Complementary 'Fat Only' and 'Water Only' Abdominal MR Images in a Single Breath-Hold

By Elmar Merkle, MD

Reconstructing water and fat images from a 3D gradient dual echo sequence just recently became a true clinical reality with GE Healthcare's new LAVA-Flex. This is accomplished by applying a two-point Dixon method to data from a gradient dual echo acquisition with in-phase and opposed-phase images. Reliable phase error correction prevented this technique from becoming a key component of a routine body MR protocol in the past. Today, LAVA-Flex makes this possible by processing regions with a higher signal-to-noise ratio (SNR) and smaller phase variations. These regions then guide the phase correction in areas with lower SNR and larger phase variations.

A key benefit is the ability to generate (post process) the 'water only' and 'fat only' images using preexisting in-phase and opposed-phase raw data without incurring additional scanner time. These two complimentary datasets offer several advantages:

- The 'water only' image offers superior fat suppression over more common techniques. This two-point Dixon technique is less prone to magnetic field inhomogeneities (Figure 1). In addition, the 'water only' image may serve as a complimentary gradient echo T1W image with fat suppression for comparison purposes in cases where no dedicated pre contrast T1W gradient echo with fat suppression was acquired.
- The 'fat only' image offers several clinical benefits. First, diffuse, focal or geographic steatosis hepatis is displayed very well and quantified non-invasively (Figure 2). Second, fat containing lesions e.g. hepatic or adrenal adenoma, angiomyolipoma or pelvic dermoids can be visualized with the fatty component demonstrated with a high level of clinical confidence thus improving the characterization of focal lesions (Figure 3). Finally, iron storage diseases such as hemochromatosis or hemosiderosis can be visualized on the 'fat only' image where the T2* effects cause a hyperintense appearance of the liver and/or spleen (Figure 4).

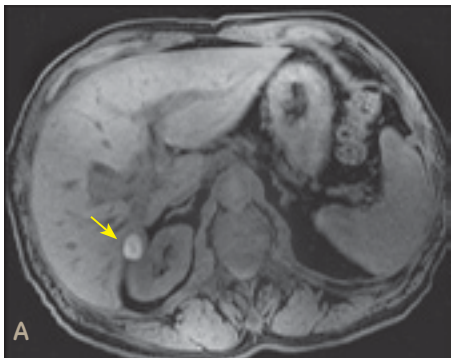
Dr. Elmar Merkle

Elmar Merkle, MD is Professor of Radiology, Head of Body Magnetic Resonance Imaging and Medical Director of the Center for Advanced Magnetic Resonance Development at Duke University. In the mid 1990s, he conducted his MR research fellowship in the laboratory of Professor Jonathan Lewin in Cleveland, where he made significant contributions to the field of interventional MR imaging. Dr. Merkle is a fellow of the Society of Computed Body Tomography and Magnetic Resonance (SCBT), and a member of the Radiologic Society of North America (RSNA), the International Society for Magnetic Resonance in Medicine (ISMRM), the American Roentgen Ray Society (ARRS) and the European Congress of Radiology (ECR) among others.

Dr. Merkle is on the editorial board of the Journal of Endovascular Therapy. He has been invited for numerous lectures, is a visiting professor to universities worldwide, and has published more than 100 peer-reviewed manuscripts and 15 book chapters.

About Duke University

The Duke University School of Medicine is a community of scholars devoted to understanding the causes, prevention and treatment of human disease. Ranked in the top ten with schools twice its age, Duke is committed to socially relevant education, translational research, compassionate patient care and global healthcare solutions.



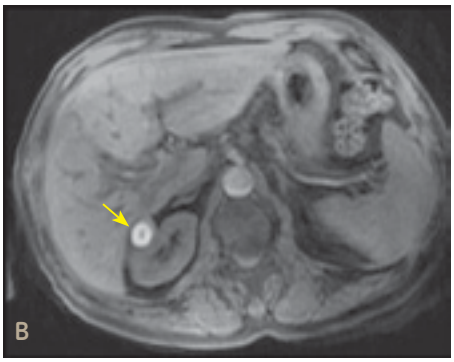


Figure 1: Patient with complicated right renal cyst (arrow). A) 'Water only' T1W 3D gradient echo image demonstrates superior fat suppression in both the retroperitoneum and the subcutaneous tissue when compared to the T1W 3D gradient echo image with chemical shift pre pulse fat suppression (B). Note, that the hyperintense renal cyst on the right side is displayed in a very similar fashion.

The ability to generate 'water only' and 'fat only' images for the detection and characterization of fat and iron within abdominal tissues without increasing data acquisition or scan time is clinically useful and helps maximize scanner efficiency. LAVA-Flex shows promise for becoming a part of routine abdominal and pelvic MR imaging as this new technique makes it possible to generate a set of four corresponding images within one breath-hold – opposed-phase, in-phase, and complementary 'fat only' and 'water only' images. ■

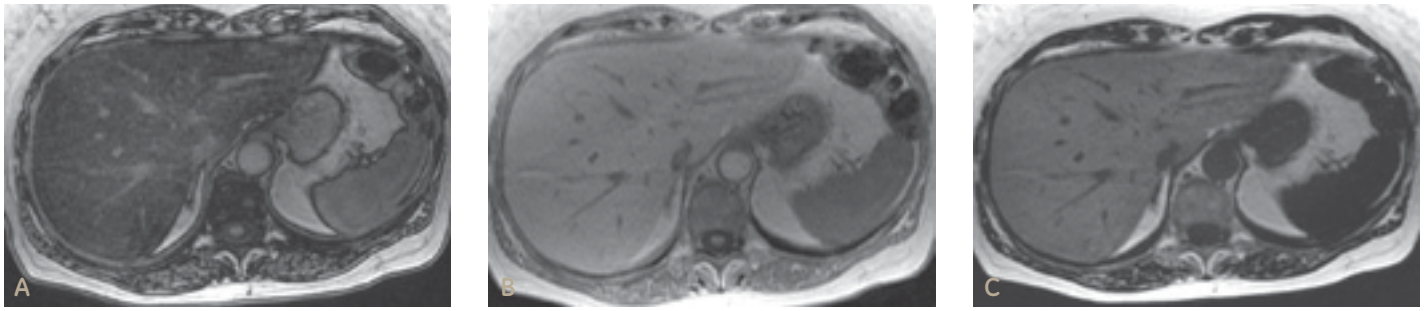


Figure 2: Patient with diffuse fatty infiltration of the liver. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates marked hepatic signal loss when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). C) Corresponding 'fat only' image shows marked hepatic signal intensity which is substantially higher than the signal intensity of the background noise and spleen. The hepatic signal-to-noise ratio correlates with the degree of fatty infiltration thus offering a fast and non-invasive semi-quantitative approach for evaluation of steatosis hepatis.

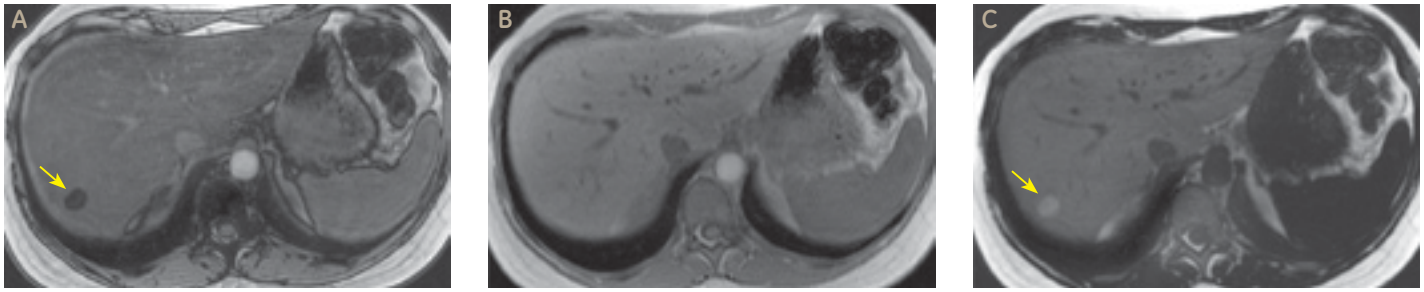


Figure 3: Patient with diffuse fatty infiltration of the liver and fat-containing hepatic adenoma in segment 7. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates marked hepatic signal loss when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). The focal hepatic lesion in segment 7 (arrow) is not visualized on 'in-phase' imaging, but clearly seen on both, the 'opposed-phase' image (A) and the 'fat only' image (C) where the lesion appears hyperintense compared with the fat containing liver.

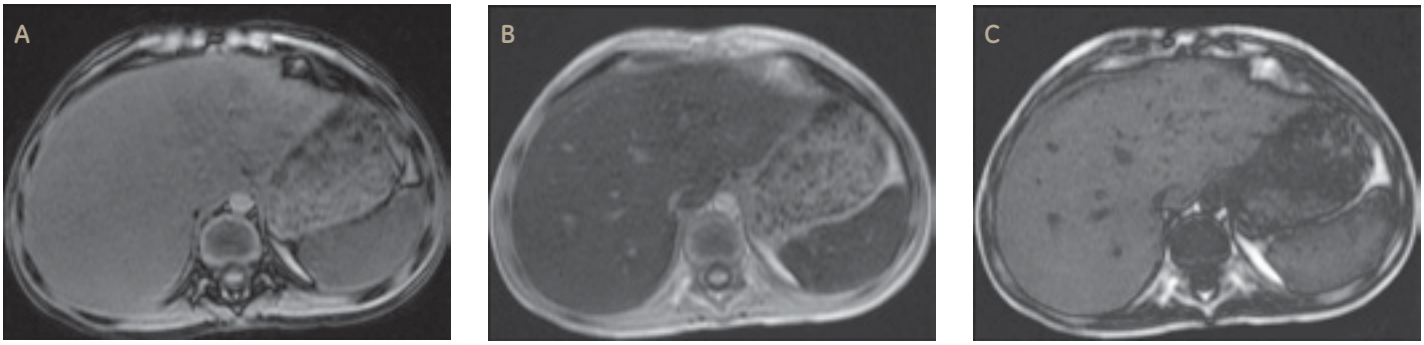


Figure 4: Eight-year old child with hemosiderosis following multiple blood transfusions. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates markedly higher hepatic and splenic signal intensity when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). This is due to iron deposits in the liver and spleen which cause substantial shortening of the T2* relaxation time and subsequent signal loss on the image with the longer echo time. The 'fat only' image (C) also shows these effects as a hyperintense signal in the liver and spleen when compared with the background noise. This finding may not be misconstrued as steatosis hepatis, but must be correlated with the 'in-phase' and 'opposed-phase' images.