

Bladder Filling Volume Variation in Computed Tomography (CT) Simulation for Prostate Cancer Intensity Modulated Radiation Therapy (IMRT) and Its Correlation with Estimated Glomerular Filtration Rate (eGFR)

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Precise bladder volume management throughout the Computed Tomography Simulation (CT-Sim) is an important requirement for prostate cancer patients who are undergoing Intensity Modulated Radiation Therapy (IMRT). The estimated Glomerular Filtration Rate (eGFR), an indicator of renal function, may influence bladder filling dynamics. This study focused on investigating relationship between bladder filling volume variation during CT-Sim for prostate cancer IMRT and its correlation with eGFR, quantifying bladder filling volume variation among prostate cancer patients and evaluating association between bladder filling volume variation and changes in eGFR levels. This prospective cohort study was conducted at the National Cancer Institute, Maharagama, Sri Lanka, with 92 prostate cancer patients. The patient was asked to micturate and was administered 350 ml of water orally 30 minutes prior to the CT-Sim. Bladder volume was contoured and measured using 3D slicer software. The eGFR was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. Data on patient age, body mass index (BMI) and Gleason score were collected. Statistical analyses were performed using correlation analysis, Shapiro-Wilk tests and Kruskal-Wallis tests using SPSS 25.0. The mean bladder filling rate was 1.59 ± 1.34 ml/min, with significant variability and the mean of eGFR was 77.13 ± 14.992 ml/min/ 1.73 m^2 . A weak positive correlation (spearman's $\rho = 0.277$, $p = 0.008$) between bladder filling rate and eGFR was observed. The variability of bladder filling rate was not constant across different eGFR levels. Several outliers were observed. Bladder filling rate has shown weak negative correlation with BMI (-0.047), weak positive correlation with Gleason score (0.11) and weak negative correlation with age (-0.203). There were statistically significant differences in bladder filling rate across different eGFR groups ($p = 0.005$). The usage of a simple, universally applicable bladder protocol solely is insufficient to maintain reproducible and precise bladder volume. Hence, onboard imaging (bladder scanning/ Cone Beam CT) is recommended with a tailored bladder protocol that considers broader physiological and behavioural variables, such as patient hydration habits, environmental conditions and compliance with instructions.

Keywords: Bladder filling volume, computed tomography simulation, intensity modulated radiation therapy, estimated glomerular filtration rate