

**Enhancing Gadoxetic Acid-enhanced Liver MRI: A Synergistic Approach with Deep Learning CAIPIRINHA-VIBE and  
Optimized Fat Suppression Techniques  
ELECTRONIC SUPPLEMENTARY MATERIAL**

**Table S1** Details of interobserver agreement for image quality assessment of standard, DL, and HR-DL CAIPIRINHA-VIBE on pre-contrast and HBP images

| Interobserver Agreement between Reader 1 and 2 |                          |                          |                          |                         |                         |
|------------------------------------------------|--------------------------|--------------------------|--------------------------|-------------------------|-------------------------|
| Image Quality Parameter                        | Pre-contrast Image       |                          | HBP Image                |                         |                         |
|                                                | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE       | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE      | HR-DL CAIPIRINHA-VIBE   |
| Liver edge sharpness                           | 0.349<br>(0.263, 0.434)  | 0.149<br>(0.081, 0.218)  | 0.324<br>(0.248, 0.401)  | 0.136<br>(0.074, 0.199) | 0.066<br>(0.011, 0.120) |
| Hepatic vessel conspicuity                     | 0.428<br>(0.341, 0.515)  | 0.471<br>(0.407, 0.534)  | 0.177<br>(0.114, 0.240)  | 0.327<br>(0.275, 0.378) | 0.327<br>(0.270, 0.384) |
| Bile duct conspicuity                          | ...                      | ...                      | 0.380<br>(0.320, 0.440)  | 0.357<br>(0.297, 0.417) | 0.318<br>(0.257, 0.379) |
| Respiratory motion artifact                    | 0.106<br>(0.027, 0.186)  | 0.056<br>(-0.011, 0.123) | 0.211<br>(0.143, 0.279)  | 0.117<br>(0.053, 0.182) | 0.187<br>(0.115, 0.260) |
| Cardiac ghosting artifact                      | 0.202<br>(0.127, 0.276)  | 0.283<br>(0.221, 0.344)  | 0.205<br>(0.130, 0.280)  | 0.283<br>(0.222, 0.343) | 0.336<br>(0.260, 0.411) |
| Ringing artifact                               | 0.732<br>(0.682, 0.782)  | 0.658<br>(0.604, 0.713)  | 0.686<br>(0.635, 0.736)  | 0.568<br>(0.513, 0.623) | 0.659<br>(0.601, 0.716) |
| Perceived SNR                                  | 0.841<br>(0.799, 0.883)  | 0.878<br>(0.843, 0.914)  | 0.480<br>(0.432, 0.529)  | 0.369<br>(0.310, 0.427) | 0.423<br>(0.362, 0.484) |
| Subjective Noise Level                         | 0.698<br>(0.650, 0.745)  | 0.764<br>(0.718, 0.810)  | 0.802<br>(0.752, 0.851)  | 0.809<br>(0.762, 0.855) | 0.624<br>(0.552, 0.696) |
| Synthetic Appearance                           | 0.479<br>(0.418, 0.540)  | 0.437<br>(0.386, 0.487)  | 0.444<br>(0.382, 0.506)  | 0.286<br>(0.232, 0.340) | 0.234<br>(0.169, 0.298) |
| Overall artifact level                         | 0.856<br>(0.815, 0.897)  | 0.908<br>(0.878, 0.939)  | 0.857<br>(0.816, 0.898)  | 0.905<br>(0.874, 0.937) | 0.708<br>(0.648, 0.768) |
| Overall image quality                          | 0.818<br>(0.773, 0.862)  | 0.936<br>(0.911, 0.962)  | 0.830<br>(0.786, 0.873)  | 0.920<br>(0.891, 0.949) | 0.735<br>(0.678, 0.792) |
| Interobserver Agreement between Reader 2 and 3 |                          |                          |                          |                         |                         |
| Image Quality Parameter                        | Pre-contrast Image       |                          | HBP Image                |                         |                         |
|                                                | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE       | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE      | HR-DL CAIPIRINHA-VIBE   |
| Liver edge sharpness                           | 0.723<br>(0.670, 0.777)  | 0.770<br>(0.725, 0.815)  | 0.746<br>(0.691, 0.802)  | 0.757<br>(0.708, 0.806) | 0.302<br>(0.215, 0.390) |
| Hepatic vessel conspicuity                     | 0.686<br>(0.634, 0.739)  | 0.762<br>(0.716, 0.807)  | 0.645<br>(0.582, 0.708)  | 0.705<br>(0.652, 0.758) | 0.561<br>(0.486, 0.635) |
| Bile duct conspicuity                          | ...                      | ...                      | 0.769<br>(0.717, 0.821)  | 0.743<br>(0.691, 0.795) | 0.545<br>(0.475, 0.615) |
| Respiratory motion artifact                    | 0.693<br>(0.632, 0.754)  | 0.631<br>(0.571, 0.690)  | 0.725<br>(0.660, 0.790)  | 0.595<br>(0.525, 0.665) | 0.335<br>(0.248, 0.421) |
| Cardiac ghosting artifact                      | 0.728<br>(0.675, 0.780)  | 0.814<br>(0.772, 0.856)  | 0.751<br>(0.694, 0.808)  | 0.774<br>(0.725, 0.823) | 0.618<br>(0.546, 0.69)  |
| Ringing artifact                               | 0.801<br>(0.757, 0.846)  | 0.821<br>(0.778, 0.864)  | 0.841<br>(0.800, 0.882)  | 0.833<br>(0.789, 0.876) | 0.613<br>(0.554, 0.673) |
| Perceived SNR                                  | 0.757<br>(0.709, 0.805)  | 0.757<br>(0.711, 0.803)  | 0.767<br>(0.715, 0.819)  | 0.743<br>(0.692, 0.794) | 0.575<br>(0.508, 0.641) |
| Subjective Noise Level                         | 0.749<br>(0.697, 0.801)  | 0.743<br>(0.695, 0.792)  | 0.726<br>(0.660, 0.791)  | 0.727<br>(0.668, 0.786) | 0.507<br>(0.432, 0.582) |
| Synthetic Appearance                           | 0.792<br>(0.745, 0.839)  | 0.825<br>(0.782, 0.867)  | 0.815<br>(0.767, 0.862)  | 0.789<br>(0.733, 0.845) | 0.499<br>(0.418, 0.579) |
| Overall artifact level                         | 0.782<br>(0.730, 0.833)  | 0.799<br>(0.753, 0.846)  | 0.809<br>(0.759, 0.858)  | 0.799<br>(0.751, 0.847) | 0.689<br>(0.628, 0.751) |
| Overall image quality                          | 0.768<br>(0.717, 0.819)  | 0.799<br>(0.755, 0.843)  | 0.768<br>(0.717, 0.818)  | 0.799<br>(0.753, 0.846) | 0.660<br>(0.601, 0.718) |
| Interobserver Agreement between Reader 1 and 3 |                          |                          |                          |                         |                         |
| Image Quality Parameter                        | Pre-contrast Image       |                          | HBP Image                |                         |                         |
|                                                | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE       | Standard CAIPIRINHA-VIBE | DL CAIPIRINHA-VIBE      | HR-DL CAIPIRINHA-VIBE   |
| Liver edge sharpness                           | 0.494<br>(0.427, 0.561)  | 0.253<br>(0.180, 0.327)  | 0.472<br>(0.408, 0.537)  | 0.346<br>(0.271, 0.420) | 0.812<br>(0.766, 0.857) |
| Hepatic vessel conspicuity                     | 0.500<br>(0.430, 0.570)  | 0.412<br>(0.337, 0.487)  | 0.380<br>(0.301, 0.459)  | 0.330<br>(0.247, 0.414) | 0.830<br>(0.787, 0.873) |
| Bile duct conspicuity                          | ...                      | ...                      | 0.413<br>(0.336, 0.489)  | 0.373<br>(0.292, 0.454) | 0.824<br>(0.778, 0.870) |
| Respiratory motion artifact                    | 0.261<br>(0.187, 0.336)  | 0.268<br>(0.199, 0.336)  | 0.422<br>(0.350, 0.494)  | 0.421<br>(0.348, 0.494) | 0.769<br>(0.714, 0.825) |
| Cardiac ghosting artifact                      | 0.305<br>(0.230, 0.380)  | 0.285<br>(0.213, 0.357)  | 0.397<br>(0.330, 0.464)  | 0.416<br>(0.347, 0.485) | 0.699<br>(0.645, 0.754) |
| Ringing artifact                               | 0.475<br>(0.399, 0.552)  | 0.420<br>(0.337, 0.503)  | 0.579<br>(0.515, 0.644)  | 0.422<br>(0.346, 0.497) | 0.763<br>(0.715, 0.811) |

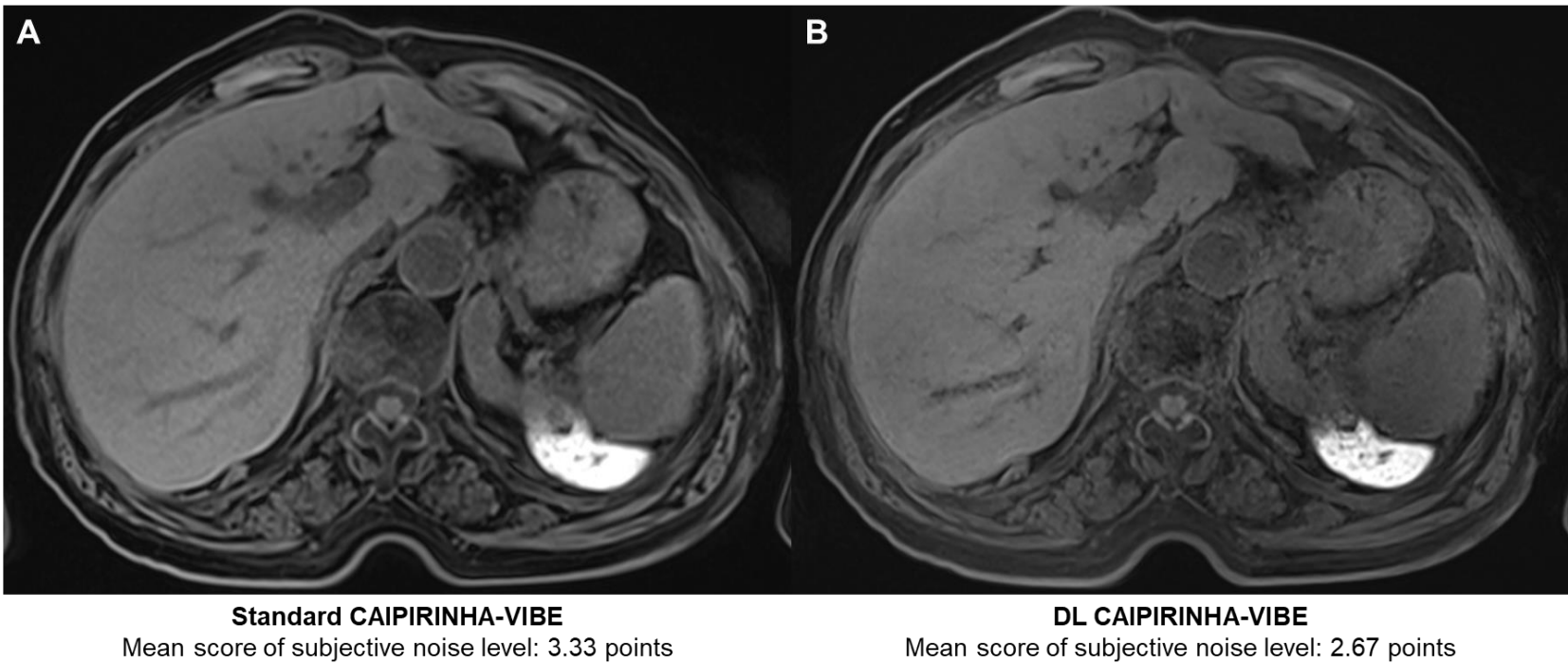
|                        |                         |                         |                         |                         |                         |
|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Perceived SNR          | 0.690<br>(0.634, 0.747) | 0.695<br>(0.641, 0.748) | 0.497<br>(0.426, 0.568) | 0.523<br>(0.452, 0.595) | 0.789<br>(0.737, 0.841) |
| Subjective Noise Level | 0.736<br>(0.686, 0.785) | 0.791<br>(0.744, 0.838) | 0.740<br>(0.685, 0.795) | 0.838<br>(0.796, 0.880) | 0.776<br>(0.729, 0.824) |
| Synthetic Appearance   | 0.460<br>(0.396, 0.524) | 0.459<br>(0.400, 0.518) | 0.556<br>(0.502, 0.610) | 0.514<br>(0.460, 0.568) | 0.685<br>(0.620, 0.749) |
| Overall artifact level | 0.801<br>(0.755, 0.848) | 0.807<br>(0.763, 0.852) | 0.814<br>(0.768, 0.860) | 0.819<br>(0.774, 0.863) | 0.763<br>(0.715, 0.811) |
| Overall image quality  | 0.782<br>(0.735, 0.829) | 0.779<br>(0.732, 0.825) | 0.754<br>(0.700, 0.808) | 0.813<br>(0.768, 0.859) | 0.778<br>(0.729, 0.827) |

Data are Gwet’s AC1 coefficients, with 95% confidence intervals in parentheses.

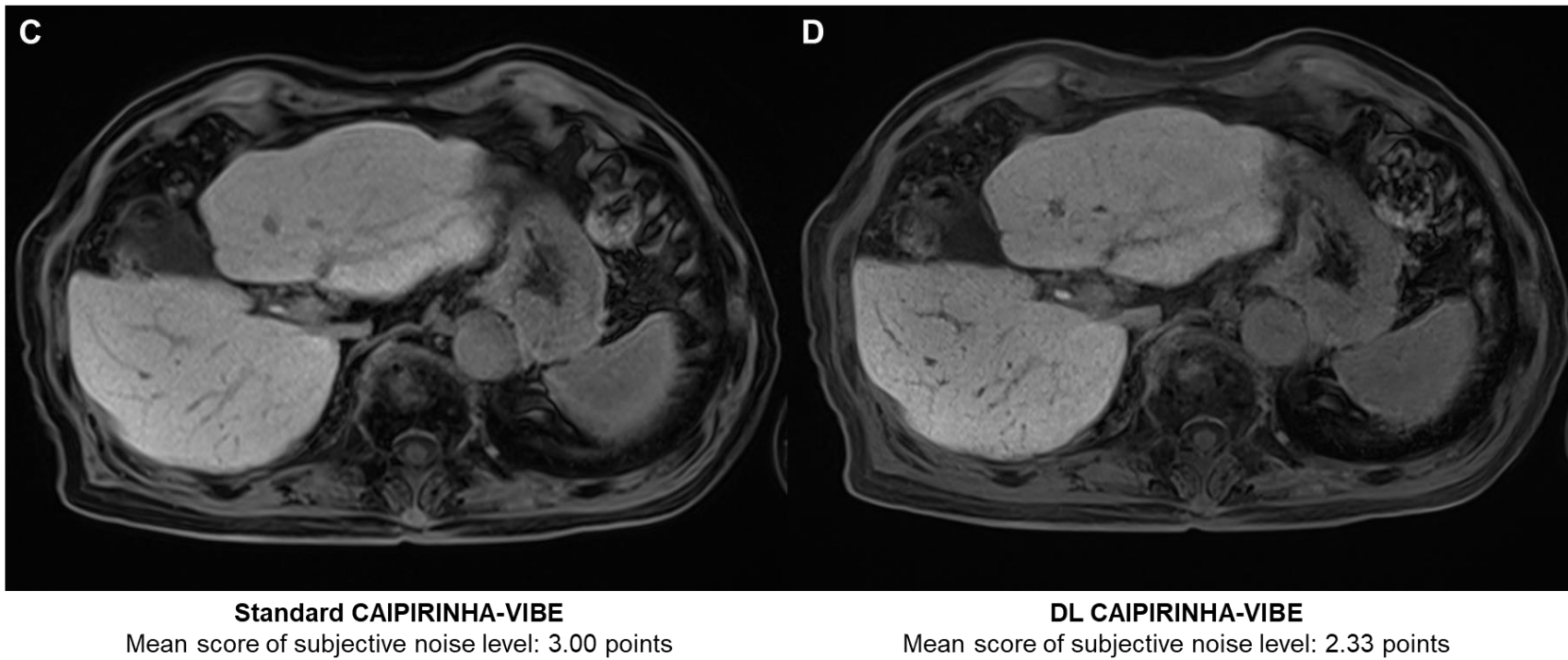
Interobserver agreement was assessed by the AC1 coefficients, as follows: <0, poor agreement; 0.01-0.20, slight agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and 0.81-1.00, almost perfect agreement.

CAIPIRINHA, controlled aliasing in parallel imaging results in higher acceleration; DL, deep learning; HBP, hepatobiliary phase; HR, high resolution; SNR, signal noise ratio; VIBE, volumetric interpolated breath-hold examination.

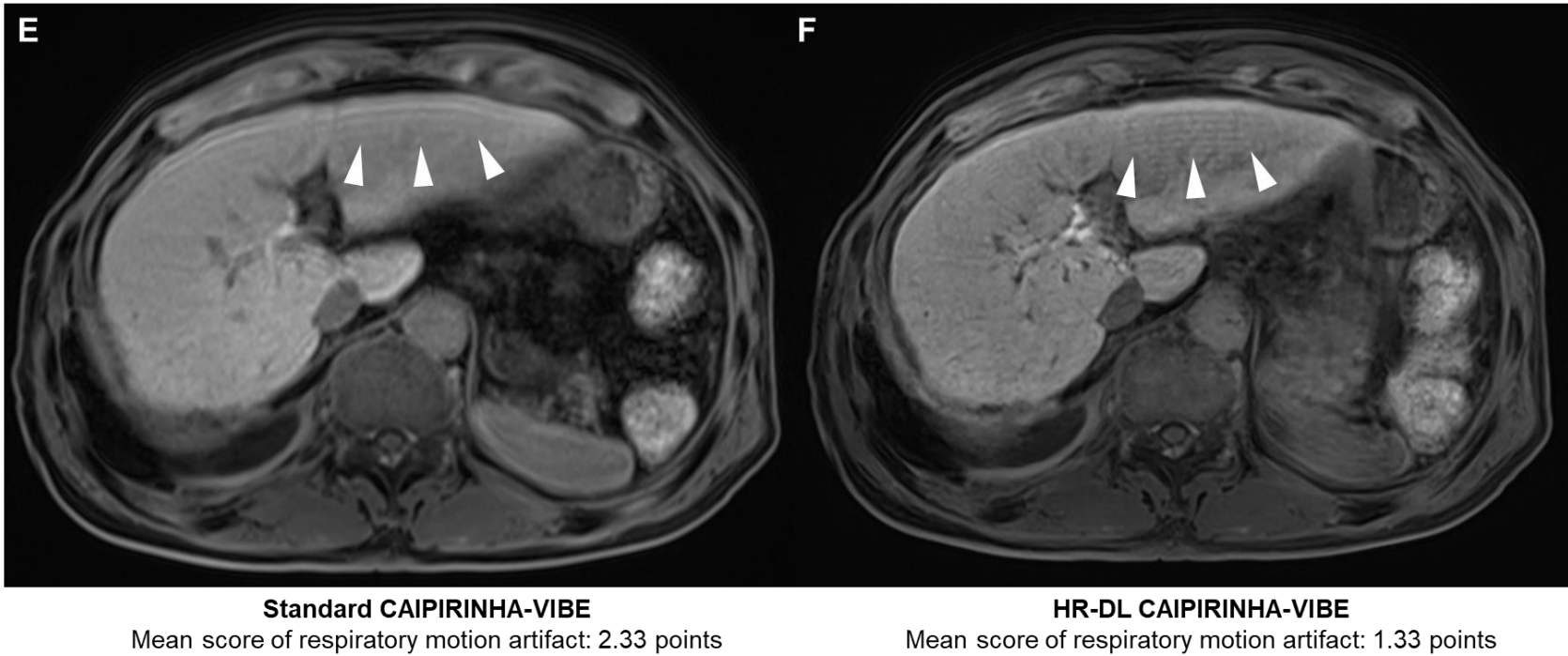
Pre-contrast images



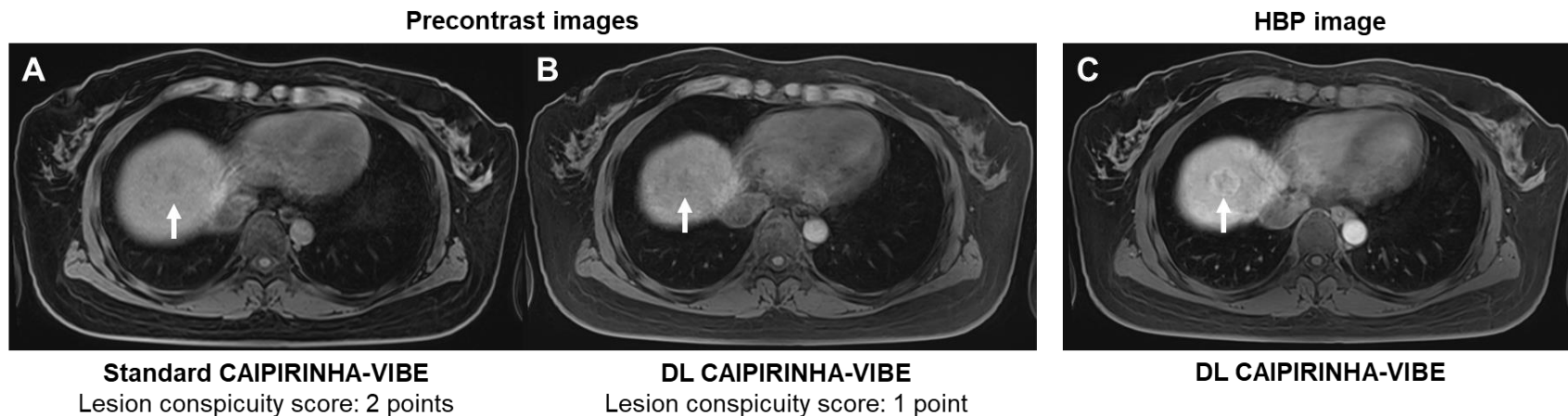
HBP images



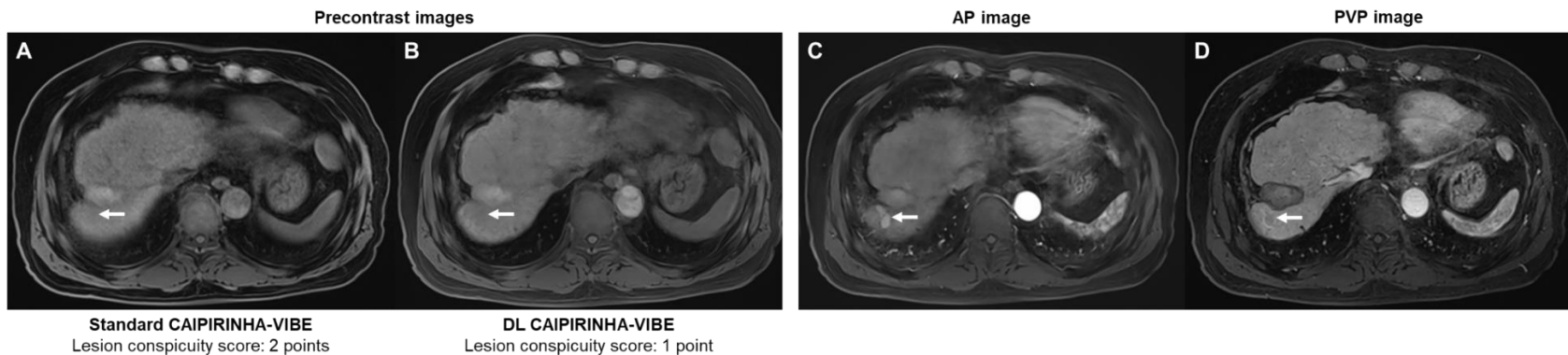
HBP images



**Figure S1** Cases with poorer image quality in DL or HR-DL CAIPIRINHA-VIBE compared to the standard CAIPIRINHA-VIBE on precontrast and HBP images. On precontrast images, the **(B)** DL CAIPIRINHA-VIBE shows lower mean score of subjective noise level than **(A)** standard CAIPIRINHA-VIBE in a 75-year-old female with HCC. On HBP images, the **(D)** DL CAIPIRINHA-VIBE shows lower mean score of subjective noise level than **(C)** standard CAIPIRINHA-VIBE in an 88-year-old male with HCC. On HBP images, the **(F)** HR-DL CAIPIRINHA-VIBE shows lower mean score of respiratory motion artifact than **(E)** standard CAIPIRINHA-VIBE in a 66-year-old male with HCC. CAIPIRINHA, controlled aliasing in parallel imaging results in higher acceleration; DL, deep learning; HBP, hepatobiliary phase; HCC, hepatocellular carcinoma; HR, high resolution; VIBE, volumetric interpolated breath-hold examination.



**Figure S2** T1-weighted (**A, B**) precontrast and (**C**) HBP images of gadoxetic acid-enhanced MRI in a 43-year-old female with a 2.5 cm FNH (*arrows*) at segment 8 of the liver. The reviewer 1 assigned a lesion conspicuity score of 2 points in the (**A**) standard CAIPIRINHA-VIBE and of 1 point in the (**B**) DL CAIPIRINHA-VIBE on precontrast images. CAIPIRINHA, controlled aliasing in parallel imaging results in higher acceleration; DL, deep learning; FNH, focal nodular hyperplasia; HBP, hepatobiliary phase; MRI, magnetic resonance imaging; VIBE, volumetric interpolated breath-hold examination.



**Figure S3** T1-weighted (**A**, **B**) precontrast, (**C**) AP and (**D**) PVP images of gadoxetic acid–enhanced MRI in a 67-year-old male with a 2.1 cm HCC (*arrows*) at segment 7 of the liver. The reviewer 2 assigned a lesion conspicuity score of 2 points in the (**A**) standard CAIPIRINHA-VIBE and of 1 point in the (**B**) DL CAIPIRINHA-VIBE on precontrast images. AP, arterial phase; CAIPIRINHA, controlled aliasing in parallel imaging results in higher acceleration; DL, deep learning; HCC, hepatocellular carcinoma; MRI, magnetic resonance imaging; PVP, portal venous phase; VIBE, volumetric interpolated breath-hold examination.



**Figure S4** T1-weighted (**A, B**) HBP images of gadoxetic acid–enhanced MRI in a 75-year-old female with a 2.3 cm dysplastic nodule (*arrows*) at segment 8 of the liver. The reviewer 3 assigned a lesion conspicuity score of 2 points in the (**A**) standard CAIPIRINHA-VIBE and of 1 point in the (**B**) DL CAIPIRINHA-VIBE on HBP images. CAIPIRINHA, controlled aliasing in parallel imaging results in higher acceleration; DL, deep learning; HBP, hepatobiliary phase; MRI, magnetic resonance imaging; VIBE, volumetric interpolated breath-hold examination.

Eur Radiol (2024) Wei H, Yoon JH, Jeon SK, et al.

