Magnetic resonance imaging-based treatment planning for prostate brachytherapy

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ABSTRACT

PURPOSE: Transrectal ultrasound (TRUS) is the standard imaging modality for planning prostate brachytherapy. However, magnetic resonance imaging (MRI) provides greater anatomic detail than TRUS. We compared treatment plans generated using TRUS, endorectal coil MRI (erMRI), and standard body array coil MRI (sMRI).

METHODS AND MATERIALS: Treatment plans were used from patients treated with permanent, stranded-seed 125I brachytherapy in a prospective trial. All men underwent pretreatment planning based on TRUS, and all underwent erMRI before treatment and sMRI 30 days after the implant. Treatments for 20 consecutive patients were replanned on sMRI and erMRI images by investigators blinded to TRUS-based plans. Prostate volume/dimensions, radioactivity-to-prostate-volume ratio, and dosimetric parameters were compared.

RESULTS: Compared with TRUS, mean prostate volume measured by erMRI was smaller, medial-lateral diameter was larger, and anterior-posterior diameter was smaller, suggesting that the endorectal coil produced anatomic distortions. Craniocaudal prostate length was smaller on both types of MRI than on TRUS, suggesting that TRUS overestimates prostate length. Activity per volume was 7.5% lower for plans based on sMRI than on TRUS (0.901 vs. 0.974 mCi/cm³, p < 0.001). sMRI plans had similar coverage of the planning target volume (PTV) (dose to 90% of the prostate [D90] 116.6% sMRI vs. 117.5% TRUS, p = 0.526) and improved dose homogeneity (percentage of PTV receiving 150% of the prescription dose [V150] 47.4% sMRI vs. 53.8% TRUS, p = 0.001 and percentage of PTV receiving 200% of the prescription dose [V200] 16.6% sMRI vs. 19.2% TRUS, p < 0.001).

CONCLUSIONS: Staging erMRI should not be routinely used for treatment planning because it produces anatomic distortion. sMRI may have treatment planning advantages over TRUS because of superior soft-tissue delineation of the prostate and adjacent normal tissue structures. © 2013 American Brachytherapy Society. Published by Elsevier Inc. All rights reserved.

Keywords: Prostate; Brachytherapy; Image guidance; Endorectal MRI

Introduction

Transrectal ultrasound (TRUS) is a well-established (1) and commonly used (2) imaging modality for planning prostate brachytherapy. TRUS is the standard imaging modality when used for either preplanning or intraoperative planning (3, 4). However, TRUS has important limitations such as interoperator variability in determining prostate volume and dimensions (5); this seems to be due in part to operator experience (6–8) and in part to limitations in TRUS image resolution. Any uncertainty in prostate delineation is significant for planning brachytherapy given the high conformality and rapid dose falloff inherent in brachytherapy. Uncertainties in prostate
dimensions may result in more seeds being implanted than are necessary to cover the volume, or seeds being placed outside the prostate in adjacent structures such as the bladder neck, anterior rectal wall, urogenital diaphragm, and penile bulb.

Use of improved imaging modalities would help to enhance the quality of brachytherapy for prostate cancer. Computed tomography (CT) is imprecise for visualizing the prostate (9) and is associated with significant uncertainty and variability in delineating prostate dimensions (10–12); prostate volumes estimated from CT scans have been shown to be up to 50% larger than those estimated using TRUS (13, 14).

Magnetic resonance imaging (MRI) has been explored as an imaging modality for prostate biopsy (15, 16) and for prostate brachytherapy (17, 18). MRI-based estimates of prostate volume have been shown to correlate well with TRUS-based volumes (19, 20), with significantly improved resolution and visualization of prostate anatomy. Moreover, endorectal coil MRI (erMRI) has demonstrated even greater resolution than standard body array coil MRI (sMRI) for prostate visualization (21, 22), which could provide further advantages for treatment planning.

The purpose of the present study was to compare TRUS, the standard modality used for planning prostate brachytherapy at MD Anderson Cancer Center, with erMRI and sMRI for brachytherapy planning. We aimed to explore the feasibility of using erMRI and sMRI for treatment planning, and also to determine the advantages and disadvantages of each modality. Specifically, we aimed to compare prostate volume and dimensions, total activity-to-prostate-volume ratio, and dosimetric parameters obtained from TRUS, erMRI, and sMRI-based plans to quantify anatomic and treatment planning differences between the three imaging modalities.

Methods and materials

Patient selection

Cases were selected for analysis from men enrolled in a prospective phase II trial at MD Anderson who received a permanent prostate \(^{125}\)I stranded-seed implant as monotherapy for histologically confirmed adenocarcinoma of the prostate. Patients had clinical stage T1c–T2b N0 M0 disease (American Joint Committee on Cancer [AJCC] Cancer Staging Manual 6th edition, 2002) and intermediate-risk disease, defined as (1) Gleason score <7, prostate-specific antigen [PSA] level 10–15 ng/mL; or (2) Gleason score 7, PSA <10. Prostate volume had to be \(\leq 60 \text{ cm}^3\) as measured by TRUS, and each patient had to have an American Urological Association Symptom Score of \(\leq 15\). Other exclusion criteria were prior transurethral resection of the prostate, cryosurgery, pelvic radiation, chemotherapy, or androgen deprivation therapy. Twenty consecutive patients from this protocol were chosen for the present retrospective anatomic and dosimetric analysis.

Staging, imaging, and treatment

All patients underwent a history and physical examination (including a digital rectal examination), serum PSA measurements, pelvic CT scan, and TRUS before treatment to rule out pubic arch interference and ensure the technical feasibility of a sufficiently high-quality implant. All TRUS studies were performed by a radiation oncologist (SJF) using the Siemens SONOLINE G20 ultrasound system with an Endo P-II Intracavitary Transducer. As part of the protocol, all patients underwent erMRI scanning before treatment to rule out extraprostatic extension or seminal vesicle involvement. The VariSeed 8.0 planning system (Varian Medical Systems, Palo Alto, CA) was used for treatment planning. The preimplant TRUS images were used to generate a preplan, and a standard modified peripheral loading technique with stranded seeds was used for all patients. The planning target volume (PTV) was defined as a 3-mm expansion from the prostate anteriorly and laterally, a 5-mm expansion cranially and caudally, and no expansion posteriorly. All treatment plans used a prescription dose of 145 Gy with \(^{125}\)I sources and aimed to satisfy the following dosimetric parameters: percentage of PTV receiving 100% of the prescription dose (PTV \(V_{100}\)) >95%, percentage of PTV receiving 150% of the prescription dose (PTV \(V_{150}\)) <60%, percentage of PTV receiving 200% of the prescription dose (PTV \(V_{200}\)) <20%, rectal volume receiving 100% of the prescription dose (\(R_{100}\)) <1 cm\(^3\), and urethral volume receiving 200% of the prescription dose (\(U_{200}\)) to be near 0. All patients underwent permanent interstitial prostate implants, and intraoperative TRUS was used to guide needle placement and verify the positioning of the strands. In addition to CT scans on Day 0 and Day 30 after the implant, all patients underwent sMRI on postimplant Day 30.

MRI-based planning

For the purposes of the present study, the preimplant erMRI and 30-day postimplant sMRI images were used to retrospectively replan the seed placement for each patient. The T2-weighted series for both the erMRI and sMRI were imported into the VariSeed system. Contours for the prostate, bladder, rectum, urethra, and seminal vesicles were outlined independently on the erMRI and sMRI. All contours were approved by the two reviewers. The PTV was defined in the same way as for the actual treatment, as a 3-mm expansion from the prostate anteriorly and laterally, a 5-mm expansion cranially and caudally, and no expansion posteriorly. The erMRI- and sMRI-based plans were jointly developed by a medical dosimetrist and radiation oncologist who were blinded to the TRUS-based plans; they used the same standard modified peripheral loading technique as that used for TRUS-based plans, optimized to the anatomic detail visible on the MRI. Planning was done independently.
for both erMRI and sMRI. All MRI-based treatment plans were designed to use the same dosimetric parameters as those used in the actual treatments: PTV $V_{100} > 95\%$, $V_{150} < 60\%$, $V_{200} < 20\%$, $R_{100} < 1\text{ cm}^3$, and $U_{200}$ near 0.

Statistical analysis

Prostate volume and dimensions, the radioactivity-to-prostate-volume ratio, and dosimetric parameters (PTV $V_{100}$, $V_{150}$, $V_{200}$; dose to 90\% of the prostate [$D_{90}$]; $R_{100}$; $U_{200}$) were compared for the three modalities (TRUS, erMRI, and sMRI) by using the Wilcoxon signed-rank test for paired samples. Comparisons were performed pair wise between each of the MRI modalities and TRUS. All $p$-values were obtained by using two-tailed tests, and a $p$-value of $< 0.05$ was considered statistically significant.

Data were analyzed with PASW Statistics 17.0 (SPSS, Inc., Chicago, IL).

Results

Distortion of prostate anatomy with endorectal coil

To determine whether the different imaging modalities resulted in differences in the visualized anatomy of the prostate, the mean prostate volume and dimensions measured by TRUS, erMRI, and sMRI were compared (Table 1). When compared with TRUS, the mean prostate volume measured by erMRI was smaller (29.5 vs. 32.5 cm$^3$ by TRUS, $p = 0.001$), the mean medial-lateral diameter was larger (5.01 cm by TRUS vs. 4.65 cm by TRUS, $p < 0.001$), and the mean anterior-posterior diameter was smaller (2.69 cm vs. 3.06 cm by TRUS, $p < 0.001$), suggesting that the use of the endorectal coil caused substantial anatomic distortion (Fig. 1).

In contrast, no significant difference was found between the mean prostate volume estimated by sMRI and that estimated by TRUS (33.9 cm$^3$ sMRI vs. 32.5 cm$^3$ TRUS, $p = 0.076$). Moreover, the difference in medial-lateral diameter between these two modalities was less than 2 mm, and of only borderline significance ($p = 0.050$), although the anterior-posterior diameter was larger on sMRI (3.50 cm sMRI vs. 3.06 cm TRUS, $p < 0.001$). These smaller differences are likely attributable to the anatomic distortion caused by the TRUS probe. Notably, sMRI- and erMRI-based measurements of prostate volume, anterior-posterior diameter, and medial-lateral diameter were all different from one another ($p < 0.001$ for all comparisons).

Overestimation of prostate length with TRUS

Because accurate measurement of craniocaudal prostate length is a critically important step in brachytherapy treatment planning and delivery, we compared this measurement among the three imaging modalities and found that craniocaudal length was shorter when estimated by either type of MRI than by TRUS (TRUS 4.23 cm, erMRI 3.71 cm, $p < 0.001$; sMRI 3.55 cm, $p < 0.001$) (Table 1). This suggests that TRUS may overestimate prostate length, which could result in seeds inadvertently being placed in the urogenital diaphragm or penile bulb—a hypothesis that was confirmed by review of postimplant MRIs (Fig. 2). A small difference in craniocaudal length of less than 2 mm was noted between erMRI and sMRI ($p = 0.040$).

Treatment planning difficulties with erMRI

The anatomic distortions induced by the endorectal coil made treatment planning with the erMRI images problematic. Specifically, the flattening of the gland against the pubic bone (Fig. 1) resulted in nonstandard, often asymmetric loading patterns to adequately cover the PTV. In addition, the compression of the prostate placed it in close proximity to the rectum over much of its length, which would have resulted in some needles penetrating the anterior rectal wall to achieve adequate peripheral zone coverage. A representative midgland slice for 1 patient is shown in Fig. 3, demonstrating needle and seed placement for all the three imaging modalities.

One metric that was used to quantify the differences in needle loading required for the erMRI-based plans was the number of seeds per strand. To produce adequate PTV coverage over the distorted prostate gland, erMRI-based plans would have fewer seeds per strand than TRUS-based plans (3.33 vs. 3.54, $p = 0.021$). Of note, no significant difference was found between the number of seeds per strand on sMRI compared with TRUS (3.45 vs. 3.54, $p = 0.322$).

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TRUS Measure (95% CI)</th>
<th>sMRI Measure (95% CI)</th>
<th>erMRI Measure (95% CI)</th>
<th>$p$-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (cm$^3$)</td>
<td>32.5 (29.7–35.2)</td>
<td>33.9 (31.1–36.7)</td>
<td>29.5 (27.0–32.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Medial-lateral diameter (cm)</td>
<td>4.65 (4.50–4.79)</td>
<td>4.48 (4.38–4.59)</td>
<td>5.01 (4.85–5.17)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anterior-posterior diameter (cm)</td>
<td>3.06 (2.92–3.20)</td>
<td>3.50 (3.34–3.67)</td>
<td>2.69 (2.57–2.81)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Superior-inferior length (cm)</td>
<td>4.23 (4.02–4.43)</td>
<td>3.55 (3.40–3.70)</td>
<td>3.71 (3.53–3.89)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

TRUS = transrectal ultrasound; sMRI = standard body array coil magnetic resonance imaging; erMRI = endorectal coil magnetic resonance imaging; CI = confidence interval; MRI = magnetic resonance imaging.

*p-Values are for each MRI modality compared with TRUS.
Decreased activity-to-volume ratio with sMRI

To determine whether the differences in prostate delineation between the different imaging modalities affected the amount of radioactivity required to cover the target volume, we compared the amounts of radioactivity between TRUS-based plans with plans based on each MRI modality. Comparing the ratio of activity per volume instead of total activity eliminates any confounding effect of prostate volume differences between the imaging modalities. The mean activity-per-volume ratio of the sMRI-based plans was lower than that for TRUS-based plans (0.901 vs. 0.974 mCi/cm³, \( p < 0.001 \)). This represents a 7.5% reduction in activity per volume from using sMRI-based plans. Notably, no difference in activity-per-volume ratio was noted between TRUS-based and erMRI-based plans (\( p = 0.852 \)) (Table 2).

Similar PTV coverage and improved dose homogeneity with sMRI

To determine whether the decreased activity per volume used with sMRI affected PTV coverage and homogeneity, we compared dosimetric parameters between sMRI- and TRUS-based plans. PTV coverage was similar between the two modalities; the PTV \( V_{100} \) was slightly better for sMRI (97.3% vs. 96.2%, \( p = 0.001 \)), and the \( D_{90} \) was not significantly different (116.6% for sMRI and 117.5% for TRUS, \( p = 0.526 \)). Dose homogeneity was improved with the sMRI-based plans, as the mean \( V_{150} \) was 47.4% (vs. 53.8% for TRUS, \( p = 0.001 \)), and the mean \( V_{200} \) was 16.6% (vs. 19.2% for TRUS, \( p < 0.001 \)) (Table 2). Notably, \( R_{100} \) was <1 cm³ and \( U_{200} \) was less than 0.07 cm³ for all plans.

When comparing dosimetric parameters between erMRI- and TRUS-based plans, it was noted that there was a small difference in PTV coverage, with slightly better coverage for the erMRI-based plans. Although the absolute differences were small, they did reach statistical significance for both the \( V_{100} \) (\( p < 0.001 \)) and the \( D_{90} \) (\( p = 0.025 \)). Also, while the \( V_{200} \) was lower for the erMRI-based plans (\( p < 0.001 \)), there was no difference in the \( V_{150} \) (\( p = 0.156 \)) (Table 2).

Discussion

To the authors’ knowledge, this is the first study to directly compare TRUS, erMRI, and sMRI in terms of
prostate volume/dimensions and brachytherapy planning. We demonstrate that using sMRI instead of TRUS for brachytherapy planning results in improved visualization of prostate anatomy, and that using sMRI results in less activity per volume required to achieve adequate PTV coverage. It is also notable that sMRI-based plans had improved dose homogeneity, as demonstrated by lower mean $V_{150}$ and $V_{200}$ values with the use of sMRI. Moreover, we found that the use of an endorectal coil induced considerable distortion of the prostate, which suggests that erMRI may not be the ideal imaging modality for brachytherapy treatment planning.

Our results highlight the susceptibility of brachytherapy treatment planning to changes in target delineation. Given the rapid dose falloff inherent in brachytherapy, even minor changes in target delineation can have a significant impact on the accuracy of dose delivery. The sharper anatomic detail visualized by MRI in treatment planning and delivery would allow more accurate seed placement and perhaps better control of the dose to be delivered. Ultimately, this could result in decreased toxicity by reducing the radiation dose to the bladder neck, rectum, urogenital diaphragm, and penile bulb. For example, in one study of factors related to penile bulb dose, postimplant MRI/CT fusion showed that a decrease in the distance from the prostate apex to the penile bulb (which ranged from 5 to 33 mm in that study) correlated with increased penile bulb dose, with approximately one-third of patients receiving potentially clinically significant penile bulb doses (23). Increased dose to the penile bulb has been associated with the development of postbrachytherapy erectile dysfunction in several reports (24, 25), although this association is not conclusive (26, 27). Regardless, the use of MRI for treatment planning

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TRUS Measure</th>
<th>sMRI Measure</th>
<th>sMRI p-Value*</th>
<th>erMRI Measure</th>
<th>erMRI p-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity per volume (mCi/cm³)</td>
<td>0.974</td>
<td>0.901</td>
<td>&lt;0.001</td>
<td>0.979</td>
<td>0.852</td>
</tr>
<tr>
<td>$V_{100}$ (%)</td>
<td>96.2</td>
<td>97.3</td>
<td>0.001</td>
<td>98.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>$D_{90}$ (%)</td>
<td>117.5</td>
<td>116.6</td>
<td>0.526</td>
<td>120.4</td>
<td>0.025</td>
</tr>
<tr>
<td>$V_{150}$ (%)</td>
<td>53.8</td>
<td>47.4</td>
<td>0.001</td>
<td>51.9</td>
<td>0.156</td>
</tr>
<tr>
<td>$V_{200}$ (%)</td>
<td>19.2</td>
<td>16.6</td>
<td>&lt;0.001</td>
<td>15.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

TRUS = transrectal ultrasound; sMRI = standard body array coil magnetic resonance imaging; erMRI = endorectal coil magnetic resonance imaging; mCi = millicurie; PTV $V_{100}$ = percentage of PTV receiving 100% of the prescription dose; $D_{90}$ = dose to 90% of the prostate; PTV $V_{150}$ = percentage of PTV receiving 150% of the prescription dose; PTV $V_{200}$ = percentage of PTV receiving 200% of the prescription dose; MRI = magnetic resonance imaging.

*p-Values are for each MRI modality compared with TRUS.

Fig. 3. Treatment plans based on transrectal ultrasound (TRUS) vs. standard body array coil magnetic resonance imaging (sMRI) vs. endorectal MRI (erMRI). A representative midgland slice for 1 patient demonstrates needle and seed placement in plans calculated with (a) TRUS, (b) sMRI, or (c) erMRI. On the erMRI-based plan, penetration of several needles through the anterior rectal wall would have been required to obtain adequate peripheral zone coverage along the entire gland length. (Dark blue line indicates prostate; light blue line, planning target volume [PTV]; red line, 100% isodose curve; dark green line, rectum; and green dots, seeds.) (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
would allow improved treatment accuracy and improved ability to quantify dosimetric factors associated with treatment-related morbidity.

Another possible benefit of better anatomic visualization is improved control over dose heterogeneity. Accurate visualization of prostate glandular tissue and the urethra would allow improved urethral sparing and facilitate dose escalation to dominant lesions. In fact, advanced MRI techniques such as MRI spectroscopy have been explored for dose escalation using brachytherapy (28, 29) and external beam radiation therapy (30).

Successful implementation of MRI for pretreatment planning will require the ability to use MRI guidance in the operating room. The feasibility of intraoperative MRI for prostate brachytherapy has been demonstrated by the Brigham and Women’s/Dana Farber Cancer Center group (18). In that series, an open MRI was used to perform the implants with real-time intraoperative imaging, using intraoperative planning and optimization. Another study from the same group showed that prostate deformation is seen with pretreatment erMRI when compared with intraoperative MRI (31). These findings are consistent with the gland deformation seen in the present study and underscore the importance of accurate integration of pretreatment and intraoperative MRI, which is of particular importance when using preplanning techniques.

Another means of using MRI in preplanning is MRI/TRUS fusion. Fusing MRI to TRUS has been shown to be feasible and to improve visualization of the prostate, particularly with respect to identifying the base and apex slices on TRUS (32, 33). Those studies demonstrated that TRUS underestimated the extent of the prostate at both the base and the apex. Conversely, we found that TRUS overestimated prostate length, highlighting the interoperator variability inherent with TRUS; presumably this variability could be improved by using MRI/TRUS fusion. A previous dosimetric study compared TRUS-based and MRI-based preplanning and used MRI/TRUS fusion to confirm the reliability of MRI for preplanning (34). Those investigators found almost identical dosimetric parameters between the MRI- and TRUS-based approaches, which would be expected because they used identical seed and needle locations on both MRI and TRUS followed by MRI/TRUS fusion, and did not independently optimize the plans based on the anatomic detail from each image as was done in the present study.

Our finding of prostate gland distortion with erMRI is consistent with previous studies. Heijmink et al. (35) found that introduction of an endorectal coil reduced mean prostate volume by 17.9% compared with standard body array coil MRI, which is comparable to the 13% reduction seen in the present study. Those authors also found that the endorectal coil led to significantly shorter mean anterior-posterior diameter (5.38 mm), longer medial-lateral diameter (3.49 mm), and longer cranio-caudal length (2.24 mm) ($p < 0.05$ for all comparisons); all of these findings are consistent with our results and with those from another study evaluating prostate distortion with erMRI (36). However, to the authors’ knowledge, our study is the first to directly evaluate erMRI for prostate brachytherapy preplanning and compare it with other imaging modalities. From our analysis, we conclude that erMRI is not ideal for treatment planning, because the resulting anatomic distortion required nonstandard, often asymmetric loading patterns, and also often required needles to track through the rectum to achieve adequate peripheral zone coverage. Given the susceptibility of brachytherapy treatment planning to minor changes in target delineation, the distortion in prostate volume and dimensions with the endorectal coil could result in major changes in the accuracy of dose delivery; because the prostate will return to its normal shape after the procedure, the erMRI-based plan does not accurately represent the anatomy that exists for the duration of treatment delivery. Notably, we used erMRI images for the present study that were obtained for the purpose of ruling out extraprostatic extension or seminal vesicle involvement, and were thus optimized for this purpose. erMRI may be more useful for treatment planning if it was optimized for treatment planning, such as minimizing anatomic distortion by filling the balloon less, and this represents an interesting direction for future study.

There are several important limitations to the present study that must be considered. For example, the retrospective nature of this study necessitated the use of scans acquired at different time points—preimplant TRUS and erMRI images were used along with sMRI images acquired 30 days postimplant. This introduces the possibility that postimplant edema could alter prostate volume and dimensions and thus affect treatment planning on the postimplant MRI. However, Crook et al. (37) demonstrated in a study of 241 patients that approximately 90% of postimplant edema resolves at 1 month, although some patients may experience prolonged edema. Further, we found no significant difference between the mean prostate volume using sMRI compared with TRUS (33.9 cm$^3$ sMRI vs. 32.5 cm$^3$ TRUS, $p = 0.076$). Therefore, we believe that using a 30-day postimplant sMRI allows sufficient time for resolution of edema to reasonably approximate preimplant volumes and permit meaningful analysis of treatment planning parameters. Furthermore, the lack of a mean volume difference between TRUS and sMRI suggests that the small differences noted in medial-lateral and anterior-posterior diameter between these two modalities are likely attributable to the minor anatomic distortion caused by the TRUS probe. Regardless, given the previously discussed susceptibility of brachytherapy treatment planning to changes in target delineation, the use of scans from different time points does limit the interpretation of our data. Of note, the visualization of the stranded seeds on the Day 30 sMRI (Fig. 3b) did not affect treatment planning, as the images were used only for anatomic delineation and the treatment planning phase of the study considered only the defined contours.
It is also important to note that the present study used only one TRUS system with one operator. Given the well-described interoperator variability when using TRUS (5–8), it is possible that the volumetric and dosimetric comparisons made in our study may not generalize to other centers. Further, ultrasonographic technologies and techniques continue to improve (38), and improved resolution and anatomic visualization with ultrasound may provide some of the same advantages as MRI. Nevertheless, given some of the inherent limitations of ultrasound, this initial volumetric and dosimetric analysis highlights some of the potential advantages of using MRI for brachytherapy treatment planning.

Conclusions

Improved imaging modalities will continue to help enhance the quality and consistency of prostate brachytherapy, particularly important considerations in an era when improved quality control has become a major focus in radiation oncology. In the present study, we provide data to suggest that the improved anatomic detail visualized with MRI may confer treatment planning advantages when compared with TRUS. We further demonstrate the importance of considering the effect of imaging technique on anatomy, as the prostate gland deformation seen with MRI may confer treatment planning advantages when MRI is used. Nevertheless, given some of the inherent limitations of ultrasound, this initial volumetric and dosimetric analysis highlights some of the potential advantages of using MRI for brachytherapy treatment planning and delivery.

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