Dual Asymmetric Echo Steady State Imaging with CAIPIRINHA Acquisition Mode

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Introduction:

The 3D Dual-Echo Steady state sequence (DESS) is particularly useful on orthopedic imaging. High resolution images are favored in clinical diagnostic, but the long measurement time limits its application. In this work, CAIPIRINHA [1], in combination with asymmetric echo and separated reference scan, are implemented in DESS sequence to accelerate image acquisition.

Method:

First, the CAIPIRINHA acquisition mode is implemented on a commercial version of DESS sequence(Siemens Healthcare) .A separated small flip angle GRE reference scan and image domain GRAPPA reconstruction algorithm [2] are used for further time saving, two echoes share the same calibration data in reconstruction. Then, by modifying pre- and post-gradient momentum (Fig 1, red arrow), the original full echoes are transformed into asymmetric echoes. The asymmetric ratio echo is adjustable and optimized on volunteer examination.

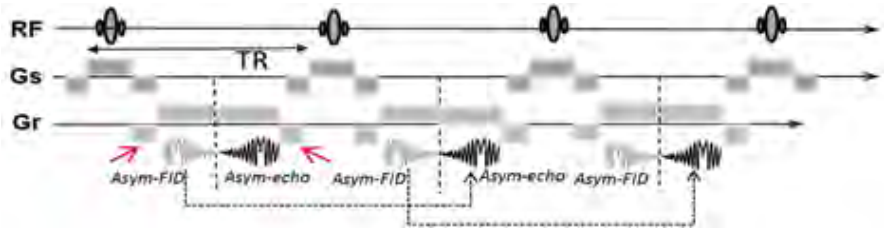

Fig 1. Modified Dual-Asymmetric-echo sequence diagram, phase encoding gradients are not included Asymmetric ratio can be adjusted by modifying pre and post gradients momentum in RO direction (red Arrow),

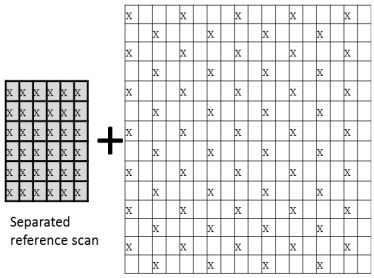

Fig 2. The optimal CAIPIRINHA pattern with total Acceleration factor 4

Result:

Volunteer scans are performed on a 1.5 Magnetom Aera System (Siemens Healthcare) with a 16-channel Foot /Ankle coil, Relevant parameters include: Water Excitation mode, TE/TR = 7.43ms/20.28ms,flip angle = 25, partitions =96, voxel size =0.6x0.6x1.0mm, phase oversampling = 40%, SL oversampling = 25%, Phase Partial Fourier 7/8; Slice Partial Fourier = 6/8, total Acceleration factor = 4. By the way, when using asymmetric echo the value of minimum TE and TR would be reduced, which make signal evolution faster into steady-state, however, detailed analysis is not included in this abstract, since we focus on time saving. The results are displayed on Fig 3, the image using traditional GRAPPA technology (Fig2a) shows lower SNR and residual fat signal on tibia and calcaneus. Images with separated CAIPIRINHA mode (Fig2 b, c, d) show higher SNR and better fat suppression The measurement time is reduced to 2 minutes 44 seconds with 90% asymmetric echo, and the image quality is still quite good.(figure 3 d)

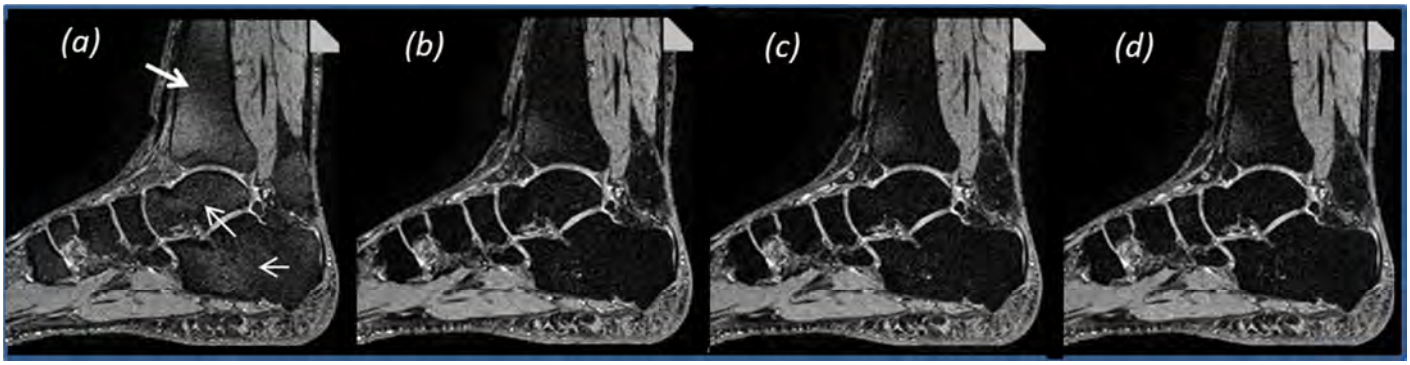

Fig 3. Volunteer test results; (a) Traditional Grappa with Acceleration factor 4(PE2xSL2), scan time 3'12"(b) CAIPIRINA with Acceleration factor 4(the optimal CAIPIRIHNA pattern is show on the figure 2), scan time 3'00"; (c)Modifying b into dual asymmetric echoes(ratio 0.94), scan time 2:50"; (d) Modifying b into dual asymmetric echoes(ratio 0.90), scam time 2:44"

Discussion:

Shortening scan time in high resolution orthopedic imaging is very important for clinical application, not only for patient comfort but also for image quality consistency. By combining factors of CAIPIRINHA, Asymmetric echo and sharing separated references scan on Dual Echo Steady State sequence (DESS), the measurement time is reduced 15% without compromising the image quality, but we still can't explain the residual fat signal on traditional GRAPPA image.

Reference:

[1]. Breuer F, et al. MRM 2006; 55;549-556.
[2] J. Wang et al, ISMRM. 13 (2005)