

Clinical Evaluation of Deep Learning-based Metal Artifact Reduction in CT for Total Knee Arthroplasty

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For patients with end-stage knee osteoarthritis (OA), knee replacement surgery is the treatment of choice and the use of Total Knee Arthroplasty (TKA) is continuing to increase. Computed tomography (CT) plays an important role in the assessment of various complications after TKA, such as aseptic loosening, infection, and so on. However, severe metal artifacts caused by large TKA components, obscure surrounding bone and soft tissue limiting the utility of the CT. To overcome this, various metal artifact reduction (MAR) algorithms have been proposed, however, those methods cannot remove artifacts from large and dense metallic implants completely, or sometimes introduce new artifacts. In this study, we proposed a novel Deep Learning(DL)-based MAR (DL-MAR) technique and compared MAR performance with a commercial MAR software (O-MAR, Philips Healthcare, Best, the Netherlands). The training dataset consisted of 640 image pairs obtained from 10 lower extremity CT scans without a metal prosthesis. Each image pair consists of a metal artifact-free image with a virtual metal shape embedded in the original image and a metal artifact image simulated through sinogram handling. A convolutional neural network with encoder-decoder structure and skip connections was implemented and trained with the training dataset. For the test dataset, we used 10 lower extremity CT examinations, and a total of 13 knee joints were used for analysis. For clinical evaluation, images were rated with a 4-point Likert scale regarding the degree of overall metal artifacts, conspicuity of bone cortex and trabeculae, and assessment of soft tissue around the prosthesis. Figure 1 shows stacked bar graphs containing cumulative frequency of subjective grading. Lighter colors mean better performance of the methods. Overall artifact was lowest in the DL-MAR method, and bone conspicuity was best in the DL-MAR. However, there was no significant difference between O-MAR and DL-MAR to evaluate soft tissue. In conclusion, The DL-MAR technique has been successfully developed by generating the paired dataset. And the proposed technique has shown comparable performance with conventional projection completion algorithms.

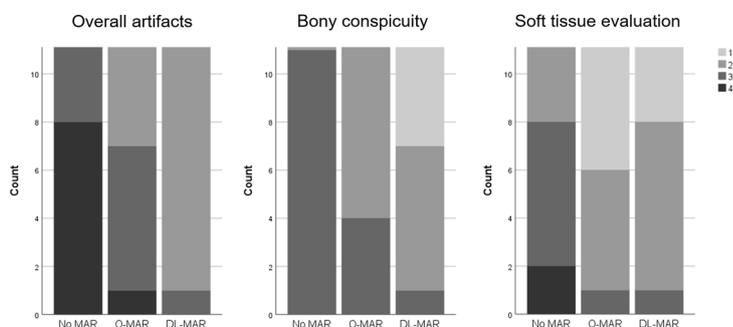


Fig. 1. Comparison of clinical evaluation results among No MAR, O-MAR, and DL-MAR

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