Article published online: 2024-07-17

Original Article

Imaging Classification of Exophytic HCC and Our Experience with Microwave Ablation of Type 2 Lesions

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Indian J Radiol Imaging

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Abstract

Purpose The purpose of this article is to classify hepatocellular carcinoma (HCC) based on imaging and to evaluate the role of ultrasound-guided microwave ablation (MWA) in the management of type 2 exophytic HCC.

Materials and Methods A retrospective study was performed at our institution after approval by the Institutional Review Board. The study was undertaken from January 2017 to May 2022. Based on the location, HCC was classified and categorized on cross-sectional imaging into four types. All MWA procedures were performed using ultrasound guidance. Patients were followed up every 3 months with cross-sectional imaging.

Results During the study period, 225 lesions were reviewed. MWA was performed in 13 type 2 exophytic HCC patients. Segment 3 (38%) was the most common site when categorized as per Couinaud classification and segment 6 was the next common site. Technical success of complete ablation, evaluated by postprocedure contrast-enhanced computed tomography scan, was 100%. The median follow-up period was 24 months (range: 9–24 months). One patient presented with a residual lesion on the first follow-up at 30 days. Two other patients followed up to 9 months were free of HCC. Ten patients followed up at 1 year showed no recurrence, while 7 of them were followed up for 24 months, and 1 of whom showed multicentric recurrence which was treated by selective intra-arterial radiation therapy.

Conclusion A classification system for exophytic lesions can allow for better patient selection, planning, and reporting of ablative outcomes. MWA has performed well when ablating these technically challenging lesions with a certain degree of planning.

Keywords

- ablation
- classification
- HCC
- microwave ablation

Introduction

Hepatocellular carcinoma (HCC) is one of the most common causes of cancer-related deaths worldwide. It is estimated that more than a million patients will be affected by it by 2025.[1] The management of HCC is at large based on the Barcelona Clinic Liver Cancer (BCLC) staging system. Thermal ablation is one of the recommended treatment options in early HCC according to the BCLC system. Ablation has demonstrated similar outcomes when compared with resection.[2,3] When defining an exophytic HCC, a significant ambiguity is noted in the literature. Mogahed et al reported

DOI https://doi.org/10.1055/s-0044-1788574.
ISSN 0971-3026.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

lesions just extending beyond the liver surface as exophytic.[4] Ding et al discussed about exophytic lesions extending more than one-third beyond the liver capsule.[5] Due to a lack of normal parenchymal protection, exophytic lesion ablation is associated with a higher risk of hemorrhage and tumor seeding.[6] Other complications associated with the ablation of the exophytic lesion include inadequate/incomplete ablation, local recurrence, and bowel injury.[7–10] Newer studies have reported better outcomes in ablation of exophytic lesions using radiofrequency ablation.[11,12]

As per our literature search, an exophytic HCC is one when the center of the lesion is beyond the confines of the liver margin.[13] The conundrum in literature is unraveled, exposing a lack of a clearer understanding of ablation in this group. All the previous studies were focused on lesions that were not truly exophytic. Our study aims to (1) suggest a classification system of HCC on cross-sectional imaging and (2) understand how microwave ablation (MWA) performs when ablating a truly exophytic (type 2) lesion. We also aim to assess the safety, and efficacy and evaluate the local tumor recurrence on follow-up.

Materials and Methods

A retrospective study was undertaken from January 2017 to May 2022 at our institution after approval by the Institutional Review Board. A written informed consent was taken from all patients before MWA. The inclusion criteria for the study were (1) type 2 exophytic HCC as defined later and (2) visualized on ultrasound. Exclusion criteria were (1) serum bilirubin > 3 g/dL and (2) platelet count < 50,000. During this period, MWA was performed in 225 patients of which 13 patients presented with exophytic HCC. All the patients included in this study either were not fit or deferred for surgical interventions. All lesions were screened on dynamic triple-phase cross-section images (computed tomography [CT]/magnetic resonance imaging [MRI]) and were categorized. HCC was classified as per our classification system (►**Fig. 1**) into (1) intraparenchymal HCC, (2) subcapsular HCC (►**Fig. 2**), and (3) exophytic HCC. Exophytic lesions were further classified as type 1 (►**Fig. 3**) and type 2 (►**Fig. 4**).

Lesions were defined as truly exophytic (or type 2) if 50% or more of the tumor extended outside a tangential line drawn on the hepatic capsule (►**Fig. 5**). Type 1 were those that were less than 50%. Subcapsular lesions were those lesions that were within 0.5 cm of the liver capsule.

A written informed consent was taken from all patients before the procedure. All MW ablation procedures were performed using a Covidien (Medtronic, Minneapolis, United States) microwave instrument. A 13G antenna with an active tip of 2.8 cm was used with a generator output power ranging between 75 and 100 W. A 1.0- to 5.0-MHz convex array probe (Sequoia, Siemens Healthineers, Erlangen, Germany) was used for placement and confirmation of the MW antenna.

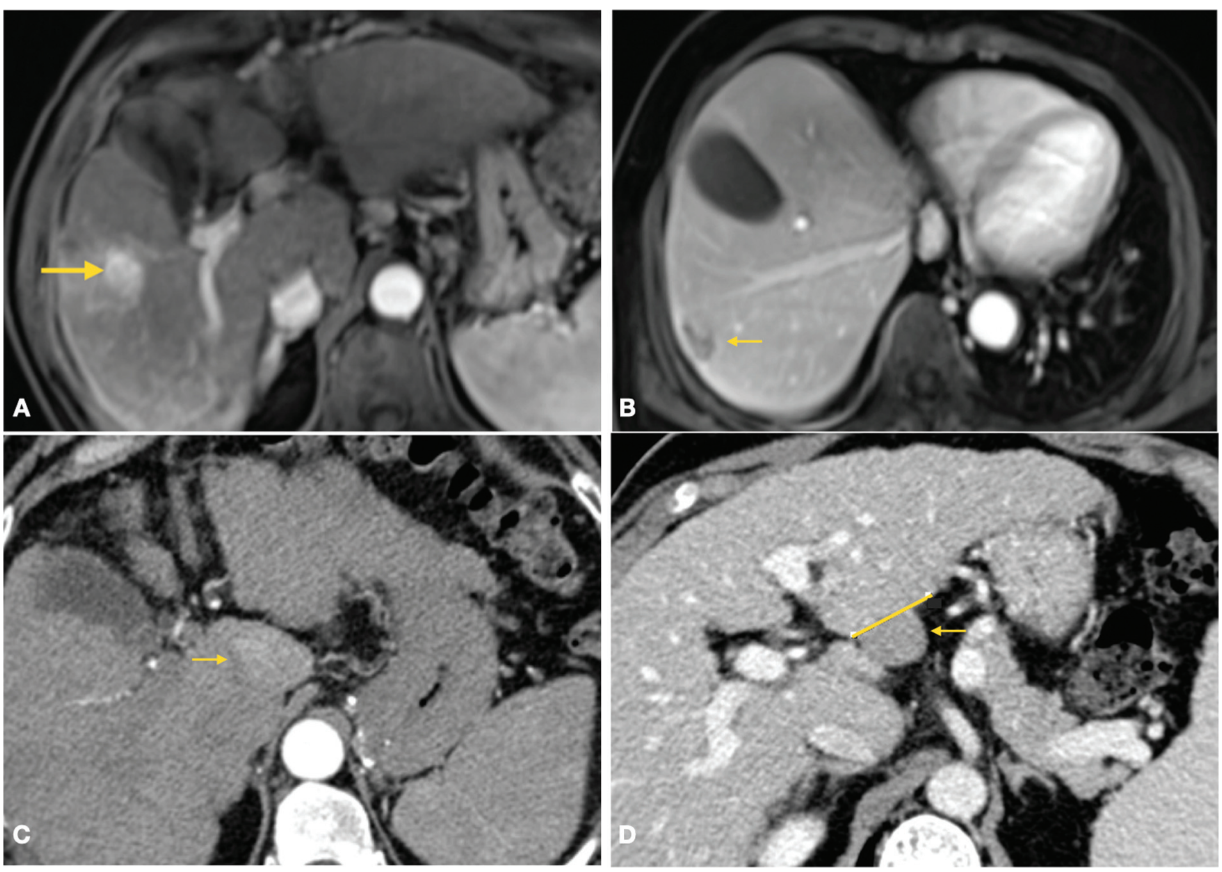

Fig. 1 Various types of HCC: (A) intraparenchymal HCC, B) subcapsular HCC, (C) type 1 exophytic HCC, and (D) type 2 exophytic HCC (lesions marked with arrow). HCC, hepatocellular carcinoma.

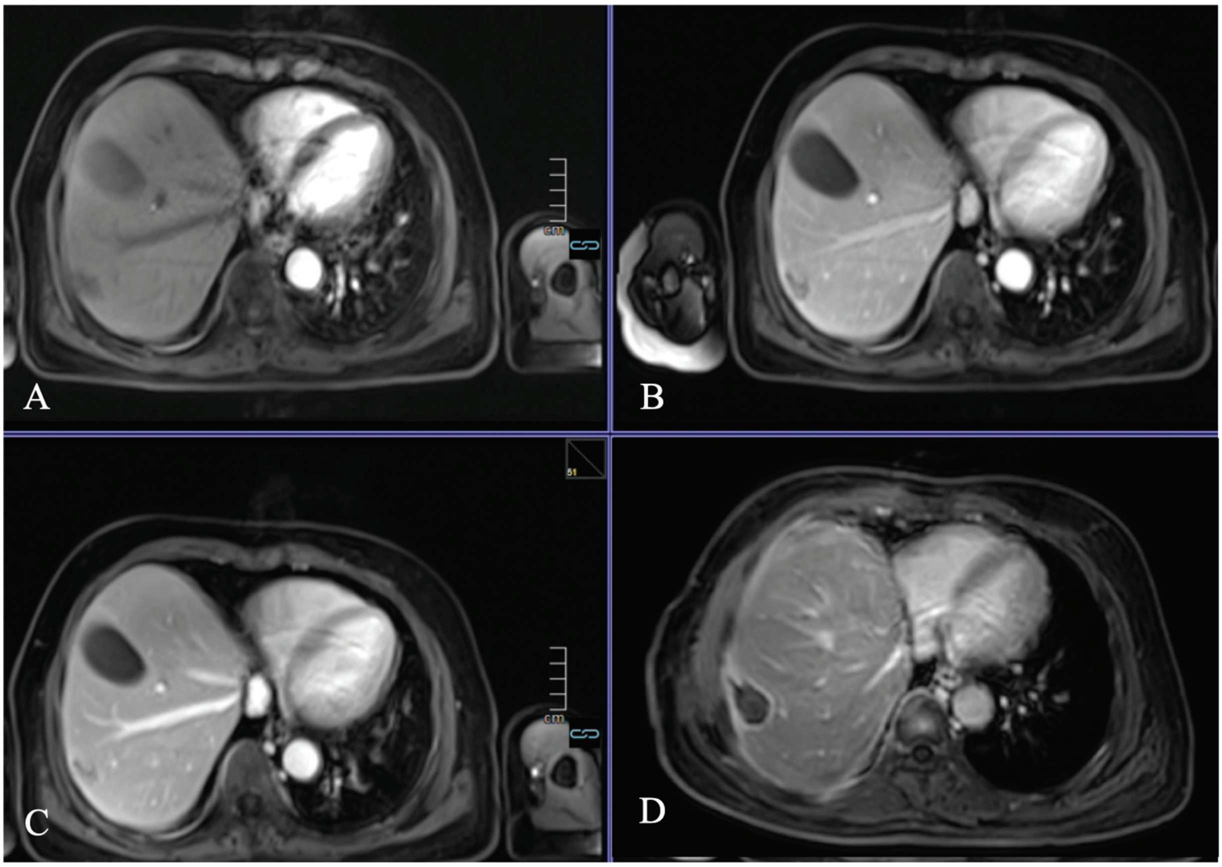

Fig. 2 Subcapsular HCC: (A–C) dynamic MRI liver axial sections depicting an HCC abutting the liver capsule and not causing contour deformity and (D) shows postablation follow-up MRI at 1 year with no residual or recurrent lesion. HCC, hepatocellular carcinoma; MRI, magnetic resonance imaging.

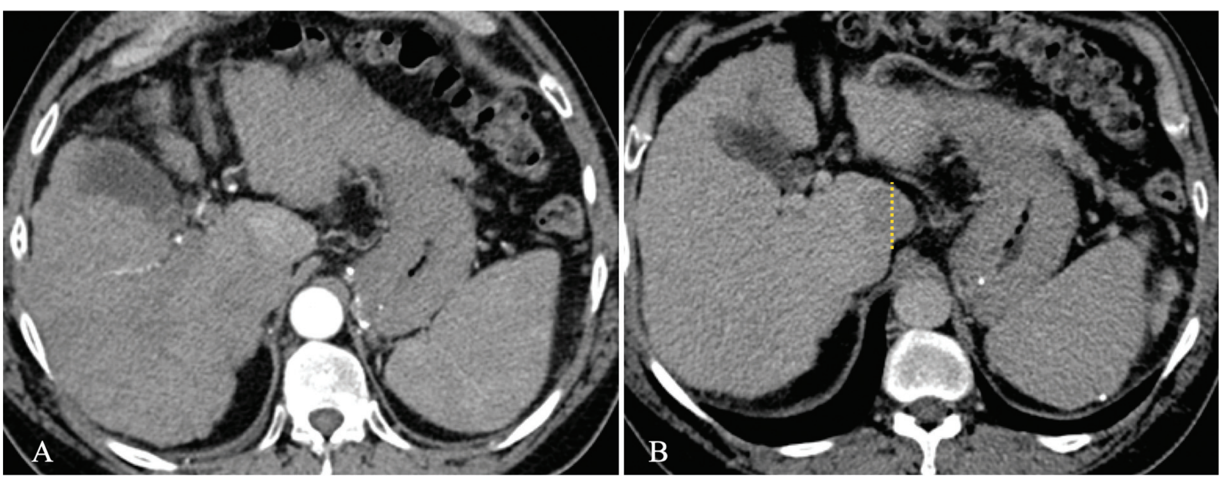

Fig. 3 Type 1 exophytic lesion: (A, B) axial images of contrast-enhanced CT show a nodule extending less than 50% beyond the tangential line (yellow dotted line). CT, computed tomography.

All procedures were performed using local anesthesia with moderate intravenous sedation. A normal parenchymal track was always included while placing the MW antenna which was ablated post lesion ablation. Hydrodissection was performed with 5% dextrose solution when the proximity endangered a risk of burn in the surrounding vital structure.

Hydrodissection was performed after placing a 22G needle in locations where there was a risk of ablative injury. Once the needle was placed, 5% dextrose solution was injected by hand to separate the planes between the two structures and infusion was continued until ablation was completed. Planes are hydrodissected when fat planes are not well appreciated between the lesion and the adjacent structure or distance between the two are less than 3 mm.

Following the ablation, a dynamic contrast CT was performed to (1) assess the area ablated, (2) look for any residual

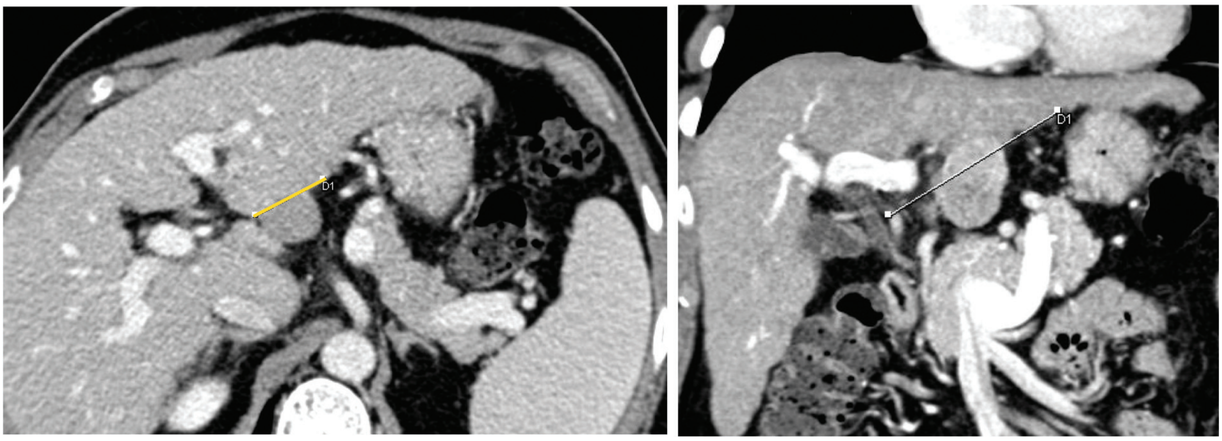

Fig. 4 Type 2 exophytic lesion: axial and coronal images of contrast-enhanced CT show nodules extending more than 50% beyond the tangential line. CT, computed tomography.

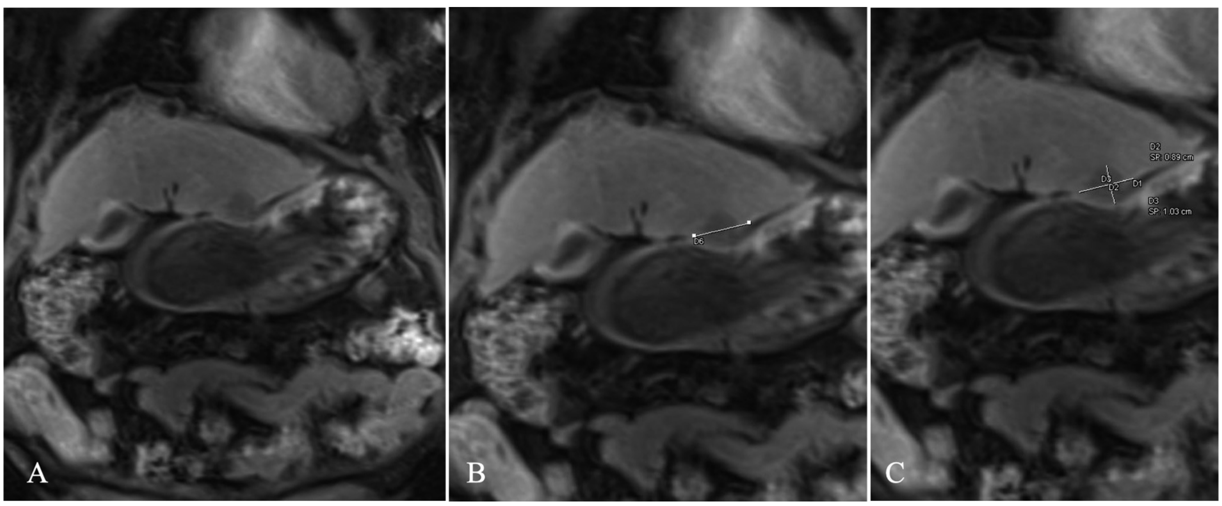

Fig. 5 Type 2 exophytic lesion: coronal dynamic MRIs (A–C) show a exophytic lesion with the lesion extending more than 50% across the tangential line drawn. MRI, magnetic resonance imaging.

component, and (3) review any immediate postprocedure complications (especially hemorrhage) (►**Fig. 6**).

A nodular hypoattenuated area with no contrast enhancement represented a treated area or necrosis. Any residual enhancing component was considered incomplete ablation after comparing with preprocedure images. A repeat ablation was performed if any residual component was confirmed. All complications were assessed as per Society of Interventional Radiology (SIR) guidelines.

Patients were followed up with a repeat liver function test and a dynamic MRI at 1 month as per institutional protocol. Complete ablation of the treated area was considered treatment success and patients were kept on a 3-month follow-up with dynamic MRI (►**Figs. 7**–**9**).

Data were tabulated in Microsoft Excel and statistical analysis was performed using the SPSS (version 24.0) software. Descriptive statistics were represented as mean and

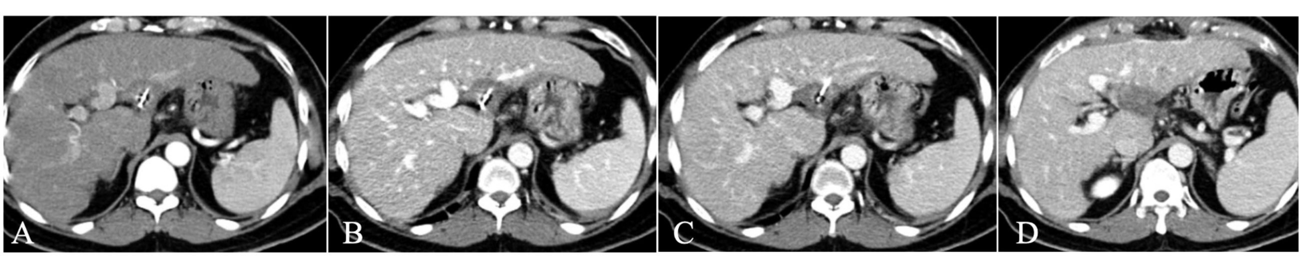

Fig. 6 (A–C) Contrast-enhanced axial CT depicting ablation with CT acquired in arterial, portal, venous phases with ablation needle in situ, and (D) shows postablative changes with some hyperdense content. CT, computed tomography.

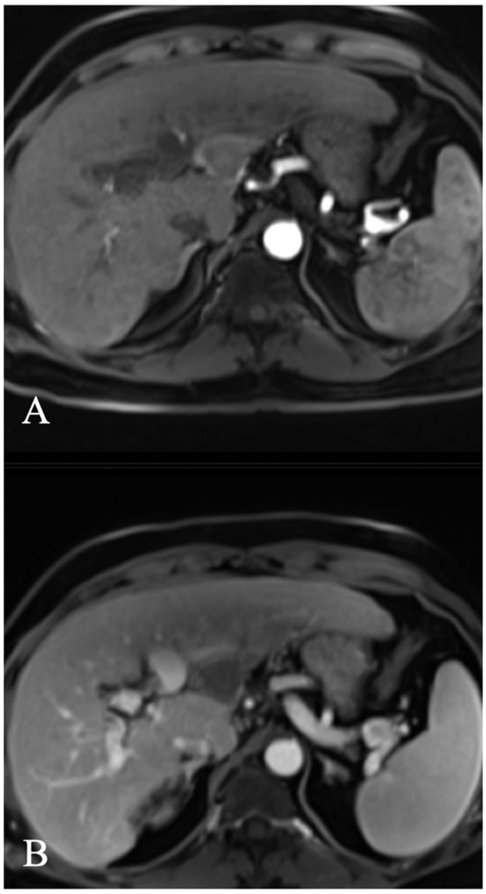

Fig. 7 Postablative dynamic MRIs (A, B) show no residual or recurrent lesion at the ablative site. MRI, magnetic resonance imaging.

standard deviation. Local recurrence/residual disease was represented by the Kaplan–Meier curve.

Results

During the study period, MWA was performed in 13 type 2 exophytic HCC patients. The baseline characteristics are shown in ►**Table 1**. One patient had a lesion more than 3 cm (measuring 5.4 cm) which was treated by a combination approach of transarterial chemoembolization (TACE) followed by ablation.

Segment 3 (38%) was the most common site when categorized as per Couinaud classification and segment 6 was the next common site. When lesions were assessed based on their proximity to visceral organs, four lesions were adjacent to the stomach. Other common structures of abutment were the abdominal wall, kidney, bowel, diaphragm, gallbladder, and colon in three, one, one, one, one, and one patients, respectively.

Hydrodissection was performed with 5% dextrose solution when the proximity endangered a risk of burn in the surrounding vital structure. Hydrodissection was performed after placing a 22G needle in locations where there was a risk of ablative injury. Once the needle was placed, 5% dextrose solution was injected by hand to separate the planes between the two structures and infusion was continued until ablation was completed. Planes are hydrodissected when fat planes are not well appreciated between the lesion and the adjacent structure or distance between the two are less than 3mm.

The mean lesion size treated was 2.95 cm (range: 1.9–5.4 cm). Lesions that were more than 3 cm were as combination treatment (TACE plus MWA). One patient underwent TACE after which MWA was performed after 4 weeks.

Immediate postprocedure complication was seen in the form of hemoperitoneum in one patient, which was managed conservatively. Hemoperitoneum was secondary to bleeding from track which was minimal in quantity and was self-limiting on follow-up, requiring no further intervention. No other major complications were noted.

Technical success of complete ablation, evaluated by postprocedure contrast-enhanced CT scan was 100%. The median follow-up period was 24 months (range: 9–24 months). One patient presented with a residual lesion on the first follow-up at 30 days. The reason for recurrence at 1 month was likely associated with the larger size of the lesion. Two other patients followed up at 9 months were free of HCC. Ten patients followed up at 1 year showed no recurrence, while seven of these were followed up for 24 months, and one of which showed multicentric recurrence which was treated by selective intra-arterial radiation

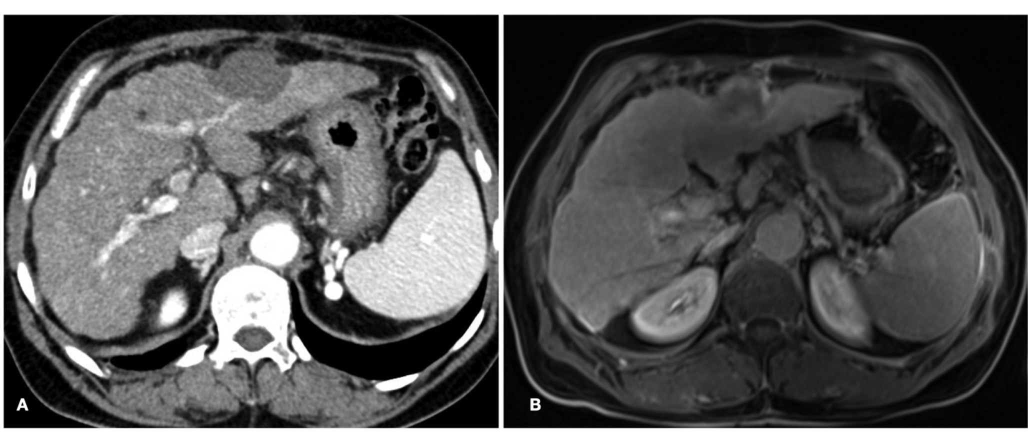

Fig. 8 Postablative dynamic images: (A) immediate postablative CT demonstrating complete ablation and (B) follow-up MRI shows no residual or recurrent lesion at the ablative site. CT, computed tomography; MRI, magnetic resonance imaging.

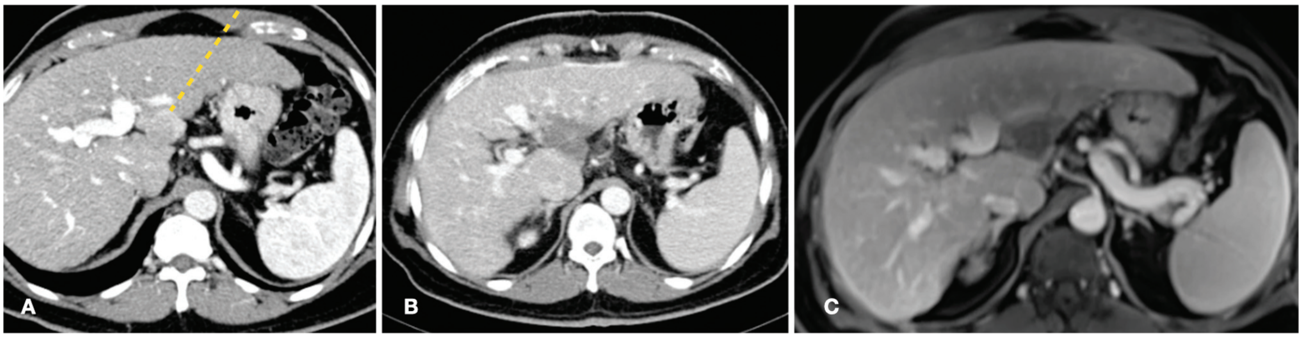

Fig. 9 Contrast-enhanced axial CT images (A–C): (A) demonstrates the proposed plan, (B) demonstrates the ablation and the ablative track as planned, and (C) demonstrates follow-up MRI with no residual/recurrent lesion. Also note the previous ablated track. CT, computed tomography; MRI, magnetic resonance imaging.

Table 1 Clinical demographics of patients

Patient		Total ($n = 13$)
Child–Pugh classification	A	7
	B	5
	C	1
Viral markers	HBV	4
	HCV	4
	None	5
Segment	2	1
	3	5
	5	2
	6	3
	Caudate	1
	8	1
Lobe	Left	6
	Right	7
Tumor adjacent structure	Abdominal wall	3
	Bowel	1
	Diaphragm	1
	GB	1
	Kidney	2
	Kidney and colon	1
	Stomach	4
Complication	Hemoperitoneum	1
	None	12

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus.

therapy. One patient was lost to follow-up at the end of 1 year.

Discussion

This study was focused on (1) suggesting a classification system of HCC on cross-sectional imaging and (2) understanding how MWA performed when ablating a truly exophytic HCC.

Literature has revealed a gray zone in clearly defining and classifying liver lesions based on locations. As per our literature review, an exophytic HCC is defined as a lesion with the center of the lesion lying beyond the confines of the liver margin.[13] Ablation of purely exophytic lesions is associated with significant challenges, including the risk of incomplete ablation. Based on this, we devised a classification system dividing the lesions into (1) intraparenchymal HCC, (2) subcapsular HCC, and (3) exophytic HCC. Exophytic lesions were further classified as types 1 and 2 (►**Table 2**).

It has been previously reported that ablation of subcapsular lesion is associated with several complications including hemorrhage, recurrence, track seeding, and risk of injury to surrounding structures.[14,15] Hence, presuming ablation of truly exophytic lesion would increase this risk several folds is not wrong.

Ablation is associated with increase in intratumoral pressure secondary to water vapor production, which can be tackled efficiently by including a normal parenchymal track. Included parenchyma carries tumor feeders which during ablation gets thrombosed preventing a significant rise in intratumoral pressure. This along with creation of artificial ascities/hydrodissection are protective measures to prevent complication especially when treating exophytic lesion.

Earlier studies have reported to consider other form of treatment including surgery, when dealing with exophytic lesions over ablation due to complications.[16]

Ablation of type 2 exophytic HCC comes with significant challenges as a significant portion of the lesion has no parenchymal protection and needs to be ablated with precision resulting in complete ablation without any undue complications.

Previous study has shown the safe and efficacious use of RF for ablation of subcapsular and type 1 exophytic lesions.[11,12,16–19] Ding et al[5] classified and ablated lesions into two specific groups classified as exophytic and subcapsular lesions. This study found similar local and long-term response in subgroup analysis while performing MW ablation. Exophytic lesion was defined as those lesion with one-third portion extending beyond the capsule[5]; however, we considered lesion with the center beyond the margin[13] which is possible only when 50% of the lesion is beyond the capsule.

Table 2 Classification of HCC based on cross-sectional imaging

HCC classification		
Intraparenchymal	Lesions that are within the liver and more than 0.5 cm from the liver capsule	
Subcapsular	Lesions that are abutting (not causing contour deformity) and/or within 0.5 cm of the liver capsule	
Exophytic	Type 1	Nodule causes a capsular bulge but less than 50% of the tumor extends outside a tangential line drawn on the hepatic capsule
	Type 2	Nodule causing a capsular bulge with 50% or more of the tumor extending outside a tangential line drawn on the hepatic capsule

Abbreviation: HCC, hepatocellular carcinoma.

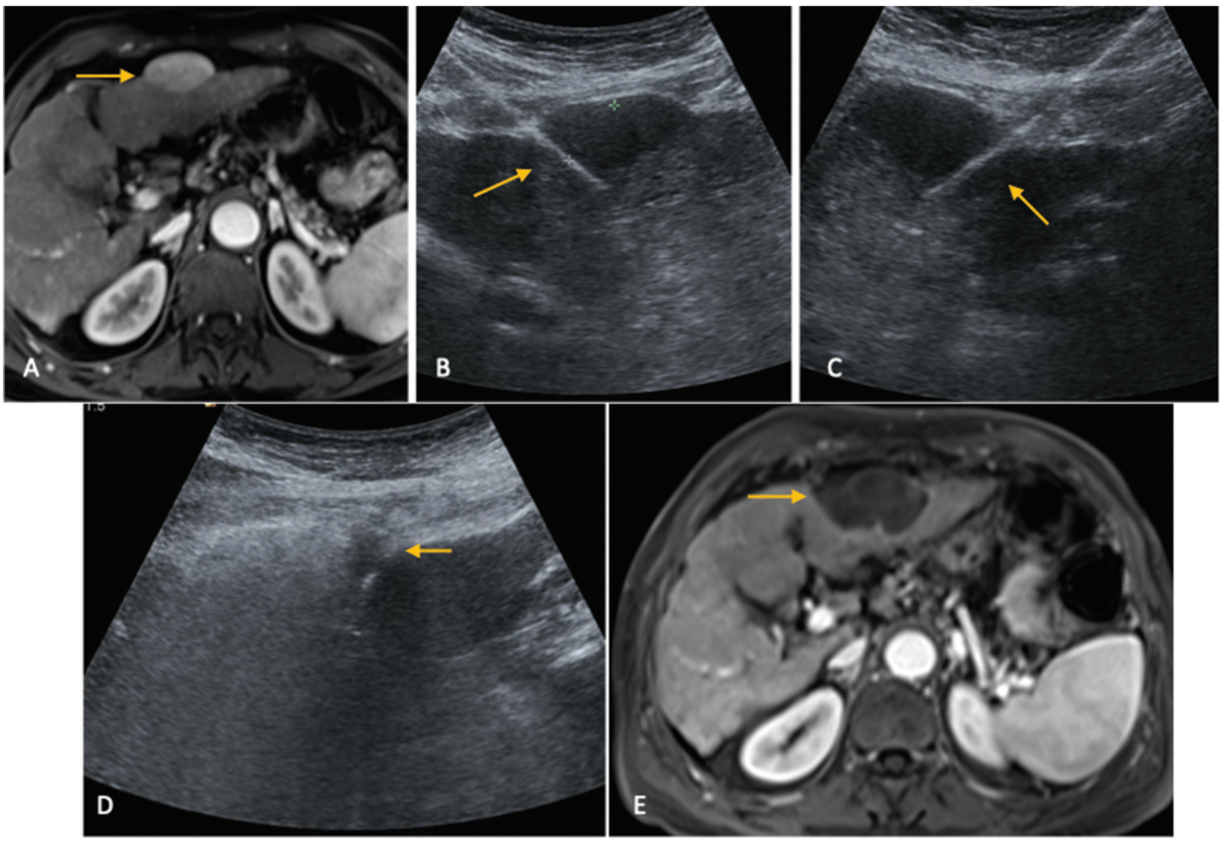

Fig. 10 "No-touch" ablation of anterior capsular lesion: (A) arterially enhancing exophytic type 2 lesion seen in the anterior capsule of left lobe, (B, C) ablation needle placed tangentially on either side, (D) postablation ultrasound images, and (E) postcontrast axial CT shows complete ablation of the lesion. CT, computed tomography.

A newer technique, termed as "no touch wedge ablation technique" has been described.[20,21] This technique allows complete ablation by placing multiple tangential needles for the ablation of peripheral subcapsular lesions. This technique allows overlapping ablation with peritumoral margin allowing complete treatment with no local tumor progression and track seeding. However, its role has not yet been studied in truly exophytic lesions. We performed one case of the "no touch ablation" and found similar results (►**Fig. 10**). Our study has some limitations, it was a retrospective study with a small sample size. Multicentric studies with larger sample size will help in further assessment of safety profile and the future course when dealing with these difficult lesions.

Conclusion

A classification system for exophytic lesions can allow for better patient selection, planning, and ablative outcomes. MW ablation has performed well when ablating these technically challenging lesions with a certain degree of planning.

Funding
None.

Conflict of Interest
None declared.

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