AbstractID: 8467 Title: Accurate dose assessment for prostate cancer patients using 3D ultrasound and Monte Carlo dose calculation

Purpose: To investigate the use of a novel multi-application 3D ultrasound system to determine prostate motion on a daily basis. To use Monte Carlo-based dose calculations to assess daily dose differences to the prostate, rectum and bladder.

Method and Materials: A novel 3D ultrasound system was used to determine the prostate volume and position for daily radiotherapy treatment fractions. These measurements were compared to 3D ultrasound measurements taken at the time the planning CT was acquired, from which the daily shifts were calculated (32 patients). The measured prostate shifts and volumes were used to define contours of the PTV, rectum and bladder. The measurements were used to define organs for XVMC Monte Carlo dose calculations, taking patient heterogeneities into account. Calculations were done for patients whose setup was corrected and un-corrected for shifts. In the simplest case only prostate translation was taken into account. In a separate evaluation the prostate motion was determined by fitting the prostate volume with 6 degrees of freedom (translation and rotation).

Results: Average prostate shifts were found to be 0.17 mm (R/L), 3.3 mm (A/P) and 1.1 mm (S/I). The ranges were [-22.3;16.6] mm (R/L), [-19.1;33.5] mm (A/P) and [-21.5;39.0] mm (S/I). Dose differences to the PTV were up to 20% in D95 when no setup correction was performed. Dose differences to rectum and bladder were also significant. With setup correction based on ultrasound measurements the delivered dose was very close to the planned dose with a maximum difference of a few percent.

Conclusion: It was found that a 3D ultrasound system, using intramodality imaging comparisons to ultrasound images taken at the CT planning stage led to significant setup corrections. Monte Carlo dose calculations for uncorrected cases showed significant underdosing of the prostate. After setup correction errors were reduced to a few percent maximum.