Debate III: For prostate radiation treatments a non-ionizing imaging system is a better IGRT.

Ultrasound & MRI localization

EM localization - Calypso® & RayPilot®
Advantages of non-ionizing IGRT system

- No added radiation exposure
- Accurate
- Based on prostate position (markers in prostate/prostate)
- EM systems are non-ambiguous – no interpretation needed
- MRI has superior soft tissue anatomy
- Quick alignment
- Quick Intra-Fraction motion management
- Decreased margins

Advantage: Accurate & non-ambiguous

A comparison of radiographic techniques and electromagnetic transponders for localization of the prostate

Foster, R, Pistenmaa D, Solberg, T.

Localization of the prostate using electromagnetic transponders agrees well with radiographic techniques and each technology is suitable for high precision radiotherapy. This study finds that there is a more uncertainty in CBCT localization of the prostate than in 2D orthogonal imaging, but the difference is not clinically significant.

MRI: Better Visualization + real-time monitoring (ViewRay)
Advantage: Intrafraction motion management

Intrafraction prostate displacement in radiotherapy estimated from pre- and post-treatment imaging of patients with implanted fiducial markers

Tomas Kron1, Jessica Thurner, Chris Fox, Ann Thompson, Rebecca Oved, Alan Henschke, Annette Havrilesky2, Konstanze Tan1, Felizita Feminic2

Intrafraction motion of the prostate gland appears to be a limiting factor when considering margins for radiotherapy. Given the variation between patients, a uniform set of margins for all patients may not be satisfactory when high target doses are to be delivered.

Intrafraction Motion - Frequency

Displacement >5mm occurs about 10% of the time.
Intra-Fraction motion – Magnitude

Prostate Intrafraction Translation Margins for Real-Time Monitoring and Correction Strategies

Continuous electromagnetic monitoring and automated correction have the potential to reduce prostate margins to 2-3 mm, while ensuring that a higher percentage of patients (99% versus 90%) receive a greater percentage (99% versus 95%) of the prescription dose.

Assessment of Planning Target Volume Margins for Intensity Modulated Radiotherapy of the Prostate Gland: Role of Daily Inter- and Intrafraction Motion
James A. Tanyi, Ph.D., Tongming He, Ph.D., Paige A. Summers, B.S., Ruth G. Mburu, Catherine M. Kato, Stephen M. Rhodes, B.S., R.T.(T), Arthur Y. Hung, M.D., Martin Fuss, M.D., Ph.D.
Oregon Health and Science University, Portland, OR

<table>
<thead>
<tr>
<th>LR (mm)</th>
<th>SI (mm)</th>
<th>AP (mm)</th>
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<tbody>
<tr>
<td>Skin</td>
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<tr>
<td>Intra-Fraction</td>
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</tbody>
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Advantage: Decreased margin

Reduction in Patient-reported Acute Morbidity in Prostate Cancer Patients Treated With 81-Gy Intensity-modulated Radiotherapy Using Reduced Planning Target Volume Margins and Electromagnetic Tracking: Assessing the Impact of Margin Reduction Study.
Howard M. Sandler, Ping-Yu Liu, Rodney L. Dunn, David C. Khan, Scott E. Trupel, Martin G. Sanda, Constantine A. Mantis.

“Prostate cancer patients treated with reduced margins and tumor tracking had less radiotherapy-related morbidity than their counterparts treated with conventional margins.”
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Intrafraction Motion – Time from alignment

Displacement increase with time:
Advantage: Intervention at any time