Purpose: Under daily IGRT, treatment planning margins can be significantly reduced. To evaluate effectiveness of the current empirical planning margins, we developed an efficient method to assess daily and cumulative doses.

Methods: Under daily kilo-voltage cone beam CT (KV-CBCT), daily dose can be calculated directly using the CBCT, but this method is cumbersome and not necessarily accurate due to fluctuation of the CT numbers. Based on the Computational Environment for Radiotherapy Research (CERR) software, we developed additional MATLAB codes to shift the planning dose matrix according to the daily shifts detected by IGRT. Because the shifted dose matrices were in the same coordinate system, cumulative dose can be obtained by simple summation. For 20 patients with prostate cancer, the planning margin of 4 mm posterior and 6 mm elsewhere were utilized. For these patients, we calculated the daily doses and cumulative doses with and without IGRT to assess sufficiency of planning margins. The calculated composite delivery doses were compared to the planning doses for the prostate and the planning target volume (PTV).

Results: For the 20 cases examined, the dose differences to 95% of the prostate (D95) between the delivered and planned dose were from -3.5% to 0.4% (mean -0.1%). For the PTV, the differences in D95 were from -11.2% to 0.0% (mean -1.8%). The dose differences to the 50% of the rectal and bladder were from -5.2% to 13.2% (mean 3.1%) and from -19.6% to 1.0% (mean -5.0%), respectively.

Conclusions: The composite dose of multiple-fraction treatment can be obtained by using the shifting dose matrix method. Because of the adequate planning margin, the cumulative dose changes due to the prostate motion are small, even without IGRT, indicating either the planning margin can be reduced or the frequency of the IGRT can be reduced.