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Dosimetric Verification of Real-Time Anatomy-Based Multiplane Dual Target Gating on a 0.35T MRI Linac

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PURPOSE / OBJECTIVES

This study presents a phantom based verification of multiplane, multitarget gating on a 0.35T MRI Linac. By combining two motion phantoms, we were able to independently drive two separate targets and ensure dosimetric accuracy using both radiochromic film and ionization chamber measurements. Each of the five new tracking algorithms was tested both with and without motion correction.

MATERIAL & METHODS

Following a recent upgrade to a 0.35T MR-Linac, multiplane cine imaging and the ability to gate on multiple distinct objects simultaneously became available for real-time anatomy-based gating during clinical treatment. To verify the dosimetric accuracy of the system when tracking two independent targets across different cine planes, two MRI4D QUASAR (IBA, Herndon, VA) motion phantom motors and inserts were used. Targets were created based on the two motion phantom inserts which could then be driven independently. Ion chamber (IC) measurements were recorded for both inserts using all 5 available tracking algorithms (Standard, Rigid, Small Mobile, Large Deforming, Complex Mobile) and were repeated using motion correction. IC results for all tests were compared against reference measurements without either insert moving. Radiochromic film measurements were likewise acquired using the Standard tracking algorithm with and without motion correction. Gamma analysis was performed between stationary and moving films using an in-house developed MATLAB script. “Beam on Latency” was set to 1 frame to ensure that both targets were within their respective gating boundary prior to the system producing beam.

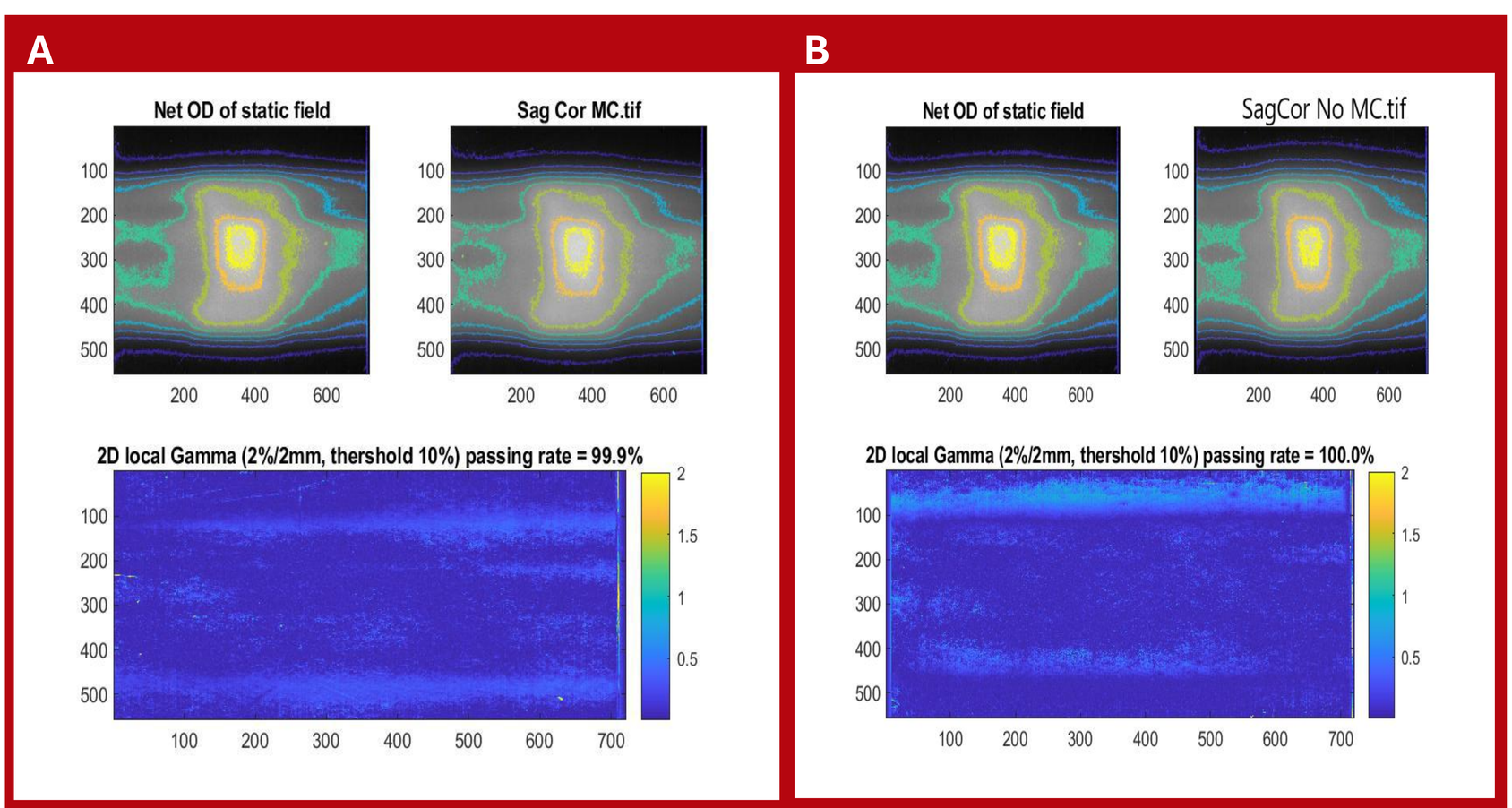

Figure 1: Film results using: A) standard tracking algorithm, dual plane cine imaging (Sagittal/Coronal), with motion correction and B) standard tracking algorithm, dual plane cine imaging (Sagittal/Coronal), without motion correction. 2D Local gamma passing rate at 2%2mm was 99.9% (A) & 100% (B) using a 10% threshold.

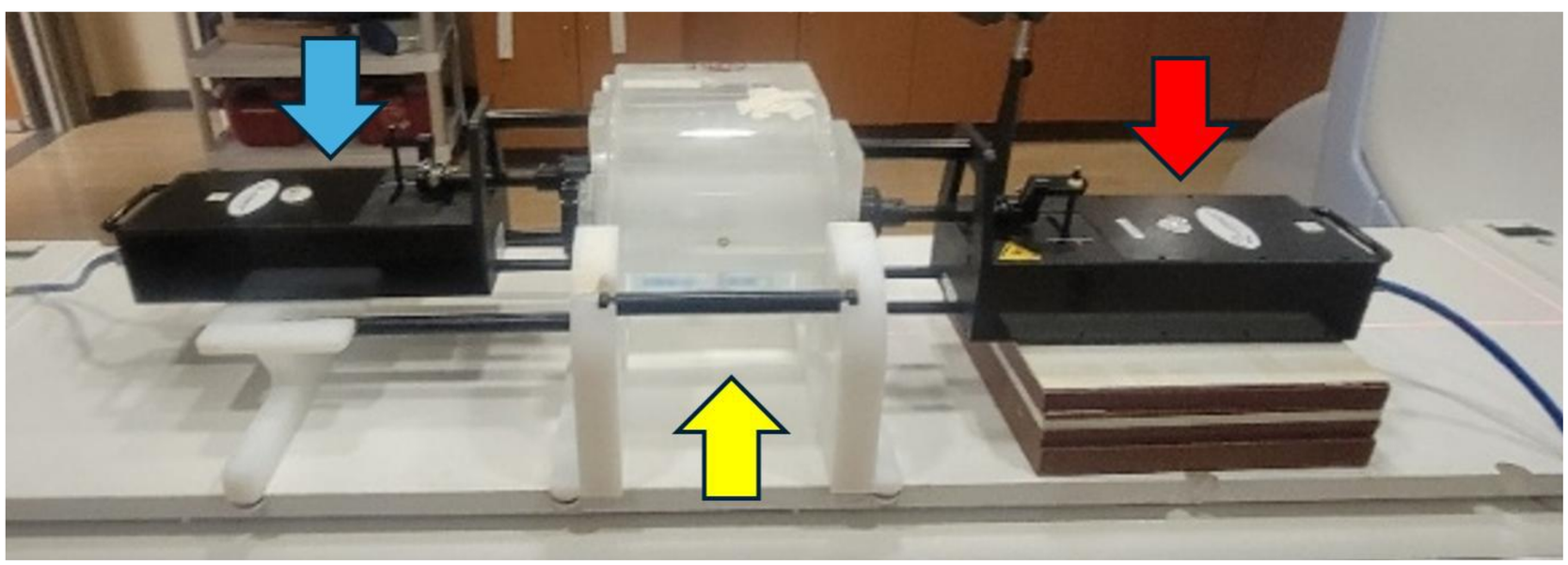

Figure 2: Dual motor phantom setup prior to placing the two flexible torso coils required for imaging. The first motor (blue arrow) drives the insert in center of the phantom (yellow arrow). The second motor (red arrow) drives the insert on the patient left of the phantom. Motors are attached to independent motor controllers and laptops located away from the scanner and outside of the RF shielding.

RESULTS

All IC results were within 1.88% of the reference measurements with no significant differences found between tracking algorithms or the use of motion correction. Film measurements were within 99.90% using a 2%2mm local gamma criterion with a 10% threshold.

CONCLUSION

We verified the dosimetric accuracy of multiplane dual target gating on a 0.35T MRI Linac for all tracking algorithms both with and without motion correction. All measurements were within expected tolerances.

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