University Hospitals Seidman Cancer Center

Evaluation of an Atlas-Based Segmentation Method for High Risk Prostate Cancer with RTOG Defined Pelvic Lymph Node

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Purpose

Intensity modulated radiation therapy (IMRT) for high risk prostate cancer requires careful contouring and segmentation of at risk pelvic lymph nodes. However, this process can be very time consuming and difficult compared to traditional prostate only fields. One possible solution to improve target volume contouring efficiency is to use atlas based segmentation software. For this pilot study, we compiled a prostate target atlas database and evaluated an atlas based segmentation method.

Methods

Institutional review board approval was obtained to retrospectively analyze patient CT simulation scans to develop an atlas database. Atlas contours included prostate, seminal vesicles, and RTOG-defined pelvic lymph node levels for treatment volumes. Lymph node levels were contoured using RTOG guidelines by following the internal/external iliac vessels and its associated lymph nodes from the L5-S1 vertebral level to obturator nodes at the pubic symphysis. A total of 23 patients with contours reviewed by three different physicians were included in our atlas database. Once this database was compiled we evaluated the performance developing using Dice similarity index (DICE) scores.

Results

Atlas segmentation was designed using a leave-one-out analysis (subject being tested was excluded from the atlas). Then the 5 best-matched atlas subjects were automatically chosen and deformed to the test subject. The atlas segmentation method included an additional automatic registration approximation component to influence the intensity-based deformable registration. The 5 sets of auto contours were combined using majority vote where 3 of 5 contours overlapped. Final auto contours were then compared to the manually defined contours using DICE. Using this algorithm for all 23 atlas subjects, the mean DICE score was 0.67 +/- 0.14 for the prostate target volume and 0.74 +/- 0.05 for the pelvic lymph node target volume.

Figure 1
Atlas-Based Segmentation Workflow

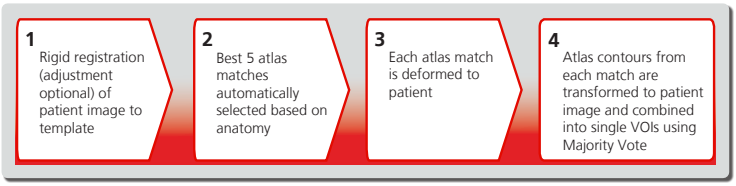
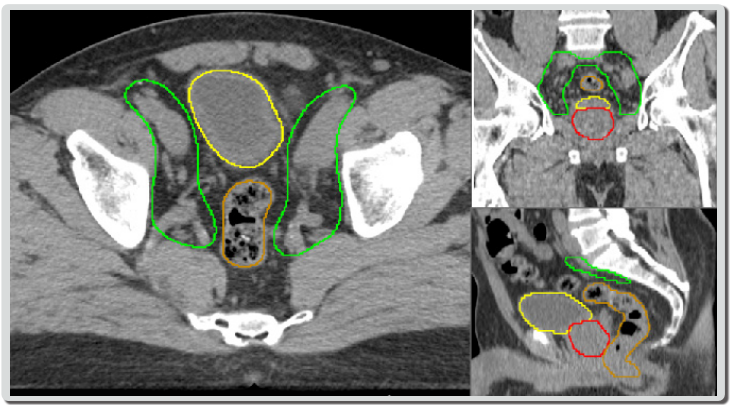


Table 1
Five Test Subject Results

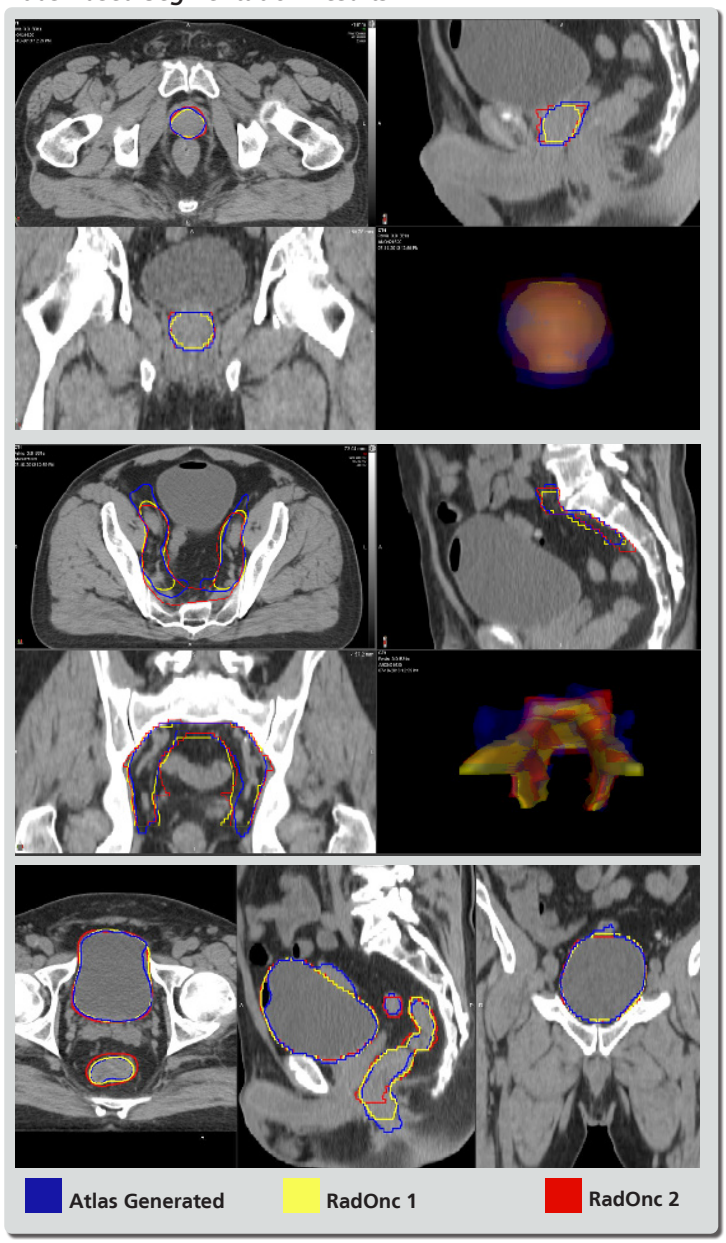
P-values	Bladder	Prostate	Rectum	Pelvic LN
RadOnc 1 vs Atlas compared with **RadOnc 2 vs Atlas**	0.183	0.836	0.818	0.711
RadOnc 1 vs Atlas compared with **RadOnc 1 vs RadOnc 2**	0.830	0.075	0.622	0.623
RadOnc 2 vs Atlas compared with **RadOnc 1 vs RadOnc 2**	0.069	0.147	0.865	0.086

Figure 2
Patient Image



Manually defined atlas contours for the Prostate, Bladder, Rectum, and Pelvic LN.

Figure 3
Atlas-Based Segmentation Results



Patient with atlas-based segmentation results using 5 atlas matches vs RadOnc 1 and RadOnc 2 manual contours.

Conclusion

Our atlas segmentation method provided accurate contours for high risk prostate cancer. This segmentation method has may have potential for greater accuracy and less variance than traditional inter-individual user contours. In particular, the accuracy of our atlas based segmentation algorithm for pelvic lymph nodes was very good. This is likely due to their association with rigid structures and reduced motion compared to other structures such as the prostate and seminal vesicles. Therefore, our results demonstrate, that atlas based auto-contouring of the pelvic nodes could both help increase consistency for treatment volumes in high risk patients between different cancer centers as well as decrease time related to treatment planning for radiation oncologist.