AbstractID: 9776 Title: Custom built small animal IGRT platform

Over the past 2 decades, there has been a widening technological disparity between laboratory radiation research and clinical radiation therapy. Whereas simple single beam/single fraction techniques are commonly used to irradiate laboratory animals, advanced three-dimensional (3D) and computer-controlled delivery technologies are now used clinically to pinpoint fractionated conformal radiation therapy (CRT) and intensity modulated radiation therapy (IMRT). The technological disparity presents a difficult hurdle in the development of novel treatment methods that combine conformal irradiation and other therapeutic agents. There is clearly a pressing need to bridge the technological gap between laboratory radiation research and human treatment methods.

To that end, we have constructed a Small Animal Radiation Research Platform (SARRP) which integrates imaging, radiation delivery and treatment planning capabilities. The SARRP spans 3 ft x 4 ft x 6 ft (WxLxH). A dual-focal (0.4 mm and 3.0 mm) spot, constant voltage x-ray source is mounted on isocentric gantry. The source to isocenter distance is 35 cm. Eighty to 100 kVp x-rays from the smaller focal spot are used for imaging. Both focal spots operate at 225 kVp for irradiation. Robotic translate/rotate stages are used to position the animal. A novel configuration is devised for CBCT imaging by rotating the horizontal animal between the x-ray source and a flat panel amorphous silicon detector that are fixed at opposite horizontal positions of 90^o and 270^o respectively. Radiation beams ranging from 0.5 mm in diameter to (60 X 60) mm^2 are available. Conformal dose distributions are delivered using a combination of gantry and robotic stage motion. Treatment planning is performed at sub-mm resolution where Monte Carlo dose calculations are coupled to a research Pinnacle system for visualization. Depending on filtration, the isocenter dose outputs at 1 cm depth in water range from 22 to 375 cGy/min from the smallest to the largest radiation fields. The 20% to 80% dose fall-off spans 0.16 mm. CBCT with (0.55 x 0.55 x 0.55) mm^3 voxel resolution is acquired with less than 1 cGy in 4 min. The ability of our system to focally irradiate a specific anatomic region or target in a mouse subject has generated exciting new collaborations between laboratory and translational research. These include the study of the response of normal tissue and tumor to focal radiation injuries; the development of molecular imaging markers for early assessment of radiation induced toxicity in the lungs; and the study of molecularly targeted therapy in combination with radiation. We are hopeful that our SARRP, and other similar initiatives, will serve to provide the timely and powerful technology to greatly transform future cancer treatment.

Learning objectives:

1. Appreciate the disparity between animal radiation research methods and clinical treatment.
2. Understand the challenges in down-sizing human treatment methods for small animal.

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