CHARACTERISTICS OF OFF-CENTER ANATOMY-RELATED ARTIFACT IN OPEN MRI

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Introduction: Tissue composition of thigh area is a key biomarker for physiological characteristics, such as insulin resistance, hip fracture and healthy aging [1]. Open type MRI is beneficial to musculoskeletal imaging due to their easy patient access configuration, low-cost efficiency and excellent soft tissue contrast of the human thigh area without ionizing radiation [2]. However, intensity and geometric distortion severely suffered by unwanted background magnetic field inhomogeneity when imaging anatomy, such an upper and lower limbs, is placed at the off-center region. In this study, we describe characteristics of off-center anatomy-related artifact in open MRI.

Methods:

The cylindrical phantoms (300 mm length × 190 mm diameter) were used in this study. The cylindrical phantom image was acquired on isocenter as a reference image that is assumed to be without geometrical distortion. The axial image of two cylindrical phantoms on off-center was scanned to analogous position of human thigh and shifted image along to the right direction 90 mm was also acquired. MR acquisitions were performed on an open 0.32 T MRI permanent systems (Magfinder II, SciMedix Co., Ltd., Korea) with an H-shaped vertical permanent magnet and a quadrature body coil. The patient table can be laterally shifted up to 120 mm from the isocenter and the diameter of magnet is a wide aperture of 1370 mm. The 2D T1 weighted axial images of the cylindrical phantom were acquired with following imaging parameters: TR = 475 ms, TE = 15 ms, matrix = 256 × 256, FOV = 450 mm, slice thickness = 5 mm, bandwidth = 52.6 kHz. One human subject underwent MRI scans at the level of the thigh. Informed consent was obtained from the subject. Conventional thigh image were obtained at the off-center region, followed by scanning 70 mm shifted on-axis image of on one side of the thigh. The T1 weighted axial images of thigh were acquired with a spin echo using the following parameters: TR = 400 ms, TE = 15 ms, matrix = 256 × 256, FOV = 480 mm, slice thickness = 9 mm, number of signal average = 2.

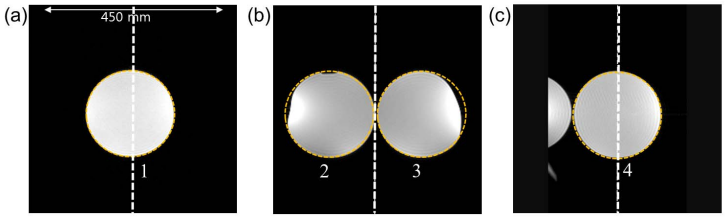

Fig. 1. Axial image of cylindrical phantom acquired at magnet isocenter (a). Conventional image of two cylindrical phantoms placed on off-center (b). Axial image of on one side of the two cylindrical phantoms using the object shifting scheme (c). The contour of the phantom was drawn on the axial isocentric image (yellow contour) as a reference and overlaid to the other two MR images.

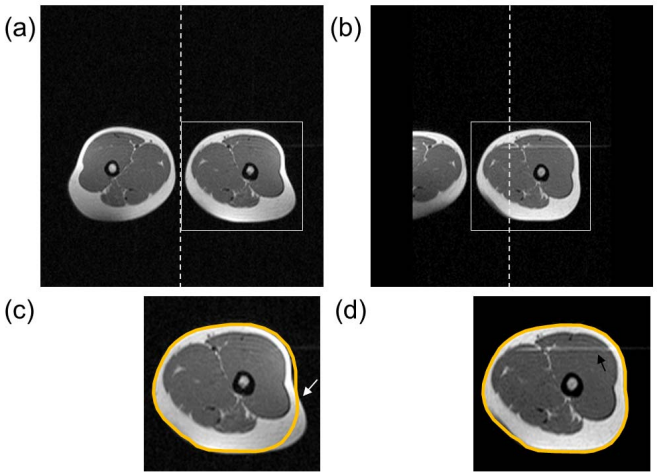

Fig. 2. Upper thigh axial images acquired at conventional off-center position and shifted on-axis (a and b). The contour of the external thigh was drawn on the isocentric image (yellow contour) as a reference and overlaid to the other off-center position images. White arrow indicates that geometric distortion of thigh morphology and black arrow indicates cusp artifact caused by thigh volume of the outside the field of view (c and d).

Results and Discussion: Fig. 1 shows axial image of cylindrical phantom acquired at magnet isocenter. The number on the images is the positional related phantom symbols. Cross-sectional area difference compared with number 1 location were 1.62% ± 0.16, 5.18% ± 0.14 and 0.29% ± 0.16, respectively. Main field homogeneity and gradient field linearity are guaranteed on and near the isocenter relative to points far from the center due to MRI systems are typically designed with a homogeneous magnetic field near the isocenter. The MR scanning of the objects near the isocenter enable the effect of geometric distortion to be decreased. Fig. 2 shows upper thigh axial images acquired at conventional off-center position and shifted on-axis. The cross-sectional area difference of thigh adipose tissue and muscle of knee extensors was as high as 5.56% and 2.67% on conventional off-center position and shifted on-axis. Black arrow indicates cusp artifact caused by thigh volume of the outside the field of view due to shifted on-axis scanning scheme.

Conclusion: Intensity and geometrical distortion were generated by off-center position scanning in open MRI. In musculoskeletal MR imaging, cross-sectional area errors should be more minimized by proper calibration procedure and geometric distortion-correction (GDC).

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References

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