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Real-time tracking of inter marker distances to assess marker stability, organ deformation in prostate cancer

Purpose: The use of intraprostatic fiducials as surrogates for prostate gland position assumes that the markers are rigidly positioned within the prostate. To test this assumption, the intermarker distances (IMD) of implanted Calypso® beacon transponders were monitored during radiation therapy to determine marker stability within the prostate gland.

Methods and Materials: The analysis is performed on 4 patients treated with intensity-modulated radiotherapy. A total of 12 markers (3 transponders per patient) were implanted. Each of the three transponder locations are continuously measured using the Calypso® 3D Localization and Real Time Tracking system at a rate of 10 Hz. A total of 110,265 sampling points were available for analysis. Each sampling point allows the computation of the 3 IMDs. To study variations in marker position, daily IMDs were compared with the IMD that was observed during the first alignment. We defined the variation in the IMD as the important measure of intrinsic marker position variation. The standard deviation (SD) of IMD variations was studied as a measure of the extent of marker position variation.

Results: The maximum deformation as measured by analysis of IMDs with a 95% confidence interval was ± 2.8 mm across all 4 patients with the minimum deformation of ± 0.28 mm. The average deformation with a 95% confidence interval was ± 2 mm. The maximum relative variation of all the IMDs was 7.7% in the worse case scenario and represents at least a 92.7% confidence in the data.

Conclusion: IMDs varied minimally, which indicated relatively little deformation of the gland as well as the absence of significant marker migration. Intraprostatic implanted Calypso® beacon transponders in the prostate allow for a reliable localization of the prostate gland.