First clinical implementation of Kilovoltage Intrafraction Monitoring with gated RapidArc

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Aim

Kilovoltage Intrafraction Monitoring (KIM) provides real-time tumour position from kV imaging during treatment allowing adaptation such as MLC tracking or gate and shift. The first prostate cancer patients will soon be treated with KIM-guided gated RapidArc, as part of a 30 patient clinical trial to demonstrate feasibility. The purpose of this work is to present the development of novel clinical processes to ensure safe delivery of this pioneering technique and lessons learned from initial patients.

Methods and materials

The KIM gating system utilises during treatment kV images with autosegmentation of implanted fiducials and application of a probabilistic model to convert 2D marker coordinates into 3D coordinates. We image at 10 Hz with standard pelvis kV settings (125kV, 1mAs) using the smallest field possible to reduce imaging dose. Phase 1 includes 10 patients treated with 80Gy/40# with 7mm margin, and phase 2 allows hypofractionation with reduced margins. Patients are treated in clinical mode with in-house KIM software combined with VMAT delivery. Analysis will include fractions successfully segmented, geometric accuracy and dosimetric accuracy of delivered versus planned dose accumulation. Further patient specific quality assurance tests and novel clinical processes were developed by process mapping and FMEA to ensure safe patient treatment delivery.

Images for this section:
Fig. 1: Process map for individual patient treatment with Kilovoltage Intrafraction Monitoring (KIM) used for this trial.
Results

The clinical trial is open to accrual and expected to recruit quickly. We will report from the initial patients the geometric accuracy and dosimetric accuracy of the 3mm/5s gating tolerance. We will report on the clinical workflow developed and evolving with this world first implementation.

Conclusion

Clinical process and QA practices for the safe clinical implementation of KIM gating for real-time adaptation in prostate cancer VMAT have been developed and implemented. The first KIM gating patients will be treated, at Northern Sydney Cancer Centre, as part of a 30-patient clinical trial to assess feasibility of the technique.

Personal information

Jeremy Booth, PhD QMPS is the Head of Medical Physics at Northern Sydney Cancer Centre and is an affiliate of the University of Sydney. Jeremy has investigated image guided radiotherapy over many years and more recently has pursued implementation of adaptive radiotherapy techniques like MLC tracking and KIM.

Jin Aun Ng, PhD completed his doctoral studies in 2014 studying and developing Kilovoltage Intrafraction Imaging. Jin is currently a postdoc supporting this clinical trial and further development of KIM.

Prof Paul Keall is the Director of Radiation Physics Lab at University of Sydney and an NHMRC Australia Fellow. Prof Keall has made several fundamental inventions to improve radiotherapy over a sparkling career including KIM, MLC tracking and 4DCT. He leads a team of 20 researchers and currently leads an Adaptive RT group, and the Australian MR linac program.

Linda Bell and Florencia Alfieri are Radiation Therapists at Northern Sydney Cancer Centre and were fundamental to the implementation of the technology, development of procedures and training.
A/Prof Kneebone and A/Prof Eade are Senior Radiation Oncologists at Northern Sydney Cancer Centre and have led the clinical implementation of KIM, providing support and good ideas.

Per Poulsen PhD is a senior medical physics researcher at Aarhus University Hospital in Denmark. Dr Poulsen is a co-inventor of KIM with Prof Keall.

Ricky O'Brien PhD is a mathematician and programmer working with Prof Keall at the Radiation Physics Lab at University of Sydney. Ricky has developed most of the software for KIM.

References


