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In this issue

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In this issue

I am pleased to introduce the third issue of the *Journal of Radiotherapy in Practice* for Volume 19, published in September 2020. In this issue, there are 13 original articles on a range of topics and two literature reviews—one on the role of brachytherapy in the management of early-stage breast cancer and another on a review of ultrasound-mediated microbubbles technology for cancer therapy as a vehicle for chemotherapeutic drug delivery. The technical note is on the subject of the role of fiducial markers in the assessment of prostate bed motion in post prostatectomy patients treated with volumetric modulated arc therapy (VMAT). The case study in this issue is on three interesting cases of bilateral breast cancer.

In the first paper, Cvetkova, Craig, O'Donovan and Mullaney calculate setup errors observed for palliative patients when positioned using one skin mark vs. three skin marks, and assess the accuracy of both approaches.

Displacements in the left–right and superior–inferior directions were retrospectively analysed for 175 sites treated with a course of fractionated palliative radiotherapy (RT). Population mean, systematic and random errors were calculated in both directions for patients positioned with one and three skin marks. The frequency of deviations was also examined for both groups.

Findings indicate that three skin marks are recommended for patients receiving a fractionated course of palliative RT as it reduces setup error, reduces the number of gross displacements (>10 mm) and increases the number of displacements within the clinically acceptable tolerance of 5 mm.

In the next paper, Bridge, Kirby and Callender present their findings from a plan evaluation workshop that facilitated a comparison of Virtual Environment for Radiotherapy Training (VERT) with conventional treatment planning software (TPS).

Students on a pre-registration postgraduate diploma in radiotherapy worked in small groups evaluating lung plans using both VERT and Eclipse TPS tools. All students were invited to provide ratings concerning how helpful each modality was for a range of evaluation parameters and preferences for use. Findings reported that most students found the session useful and expressed a desire to use VERT in future plan evaluation. TPS was perceived to be more helpful with constraint-based evaluation, while VERT was more helpful with evaluating plans for clinical setup and delivery. Student therapeutic radiographers found VERT to be helpful as a plan evaluation tool alongside standard TPS tools, in particular for clinical setup and delivery aspects of planning. Future work is ongoing to identify the specific impact of VERT as a plan evaluation tool for both students and qualified planners.

In the next paper, Spatola, Milazzotto, Tocco et al. investigate if reirradiation with stereotactic radiotherapy technique (SBRT) is a good option as definitive treatment for patients with metachronous non-small cell lung cancer (NSCLC). Treatment of metachronous second primary NSCLC in patients already treated with definitive radiotherapy is a matter of debate as most patients are excluded from surgical treatment, which remains a therapeutic standard for patients with isolated lung masses. Salvage chemotherapy or immunotherapy alone offers a low probability of disease control. The option of reirradiation often remains the only viable possibility, but the risks of severe acute or late toxicities affecting the surrounding normal tissues make this a real clinical challenge.

From January 2015 to April 2018, five patients (male/female 4/1; age 54–81 years; median 68) with previously irradiated NSCLC presented with a second primary lung tumour. The authors report their initial experience about the use of SBRT in already irradiated patients and found a local disease control in all cases with an acceptable toxicity.

The aim of the study by Alsbou, Ahmad and Ali was to investigate quantitatively the correlation of displacement vector fields (DVF) from different deformable image registration algorithms (DIR) to register images from helical (HCT), axial (ACT) and cone beam CT (CBCT) with motion parameters.

CT images obtained from scanning of the mobile phantom were registered with stationary CT images using four DIR algorithms from the DIRART software: Demons, Fast-Demons, Horn-Schunck and Lucas-Kanade. HCT, ACT and CBCT imaging techniques were used to image a mobile phantom, which included three targets with different sizes (small, medium and large) that were manufactured from a water-equivalent material and embedded in low-density foam to simulate lung lesions. The phantom was moved with controlled cyclic motion patterns where a range of motion amplitudes (0–20 mm) and frequencies (0.125–0.5 Hz) were used.

The findings are the local DVFs provide direct quantitative values for the actual internal tumour shifts that can be used to determine margins for the internal target volume that consider

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tumour motion during treatment planning. Furthermore, DVF distributions can be used to extract motion parameters such as motion amplitude, which can be extracted from the maximal or minimal DVF calculated by the different DIR algorithms employed in the management of patient motion.

In the study by Bagheri, Firouzjah and Farhood, the authors undertake the measurement of photon and thermal neutron doses of the contralateral breast (CB) surface in breast cancer radiotherapy. The right breast region of RANDO phantom was considered as CB, and the measurements of photon and thermal neutron dose values were carried out on this region surface.

The results revealed that the total dose values received by the CB surface during radiotherapy with high-energy photon beams was remarkable. In addition, the dose values received by the CB surface when using a physical wedge were greater than when using a dynamic wedge, especially for medial tangential field. The correlation of displacement vector fields was calculated by different deformable image registration algorithms with motion parameters in helical, axial and cone beam CT imaging.

In the paper by Tharavichitkul, Chakrabandhu, Klunklin et al., the authors present their early results of localised, high-risk prostate cancer treated by moderate hypofractionation (70 Gy at 2.5 Gy per fraction).

Between 2012 and 2017, 40 patients with high-risk, localised prostate cancer were treated by a moderately hypofractionation regimen (70 Gy at 2.5 Gy per fraction) with intensity-modulated radiation therapy. Data relating to treatment outcomes and toxicities were evaluated. The study found that this regimen yielded tolerable, acceptable toxicity profiles in high-risk, localised prostate cancer patients.

In the next paper, Kaewpruk, Chakrabandhu, Wanwilairat and Nobnop compare the dosimetric results regarding the sparing effect on normal tissue between RapidArc (RA) and helical tomotherapy (HT) plans for nasopharyngeal carcinoma (NPC) patients in cases of equal target dose controls utilising two techniques.

Thirteen NPC patients treated with HT were replanned using the Varian Eclipse treatment planning system (TPS) for the RA plan. The target dose of the RA plan was optimised equally to the HT plan in terms of target coverage, dose conformity and dose homogeneity for assessing normal tissue sparing between the two techniques. All dose volume parameters, monitor unit (MU) and delivery time were also investigated.

With the same PTV coverage, homogeneity and conformity, almost all of RA and HT treatment planning met the planning goal for normal tissue sparing. There were no significant differences between the two techniques except in the left parotid gland. The RA plans were superior to HT plans by effectively reducing the MU and treatment time.

In the paper by Geraily, Monzari, Hadisinia et al., the aim was to produce a low-cost anatomical model of an adult male, including lower limb, to evaluate the 3D dose distribution for dosimetry measurements, especially in total body irradiation (TBI) and total skin electron therapy (TSET).

CT scan images of the atomic energy organisation RANDO phantom and leg CT scan images of 20 healthy persons were averaged. Selections of different body tissue substitute materials and phantom validation were performed according to previous studies. The authors concluded that this validated phantom has numerous advantages and recommend it to be used in TBI and TSET dosimetry.

In the next paper, Gangopadhyay and Saha present their retrospective study into the assessment of pelvic wall disease control and toxicity in patients who received individually customised parametrial boost (PMB) for locally advanced cervical cancer with 2D planned external beam radiotherapy. Outcomes of an escalated dose combined boost were also evaluated.

Toxicity and pelvic wall recurrence were evaluated over a median period of 24 months between two groups who received different pelvic wall doses. One group was randomised to receive either intracavitary brachytherapy with an external beam PMB using a customised midline shield, or a dose-escalated combined boost with interstitial brachytherapy and PMB. The comparator group received no PMB. Findings point out that individually customised 2D parametrial boosts with 3D image-based intracavitary brachytherapy improved pelvic wall control in locally advanced cervix cancer. Dose-escalated combined boosts offered no significant benefit over standard boost doses.

In the study by Nadi, Abedi-Firouzjah, Banaei et al., the authors evaluated the dosimetric parameters of level II lymph nodes in chest wall 3D conformal radiotherapy (3D-CRT) and intensity-modulated radiotherapy (IMRT) of mastectomy patients using a dual isocentric technique (DIT) and mono-isocentric technique (MIT).

CT images of 20 mastectomy patients undergoing chest wall external radiotherapy were used as input data for the two above-mentioned techniques. Selected dosimetric parameters were calculated for the axillary level I–III lymph nodes, chest wall, heart and lung. A paired *t*-test statistical analysis was used for comparing the results of MIT and DIT in both 3D-CRT and IMRT methods.

In both 3D-CRT and IMRT methods, the lymph node level II dose distribution in MIT was closer to the prescribed dose compared to DIT due to the position of these nodes in the field junction area. To achieve a better dose homogeneity, it could be recommended to use MIT instead of DIT in 3D-CRT and IMRT for mastectomy patients.

The aim of the next paper by Varghese, Sidhique, Prabhu et al. was to assess relapse-free survival (RFS) and the factors influencing local recurrence in patients with desmoid fibromatosis (DF) and to determine the role of postoperative radiotherapy in improving local control.

A retrospective analysis of 51 patients treated for DF from January 2004 to December 2013 was done. RFS was calculated using Kaplan–Meier curve. Univariate analysis was done to assess correlation with tumour size, site, extent of surgery and margin status and adjuvant radiotherapy with RFS. The authors concluded that a complete excision with negative margins gave the best local control in desmoid fibromatosis; the benefit of postoperative radiotherapy could not be ascertained.

In the next paper by Aghdam, Siavashpour, Mahdavi et al., they estimated the radiation contamination dose (RCD) for different combinations of electron energy/distance, applicator and radius around the light intraoperative accelerator (LIAC®), using a high-dose-per-pulse, dedicated intraoperative electron radiotherapy machine

The Monte Carlo Nuclear Particles (MCNP) code was used to simulate the LIAC® head and calculate RCD. Experimental RCD measurements were also done by the Advanced Markus chamber inside an MP3-XS water phantom. Relative differences of simulations and measurements were calculated. RCD seems to be strongly dependent on electron beam energy, applicator size and distance from the accelerator head. Agreement between MCNP results and ionometric dosimetry confirms the applicability of this

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simulation code in modelling the intraoperative electron beam and obtaining dosimetric parameters. RCD is a parameter that would restrict working with LIAC in an unshielded operative room.

In the paper by Chakravarty, Semwal, Trivedi et al., the authors present their study on the 2D and 3D dosimetric values for bladder and rectum, and the influence of bladder volume on bladder dose in high-dose-rate (HDR) intracavitary brachytherapy (ICBT).

The authors prospectively collected data from 103 consecutive cervical cancer patients (over 310 HDR fractions) undergoing CT-based HDR-ICBT. Correlation among bladder and rectum maximum volume doses and corresponding International Commission on Radiation Units (ICRU) point doses were estimated and analysed. The impact of bladder volume on bladder maximum dose was assessed. Findings are that ICRU point doses to bladder and rectum are less likely to correlate with long-term toxicities to these organs. Further, in clinical practice where inter-fraction bladder volume does not vary widely, there is no correlation between bladder volume and bladder dose.

The next paper is a literature review by Thorpe and Drury-Smith on the role of brachytherapy in the management of early-stage breast cancer. This review evaluates whether brachytherapy can be considered an alternative to whole-breast irradiation (WBI) using criteria such as local recurrence rates, overall survival rates and quality-of-life (QoL) factors. This is an important issue because of a decline in local recurrence rates, suggesting that some women at a very low risk of recurrence may be incurring the negative long-term side effects of WBI without benefitting from a reduction in local recurrence and greater overall survival. As such, the purpose of this literature review is to evaluate whether brachytherapy is a credible alternative to external beam radiation with a particular focus on the impact it has on patient's QoL.

Findings showed that brachytherapy is superior to WBI for some QoL factors such as being less time-consuming and equal in terms of others, such as breast cosmesis. The results showed that brachytherapy does come with its own local toxicities, which could impact upon QoL such as the poor breast cosmesis associated with some brachytherapy techniques. In conclusion, brachytherapy is deemed a safe or acceptable alternative to WBI, but there is a need for further research on the long-term local recurrence rates, survival rates and QoL issues as the volume of evidence is still significantly smaller for brachytherapy than for WBI.

The second literature review by Osei and Al-Asady surveys the ultrasound-mediated microbubbles technology for cancer therapy as a vehicle for chemotherapeutic drug delivery. The unique behaviour of microbubbles under an ultrasound acoustic pressure makes them an useful agent for drug and gene delivery. Several studies have demonstrated the potential application of microbubbles as a non-invasive, safe and effective technique for a targeted delivery of drugs and genes. Drugs can be incorporated into the microbubbles and then carried to the site of interest where they get released by the breaking of microbubbles using ultrasound to achieve the required therapeutic effect. The conclusion drawn is that ultrasound-mediated microbubbles technology has a potential to significantly improve chemotherapy drug delivery to treatment sites with minimal side effects.

The technical note, by authors Vlachaki, Ahmad, Kennedy, Aref, and Chuba, is on the role of fiducial markers in the assessment of prostate bed motion in post-prostatectomy patients treated with VMAT.

Accurate localisation of target position is crucial when using techniques with sharp dose fall-off such as VMAT. Gold seed fiducial markers have been used for target localisation in image-guided radiation therapy (IGRT) for various tumours, including intact prostate cancers. However, their role in target localisation in post-prostatectomy radiotherapy is unclear. This study was undertaken to determine the feasibility and effectiveness of gold seed fiducial markers in patients undergoing prostate bed VMAT.

An institutional radiation oncology database was used to analyse the treatment data of 18 post-prostatectomy patients with implanted gold seed fiducial markers. The shifts of fiducial markers were reviewed, tabulated and statistically analysed.

The final paper is a case study by Tudu, Kumar, Singh and Raina involving three cases of bilateral breast cancer.

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