Incorporation of geometrical information on structure position into gamma analysis results for portal dosimetry based IMRT prostate verification

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Introduction

Gamma analysis became a standard tool to evaluate the agreement between planned and delivered fluence/dose distribution. The importance of points out of tolerance is always the same, because the analysis does not include any information on position of relevant structures for the current Beam´s eye view (BEV). We have suggested the method for incorporation probable structure position into the gamma analysis result.

The aim

The aim of this work was to create the application in Matlab software that would use the corrective matrix to be applied to the result matrix of gamma analysis from portal dosimetry with EPID for each new prostate IMRT patient to warn about unacceptable results in the most critical areas.

Methods

The results of gamma analysis for 30 prostate patients were analyzed. Patients were treated with 5 fields sliding window IMRT on Clinac DHX unit (Varian). Gamma map was matched with BEV projection of PTV, rectum, and bladder for current patient. The sum matrix of BEV for each gantry angle was created to show the most frequent BEV localization of current structure for all patients. Two weighting matrices were created to be applied to the gamma analysis results of prostate IMRT increasing the importance of unsatisfactory results at areas where projections of structures are most probable.

Results

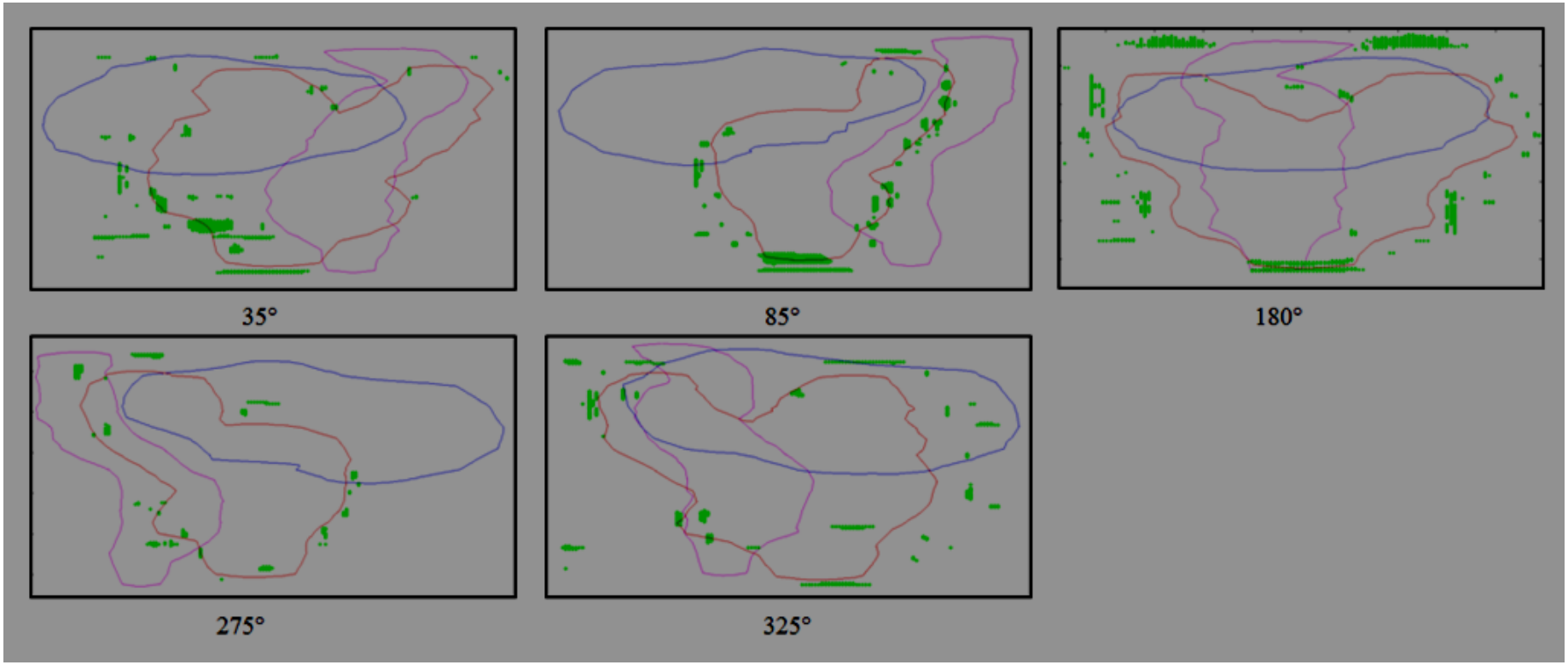

Fig. 1: For each patient, BEVs for PTV (red), rectum (pink), and bladder (blue) were projected to the gamma analysis map, green points were out of tolerance (criteria 3%/3mm) for each field

Results

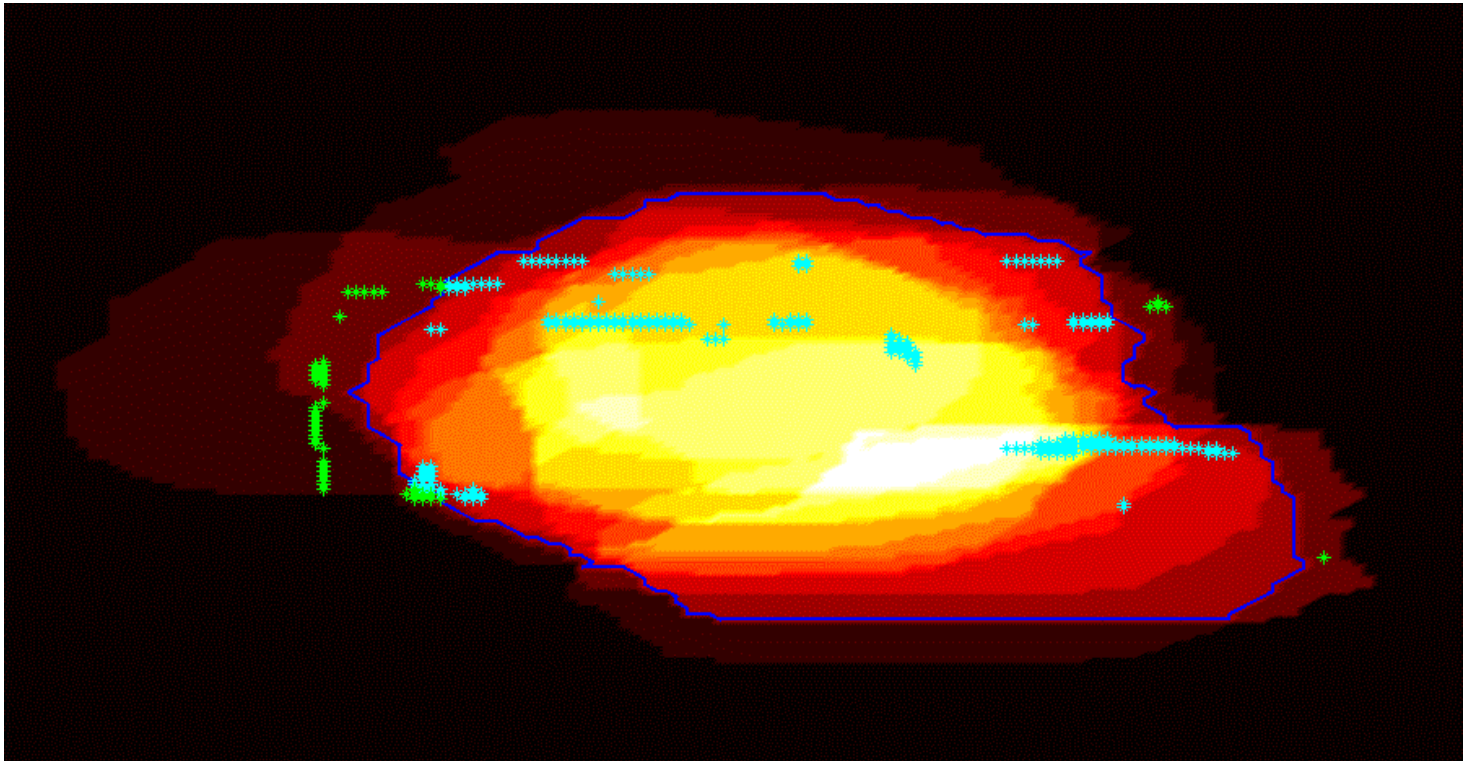

Fig. 2: Sum matrix for each structure was calculated for each field to show the most probable structure location in the gamma map. All points out of tolerance but inside current structure for particular patient were projected to the sum matrix. In figure, example for bladder and 180° field shows good sensitivity (blue line shows area where was bladder in 20% cases).

Results

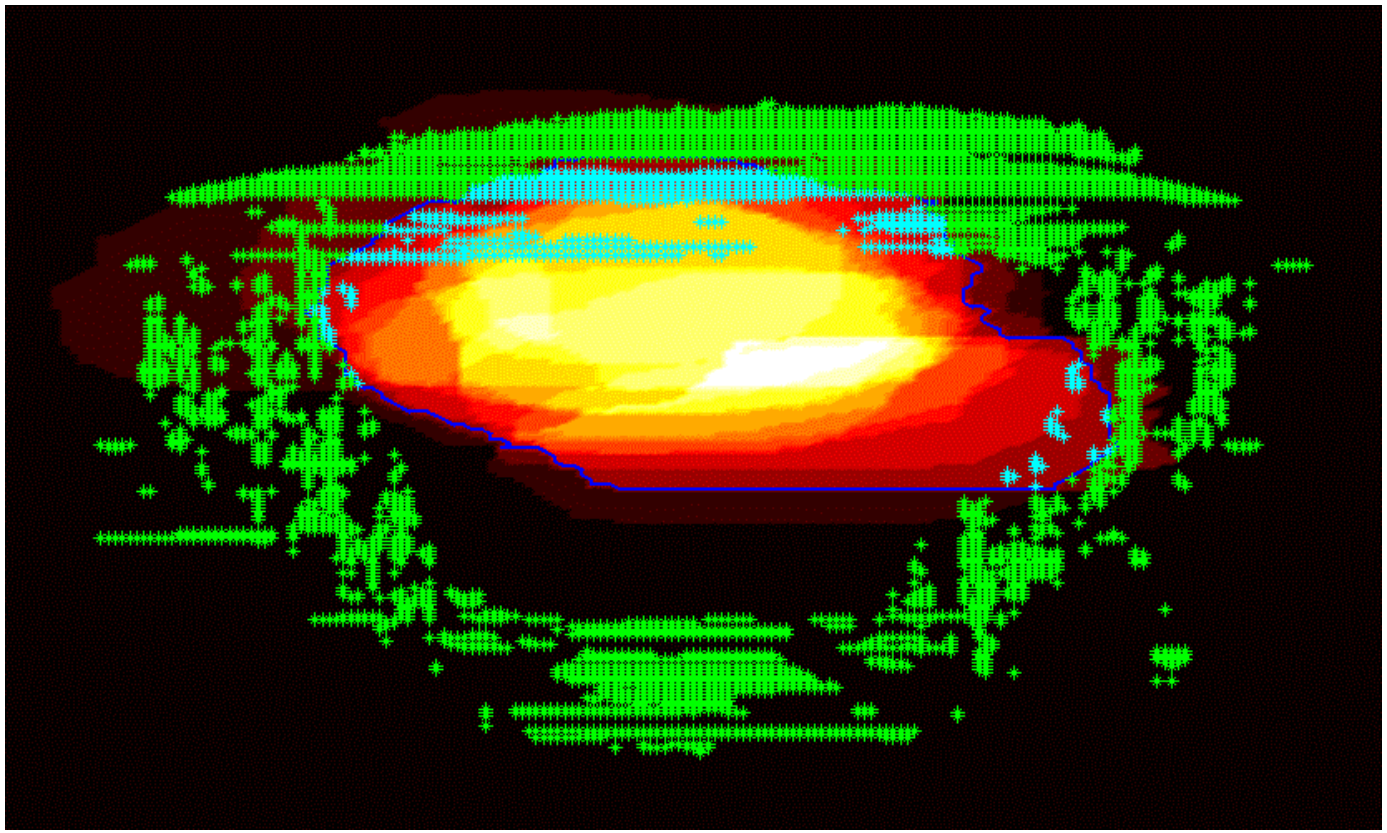

Fig. 3: Sum matrix for each structure was calculated for each field to show the most probable structure location in the gamma map. All points out of tolerance but outside current structure for particular patient were projected to the sum matrix. In figure, example for bladder and 180° field shows good specificity (blue line shows area where was bladder in 20% cases).

Results

Gamma area results (%)				
		Portal Dosimetry	Matrix 1	Matrix 2
Enhancement of sensitivity for EPID based gamma analysis	Patient 1	4,0	12,7	10,1
	Patient 2	4,8	10,7	8,6
	Patient 3	1,9	4,9	5,2
	Patient 4	1,2	3,1	3,4
	Patient 5	1,0	3,3	2,8
Enhancement of specificity for EPID based gamma analysis	Patient 6	3,0	0,4	0,4
	Patient 7	2,3	0,7	0,8
	Patient 8	2,6	0,0	0,2
	Patient 9	2,3	0,3	0,4
	Patient 10	2,8	0,0	0,1

Tab 1. Two weighting matrices applied to selected new patients showed enhanced sensitivity/specificity for gamma area parameter. Weight is set to 0 when gamma > 1 lies outside of probable structure areas. Matrix 1 stresses the importance of gamma > 1 at the probable area of OARs, Matrix 2 stresses the importance of gamma > 1 in OARs and PTV.

Conclusion

The proposed method uses probabilistic approach and weighting matrices to allow for the position of PTV and OARs projections for the current gantry angle during EPID verification. The weighting matrices and structure borders were the result of optimization process which took into account frequent position of BEVs and frequent position of pixels out of tolerance within gamma analysis.

Authors have no potential conflict of interest to disclose.