Purpose: In HDR brachytherapy planning, one of the issues that have to be accounted for is the selective existence of high dose volumes around some few dominating dwell positions. This effect can be eliminated by limiting the free dwell time modulation. This possibility can be offered by an inverse treatment plan optimization algorithm such as HIPO.
Methods: The dose distributions of 12 clinical HDR brachytherapy implants for prostate that were produced by HIPO with and without modulation restriction (MR) are compared. Common dose-volume indices were used to examine the clinical effectiveness of the different dose distributions. The response probabilities of the prostate tumors and organs at risk (OARs) were calculated using the Poisson and the relative seriality models. In treatment plan evaluation and comparison, the complication-free tumor control probability, P+ and the biologically effective uniform dose ( ) were also used.
Results: HIPO with a MR of 0.1-0.2 can produce high quality treatment plans which are practically equivalent to those that are produced by HIPO without MR. However, a considerable variation between the different plans could be indicated by the radiobiological indices. The HIPO with MR treatment plans demonstrated a statistically significant ($p=0.002$) lower total dwell time by a mean of 1.4% compared to the HIPO without MR plans. Furthermore, due to a better sparing of the OARs by 1.0%, the HIPO with MR plans produced a higher P+ by 0.5%.
Conclusions:The present analysis shows that on average the HIPO with MR and without MR treatment plan optimizations give similar results regarding common dosimetric indices and widely known radiobiological measures. It appears that the examined dwell time regularization technique can introduce a minor only improvement in the effectiveness of the optimized HDR dose distributions.