BOOST: Genitourinary—Integrated Science and Practice (ISP) Session

Wednesday, 10:30 AM - 12:00 PM • S103CD

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MSRO42 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Co-Director
Fergus V Coakley , MD
Co-Director
Bruce G Haffty , MD
Moderator
Phuoc T Tran , MD, PhD *
Moderator
Martin Colman , MD

MSRO42-01 • Invited Speaker:
Ashesh B Jani MD (Presenter)

MSRO42-02 • Improved Dosimetry in Prostate Brachytherapy Using High Resolution Contrast Enhanced Magnetic Resonance Imaging

Karen Buch MD (Presenter) ; Tye Morancy ; Irving Kaplan MD ; Mustafa Qureshi ; Ariel E Hirsch MD ; Neil M Rofsky MD ; Edward J Holupka PhD ; Renee Oismueller ; Robert Hawliczek ; Thomas H Helbich MD * ; Boris N Bloch MD

PURPOSE
Postbrachytherapy prostate dosimetry data is generally derived from computed tomography (CT), however, studies have demonstrated superior delineation of prostatic and periprostatic structures on magnetic resonance imaging (MRI). The purpose of this study was to evaluate dosimetry data from postbrachytherapy CT versus high resolution, contrast-enhanced MRI (HR-HR-CEMRI).

METHOD AND MATERIALS
Following institutional review board approval, 11 postbrachytherapy prostate cancer patients underwent HR-CEMRI and CT imaging. CT and HR-CEMRI images were randomized and 2 independent, expert readers created contours of prostate, intra- and peri-prostatic structures. Dosimetry data including V100, D90 and D100 was calculated based on these contours. Mixed-effect models were used to test for differences between the two modalities.

RESULTS
Mean (± standard deviation, SD) V100 values from CT and HR-CEMRI contours were as follows: prostate (98.5% ± 1.5 and 96.2% ± 3.6, P=0.003), urethra (81.0% ± 6.6 and 88.7% ± 7.8, P=0.027), anterior rectal wall (ARW) (8.9% ± 5.8 and 2.8% ± 1.7, P
CONCLUSION
Statistically significant differences in prostate, intra- and peri-prostatic dosimetry were seen between CT and HR-CEMRI. These differences suggest volume overestimation of CT derived contours compared to HR-CEMRI. Superior MRI soft tissue contrast enables improved delineation of prostatic and peri-prostatic structures and seems to be superior for dosimetry analysis.

CLINICAL RELEVANCE/APPLICATION
HR-CEMRI likely is superior to CT for prostate postbrachytherapy dosimetry with a more accurate assessment of clinically and functionally relevant prostatic structures for improved clinical outcomes.

MSRO42-03 • Toward Contouring Guidelines for Prostate Cancer Focal Therapy Planning on MRI: Characterization of Tumor Boundary Contrast via Accurate Pathology Fusion

Eli Gibson MSc (Presenter) ; Mena Gaed MD ; Jose A Gomez ; Madeleine Moussa ; Cesare Romagnoli MD ; Suha Ghoul MBBS, MSc ; Derek W Cool MD, PhD * ; Matthew Bastian-Jordan MBBS, BSc ; Jonathan Mandel MD, FRCPC ; Stephen E Pautler MD ; Joseph Chin MD ; Cathie Crukley ; Glenn S Bauman MD * ; Aaron Fenster PhD * ; Aaron D Ward PhD

PURPOSE
Multi-parametric magnetic resonance imaging (MPMRI) is useful for detection and staging of prostate cancer (PCa); however, intra-prostatic lesion (GTV) focused therapy (e.g. radiation boost or ablative focal therapy) requires precise tumor delineation on T2-weighted (T2W) MRI. Our purpose was to measure the detectability (measured as intensity contrast with non-cancerous contralateral/non-neighboring tissue) and boundary localizability (intensity contrast with non-cancerous neighboring tissue) of Gleason score (GS) 7 tumors in the peripheral zone (PZ), contoured by a pathologist on prostatectomy specimens and deformably registered to T2W MRI with high accuracy.

METHOD AND MATERIALS
We acquired endorectal T2W MRI (3T GE Discovery MR750, FSE, TR=5434, TE=159) and histology from 6 subjects. Histology grading and contouring were approved by a genitourinary pathologist, identifying 7 PZ PCa foci with GS 7. To mitigate the bias toward high-contrast tumor boundaries inherent in qualitative consensus mapping of histology contours onto MRI, we used a histology–MRI deformable registration, blinded to the tumor locations, comprising a fiducial-based 3D histology reconstruction to *ex vivo* MRI followed by a deformable registration to *in vivo* MRI. For each focus mapped from histology to T2W MRI, we took 3 mean intensity measurements: T (tumor tissue), N (non-cancerous PZ tissue < 5 mm from the tumor), and C (non-cancerous contralateral PZ tissue). We characterized detectability as $D = (T–C)/C$ and localizability as $L = (T–N)/N$; values < 0 denote tumor hypointensity and 0 indicates no contrast.

RESULTS
Detectability: All foci were hypointense relative to contralateral tissue ($-0.53 < D < -0.15$). Localizability: 3 of 7 foci had clear boundaries ($L < -0.19$); 4 had more poorly defined margins ($-0.12 < L < 0.08$). The mean target registration error was 2 mm.

CONCLUSION
Accurate deformable registration of pathology-defined GS 7 PZ tumors to T2W MRI shows tumor hypointensity but low boundary contrast, challenging accurate tumor boundary delineation for PCa treatment planning. Our preliminary results motivate further study to measure the performance of T2W MRI for tumor boundary delineation or augment it with MPMRI.

CLINICAL RELEVANCE/APPLICATION
Low tumor boundary contrast on T2W MRI for Gleason 7 peripheral zone prostate cancers suggests further assessment of T2W MRI is needed for contouring guidelines for focal/boosted therapy planning.

MSRO42-04 • MR Imaging of Ex Vivo Prostate Specimens for Predicting Resection Margins in Prostate Cancer: A Pilot Study

Martijn Hoogenboom MSc (Presenter) ; Iringo Kovacs ; Isabell Steinseifer ; Andor Veltien ; Iris Nagtegaal PhD ; Michiel Sedelaar MD, PhD ; Fred Witjes MD, PhD ; Jurgen J Futterer MD, PhD ; Jelle O Barentsz MD, PhD ; Arend Heerschap PhD ; Christina A Hulsbergen-Van De Kaa MD, PhD

PURPOSE
This study has been designed to explore if ex-vivo 7T MR imaging can be used for identification of potential positive resection margins in radical prostatectomy specimens.

METHOD AND MATERIALS
Fresh radical prostatectomy specimens (n=6) underwent MR imaging immediately after surgery. Tubes filled with saline both in the urethra and next to the prostate were used as markers. The prostate was doped in

gadolinium to highlight the surgical margins. All specimens were emerged in oil (fomblin) to eliminate susceptibility artifacts. High resolution T2-weighted (T2W) and diffusion weighted images (DWI) were acquired. After evaluation of the in vivo MRI, the tumor and position of possible positive resection margins were determined at the ex vivo images (T2, DWI). Histopathology slices, every 4mm, were made according to the ex vivo images in transversal direction. The ex-vivo images were correlated with the histopathology.

RESULTS
In T2W MR images of ex-vivo prostate zonal distinction (peripheral vs. transition) is less clear than in MRI of the prostate in vivo. In all patients the tumor was visible on the DWI images, however also benign lesions showed reduced ADC and high signal intensity on the b1200 images. The resection margin was free of tumor in all patients with a high intense border at T2W images and a border of high ADC values between tumor and the outside of the prostate. Two patients showed a positive resection margin at the MR images, which correlated with the histopathology. However, in two patients a positive resection margin seemed to be visible based on the MR images, while the histopathology showed a negative resection margin. Therefore in these cases a histopathology confirmation is needed (frozen section).

CONCLUSION
Ex-vivo MRI has the potential to identify benign and malignant structures and to predict resection margins. However, further optimization of the MR imaging protocol is required guided by information from fast frozen histopathology sections to confirm the presence or absence of positive regions.

CLINICAL RELEVANCE/APPLICATION
A fast method is necessary to determine the resection margins after radical prostatectomy for direct extended resection or brachytherapy, ex-vivo MR might be a solution.

MSRO42-06 • Evaluation of Two Automatic Deformable Contouring Methods for Prostate Image-guided Adaptive Radiation Therapy (IGART) in Terms of Delivered Dose Values

Zhilei Shen ; Sara Pirozzi BS (Presenter) * ; Jon W Piper BEng * ; Aaron S Nelson MD *

PURPOSE
Two deformable contouring methods for prostate CBCT, Adaptive and Multi-Adaptive, previously demonstrated good accuracy in terms of Dice coefficients. Now these methods are evaluated by comparing their delivered dose values with those from manual contouring.

METHOD AND MATERIALS
Twenty CBCTs were selected from 4 patients with prostate cancer. Prostate, bladder, rectum, left and right hip contours were manually defined on all the CBCTs. Adaptive contours were created by deforming manually defined Day 1 CBCT contours to subsequent CBCTs, for a total of 16 contour sets. Multi-Adaptive contours were generated by deforming the other 4 CBCTs to the remaining CBCT and combining contours using Majority Vote for a total of 20 contour sets. The daily dose values were measured from the deformed and manual contours. Bland-Altman analysis was used to analyze the 95% confidence limits of agreement (LOA) between manual and deformable contouring.

RESULTS
The mean±SD percentage differences and 95% LOA for Manual vs. Multi-Adaptive were: CTV Mean (-0.6±2.8%) [-0.12,0.09], D25 Bladder (-1.8±25.3%) [-0.54,0.46], D50 Bladder (-4.1±22.8%) [-0.39,0.31], D20 Rectum (0.3±8.3%) [-0.24,0.24], D40 Rectum (0.9±10.3%) [-0.21,0.22], D20 Left Hip (-0.1±0.7%) [-0.01,0.01], and D20 Right Hip (0.1±1.0%) [-0.02,0.02]. For Manual vs. Adaptive the results were: CTV Mean (-0.6±-3.9%) [-0.16,0.13], D25 Bladder (-1.2±-28%) [-0.71,0.45], D50 Bladder (-15.5±-25.2%) [-0.75,0.36], D20 Rectum (1.0±-9%) [-0.25,0.28], D40 Rectum (4.8±-10.9%) [-0.18,0.29], D20 Left Hip (-0.1±-0.6%) [-0.01,0.01], and D20 Right Hip (0.2±-1.1%) [-0.02,0.02].

CONCLUSION
Multi-Adaptive showed increased agreement and decreased bias compared to Adaptive. The 95% LOA showed

that there were no clinically significant differences for CTV Mean, Left Hip, and Right Hip indicating the deformable methods were as good as manual in delineating these structures. Although the 95% LOA were larger for the other structures, the rectum may fall within clinical tolerances.

CLINICAL RELEVANCE/APPLICATION
Tracking dose using deformable contouring of CBCTs has the potential to identify deviations from the planned treatment. Deformable methods have the potential to reduce the burden for contouring.

MSRO42-07 • Neurovascular Bundle Sparing Technique in Prostate Brachytherapy, and the Utility of Intraoperative Ultrasound Fusion with Day 30 CT

Daniel A Jones MD (Presenter)

ABSTRACT
Purpose/Objective(s): Reducing dose to the cavernous neurovascular bundles may be important in maintaining sexual potency after prostate brachytherapy. Last year, we reported the feasibility of the nerve sparing technique, and a significant 28% reduction of mean dose to the NVB associated with the non-cancerous lobe. Dose calculations in the initial study were based on intraoperative assessments. The purpose of this study was to report longer follow up of the cohort, and to integrate a novel fusion technique of the intraoperative ultrasound images, with that of the day 30 CT scan. **Materials/Methods:** Of the previously reported cohort of fourteen patients in which intraoperative contouring of NVB was performed, six had bilateral NVB contoured, and were thus available for comparison. All were categorized as having unilateral prostate cancer. The non-cancerous lobe was implanted with the NVB sparing technique, placing no radioactive seeds within a 5 mm radius of the NVB. Implant standards for V100 and D90 were maintained. Sexual function was measured with the IIEF questionnaire. Intraoperative assessment and contouring of the cavernous NVB location was based on anatomical correlation with ultrasound and doppler flow. Patients were brought back for day 30 CT scan to assess the implant and to confirm good dosimetry. The intraoperative ultrasound was fused to the day 30 CT scan by matching the prostate posterior border and the urethra contours. The intraoperative NVB contours were imported into the day 30 CT scan for dose assessment. **Results:** Median follow up for the cohort approaches 24 months. All patients are in PSA remission. Four of the six are sexually potent, both with and without the aid of a phosphodiesterase (PDE) inhibitor. The mean dose to the spared NVB was 114 Gy, while mean dose to the non-spared NVB was 145 Gy. The mean per-patient dose reduction to the NVB was 16.7% (p=.27) and therefore was no longer significant. **Conclusions:** The NVB sparing brachytherapy technique remains feasible, and does not appear to compromise oncologic outcomes. The dose reduction to the spared NVB was no longer significant with the adjusted fusion technique of day 30 imaging, while previously dose reduction of 27.9% was significant with regards to real time intraoperative ultrasound calculations. The size and shape of the prostate gland may change immensely compared to the fused day 30 CT images, limiting the ability to accurately determine the location of the cavernous NVB. Fusion may be aided with deformable imaging software or reimaging with ultrasound and/or MRI at day 30 to confirm NVB location. Intraoperative assessment of dose to the NVB is probably more accurate compared to the new fusion technique and remains our preferred method at this time. Limitations include small number of patients and short follow up.

MSRO42-08 • DVH-based Comparison Analyses of PTV-coverage and Doses to Organs at Risk (OARs) between Localized Cancers of Large and Regular Volume Prostate Treated with High Dose Rate Brachytherapy (HDR-BT)

Kaidu Motoki (Presenter) ; Ayukawa Fumio ; Kensuke Tanaka ; Mika Obinata ; Hiraku Sato MD ; Nobuko Yamana ; Gen Kawaguchi ; Atushi Oota ; Eisuke Abe ; Ryuta Sasamoto ; Hidefumi Aoyama MD, PhD

ABSTRACT
Purpose/Objective(s):
HDR-BT to the large prostate is technically demanding; because of pubic arch interference, it can be difficult to insert needles at the proper position. The purpose of this study was to investigate the influence of prostate volume on PTV coverage and doses of OARs. Materials/Methods:
122 consecutive patients with localized prostate cancer who received HDR-BT of 18 Gy in 2 fractions

following three-dimensional conformal radiotherapy of 39 Gy in 13 fractions between June 2009 and December 2012 were enrolled. Treatment planning of HDR-BT was customized before each fraction in all but the initial 3 cases, for whom the initial plan was made and applied for the second treatment; thus, there were 241 plans in total. According to the prostatic volume, the 241 plans were divided into a "regular" group (<40ml, N=178) and a "large" group (40m, N=63). CTV and OARs were delineated on computed tomography. The dose was prescribed to the PTV so that a 90% volume of PTV (PTV-D90) received 9 Gy for each fraction, with the dose constraint to the rectum-V75 being < 1 ml, and that to the urethra-V125 being < 1 ml. No dose-constraint was set for the bladder, but we tried to make the bladder-V75 as small as possible.

Results:

The prostatic volume was 27.1 ml (interquartile range: 11 ml; range: 13.9-39.8) in the regular group and 49.7 ml (15.9, 40.1-70.8) in the large group. The percentage of the volume of PTV receiving 100% of the prescribed dose (PTV-V100%) referring PTV coverage and the volume of the rectum receiving 75% of the prescribed dose (rectum-V75%), urethra-V125%, and bladder-V75% are summarized in the table. The PTV-coverage was slightly better in the regular group (P=0.027). Regarding the dose to OARs, there was a trend toward slightly but significantly higher rectum-V75% (P=0.014) and bladder-V75% (P=0.000557) in the large group. There was no difference in the urethra-V125% between the 2 groups (P=0.230). Follow-up data was available in all but one patient. Local tumor control has been obtained in all but 2 patient, who was in the regular group. Above Grade 3 late advers urinary events developed in 2 patients.

Conclusions:

Large-sized prostate exhibited slightly worse PTV-coverage and doses to the bladder and rectum. However, the clinical outcomes did not reflect these differences in the DVH-based analyses.

table

Parameters	Groups regarding the prostate volume	median	inter quartile range	range	p-value (Mann-Whitney U test)	Dose constraint
PTV V100%	<40ml	94.8%	3.83	73.7-99.8	0.027	9 0 %
	4 0 m l	93.5%	3.82	80.5-98.8		
Rectum-V75%	<40ml	0.45ml	0.5	0-1.24	0.014	<1ml
	4 0 m l	0.62ml	0.44	0.07-1.47		
Urethra-V125%	<40ml	0.40ml	0.39	0.01-1.42	0.23	<1ml
	4 0 m l	0.36ml	0.39	0-1.74		
Bladder-V75%	<40ml	4.56ml	3.37	0-15.15	0.000557	not applied
	4 0 m l	5.66ml	4.9	0-18.06		

Active Handout
http://media.rsna.org/media/abstract/2013/13041568/MSRO42-08 MotokiSECURED.pdf

MSRO42-09 • Practice Patterns in the Prescription of Elective Nodal Irradiation in Prostate Cancer

David Greene MD (Presenter)

ABSTRACT
Purpose/Objective(s):
To determine practice patterns with regard to elective nodal irradiation for prostate cancer among North American radiation oncologists
Materials/Methods:
A standardized survey instrument was developed and e-mailed to 184 academic and 788 private practice radiation oncologists querying demographics, treatment techniques, and methods of assessment of nodal risk in prostate cancer. Nodal risk (RN+), as well as prescription or omission of elective nodal irradiation (ENI) in 6 case scenarios were queried. Fisher's exact test was used to determine if an association existed between the variables.
Results:
Of 972 surveys sent, 448 were read, and 90 responses were evaluable. 74% reported a private practice (48% urban, 26% rural/regional) and 26% an academic practice. Regional distribution was 50% West, 23 % South, 17% Mid-West, and 10% Northeast. Years in practice ranged from >21 to <5. 31% identified as genitourinary/prostate specialists. 97% reported their primary modality for pelvic ENI as IMRT. 51% reported using the Partin Table for assessing (RN+), 42% the Roach Formula, 17% the Kattan Nomogram, and 23% a combination of these. 85 % reported no change in prescribed dose to the prostate/fossa with ENI. 9% lowered, and 6% increased final dose with ENI. 7% of respondents reported situation dependent inclusion of para-aortic lymph nodes with ENI. 59% reported prescription of >78Gy to the prostate with ENI, while 41% prescribed >74 Gy. For a nominal intermediate risk patient, 30% favored ENI in the definitive setting while 23% favored ENI in the adjuvant setting. For favorable high risk, 67% favored ENI. For unfavorable high risk, 87% favored ENI. For locally advanced high risk, 90% favored ENI in the definitive setting and 46% favored ENI in the adjuvant setting. Considerable variability was found in assessed nodal risk for all cases. Practice setting ($p=0.017$), Practice region ($p=.03$), and Method of Nodal Assessment ($p=0.02$) were found to be significantly associated with prescription of ENI.
Conclusions:
Notable variation exists with regard to assessment of nodal risk and prescription of ENI. Practice setting, geographic region, and method of assessment of nodal risk have an impact on prescription of ENI. Ongoing prospective trials are required to determine best practices.