# Evaluation of Atlas-Based Auto-Segmentation on Daily In-Room CT for Prostate Cancer

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## INTRODUCTION

The manual contouring of region of interest (ROI) is a major time-consuming process in re-planning to correct inter-fractional changes in anatomy. Atlas-based auto-segmentation (ABAS) has been proposed to expedite this process. According to its algorithm, ABAS may render more accurate contours using atlas with multiple patient specific image sets. In the current study, the performance of ABAS with such atlas was evaluated on daily high quality verification CT images acquired with an in-room CT system.

## METHODS AND MATERIALS

The current study was performed retrospectively on patients with prostate cancer (n = 7). Prostate, rectum and bladder were manually contoured as ROI based on RTOG 0126. ABAS was performed using a commercial software program, MIM 5.4 (MIMVista, Cleveland, OH).

ABAS with Single- and Multi-image Set Atlas

To evaluate the effect of atlas size, three patient specific atlases were generated for each patient using the first one, four and seven daily CT image sets and their associated manual contours. ABAS was subsequently applied with these atlases to generate contours for the last seven daily CT image sets of each patient. The volumes of manually (Vm) and automatically (Va) generated contours, as well as their intersectional areas, were recorded on a pixel-by-pixel basis. The accuracy of the auto-contours was evaluated by their geometrical similarity to the manual counterparts using overlap index (OI) and dice similarity coefficient (DSC) as defined below:

$$OI = (Vm \cap Va) / Vm; \quad DSC = 2(Vm \cap Va) / (Vm+Va)$$

ABAS with Patient and Non-Patient Specific Atlas

To evaluate the effect of using patient specific atlas for ABAS, a non-patient specific atlas was constructed using the first daily CT image set and its associated manual contour from four different patients. ABAS was subsequently performed on the last seven daily image sets of the patients (n = 3) whose images were not included in the atlas. The OI and DSC were calculated as described above and were compared with those obtained using atlases with four patient specific image sets.

Statistical Analysis

All results were expressed as mean±SD. A two-tailed paired student *t* test was used for comparison of manual- and auto-contours. Statistical significance was assigned at P<0.05.

## RESULTS

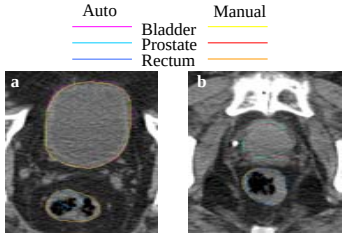


**Figure 1.** Manually and automatically generated contours on representative superior **(a)** and inferior **(b)** level slices. ABAS was performed using atlas with single patient specific image set.

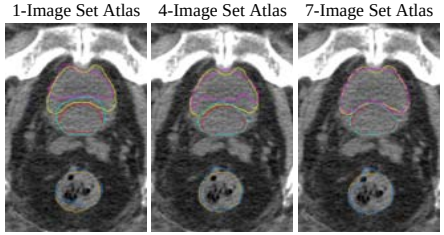


**Figure 2.** Manually and automatically generated contours on a representative mid-level slice. Auto-contours were generated using patient specific atlases with various sizes.

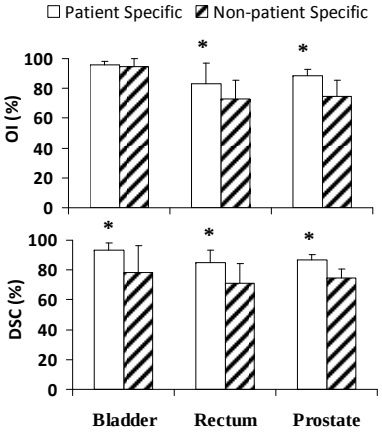


**Figure 3.** Effect of using patient specific atlas for ABAS. *P<0.05 compared to the results obtained using atlas with four non-patient specific image sets.

## RESULTS

| | | 1-Image Set | 4-Image Set | 7-Image Set |
|---|---|---|---|---|
| Bladder | OI (%) | 96.5±3.1* | 95.5±2.7 | 95.9±2.8 |
| | DSC (%) | 91.4±5.0*† | 93.6±4.3 | 94.8±2.5 |
| Rectum | OI (%) | 81.1±12.9† | 82.9±14.3 | 86.2±9.1 |
| | DSC (%) | 81.0±8.7*† | 84.7±8.6 | 87.6±14.6 |
| Prostate | OI (%) | 84.6±5.5*† | 88.7±4.2 | 87.8±5.4 |
| | DSC (%) | 82.5±6.4*† | 87.0±3.3 | 86.6±4.9 |

**Table 1.** Geometrical comparison of manual- and auto-contours. *P<0.05 compared to results from 4-image set atlas. †P<0.05 compared to results from 7-image set atlas.

On a workstation with 3.07 GHz CPU and 12 GB RAM, the ABAS process took less than 2 min.

The auto-contours of all three ROI exhibited good agreement with the manual ones (Fig. 1). The inclusion of more image sets in the atlas improved the consistency between auto- and manual-contours (Fig. 2). Significantly higher OI and DSC were observed for rectum and prostate when atlas size was increased to four (Table 1). A further increase of atlas size to seven improved the results marginally without statistical significance (Table 1).

Figure 3 shows the effect of patient specificity for atlas image sets. For all ROI, the OI and DSC were higher than those obtained with the non-patient specific atlas (P<0.01). The only exception was the DSC of bladder since the non-patient specific atlas already rendered a satisfactory result of 95%.

## CONCLUSIONS

- ❑ Satisfactory performance of ABAS is achieved on daily high quality verification CT images of prostate cancer.
- ❑ The use of atlas with patient specific and/or multiple image sets improves the contouring accuracy of ABAS.

## REFERENCES

[1] Piper J. *Medical Physics* 2007