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A preliminary study of the impact of metal-induced CT artifacts on Monte Carlo dose calculations in a pelvic prosthesis phantom

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Computed tomography (CT) images of patients undergoing radiation therapy form the basis of 3D radiotherapy treatment planning. But in the presence of metallic implants, metal streak artifacts are produced in CT images which could provide inaccurate electron density information (due to incorrect Hounsfield units (HU) values) needed for accurate calculation of patient radiation dose. In this study, the dosimetric impact of metal-induced CT streak artifacts on Monte Carlo dose calculations in a pelvic phantom that contains unilateral hip Ti implant is evaluated. Correct HU values were assigned to known materials of the pelvic prosthesis phantom to create an artifact-free phantom model in contrary to HU values generated through the original artifact-induced CT images. DOSXYZnrc Monte Carlo dose calculations were then computed in the artifact-free phantom model created from the exact geometry of the phantom with known materials and the phantom model made from the original CT images containing the metal artifacts. The dose calculations were benchmarked against Gafchromic EBT3 film measurements using 10 × 10 cm2 15 MeV electron and 10 MV photon beams. The average discrepancies between film and MC dose data decreased from 4±2% to 2±1% and from 5±3% to 3±2% in the two phantom models for the electron and photon fields, respectively. The study shows that Monte Carlo calculated dose data in the artefact-free phantom model were closer to film measurements compared to dose data computed in the original phantom model containing the metal-induced CT artifacts.

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