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SMALL ANIMAL IGRT SPECIAL FEATURE: EDITORIAL

Small animal image-guided radiotherapy

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In this special issue of BJR, we focus on the developments in small animal image-guided radiotherapy (IGRT). Translation of laboratory-based *in vivo* radiation research into the clinic has recently gone through rapid evolution with the development of sophisticated small animal irradiation platforms. These allow the replication of key aspects of advanced radiotherapy plans, where dose is modulated in space and time, and to target, with unprecedented accuracy, tumour and normal tissue models *in vivo*. These technologies and their application is a step change from conventional approaches involving the delivery of uniform beams with crude shielding approaches alongside the availability of realistic tumour models, which more precisely mimic the tumour environment. This special issue brings together a series of review articles, full papers and commentaries from selected presenters at the recent third Symposium on Small Animal Precision Image-guided Radiotherapy, which took place from 21 23 March 2016 in Ghent, Belgium, organized by Christian Vanhove and Frank Verhaegen. This symposium brought together leading specialists and vendors in the fields of radiobiology, radiotherapy, translational research, radiation physics, precision engineering, imaging and dose calculation. It included sessions on tumour/normal tissue models, research technology, precision radiotherapy, imaging and novel methods, dosimetry and technology, and translational studies.

In an introductory review (doi: https://doi.org/10.1259/bjr.20160474; Hill), the keynote speaker, Dr Richard Hill, describes the changing paradigm of tumour response to irradiation including the role of cancer stem cells, radiation damage to the vasculature and the potential for radiation to enhance immune activity against tumour cells. This evolving understanding of tumour response needs to be validated with new models and approaches such as small animal IGRT. It is also important to be aware of the differences between human and mouse models and develop possible strategies for future refinement of murine models of cancer and radiation for the benefit of both basic radiobiology and clinical translation (doi: https://doi.org/10.1259/bjr.20160441; Koontz et al). There is also an important interface between the use of small animal irradiation platforms and clinical systems utilized to deliver advanced radiotherapies to canine models for veterinary purposes (doi: https://doi.org/10.1259/bjr.20160617; Dolera et al).

The challenge of improving the accuracy of targeting by including motion management in small animal IGRT studies is covered in a commentary with a focus on respiratory-gated imaging and beam delivery approaches (doi: https://doi.org/10.1259/bjr.20160482; Hill and Vojnovic). In another study, the use of a four-dimensional mathematical 4D Digital Mouse Whole Body (MOBY) phantom aimed at performing a quantitative analysis of the impact of respiratory motion on a mouse lung tumour irradiation with small fields is described (doi: https://doi.org/10.1259/bjr.20160419; van der Heyden et al). Dynamic phantoms can also be utilized for both respiratory monitoring and micro-Positron Emission Tomography (μPET)/CT scans (doi: https://doi.org/10.1259/bjr.20160442; Frelin-Labalme and Beaudouin).

Alongside accuracy, dosimetry is challenging in this new field. Amongst existing point dosemeters, very few are dedicated to both medium-energy X-rays and millimetre beams, but scintillating fibre dosemeters are potentially promising tools for real-time dose measurements in the small animal exposure fields (doi: https://doi.org/10.1259/bjr.20160454; Le Deroff et al).

In the clinic, dual-energy CT is being utilized for patient imaging and the first study that investigated quantitative dual-energy CT imaging for small animal irradiators with an integrated cone-beam CT system is reported (doi: https://doi.org/10.1259/bjr.20160480; Schyns et al), showing clear benefits for tissue identification. Alongside CT approaches, MRI-based RT planning of murine tumours is feasible using small animal IGRT (doi: https://doi.org/10.1259/bjr.20160427; Corroyer-Dulmont et al).

Small animal IGRT is increasingly being used for hypothesis testing around non-uniform exposures, such as spatially fractionated radiotherapy (GRID) exposures, some of which are being predicted to be more effective than uniform delivery of the same physical dose (doi: https://doi.org/10.1259/bjr.20160485; Butterworth et al). For application of advanced delivery, some groups are also working on dose calculation algorithms for kilovoltage beams as alternatives to full Monte Carlo dose calculations (doi: https://doi.org/10.1259/bjr.20160426; Reinhart et al).

The future for the application of small animal IGRT holds significant potential and we hope this selection of articles will give *BJR* readers a taste of the challenges and opportunities for small animal IGRT to revolutionize pre-clinical translational radiation research.