AbstractID: 5702 Title: Comparison of inline and orthogonal imaging and treatment beam geometries for monitoring the motion of implanted markers

Purpose: The purpose of this study is to investigate the accuracy of different 2D methods monitoring implanted markers, compared to 3D method for real-time tumor tracking radiotherapy. The different imaging-treatment beam geometries were the imaging beam parallel to treatment beam (inline) and orthogonal to treatment beam.

Method and Materials: The 3D motion datasets of ten patients from Cyberknife treatments were used. For given beam angles, the positions of implanted markers were calculated and its geometric uncertainty was quantified for two 2D monitoring methods. Since neither can monitor the motion of markers in the imaging beam axis, the geometric errors were determined in that direction with respect to the treatment beam. Assuming that 3D pre-treatment online positioning was performed and thus errors are predominantly random, treatment margins due to the limitations of 2D methods were quantified. For the orthogonal monitoring, margin, $M=1.65\sigma$, was used with the assumption of zero systematic errors; while for the inline, the required margin can be calculated by integrating the probability density function of the geometric uncertainty with the dose fall-off along the beam direction.

Results: In terms of couch motion, the positioning uncertainty is lowest for coplanar treatments, consistent with predominantly superior-inferior motion. Regarding gantry angles, it is lowest for lateral beams, consistent with the smallest left-right motion. The average positioning uncertainty along the imaging beam axis is 0.05-0.16cm (1 SD) with maximum values for individual patients ranging 0.09-0.33cm, which result in 0.08-0.26cm margins for orthogonal monitoring.

Conclusion: The impact of the geometric relationship between the imaging and treatment beam has been studied by quantifying the error from out of plane motion for inline and orthogonal imaging-treatment geometries. The errors for inline geometry result in negligible additional margin required. In the absence of other errors, the orthogonal monitoring contributes up to 0.26cm to the total margin.