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Abstracts

Abstract number 1

The effect of bilateral treatment plan symmetry on postoperative dosimetric outcomes in prostate low-dose-rate brachytherapy: a single-institution study

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Aims & Introduction: The aim of this study was to evaluate the long-standing hypothesis that preoperative bilateral plan symmetry in prostate low-dose-rate (LDR) brachytherapy has a profound impact on postoperative dosimetric quality.

Materials/Methods: Retrospective analysis of 247 patients with localized prostate cancer treated consecutively with LDR brachytherapy were obtained from the Northern Ireland Cancer Centre (Belfast, Northern Ireland, UK). Unique to the data set was the introduction of bilateral treatment plan symmetry as a critical criterion during planning. Preoperative and 1-month postoperative treatment plans were available for all patients. Bilateral plan symmetry (SYMMv150) was measured by creating a contour from the preoperative prostate V150 isodose, reflecting the volumes about the prostate centroid, and computing a Dice coefficient between the left and right isodose volumes. Principle Component Analysis (PCA) feature elimination was used to identify additional preoperative variables with the largest contribution to postoperative dosimetric variance. A normalized multivariate logistic regression was performed to compare preoperative plan variables impacting postoperative dosimetric outcomes. P-values ≤ 0.05 were considered significant.

Results: PCA feature elimination showed that SYMMv150, case number (the center-specific learning curve), and preoperative D90 and V100 were the most significant variables contributing to postoperative dosimetry. Postoperative prostate V100 had a significant positive correlation with increasing case number (OR = 5.20, p = 0.006), and increased SYMMv150 (OR = 2.47, p = 0.05). Furthermore, postoperative prostate D90 had a positive correlation with increased SYMMv150 (OR = 4.12, p = 0.005), but not case number. Increased postoperative rectum D1cc only had a positive correlation with increased preoperative prostate V100 (OR = 1.84, p = 0.033).

Conclusion: Incorporating preoperative bilateral treatment plan symmetry is likely to improve postoperative target coverage – with no significant effect on rectal tissue sparing - independent of the center-specific learning curve.

Abstract number 2

An Investigation into Low Dose Rate Prostate Brachytherapy Iodine-125 Seed Damage during a Standard Transurethral Resection of the Prostate

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Aims & Introduction: Low dose rate brachytherapy (LDR) was established at Barts Health NHS trust in 2008. In a minimal number of LDR cases lower urinary tract symptoms (LUTS) persist. Transurethral resection of the prostate (TURP) is a common surgical intervention used for obstructive prostatic hypertrophy. Here a case is described where a TURP was performed on an LDR patient which subsequently resulted in the implanted seeds becoming unsealed.

Materials/Methods: In 2015, a patient was implanted with 76 Iodine-125 LDR prostate brachytherapy seeds of 16.6MBq each in accordance with department protocol. One year later his LUTS required surgical intervention. Although routine in other centres it was the first TURP post LDR Brachytherapy carried out at this Trust. The TURP was carried out using the Olympus Transurethral Resection in Saline (TURiS) system. As expected, seeds were recovered in the resected prostatic tissue, however they had become unsealed. This resulted in contamination to the area around the procedure and the saline that was used for irrigation.

Results: It was discovered that the titanium can surrounding the seeds had become cut in a number of places and small radioactive flakes were being released. Investigations involving the seed manufacturer and TURP equipment manufacturer were found to be inconclusive. Surveying other centres that carry out this procedure also did not allow a conclusion to be drawn; however one other centre reported a similar incident.

Conclusion: The root cause of this incident has not been found. As a precaution the TURP equipment manufacturer has issued an amendment to the instructions for use indicating the resection electrode must be kept 10mm away from metal parts, such as implants. It would be useful to have a discussion about a unified approach to performing TURP on LDR seed brachytherapy patients and to determine suitable equipment for such a procedure.

Abstract number 3

Modulation of spatial dose distribution in permanent prostate brachytherapy using sector dosimetry: an analysis of 394 patients from a single institution

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Aims & Introduction: To evaluate the influence of twelve sector analysis in the post-implant spatial dose distribution of permanent prostate brachytherapy (PPB) service. Post-implant global (whole gland) and twelve sector dosimetric analysis were assessed and their correlation to rectal dose has been evaluated.

Materials/Methods: 394 patients treated consecutively with I-125 PPB (145Gy and 110Gy) at a single institution were assessed. Post-implant analysis using CT was performed for whole prostate and multi-sectors. The quality of implant was reviewed using sector analysis every 50 patients to assess dosimetric differences over time. Individual sectors were generated by demarcating the prostate into three equal lengths (base, midgland, and apex). Each of these volumes was further divided into four axial sectors (right & left anterior and right & left posterior). Minimum dose to 90% of prostate (D90) for both global and individual sectors were assessed. Dose to 0.1cm3 of rectum (D0.1cc) and its correlation to sectors 7 and 8 were evaluated.

Results: The mean D90 achieved using global analysis for 394 patients is 105.8%±11.0 (first 50 cases - 95.7%±11.0 and recent 50 cases - 112.2%±10.3). Linear regression corroborated a significant improvement in global D90 with case number (R2=0.3135) at a rate of 0.054Gy/case. However, the review of patients using sector analysis aided in the improvement in D90 in base sectors with increasing case number at a rate of 0.07 Gy/case without altering dose in midgland (0.02Gy/case) and apex (0.003Gy/case). The result demonstrates a correlation between rectum D0.1cc and posterior midgland sectors (sector 7, r=0.391; sector 8, r=0.429) which is not apparent with global dosimetry (r=-0.109).

Conclusion: The result demonstrates that routine review of post-implant dosimetry using sector analysis could improve post-implant spatial dose distribution in PPB which may enhance on-going improvements in implant quality.

Abstract number 4

Robotic Prostate Biopsy and LDR/HDR Brachytherapy under MRI Guidance: The CoBra Project

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Aims & Introduction: The CoBra (Cooperative Brachytherapy) project aims to develop an innovative technology for robotic biopsy and brachytherapy under MRI guidance. The five year project is funded by EU Interreg 2 Seas, involving institutions from the UK, Belgium, Netherlands and France, led by the University of Lille. The project aims to improve the quality of both diagnosis and treatment of localized cancers, initially in the prostate with potential applications for other sites. The main deliverable will be a robotic arm for both biopsy and brachytherapy treatment (LDR and HDR), utilising a single perineum puncture needle technique, with high precision and accuracy under real-time MRI guidance. The robotic arm software development includes dedicated software responsible for needle and organ motion tracking under MRI, automatic dose optimisation and real time treatment delivery monitoring. A geographic mapping of patient need will also be undertaken. Brachytherapy may be further developed to improve accuracy, reliability, and the adoption of recent advances in focused and focal approaches. A single system to improve the effectiveness of biopsy and the accuracy of brachytherapy treatment, utilising exact knowledge of tumour location via real time MRI can reduce uncertainties. Current state-of-the-art, utilising MRI-ultrasound fusion biopsy is time and resource consuming. It is envisaged that biopsies can be performed with an automated robot under MRI guidance in real time saving staff and theatre resources and improving accuracy. Expert views are sought on the clinical and technical specification for the development.

Materials/Methods: The scope and milestones of the project will be outlined.

Results: The CoBra project was initiated in January 2018. A review of foundation work will be presented, including a fully autonomous ultrasound-guided robot for brachytherapy developed by Univ Lille/SATT-Nord.

Conclusion: The presentation will outline the CoBra project proposals, progress, and seek views of the conference delegates.

Abstract number 5

Initial experience using a rectal spacer (SPACE-OAR) with LDR brachytherapy for Prostate cancer

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Aims & Introduction: We introduced the Space-OAR (Augmenix) spacer as a new procedure for selected patients undergoing LDR brachytherapy monotherapy or combination therapy with external beam radiotherapy for Prostate cancer.

Materials/Methods: The spacer was inserted via transperineal ultrasound guided placement under general anaesthetic at the end of the LDR I-125 brachytherapy implant. An MRI scan was fused with the post implant or planning CT scan. We set up a prospective service evaluation of the procedure. Pre and post treatment the patients IPSS score was recorded and toxicity scored according to the RTOG acute radiation toxicity scoring and CTCAE v 4.0. Intra operative and post-operative dosimetry and external beam radiotherapy dosimetry was analysed.

Results: Eight patients had a Space-OAR inserted. Two patients underwent monotherapy 145Gy and had a history of previous Ulcerative Colitis. Two patients underwent monotherapy with 145Gy and had a focused implant with dose escalation to the posterior sectors. Four patients under went LDR brachytherapy 115Gy followed by external beam radiotherapy 46Gy in 23 fractions. There were no complications during the procedure and all patients were discharged on the same day. There were no reports of rectal pain or discomfort following the procedure. The spacer was in a good position in all patients with a median separation of 12mm (range 8.2mm to 14.3mm) achieved. There was no increase in acute urine toxicity seen and several patients had less urine toxicity than expected. No patients experienced acute GI radiation toxicity. The seed position and post implant prostate dosimetry was unaffected by the Space-OAR. Further follow up is needed to assess for late toxicity.

Conclusion: The use of the Space-OAR rectal spacer with LDR brachytherapy is well tolerated and may reduce rectal toxicity.

Abstract number 6

Experience of HDR brachytherapy in Leeds as a salvage treatment for locally relapsed prostate cancer

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Aims & Introduction: High Dose Rate (HDR) brachytherapy can be used as salvage treatment for local recurrence following previous radiation. We reviewed characteristics of treated patients and clinical outcomes.

Materials/Methods: Retrospective review of HDR salvage brachytherapy cases performed between 2010 and 2016 using a prospective database and review of electronic patient records.

Results: 26 men underwent HDR salvage brachytherapy. All had pelvic MRI and 12 (46%) had additional Choline-PET scans to exclude distant disease. Recurrence was confirmed using template biopsy and found to be intra-prostatic in 21 (81%), within seminal vesicles in 4 (15%) and peri-prostatic in 1 patient (4%).

Median time from initial to salvage treatment was 100.3 months (range 35.9–149.3 months). Median PSA at relapse was 4.5 (range 1.1–9.4) ng/mL. Hormonal therapy with salvage brachytherapy was used in 18 of 26 men (69%) for 6 months in 15 patients and in 3 patients long-term.

Median focal PTV D90 was 18.4Gy (15.1–20.4Gy). Rectal dose constraints were achieved in all and urethral constraints were met in 21 of 26 patients (81%).

Median length of follow up was 18.4 months (range 0.8–80.3 months).

2 year PSA progression-free survival was 55.3% (range 25.8-77.2%)

7 patients (27%) had post-salvage PSA progression with median time to progression of 15.5 months (range 7.3–65.4 months).

Grade 2 late urinary toxicity was seen in 5/26 patients (22%).

Conclusion: Early outcomes suggest acceptable toxicity with HDR salvage brachytherapy. Longer-term rates of biochemical control remain to be discerned in this group of patients. Results were influenced by concomitant hormonal therapy.

Abstract number 7

Characterising the dosimetric quality of ^{125}I LDR prostate implants and assessing inter-operator variability

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Aims & Introduction: Optimal dosimetry in low dose rate permanent seed implants can be achieved using a single stage intraoperative technique[1]. In this study, we propose a method to characterise the dosimetric quality of ^{125}I prostate implants and assess inter-operator variability for 627 Low/Intermediate risk patients implanted at a single centre.

Materials/Methods: The patient implants were performed variously by 8 operators (2 Oncologists, 6 Urologists) over a 13 year period. Dosimetric parameters (D_{90}, $V_{100\%}$, $V_{150\%}$, Rectum D_{2cc}, Urethra D_{10}) associated with the implants were collated. Scores for each dose objective were then represented by a cumulative logistic expression, and an overall quality metric formed as a product of the objective scores. Planning dose targets and constraints were used as filters to assign a binary quality outcome to each patient plan. The data was used to generate a receiver operating characteristic (ROC) curve, with the area under the curve (AUC) assumed to characterise the dosimetric quality of the implant. A reference ROC curve was generated using the total dataset. Additional curves were generated for data subsets associated with the various operators, with differences in AUC assumed to be indicative of inter-observer variation.

Results: The AUC associated with the reference ROC was observed to be 0.77 ± 0.03. The AUC associated with the individual oncologist/urologist combinations was observed to range from 0.54 ± 0.20 to 0.84 ± 0.07, with the results indicative of some inter-operator variation, and largely due to the spread in D_{90} and $V_{150\%}$.

Conclusion: A method to characterise the quality of dosimetric implants using ROC curves has been proposed. The results indicate that this could be a useful tool in assessing and optimising prostate implant techniques.

Reference

[1] A. Polo, C. Salembier, J. Venselaar, and P. Hoskin. *Review of intraoperative imaging and planning techniques in permanent seed prostate brachytherapy*." Radiother. Oncol. **94** 12-23 (2010)