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Precision Dose Tracking for MR-LINAC Radiotherapy

Stanford researchers have developed an advanced method for accurately tracking and accumulating radiation dose in magnetic resonance-guided radiotherapy. This innovation improves treatment precision by synchronizing dose calculations with real-time anatomical changes, reducing the risk of under- or over-dosing tumors and surrounding healthy tissues.

State-of-the-art magnetic resonance-guided linear accelerator (MR-LINAC) systems combine magnetic resonance imaging (MRI) with radiation therapy to precisely target and ablate tumors. MR-LINAC enables real-time imaging of patient anatomy and tumor position during radiotherapy administration, allowing treatment adjustments when internal or external movement occurs due to breathing, digestion, or patient motion. However, current methods for recalculating the delivered radiation dose after movement-related treatment interruptions rely on overly simplistic assumptions, which can lead to underdosing of the tumor or unintended overexposure of nearby healthy tissue to radiation.

The inventors' approach leverages a 3D Deformation Vector Field (DVF) to dynamically adjust dose accumulation computations based on real-time anatomical changes. By continuously updating radiation tracking and incorporating deformation-corrected MRI data to attain high spatiotemporal resolution, this method provides a more accurate representation of the cumulative radiation dose delivered. The result is enhanced treatment precision, minimized radiation exposure to healthy tissues, and improved patient safety.

Stage of Development
Validated in and ready for integration with existing MR-LINAC systems

Applications

- Adaptive radiotherapy for cancers whose targeting is sensitive to internal or patient movement, including lung, liver, and abdominal tumors
- More precise dose tracking in MR-guided radiation therapy
- Quality assurance in real-time adaptive radiation treatment plans

Advantages

- Improves treatment precision by performing accurate, real-time dose accumulation
- Enhances confidence in adaptive radiotherapy by correcting for anatomical motions as they transpire
- Reduces risk of underdosing tumors and of overexposing healthy tissue to radiation
- Seamlessly integrates with existing MR-LINAC treatment workflows

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