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Clinical Elements

Improved visualization for confident radiation oncology treatment planning

PURPOSE OF STUDY

When patients have large metallic implants, the implants can cause severe artifacts in CT simulation images that can introduce inaccuracies into the radiation therapy treatment planning process. A study was conducted by researchers from Washington University, the University of California Los Angeles, and the University of California San Diego to evaluate the performance of the first commercial orthopedic metal artifact reduction function (O-MAR) for radiation therapy, and investigate its clinical applications in treatment planning. The following is a summary of the case study published in Medical Physics in 2012.

Overview

In radiation oncology, target delineation and tissue electron density (as indicated by CT Hounsfield numbers) play a critical role in assuring treatment planning accuracy. However, metallic implants, especially large hip prostheses, can produce severe artifacts that can affect the accuracy in delineating the treatment target from organs at risk, as well as the accuracy of CT Hounsfield Units—thereby reducing the radiation oncologists' confidence in the accuracy of the treatment plan. When generating a treatment plan with CT images that have been distorted and obscured by metal artifacts, clinicians have to rely on making educated guesses in contouring both targets and critical structures based on their clinical experience.

This study used both phantom and clinical data to evaluate the performance of O-MAR corrected images compared to uncorrected images. The O-MAR corrected CT data sets provided better views of anatomical structures on patients that have large hip implants. More importantly, this evaluation demonstrated that the anatomic structure geometries were not affected by the algorithm. Without the use of the O-MAR algorithm, segmentation of nearby organs would be less confident and treatment planning accuracy could be jeopardized.

CT image sets were taken from ten patients with large hip implants and processed with the O-MAR function. Two radiation oncologists evaluated these image sets using a five-point score for overall image quality, anatomical conspicuity, and CT Hounsfield number accuracy. Using the same structure contours delineated in the O-MAR corrected images, clinical Intensity Modulated Radiation Therapy (IMRT) treatment plans for five patients were computed on the uncorrected and O-MAR corrected images, and compared.

Results

The phantom study indicated that CT Hounsfield number accuracy and noise were improved on the O-MAR corrected images.

In the patient cases, O-MAR corrected images were rated as higher quality. Structures that were formerly obscured, such as in those images with bilateral metal implants, were able to be visualized. The image quality and conspicuity in critical organs were significantly improved, and the noise levels of the selected regions of interest were reduced from 93.7 to 38.2 HU.

Conclusion

The study indicated that the O-MAR algorithm can significantly reduce metal artifacts on treatment planning CT images, which enables better anatomical structure visualization and improves radiation oncologists' confidence in target delineation.

2x improved confidence in image quality*

Reduced noise by 59-66%

Improved visualization of obscured structures

*based on image quality scale from 0-5

CLINICAL RELEVANCE

O-MAR improves image quality and visualization of critical structures and target volumes, which can improve workflow in CT simulation and treatment planning where metal from large orthopedic implants is present.

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"Clinical evaluation of a commercial orthopedic metal artifact reduction tool for CT simulation in radiation therapy", Li et al, Medical Physics, Vol 39, 2012.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

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