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The Department of Radiology undertakes radiology service at IMSUT hospital. Our expertise includes general diagnostic radiology, neuroradiology, clinical nuclear medicine, and radiation therapy. Board-certified radiologists at the Department of Radiology conduct all examinations of CT, MRI, and nuclear medicine. Radiological reports are made by the radiologists. In addition, several clinical studies are being conducted in collaboration with other departments or institutions. We also investigate the technical aspects of molecular imaging with intact small animals for its application to preclinical studies using an optical imaging system and MRI.
The Department of Radiological Technology constitutes the hospital radiology service together with the Department of Radiology. Plain radiography, dual-energy X-ray absorptiometry, and barium studies are also available at the Department of Radiological Technology, other than CT, MRI, and radioisotope examinations. More than 10,000 patients visit our department every year. Radiologic technologists at the department make an effort to provide high-quality medical images in daily practice as well as to reasonably reduce radiation exposure of a patient during the examination.

Faster acquisition of magnetic resonance imaging sequences of the knee via deep learning reconstruction: a volunteer study.

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In the present study, we aimed to evaluate whether deep learning reconstruction (DLR) can accelerate the acquisition of magnetic resonance imaging (MRI) sequences of the knee for clinical use. Twenty-seven healthy volunteers (age: 40.6 ± 11.9 years) were enrolled. Using a 1.5-T MRI scanner, sagittal fat-suppressed T2-weighted imaging (fs-T2WI), coronal proton density-weighted imaging (PDWI), and coronal T1-weighted imaging (T1WI) were performed. DLR was applied to images with a number of signal averages (NSA) of 1 to obtain 1DLR images. Then 1NSA, 1DLR, and 4NSA images were compared subjectively, and by noise (standard deviation of intra-articular water or medial meniscus) and contrast-to-noise ratio between two anatomical structures or between an anatomical structure and intra-articular water. As a result, according to objective evaluations, PDWI 1DLR images showed the smallest noise and significantly higher contrast than 1NSA and 4NSA images. For fs-T2WI, smaller noise and higher contrast were observed in the order of 4NSA, 1DLR, and 1NSA images. According to the subjective analysis, structure visibility, image noise, and overall image quality were significantly better for PDWI 1DLR than 1NSA images; moreover, the visibility of the meniscus and bone, image noise, and overall image quality were significantly better for 1DLR than 4NSA images. Fs-T2WI and T1WI 1DLR images showed no difference between 1DLR and 4NSA images. Three 1DLR image sequences were obtained within 200 s (approximately 12 minutes for 4NSA image). To sum up, compared to PDWI 4NSA images, PDWI 1DLR images were of higher quality, while the quality of fs-T2WI and T1WI 1DLR images was similar to that of 4NSA images.

Dataset augmentation with multiple contrasts images in super-resolution processing of T1-weighted brain magnetic resonance images.

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This study investigated the effectiveness of augmenting datasets for super-resolution processing of brain Magnetic Resonance Images (MRI) T1-weighted images (T1WIs) using deep learning. By incorporating images with different contrasts from the same subject, this study sought to improve network performance and assess its impact on image quality metrics, such as peak signal-to-noise ratio (PSNR) and structural similarity (SSIM). This retrospective study included 240 patients who underwent brain MRI. Two types of datasets were created: the Pure-Dataset group comprising T1WIs and the Mixed-Dataset group comprising T1WIs, T2-weighted images, and fluid-attenuated inversion recovery images. A U-Net-based network and an Enhanced Deep Super-Resolution network (EDSR) were trained on these datasets. Objective image quality analysis was performed using PSNR and SSIM. Statistical analyses, including paired t test and Pearson's correlation coefficient, were conducted to evaluate the results. Augmenting datasets with images of different contrasts significantly improved training accuracy as the dataset size increased. PSNR values ranged 29.84–30.26 dB for U-Net trained on mixed datasets, and SSIM values ranged 0.9858–0.9868. Similarly, PSNR values ranged 32.34–32.64 dB for EDSR trained on mixed datasets, and SSIM values ranged 0.9941–0.9945. Significant differences in PSNR and SSIM were observed between models trained on pure and mixed datasets. Pearson's correlation coefficient indicated a strong positive correlation between dataset size and image quality metrics. Using diverse image data obtained from the same subject can improve the performance of deep-learning models in medical image super-resolution tasks.

Publications

1. Sugawara H, Kikkawa N, Ito K, Watanabe H, Kaku S, Akai H, Abe O, Watanabe S, Yatabe Y, and Kusumoto M. Is 18F-fluorodeoxyglucose PET recommended for small lung nodules? CT findings of 18F-fluorodeoxyglucose non-avid lung cancer. Br J Radiol. 97:462-468, 2024.
2. Akai H, Yasaka K, Sugawara H, Furuta T, Tajima T, Kato S, Yamaguchi H, Ohtomo K, Abe O, and Kiryu S. Faster acquisition of magnetic resonance imaging sequences of the knee via deep learning reconstruction: a volunteer study. Clin Radiol. 79:453-459, 2024.
3. Kunimatsu A, Yasaka K, and Akai H. Texture Analysis in Neuroradiology. Handbook of Texture Analysis Generalized Texture for AI-Based Industrial Applications. (Taylor and Francis, FL). pp1-14, 2024.
4. Akai H, Yasaka K, and Kunimatsu A. Texture Analysis in Abdominal Imaging. Handbook of Texture Analysis Generalized Texture for AI-Based Industrial Applications. (Taylor and Francis, FL). pp62-71, 2024.
5. Yasaka K, Akai H, and Kunimatsu A. Texture Analysis in Thoracic Imaging. Handbook of Texture Analysis Generalized Texture for AI-Based Industrial Applications. (Taylor and Francis, FL). pp94-105, 2024.
6. Yasaka K, Uehara S, Kato S, Watanabe Y, Tajima T, Akai H, Yoshioka N, Akahane M, Ohtomo K, Abe O, and Kiryu S. Super-resolution Deep Learning

Reconstruction Cervical Spine 1.5T MRI: Improved Interobserver Agreement in Evaluations of Neuroforaminal Stenosis Compared to Conventional Deep Learning Reconstruction. J Imaging Inform Med. 37:2466-2473, 2024.

7. Yasaka K, Kanazawa J, Nakaya M, Kurokawa R, Tajima T, Akai H, Yoshioka N, Akahane M, Ohtomo K, Abe O, and Kiryu S. Super-resolution Deep Learning Reconstruction for 3D Brain MR Imaging: Improvement of Cranial Nerve Depiction and Interobserver Agreement in Evaluations of Neurovascular Conflict. Acad Radiol. 31:5118-5127, 2024.
8. Yasaka K, Akai H, Kato S, Tajima T, Yoshioka N, Furuta T, Kageyama H, Toda Y, Akahane M, Ohtomo K, Abe O, and Kiryu S. Iterative Motion Correction Technique with Deep Learning Reconstruction for Brain MRI: A Volunteer and Patient Study. J Imaging Inform Med. 37:3070-3076, 2024.
9. Kageyama H, Yoshida N, Kondo K, and Akai H. Dataset augmentation with multiple contrasts images in super-resolution processing of T1-weighted brain magnetic resonance images. Radiol Phys Technol. 2024 Dec 16. [Epub ahead of print]