

Dual-Activity on LDR Brachytherapy Prostate Plans?

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ABSTRACT

To compare and evaluate the benefit of having dual activity on LDR prostate implants as opposed to one single activity to either decrease dose in organs at risks (OARs) urethra and rectum or increase dose to inaccessible areas as in pubic arc obstruction.

An in-house brachy dose calculation engine using AAPM TG43 formalism was designed (Python) to assign two different activities to the LDR brachy plans. The process is as following: the plan is calculated in the TPS (Variseed) using all seeds with the higher activity and all seeds with the lower activity. The 3D dose distributions of both plans are compared with the calculation done by the in-house software. Then, a third calculation is done having the centralized and peripheral needles with lower and higher activity, respectively. The activities used in this study are 0.385U, 0.418U and 0.453U for treatments with 144Gy prescription dose.

When central needles have activity 0.385U and peripheral 0.418U, the dose on rectum and urethra decreases 5% when compared to one single activity plan (0.418U). There is also reduction on the 200% isodose line. When using 0.453U and 0.385U in peripheral and central needles respectively, there is 5% dose increase on the anteriorly aspect of prostate with no impact on the OARs when compare with plans with one single activity (0.418U). There is not detriment on target coverage in both cases.

Dual-activity is an option to improve the optimization of the dose 3D dose distribution on LDR brachytherapy treatments. It provides dose reduction up to 5% to rectum and urethra without compromising the target coverage (prostate). It is also an alternative to increase the dose on the anterior aspect of prostate, if pubic arc obstruction is a concern, and still keep the OARs within dose tolerances.

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INTRODUCTION

LDR brachy treatments are normally planned using one single activity for all implanted seeds. To spare organs at risk (OARs), physicists plan needles away from those organs or use lower activities specially in small prostates. Radiation oncologists also steer the needles away for the OARs during implantation. However, these techniques also generate underdose areas and/or increase the uncertainties on the prostate 3D dose distribution. This study aims to investigate the benefits of using dual-activity on the on LDR prostate treatment to optimize the dose distribution in a more controlled way. More specifically, to reduce the dose to the OARs and or increase the dose in inaccessible areas (i.e behind pubic arc).

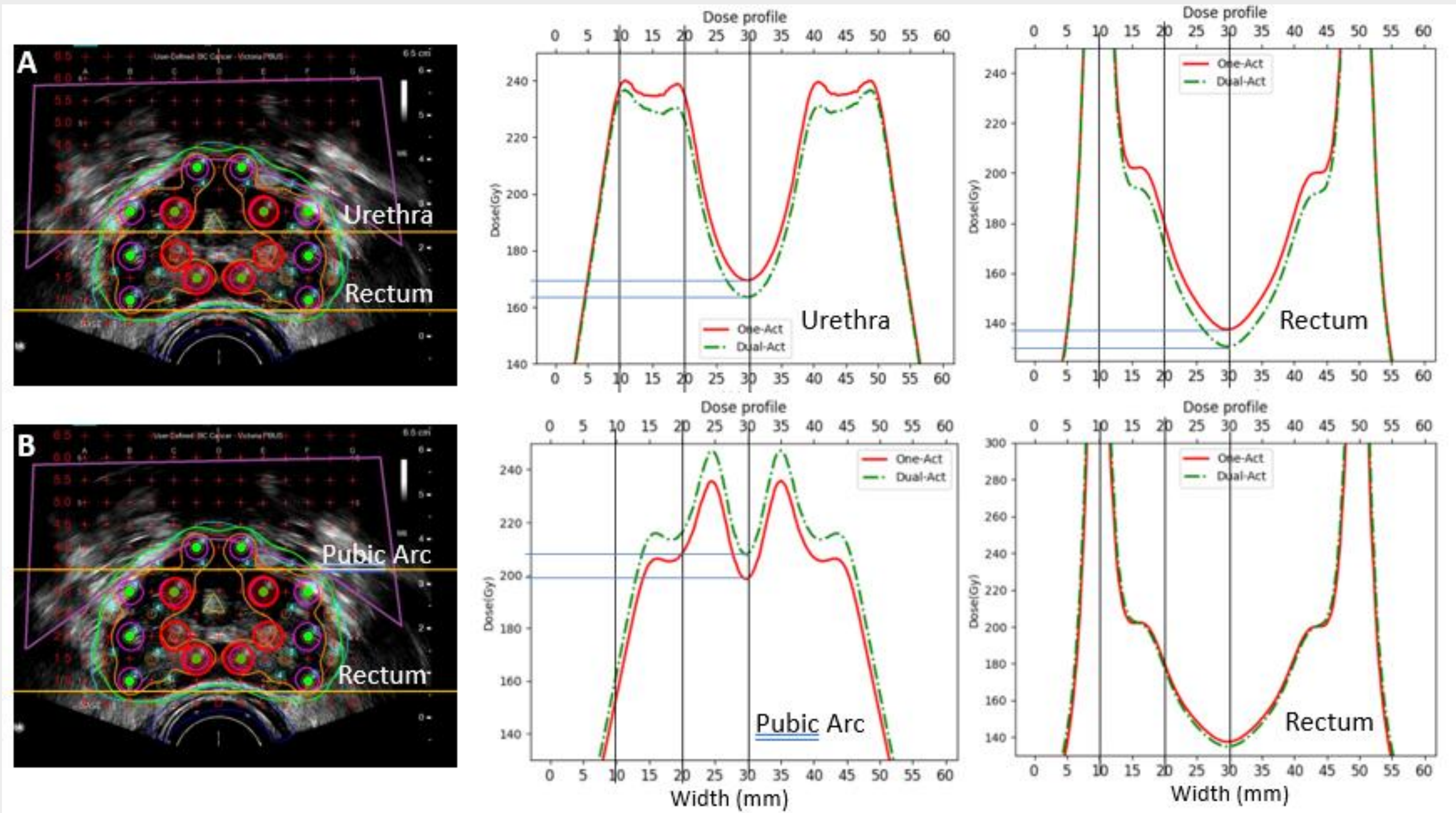


Fig 1. Dose profile in the longitudinal center of the prostate. Needles in red represent lower activity. With dual-activity, dose to urethra and rectum is reduced by 5% (A) when compared to single activity. The technique can also increase the dose by 5% on the anterior aspect of prostate without detriment to the OARs (B).

METHODS AND MATERIALS

An in-house brachy dose calculation engine using AAPM TG43 formalism was designed (Python) to assign two different activities to the LDR brachy plans. The plan is calculated in the TPS (Variseed) using all seeds with the higher activity and all seeds with the lower activity. The 3D dose distributions of both plans are compared with the calculation done by the in-house software. Then, a third calculation is done having the centralized and peripheral needles with lower and higher activity, respectively. The activities used in this study are 0.385U, 0.418U and 0.453U for treatments with 144Gy prescription dose.

RESULTS

When central needles have activity 0.385U and peripheral 0.418U, the dose on rectum and urethra decreases 5% when compared to one single activity plan (0.418U) (Fig 1.A). There is also reduction on the 200% isodose line. When using 0.453U and 0.385U in peripheral and central needles respectively, there is 5% dose increase on the anteriorly aspect of the prostate with no impact on the OARs when compare with plans with one single activity (0.418U) (Fig 1.B). There is not detriment on target coverage in both cases.

CONCLUSION

Dual-activity is an option to improve the optimization of the dose 3D dose distribution on LDR brachytherapy treatments. It provides dose reduction up to 5% to rectum and urethra without compromising the target coverage (prostate). It is also an alternative to increase the dose on the anterior aspect of prostate if pubic arc obstruction is a concern and still keep the OARs within dose tolerances.