Purpose: To identify the key factors of patient anatomy that influence the optimal dose volume histograms (DVHs) for the organs-at-risk (OARs) and to explore the tradeoffs between different OAR sparing goals.

Methods: 88 prostate IMRT plans were studied retrospectively. The PTV-OAR (bladder and rectum) geometry was described by the distance-to-target histogram (DTH) with a variable distance model to reflect the co-planar beam configuration. Principal Component (PC) analysis was applied to DVH and DTH distributions in the patient pool to extract their salient features. The PCs were interpreted in terms of the patient anatomy and dose-volume distribution metrics. The correlation coefficients between the PCs and these metrics were calculated. Finally, a stepwise multiple regression method was used to quantify the influence of these key anatomy parameters on the quality of corresponding DVHs.

Results: The first PCs of DTH and DVH characterize the means of the histograms; the second PCs characterize the gradients of the histograms within a range.

The most significant factor contributing to the first PC score (PC1) of DVH is the PC1 of DTH. It represents the correlation between the mean distance and the mean dose. The DVH PC2 is correlated with the DTH PC2, indicating the influence of DTH gradient on the gradient of DVH. Another significant factor affecting DVH PC2 is the fraction of OAR volume outside treatment fields with co-planar beam setting.

These factors combined account for significant majority of the cross patient DVH variation in the OARs: with the determination coefficients $R^{2}=0.88$ and $R^{2}=0.85$ for PC1 and PC2 of bladder, respectively, and $R^{2}=0.68$ and $R^{2}=0.69$ for PC1 and PC2 of rectum, respectively.

Conclusions: Key factors representing the influence of patient’s anatomy on the corresponding DVHs are extracted and quantified. This knowledge can be used to predict patient specific DVHs in IMRT planning.

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