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COMPARATIVE EFFICACY OF COMPUTED TOMOGRAPHY AND ULTRASOUND IN ASSESSING PATIENTS WITH HEPATOCELLULAR CARCINOMA WHO UNDERWENT MICROWAVE ABLATION

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Abstract

Background

A primary liver malignancy of vascular origin that develops in the setting of chronic liver disease or cirrhosis is termed hepatocellular carcinoma (HCC). Microwave ablation (MWA) which is a minimally invasive thermal-based treatment, now commonly used to treat localized HCC, but the evaluation of local response following MWA remains difficult. The study is to assess the implications of ultrasound (US) and computed tomography (CT), along with their combined application, on post-MWA outcomes in patients with hepatocellular carcinoma (HCC). By combining CT and US, their respective shortcomings might be addressed and a more thorough and precise post-MWA clinical evaluation could be obtained providing a more comprehensive and accurate post-MWA clinical assessment.

Objective

The study aims to analyze the impact and effectiveness of Ultrasound (US) and Computed Tomography (CT) imaging in assessing post-MWA outcomes in individuals with HCC.

Methodology

This research involved 101 HCC patients who underwent both CT and Ultrasound imaging after receiving MWA. This was a multicentered study carried out in duration of 4 months. The parameters documented and evaluated included lesion size, enhancement patterns, vascular invasion, and post-ablation complications.

Results

This study includes reports of 101 individuals with Hepatocellular carcinoma who had Microwave ablation therapy. The patients were presented with history of abdominal distension (46.53%), abdominal pain (77.73%), jaundice (37.62%), history of hepatitis (11.88%), alcohol consumption (1.98%), and liver cirrhosis (25.74%). Post procedural complications were assessed through ultrasound and computed tomography which include infection/abscess (55.45% on CT, 58.42% on US, 74.26% on both) , hemorrhage (69.31% on CT, 57.42% on US, 75.24% on both), bile duct injury (65.34% on CT, 73.27% on US, 82.18% on both), air *embolism (76.23% on CT, 77.22% on US,81.18% on both), ascites/peritoneal fluid collection (72.27% on CT, 83.17% on US, 84.16% on both), post-ablation zone complications (74.25% on CT, 71.28% on US,80% on both), pneumothorax (73.26% on CT,68.31% on US,78.21% on both), perforation of other organs (65.34% on CT, 61.38% on US, 75.24% on both), thrombosis (73.26% on CT, 75.28% on US, 82.19% on both) and other anomalies (75.24% on CT, 81.18% on US, 85.15% on both). The study shows improvement in clinical assessment and patient outcomes when both CT and ultrasound are used for post-MWA evaluation.*

Conclusions

The study concluded that although CT and ultrasound have individual strengths, CT with greater sensitivity and better lesion characteristics, and ultrasound is more cost-effective and simpler. The study demonstrates that employing both CT and Ultrasound for post-MWA evaluation improves clinical assessment and patient outcomes. Combining these modalities balances the strengths and limitations of each technique, optimizing diagnostic accuracy.

1. INTRODUCTION

Hepatocellular carcinoma is ranked sixth in the list of most common malignancies around the globe. It is the fifth frequently occurring malignancy among men and eighth most common in women. Additionally, it is ranked third as most common cancer associated mortality, following stomach and lung malignancies.[1] Hepatocellular carcinoma (HCC) is a leading malignancy. It is one of the prevalent sorts of liver cancer, typically occurring in individuals with comorbidities such as cirrhosis, hepatitis B or C or chronic liver disease. HCC is identified by the malignant alteration of hepatocytes, the main type of liver cell. This malignancy usually arises in the context of chronic liver damage and inflammation, which can be brought on by viral infections, alcohol intake, non-alcoholic fatty liver disease (NAFLD), and other illnesses leading to cirrhosis.[2]

Asia and Africa have the highest incidence of HCC, and the endemic high prevalence of hepatitis B and hepatitis C there significantly increases the risk of developing chronic liver disease and HCC. Up to 24% of patients, nevertheless, do not have a history of cirrhosis or any risk factors for it.[3]

Noninvasive imaging can frequently be used to validate the diagnosis of HCC without the need for a biopsy. Imaging is typically necessary for guiding, even in cases where biopsy is necessary.[4]

Significant complications following MWA have been documented with figures ranging between 3% and 5%. The primary treatments for HCC are liver transplantation, (TACE), local ablation therapy (microwave, percutaneous ethanol injection, cryoablation, and radiofrequency), and surgical resection.[5]

Some key complications linked with HCC include tumor rupture and hemorrhage, vascular invasion, metastasis, liver failure, Ascites, and hepatic Encephalopathy. Treatment-Related Complications includes Complications of Surgery, Postoperative complications after a partial hepatectomy include bleeding, bile leakage, infections, and liver failure, Complications of Trans arterial Therapies and Complications of Ablation Therapies.[6]

The National Comprehensive Cancer Network (NCCN) states that screening for HCC and monitoring for cirrhosis or chronic hepatitis B is thought to be cost-effective. Ultrasonography with or without α-fetoprotein (AFP) was advised by the NCCN. Testing should be done again in six months if nodules found by ultrasonography turn out to be negative. Repeat in three to six months if the nodules are small (less than 10 mm). A conclusive diagnosis can be made with further imaging using computed tomography (CT) or magnetic resonance imaging (MRI) in patients with vascular invasion, large nodules (≥10 mm), capsular retraction, or a positive AFP test result.[7]

During the process, the operator's attention is focused on positioning the device correctly before selecting the desired ablation power and time. Together with an ablative margin of at least 5 mm, the ablation volume should encompass the tumor volume.[8]

Role of Imaging Modalities in Management of HCC is essential for the surveillance, diagnosis, and evaluation of therapy response in hepatocellular carcinoma (HCC). In patients with liver cirrhosis, the emergence of HCC is the most serious consequence. The prognosis of HCC depends on the extent of spread of the tumor. Surveillance programs utilizing ultrasonography (US) are recommended for cirrhotic patients, offering the potential for treatment if HCC is detected, thereby improving patient survival.[9]

Diagnostic Imaging modalities include Ultrasound for HCC surveillance, magnetic resonance imaging, Computed Tomography, Positron Emission Tomography and Contrast Enhanced Ultrasonography.[10]

Therapy or treatment options for HCC include Radiation therapy, Intravenous Chemotherapy, Radiofrequency Ablation, microwave ablation, Immunotherapy, Surgicalresection: in form of partial or complete hepatectomy.[11]

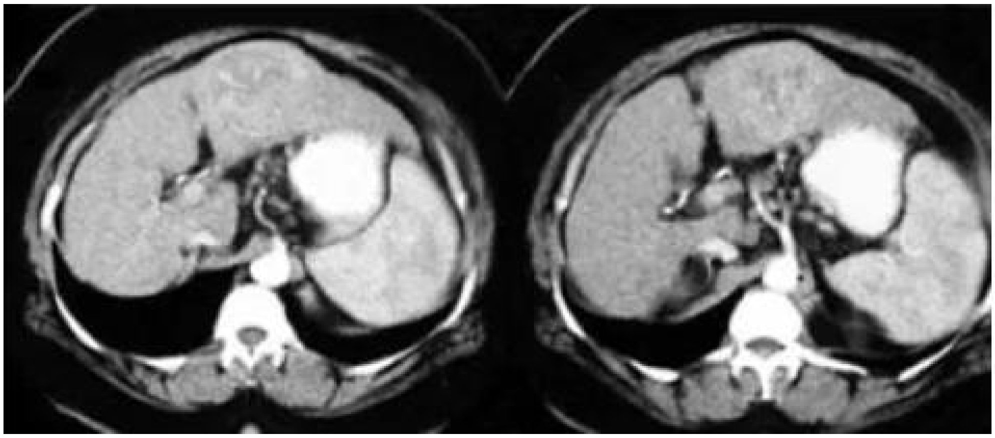

Figure 1: During the contrast enhancement hepatic arterial phase on CT scan, there is evidence of neovascularity in a low-density liver mass [12].

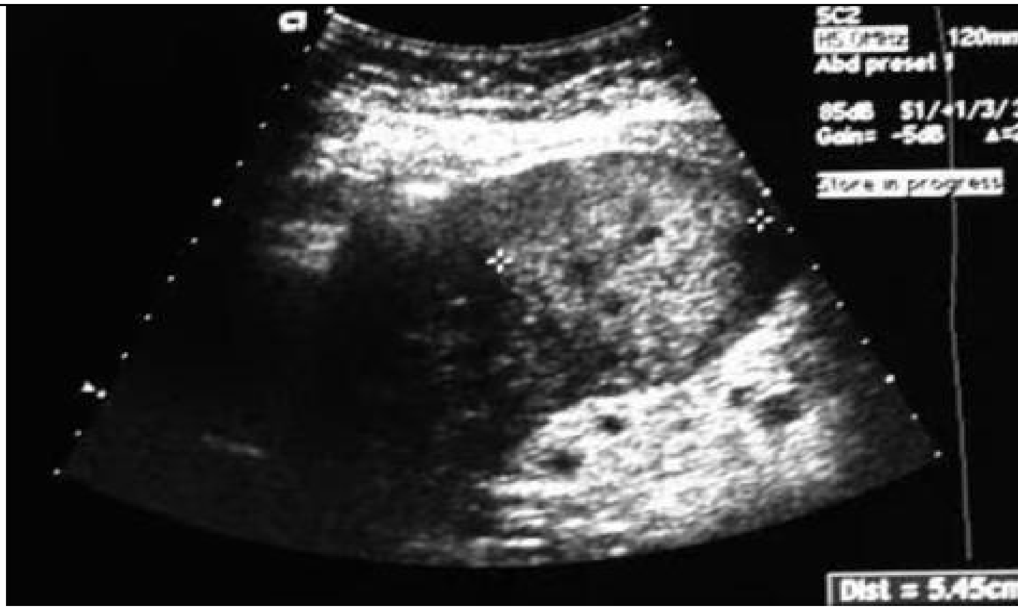

Figure 2: Ultrasound shows hyperechoic mass representing HCC[12].

The modality of choice for assessment of HCC is distinct from other cancers because its diagnosis can frequently be made through radiographic imaging alone, without the need for histological confirmation. Major professional liver organizations all around the globe prefer abdominal ultrasonography as a diagnostic modality for HCC surveillance and diagnosis.[13]

Advantages of using Ultrasound as a diagnostic modality includes, it is readily available, Inexpensive, Non-invasive, no ionizing radiation, High sensitivity of around 94% in diagnosing HCC at any stage. There has been growing interest in alternative imaging modalities like computed tomography (CT) for diagnosing HCC and for the assessment of radiotherapy outcomes. Its advantages include Quick processing and acquisition, bettervascular assessment, Detailed imaging, contrast enhanced imaging and it is Readily available.[14]

The goal of image-guided percutaneous thermal ablation in patients with early-stage HCC is to eliminate every living malignant cell in the target tumor.[15]

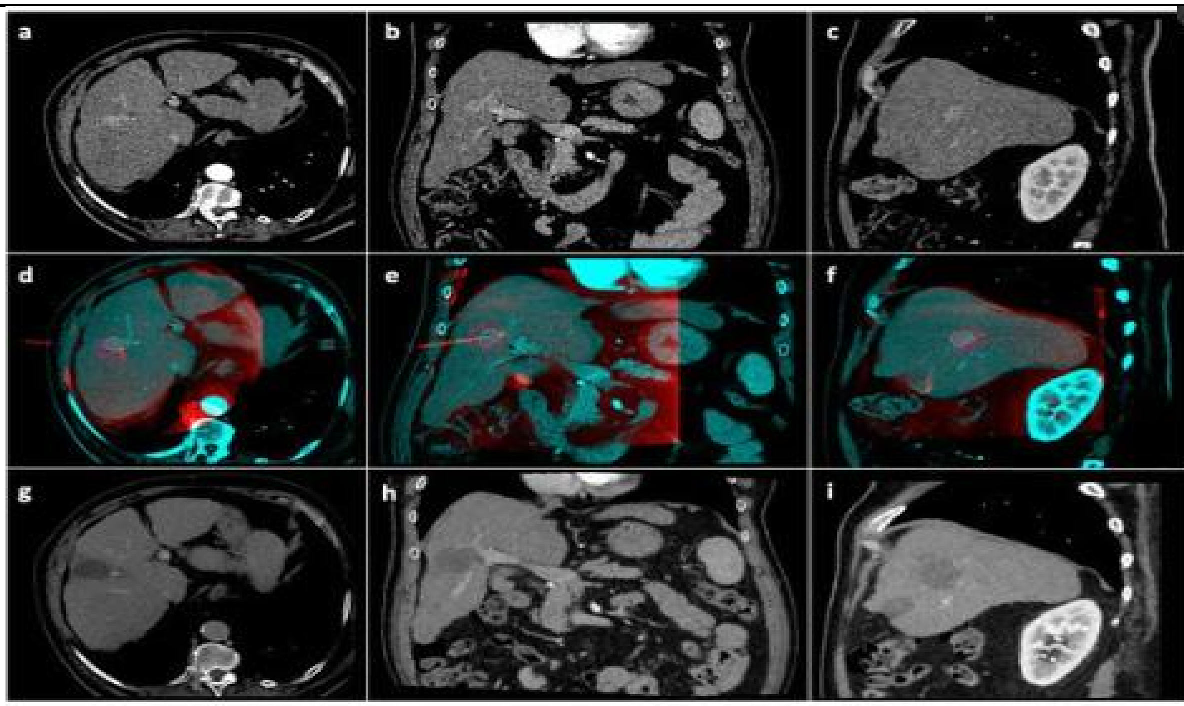

Figure 3: To identify tumor regions, to estimate ablation volume and to evaluate the outcomes after treatment. These are preprocedural CT coronal(b), CT sagittal(c), CT axial (a) planes of arterial phase pictures. Intraprocedural fusion image that shows the combination of pre- and intra-procedural CT scans of the tumor (blue) and the microwave antenna location (red), in the axial(d), coronal(e), and sagittal planes(f). Ablation power and time with the antenna location are used to create the virtual anticipated ablation volume (purple) including the tumor volume (blue line) with a 5 mm safety margin (green line) in the combined pictures. Axial (g), coronal (h), and sagittal (i) CT scans in the following month show complete resolution. [16].

Preventing harm to non-target structures and preserving the surrounding non-tumoral tissue. There are various modalities that can be employed alone or in combination for imaging guidance.[17]

Despite the fact that every international organization advises ultrasonography as a screening method for HCC, the American College of Radiology (ACR) imaging guidelines recognize that this modality is especially limited for detecting HCC in individuals with nodular cirrhosis, obesity, and nonalcoholic fatty liver disease (NAFLD).[16] The American College of Radiology (ACR) states that because ultrasonography is so limited in these patient groups and in patients waiting for liver transplants, screening for HCC with multiphase CT or MRI should be considered.[18]

Ultrasound (US) offers the benefit of imaging in real time, large patients, deep lesions or poor tumoral sonographic conspicuity may restrict visibility. Although computed tomography (CT) offers a high spatial resolution, it lacks real-time evaluation and implies radiation.[19]

In clinical practice, accurately assessing treatment results in patients having hepatocellular carcinoma (HCC) after microwave ablation (MWA) is still a major difficulty. The two most popular imaging modalities for post-ablation monitoring are computed tomography (CT) and ultrasonography (US), although each has drawbacks when used alone. Although CT is well-known for its excellent sensitivity, spatial resolution, and capacity to identify extrahepatic metastases and vascular invasion, it also exposes patients to ionizing radiation and has drawbacks related to contrast agents. Although ultrasound is non-invasive, affordable, and radiation-free, it has drawbacks, including operator dependence and decreased accuracy in some patient profiles, such as those with obesity or deeply positioned lesions. Despite their distinct advantages, nothing is known about how they might be used in conjunctions.

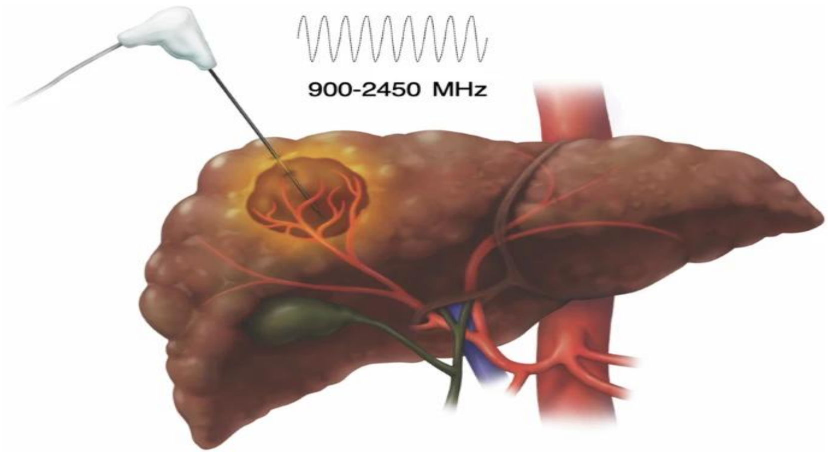

Figure 4: Microwave Ablation procedure [20]

There is a lack of research on the combined use of computed tomography (CT) and ultrasound (US), two commonly used imaging modalities for tracking hepatocellular carcinoma (HCC) after microwave ablation (MWA). Most of the current research assesses these modalities separately, concentrating on their unique advantages and disadvantages. Although CT has better sensitivity and spatial resolution, it also puts patients at risk for contrast agents and ionizing radiation. Despite being non-invasive and economical, ultrasound has limitations due to operator dependence and reduced accuracy in some situations, such as assessing lesions that are deeply situated. This research is focusing on how their integration might improve post-treatment monitoring and diagnostic accuracy are still rare, despite their complementing benefits. This disparity emphasizes the necessity of thorough research into the complementary advantages of CT and US for enhancing the detection
The purpose of this research is to look for optimal assessment of treatment response. Imaging and therapeutic modalities of choice include comparative efficacy of USG and CT in patients of HCC receiving microwave ablation therapy. This can lead to improved patient management, more personalized treatment strategies, and ultimately better clinical outcomes for HCC patients.

2. AIM AND OBJECTIVES

- To rule out the efficacy of CT and ultrasound in assessing HCC patients who underwent MWA
- To rule out whether the combined use of CT and ultrasound improves treatment monitoring and follow-up strategy planning for patients with hepatocellular carcinoma after microwave ablation.
- The purpose of this study is to look for optimal assessment of treatment response and includes comparative efficacy of both modalities in patients of HCC receiving MWA.

3. METHODOLOGY

3.1. Research Design: Cross-sectional Study

3.2. Clinical Settings: Sheikh Zayed Hospital, PKLI, Fouji Foundation

3.3. Sample Size: Sample size of 101 is calculated through formula given below in which Margin of error was 5%, while confidence level was 95%.

Calculated through formula $\mathbf{n} = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$

3.4. Sampling Technique: Convenient Sampling Technique

3.5. Duration of Study: Duration of this study was 4 months.

3.6. Selection Criteria

3.6.1. Inclusion Criteria

- Patients who have no history of other malignancies.
- Patients aged between 18-80 years.
- Patients referred by physician for CT scan and ultrasound.
- Patients who provide informed consent for participation in the study.

3.6.2. Exclusion Criteria

- Exclusion of patients with malignant tumors other than HCC.
- Exclusion of individuals with a history of prior treatment for malignancy.
- Pregnant women
- Patients with severe heart, lung or kidney insufficiency.

3.7. Ethical Consideration

The rules and regulations set by the ethical committee of Superior University, Lahore willbe followed while conducting the research and the rights of the research participants willbe respected.

- From all the participants written informed consent was taken.
- All data and information gathered was kept private.
- Throughout the study, participants maintained their anonymity.
- The participants were informed that there are no dangers or drawbacks to the research process.
- Participants were informed that they can leave the study at any moment.
- Every precaution was taken to keep patients' privacy safe. No publication resulting from this study revealed who they were.
- Patients were not forced to participate in this research project. Participation was entirely voluntary, and they had the right to revoke their consent at any moment. If they withdrew from this study or chose not to participate, they were not penalized in any way.

3.8. Data Collection Procedure

Firstly, informed consent was obtained from each patient, ensuring they were fully aware of the purpose, methods, and potential risks associated with imaging and study procedures. Relevant clinical and demographic information was recorded, including age, gender, tumor characteristics, and liver function status. Patients who had undergone microwave ablation (MWA) for hepatocellular carcinoma (HCC) were selected for imaging assessment. Imaging was performed using CT, ultrasound, and combined imaging (CT and ultrasound) based on predefined imaging protocols. The data collection procedure for this study involved recruiting eligible patients scheduled for Computed Tomography and ultrasonography. Data was collected through interviews and medicalrecords.

For Ultrasound GE Healthcare equipment was used. For better visualization patients were observed in different positions, including Supine, semi erect, LPO, LLD. A convex transducer was used to obtain a wide field of view.

For Computed Tomography GE Healthcare 128 slice machine was used, with patient lying in supine position.

3.9. Data Analysis

The data was collected from the Radiology Department. It was evaluated and analyzed using Microsoft Excel 2016. A detailed descriptive analysis was performed to investigate the distribution, frequency, percentage, and diagnostic accuracy of variables derived from CT and ultrasound imaging in the assessment of patients undergoing microwave ablation (MWA) for hepatocellular carcinoma (HCC). The data was securely stored in Microsoft Excel, facilitating organized management and retrieval for subsequent analyses. A comprehensive list of dependent and independent variables was generated to structure the analytical approach. Dependent variables were diagnostic accuracy of CT, ultrasound, and their combined use, as well as post-ablation outcomes such as residual disease detection and recurrence. Independent variables were patient demographics, tumor characteristics, and treatment parameters. These comparative analyses aim to highlight significant differences in diagnostic performance and clinical outcomes when using combined imaging (CT and ultrasound) versus individual modalities. By providing insights into the efficacy of imaging strategies in evaluating MWA-treated patients, the study will contribute to optimizing post-ablation imaging protocols for HCC management.

4. RESULTS

The study analyzed data from 101 patients diagnosed with hepatocellular carcinoma (HCC) who underwent microwave ablation (MWA) therapy. The cohort included 58 males (57.43%) and 43 females (42.57%). The most common clinical presentation was abdominal pain, reported by 78 patients (77.73%), comprising 40 males and 38 females. Abdominal distension was observed in 47 patients (46.53%), with 27 males and 20 females affected. Jaundice was present in 38 patients (37.62%), including 18 males and 20 females. A family history of liver disease was reported by 55 patients (54.46%), with 34 males and 21 females. Liver cirrhosis was diagnosed in 26 patients (25.74%), of which 15 were males and 11 were females. A history of previous procedures was noted in 27 patients (26.73%), including 17 males and 10 females. Additionally, 12 patients (11.88%) had a history of hepatitis (5 males and 7 females), and alcohol consumption was documented in 2 males (1.98%). These findings reflect the diverse clinical and demographic characteristics of the study population, underscoring the multifactorial nature of HCC in patients undergoing MWA therapy.

Post-procedural complications following microwave ablation (MWA) for hepatocellular carcinoma (HCC) were assessed using ultrasound (US), computed tomography (CT), and a combination of both modalities. The findings demonstrated varying detection rates for different complications across the imaging techniques. Infection or abscess was identified in 55.45% of cases using CT, 58.42% with US, and 74.26% when both modalities were combined. Hemorrhage was detected in 69.31% of cases with CT, 57.42% with US, and 75.24% with combined imaging. Bile duct injury was observed in 65.34% of cases using CT, 73.27% with US, and 82.18% with both. Air embolism was identified in 76.23% of cases on CT, 77.22% with US, and 81.18% with combined imaging. Ascites or peritoneal fluid collection was detected in 72.27% of cases using CT, 83.17% with US, and 84.16% with both modalities. Post-ablation zone complications were observed in 74.25% of cases on CT, 71.28% with US, and 80% with combined imaging. Pneumothorax was detected in 73.26% of cases using CT, 68.31% with US, and 78.21% with both. Perforation of other organs was identified in 65.34% of cases with CT, 61.38% with US, and 75.24% with combined imaging. Thrombosis was observed in 73.26% of cases on CT, 75.28% with US, and 82.19% with both. Other anomalies were detected in 75.24% of cases with CT, 81.18% with US, and 85.15% with combined imaging. The results indicate that combining CT and ultrasound improves the detection of post-procedural complications and enhances clinical assessment and patient outcomes after MWA.

CROSSTAB History & Gender Distribution			
History/Complaint	Gender	Count	% of Total
Abdominal Distension	Male	27	26.73%
	Female	20	19.80%
Total		47	46.53%
Abdominal Pain	Male	40	39.60%
	Female	38	38.12%
Total		78	77.73%
Jaundice	Male	18	17.82%
	Female	20	19.80%
Total		38	37.62%
History of Hepatitis	Male	5	4.95%
	Female	7	6.93%
Total		12	11.88%
Alcohol Consumption	Male	2	1.98%
	Female	0	0.00%
Total		2	1.98%
Liver Cirrhosis	Male	15	14.85%
	Female	11	10.89%
Total		26	25.74%
Any Previous Procedure	Male	17	16.83%
	Female	10	9.90%
Total		27	26.73%
Family History	Male	34	33.66%
	Female	21	20.79%
Total		55	54.46%
Grand Total	Male	58	57.43%
	Female	43	42.57%
	Overall Total	101	100.00%

Table 1:This table presents patient history/presenting complaint and their demographic data which includes several symptoms such as abdominal distension, abdominal pain, jaundice along with patient's family history, history of hepatitis, alcohol consumption or liver cirrhosis. Most frequently reported symptom was pain in upper right quadrant of abdomen and incidence of HCC was high in patients having family history of cancer.

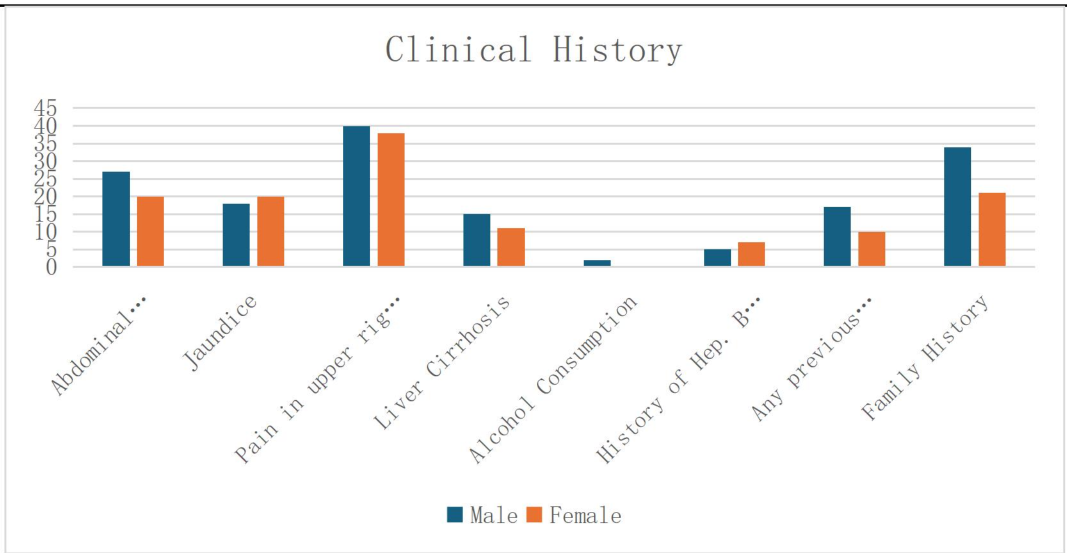

Figure 5: This bar chart shows the clinical history of patients and symptoms along with their frequency and gender distribution. blue color is presenting male population while orange is presenting female participants.

Complications	Findings on CT		Findings on US		Findings on both modalities	
	Detected	Not Detected	Detected	Not Detected	Detected	Not Detected
Infection/abscess	56	45	59	42	75	26
Hemorrhage	70	31	58	43	76	25
Bile Duct Injujry	66	35	74	27	83	18
Air Embolism	77	24	78	23	82	19
Ascites/peritoneal fluid collection	73	28	84	17	85	16
Post-ablation zone complications	74	27	72	29	80	21
Pneumothorax	74	27	69	32	79	22
Perforation of other organs	66	35	62	39	76	25
Hepatic Artery Thrombosis/portal venous thrombosis	74	27	76	25	83	18
Other anomalies(mass.lesion.nodule.hernia)	76	25	82	19	86	15

Table 2: The table illustrates post-therapy complications in patients with hepatocellular carcinoma (HCC) who underwent microwave ablation (MWA), including infection/abscess, hemorrhage, bile duct injury, air embolism, ascites or peritoneal fluid collection, post-ablation zone complications, pneumothorax, perforation of adjacent organs, thrombosis, and other anomalies (e.g., lesions or nodules). It also compares the detection of these complications using computed tomography (CT) alone, ultrasound (US) alone, and the combined use of these imaging modalities as diagnostic tools.

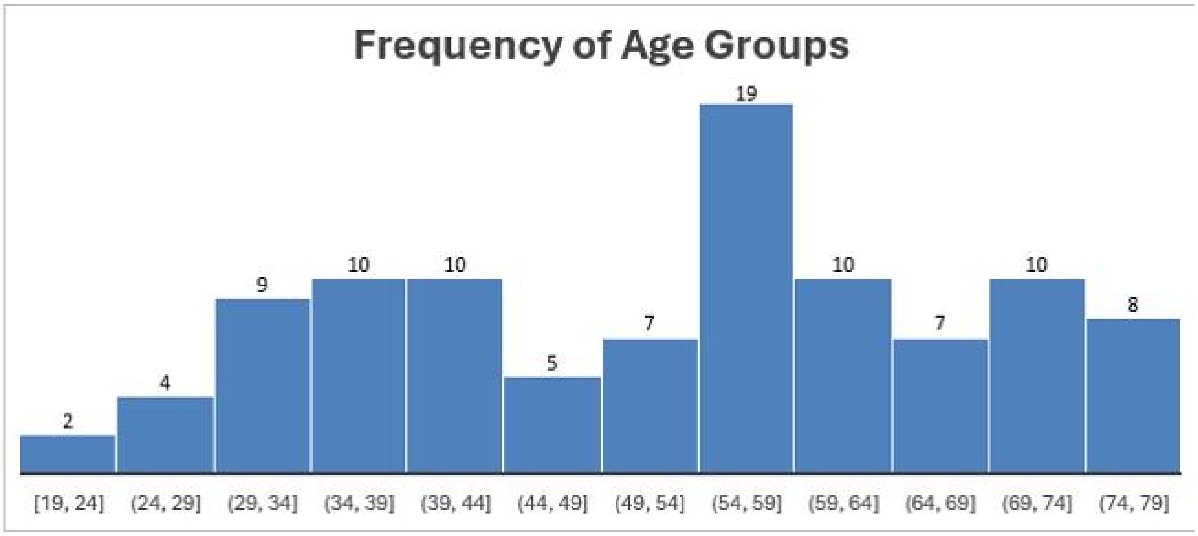

Figure 6: This graph depicts the frequency of age groups among the 101 participants in this study. The distribution includes: 2 patients aged 19–24 years, 4 patients aged 24–29 years, 9 patients aged 29–34 years, 10 patients aged 34–39 years, 10 patients aged 39–44 years, 5 patients aged 44–49 years, 7 patients aged 49–54 years, and 19 patients aged 54–59 years, which represents the highest incidence of HCC. Additionally, there are 10 patients aged 59–64 years, 7 patients aged 64–69 years, 10 patients aged 69–74 years, and 8 patients aged 74–79 years.

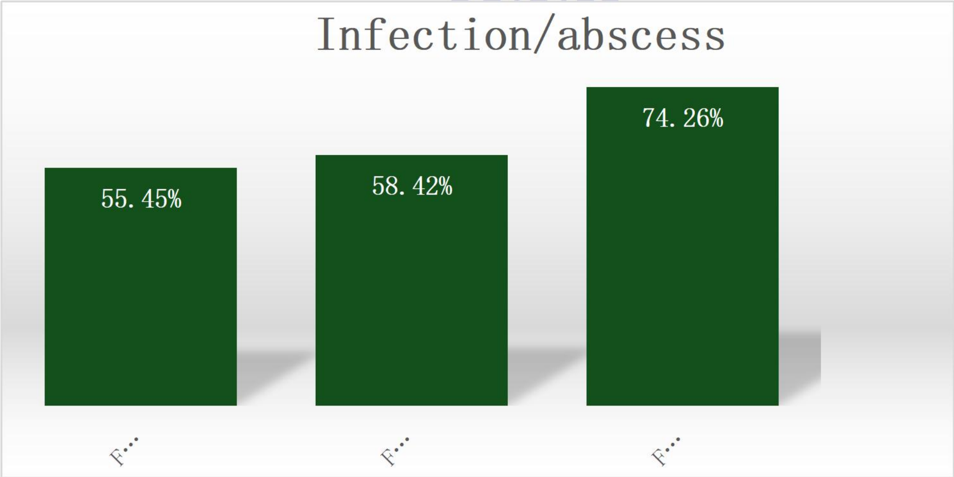

Figure 7: The bar chart illustrates the detection rates of post-therapy complications, specifically infections or abscesses, using three imaging modalities: Computed Tomography (CT), Ultrasound (US), and their combined application. CT demonstrated a detection rate of 55.45%, successfully identifying 56 cases out of 101, while US achieved a slightly higher rate of 58.42%, detecting 59 cases. Notably, the combined use of CT and US significantly improved the detection rate to 74.26%, identifying 75 cases and leaving only 26 undetected. These results underscore the superior diagnostic efficacy of combining CT and US compared to utilizing either modality individually.

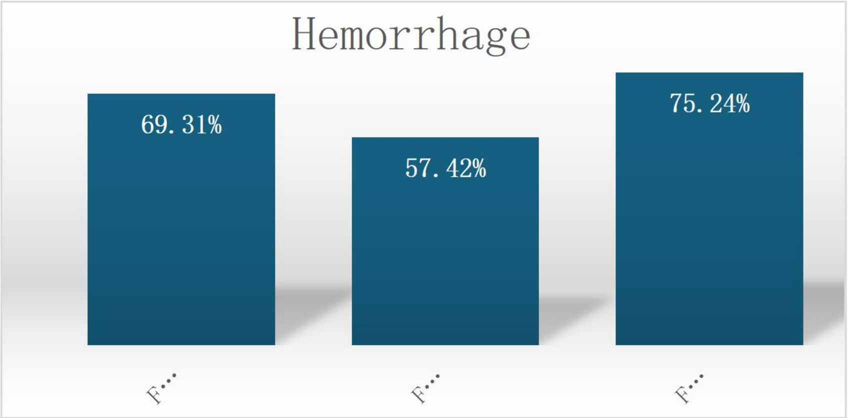

Figure 8: The graph depicts the detection rates of hemorrhage using Computed Tomography (CT), Ultrasound (US), and their combined application. CT achieved a detection rate of 69.31%, successfully identifying 70 cases out of 101, while US demonstrated a lower detection rate of 57.42%, detecting 58 cases. The combined use of CT and US showed the highest detection rate at 75.24%, identifying 76 cases and leaving only 25 undetected. This highlights the enhanced accuracy of combining CT and US.

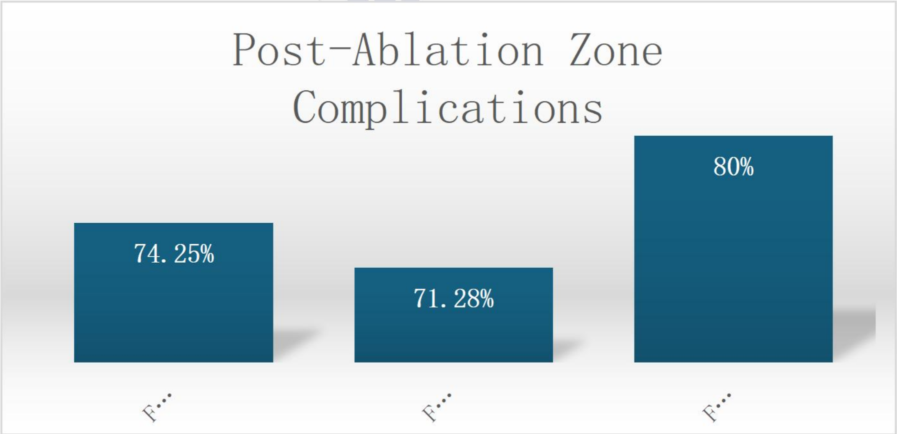

Figure 9: The bar chart depicts the detection rates of post-ablation zone complications using Computed Tomography (CT), Ultrasound (US), and their combined approach. CT detected 75 cases, achieving a detection rate of 74.25%, while Ultrasound identified 72 cases.

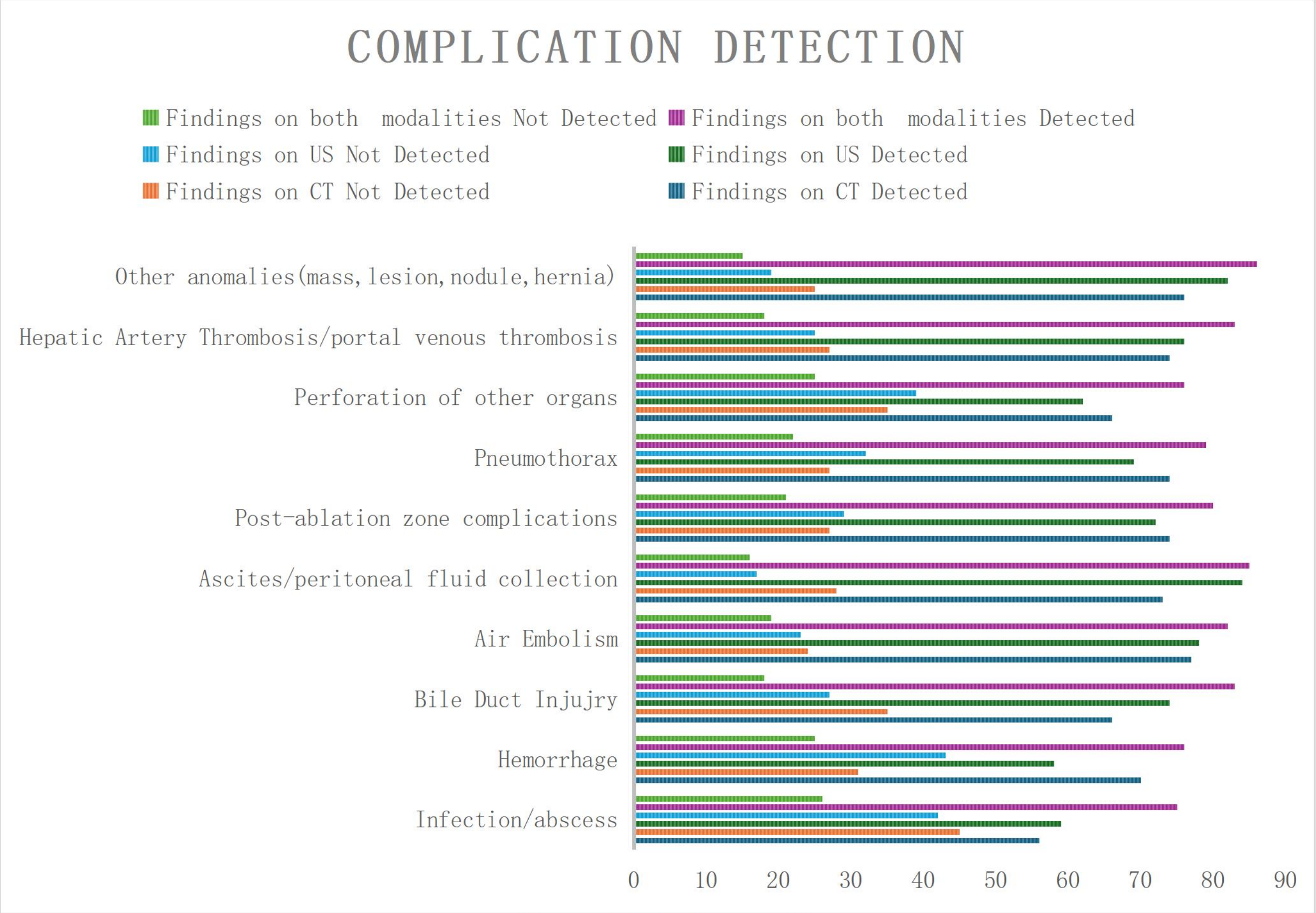

Figure 10: This clustered bar chart illustrates the detection of post-treatment complications in patients using CT, ultrasound (US), and the combined use of these modalities. The results highlight that the combined use of CT and US consistently improves the detection of complications compared to using either modality alone. For instance, infection and abscess were detected in 55.45% of patients using CT, 58.42% using US, and 74.26% using combined modalities. Hemorrhage was detected in 69.31% of patients using CT, 57.42% using US, and 75.24% using combined modalities. Similarly, bile duct injury was identified in 65.34% of patients on CT, 73.27% on US, and 82.18% with combined modalities. Air embolism was detected in 76.23% of cases on CT, 77.22% on US, and 81.18% with combined imaging. Ascites or peritoneal fluid collection was noted in 72.27% of cases on CT, 83.17% on US, and 84.16% using combined modalities. Post-ablation zone complications were identified in 74.25% of patients using CT, 71.28% using US, and 80% with combined modalities. Pneumothorax was detected in 73.26% of cases on CT, 68.31% on US, and 78.21% with combined imaging. Perforation of other organs was noted in 65.34% of cases on CT, 61.38% on US, and 75.24% using combined modalities. Hepatic artery or portal venous thrombosis was detected in 73.26% of patients on CT, 75.28% on US, and 82.19% with combined imaging. Finally, other anomalies, such as lesions or nodules, were detected in 75.24% of cases using CT, 81.18% using US, and 85.15% with combined modalities.

5. DISCUSSION

A thorough review of 101 patients with hepatocellular carcinoma (HCC) who had microwave ablation (MWA) therapy is presented in this study, with an emphasis on the diagnostic value of CT and ultrasound as well as their combined application for post-procedural evaluation. As opposed to utilizing either modality alone, the results show the increased utility of combining CT and ultrasound, which offers more precise detection of problems.

One of the most prevalent and deadly types of cancer in the world is hepatocellular carcinoma (HCC). The incidence and mortality burden of HCC are disproportionately high among racial/ethnic minorities, and the disease is more common in men.

The disease's image has evolved as a result of public health initiatives to combat viral hepatitis, one of the most prevalent risk factors. [21]

Patients in this study exhibit a range of clinical symptoms that are frequently linked to HCC and advanced liver disease. Demographics show gender distribution of 57 males and 44 women. The highest occurrence rate was observed in age group of 54 to 59 years. Zhang X et.al (2020) also reported incidence of HCC according to gender and ethnicity. Up until the age of 75, incidence rates of HCC and age were directly connected in the majority of populations. However, the median age at diagnosis was typically a little lower. In most of the states, men's incidence rates of HCC were two to four times greater than women's.[22] Asia and Africa have the world's highest incidence rates.[23]

Abdominal discomfort (77.73%) and distension (46.53%) were the most common symptoms, followed by jaundice (37.62%), a sign of liver dysfunction. Given that liver cirrhosis frequently makes both the course of the disease and its treatment more difficult, the fact that 25.74% of patients had this condition highlights the complexity of this patient population. A lower percentage of patients (11.88%) had a history of hepatitis, which is frequently a major underlying cause of HCC. It is noteworthy that just 1.98% of the sample reported drinking alcohol, which may indicate that hepatitis-related HCC is more common in the region than alcohol-related liver disease. Bagnardi V et. al conducted a study in which an observed risk factor for liver cancer is heavy alcohol use.In a meta-analysis of prospective studies, heavy alcohol consumption (≥3 drinks per day) was associated with a 16% increased risk of HCC. [24]

Furthermore, Turati F et.al stated that alcohol consumption may be more strongly linked to the risk of HCC in women than in men. Variations in alcohol dehydrogenase activity may be the cause of this. Different countries have different trends in alcohol consumption and alcohol-related liver disease, no alcohol consumption was observed in our research.[25]

Pathomjaruwat T et.al. (2024) also conducted a study to rule out the symptoms of HCC and their prevalence. He noted abdominal swelling/distension (58%), nausea/ vomiting (56%), lack of appetite (76%), weight loss (84%), jaundice (28%), pain and discomfort (72.16%). These symptoms are observed in our study with a greater incidence. Behavioral changes are also observed in both studies which include sadness, anxiety, lack of sleep, lack of interest in activities, fatigue and depression.[26]

This study's main goal was to identify post-procedural problems. The findings show that when it came to detecting problems, combination imaging (CT and ultrasound) consistently performed better than either modality alone. For instance, utilizing CT and ultrasound, infections or abscesses were found in 55.45% and 58.42% of cases, respectively. However, when both modalities were utilized simultaneously, the detection rate rose to 74.26%.

In a recent study conducted by Dobek A et.al to evaluate the diagnostic accuracy of contrast enhanced ultrasound in patients with hepatic abscess. There were 29 patients with 64 HA in that retrospective analysis (9 females and 20 men). The diagnostic standard was computed tomography (CT), which was contrasted with B-mode ultrasonography (B-mode) and CEUS. According to the results, CEUS provides better views of the abscess pouch, septa, and liver parenchyma, it is better than B-mode for diagnosing and tracking HA. Since there is no contrast in the purulent portion, a precise judgment is possible. CEUS can help choose patients for percutaneous intervention and take the place of CT for monitoring.[27]

Similarly, 69.31% of hemorrhages were detected by CT, 57.42% by ultrasound, and 75.24% with combination imaging. These results imply that the diagnostic accuracy for complications after MWA is improved by fusing the dynamic, real-time capabilities of ultrasound with the high spatial resolution of CT.

The higher detection rate of bile duct injury—65.34 percent on CT, 73.27% on ultrasound, and 82.18% with combined imaging—is another significant discovery. Early detection of bile duct injuries is essential because a delayed diagnosis may result in severe consequences, such as strictures or biliary leakage. The increased detection rates with combined imaging emphasize how important it is to guarantee prompt diagnosis and treatment. De Muzio F et.al conducted a study in which he stated that understanding the radiological findings of post-ablation complications can assist in identifying the primary issues that may occur right away following an ablative procedure, enabling the potential of early and targeted treatment. While CEUS is a diagnostic tool that may be used both as a surveillance tool and during therapy, CT with multiphase contrast studies is still the preferred method in emergency situations such as biliary leak.[28]

The study also assessed other problems, including ascites/peritoneal fluid accumulation, where combined imaging showed the highest detection rate (84.16%), and air embolism, which was found in 76.23% of cases on CT, 77.22% on ultrasound, and 81.18% with combined imaging. Accurate assessment is crucial for appropriate care because ascites is a common finding in cirrhotic individuals and can exacerbate the post-ablation course.

A critical metric for assessing the effectiveness of MWA, post-ablation zone problems, was found in 74.25% of CT cases, 71.28% of ultrasound cases, and 80% of cases employing both modalities. Because the post-ablation zone is a major location for possible recurrence or partial tumor elimination, this finding is noteworthy. By directing further interventions or surveillance, the capacity to more precisely evaluate this region with combined imaging may have a direct effect on patient outcomes.

Ablation zone complications are also reported by Voizard N et al. (2019), according to which needle trajectory in hepatic parenchyma is observed towards tumor due to tract cauterization after MWA. For up to a month post treatment of HCC using MWA gas foci can be observed, which reflects entry of air during the injection procedure or due to necrosis. In this study only CT examination was done while in our study the combined use of ultrasound and CT has provided better results of 80%.[29]

Less frequent but possibly fatal side effects include thrombosis, pneumothorax, and organ perforation. Additionally, combined imaging showed better detection rates for these, identifying thrombosis in 82.19% of cases, organ perforation in 75.24%, and pneumothorax in 78.21% of cases. These results demonstrate how crucial comprehensive imaging is for managing and preventing serious issues that would otherwise go unnoticed with a single modality.

Last but not least, combined imaging had the highest detection rate of additional anomalies, such as unusual presentations or unexpected discoveries, at 85.15 percent, compared to 75.24% on CT and 81.18% on ultrasonography.

Biondetti P et.al performed a study in which the finding predictors of outcome and complications in patients with small hepatocellular carcinoma (HCC) receiving percutaneous microwave ablation (MWA) was the goal of the current investigation. Age, sex, albumin, platelet count, liver status, liver disease etiology, tumor size, margin, and hepatic segment, tumor subcapsular, perihilar or perivascular location, HCC focality, and ascites were all recorded for every patient. Complications and results were recorded over the follow-up period. After then, variables were examined in light of complications and results. There were 74 patients in total. The average CT follow-up period was 6 months, with a range of 1–24 months. 47.8% of patients experienced at least one problem, most of which were asymptomatic imaging results that didn't need to be treated. There was one significant finding (duodenal perforation: 1.3%).[30]

This suggests that a more comprehensive assessment of post-procedural problems and incidental findings is made possible by the complementing qualities of CT and ultrasonography, guaranteeing that no important details are missed.

The results of the study are consistent with the increasing amount of data that backs up the application of multimodal imaging in challenging clinical situations. The combination of CT and ultrasound makes use of each modality's distinct advantages: CT's high spatial resolution and detailed cross-sectional imaging, while ultrasound's dynamic, real-time assessment and enhanced sensitivity to fluid collections or vascular complications. These techniques work in conjunction to provide a thorough and trustworthy assessment of patients who have had MWA. These findings highlight how crucial it is to use combined imaging procedures when routinely evaluating patients receiving MWA for HCC. By increasing diagnostic precision, combined imaging helps with fast clinical decision-making and early problem detection, which may lower morbidity and enhance patient outcomes.

6. CONCLUSIONS

This study demonstrates that combined CT and US imaging is better than either modality alone for post-MWA evaluation in patients with HCC. Both CT and ultrasound have advantages—CT is more sensitive and encounters better lesion characteristics, while ultrasound is easier to use and more affordable—using both imaging modalities together yields great advantages for precise diagnosis. These two methods can help with the better diagnosis of remaining tumor tissue and guarantee proper surveillance for recurrence or consequences if follow-up data are thoroughly examined. Therefore, to enhance follow-up treatment for patients with HCC receiving MWA, think about integrating both imaging modalities into clinical practice.

The results provide credence to the idea that integrating combined imaging procedures into standard clinical practice can improve patient outcomes and diagnostic accuracy. It is advised that future multicenter research be conducted to confirm these results and investigate the financial viability of using integrated imaging techniques.

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