the arterial phase showed no enhancement is seen in the enlarged coagulation zone, suggesting the absence of residual tumor.

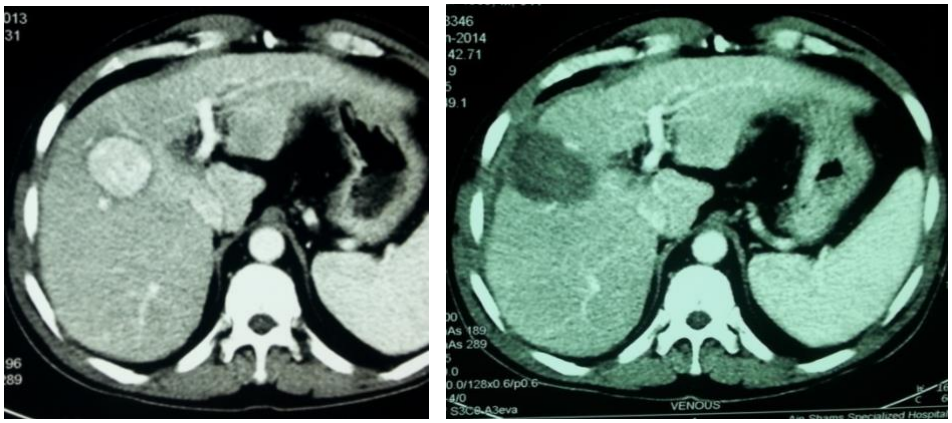

Fig. (9): (a) Contrast CT shows enhancing mass before treatment. (b) Contrast CT shows that coagulated necrosis area completely enveloped nodule after microwave treatment.

Case 2

A case of HCC nodule in the right hepatic lobe. Just anterior to the IVC. Pre-ablation tri-phasic CT liver scan showed faint arterial contrast of contrast with washout of contrast with delayed phase. Post-Microwave ablation tri-phasic CT liver study is done after 1 month showed that coagulated necrosis area completely enveloped in the unenhanced images. The Contrast enhanced scan images showed an area of hypoattenuating without enhancement, suggestive of complete response.

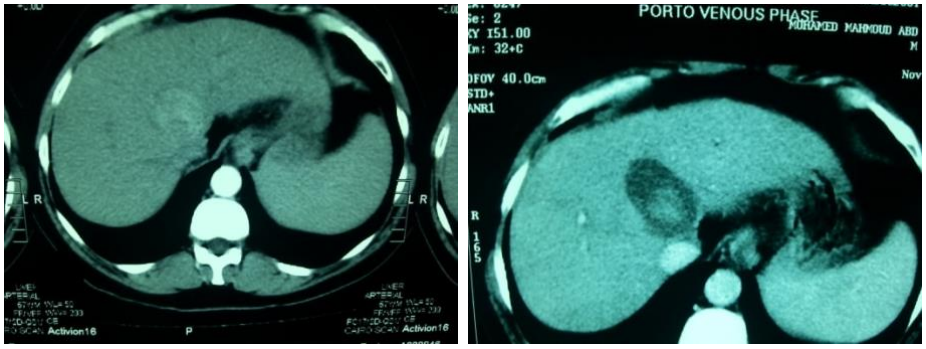

Fig. (10): (a) Contrast CT shows enhancing mass before treatment. (b) Contrast CT shows that coagulated necrosis area completely enveloped nodule after microwave treatment.

Case 3

A case of liver cirrhosis and HCC in right hepatic lobe near the right portal vein treated with Microwave ablation. Pretreatment tri-phasic CT liver study showed intense contrast enhancement in the arterial phase. Post-microwave ablation tri-phasic CT liver study, Contrast-enhanced image showed a non enhancing area which is hypoattenuating denoting well ablation with no residual viable tumor tissue.

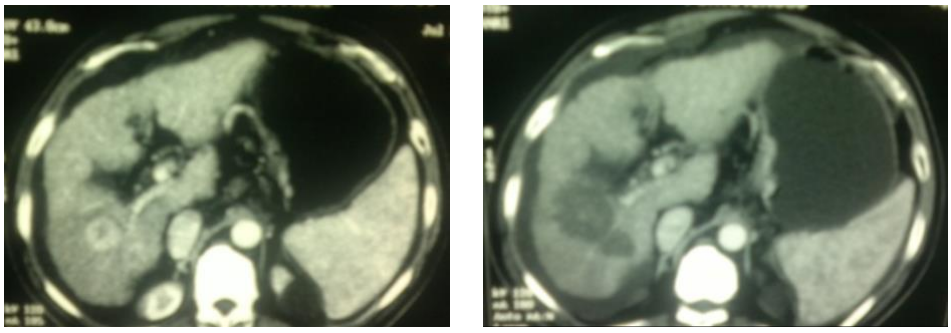

Fig. (11): (a) Contrast CT shows enhancing mass before treatment. (b) Contrast CT shows that coagulated necrosis area completely enveloped nodule after microwave treatment.

DISCUSSION

With the advantages of minimal invasiveness and predictability of therapeutic efficacy, thermal ablation has quickly gained a great deal of attention in the management of HCC.

In recent years, the potential role of microwave ablation (MWA) has become increasingly apparent, micro-wave device and antenna had been greatly improved.[4,5] In microwave ablation an ultra-high-speed microwave (usually 2450MHz) is emitted from exposed antenna of the electrode, causing the water molecules in the tissue to vibrate and rotate with similar frequency. Heat is generated and results in thermal coagulation of the target tissue.[6]

In the current study, a 2450MHz internally cooled-shaft antenna was used. It has two channels inside the shaft lumen with distilled water circulated by a peristaltic pump

to continuously cool the shaft. The low antenna shaft temperature can deliver more energy into the tissue without causing skin burn. In addition, low antenna shaft temperature can reduce higher temperature in the center to decrease tissue charring and improve energy transfer, which makes possible higher output and longer duration treatment.[7] As result, the ablation zone can be remarkably expanded.

Microwave ablation can be performed percutaneously, laparoscopically, thoracoscopically, or at laparotomy. Percutaneous treatment offers several advantages over other approaches.[8] The percutaneous approach is the least invasive, relatively expensive, can be performed on outpatient basis, and can be repeated to treat recurrent tumor, laparoscopic and thoracoscopic approaches may be employed to ablate tumors at locations inaccessible by the percutaneous approach.[8]

In the current study, the ablation procedures were performed percutaneously with HS Amica probe. Percutaneous MWA appeared to be a well tolerated treatment in our patient group with no post-operative deaths and no complication occurred related to the ablation procedure. None of the patients in this study showed evidence of sepsis, bile duct damage, uncontrollable bleeding, or significant systemic upset. Only one patient developed pleural effusion and this compares very favorably with studies of alternative ablative modalities which have reported complications in up to 33% of the patients treated.[9,10] Also, the study of **Xu et al. (2004)**[6], reported complications related to MW ablation in nine patients including pleural effusion in two liver failure in one, hepatic abscess in two, skin burn in two and sub capsular hematoma in two.

In the present study, by using the cooled-shaft microwave antenna, and repeated probe re-insertion technique, the complete ablation rates for tumors 5cm or less and those larger than 5cm were 100% (28 of 28 nodules)and 100% (10 of 10 nodules), respectively. These results were comparable to but even better than those reported from **Lu et al. (2001)**[9] whose technical success rates for tumors 2cm or smaller and those larger than 2cm were 98% (45 of 46 nodules) and 92% (56% of 61 nodules), respectively, and after additional MW ablation sessions technical success was achieved in all his incompletely ablated tumors.

The results in the current study were comparable to those of **Kung et al. (2007)**[5] who treated 90 patients with unresectable liver cancers. The complete ablation rates were 94%, 91%, and 92% for small (3cm), intermediate (3.1-5.0cm) and large (5.1-8.0cm) liver cancers. Additionally, in the study of **Xu et al. (2004)**[6] using multiple electrode insertion technique, the complete ablation rates at 1 month post-ablation in tumors 2.0, 2.1-3.9 and 4.0cm in diameter were 93.1%, 93.8%, and 86.4%, respectively.

In the current study, all the patients with elevated α-FP showed decreased levels to within the normal range one month after ablation. In the study of **Lu et al. (2001)**[11], 18/50 patients with elevated α-FP before ablation showed marked decrease at 1 month after MWA. **Dong et al. (2003)**[12], had in their study 139/234 patients with elevated α-FP level pre-ablation. At 1 month post-ablation 101/139 had decreased α-FP to normal level

and 28/139 showed decrease in α-FP level although it did not drop to normal. The α-FP levels remained unchanged after MWA in 10 patients.

Though evaluating long term results and survival rates of percutaneous MWA is beyond our objective in this study, yet in our limited follow up period (10 months), the survival rate was 100%. This compares favorably with study of **Lu et al. (2001)**[11], where the 1yr survival rate for 36 patients was 96%, and that of **Dong et al. (2003)**[12], 1yr survival rate for 185 patients was 92.7%.

Limitation of our study; it was a short limited study and hence reliable long term results and survival rates could not be properly evaluated. It is a short term preliminary study focused on the technical efficacy and safety of this new MW technology rather than a long term follow-up study. However, further study with a larger patient sample and longer follow-up period is needed to prepare for a subsequent long term follow-up and survival rate study.

CONCLUSION

MWA technique represents a safe, fast and efficacious way to perform hepatic ablation in patients with HCC. Initial results are encouraging; however, longer follow-up is needed for further classification of our results.

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