Automatic volume field of view detection in non-selective, scoutless, multi-station MRA

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Introduction:

Recently a new method using non-selective excitation, EZ-STEP, has been proposed for the scoutless acquisition of peripheral and whole-body MRA [1, 2]. The use of this technique can reduce the examination time by up to 50%, due to the workflow efficiency gained by the elimination of the need to acquire scout images and to carefully position the imaging volume at each station. However, it is necessary to make sure the full anatomy is covered in all stations to prevent tissue from outside the field of view from wrapping into the imaging volume and potentially obscuring important anatomical information. Consequently, the field of view in the phase and slice direction is made significantly larger than the anatomy, introducing unnecessary imaging time. We propose the use of an embedded edge-detection method, which will automatically determine the edges of the imaging volume in the phase and slice direction for each station and modify the sequence to acquire only the field of view containing anatomy.

Methods:

The edge-detection algorithm was implemented on a GE 3.0T Signa Twinspeed system (GE Healthcare Technologies, Waukesha, WI). Just prior to the imaging section of each station, a k-space line is acquired along the slice encode direction and a second k-space line is acquired along the phase encode direction in two separate TRs. A hard RF pulse is used for excitation, and no gradients are played along the phase and slice encode directions. The edge-detection flip angle was set to 7º to maximize the signal of the tissue and facilitate the detection of the edges. For each k-space line, a 1D FFT is performed on the multi-channel data, followed by sum-of-square coil combination, which results in two image-domain projections along the slice and phase direction respectively. A Prewitt operator [3] is applied on the combined data, and edges are determined through thresholding. Based on the edges estimated by the algorithm, the sequence recalculates the slice gradient table, the excitation and receiver frequency, the phase gradient table and the phase offset while maintaining the prescribed slice and phase resolution.

Following informed consent, multistation peripheral MRA was performed on healthy volunteers. The 3-station peripheral MRA was prescribed in the coronal plane with slice and phase FOV of 26 and 45 cm respectively. Prior to contrast injection, a mask was acquired for each station without the use of the automatic field of view detection algorithm. Immediately following the mask, an angiogram was acquired using the automatic field of view detection algorithm. The anatomical coverage using the automatic field of view adjustment was validated by comparing axial reformats of the mask and angiographic acquisitions along different sections of the anatomy for each station.

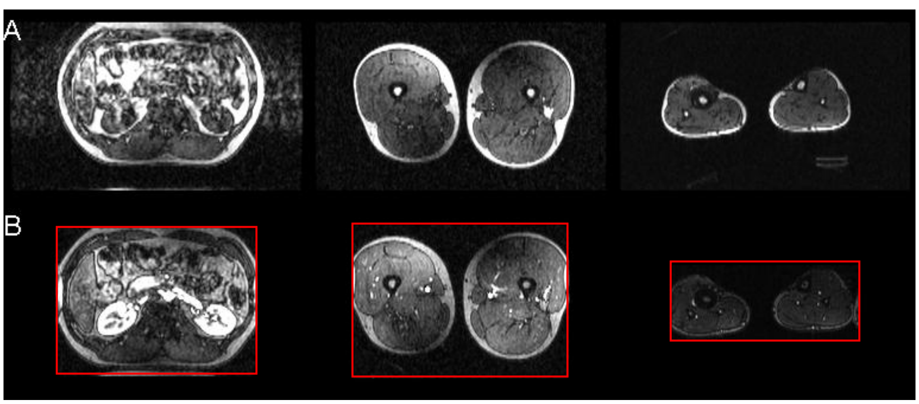

Figure 1. Axial reformats of a 3-station peripheral EZ-STEP coronal MRA. The mask acquisition (A) covered the complete prescribed volume while the angiographic acquisition (B) covered the volume specified by the automatic field of view adjustment algorithm, as indicated by the red box around the images. Careful examination shows that the anatomy of both acquisitions matches extremely well, with the difference in appearance coming from the absence (A) or presence (B) of contrast, as well as from motion artifacts. The use of the algorithm results in an acquisition that covers the only the anatomy while maintaining the benefits in efficiency provided by a traditional EZ-STEP acquisition.

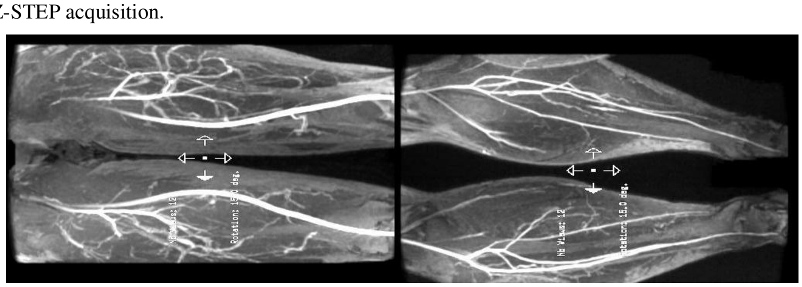

Figure 2. Maximum intensity projection of the two lower stations of the MRA using the field of view adjustment algorithm. The vessel tree can be clearly visualized.

Results:

Figure 1 shows an axial reformat of a peripheral MRA acquired with and without the use of the automatic volume coverage prescription along the largest anatomical region of each station. Only the full anatomy is covered by the acquisition using the automatic FOV detection, with no data coming from outside the body. Figure 2 shows the maximum intensity projection of the MRA acquired using the automatic filed of view selection algorithm. For this particular study, the peripheral MRA was acquired in 133s without and in 70s with the automatic FOV detection algorithm.

Discussion and conclusion:

The use of an automatic volume coverage adjustment algorithm further simplifies the acquisition of an angiographic examination. This method ensures proper coverage, thus eliminating failed examinations due to the appearance of wrap in the slice or phase directions. Moreover, in combination with the non-selective RF excitation, it eliminates the possibility of incomplete vascular coverage. It also maximizes the scan efficiency by utilizing the minimum amount of time necessary to cover the target anatomy, therefore reducing the likelihood of motion artifacts.

References:

[1] Li, W et al; ISMRM 2005; Pg 1709 [2] Li, W et al; ISMRM 2006; Pg 565 [3] Prewitt; Object Enhancement and Extraction in Picture Processing and Psycho Pictorics; Pg 75, 149