

# Evaluation of Deformable Prostate Cone-Beam Computed Tomography (CBCT) Contouring Methods for Adaptive Radiation Therapy

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## Purpose

In a companion work, an adaptive recontouring method, where contours are deformed from one CBCT to another CBCT, has been shown to be an accurate method for contour generation as part of an automated adaptive radiation therapy workflow<sup>1</sup>. Our goal in this current work is to evaluate the accuracy of adaptive and three additional deformable contouring methods compared to manual contouring for prostate CBCT.

## Materials/Methods

Five daily CBCT scans were selected for 5 patients with prostate cancer. Contours were manually defined on each CBCT scan by a single observer for the bladder, rectum, CTV, right and left hip. Five patient specific atlases were built in a leave-one-out fashion using the 5 CBCTs and contours for each patient. Four automatic deformable contouring methods (MIM Software) were used, including (1) "Adaptive", i.e. deforming first day to each subsequent day, (2) "SBM", i.e. deforming the single best match from a patient specific atlas, (3) "Multi4", i.e. deforming 4 atlas matches and combining contours with majority vote (MV), and (4) "Multi4-Adaptive", i.e. deforming the other 4 CBCTs to the remaining CBCT and combining contours with MV. The software used has different registration parameters for atlas-based deformation and adaptive deformation, which is the principal difference between "Multi4" and "Multi4-Adaptive." Dice coefficients were obtained for each contour by comparing these four deformable contouring methods to manual contouring. Paired t-tests were performed to determine the best automatic deformable method.

## Results

Based on all contours from all five patients, the mean Dice coefficients obtained from the 4 deformable contouring methods were  $0.82 \pm 0.15$ ,  $0.78 \pm 0.21$ ,  $0.81 \pm 0.15$ ,  $0.86 \pm 0.11$  for "Adaptive", "SBM", "Multi4", and "Multi4-Adaptive", respectively. Paired t-test results show that (1) "Multi4-Adaptive" was significantly better than "Adaptive", "SBM", and "Multi4" ( $p < 0.001$ ), (2) no significant difference existed between "Adaptive" and "Multi4" ( $p = 0.14$ ), and (3) both "Adaptive" and "Multi4" were significantly better than "SBM" ( $p < 0.01$ ). When examining individual contours, "Multi4-Adaptive" was found to be significantly better than "SBM" and "Multi4" for each of the five contours and better than "Adaptive" for the rectum and left hip ( $p < 0.05$ ).

Table 1

Average Dice Similarity Coefficient

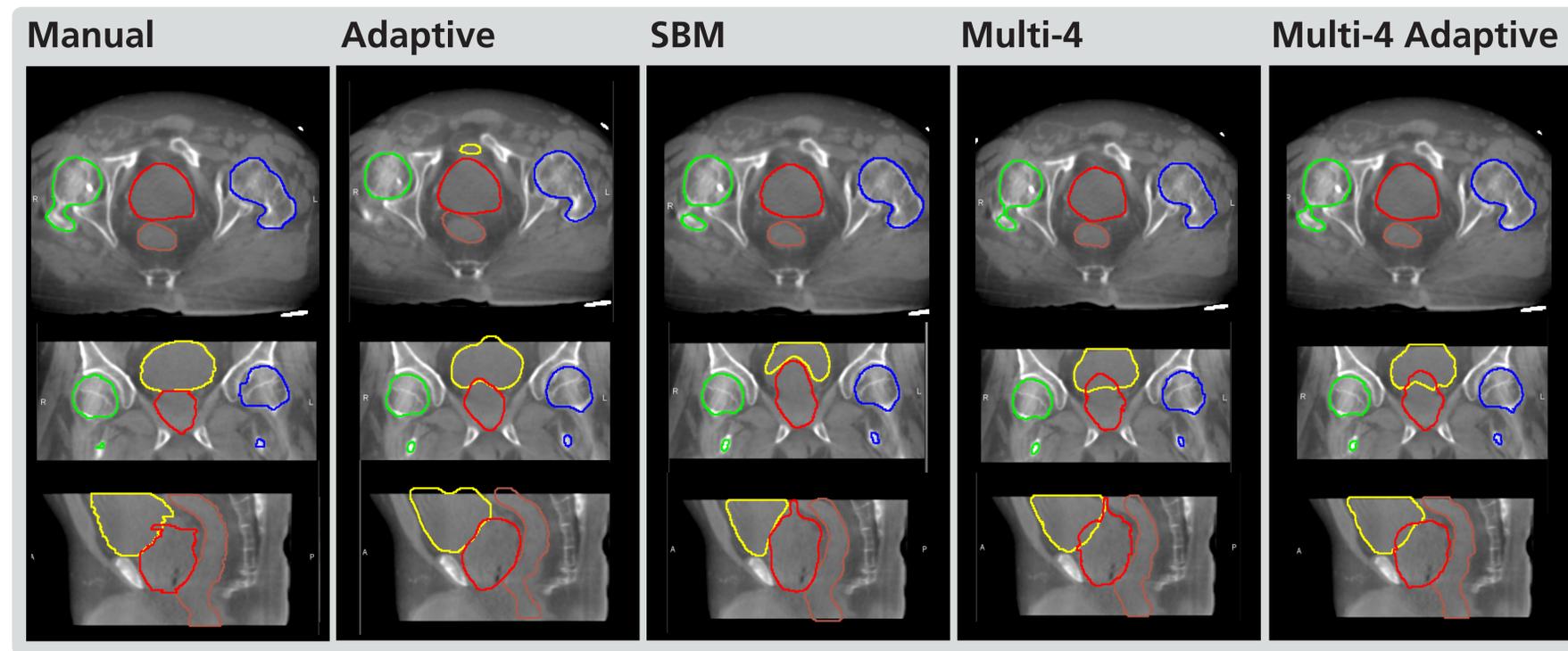
Structure	Adaptive	SBM	Multi-4	Multi-4 Adaptive
Bladder	$0.75 \pm 0.15$	$0.73 \pm 0.18$	$0.74 \pm 0.16$	$0.80 \pm 0.13$
CTV	$0.80 \pm 0.11$	$0.69 \pm 0.26$	$0.77 \pm 0.14$	$0.83 \pm 0.09$
Left Hip	$0.93 \pm 0.04$	$0.91 \pm 0.04$	$0.91 \pm 0.03$	$0.95 \pm 0.01$
Rectum	$0.67 \pm 0.16$	$0.65 \pm 0.23$	$0.72 \pm 0.16$	$0.78 \pm 0.10$
Right Hip	$0.92 \pm 0.06$	$0.91 \pm 0.07$	$0.91 \pm 0.05$	$0.94 \pm 0.02$
Overall	$0.82 \pm 0.15$	$0.78 \pm 0.21$	$0.81 \pm 0.15$	$0.86 \pm 0.11$

Average Dice Similarity Coefficient across five patients using segmentation results from all deformable methods. Segmentation results for Multi-4 and Multi-4 Adaptive were combined using majority voting.

## Conclusion

While "Adaptive", "Multi4-Adaptive", and "Multi4" all showed good accuracy compared to manual contours in terms of Dice coefficients (0.81 to 0.86), "Multi4-Adaptive" was the most accurate. These deformable contouring methods have the potential to be incorporated into an automated prostate adaptive radiation therapy workflow.

Figure 1



Patient image displaying segmentation results from manual and automated deformable contouring methods.

## Reference

1 Ellis R, Traugber B, Kaminsky D, et al. Evaluation of a Free-Form Intensity Based Deformable Contouring Method for Prostate Image-Guided Adaptive Radiation Therapy (IGART): Multiple Observer Comparison. Accepted for presentation at AAPM 2013.