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ORIGINAL RESEARCH

Outcome of Laparoscopic Assisted Percutaneous Microwave Ablation for Exophytic Versus Non-exophytic Hepatocellular Carcinoma

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Abstract

Background Hepatocellular carcinoma (HCC) is one of the most common malignancies and is the third cause of cancer-related death worldwide. Surgery is the optimal treatment for early HCC; however, the majority of cases are not suitable for curative resection at the time of diagnosis. Surgical resection difficulties may be related to size, site, number of tumors, extrahepatic involvement, and patient general condition. Exophytic tumors were considered as relative contraindication for thermal ablation because of the risk of incomplete ablation or major complications as hemorrhage and seeding. Aim of this study: to evaluate the safety and efficacy of microwave ablation (MWA) of exophytic HCC in comparison with non-exophytic HCC.

Methods Prospective comparative study carried on 30 patients having 30 exophytic (six of those patients had another non-exophytic lesion) and 32 patients having 44 non-exophytic HCC lesions (22 had single lesion, 8 patients had 2 lesions, and 2 patients had 3 lesions) within Milan criteria. All patients were child A or B, they were subjected to full clinical assessment, laboratory investigations, and radiological investigations. Laparoscopic assisted percutaneous MWA was the procedure of choice in our study for all patients either having exophytic or non-exophytic lesions using no-touch wedge technique for exophytic lesions and direct puncture for non-exophytic lesions.

Results Technical success was 100% in both groups, all lesions were completely ablated as confirmed by LIOUS. There were no major complications or perioperative mortality and low incidence of local tumor progression in both exophytic and non-exophytic groups.

Conclusion Laparoscopic assisted MWA of exophytic HCC is safe and effective with comparable results to non-exophytic HCC. Exophytic HCC is not contraindication for MWA with proper technique selection.

Keywords Exophytic HCC · Microwave ablation · Laparoscopic surgery

Introduction

Hepatocellular carcinoma (HCC) is one of the most common malignancies in the world, HCC is the third most common cause of cancer-related death worldwide [1]. Surgery is the optimal treatment for early HCC; however, the majority of primary liver cancers are not suitable for curative resection at the time of diagnosis. Surgical resection difficulties may be related to size, site, and number of tumors and extrahepatic involvement as well as the general condition of the patient [2–5].

Thermal ablation is the best treatment option for patients not suitable for resection or transplantation with child-A/B cirrhosis and within Milan criteria. Traditionally, surface or exophytic tumors were considered as relative contraindication for thermal ablation because of the risk of incomplete ablation or major complications as hemorrhage and tumor seeding, bowel injury, and the possibility of local tumor recurrence [6, 7]. Technology has improved the safety and efficacy of thermal ablation and the concept of high-risk tumor location has been challenged [8].

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Aim

The current study is designed to evaluate the safety and efficacy of laparoscopic assisted MW ablation of exophytic versus non-exophytic HCC and compare the rate of local tumor recurrence, morbidity, and mortality between the two groups.

Patients and Methods

This prospective comparative study conducted in National Hepatology and Tropical Medicine Research Institute (NHTMRI), Cairo, Egypt, from May 2017 to April 2020 on 62 patients (46 males and 16 females) with 80 HCC lesions. The median age of patients was 59 years.

Patients were classified into exophytic and non-exophytic groups according to the tumor location. Tumors exceeding the hepatic surface were defined to be exophytic. Laparoscopic assisted percutaneous MWA of 30 exophytic HCC lesions in 30 patients (six of those patients had another non-exophytic lesion) and 44 non-exophytic HCC lesions in 32 patients (22 had single lesion, 8 patients had 2 lesions, and 2 patients had 3 lesions). Description of patients and HCC lesions included in the study are shown in Table 1. And frequency of exophytic and non-exophytic lesions is shown in Fig. 1.

The paper was approved by local ethical committee of General Organization of Teaching hospitals and Institutes (GOTHI) and written informed consent form was signed by all patients after detailed explanation of the procedure and possible complications.

Patient Inclusion Criteria

Patient with HCC lesions either exophytic or non-exophytic less than 5 cm. all patients are within Milan criteria and class A disease Barcelona Clinic Liver Cancer (BCLC).

Table 1 Description of patients and HCC lesions included in the study.

Group	Exophytic	Non-exophytic
Number of patients	30	32
Male/female	22/8	24/8
Median age (years)	58 (47.0–73.0)	59 (46.0–74.0)
Number of lesions	30	50 (44 + 6)
Within Milan criteria *n* (%)	30 (100%)	32 (100%)
Child-Pugh A/B	27/3	26/6
Liver cirrhosis *n* (%)	30 (100%)	32 (100%)
Size of lesions (cm)	2.93 ± 0.89	2.85 ± 0.97
Ablation time (min) range	12–20	6–12

Exclusion Criteria

Patients with Child-Pugh C, PV thrombosis, metastases outside the liver, bleeding diathesis, tumors > 5 cm, patients with uncontrolled diabetes mellitus, or renal diseases were excluded from the study.

All patients were subjected to full clinical assessment, laboratory investigations (CBC, RBS, creatinin, INR, liver enzymes, albumin, bilirubin levels, and alpha fetoprotein) and at least one or two radiological investigations (ultrasonography, computed tomography, or magnetic resonance images) for the abdomen and pelvis and peri-operative echocardiography.

Procedures

Laparoscopic assisted percutaneous MWA guided by laparoscopic intraoperative ultrasound (LIOUS) were done for all cases either exophytic or non-exophytic.

Technique for Exophytic Lesions

As thermal ablation by direct puncture of exophytic HCC may carry increased risk of hemorrhage or tumor seeding, so laparoscopic assisted percutaneous MWA using no-touch wedge technique was done using multiple consecutive probe positions tangential to the tumor to secure complete ablation of the base and periphery then the whole tumor (Fig. 2).

Technique for Non-exophytic Lesions

Laparoscopic assisted percutaneous MWA with direct puncture technique where needle was inserted in the center of the lesions till complete ablation of the lesions is achieved. The use of laparoscopic assisted percutaneous MWA was due to critical anatomical locations of the HCC lesions (near bowel, sub-diaphragmatic, or close to large hepatic vessels) [9]. Figure 3 shows non-exophytic sub-diaphragmatic HCC lesion before MWA.

Complete lesions ablation was confirmed by LIOUS for both groups.

Detailed Surgical Procedures

Procedures were done under general anesthesia. Pneumoperitoneum with inflation pressure maintained at 11–13 mmHg was done. Another trocar was inserted in the left or right upper quadrant according to the lesion locations for LIOUS. After abdominal exploration, LIOUS was performed for proper detection of tumor site and size. MW ablation needles were inserted percutaneous under direct laparoscopic vision and LIOUS guidance. For exophytic lesions, no-touch wedge technique was used while for non-exophytic lesions, direct puncture technique was used. Complete tumor ablation was confirmed in all patients

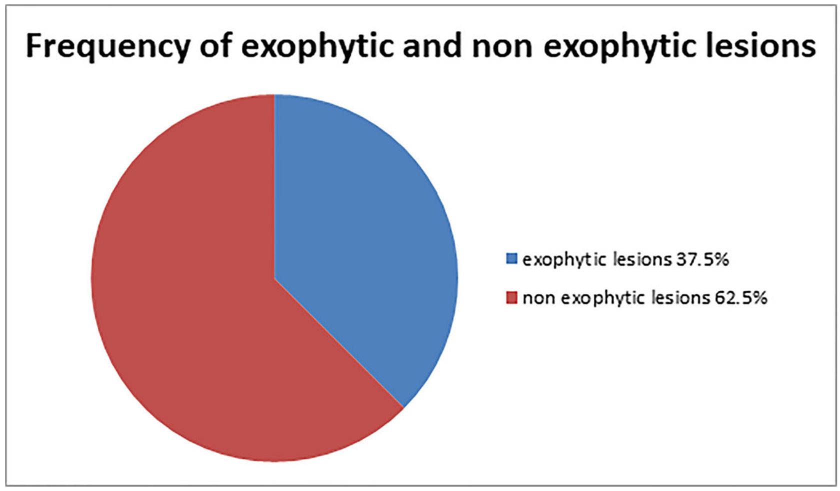

Fig. 1 Frequency of exophytic and non exophytic lesions

during the procedure by LIOUS; then, a drain was inserted to be removed postoperatively.

Microwave Ablation

It is electromagnetic energy, not electric current, not needing grounding pads, consists of generator, flexible cable, and antenna. The electromagnetic field causes rapid and homogeneous heating of the tissue and consequently coagulation necrosis in the absence of current flow [10]. Ionic polarization with conversion of kinetic energy into heat is another mechanism of MWA function. A more homogeneous, larger ablation zone that is easily predicted, feasible and the heat-sink effect is attenuated [11, 12]. The microwave system used in the current study is AMICA-GEN Microwave ablation device apparatus with a frequency of 2.450 MHz and generators capable of generating 140 W of power. AMICATM probe has sharp trocar point with excellent US visibility for efficient penetration into tissues. This MWA system provides large and fast ablations with a single probe of more than 4 cm in diameter in less than 10 min (Fig. 4).

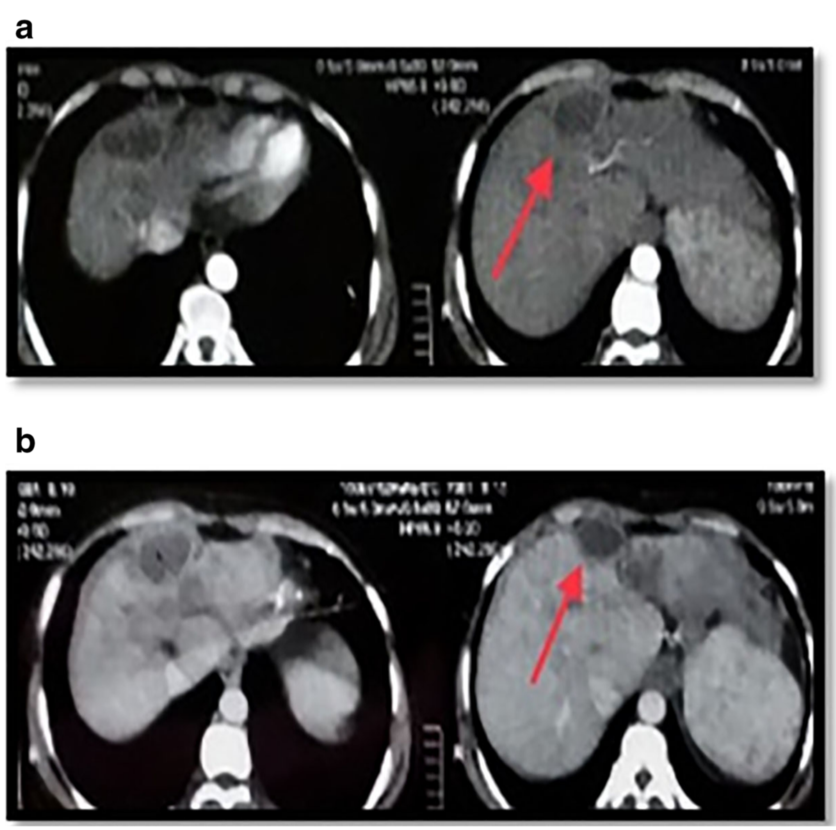

Fig. 2 Case of follow-up after MW ablation of exophytic HCC at segment VIII; by triphasic CT, there is 4-cm exophytic subcapsular HCC (the ablation zone shown by red arrows). **a** Arterial phase images showing no definite enhancement at the ablation zone. **b** Porto-venous phase showing no definite enhancement at the ablation zone

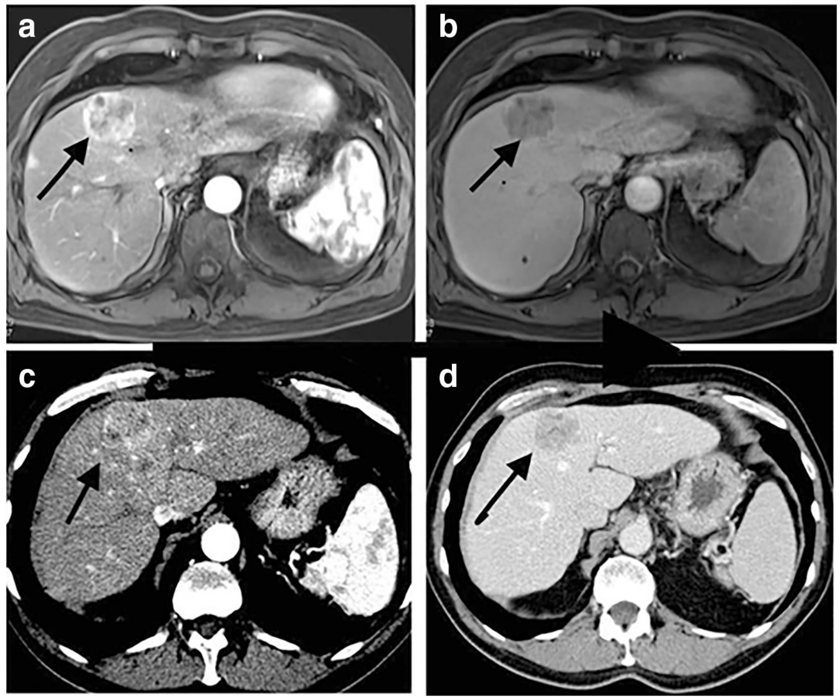

Fig. 3 Case of pre-ablation CT& MRI examinations of the liver for left hepatic lobe segment IV-a 2.5-cm sub-diaphragmatic HCC (black arrows). **a** Axial MR T1WIs arterial phase showing intense heterogeneous enhancement with non-enhanced central areas of degeneration. **b** Axial MR T1WIs port phase showing rapid wash out of contrast denoting tumoral activity. **c** Axial CT cuts arterial phase showing nearly same early heterogamous enhancement. **d** Axial CT cuts portal phase also showing rapid wash out contrast material by tumoral tissue

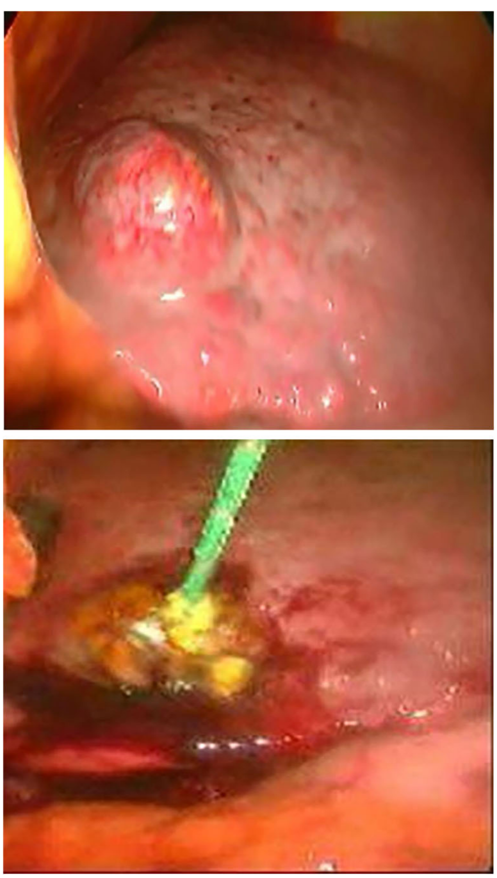

Fig. 4 Exophytic HCC lesion before and during MWA

Postoperative Follow-up

For both groups, the median hospital stay was 3 days. Abdominal ultrasound was done at hospital discharge day for all patients. Routine postoperative follow-up was done with serum alpha fetoprotein, triphasic CT, and/or MRI for all patients after 1 month, every 3 months in the first year for early detection of local tumor progression. Local tumor progression (LTP) is defined as enhancement at the arterial phase with washout lesion at the delayed phase of triphasic CT inside or abutting the ablation zone during follow-up (Fig. 5).

Statistical Analysis

Descriptive statistics were reported in the current study as frequencies and percent.

Results

This study carried on 62 patients with 80 HCC lesions. In this study, 30 patients with 30 exophytic HCC lesions, 6 non-exophytic lesions, and 32 patients with 44 non-exophytic HCC lesions underwent laparoscopic assisted percutaneous MWA. In the non-exophytic HCC patients, there were 22 patients (69%) who had single lesion, 8 (25%) had two lesions, and 2 patients (6%) had three lesions. Technical success was 100% in both groups, no conversion to open surgery, all lesions were completely ablated as confirmed by LIOUS. The MW ablation time for exophytic lesion range was (12–20 min)

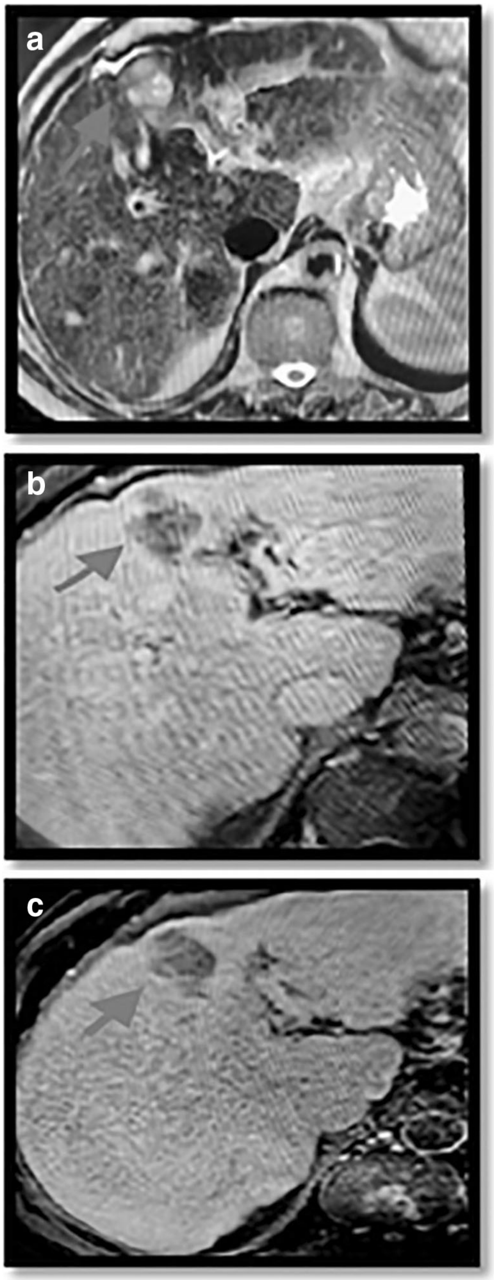

Fig. 5 Case showing follow-up post-ablation dynamic MRI for the liver after 3 months, showing left hepatic lobe segment VI-a partially exophytic HCC of about 3 cm (the ablation zone shown by blue arrows showing liquefaction necrosis with small rime of enhancement denoting residual tumoral activity). **a** Axial T2WI showing high signal with areas of fluid signal representing post-ablation necrosis. **b** Axial T1WI post contrast image showing minimal rime of residual enhancement denoting tumoral reactivity. **c** Axial T1WI delayed image showing more evidenced wash out of the enhanced area

and for non-exophytic lesions was 6–12 min. There was no perioperative mortality. No patients had major complications (major hemorrhage, tumor seeding, or bowel injury), mild pleural effusion occurred in 2 patients one in the exophytic group and one in the non-exophytic group, both treated conservatively. Post ablation fever occurred in 9 patients of exophytic and 10 patients of non-exophytic groups. Two patients in each group had liver dysfunction that improved with medical treatment (all 4 patients were Child B). The median postoperative hospital stay was 3 days for both groups.

The follow-up period was at least 12 months (12–32 months) with serum alpha fetoprotein, triphasic CT, and/or MRI for all patients after 1 month, every 3 months for the first year and every 6 months thereafter. No major difference in local recurrence rate in both groups on follow-up, local tumor progression (LTP) occurred in 2 of total 80 lesions (2.5% of all lesions) at 12-month follow up visit one (3.3%) in the exophytic group and one (2%) in the non-exophytic group, both lesions were more than 3 cm.

Discussion

MW ablation is one of the best treatment options for patients not suitable for resection or transplantation with Child-A/B cirrhosis and within Milan criteria. Exophytic HCC is quite common. The frequency of patients with exophytic HCC in the current study was 48% (30/62) and ranged from 16 to 52 % in other studies [7, 8]. Traditionally exophytic HCC were considered as relative contraindication of MWA because of reported high incidence of major complications and increased LTP. This consideration will deprive a large number of patients from the benefits of safe and effective procedure of MW ablation [13–17].

In previous studies, major complication rates reached up to 10.6%, and mortality rates reached up to 1.45%. The possible reason behind higher complication rate and higher LTP reported in previous studies with exophytic HCC ablation was the technical difficulty of placing the MW needle through percutaneous technique for exophytic lesions as compared with non-exophytic lesions, thus leading to incomplete tumor ablation, tumor seeding, and increased local recurrence [13–16].

In our study, this technical difficulty was avoided by using laparoscopic assisted percutaneous MWA instead of percutaneous MWA. This strategy has many benefits including tumor ablation under direct vision with proper positioning of the MW needle, protection of adjacent viscera and large hepatic vessels, and ensure complete ablation by LIOUS [18].

In our study, laparoscopic assisted percutaneous MWA using no-touch technique was done for exophytic tumors using multiple consecutive probe positions tangential to the tumor to secure complete ablation of the base and periphery then the whole tumor followed by needle track thermocoagulation so none of our cases had tumor seeding. These results are consistent with the results of Kang TW 2016 and Worakitsitisatorn, 2020 as they recorded no seeding [19, 20], while Llovet JM study showed needle track seeding in 12.5% of its cases and related iatrogenic dissemination to subcapsular location [6].

In the current study, technical success was 100% in both exophytic and non-exophytic groups, no conversion to open surgery, all lesions were completely ablated as confirmed by LIOUS. There were no major complications and no perioperative mortality. In our study, we avoided direct puncture of exophytic HCC and adopted no-touch wedge technique while direct puncture of the exophytic tumor performed by Liovet and Jaskolka was associated with high rate of tumor seeding [6, 7, 9].

In the current study, the LTP occurred in 2 of total 80 lesions (2.5% of all lesions) and in 1/30 (3.3%) of exophytic lesions and 1/50 (2%) of non-exophytic lesions at 12 months. Komorizono study revealed that subcapsular location was considered to be associated with local recurrence; however, the recent studies of Kang TW, Worakitsitisatorn, and Francica G showed no significant differences between exophytic and non-exophytic tumors as regards LTP [19–21]. The current study concludes that laparoscopic assisted MWA of exophytic HCC using no-touch technique is safe and effective as no major complications or perioperative mortality occurred, technical success rate was 100% and low LTP with comparable results to non-exophytic HCC.

Conclusion

Laparoscopic assisted MWA of exophytic HCC is safe and effective with comparable results to non exophytic HCC. Exophytic HCC is not contraindication for MWA with proper technique selection.

Authors' Contributions Guarantor of integrity of the entire study: all authors.

Study concepts and design: all authors.
Literature research: all authors.
Clinical studies: all authors.
Data analysis: all authors.
Statistical analysis: all authors.
Manuscript preparation: all authors.
Manuscript editing: all authors.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethics Approval and Consent to Participate This study was approved by our Institutional Review Board (IRB). Informed written consent was obtained from the patients.

Research Involving Human Participants Institution ethical approval obtained.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Consent for Publication All authors gave a consent to publish the manuscript.

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