Med. J. Cairo Univ., Vol. 87, No. 4, June: 2515-2522, 2019
www.medicaljournalofcairouniversity.net

Role of Artificial Ascites Pre-Radiofrequency Ablation of Sub Capsular Liver Tumors

AHMED H. SOLIMAN, M.D.

The Department of Diagnostic and Interventional Radiology, Faculty of Medicine, Ain Shams University

Abstract

Background: Radiofrequency ablation for liver tumours is a common practice because of its many advantages including feasibility, relatively low cost, being a day case procedure, and minimal invasiveness. Sub-capsular hepatomas management represents a challenge due to liability of thermal injury to major organs and occurrence of serious complications.

Aim of Study: To assess the safety and technical efficacy of percutaneous radiofrequency ablation after artificial ascites in sub-capsular hepatoma.

Methods: In our study, 18 patients had hydro dissection procedure done to facilitate ultrasound guided Radiofrequency Ablation (RFA) for sub-capsular hepatic lesions. Hydro dissection was performed with 5% dextrose in water to displace adjacent structures away from the liver capsule. RFA system with cluster or single internally cooled electrodes were used for treatment of hepatic malignancies. The feasibility, safety, and efficacy of this technique were assessed on follow-up.

Results: Our patients' mean age was 59.6 years old. No major complications related to hydro dissection were recorded. One of our patients had a thermal injury (5.5%). No patients suffered from biliary injury, haemorrhage or tumour seeding. Mean hydro dissection displacement of nearby organs was 1.6cm.

Conclusion: Hydro-dissection (artificial ascites) proved to improve technical efficacy and safety for ultrasound guided radiofrequency of sub-capsular hepatomas.

Key Words: *Sub-capsular hepatoma – Artificial ascites – Radiofrequency.*

Introduction

HEPATOCELLULAR Carcinoma (HCC) is a global health issue, ranking as the fifth most common malignancy and the third leading cause of death caused by malignant tumors [1].

HCC depends on early and prompt diagnosis where treatment aiming to cure such as liver transplantation, surgical resection, or local ablation including Radiofrequency Ablation (RFA) can be used [2].

RFA is one of the modalities for treatment HCC. Hepatic resection versus RFA for small HCCs remains debatable. Hepatic resection might be superior to RFA in small HCCs eligible for surgical resection, particularly for tumors (3cm) in size [3,4].

There is no major evidence based difference between hepatic resection and RFA in overall survival rates [5]. A recent study indicated that "percutaneous RFA produced a similar therapeutic effect as hepatic resection." [6].

RFA is a safe surgical alternative, especially in a Child- Pugh B status and associated health problems. Difficult-to-ablate HCCs are hepatomas abutting the diaphragm or near gastrointestinal system structures such as the colon, bile duct, or gallbladder.

In such located hepatomas, the risk of thermal injury to vital structures was an obstacle and a driving force towards surgery. Assistant techniques including artificial ascites, artificial pleural effusion, and cooling by endoscopic nasobiliary drainage changed the practice for such tumors by enabling an improved locating view and protecting adjacent vital organs from thermal injury induced by RFA [7].

RF ablation for liver tumors is a common practice because of its many advantages including feasibility, relatively low cost, being a day case procedure, and minimal invasiveness [8]. As for the problems, major complications of hepatic RF ablation have been reported scarce, ranging between 2% and 3%, and complications were less observed

Correspondence to: Dr. Ahmed H. Soliman, The Department of Diagnostic and Interventional Radiology, Faculty of Medicine, Ain Shams University

in cases of HCC (1.8%) in comparison to metastasis (5.8%) [9-11].

Inspite of the fact that in site tumor recurrence can occur even after successful RF ablation, local recurrence rates are totally variable between patients with and without an adequate safety margins [12,13]. Therefore, when performing RF ablation, the procedure should aim to ensure an adequate ablative margin in all directions surrounding the tumor to reduce local recurrence rate.

The liver, being a vast organ with many borders and surfaces encroaching thermally sensitive structures as gastrointestinal tract and diaphragm, makes RF procedure a critical one in sub-capsular hepatomas because of the risk of collateral thermal damage to the adjacent organs. As for liver upper surface tumors, as hepatic dome, the visualization of the tumor with US is masked by the lung [14].

Artificial Ascites (AA) can be effectively be used to minimize the risk in such conditions. Indeed, the AA method is safe and practical when performing RF ablation for tumors adjacent to organs thermally sensitive because it creates a plane between the RF ablation zone from the adjacent organs and improve the visibility of the tumor [15,16].

If AA is difficult in cases with history of prior surgery, artificial pleural effusion may be a wise solution to improve the visualization when performing RF ablation for a tumor in the hepatic dome [17,18].

However, in contrast with AA, artificial pleural effusion doesn't protect the diaphragm from thermal injury [19].

To reduce local recurrence rates after RF ablation, it is crucial to ensure a adequate ablative margin. When index tumors are in high-risk locations within the liver, the procedure may result in complications followed by inadequate treatment. Experienced operators should be familiar with other strategies, such as AA, needle track ablation, fusion imaging guidance, parallel targeting, and bypass targeting. These methods may be aid in overcoming challenges related to the location and shape of the tumors and provide safe intervention conditions. Thereby, RF ablation can be successfully performed with curative target [20].

Aim of the study:

To assess the safety and technical efficacy of percutaneous radiofrequency ablation after artificial ascites in sub-capsular hepatoma.

Patients and Methods

From March 2017 to December 2018, Artificial Ascites Technique was performed in 18 cases of sub-capsular hepatomas to displace and protect bowel in proximity to the ablation zone.

In our study, 66.7% of our patients were males and 33% were females with mean age of 59.67 years old. 77.8% of our patients were Child A while 22.2% of our patients were child B.

In our cases, 61.1% (n=11) of sub-capsular hepatomas were in segment (5), 27.8% (n=5) were in segment (6) while 11.1% (n=2) were in segment (3).

The study was carried out in Interventional Radiology Unit, Ain Shams University, after Ethical Committee Approval. Informed consent was obtained from all of the patients. This is a prospective cohort study.

The inclusion criteria for the patients were as follows:

A solitary tumor 3cm or less, well demarcated at hepatic surface; Child-Pugh class A or B liver cirrhosis and normal coagulation profile (Prothrombin time, prothrombin concentration, INR and Platelets count.). Proximity of gastrointestinal tract to tumor was ascertained with dynamic radiological cross-sectional studies and corresponding ultrasonography.

Exclusion criteria:

Patients with multi-centric HCC, patients with hepatic vascular invasion and patients having bad coagulation profile.

Artificial ascites installation:

A 16-gauge Intravenous (IV) catheter (BD Angio-cath; Sandy, UT, USA) was inserted into the peritoneal cavity along the edge of the liver under ultrasound guidance following the administration of local anesthesia with 1% lidocaine to the skin, abdominal wall and peritoneum.

When ultrasound showed that the catheter was inserted into the correct site, the outer catheter was advanced further to position the tip near the index tumor whenever possible, and the inner stylet was then removed. Ground pads were applied to patients' lower limb.

Once the catheter was in place, we injected a sufficient amount of 5% dextrose until a separation of at least 0.5cm between the target tumor and the adjacent gastrointestinal tract was achieved. We then considered the induction of artificial ascites successful and perform the radiofrequency ablation procedure. The induction was judged as a failure if sufficient separation was not achieved with 1500mL 5% dextrose. The drip infusion was continued while performing radiofrequency ablation to maintain the distance of at least 0.5cm between the ablation zone and the adjacent gastrointestinal tract.

All RFA procedures were performed percutaneously using Ultrasound (US) with Covidien cool tip RF ablation system. All the procedures were performed under local anesthesia and conscious sedation. The direct puncture of lesion was avoided and an oblique pathway was taken so as to get a rim of non-tumorous liver tissue while placing the electrode. Once the needle was positioned in the lesion, set the target temperature at 105ºC (we use the automatic temperature control mode) and the power at 150W and pressed the start button. Set timer after target temperature reached was according to size of tumor (5min for 2cm diameter and 6min for 3cm diameter. If at the end of the cool-down mode the temperatures are above 60ºC, this is a good indication of complete tumor ablation. To ablate the needle track we retract completely the tines of the device and press the track ablation start button and then the needle was slowly withdrawn.

Contrast-enhanced CT or MRI was performed 1 month after the ablation to evaluate technique effectiveness, and to complete ablation. Complete ablation was defined as a lack of enhancement of the entire tumor. If complete ablation was achieved, routine contrast-enhanced CT or MRI was repeated to assess local tumor progression at 3 months after radiofrequency ablation and then at 6-month intervals. Local tumor progression was defined as the reappearance of tumor enhancement within or adjacent to the ablation zone.

Complications caused by the procedure such as pain, fever, bleeding, hemo-thorax, injury to adjacent gastrointestinal organs, volume overload, infection, incomplete elimination of mass and hepatic decompensation were followed-up after procedure and after 1 month post-ablation and were detected using ultrasound, CT or MRI and laboratory tests.

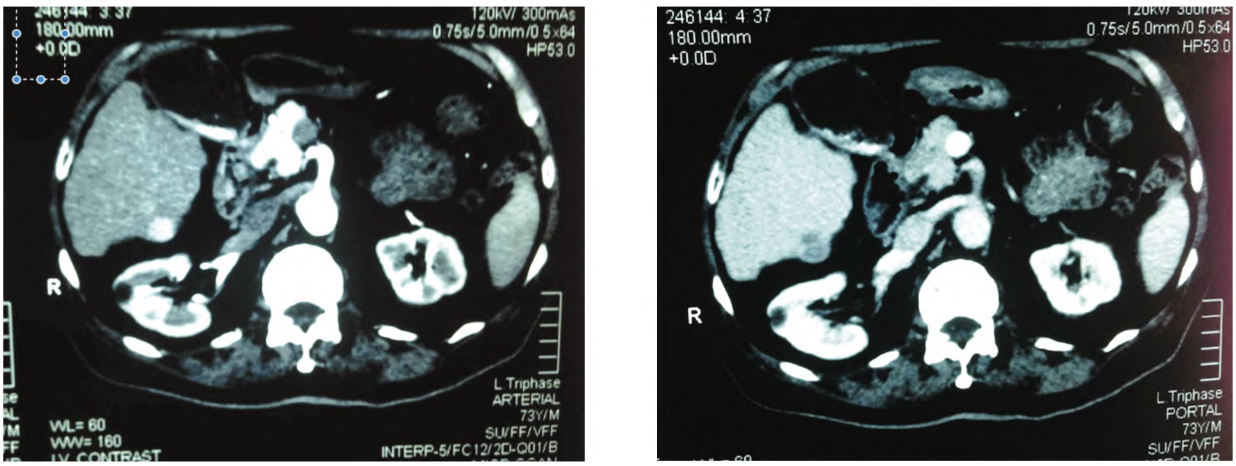
Statistical analysis:

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test. Correlations between quantitative variables were done using Spearman correlation coefficient. p-values less than 0.05 were considered as statistically significant.

Results

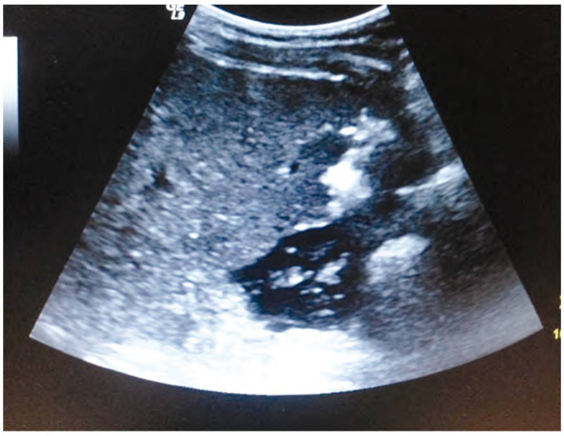
In our study,66.7% of our patients were males and 33% were females with mean age of 59.67 years old. 77.8% of our patients were Child A while 22.2% of our patients were child B.

In our cases, 61.1% (n=11) of sub-capsular hepatomas were in segment (5), 27.8% (n=5) were in segment (6) while 11.1% (n=2) were in segment (3).

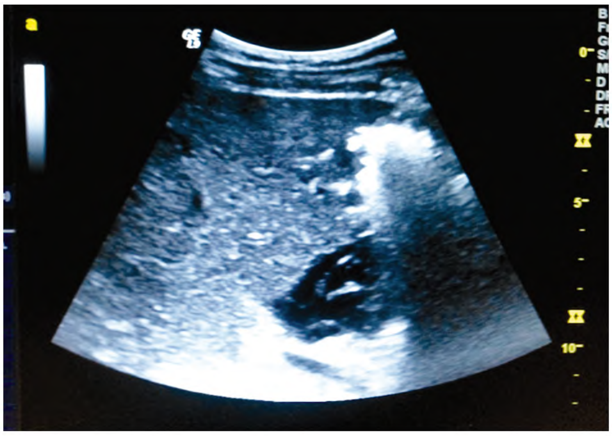


(A) (B)

Fig. (1): (A,B): Male patient, 59 years old, figure showing. Initial pre-ablation Triphasic CT abdomen showing small enhancing focal lesion in segment 6 in arterial phase with subsequent washout out in the porto-venous phase.

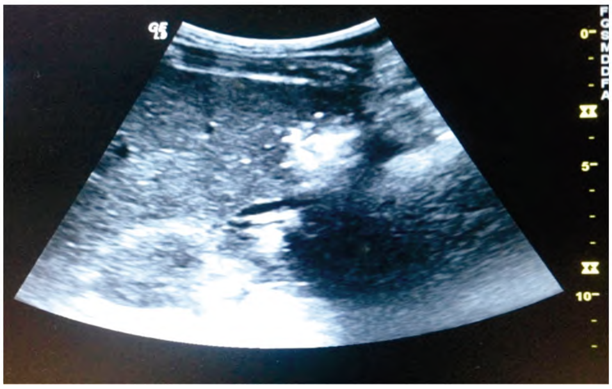


(C)



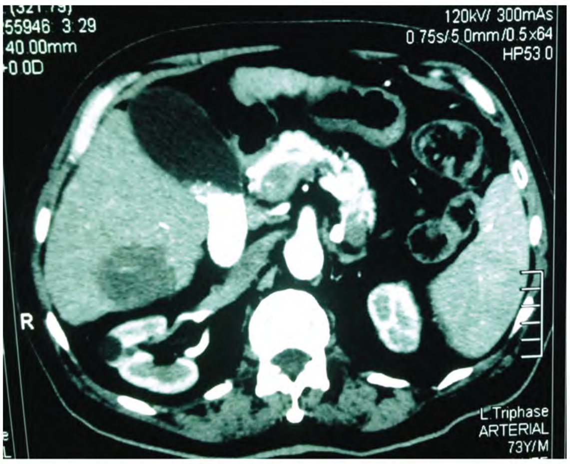
(D)

(E)

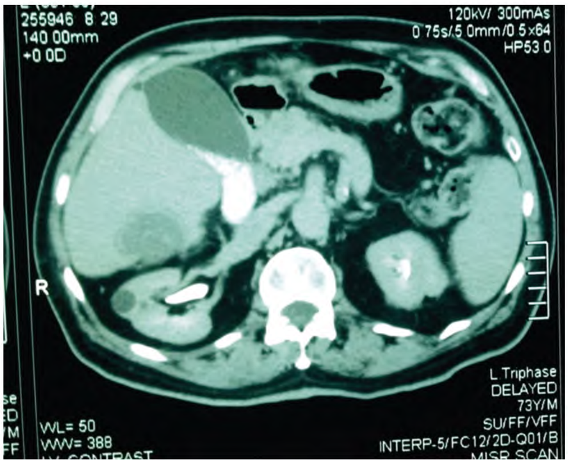


(F)

Fig. (1): (C, D, E, F): Ultrasonography pictures showing tip of needle within the lesion with progressive formation of gas bubbles ensuring ongoing ablation process and surrounding ascetic fluid related to the ablation segment.



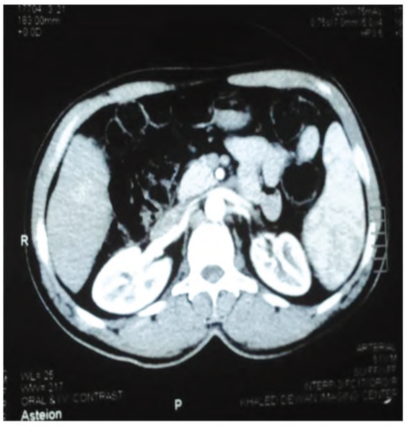
(G)



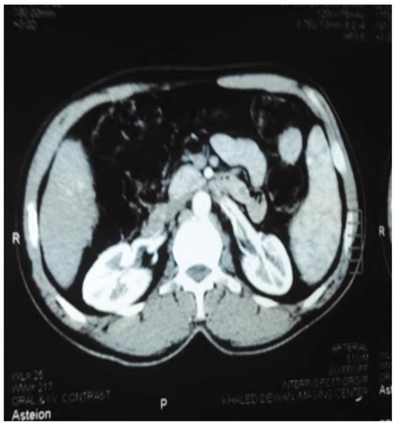
(H)

Fig. (1): (G, H): Post ablation CT with contrast for follow-up showing total ablation of the lesion with complete central charring with lack of contrast uptake and washout in arterial and delayed phases denoting successful complete ablation.

(A)

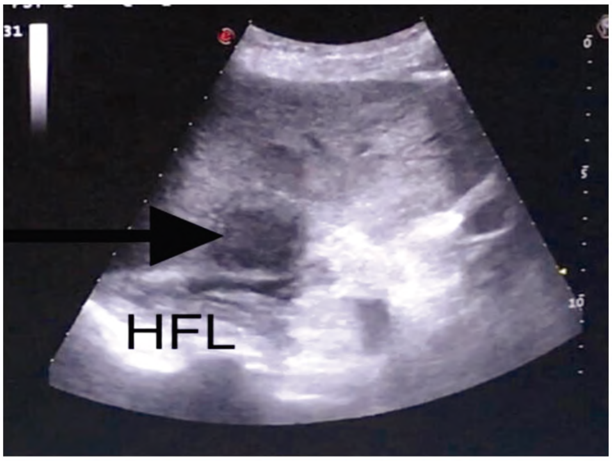


(B)

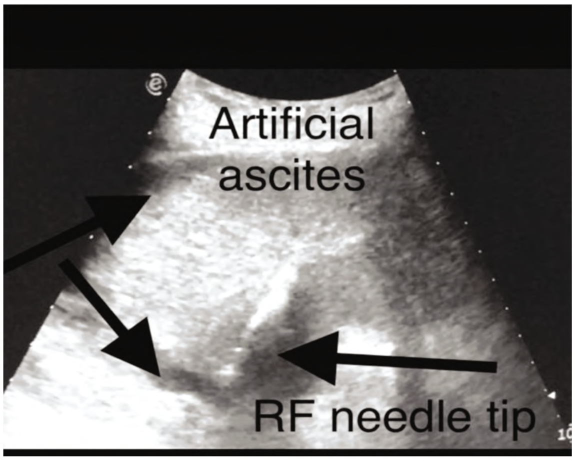


(C)

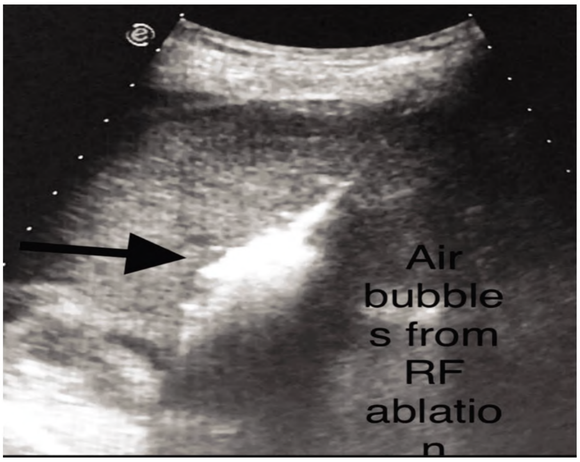
Fig. (2): (A, B, C): Male patient, 49 years old, CT with contrast pre-ablation pictures showing arterial faintly enhancing lesion and wash out in porto-venous phase.



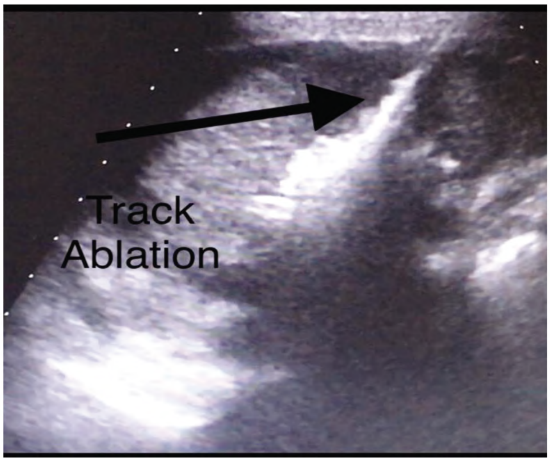
(D)



(E)



(F)



(G)

Fig. (2): (D, E, F, G): (D) Showing hypoechoic solid focal lesion on ultrasonography corresponding to the enhancing lesion on triphasic CT abdomen in Fig. (2A, B, C), (E) Showing artificial ascites (black arrows) and tip of RF needle inserted within the entire focal lesion, (F) Gas bubbles formation on ongoing ablation process, (G) Track ablation at end of ablation process with bubbles streaks reaching hepatic capsule surface.

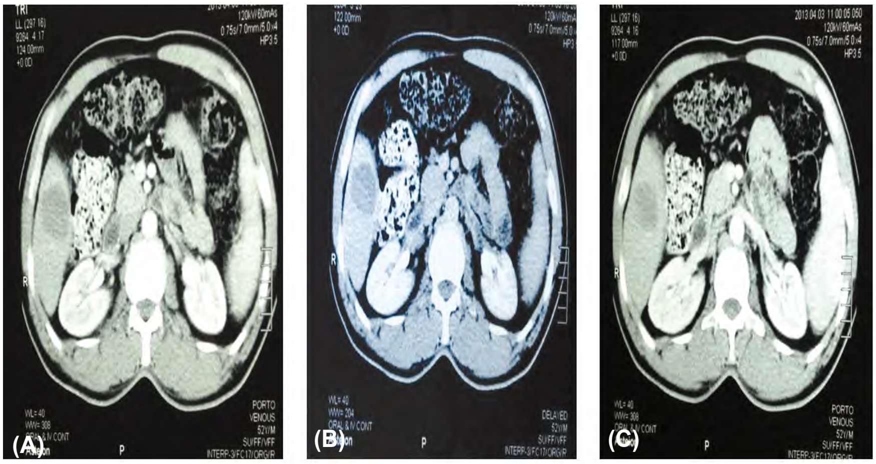


Fig. (2): (H, I, J): CT with contrast showing post ablation follow-up pictures successful lesion ablation with absent contrast uptake or washout in any of arterial, porto-venous or delayed phases.

Table (1): Showing mean, SD, median IQ range of the lesion size of masses and hydro-dissection distances included in our study.

	Mean	Standard deviation	Median	Minimum	Maximum
Lesion size	1.80cm	0.50	1.80	0.90	3.00
Hydro dissection	1.63cm	0.40	1.70	1.00	2.30

Table (2): Showing the complications in follow-up immediately after the procedure and after 1 month, the number of patients who had it and its percentage from total number of patients.

	(N)	%
Bowl perforation:		
Yes	1	5.5
No	17	85
Hepatic decompensation:		
Yes	1	5.6
No	17	94.4
Infection:		
Yes	2	11.1
No	16	88.9
Local tumor progression:		
No	18	100.0
Bleeding:		
No	18	100.0
Incomplete ablation:		
Yes	1	5.6
No	17	94.4
Volume overload:		
Yes	1	5.6
No	17	94.4
Liver infarction:		
No	18	100.0
Fever:		
Yes	18	1000
Biliary injury:		
No	18	1000
Tumor seeding:		
No	18	100.0

Complications:

In our study we faced some complications in few number of patients, as one case of bowl perforation which could be attributed that the case had multiple laparotomies done before. One case of hepatic decompensation 3 weeks after procedure which could be related to deterioration of general condition due to associated viral hepatitis status of the patient. One case with our largest tumor had a residual part on follow-up and complained of some signs of volume overload relieved with diuretics with no residual problems.

All cases had mild fever relieved within one week of the procedure. No bleeding, liver infarction or local tumor progression was detected in any of our patients. No biliary injury or tumor seeding was encountered.

Discussion

Introducing artificial ascites is a rapid and safe procedure. Artificial ascites can separate the liver surface from adjacent organs. The fluid between the liver and the gastrointestinal tract plays a role in insulating thermal energy transmission and lowering the temperature around the liver, thus protecting the gastrointestinal tract from thermal injury. Moreover, artificial ascites improves tumor visibility by replacing the surrounding air in the gastrointestinal tract **[21]**.

Our main aim for this study was to assess the safety and technical efficacy of percutaneous radiofrequency ablation after artificial ascites in sub-capsular hepatomas the safety and technical efficacy of percutaneous radiofrequency ablation after artificial ascites in sub-capsular hepatoma.

Laeseke et al., [22] used animal models to study the protective effect of artificial ascites in RF ablation. Their results showed that 5% dextrose in water could offer better protection of the adjacent gastrointestinal tract compared with 0.9% saline. Although our study was not a comparative study between 2 fluid agents but the results we have is more than satisfactory as using 5% dextrose in our patients agreed with the results priorily mentioned, as only one patient had bowel injury due to thermal effect.

Song et al., [23] induced artificial ascites in 143 patients with 148 HCCs abutting the diaphragm and gastrointestinal tract and then performed RF ablation. The study suggested that the use of artificial ascites was a simple and effective approach to avoiding thermal injury and improving tumor visibility, with an artificial ascites induction success rate of 90.9%, primary technique effectiveness of 85.3%, and local tumor progression of 12%, our study had nearly similar results adding additional value to the effectiveness and safety of artificial ascites in RF of sub-capsular hepatomas with no local tumor progression occurrence and only one case (5.5%) of cases had a thermal injury occurrence which was attributed to it being the largest mass diameter in our patients.

According to Liang P. et al., and Zhang et al., hemorrhage and tumor seeding are potential complications related to artificial ascites because ascites can wash away coagulation substances at the puncture site and decrease the compression of the opposing abdominal wall against the liver, facilitating the dissemination of tumor cells at the same time and cauterizing the needle track during MW antenna withdrawal prevent hemorrhage and tumor seeding. They also mentioned that no intraperitoneal hemorrhage or tumor seeding was observed after MW ablation during follow-up. [21,24] which was augmented with our study finding on radiofrequency ablation, which had no complications as hemorrhage and tumor seeding.

In our study we faced some complications in few number of patients, as one case of bowl perforation which could be attributed that the case had multiple laparotomies done before. One case of hepatic decompensation 3 weeks after procedure which could be related to deterioration of general condition due to associated viral hepatitis status of the patient. One case with our largest tumor had a residual part on follow-up and complained of some signs of volume overload relieved with diuretics with no residual problems. The results of this study demonstrate that AA can increase the number of tumors eligible for treatment by radiofrequency ablation by protecting vulnerable structures adjacent to the ablation zone.

Limitations:

The cost per patient due to the rising prices of equipment limited my number of cases included, added to the rarity of such located tumors.

These limitations are in plan to be overcomed in fore-coming research recruiting larger number of patients and comparing different modalities.

Conclusion:

In summary, ultrasound-guided percutaneous radiofrequency ablation assisted by artificial ascites is a safe and effective method for the treatment of sub-capsular hepatomas adjacent to the gastrointestinal tract. This strategy can achieve good local control of such tumors without serious complications.

Conflict of interest:

We have no conflict of interests and I didn't receive any fund from any institution.

References

1- MOHAMED K. SHAKER1, HEBA M. ABDELLA, MOHAMED O. KHALIFA and AHMED K. EL-DORRY: Epidemiological characteristics of hepatocellular carcinoma in Egypt: A retrospective analysis of 1313 cases. Liver Int., 33: 1601-6, 2013.

2- KAO J.H., CHEN P.J. and CHEN D.S.: Recent advances in the research of hepatitis B virus-related hepatocellular carcinoma: Epidemiological and molecular biological aspects. Adv. Cancer Res., 108: 21-72, 2010.

3- ZHOU Y., ZHAO Y., LI B., XU D., YIN Z. and XIE F.: Meta-analysis of radiofrequency ablation versus hepatic resection for small hepatocellular carcinoma. BMC Gastroenterol., 10: 78, 2010.

4- XU G., QI F.Z., ZHANG J.H., CHENG G.F., CAI Y. and MIAO Y.: Metaanalysis of surgical resection and radiofrequency ablation for early hepatocellular carcinoma. World J. Surg. Oncol., 10: 163, 2012.

5- LIU J.G., WANG Y.J. and DU Z.: Radiofrequency ablation in the treatment of small hepatocellular carcinoma: A meta-analysis. World J. Gastroenterol., 16 (27): 3450-6, 2010.

6- FENG K., YAN J., LI X., XIA F., MA K. and WANG S.: A randomized controlled trial of radiofrequency ablation and surgical resection in the treatment of small hepatocellular carcinoma. J. Hepatol., 57 (4): 794-802, 2012.

7- INOUE T., MINAMI Y., CHUNG H., HAYAISHI S., UEDA T. and TATSUMI C.: Radiofrequency ablation for hepatocellular carcinoma: Assistant techniques for difficult cases. Oncology, 78 (Suppl 1): 94-101, 2010.

8- THANOS L., MYLONA S., GALANI P., POMONI M,. POMONI A. and KOSKINAS I.: Overcoming the heatsink phenomenon: Successful radiofrequency thermal ablation of liver tumors in contact with blood vessels. Diagn. Interv. Radiol., 14: 51-6, 2008.

9- RHIM H., YOON K.H., LEE J.M., CHO Y., CHO J.S. and KIM S.H.: Major complications after radio-frequency thermal ablation of hepatic tumors: Spectrum of imaging findings. Radiographics, 23: 123-34; discussion, 134-6, 2003.

10- LIVRAGHI T., SOLBIATI L., MELONI M.F., GAZELLE G.S., HALPERN E.F. and GOLDBERG S.N.: Treatment of focal liver tumors with percutaneous radio-frequency ablation: Complications encountered in a multicenter study. Radiology, 226: 441-51, 2003.

11- MENDIRATTA-LALA M., BROOK O.R., MIDKIFF B.D., BRENNAN D.D., THORNTON E. and FAINTUCH S.: Quality initiatives: Strategies for anticipating and reducing complications and treatment failures in hepatic radiofrequency ablation. Radiographics, 30: 1107-22, 2010.

12- KIM Y.S., LEE W.J., RHIM H., LIM H.K., CHOI D. and LEE J.Y.: The minimal ablative margin of radiofrequency ablation of hepatocellular carcinoma (>2 and <5cm) needed to prevent local tumor progression: 3D quantitative assessment using CT image fusion. AJR. Am. J. Roentgenol., 195: 758-65, 2010.

13- NAKAZAWA T., KOKUBU S., SHIBUYA A., ONO K., WATANABE M. and HIDAKA H.: Radiofrequency ablation of hepatocellular carcinoma: Correlation between local tumor progression after ablation and ablative margin. AJR. Am. J. Roentgenol., 188: 480-8, 2007.

14- SONG I., RHIM H., LIM H.K., KIM Y.S. and CHOI D.: Percutaneous radiofrequency ablation of hepatocellular carcinoma abutting the diaphragm and gastrointestinal tracts with the use of artificial ascites: Safety and technical efficacy in 143 patients. Eur. Radiol., 19: 2630-40, 2009.

15- RHIM H., LIM H.K., KIM Y.S. and CHOI D.: Percutaneous radiofrequency ablation with artificial ascites for hepatocellular carcinoma in the hepatic dome: Initial experience. AJR. Am. J. Roentgenol., 190: 91-8, 2008.

16- KANG T.W., LEE M.W., HYE M.J., SONG K.D., LIM S. and RHIM H.: Percutaneous radiofrequency ablation of hepatic tumours: Factors affecting technical failure of artificial ascites formation using an angiosheath. Clin. Radiol., 69: 1249-58, 2014.

17- KODA M., UEKI M., MAEDA Y., MIMURA K., OKAMOTO K. and MATSUNAGA Y.: Percutaneous sonographically guided radiofrequency ablation with artificial pleural effusion for hepatocellular carcinoma located under the diaphragm. AJR. Am. J. Roentgenol., 183: 583-8, 2004.

18- MINAMI Y., KUDO M., KAWASAKI T., CHUNG H., OGAWA C. and INOUE T.: Percutaneous ultrasound-guided radiofrequency ablation with artificial pleural effusion for hepatocellular carcinoma in the hepatic dome. J. Gastroenterol., 38: 1066-70, 2003.

19- KIM Y.J., LEE M.W. and PARK H.S.: Small hepatocellular carcinomas: Ultrasonography guided percutaneous radiofrequency ablation. Abdom Imaging, 38: 98-1112Q, 2013.

20- JIN WOONG KIM, SANG SOO SHIN and SUK HEE HEO: Ultrasound-guided percutaneous radiofrequency ablation of liver tumors: How we do it safely and completely? Korean J. Radiol., 16 (6): 1226-39, 2015.

21- MIN ZHANG, PING LIANG and ZHI-GANG: Efficacy and safety of artificial ascites in assisting percutaneous microwave ablation of hepatic tumors adjacent to the gastrointestinal tract. Int. J. Hyperthermia, 30 (2): 134-41, 2014.

22- LAESEKE P.F., SAMPSON L.A., BRACE C.L., WINTER III T.C., FINE J.P. and LEE Jr.F.T.: Unintended thermal injuries from radiofrequency ablation: Protection with 5% dextrose in water. Am. J. Roentgenol., 186: S249-54, 2006.

23- SONG I., RHIM H., LIM H.K., KIM Y.S. and CHOI D.: Percutaneous radiofrequency ablation of hepatocellular carcinoma abutting the diaphragm and gastrointestinal tracts with the use of artificial ascites: Safety and technical efficacy in 143 patients. Eur. Radiol., 19: 2630-40, 2009.

دور الأستسقاء الإصطناعى
قبل الإستئصال الإشعاعى لأورام الكبد الفرعية

الهدف من البحث هو تقييم السلامة والفعالية لإستخدام تقنية الأستسقاء الإصطناعى مصاحباً للترددات الراديوية عن طريق الجلد فى علاج أورام الكبد.

يتم الإستئصال عن طريق الكى الحرارى بالترددات الراديوية لأورام الكبد على نطاق واسع بسبب مزاياها العديدة بما فى ذلك سهولة الإستخدام والتكلفة المنخفضة نسبياً والوقت القصير فى المستشفى والحد الأدنى من الخطورة.

إستخدام تقنية الأستسقاء الإصطناعى مصاحباً للكى الحرارى بالترددات الراديوية ساعد فى سهولة وفعالية إستخدام التقنية فى أورام الكبد الصعب الوصول لها خاصة الملاصقة للجهاز الهضمى والحجاب الحاجز.