A gated IMRT study based on comparative 2D and 3D dose measurements

Although 4DRT and gating have become routine during recent years, detailed knowledge and understanding of the limitations of dedicated real-time position management technology is vital. In this study we reproduced treatment delivery of a gated IMRT case (treated in end-expiration phase) on a simulated motion phantom and measured the effects of various modes and parameters of the Varian RPM system. We used real target trajectories projected in the direction of each field based on a tip of a catheter visible on 4DCT as a surrogate. In addition to a conventional 2D approach based on gamma analysis we developed an in-house 3D dose reconstruction algorithm from measured 2D dose planes and were able to quantify results using DVH display and statistics.

A major aspect of this study was the use of original as well as ‘smoothed’ target trajectories, directly derived from patient 4DCT data, together with a comparison of a 2D and 3D (DVH-based) approach to results analysis. 3D interpretation of measurements brings a clinical sense to results interpretation and, if not to replace it fully, can be effectively used to derive clinically relevant tolerance criteria for standard 2D methods.

A sample result
Variation in CTV DVH statistics (D2%, D50%, D98% - %deviation from prescribed dose) is shown in a graph summary:

- original: original reference plan
- static: static dose measurement i.e. conventional IMRT pre-treatment QA
- dyn/no gating/orig. traj.: dynamic delivery with no gating and original trajectories
- dyn/no gating/convex traj.: dynamic delivery with no gating and convex trajectories
- ...alternatively for phase- vs. amplitude- and wide vs. narrow gate for respective gated deliveries