Title: **Magnetic resonance imaging based workflow for radiotherapy planning on a small animal radiation research platform**

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Abstract:

Introduction. Computed tomography (CT) is the standard imaging modality for radiation therapy planning (RTP) because of its ability to provide information on electron density. However, magnetic resonance imaging (MRI) provides superior soft tissue contrast, facilitating the precise selection of the target volume. The aim of this study is to present an MRI based workflow for RTP on a small animal radiation research platform (SARRP), where MRI is used for target selection and for dose calculation.
Methods. Three Wistar rats (male, 382±26g) were anesthetized using isoflurane before starting MRI and CT. MRI was done on a 7T system and images of the rat brain were collected using a T1-weighted MDEFT sequence, directly followed by a ZTE sequence. ZTE offers the opportunity to acquire images from proton-poor structures with short transverse relaxation times, such as bone, by using a "zero" echo time and rapid readout of the fast decaying signal. Following MRI, the animals were moved to the SARRP to start a cone-beam CT, reconstructed by filtered back-projection, to obtain the standard-CT for RTP. ZTE and MDEFT images were co-registered to the standard-CT and the co-registered ZTE images were segmented into 2 (soft tissue, air) or 3 (bone, soft tissue, air) tissue classes to obtain 2 pseudo-CT data sets. MDEFT images, standard-CT and both pseudo-CTs were imported in the RTP software of the SARRP. On the MDEFT images, the right motor cortex was selected as target and a dose plan was calculated to deliver 10Gy using 4 beams in combination with the 3x3mm collimator. The delivered dose was computed using the standard-CT and using the two pseudo-CTs. Differences in dose delivery were quantified.
Results. The total exposure time to deliver the prescribed dose using the standard-CT was 276±2 seconds compared to 266±1 ($p<0.05$) seconds and 275±2 ($p=NS$) seconds when the pseudo-CT with two tissue and three tissue classes were used, respectively. An average absolute deviation of -40±10 cGy ($p< 0.05$) and -2±11 cGy ($p=NS$) was measured between RTP by standard-CT and by pseudo-CT using two and three tissue classes, respectively.
Conclusion. We have demonstrated the feasibility of an MRI based workflow for RTP on the SARRP. Segmentation of ZTE-MRI images offers the ability to obtain a pseudo-CT scan of electron densities, which are required for RTP. Three tissue classes are required to obtain accurate dose calculations.

Topic:

- ☐ Cancer imaging
- ☐ Central nervous system imaging
- ☐ Molecular imaging of cardiovascular diseases
- ☐ Inflammation
- ☑ Molecular imaging technology
- ☐ Other imaging modalities