Purpose: The aims of this study is to (1) introduce a 2D field of possible rectal normal tissue complication probability (NTCP) in prostate intensity modulated radiotherapy (IMRT) plan, so that based on a given prescribed dose the rectal NTCP is merely a function of the rectal wall thickness and rectal motion; and (2) separate the 2D field of rectal NTCP into area of low risk and area of high risk for rectal toxicity < Grade II, based on the threshold rectal NTCP.

Methods: The 2D field of NTCP model was developed using ten randomly selected prostate IMRT plans. The clinical rectal geometry was initially represented by the cylindrical contour in the treatment planning system. Different combinations of rectal motions, rectal wall thicknesses, planning target volume margins and prescribed doses were used to determine the NTCP in prostate IMRT plans.

Results: It was found that the functions bordering the 2D field for the given AP, LR and SI direction can be described as exponential, quadratic and linear equations, respectively. A ratio of the area of 2D field containing data of the low risk NTCP to the entire area of the field was introduced and calculated. Although our method is based on the Kutcher's dose response model and published tissue parameters, other mathematical models can be used in our approach.

Conclusions: The 2D field of rectal NTCP is useful to estimate the rectal NTCP range in the prostate pre-treatment and treatment QA. Our method can determine the patient's threshold immobilization for a given rectal wall thickness so that prescribed dose can be delivered to the prostate to avoid rectal complication. Our method is also applicable to multi-phase prostate IMRT, and can be adapted to any treatment planning systems.

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There is no conflict of interest for all authors.