Purpose: Kernel-based dynamic dose painting was introduced at the 2010 AAPM meeting. The purpose of this study was to investigate a practical treatment planning and delivery approach with current technology and potential dosimetric advantages on 3D patient anatomy for such an approach.

Methods: For a dynamic dose painting delivery, a dose kernel (i.e., paintbrush) is first formed from a high number of converging beams, and then such a kernel transverses (i.e., paint) continuously throughout a target volume to create a desired dose distribution. In this study, we employed fixed ball-shaped kernels modeled from the beam geometry similar to those of commercial Gamma Knife (GK) or body GK units such as Gyroknife, and dose painting was realized by shifting the patient (i.e., target) via a dynamic couch with six degrees of freedom. In addition, the size of the kernel was also made changeable along its painting path. We tested such an approach on treatment planning of prostate stereotactic body radiotherapy (SBRT) cases.

Results: Conformal prostate SBRT treatment plans were feasibly developed. At the posterior prostate target and the rectum junction area, separation in the isodose lines between 100% and 75% of the prescription dose was less than 2 mm, yielding a dose fall-off gradient of approximately 13% per mm or higher. Under a nominal dose rate of 600 MU/min, the beam-on time for such a delivery was approximately 30 minutes for a dose of 10-12 Gy to the target periphery. The effective number of the beams for such treatment however reached approximately 8,500.

Conclusions: Kernel-based dynamic dose painting offers a new level of dose conformity and normal tissue sparing surrounding a target.