Homogeneous free whole-body Lava-flex using an adaptive center frequency technique at 3T

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Purpose To develop an optimized protocol for adaptive calculate center frequency of whole body lava-flex MR imaging (WBLF) that requires shot time and minimal interaction.

Introduction Whole body lava-flex (WBLF) provides valuable information with or without contrast enhancement and is supplemental to whole-body diffusion-weighted imaging (WBDWI) due to its high spatial resolution [1,2]. However, conventional WBLF is often troubled by image background inhomogeneity. In this work, we propose a new method in setting WBLF protocols for achieving homogenous images at 3T scanner that requires no additional calibration and minimal operator interaction.

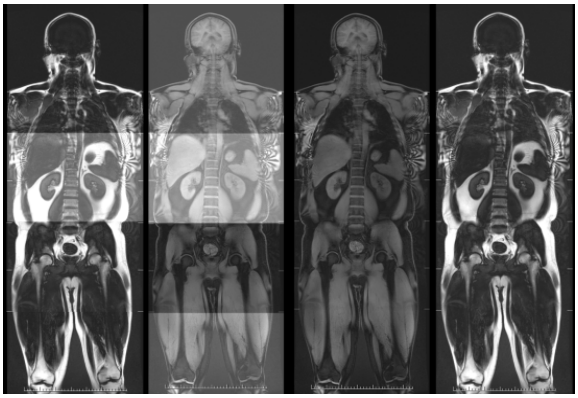

Fig.1 The Whole Body Lava-flex images.
(Left) Conventional method (Right) Our method

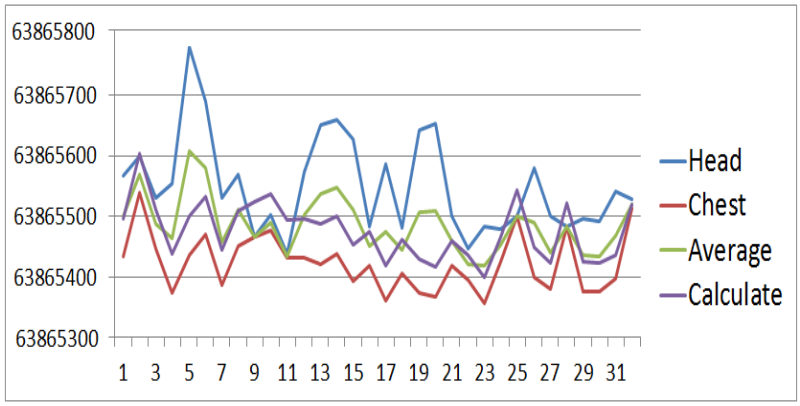

Fig.2 The relationship between head and chest center frequency.

Method Conventional whole body Lava-flex imaging consisting of cascaded multi-station acquisition is often contaminated with an inhomogeneous background Fig.1 (left case), which is mainly caused by the varying center frequencies at each station as learned from experience. To solve this issue, we use an optimal and unified setting of the center frequency, which were determine based on accumulated clinical cases. In the first attempt, center frequencies from the head station and chest station were averaged, and the averaged value is used for all the stations. This approach was effective and led to homogenous whole body images (right case in Fig.1). After a total number of about 60 trial cases, we studied the relationship between the center frequency for head and chest and discovered that the gap between the two was seen to be fairly constant (Fig.2). We collected the center frequency record for over 200 cases, and estimated the gap. We then further simplified the approach of setting the center frequency: the center frequency of the chest is obtained, and then an offset is added to it and the resulting value is used as the global center frequency value, the offset value calculate from the average gap between chest and head center frequency. In this way, only one calibration is needed for the entire whole body lava scan, which further reduces the overall scan time.

Experiment This proposed method has been realized on a GE MR 750 3.0T whole body scanner, then scanning of volunteer and patients with conventional and the proposed WBLF protocol were performed and compared. Consents forms were obtained prior to the scans. A 4-station lava-flex scan was performed on the whole body, and the scan parameters were : coronal plane, 40 slices with 6mm thickness, FOV = 44cm×44cm, matrix = 320×192, TR/TE = 4.1/1.8ms, 0.7 averages, 14cm gap between station 1 and station 2. The scan time was 22 only seconds for each station, which led to an 88secs overall scan.

Results Fig.3 shows the case of a 59 year old female volunteer, who received both whole body diffusion imaging and whole body lava-flex imaging. The center frequency used in whole body lava flex was derived from the chest station alone. However it can be seen that distortion free and homogeneous whole body lava flex images were obtained. In this case, although the participant was recruited as a volunteer, she was found to have thyroid nodules and spleen deficiency from whole body DWI and lava-flex images.

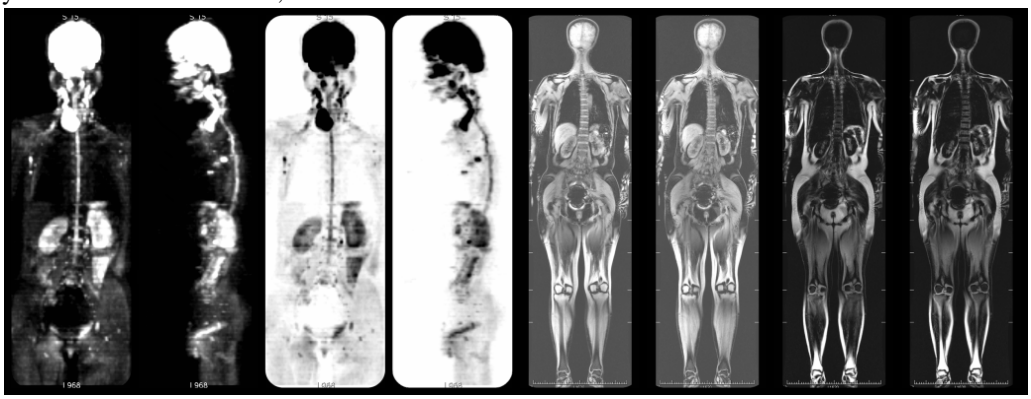

Fig.3 Whole body DWI and lava-flex of a 59 year old female volunteer, who was found to have throid nodules and spleen deficiency.

Conclusion and discussion In this work, a simple yet effective approach of setting the center frequency for different stations in Lava-flex imaging is proposed. It was derived based on over 200 accumulated cases and shown to produce images with homogeneous background. Only a single calibration scan at the chest station is needed, which the whole body acquisition to be completed in a short time frame and used in routine exams.

Reference [1]Regelink et al, 2013, BJH, 162:50-61.
[2]Thomas C. Kwee et al, J. Magn. Reson. Imaging, 2014, Vol.40 (1).