

Dual Energy Computed Tomography Versus Magnetic Resonance Imaging for Liver Fat Fraction Quantification

Jing Hong Loo

loo.jinghong@gmail.com

Sengkang General Hospital

Shi Min Yeow

Sengkang General Hospital

Kang Ren Yong

Sengkang General Hospital

Harvard Zhi Rui Lee

Sengkang General Hospital

Sze Ying Yee

Sengkang General Hospital

Srinivas Anandswaroop Uppaluri

Sengkang General Hospital

Syed Aftab

Sengkang General Hospital

Sandeep Halagatti Venkatesh

Sengkang General Hospital

Freda Jawan

Sengkang General Hospital

Shawn Shi Xian Kok

Sengkang General Hospital

Praveen M Yogendra

Sengkang General Hospital

Min On Tan

Sengkang General Hospital

Research Article

Keywords: dual-energy CT, multi-material decomposition, MRI Dixon, In-phase, Opposed-phase, hepatic steatosis

Posted Date: July 16th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10317795/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Purpose

Non-invasive quantification of hepatic steatosis is critical for the diagnosis and management of metabolic dysfunction-associated steatotic liver disease (MASLD). While MRI chemical-shift encoding with in phase/opposed phase (IP/OP) is a reliable method for fat assessment, dual-energy CT (DECT) offers a potential opportunistic alternative using multi-material decomposition (MMD). We compared DECT MMD fat fraction with MRI IP/OP fat fraction for steatosis grading.

Methods

In this retrospective cohort study of 45 patients, two ROIs (2 cm²) were placed in hepatic segments VI and VII on both DECT and MRI. Correlation (Spearman), agreement (Bland–Altman), diagnostic performance (ROC), and inter-modality reliability (ICC) were assessed.

Results

DECT and MRI fat fractions correlated positively in both segments (Spearman $\rho = 0.50$, $P < 0.001$ for segment VI; $\rho = 0.57$, $P < 0.001$ for segment VII). Bland–Altman analysis revealed systematic underestimation by DECT (mean difference -3.39% for VI; -2.57% for VII). Area under the curve for mild steatosis was 0.77 (95% CI 0.63–0.91) for both segments, improving to 0.88–0.99 for moderate-to-severe disease. Inter-modality ICC indicated moderate reliability (0.62 for VI, 0.66 for VII). Time interval between scans did not affect measurement differences ($P > 0.05$).

Conclusions

DECT MMD demonstrates moderate-to-good diagnostic accuracy for moderate and severe hepatic steatosis but is limited in the detection of mild disease. These findings support the role of DECT as an opportunistic screening tool for clinically significant steatosis rather than a substitute for dedicated MRI-based quantification.

Introduction

An accurate assessment of hepatic steatosis is essential for diagnosing and monitoring metabolic dysfunction-associated steatotic liver disease (MASLD), grading treatment response, and predicting cardiometabolic risk [1]. Historically, liver biopsy served as the reference standard, but its clinical utility is limited by its invasive nature, potential for procedural complications, and potential sampling variability [2]. Consequently, non-invasive imaging modalities have emerged as integral tools in both clinical practice and research trials [3]. Among these, chemical-shift-encoded (CSE) MRI with proton density fat fraction (PDFF) mapping—has been established as a reference method for fat assessment. However, MRI-PDFF requires specialized, multi-echo pulse sequences and advanced post-processing software that are not universally available. Instead, standard abdominal MRI protocols typically rely on traditional dual-echo in-phase and opposed-phase (IP/OP) imaging, which is highly sensitive for the qualitative detection of microscopic intracellular lipid presence [4]. In a recent prospective study, Hupfeld et al. explore the correlation of different MRI sequences for hepatic fat fraction (FF) quantification against a reference standard of histopathological examination. Both MRI IP/OP imaging and multigradient echo imaging showed strong correlation with biopsy FF [5].

Concurrently, dual-energy computed tomography (DECT) has gained traction as a rapid alternative for hepatic evaluation [6]. The clinical utility of DECT lies primarily in its potential for opportunistic screening and high-throughput monitoring

without additional radiation exposure. While routine single-energy CT relies on basic, non-specific attenuation measurements (Hounsfield units) that may be confounded by co-existing pathologies or intravenous contrast timing [7], DECT leverages a multi-material decomposition (MMD) algorithm to mathematically isolate tissue components [8]. By evaluating tissue pixels against predefined material pairs or triplets, MMD separates lipid-specific profiles from surrounding structures, enabling extraction of an objective fat volume or mass fraction from standard clinical datasets. This algorithmic processing represents a significant advancement over conventional attenuation measurements, particularly because overlapping density values between fat, fibrosis, and blood vessels limit the reliability of Hounsfield-based quantification alone.

These operational and algorithmic differences directly influence the diagnostic performance and practical utility of each modality. Conventional MRI IP/OP imaging delivers high sensitivity and specificity for identifying hepatic steatosis and is highly reproducible across different scanner manufacturers, though its quantitative metrics can be confounded by severe hepatic iron overload. Conversely, DECT utilizing MMD exhibits lower sensitivity for mild steatosis but offers better diagnostic accuracy for moderate-to-severe disease. The primary strength of DECT MMD lies in its ability to be integrated into routine oncology or emergency CT protocols, effectively allowing for retroactive fat quantification even on contrast-enhanced images via virtual unenhancement processing. Ultimately, while conventional MRI IP/OP sequences remain a dedicated tool for metabolic evaluation, DECT MMD serves as a potential screening alternative capable of identifying hepatic steatosis incidentally during routine clinical imaging. Hence, we conducted a retrospective cohort study in our institution to compare liver FF measurements from MRI IP/OP and DECT.

Methods

Study population

This retrospective observational study was approved by the local institutional review board, which granted a waiver of informed consent due to the retrospective nature of the analysis. The cohort comprised all patients who underwent both abdominal CT and MRI imaging at Sengkang General Hospital, Singapore between 2023 and 2025. Patients with incomplete datasets, motion artifacts precluding reliable ROI placement, or contraindications to MRI were excluded.

MRI protocol

All MRI examinations were performed using a 1.5 or 3 Tesla scanner (Siemens MAGNETOM Aera, Siemens MAGNETOM Vida; Siemens Healthineers). T1-weighted volumetric interpolated breath-hold examination (VIBE) Dixon sequences were acquired for the upper abdomen, incorporating both in-phase (IP) and opposed-phase (OP) imaging, alongside the generation of fat- and water-selective maps. MRI acquisition parameters for IP/OP were as follows: breath hold lasting 15 s, TR 3.97 ms; out-of-phase TE 1.29 ms, in-phase TE 2.52 ms, flip angle 9°; FOV: 380 × 309 mm; voxel size 1.2 × 1.2 × 2.5 mm³; slice thickness = 2.5 mm. These parameters align with vendor guidance for reproducible single-breath-hold Dixon acquisitions.

CT protocol

All dual-energy CT examinations were performed using a third-generation dual-source scanner (Siemens SOMATOM Force, Siemens Healthineers). Following scout acquisition, images were obtained with the patient in a supine position and in the craniocaudal scanning direction. Data acquisition commenced 80 seconds after the administration of 75 mL non-ionic iodine contrast agent at 3.5 mL/s (Iohexol 350 mg I/mL, Omnipaque 350), followed by a 30 mL saline flush. The CT acquisition parameters were as follows: dual-energy spectral imaging scanning mode with instantaneous switching of tube voltages between 100 and 150 kVp; reference mAs 190/95; collimation 128 × 0.6 mm; spiral scanning mode;

rotation time 0.5 s/cycle; pitch 0.6. Images were reconstructed in the sagittal and coronal planes using a soft-tissue kernel at a slice thickness of 3 mm, matrix 512 × 512. Dose optimization was performed via automatic exposure control (CARE Dose 4D, Siemens Healthineers).

Image evaluation

Abdominal MRI images were analysed by manually drawing two regions of interest (ROI) of size 2 cm² in hepatic segments VI and VII (Fig. 1). These segments were chosen due to their large homogenous volume and standard vascular inflow, reduced susceptibility to cardiac pulsation and respiratory motion, and avoidance of focal fat sparing or infiltration [9]. The ROIs were selected in liver parenchyma not containing large hepatic vessels, biliary structures, and focal lesions [10]. In-phase and opposed-phase liver signal intensities in hepatic segment VI and VII were processed via a web-based radiology tool (Phillip Cheng Hepatic Fat MRI Calculator; available at pcheng.org), which derives hepatic FF values utilizing standard Dixon chemical shift imaging principles [11].

Dual-energy CT acquires data using high- and low-energy X-ray spectra, enabling tissue differentiation based on the energy-dependent attenuation profiles of various substances. During post-processing, multi-material decomposition algorithms are applied to model each voxel as a mixture of three primary constituents—iodine, fat, and water. By exploiting the distinct attenuation characteristics of fat relative to other soft tissue, MMD algorithms can isolate and quantify FF within each voxel. All DECT images were analyzed using the post-processing software (Syngo.Via, Siemens Healthineers). This platform provided the quantitative fat maps and virtual non-contrast images directly from the DECT source data. The sizes and locations of the two ROIs were manually matched with the MRI images to facilitate comparison (Fig. 2).

Statistical analysis

Continuous variables were expressed as mean ± standard deviation. The agreement between DECT FF and MRI IP/OP FF was assessed using Spearman rank correlation analysis, supplemented by scatter plots with linear regression lines. Bland–Altman plots were subsequently generated to evaluate systematic measurement bias, calculating the mean difference and 95% limits of agreement between the techniques. Receiver operating characteristic curve analysis was used to evaluate the efficacy of CT to identify hepatic steatosis against the MRI FF as the reference standard. Diagnostic efficacy of DECT for differentiating normal from mild (MRI FF ≥ 5%), moderate (MRI FF ≥ 15%) and severe (MRI FF ≥ 25%) steatosis was evaluated [12]. The robustness of these findings was validated by evaluating the intraclass correlation coefficient (ICC) for inter-observer agreement. Values less than 0.5 indicate poor reliability, 0.5–0.75 suggest moderate reliability, 0.75–0.90 signify good reliability, and values greater than 0.90 reflect excellent reliability. Sensitivity analysis using linear and logistic regression models was done to assess if the variation in time intervals between CT and MRI imaging affected FF assessments. Statistical significance was defined as a two-sided P-value < 0.05. All statistical computations were performed using R software, version 4.6.1.

Results

Patient characteristics

The study cohort comprised 45 patients (20 males and 25 females; mean age 44.8 ± 14.2 years). These patients underwent CT and MRI body imaging for routine clinical evaluation. The mean MRI FF was 7.77 ± 9.91% for segment VI and 8.03 ± 9.91% for segment VII. The mean CT FF was 4.38 ± 8.81% for segment VI and 5.46 ± 8.74% for segment VII. These descriptive values provide the baseline distribution that informs the subsequent correlation and diagnostic performance analyses.

Correlation and agreement analysis

The relationship between DECT FF and MRI FF was examined using Spearman rank correlation. DECT and MRI FF values demonstrated a statistically significant positive correlation for both segment VI (Spearman $\rho = 0.50$; $P < 0.001$) (Fig. 3) and segment VII (Spearman $\rho = 0.57$; $P < 0.001$) (Fig. 4).

Bland–Altman analysis was performed to assess systematic bias and the 95% limits of agreement. The analysis revealed a mean difference of -3.39% (95% limits of agreement: -11.84% to 18.63%) for segment VI (Fig. 5) and -2.57% (95% limits of agreement: -11.87% to 17.00%) for segment VII (Fig. 6). This indicates a systematic underestimation of hepatic FF by DECT relative to MRI across both segments. Visual inspection of the plots suggests widening of the inter-modality difference at higher FF.

Diagnostic performance and Receiver Operating Characteristic Curves

The diagnostic performance of DECT FF for the categorical grading of hepatic steatosis was evaluated using receiver operating characteristic curve analysis against MRI FF, with thresholds of $\geq 5\%$, $\geq 15\%$, and $\geq 25\%$ defining mild, moderate, and severe steatosis, respectively.

DECT-derived fat FF demonstrated discriminative ability against MRI-FF. The diagnostic accuracy increased with severity thresholds. For segment VI, the area under the curve was 0.77 (95% CI 0.63–0.91) for detecting mild steatosis (Fig. 7). At the optimal Youden-derived threshold of 4.96%, sensitivity was 68.0% and specificity 90.0%, yielding a Youden J statistic of 0.58. For segment VII, the area under the curve was 0.77 (95% CI 0.63–0.91) (Fig. 8). At the optimal Youden-derived threshold of 5.53%, sensitivity was 64.0% and specificity was 90.0%, yielding a Youden J statistic of 0.54.

Diagnostic accuracy improved markedly for detecting moderate and severe steatosis. For moderate steatosis (MRI-FF $\geq 15\%$), segment VI achieved an AUC of 0.88 (95% CI 0.72–1.00) with a cutoff of 11.21%, sensitivity of 71.4%, and specificity of 92.1%. Segment VII achieved an AUC of 0.89 (95% CI 0.74–1.00) with a cutoff of 9.52%, sensitivity of 85.7%, and specificity of 84.2%. For severe steatosis (MRI-FF $\geq 25\%$), segment VI achieved an AUC of 0.99 (95% CI 0.95–1.00) with a cutoff of 11.21%, sensitivity of 100%, and specificity of 92.5%. Segment VII achieved an AUC of 0.94 (95% CI 0.83–1.00) with a cutoff of 12.09%, sensitivity of 100%, and specificity of 83.3%.

Intra-class correlation coefficient (ICC) analysis

Inter-observer agreement for hepatic FF measurements was evaluated using the intraclass correlation coefficient. The ICC was 0.62 (95% CI 0.37–0.78; $P < 0.001$) for segment VI and 0.66 (95% CI 0.45–0.80; $P < 0.001$) for segment VII, indicative of moderate inter-observer reliability in both segments. These values fall within the 0.5–0.75 interval interpreted as moderate reliability

Sensitivity analysis

To evaluate whether the time interval between imaging modalities affected the underlying relationship between CT and MRI FF measurements, multiple linear regression with interaction term (MRI x Time interval between CT and MRI acquisition) were constructed. The interaction did not reach statistical significance for both segment VI ($\beta = 0.0002$, 95% CI: -0.001 to 0.001 ; $t = 0.22$, $P = 0.83$) and segment VII ($\beta = 0.0002$, 95% CI: -0.001 to 0.001 ; $t = 0.42$, $P = 0.67$). These findings indicate that the slope of the relationship—and by extension, the Spearman rank correlation—did not significantly modify as a function of the chronological delay between scans in either liver segments.

Consistent with these stable relationships, a linear regression was performed to evaluate the effect of the time interval between CT and MRI acquisition on the measurement differences (Bland-Altman analysis) of FF. The regression analysis

revealed that the chronological delay between scans did not significantly influence the measurement differences in segment VI ($\beta = 0.004$, 95% CI: -0.01 to 0.01 ; $t = -0.73$, $P = 0.47$) (Fig. 9) and segment VII ($\beta = -0.003$, 95% CI: -0.01 to 0.01 ; $t = -0.52$, $P = 0.60$) (Fig. 10). The widening of the 95% confidence limits at increasing time interval is attributable to lower density of data points in that range rather than a significant temporal trend.

Separately, a logistic regression was performed to evaluate if the time interval affects the diagnostic discrimination of CT with reference to MRI at different thresholds. After accounting for the time interval as a covariate, the adjusted ROC curves yielded comparable AUC values. The DeLong test for paired, correlated ROC curves confirmed no statistically significant difference in model performance at all thresholds ($P > 0.05$) (Fig. 11). This affirms that the time elapsed between DECT and MRI acquisitions does not materially alter the diagnostic classification of steatosis severity.

Discussion

The present study demonstrates a statistically significant, moderate correlation between DECT MMD and MRI IP/OP FF (Spearman $\rho = 0.50$ – 0.57). This builds upon the growing body of literature evaluating the role of DECT as a precise modality for hepatic fat quantification. Gassenmaier et al. demonstrated that liver fat quantification is feasible using portal-venous phase contrast-enhanced dual-source DECT ($r = 0.73$) against a multi-echo Dixon MRI reference sequence [13]. Hong et al. evaluated a specialized Multi-Material Decomposition (MMD) algorithm utilizing a low-dose, non-contrast DECT protocol and demonstrate strong correlation with MRI-PDFF ($r = 0.76$) [14]. Furthermore, Zhang et al. contrasted the accuracy of density metrics versus advanced material separation by showing that direct fat concentration measurements derived from unenhanced spectral-detector CT lipid maps exhibit superior diagnostic alignment with MRI-PDFF compared to the standard liver-spleen (L/S) CT ratio [15]. While prior investigation in this domain has focused on validating DECT against MRI-PDFF, our study explicitly evaluates its correlation with conventional two-point Dixon IP/OP imaging. This distinction is critical because, although PDFF is recognized as a highly controlled quantitative reference standard, traditional IP/OP signal intensity metrics remain far more ubiquitous in routine diagnostic radiology workflows. The significant correlation between both modalities demonstrates that CT methodology is a reliable tool for assessing the directional trajectory of hepatic steatosis within the cohort. The strength of the correlation is albeit moderate, suggesting that the modalities are not interchangeable at the individual-patient level, especially for precise monitoring and quantification of hepatic steatosis.

A key finding of our study is the systematic underestimation of liver FF by DECT relative to MRI (Bland–Altman mean differences of -3.39% for segment VI and -2.57% for segment VII). The 95% limits of agreement were relatively broad, spanning about 30%, indicating notable individual variation between the two modalities. This directional bias has been previously described and is likely multifactorial: MMD algorithms model fat content within a three-compartment framework (fat–water–iodine) that may be sensitive to partial-volume effects and beam-hardening artifacts [16, 17], whereas MRI IP/OP imaging benefit from confounder correction for T1, T2*, and frequency shifts [18]. The widening of differences at higher true fat fractions observed on our Bland–Altman plots is clinically important because it suggests that absolute DECT FF values may progressively diverge from MRI-derived reference in advanced steatosis, potentially leading to under-grading of severe disease if DECT is used as the primary diagnostic modality rather than a screening gatekeeper.

Diagnostic performance metrics in our study mirror established performance thresholds described in prior studies. In a single institution retrospective review by Zhang et al., DECT achieved AUC values between 0.83–0.87 when considering MRI PDFF $> 6\%$ as diagnostic threshold. Instead of MMD techniques, the study compared attenuation parameters like virtual non-contrast Hounsfield units and liver-spleen attenuation difference against MRI FF [19]. Wang et al. reported that dual-layer spectral-detector CT (SDCT) parameters enables accurate, non-invasive grading of liver fat, showing reliable performance in detecting moderate to severe hepatic steatosis [20]. Molwitz et al. performed a literature review comparing DECT vs single-energy CT for the diagnostic of hepatic steatosis [21]. Fat quantification in the liver by DECT

showed robust results when compared to histology and MRI modalities. For determination of hepatic steatosis in contrast-enhanced CT images, DECT was found to superior to SECT. Our study demonstrates the increasing diagnostic utility of DECT with worsening severity of hepatic steatosis. The optimal CT cutoffs derived by Youden index (approximately 4.96–5.53% for mild, 9.52–11.21% for moderate, and 11.21–12.09% for severe disease) differ slightly from historical MRI-based thresholds and should be interpreted in the context of MMD-specific vendor algorithms and scanner calibration. When placing our work in the broader clinical context, CT-based steatosis quantification has been recognized as a potentially cost-effective opportunistic screening strategy because abdominal CT is already frequently performed for unrelated indications. The absence of additional radiation beyond the routine CT acquisition makes DECT MMD particularly attractive for large-scale opportunistic programs, provided that detection thresholds are set conservatively to favor specificity in populations with low pre-test probability. In our data, specificity at mild steatosis cutoffs was 90%, which is favorable for a screening test since false positives are minimized. However, the sensitivity of 64–68% for mild disease means that roughly one in three patients with early steatosis would be missed if DECT were used in isolation, reinforcing its role as a first-line filter rather than a definitive diagnostic discriminant.

Sensitivity analyses confirmed that temporal separation of CT and MRI acquisitions did not meaningfully bias FF assessments or ROC-based diagnostic discrimination. This is reassuring for retrospective study designs in which scan pairing is opportunistic and may span weeks or months. It also implies that the biological stability of liver fat content is sufficient for cross-modal comparison within the observed time window [22]—a prerequisite for opportunistic screening programs that leverage DECT.

Our study has limitations inherent to retrospective, single-institution designs, including a relatively small sample size ($N = 45$), selection bias toward patients who had both imaging modalities available, and the use of manual ROI placement rather than automated whole-liver volumetric analysis. Additionally, we did not have histologic confirmation in our cohort, relying instead on MRI IP/OP as an imperfect reference standard. The MMD algorithm implemented in Syngo.Via may behave differently on single-source DECT systems or at different phantom calibration settings; generalizability to other vendors (GE, Philips, Canon) or energy-switching protocols requires further investigation. Finally, hepatic iron overload is known to confound both MRI IP/OP and DECT MMD quantification. Our cohort did not systematically stratify by iron status, and future studies should explicitly correct or exclude iron-overloaded patients when comparing modalities quantitatively.

Conclusion

This study demonstrates that DECT multi-material decomposition provides robust diagnostic accuracy for moderate and severe hepatic steatosis. While DECT serves as a valuable opportunistic screening tool with high specificity for clinically significant steatosis, its limited sensitivity for mild disease and systematic underestimation relative to MRI IP/OP constrain its use as a standalone diagnostic standard. Given the expanding prevalence of MASLD and the need for non-invasive surveillance, DECT MMD can be integrated into routine clinical CT workflows to triage patients for further MRI-based evaluation or longitudinal monitoring. Standardization of ROI placement, multi-vendor algorithm harmonization, and prospective histologically validated studies are recommended before DECT-derived FF thresholds are generalized to clinical decision-making.

Declarations

Author Contribution

JHL: data curation, data analysis, writing-original draft, writing-reviewing and editing. SMY: writing-original draft. KRY: writing – original draft. HZRL: data collection, data curation. SY: writing-original draft. SAU: writing-original draft. SA:

writing-original draft. SHV: writing-original draft. FJ: writing-original draft. SSXK: writing-original draft. PMY: writing-original draft, supervision. MOT: conceptualization, supervision, writing-original draft, and writing-reviewing and editing

Data Availability

Data and subsequent analysis are held in repository with the study authors. The data could be made available upon request.

References

1. Gallo G, Nalli G, Baratta F, Desideri G, Savoia C. Metabolic Dysfunction-Associated Steatotic Liver Disease: A Silent Driver of Cardiovascular Risk and a New Target for Intervention. *Int J Mol Sci* 2025;26(16):
2. Chowdhury AB, Mehta KJ. Liver biopsy for assessment of chronic liver diseases: a synopsis. *Clinical and Experimental Medicine* 2023;23(2):273–285.
3. Reeder SB, Cruite I, Hamilton G, Sirlin CB. Quantitative Assessment of Liver Fat with Magnetic Resonance Imaging and Spectroscopy. *J Magn Reson Imaging* 2011;34(4):729–749.
4. Ünal E, Karaosmanoğlu AD, Akata D, Özmen MN, Karçaaltınçaba M. Invisible fat on CT: making it visible by MRI. *Diagn Interv Radiol* 2016;22(2):133–140.
5. Hupfeld S, Pischel D, Jechorek D, Janicová A, Pech M, Fischbach F. MRI-based fat quantification of the liver: Is it time for commercially available products? *Eur J Radiol* 2021;144(109993).
6. Hyodo T, Yada N, Hori M, et al. Multimaterial Decomposition Algorithm for the Quantification of Liver Fat Content by Using Fast-Kilovolt-Peak Switching Dual-Energy CT: Clinical Evaluation. *Radiology* 2017;283(1):108–118.
7. Pickhardt PJ, Graffy PM, Reeder SB, Hernando D, Li K. Quantification of Liver Fat Content With Unenhanced MDCT: Phantom and Clinical Correlation With MRI Proton Density Fat Fraction. *AJR Am J Roentgenol* 2018;211(3):W151-w157.
8. Zhu L, Wang F, Wang H, et al. Liver fat volume fraction measurements based on multi-material decomposition algorithm in patients with nonalcoholic fatty liver disease: the influences of blood vessel, location, and iodine contrast. *BMC Med Imaging* 2024;24(1):37.
9. Bonekamp S, Tang A, Mashhood A, et al. Spatial distribution of MRI-Determined hepatic proton density fat fraction in adults with nonalcoholic fatty liver disease. *J Magn Reson Imaging* 2014;39(6):1525–1532.
10. Guglielmo FF, Barr RG, Yokoo T, et al. Liver Fibrosis, Fat, and Iron Evaluation with MRI and Fibrosis and Fat Evaluation with US: A Practical Guide for Radiologists. *Radiographics* 2023;43(6):e220181.
11. Dixon WT. Simple proton spectroscopic imaging. *Radiology* 1984;153(1):189–194.
12. Starekova J, Hernando D, Pickhardt PJ, Reeder SB. Quantification of Liver Fat Content with CT and MRI: State of the Art. *Radiology* 2021;301(2):250–262.
13. Gassenmaier S, Kähm K, Walter SS, Machann J, Nikolaou K, Bongers MN. Quantification of liver and muscular fat using contrast-enhanced Dual Source Dual Energy Computed Tomography compared to an established multi-echo Dixon MRI sequence. *European Journal of Radiology* 2021;142(109845).
14. Hong SB, Lee NK, Kim S, Um K, Kim K, Kim IJ. Hepatic Fat Quantification with the Multi-Material Decomposition Algorithm by Using Low-Dose Non-Contrast Material-Enhanced Dual-Energy Computed Tomography in a Prospectively Enrolled Cohort. *Medicina (Kaunas)* 2022;58(10):
15. Zhang M, Yu N, Yang C, Duan H, Ren Z. Quantifying non-alcoholic fatty liver: liver-spleen CT ratio and fat concentration in dual-energy spectral CT: Accuracy comparison with proton density fat fraction MRI. *Radiologie (Heidelberg)* 2026;

16. Khodajou-Chokami H, Ding H, Molloi S. Accurate iodine quantification and residual error reduction with principal component analysis multmaterial decomposition using spectral CT. *Med Phys* 2026;53(4):e70407.
17. Salyapongse AM, Szczykutowicz TP. Misinterpretations about CT numbers, material decomposition, and elemental quantification. *Eur Radiol* 2025;35(2):862–870.
18. Kinner S, Reeder SB, Yokoo T. Quantitative Imaging Biomarkers of NAFLD. *Dig Dis Sci* 2016;61(5):1337–1347.
19. Zhang PP, Choi HH, Ohliger MA. Detection of fatty liver using virtual non-contrast dual-energy CT. *Abdom Radiol (NY)* 2022;47(6):2046–2056.
20. Wang M, Chen H, Ma Y, et al. Dual-layer spectral-detector CT for detecting liver steatosis by using proton density fat fraction as reference. *Insights Imaging* 2024;15(1):210.
21. Molwitz I, Leiderer M, Özden C, Yamamura J. Dual-Energy Computed Tomography for Fat Quantification in the Liver and Bone Marrow: A Literature Review. *Rofo* 2020;192(12):1137–1153.
22. Lallukka S, Sädevirta S, Kallio MT, et al. Predictors of Liver Fat and Stiffness in Non-Alcoholic Fatty Liver Disease (NAFLD) – an 11-Year Prospective Study. *Scientific Reports* 2017;7(1):14561.

Table

Table 1 Diagnostic performance of DECT fat fraction for detecting hepatic steatosis against MRI fat fraction as the reference standard, stratified by liver segment and severity grade

Segment	Severity	Reference	AUC	95% CI	Cutoff (%)	Sensitivity	Specificity	PPV	NPV	Youden J
VI	Mild	MRI-FF ≥ 5%	0.77	0.63–0.91	4.96	0.68	0.90	0.89	0.69	0.58
VI	Moderate	MRI-FF ≥ 15%	0.88	0.72–1.00	11.21	0.71	0.92	0.63	0.95	1.64
VI	Severe	MRI-FF ≥ 25%	0.99	0.95–1.00	11.21	1.00	0.93	0.62	1.00	1.93
VII	Mild	MRI-FF ≥ 5%	0.77	0.63–0.91	5.53	0.64	0.90	0.88	0.67	1.54
VII	Moderate	MRI-FF ≥ 15%	0.89	0.74–1.00	9.52	0.86	0.84	0.50	0.97	1.79
VII	Severe	MRI-FF ≥ 25%	0.94	0.83–1.00	12.09	1.00	0.83	0.30	1.00	1.83

AUC = area under the receiver operating characteristic curve; CI = confidence interval; PPV = positive predictive value; NPV = negative predictive value; Youden J = Youden index.

Figures

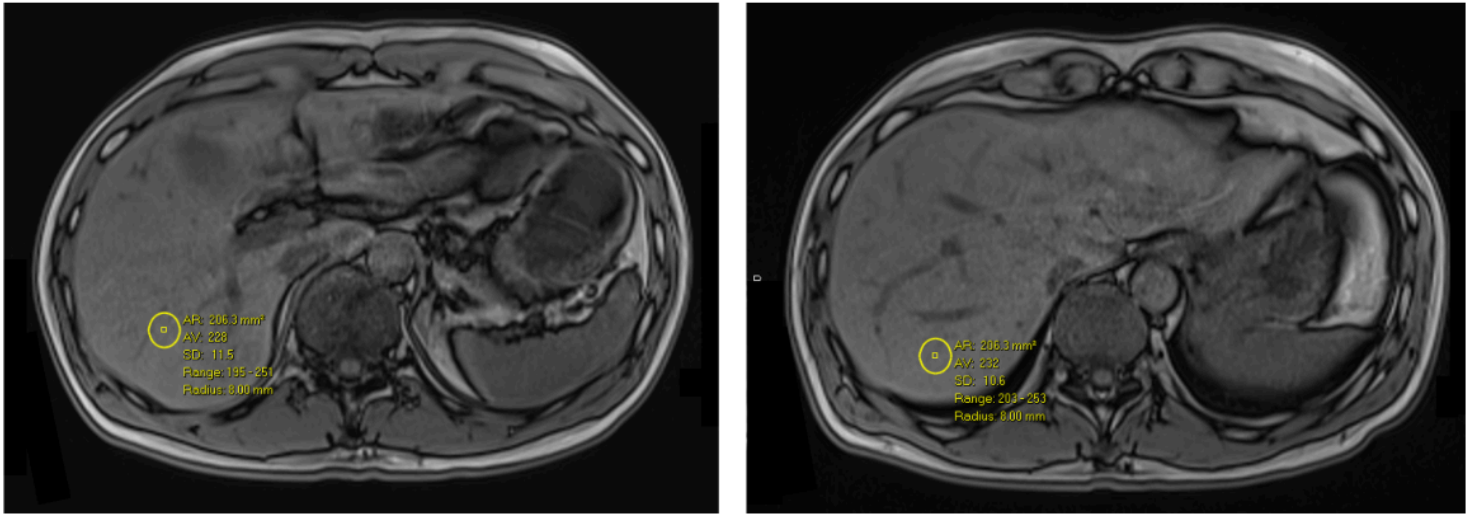


Figure 1

Representative regions of interest (ROIs) placed in hepatic segment VI (left image) and segment VII (right left) on MRI in-phase/out-of-phase imaging, avoiding major hepatic vasculature.

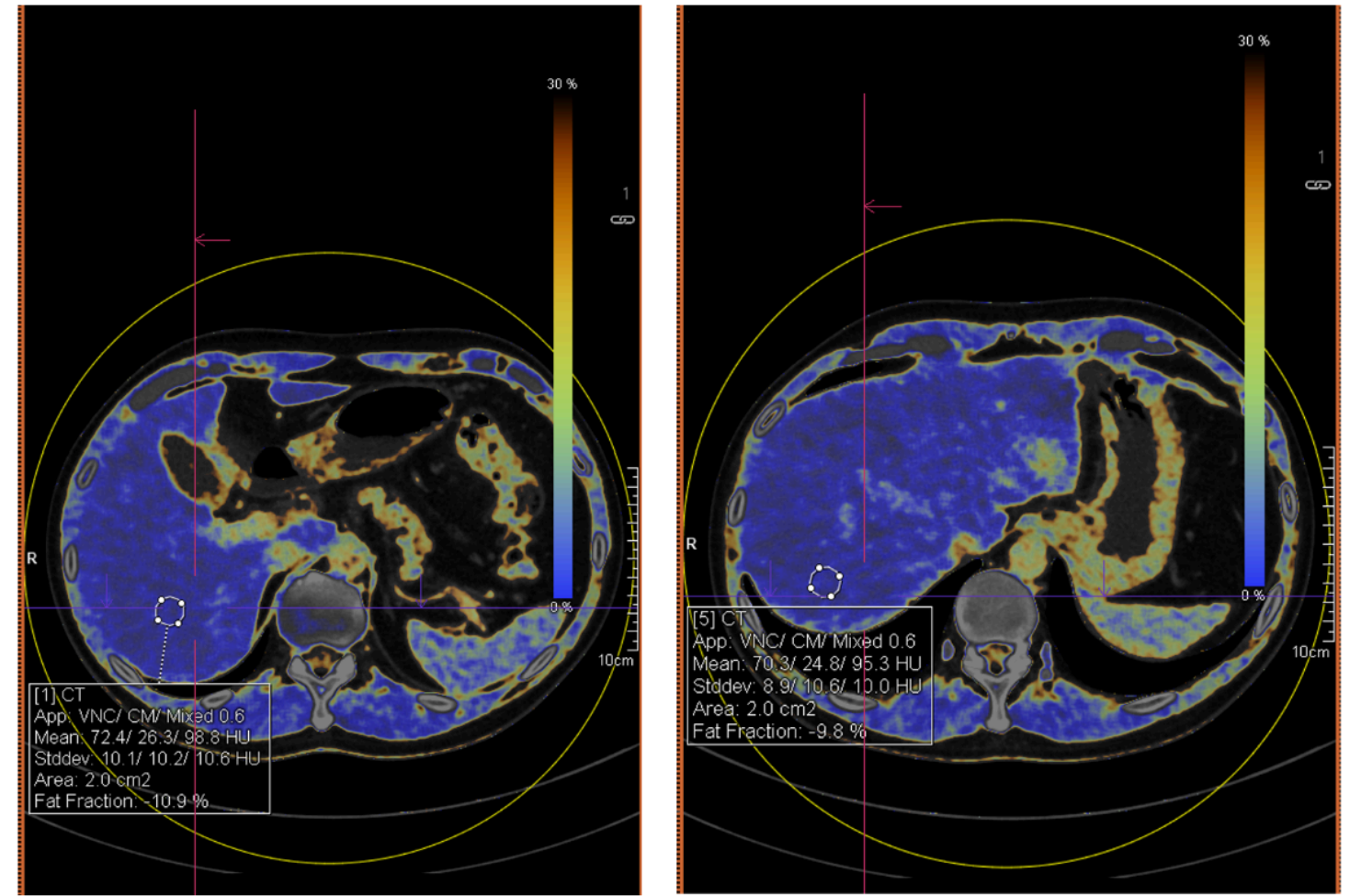


Figure 2

Corresponding ROI placement on dual-energy CT hepatic fat map generated by multi-material decomposition (Syngo.Via), matched to MRI ROIs.

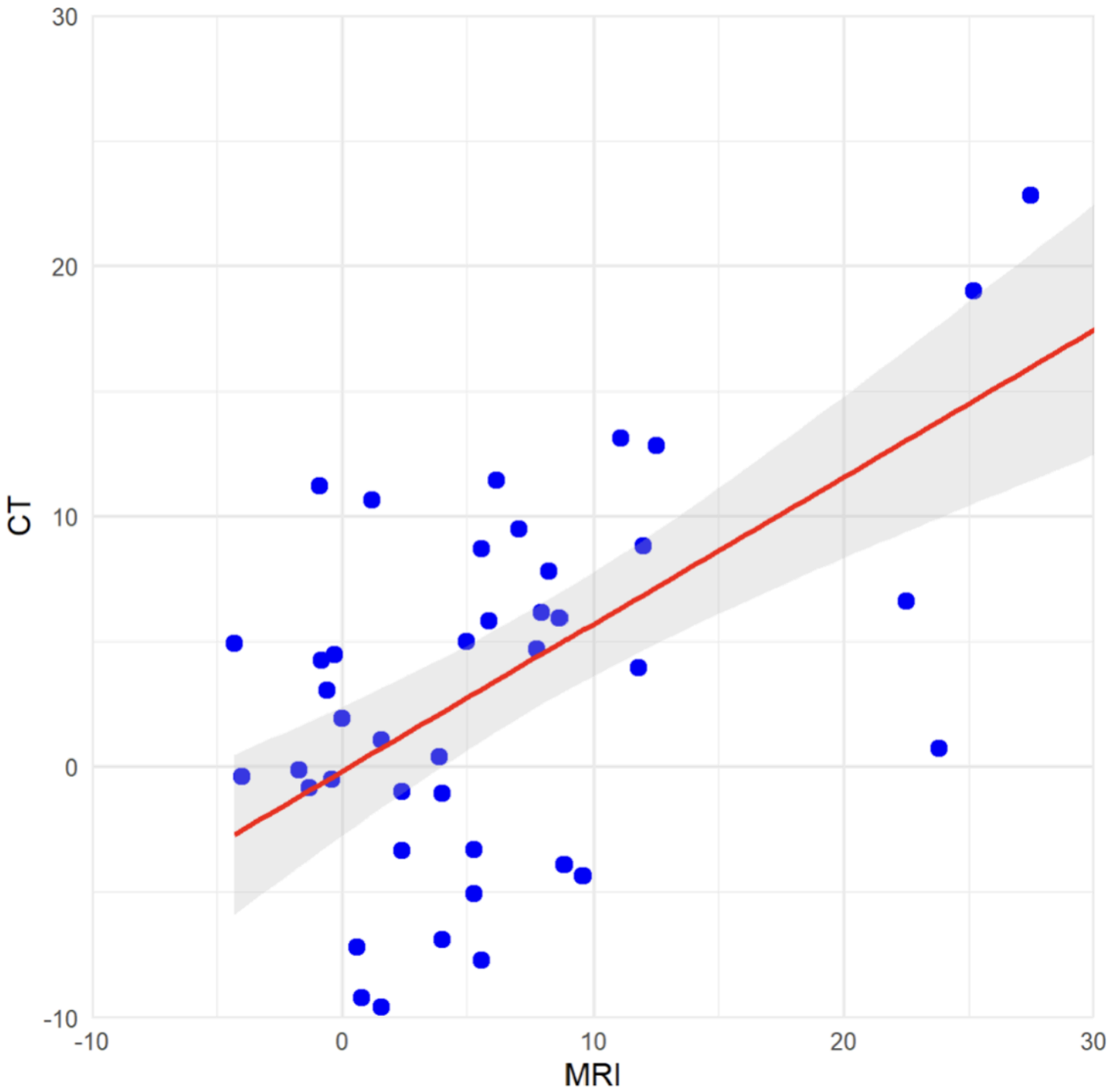


Figure 3

Spearman correlation scatter plot for segment VI: DECT fat fraction versus MRI fat fraction (Spearman $\rho = 0.50$, $P < 0.001$)

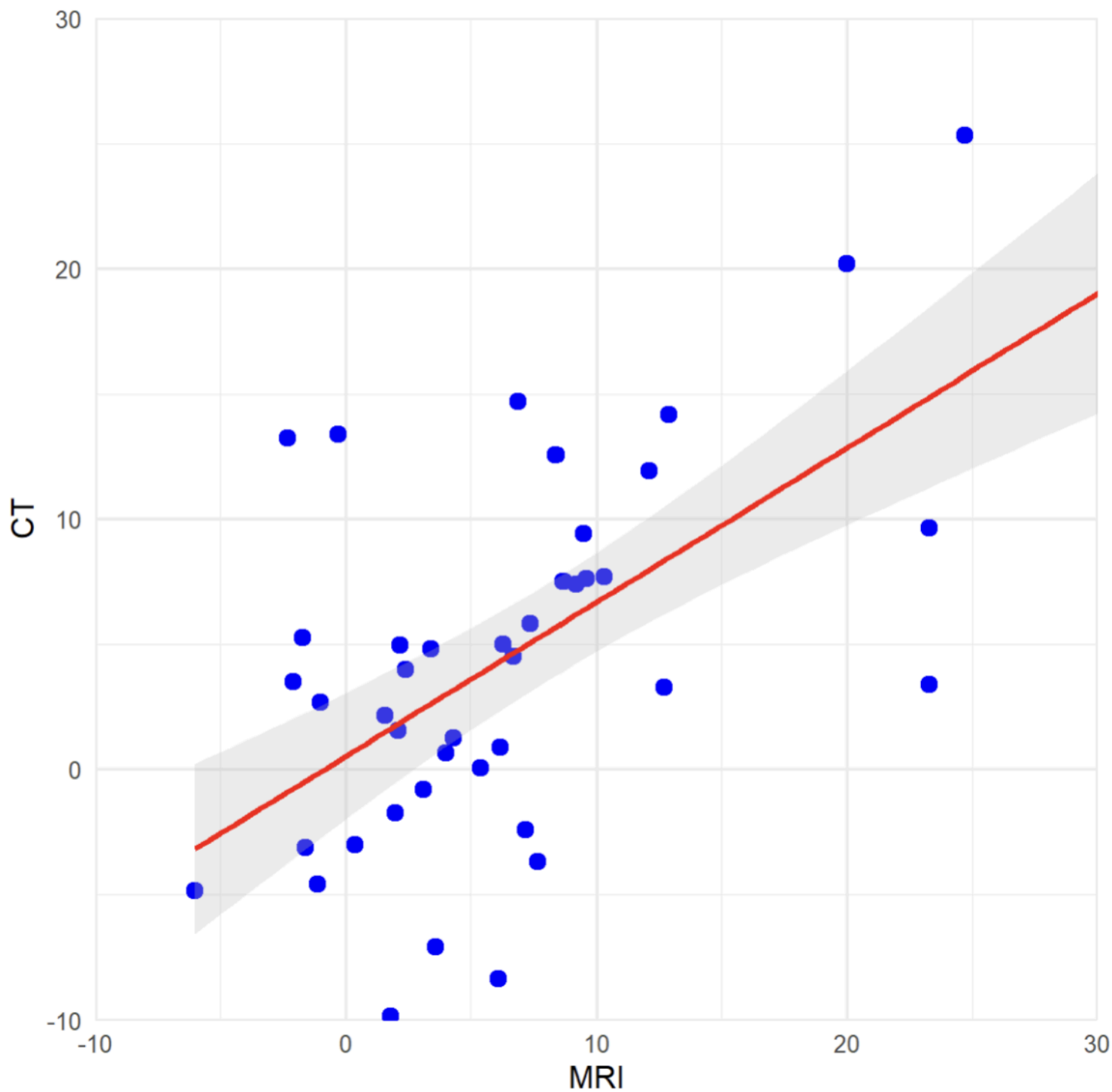


Figure 4

Spearman correlation scatter plot for segment VII: DECT fat fraction versus MRI fat fraction (Spearman $\rho = 0.57$, $P < 0.001$)

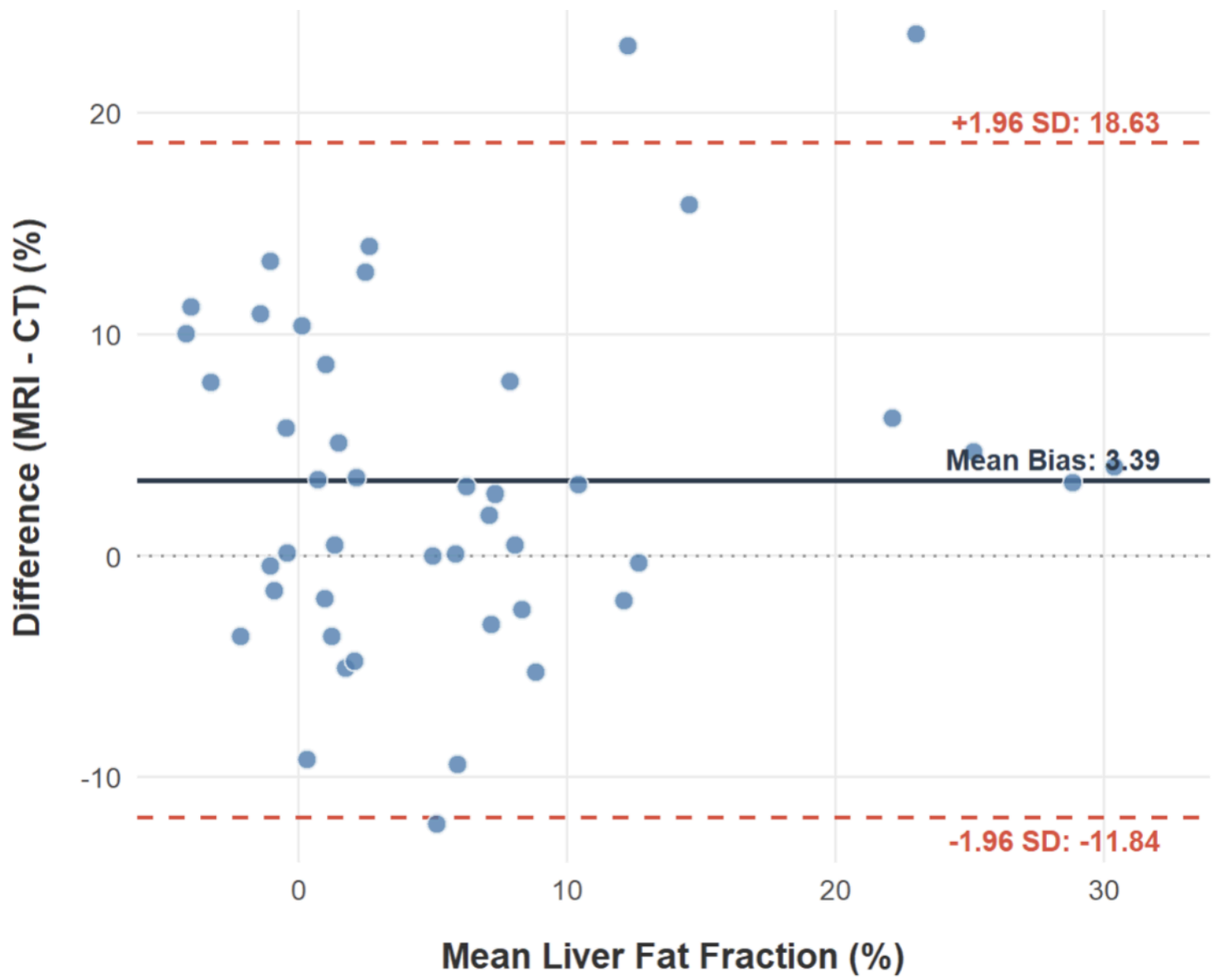


Figure 5

Bland–Altman plot for segment VI showing mean difference (3.39%) and 95% limits of agreement (–11.84% to 18.63%)

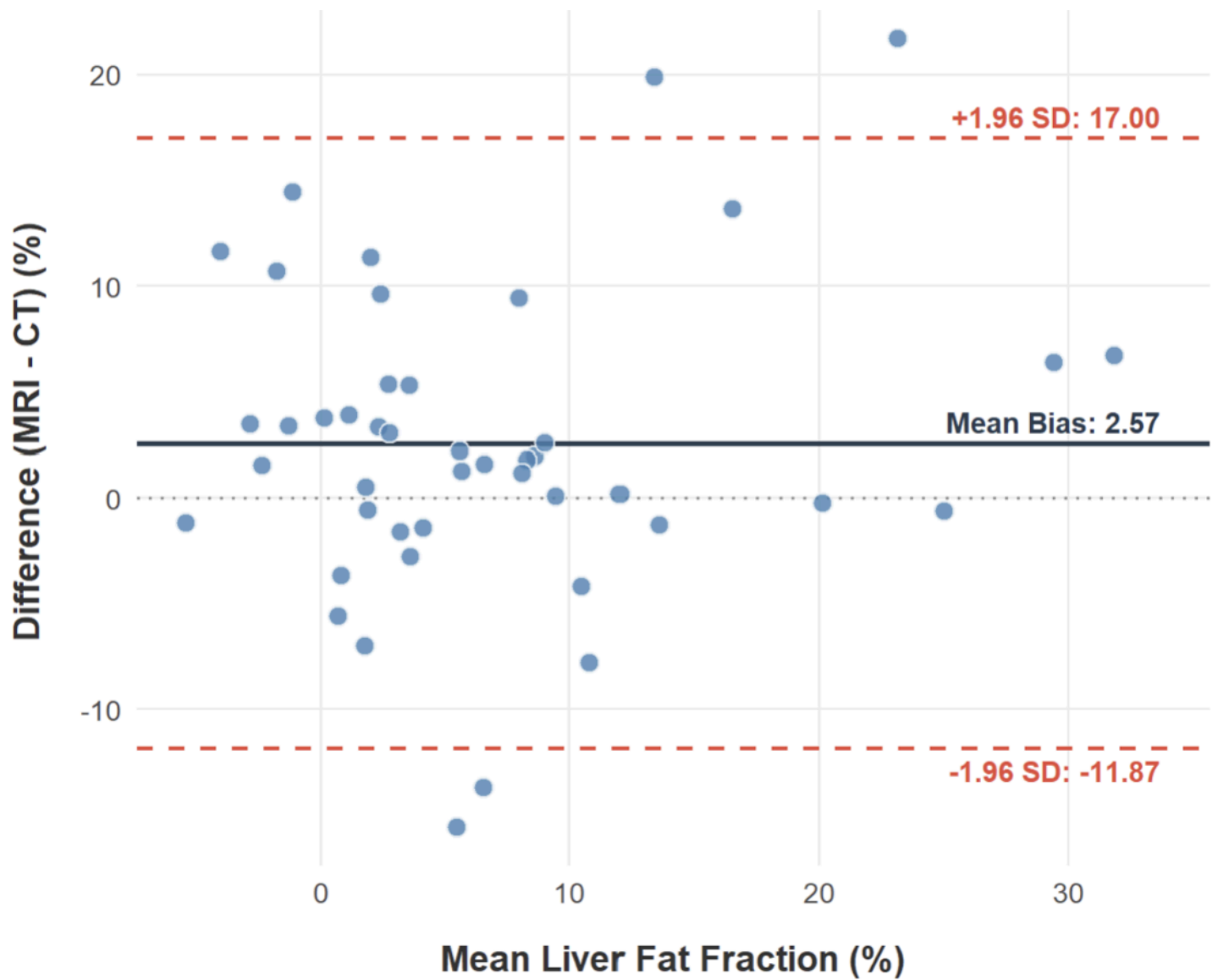


Figure 6

Bland–Altman plot for segment VII showing mean difference (2.57%) and 95% limits of agreement (–11.87% to 17.00%)

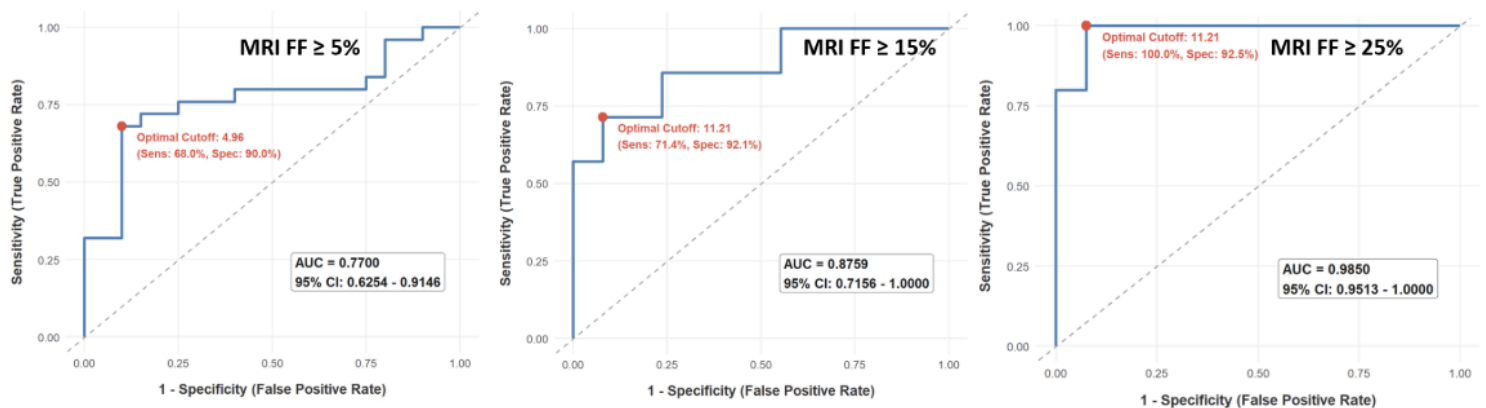


Figure 7

Receiver operating characteristic curve for DECT fat fraction detecting mild ($\text{MRI-FF} \geq 5\%$), moderate ($\text{MRI-FF} \geq 15\%$) and severe ($\text{MRI-FF} \geq 25\%$) hepatic steatosis in segment VI

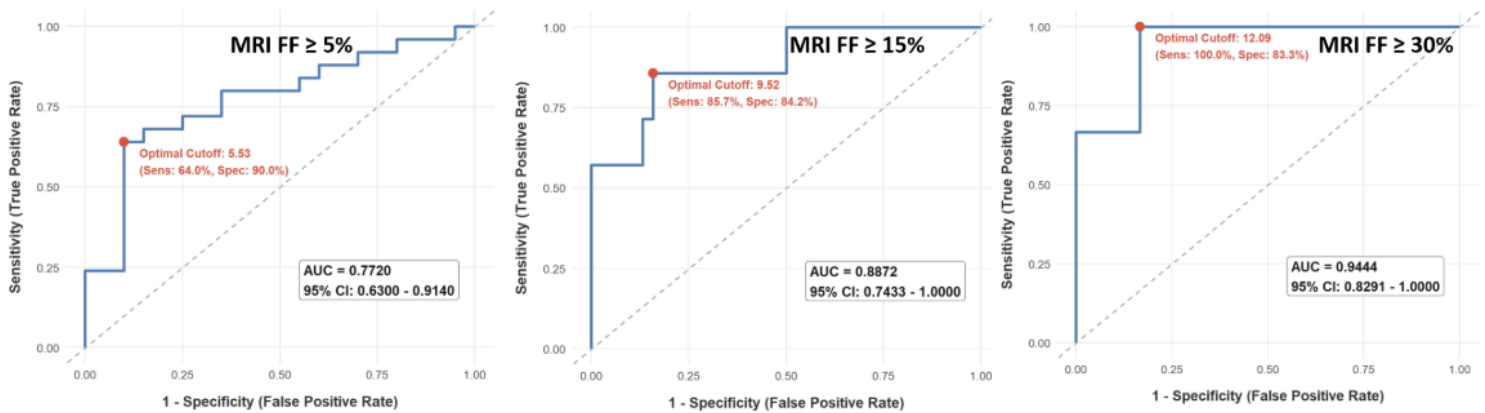


Figure 8

Receiver operating characteristic curve for DECT fat fraction detecting mild ($\text{MRI-FF} \geq 5\%$), moderate ($\text{MRI-FF} \geq 15\%$) and severe ($\text{MRI-FF} \geq 25\%$) hepatic steatosis in segment VII

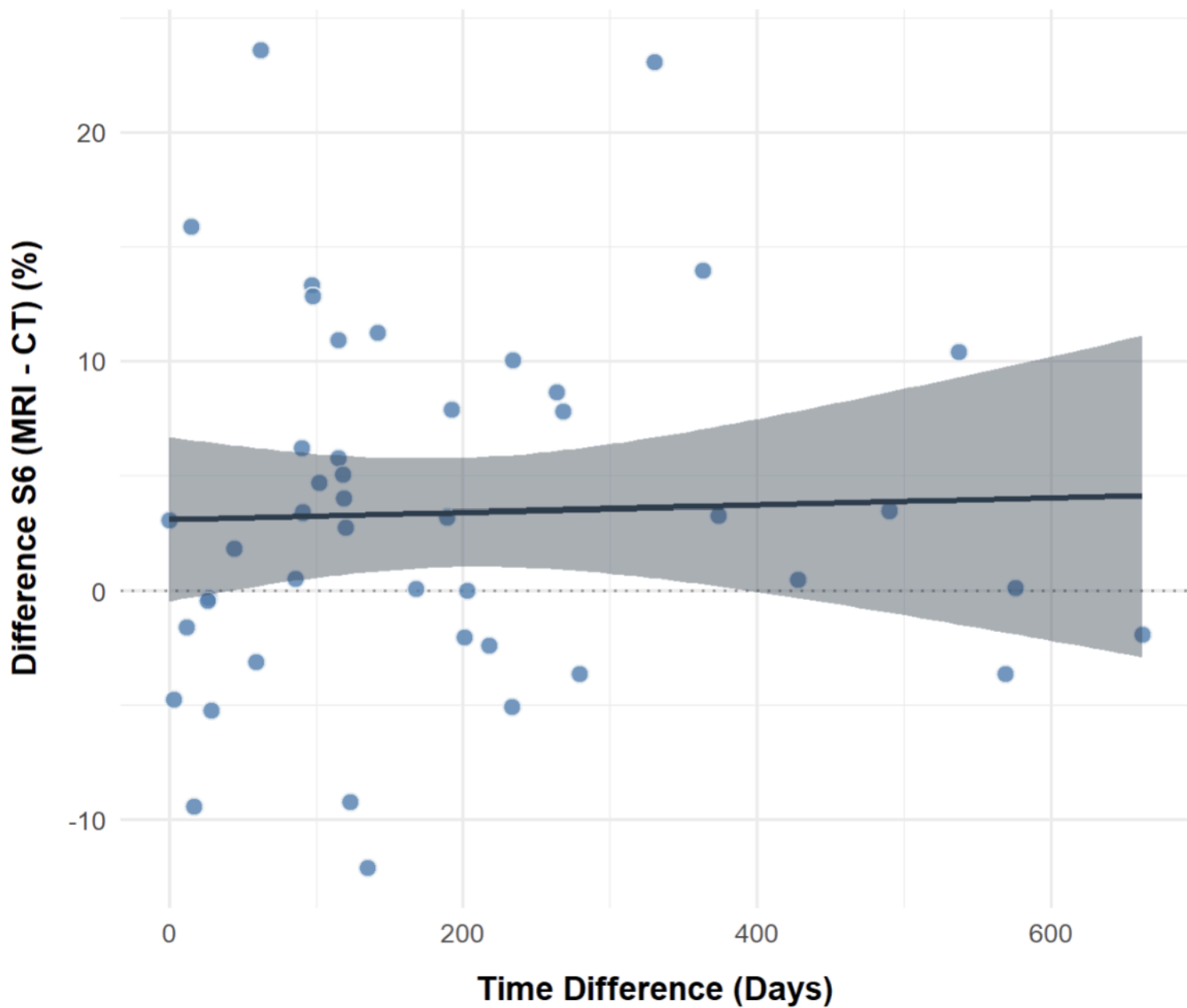


Figure 9

Linear regression of measurement differences (MRI minus DECT) against time interval between scans for segment VI

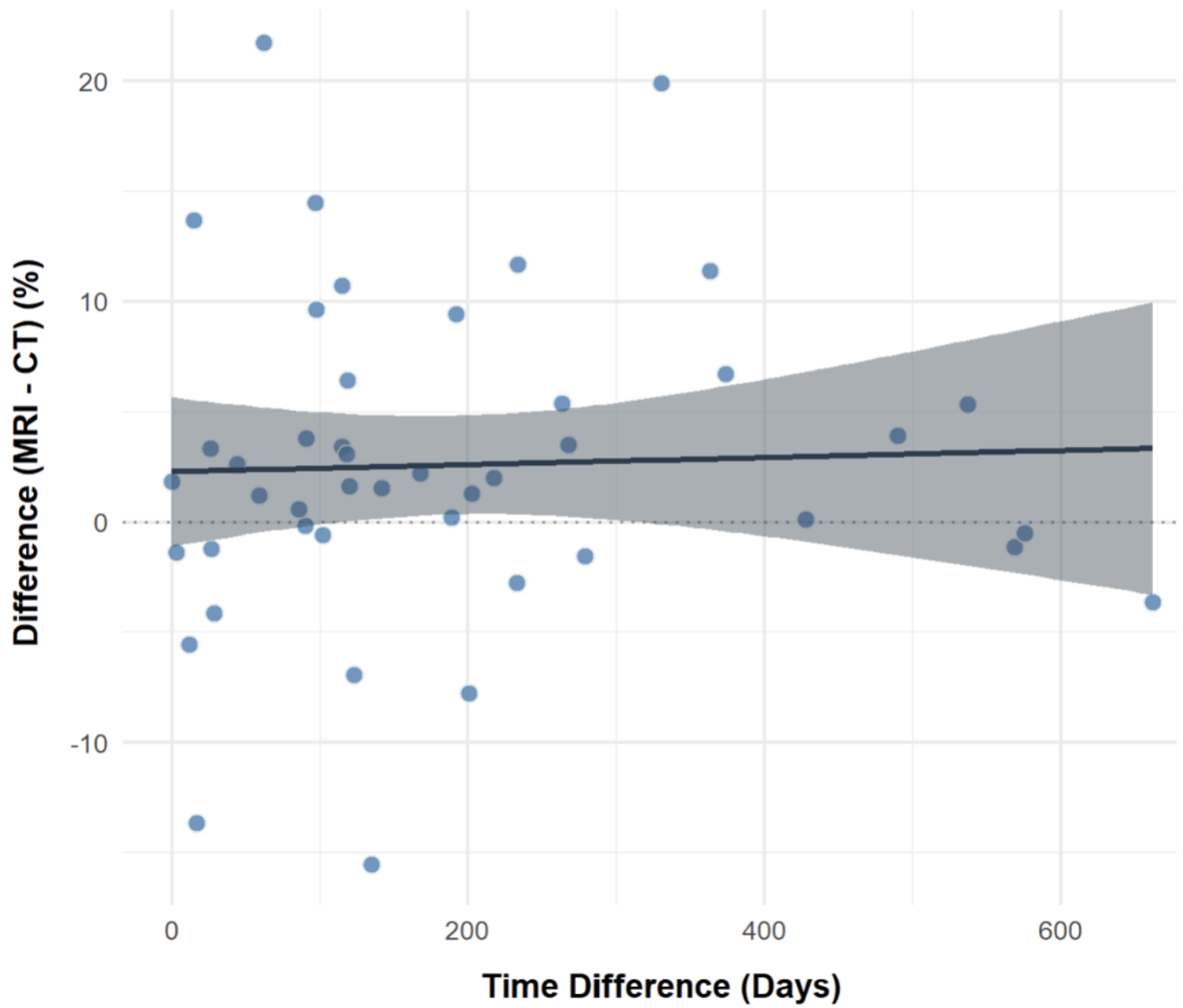


Figure 10

Linear regression of measurement differences (MRI minus DECT) against time interval between scans for segment VII

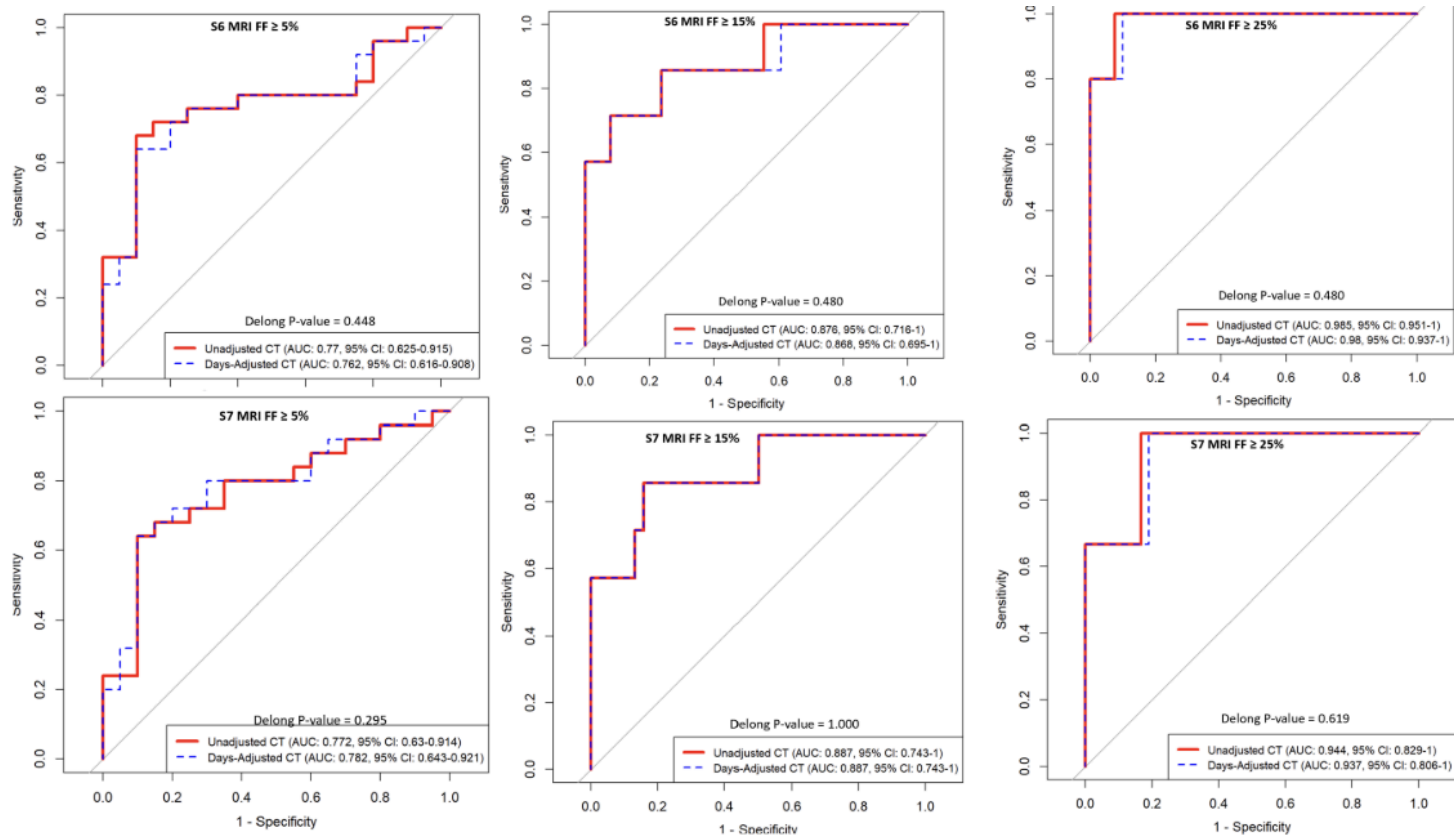


Figure 11

Receiver Operating Characteristic (ROC) curves comparing unadjusted and days-adjusted CT for predicting different thresholds of MRI FF in segment VI and segment VII