

Selecting an Optimal Treatment Platform for Prostate SBRT in Patients With Hip Prostheses

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Objective

To assess the feasibility of prostate stereotactic body radiation therapy (SBRT) in patients with unilateral and bilateral hip prostheses across multiple treatment platforms, focusing on image quality, planning feasibility, delivery characteristics, motion management, and adaptive capability.

Methods

- Three prostate SBRT cases (40 Gy in 5 fractions) were evaluated: two with bilateral hip prostheses and one with a unilateral prosthesis.
- Treatment planning was performed using four platforms available at our institution: a 0.35 T MR-guided linear accelerator (ViewRay MRIdian), Accuray CyberKnife, Accuray Radixact, and Varian TrueBeam.
- One bilateral prosthesis case was initially planned on the MR-LINAC and the second on CyberKnife; both failed to meet departmental dosimetric criteria, prompting replanning on alternative systems (MR-LINAC → Radixact and CyberKnife → TrueBeam).
- Institutional target coverage and organ-at-risk constraints were applied, with beam entry restricted to avoid prosthetic material using a 5-cm margin. Image quality, contouring capability, plan quality, delivery feasibility, motion management, and adaptive functionality were evaluated.

Results

The MR-LINAC provided excellent soft-tissue visualization for both unilateral and bilateral prosthesis cases. Clinically acceptable plans were achieved for the unilateral prosthesis; however, due to limited beam access and step-and-shoot IMRT delivery, bilateral prosthesis plans did not meet departmental criteria.

CyberKnife image quality was limited by metal artifact but improved with metal artifact reduction; diagnostic MRI was required for contouring. Unilateral prosthesis plans met criteria, while bilateral plans did not.

Radixact and TrueBeam produced clinically acceptable plans for both unilateral and bilateral prosthesis cases using similar avoidance strategies, though without online adaptive replanning.

Platform	Soft-tissue imaging	Unilateral plan	Bilateral plan	Online adaptive
MR-LINAC 0.35 T MRIdian	MR-Based	Met ✓	Not met ✗	Yes ✓
CyberKnife	CT-Based (MR images for contouring)	Met ✓	Not met ✗	No ✗
Radixact	CT-based (MR images for contouring)	Met ✓	Met ✓	No ✗
TrueBeam	CT-based (MR images for contouring)	Met ✓	Met ✓	No ✗

Met = institutional target-coverage & OAR constraints satisfied with 5-cm beam-avoidance margin around prosthetic material.

Key findings

Which platform for which patient?	
Radixact	Unilateral + bilateral prostheses ✓
TrueBeam	Unilateral + bilateral prostheses ✓
MR-LINAC	Unilateral only — best imaging & adaptive
CyberKnife	Unilateral only — needs MAR + MRI
Key finding	CT-based modulation most consistently met criteria; selection is patient-specific

Conclusion

- Prostate SBRT feasibility in patients with hip prostheses is highly platform-dependent. Low-field MR-LINAC systems offer superior soft-tissue imaging and adaptive potential but are limited for bilateral prosthesis cases by planning and delivery constraints. CT-based platforms with greater beam modulation flexibility more consistently met dosimetric criteria, underscoring the importance of individualized platform selection and institution-specific guidelines.

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Figure 1 | Platform suitability for prostate SBRT (40 Gy / 5 fx) with hip prostheses