IODINE MAPPING

Ứng Dụng Trong Đánh Giá Khối U Gan

Clinical Applications in Hepatic Tumor Assessment

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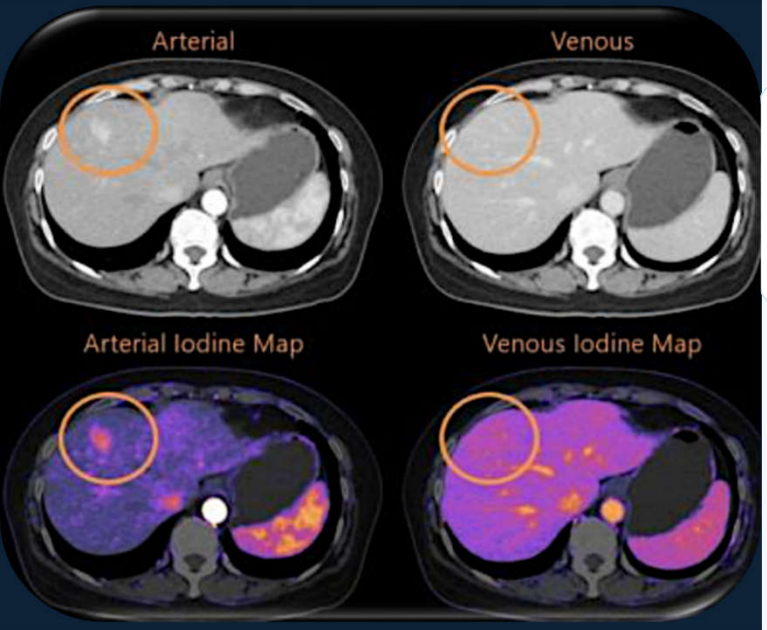
NỘI DUNG TRÌNH BÀY

AGENDA

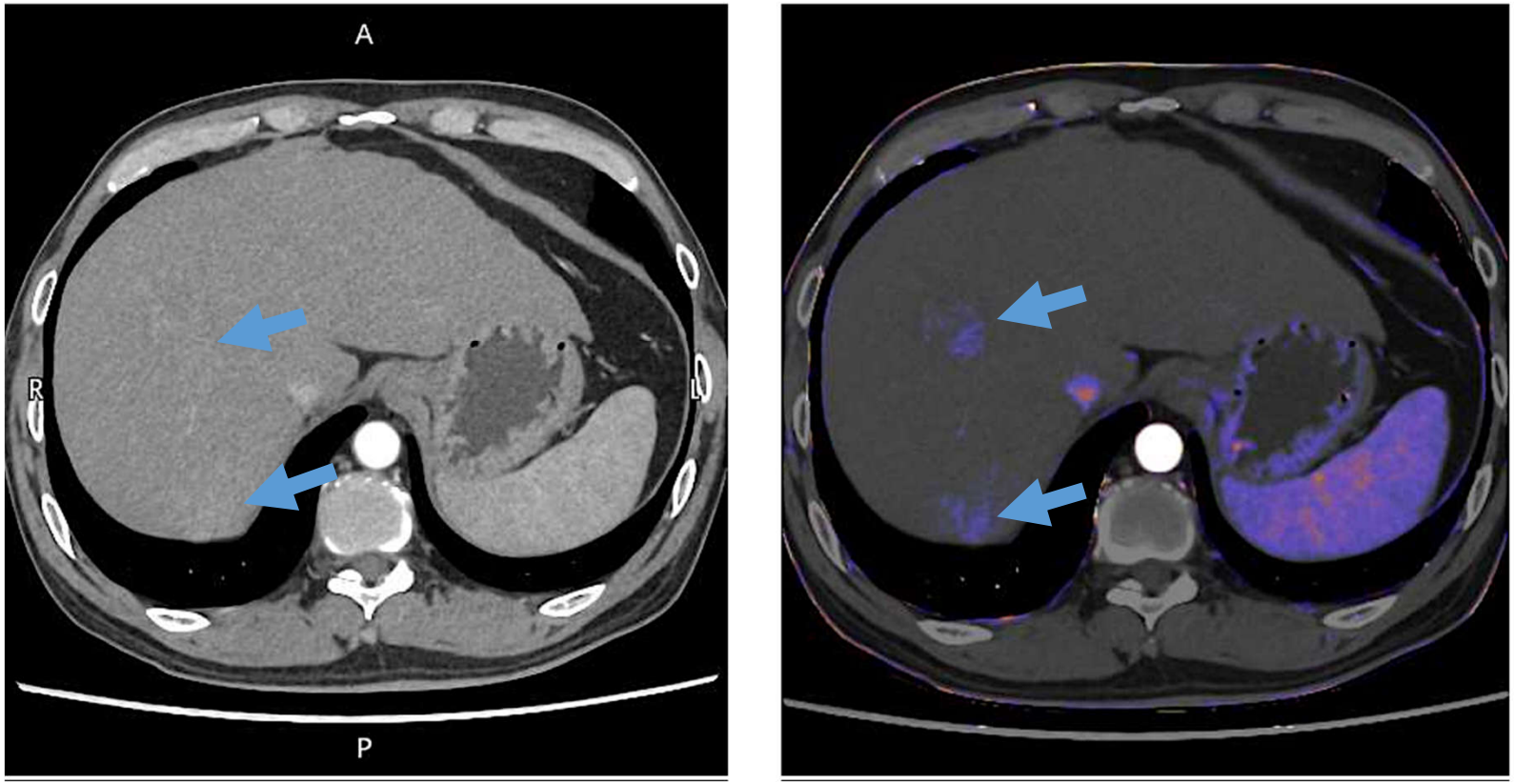


1. **Tổng Quan về Iodine Mapping**
   Overview
2. **Kỹ Thuật Subtraction Iodine Mapping**
   Technological Principles
3. **Ứng dụng lâm sàng**
   Clinical Applications
4. **Kết Luận**
   Conclusions

CASE 1 — HCC

Date of Birth: 1976.01.01
Gender: M

Study Date: 2026.03.13-09:51 AM
Report Date: Mar 13, 2026, 15:41

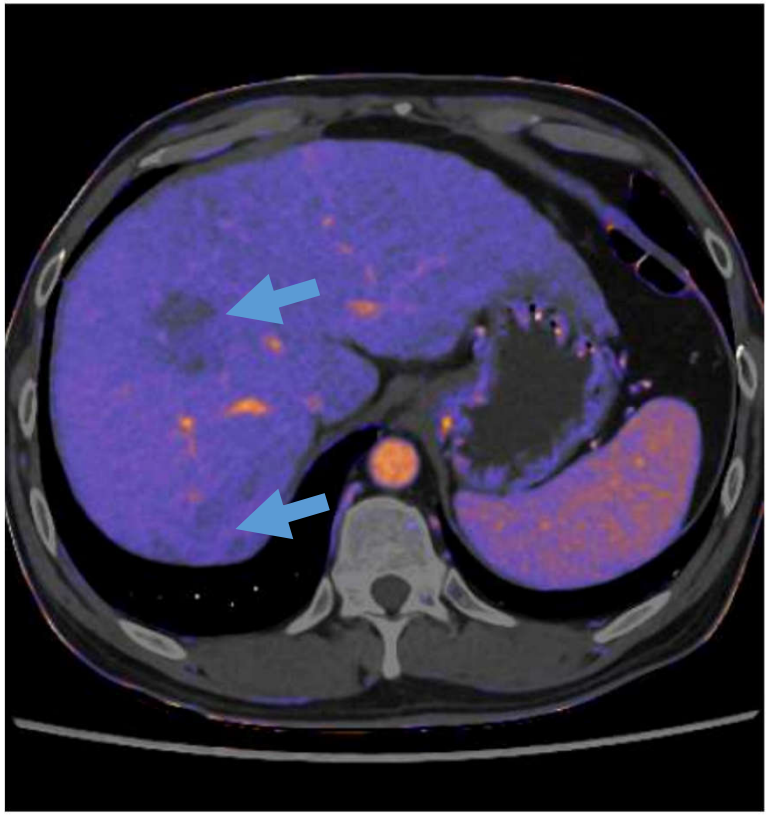


ATERIAL PHASE

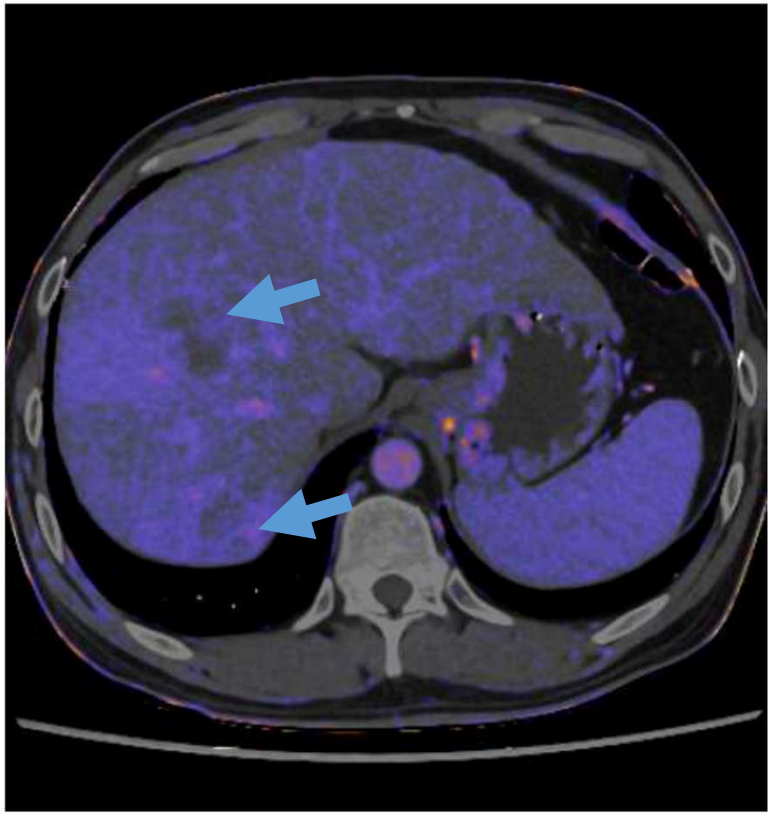
Bệnh nhân nam, 50 tuổi, viêm gan B mới phát hiện, AFP 98,8 ng/mL, PIVKA-II 6934 mAU/mL

A 50-year-old male with newly diagnosed hepatitis B , AFP 98,8 ng/mL, PIVKA-II 6934 mAU/mL

CASE 1 — HCC

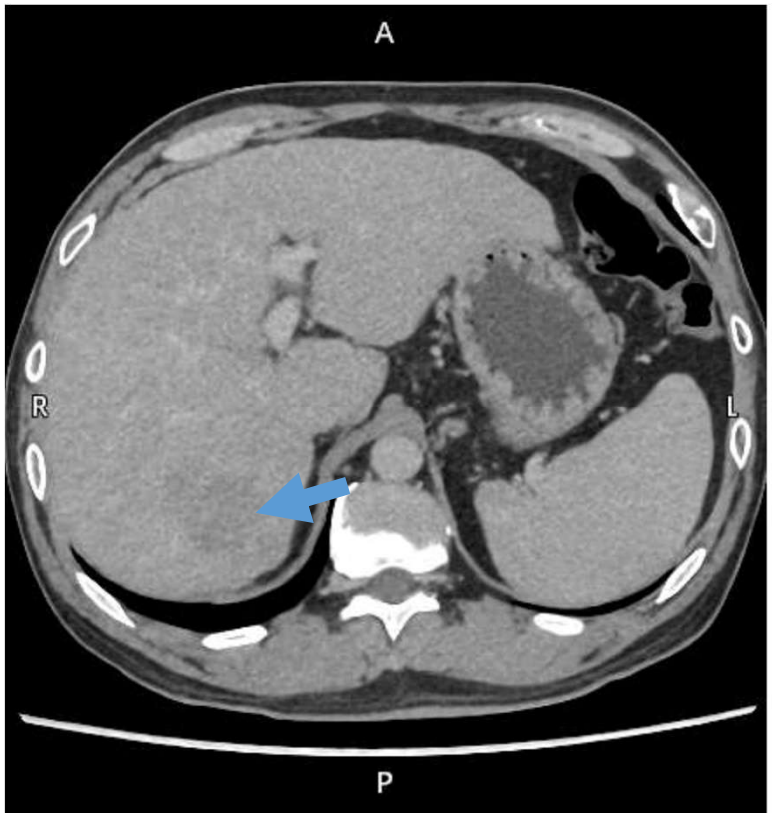


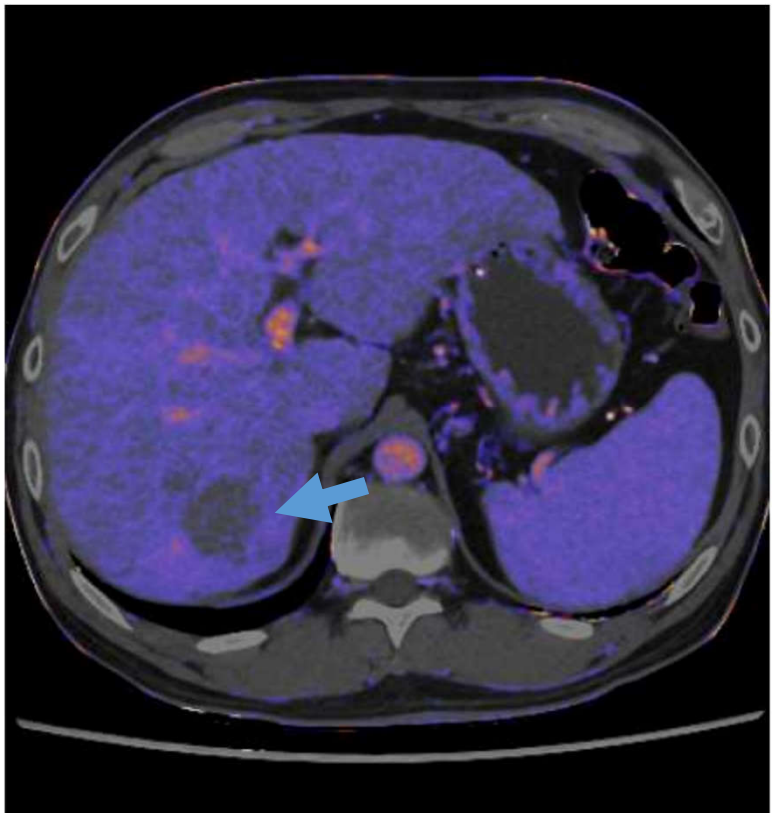
PORTAL VENOUS PHASE



DELAYED PHASE

CASE 1 — HCC





DELAYED PHASE

1

TỔNG QUAN VỀ IODINE MAPPING

Overview

IODINE MAPPING — ĐỊNH NGHĨA

ĐỊNH NGHĨA

Definition

Iodine mapping là kỹ thuật hình ảnh màu hiển thị phân bố iodine (thuốc tương phản) trong mô sau tiêm – phản ánh đặc tính **tăng quang và tưới máu mô.**

A colorized imaging technique that visualizes iodine concentration (contrast media) distribution within tissue– reflecting enhancement characteristics and tissue perfusion.

Phân biệt mô tăng quang thực sự và giả tăng quang

Enhancing vs pseudoenhancement tissue

Màu sắc mã hoá nồng độ iodine (mg/mL)

Color-encodes iodine concentration

IODINE MAPPING

Dual-Energy CT

- Phương pháp phổ biến của Spectral CT.
- Dựa trên sự khác biệt về đặc tính suy giảm tia X của Iodine ở hai mức năng lượng (thấp và cao)

-> Phân tách/ định lượng Iodine.

- *Common implementation of Spectral CT.*
- *Exploits energy-dependent X-ray attenuation*

-> Material decomposition and iodine quantification

Photon-counting CT

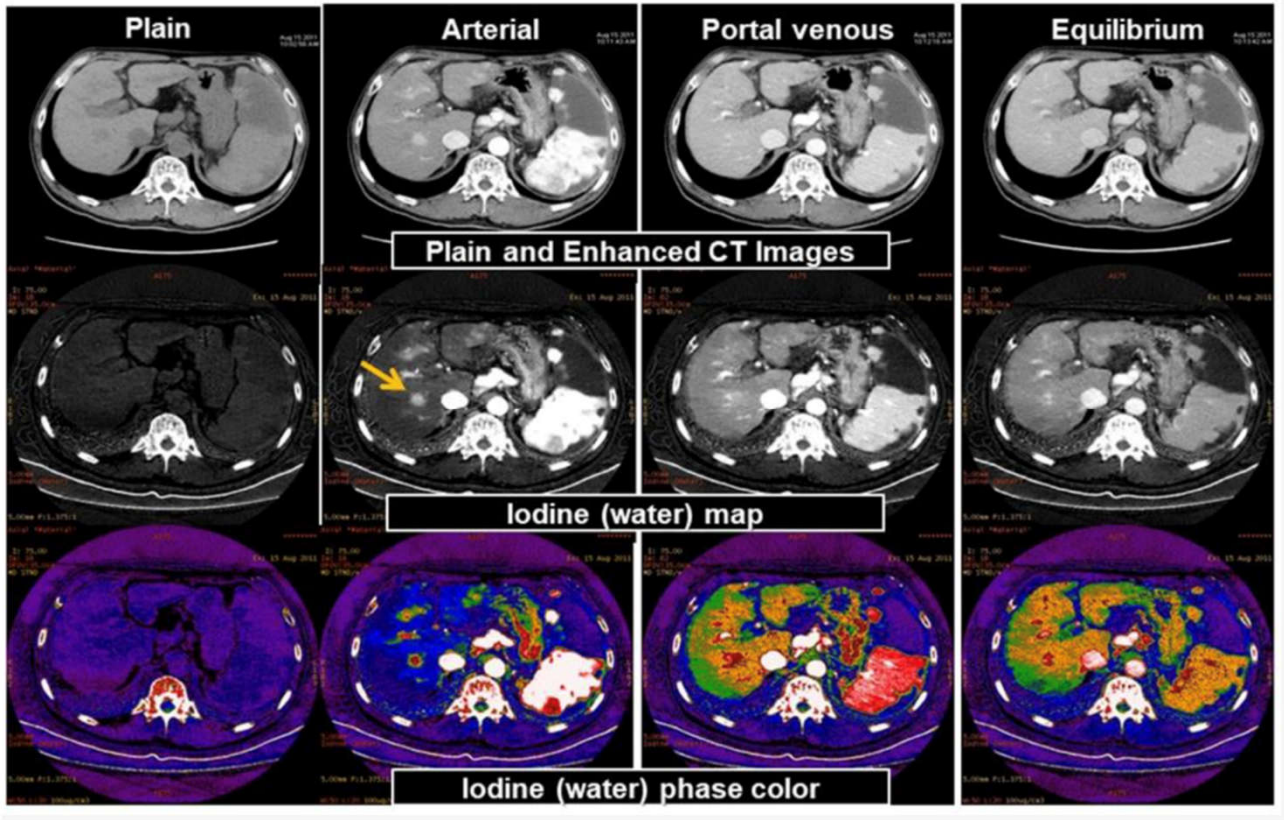
- Công nghệ thế hệ mới
- Đếm trực tiếp từng photon và phân loại theo khoảng năng lượng

-> Dựng bản đồ vật chất (bao gồm Iodine) với độ phân giải không gian và năng lượng cao

- *Next-generation technology*
- *Direct photon counting with energy discrimination*

-> Performs material decomposition (including iodine mapping) with high spatial and energy resolution.

IODINE MAPPING



Source: Tsurusaki, M., et al (2021). ***Dual-Energy Computed Tomography of the Liver: Uses in Clinical Practices and Applications****. Diagnostics, 11(2), 161. https://doi.org/10.3390/diagnostics11020161*

LIMITATIONS OF DECT & SOLUTION OF SUBTRACTION CT

DECT — Hạn Chế

Cần hệ thống Spectral CT
Requires dual-energy scanner

Không thể tái tạo từ dữ liệu CT đơn năng lượng *
Cannot retrospectively reconstruct from single-energy data

Phải chỉ định trước khi chụp*
Requires pre-scan protocol planning

Subtraction CT Canon — Ưu điểm

Thực hiện trên CT đơn năng lượng
Works on any single-energy CT — no special hardware

Liều tia chuẩn, không tăng liều
Standard radiation dose — no extra exposure

Xử lý hậu kỳ sau khi chụp
Post-processing only — no pre-scan protocol needed

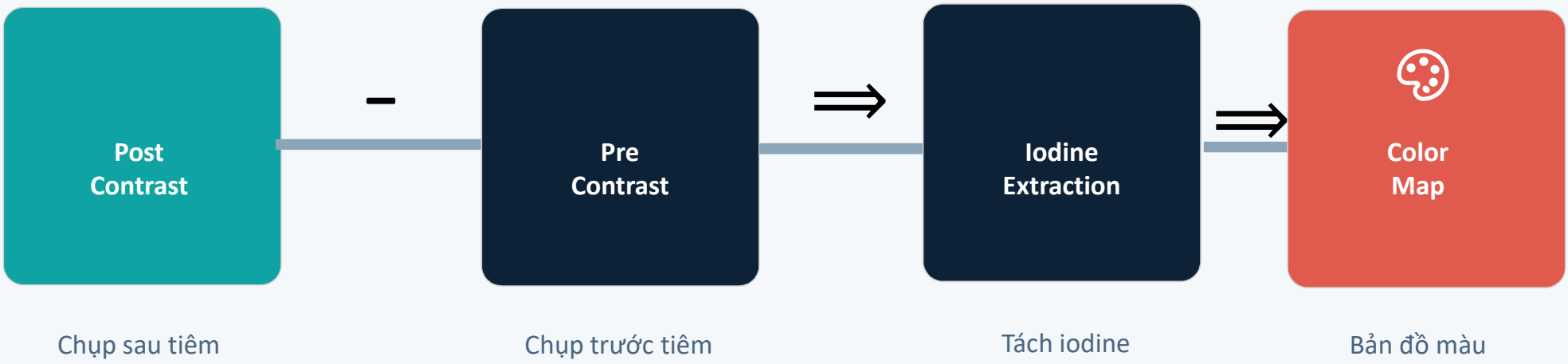
** Ngoại trừ (Except): Dual-layer Spectral CT*

2

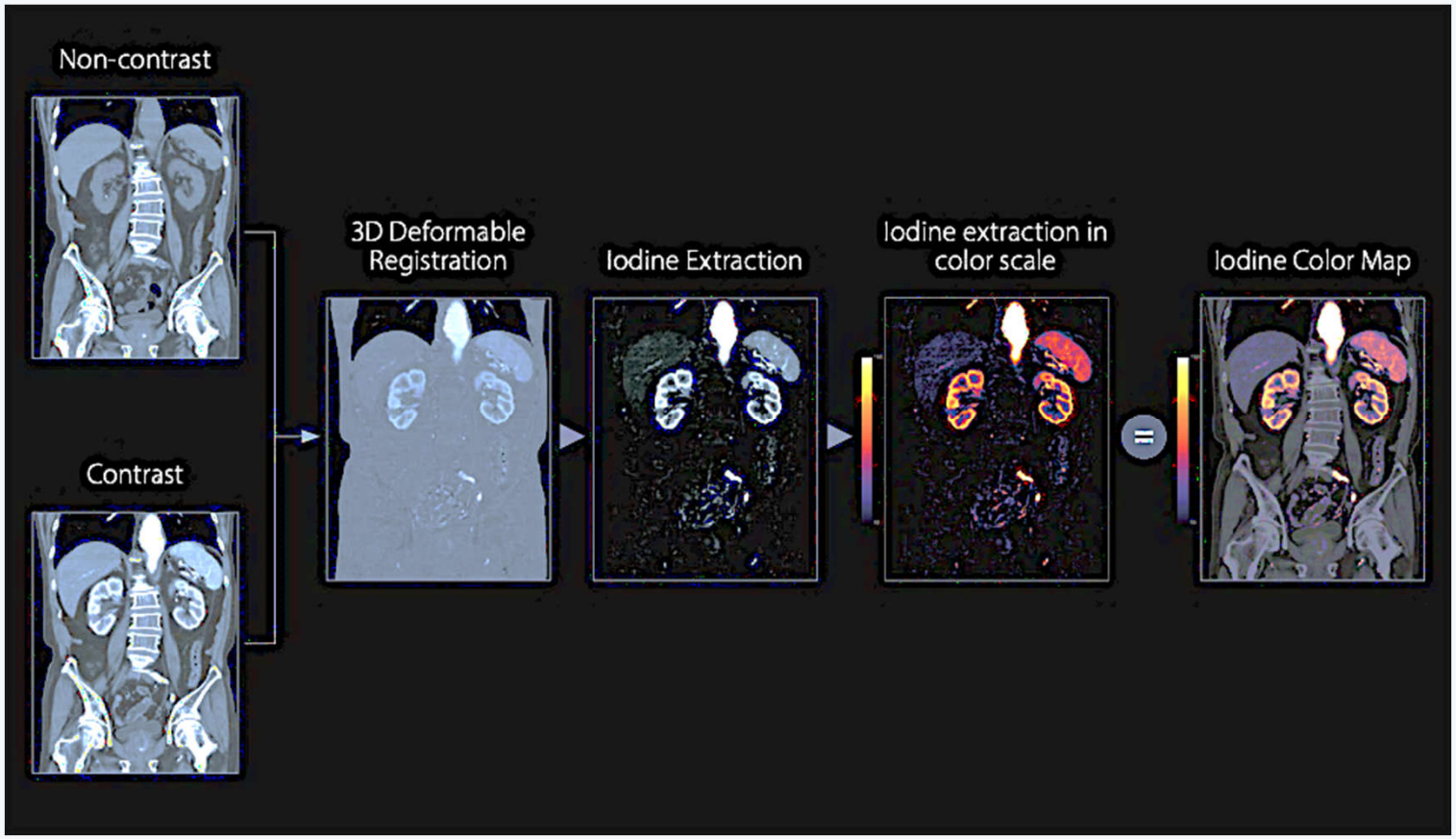
KỸ THUẬT SUBTRACTION IODINE MAPPING

Technological Principles - Canon Aquilion ONE INSIGHT Edition

QUY TRÌNH SUBTRACTION IODINE MAPPING – PROTOCOL



QUY TRÌNH SUBTRACTION IODINE MAPPING – PROTOCOL



Source: https://global.medical.canon/products/computedtomography/sure_subtraction

YẾU TỐ ẢNH HƯỞNG CHẤT LƯỢNG HÌNH ẢNH

Artifacts in Subtraction Iodine Mapping

Chuyển động hô hấp

Respiratory Motion Artifact

Sai lệch hình ảnh trước–sau tiêm do nhịp thở → xảo ảnh viền sáng/tối dọc cơ hoành và bờ gan.

Nhịp tim

Cardiac / Pulsation Artifact

Tổn thương gần tim hoặc mạch lớn dễ bị ảnh hưởng do nhịp đập → nhiễu.

Tư thế BN thay đổi giữa 2 lần chụp

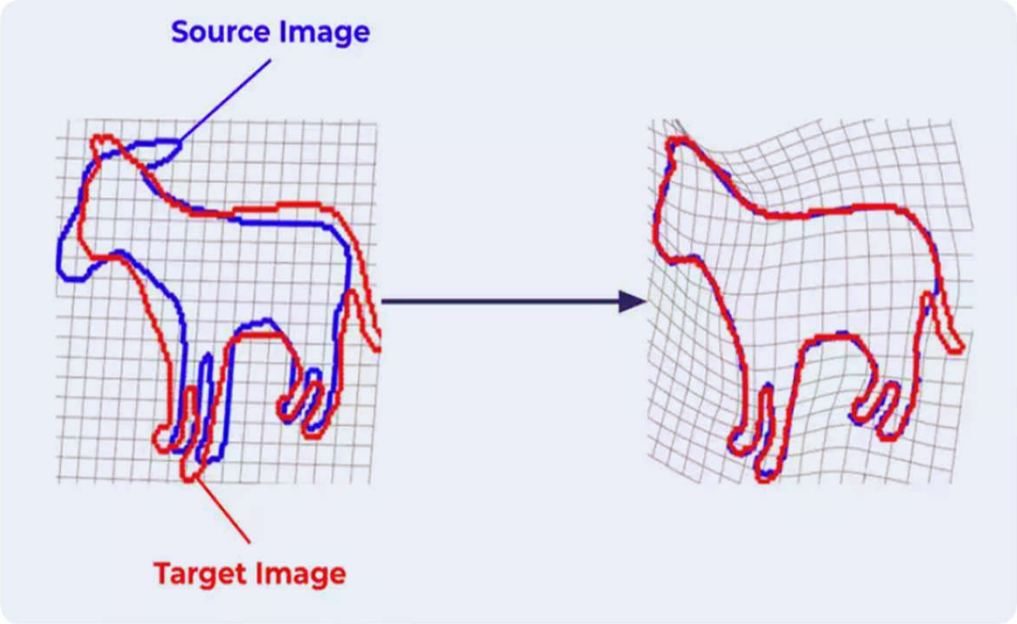
Patient Repositioning

Thay đổi tư thế giữa trước–sau tiêm → xảo ảnh

3D DEFORMABLE REGISTRATION TECHNOLOGY

Trước khi Subtraction, thuật toán hiệu chỉnh biến dạng (**3D deformable registration**) của Canon sẽ căn chỉnh chính xác từng voxel giữa dữ liệu trước và sau khi tiêm thuốc tương phản.

*Prior to subtraction, Canon's **deformable registration** performs precise voxel-to-voxel matching between pre-contrast and contrast-enhanced 3D datasets to enable accurate bone/calcium removal and iodine mapping*



Source:
1. https://www.theodo.com/blog/how-to-create-deformable-image-registration-using-deep-learning
2. https://global.medical.canon/products/computed-tomography/aquilion-lightning/technology/

3D DEFORMABLE REGISTRATION TECHNOLOGY

LỢI ÍCH CỦA 3D DEFORMABLE REGISTRATION

- ✓ **Đảm bảo sự tương thích giữa các cấu trúc giải phẫu**
  Ensure precise anatomical correspondence
- ✓ **Hạn chế xảo ảnh do sai lệch trước–sau tiêm**
  Reduce artifacts from motion
- ✓ **Tăng độ tin cậy trong chẩn đoán**
  Improve diagnostic reliability & confidence

3

ỨNG DỤNG LÂM SÀNG

Clinical Applications

ỨNG DỤNG IODINE MAPPING TRONG KHỐI U GAN

01 Phát Hiện và Phân Loại Thương Tổn

- Tăng độ rõ nét tổn thương
- Phân tích kiểu phân bố iodine đặc trưng
- Phát hiện tổn thương < 1 cm nhờ CNR cao

02 Sau Điều Trị HCC (TACE/RFA)*

- Phát hiện khả năng còn tồn tại mô u
- Nhạy hơn trong phát hiện tái phát sớm
- Hỗ trợ phân loại LR-TR theo LI-RADS 2024
- Hỗ trợ quyết định can thiệp tiếp theo

01 Lesion Detection & Characterization

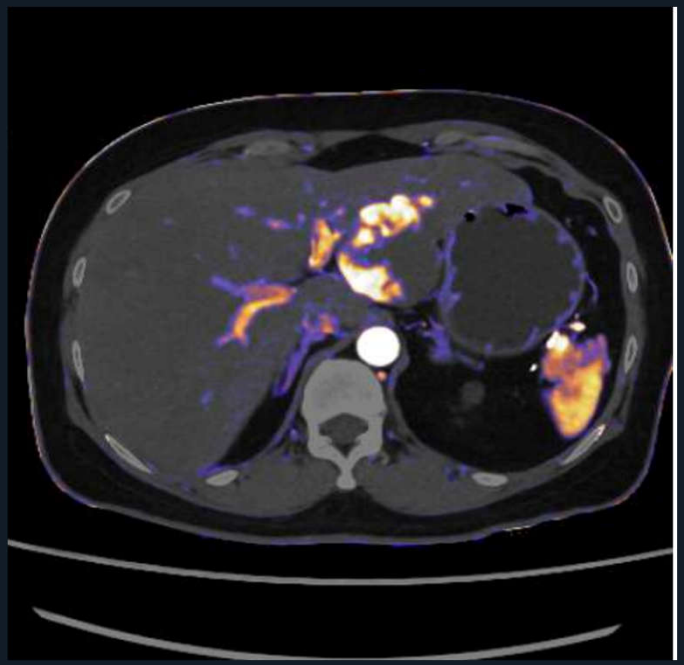
- Enhanced lesion conspicuity
- Analysis of characteristic iodine distribution patterns
- Detection of lesions < 1 cm due to higher CNR

02 Post-Treatment Assessment

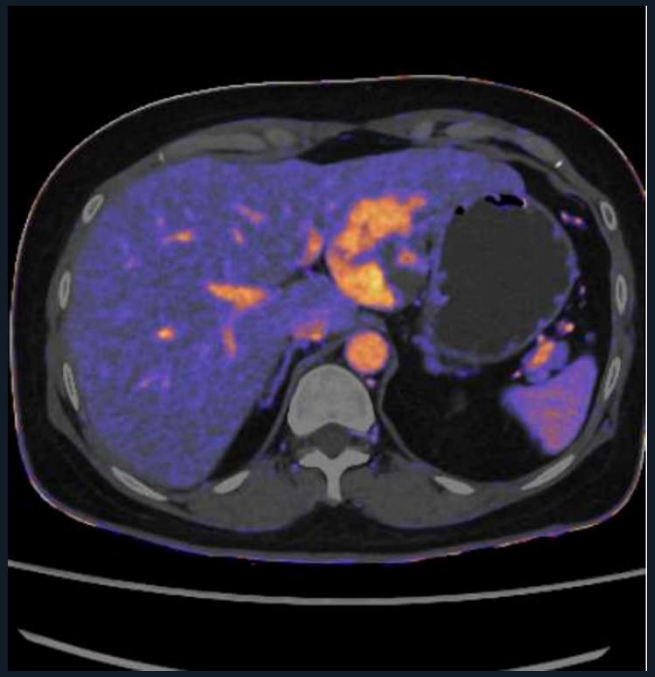
- Detection of viable tumor tissue
- Higher sensitivity in detecting early recurrence
- Assisting in LR-TR classification according to LI-RADS 2024
- Supporting decisions on subsequent interventions

CASE 2 — HEMANGIOMA

Conventional CT (Arterial Phase)



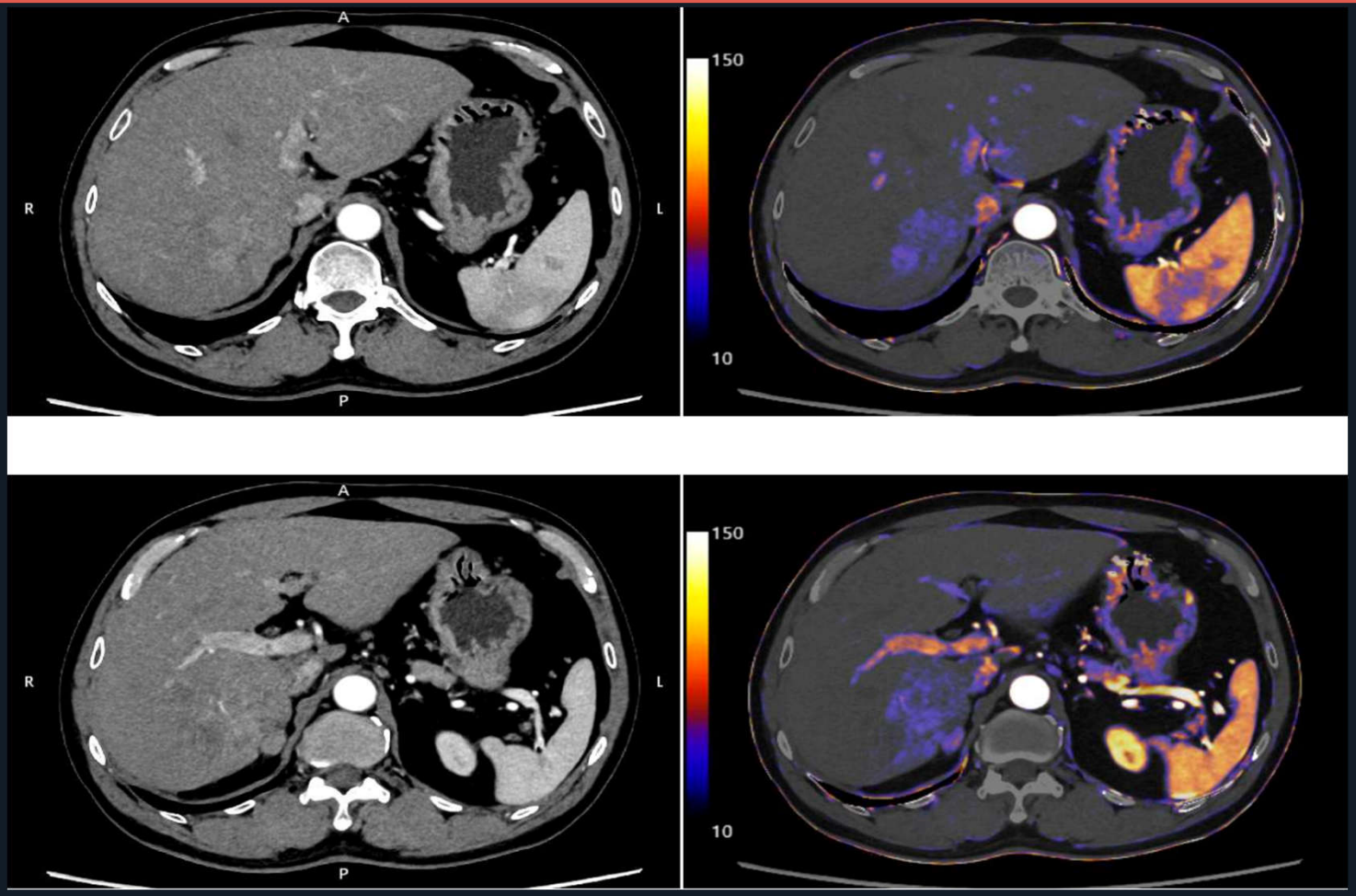
Iodine Map (Arterial Phase)



Iodine Map (Delayed Phase)

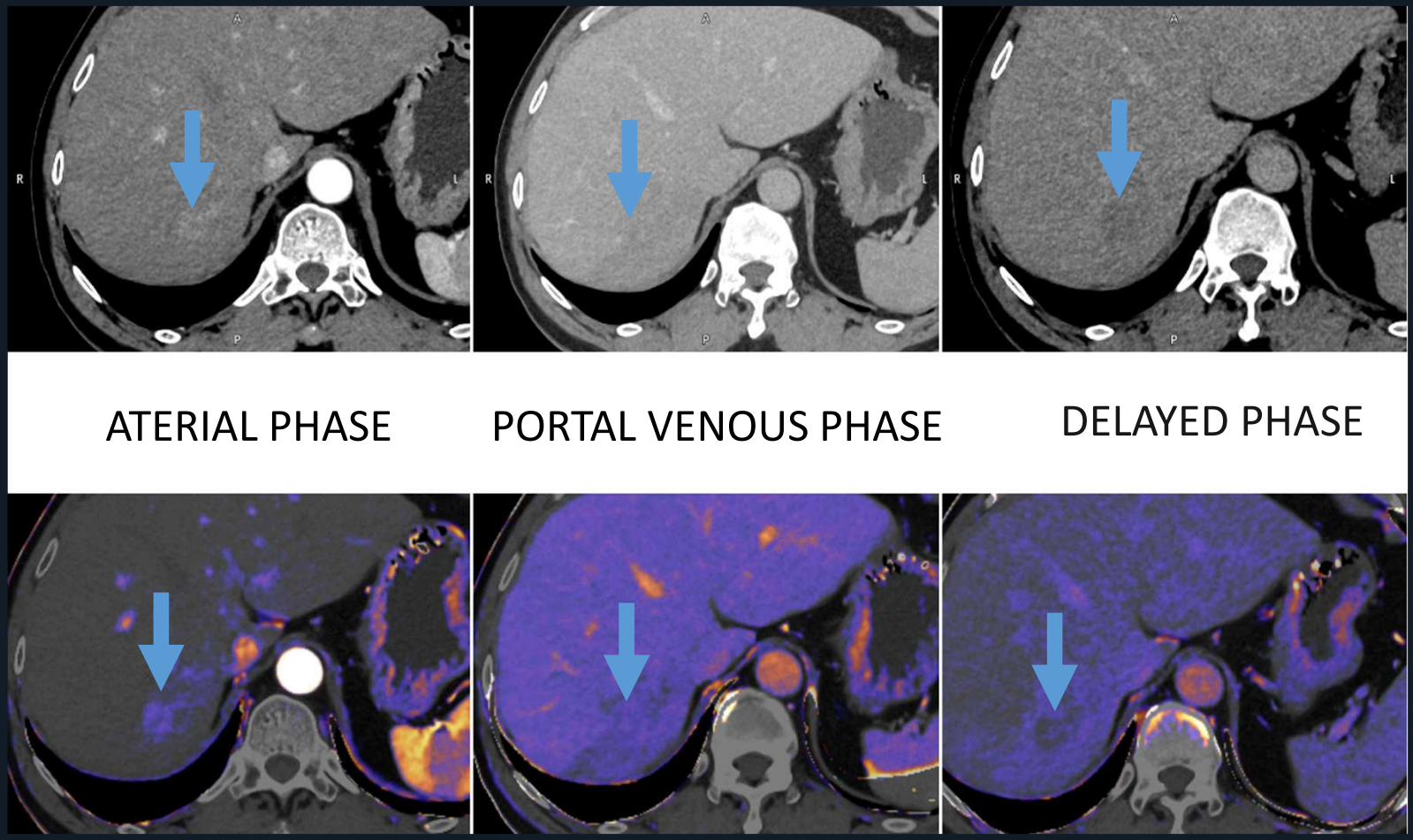
Female, 48 y/o: *Lesion with peripheral nodular enhancement in the arterial phase and progressive centripetal fill-in in the delayed phase.*

CASE 3 — HCC & DI CĂN (HCC & Metastasis)



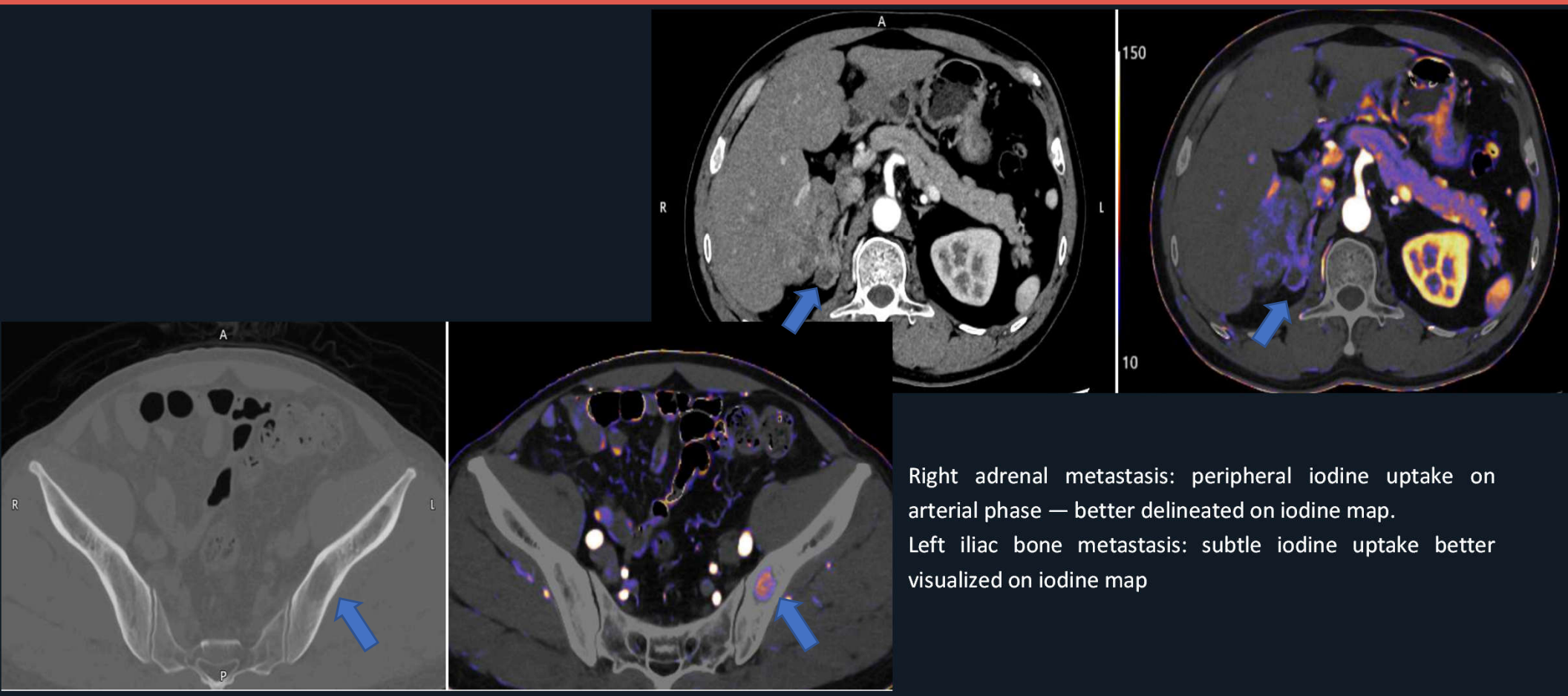
Male, 51y.o, HCC: Poorly marginated on conventional CT. Iodine map reveals heterogeneous enhancement.

CASE 3 — HCC & DI CĂN (HCC & Metastasis)



HCC: Poorly marginated on conventional CT. Iodine map reveals heterogeneous enhancement.

CASE 3 — HCC & DI CĂN (HCC & Metastasis)



Right adrenal metastasis: peripheral iodine uptake on arterial phase — better delineated on iodine map.

Left iliac bone metastasis: subtle iodine uptake better visualized on iodine map

BẰNG CHỨNG LÂM SÀNG
Clinical Evidence

Jimi Huh, et al., 2021 *Investigative Radiology 56(2):109–116*

151 HCCs TREATED

Added Value of CT Arterial Subtraction Images in LI-RADS LR-TR Categorization for TACE-treated HCC

98.7%
Chất lượng hình ảnh tốt–hoàn hảo
Quality of subtraction images: mostly good to perfect

#35%
Tăng độ nhạy
Higher sensitivity for detecting viable HCC

κ=0.97
Interobserver agreement (set 2)

Padre et al., 2024 *J Med Imaging Radiat Sci 55(3):101476*

Application of Subtraction Iodine Mapping in Immediate Liver Tumour Ablation CT — Initial Experience

Kết luận: Iodine mapping là công cụ hữu ích phát hiện sớm và chính xác mô u còn tồn tại và biến chứng sau đốt u so với CT thông thường.

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> Invest Radiol. 2021 Feb 1;56(2):109-116. doi: 10.1097/RLI.0000000000000714.

Added Value of CT Arterial Subtraction Images in Liver Imaging Reporting and Data System Treatment Response Categorization for Transcatheter Arterial Chemoembolization–Treated Hepatocellular Carcinoma

Jimi Huh [1], Bohyun Kim [2], Jei Hee Lee [1], Je Hwan Won [1], Jinoo Kim [1], Yohan Kwon [1], Jai Keun Kim [1]

Affiliations + expand

PMID: 33405431 DOI: 10.1097/RLI.0000000000000714

Abstract

Objectives: The aim of this study was to assess the benefit of adding arterial subtra from computed tomography (CT) to the Liver Imaging Reporting and Data System (L treatment response (LR-TR) categorization in patients treated with transcatheter arte chemoembolization (TACE) for hepatocellular carcinoma (HCC).

Materials and methods: This retrospective study included 115 patients with 151 HCCs treated by TACE using an emulsion of doxorubicin and iodized oil who underwent multiphasic CT protocol that additionally generated arterial subtraction images based on nonrigid anatomic correction algorithm. Of 151 HCCs, 67 (44.4%) were viable and 84 (55.6%) were nonviable. Two independent readers assessed the per-lesion LR-TR categories in set 1 of multiphasic CT images alone and set 2 including both set 1 and CT arterial subtraction images, besides diagnostic confidence, and the quality of subtraction images. The sensitivity and specificity of LR-TR viable category between the sets were compared using the generalized estimating equation. Interobserver agreements of LR-TR categorization in each set and the quality of subtraction images were assessed by Cohen κ.

Results: The quality of subtraction images was mostly good to perfect (98.7%) with good interobserver agreement (κ = 0.71), and none were nondiagnostic. For detecting viable HCC, LR-TR viable category showed sensitivity of 53.7% to 56.7% and specificity of 96.4% to 98.8% in set 1. In comparison, set 2 showed significantly higher sensitivity of 88.1% to 89.6% ($P < 0.002$) and equivalent specificity of 94% to 95.2% ($P > 0.13$) for the same category. In sets 1 and 2, 31.3% to 34.3% and 9% to 10.4% of viable HCC were miscategorized as LR-TR nonviable, respectively. LR-TR equivocal category was less assigned in set 2 (1.3%) than in set 1 (6.6%-7.9%). Set 2 showed slightly higher level of confidence for LR-TR categorization compared with set 1 (3.4 ± 0.8 vs 3.8 ± 0.5). Interobserver agreement was excellent in both sets (κ = 0.85 in set 1 and 0.97 in set 2).

Conclusions: The LR-TR viable category is highly specific but inadequately sensitive for detecting viable tumor in TACE-treated HCC on conventional multiphasic CT. Adding arterial subtraction images to the conventional CT images significantly increases sensitivity without compromising the specificity and improves the diagnostic confidence of LR-TR viable category.

Source: Huh, Jimi, et al. "**Added value of CT arterial subtraction images in liver imaging reporting and data system treatment response categorization for transcatheter arterial chemoembolization-treated hepatocellular carcinoma.**" *Investigative Radiology* 56.2 (2021): 109-116.

Journal of Medical Imaging and Radiation Sciences
Volume 55, Issue 3, Supplement, October 2024, 101476

36 - Application of Subtraction Iodine Mapping in the Immediate Liver Tumour Ablation CT Scan – Initial Experience Report

Mr. Cornelio Padre, Dr. Tan Zehao, Mr. Kenneth Yeo Chye Whatt, Mr. Han Bin Ong, Dr Apoorva Gogna

Singapore General Hospital, Singapore, Singapore

Purpose

To share our initial experience and benefits of the iodine mapping application in the post-liver radiofrequency ablation CT scan compared to conventional post-contrast CT liver image reconstruction.

Methodology

The SGH hybrid angiography-CT System (installed 2021), comprises the Genesis edition CT system and Alphenix Sky+ angiography system. The CT scanner gives 640 slices per rotation, with a maximum of 16cm field coverage. Iodine mapping in the post-liver ablation is routinely performed on the post-ablation contrast-enhanced CT. This subtraction technique involves taking two scan volumes and subtracting the images to highlight the differential contrast uptake in the liver parenchyma. Color-coded maps of iodine distribution within the liver parenchyma are then generated to demonstrate enhancement and washout to facilitate interpretation.

We plan to showcase the application of the iodine map technique in liver tumor ablation to through a small retrospective case series.

Result

Through a series of 5 cases, we plan to demonstrate how iodine mapping from subtraction CT imaging after liver tumor ablation facilitates the detection of any non-ablated residual tumors and bleeding which is the most dreaded acute complication. In particular, how it is an improvement from conventional post-contrast CT image reconstructions. In addition, we will show pitfalls in imaging to prevent misinterpretation of iodine mapping subtraction CT.

Summary

Our initial experience in the application of iodine mapping for immediate post-liver ablation scans demonstrates that it is a useful adjunct for the interpretation of post-liver ablation CT to provide more early and accurate detection of residual tumors and complications.

Source: Padre, Mr Cornelio, et al. "**Application of Subtraction Iodine Mapping in the Immediate Liver Tumour Ablation CT Scan–Initial Experience Report**." *Journal of Medical Imaging and Radiation Sciences* 55.3 (2024): 101476.

4

KẾT LUẬN

Conclusion · Take-Home Messages

KẾT LUẬN / CONCLUSION

1. **Iodine mapping hiển thị phân bố iodine trong mô, phản ánh đặc tính tăng quang và tưới máu mô.**

   Iodine mapping visualizes iodine distribution — reflecting enhancement and tissue perfusion characteristics.

2. **Có nhiều kỹ thuật tạo dựng Iodine mapping: DECT, Photon-counting CT và Subtraction CT (Canon) — lựa chọn phụ thuộc mục tiêu lâm sàng và trang thiết bị.**

   Several techniques for Iodine mappiing: DECT , Photon- counting CT and Subtraction CT (Canon) — choice depends on clinical needs and available equipment.

3. **Subtraction CT thực hiện trên CT đơn năng lượng → tối ưu chi phí, liều tia chuẩn, xử lý hậu kỳ → công cụ hữu ích ứng dụng trong thực hành lâm sàng thường quy.**

   Subtraction CT on conventional scanners → cost-effective, standard dose, post-processing → useful tool for routine clinical practice.

4. **Iodine mapping nâng cao khả năng phát hiện và phân loại tổn thương, đặc biệt trong đánh giá đáp ứng điều trị HCC (TACE/RFA).**

   Iodine mapping improves lesion detection and characterization, particularly valuable for evaluating treatment response in HCC (TACE/RFA).

TÀI LIỆU THAM KHẢO / REFERENCES

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3. Huh J, et al. Added value of CT arterial subtraction images in LI-RADS treatment response categorization for TACE-treated HCC. Investigative Radiology. 2021;56(2):109–116.

4. Padre MC, et al. Application of Subtraction Iodine Mapping in Immediate Liver Tumour Ablation CT — Initial Experience. J Med Imaging Radiat Sci. 2024;55(3):101476.

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6. Canon Medical Systems. SURE Subtraction – Iodine Mapping SCT. https://global.medical.canon/products/computedtomography/sure_subtraction

THANK YOU FOR YOUR ATTENTION!

Khoa Chẩn Đoán Hình Ảnh – TDCN

Bệnh Viện Đa Khoa Hoà Hảo – Medic Cần Thơ

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