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Dual Energy CT Imaging of Hepatocellular Carcinoma Using Lipiodol in Intermediate-Stage Chemotherapy Treatment

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Abstract Hepatocellular carcinoma (HCC) is the most prevalent form of primary liver cancer, with transarterial chemoembolization (TACE) being a standard treatment for intermediate-stage disease. During TACE, Lipiodol, an iodine-based contrast agent, serves as both a drug carrier and an imaging agent. However, residual Lipiodol can create artifacts on follow-up imaging, potentially mimicking tumor enhancement and complicating diagnostic interpretations.

This study investigates the role of dual-energy computed tomography (DECT) in differentiating between Lipiodol-induced artifacts and true tumor enhancement during post-TACE surveillance of HCC. We present a case of a 62-year-old female patient with HCC who underwent TACE, followed by DECT imaging for monitoring. DECT imaging revealed a lesion in the liver that appeared to enhance in the arterial phase, raising concerns for tumor recurrence. However, virtual non-contrast (VNC) imaging showed no enhancement, and the iodine map confirmed the presence of residual Lipiodol, rather than active malignancy. This case illustrates the diagnostic challenge of distinguishing between Lipiodol and tumor lesions, particularly when residual Lipiodol mimics tumor enhancement. DECT was critical in identifying residual Lipiodol and distinguishing it from true tumor recurrence. This study highlights the utility of DECT in enhancing diagnostic accuracy for patients undergoing TACE, minimizing unnecessary interventions, and ensuring appropriate follow-up care. By providing detailed tissue characterization and iodine mapping, DECT improves differentiation between artifacts and pathological findings in post-treatment liver imaging, ultimately contributing to better patient management and outcomes.

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1. Introduction

Hepatocellular carcinoma (HCC) is the most common primary malignancy of the liver, responsible for approximately 75-85% of all primary liver cancers worldwide[1]. It is a leading cause of cancer-related morbidity and mortality, particularly in regions with high rates of chronic liver disease, such as Asia and sub-Saharan Africa[2]. Among various treatment options, transarterial chemoembolization (TACE) is widely used for patients with intermediate-stage HCC, offering a minimally invasive approach to control tumor growth by delivering chemotherapeutic agents directly to the tumor while simultaneously embolizing its blood supply[3].

Lipiodol, an iodine-based contrast agent, plays a pivotal role in TACE by providing excellent contrast for tumor visualization during and after the procedure, acting as both a drug carrier and an imaging agent[4]. However, a significant challenge in post-TACE surveillance is differentiating between residual Lipiodol and true disease recurrence on follow-up imaging[4]. Due to its high iodine content, Lipiodol enhances tumor lesions during TACE, but it also remains in the liver for extended periods, potentially creating imaging artifacts[5]. These artifacts can mimic enhancing lesions on follow-up scans, making it difficult to distinguish between viable tumor tissue and residual Lipiodol[5]. Conventional imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), may lack the sensitivity to differentiate between Lipiodol-induced artifacts and true tumor recurrence, resulting in potential misdiagnoses[5].

Dual-energy computed tomography (DECT) represents a significant advancement in imaging technology, providing enhanced tissue differentiation by using two different X-ray energy levels. DECT allows for the generation of iodine maps and virtual non-contrast (VNC) images, which are especially useful for distinguishing between residual Lipiodol and tumor lesions[6]. This study explores the role of DECT in improving diagnostic accuracy in post-TACE surveillance for HCC.

2. Case Report

A 62-year-old female with a history of HCC in the right liver lobe was treated with TACE. She had been diagnosed with intermediate-stage HCC and underwent a successful TACE procedure several months prior, during which Lipiodol was used as a contrast agent to embolize the tumor’s vasculature. Following treatment, routine follow-up imaging, including DECT, was performed to assess the status of the liver lesions and evaluate for potential recurrence.

DECT imaging revealed a suspicious lesion in segment 4 of the liver that exhibited significant enhancement in the arterial phase, raising concerns about tumor recurrence. This lesion demonstrated the typical imaging features of an HCC lesion, known for its hypervascularity. However, virtual non-contrast (VNC) images showed no enhancement, suggesting that the apparent enhancement was not related to active disease.

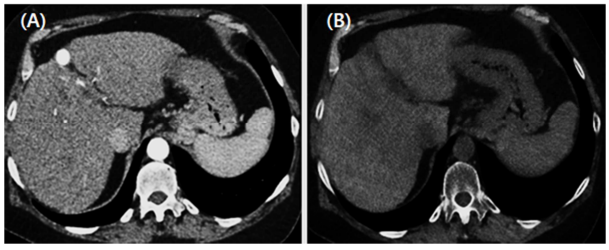

Fig. 1 Dual Energy CT image. A: A suspected lesion in the liver 4th area was shown to be enhanced in the arterial phase, raising concerns about tumor recurrence. B: No enhancement of the lesion was confirmed in the virtual

non-contrast (VNC) image.

These findings suggested that the enhancement observed in the arterial phase was due to residual Lipiodol and not to tumor recurrence. The lesion remained stable on follow-up imaging, and the patient did not exhibit any clinical signs of recurrence. The DECT analysis effectively identified residual Lipiodol and prevented unnecessary intervention, ensuring accurate management.

3. Imaging Findings

In the arterial phase, the lesion in segment 4 of the liver showed significant enhancement, raising suspicion for tumor recurrence. This enhancement was consistent with hypervascular tumors such as HCC. However, when VNC images were generated, no enhancement was observed, indicating that the apparent enhancement in the arterial phase was not due to active tumor tissue.

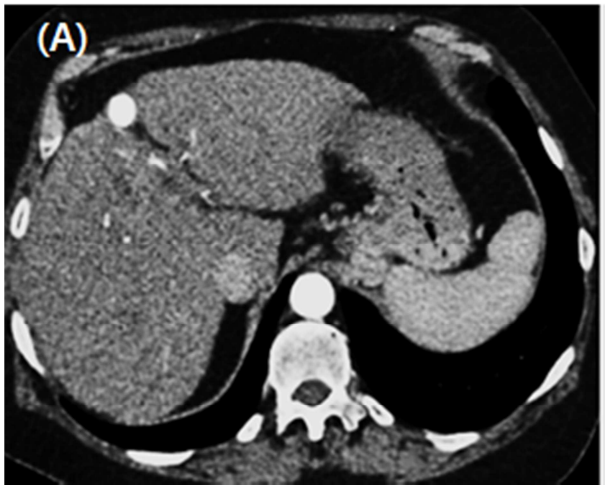

Fig. 2 DECT findings. A : In the early arterial phase, the lesion in the 4th liver area showed strong enhancement, which was a finding suggesting HCC recurrence. B: After generating the VNC image, we confirmed that there was no enhancement of the lesion, indicating that the enhancement seen in the arterial phase was not due to actual tumor tissue.

Further analysis using the iodine map revealed areas of residual Lipiodol in the treated lesion. Lipiodol, known for its high iodine content, remains visible on imaging for extended periods, making it identifiable through DECT. In the non-contrast CT phase, the lesion appeared unchanged, which further supported the hypothesis that the enhancement was due to residual contrast material rather than tumor activity.

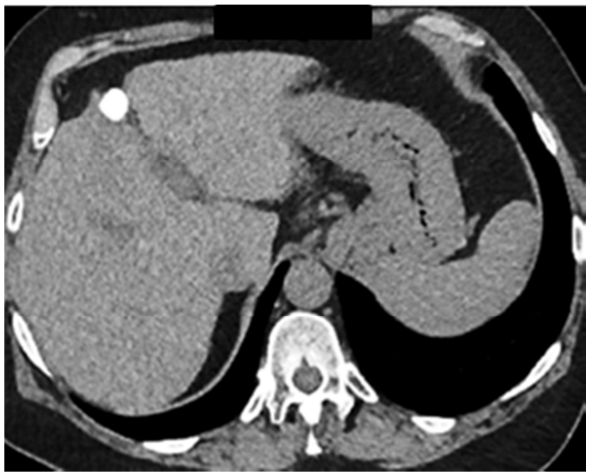

Fig. 3 Non-contrast CT, the lesion appeared unchanged, further suggesting that the enhancement was due to residual contrast material rather than tumor activity.

No enhancement was seen in the venous phase, which would typically be expected in the presence of a true tumor recurrence. These findings confirm that the apparent lesion enhancement in the arterial phase was caused by residual Lipiodol, highlighting the diagnostic value of DECT in distinguishing between Lipiodol artifacts and true tumor recurrence.

4. Discussion

4.1. Role of Lipiodol in TACE for HCC

Lipiodol is a crucial component in the management of HCC, particularly for patients undergoing TACE. As an iodine-based contrast agent, Lipiodol aids in visualizing the tumor vasculature, facilitating the embolization of blood vessels feeding the tumor. Its ability to enhance HCC lesions makes it an invaluable tool, especially for hypervascular tumors like HCC. However, a significant limitation is the prolonged retention of Lipiodol within the liver,

which can lead to imaging artifacts that may mimic enhancing lesions, complicating the interpretation of follow-up scans[7].

4.2. Challenges in Diagnosing HCC Recurrence Post-TACE

Post-treatment surveillance is essential for monitoring tumor recurrence and assessing the efficacy of TACE. However, differentiating between enhancing lesions caused by residual Lipiodol and true tumor recurrence can be challenging. Conventional CT and MRI may lack sufficient sensitivity to accurately distinguish between Lipiodol-induced artifacts and actual tumor recurrence, potentially leading to false positives and unnecessary interventions[8].

4.3. Role of Dual-Energy CT in Post-TACE Surveillance

DECT represents a significant improvement in imaging technology, offering enhanced tissue characterization through the use of two distinct X-ray energy levels. DECT allows for the generation of iodine maps and VNC images, which are particularly useful in distinguishing between areas of residual Lipiodol and active tumor lesions. In the presented case, DECT was instrumental in differentiating Lipiodol artifacts from viable tumor tissue, significantly improving diagnostic accuracy compared to conventional imaging methods[9].

4.4. Clinical Implications of DECT in HCC Surveillance

The use of DECT in post-TACE surveillance for HCC offers several clinical advantages. DECT accurately differentiates between residual Lipiodol and true tumor recurrence, helping prevent unnecessary treatments and enabling clinicians to make more informed decisions about patient management. This is particularly important for patients with a history of TACE, where the risk of misdiagnosing Lipiodol artifacts as tumor recurrence is high. Additionally, DECT provides detailed information about tumor vascularity, which can inform treatment decisions in cases requiring further intervention[10].

5. Conclusion

This case demonstrates the value of dual-energy CT (DECT) in differentiating between residual Lipiodol and true enhancing lesions in post-TACE surveillance for hepatocellular carcinoma (HCC). Lipiodol, although essential for TACE success, can cause diagnostic challenges by mimicking enhancing lesions on follow-up imaging. DECT's ability to generate iodine maps and virtual non-contrast images is crucial for distinguishing between Lipiodol-induced artifacts and actual tumor recurrence. This case highlights the potential of DECT to improve diagnostic accuracy, reduce the risk of misdiagnosis, and prevent unnecessary interventions. The application of DECT in HCC surveillance represents a promising advancement in imaging technology, contributing to better patient management and more effective follow-up care.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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