FEASIBILITY STUDY OF ATLAS-BASED IMRT PLANNING- WHAT IS THE ACCURACY IF WE USED THE BEST MATCHED IMRT PLAN THAT WE APPLY DIRECTLY?

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Purpose

The advent of kV cone beam based IGRT has facilitated isocenter and positioning accuracy to sub-millimeter levels and has opened the door to the possibility of adaptive targeting of planned fields. The adaptive radiation therapy process, however, should include real-time implementation of modified plans. This is not being practiced because of the systematic time constraints of structure definition and complex/IMRT case re-planning. This study tests the feasibility of applying template Atlas based IMRT prostate plans to multiple patients for possible IMRT planning within minutes.

Methods & Materials

An atlas of treatment contours and anatomical CT images for 99 prostate patients was generated using commercially available software (MIMvista Corp., Cleveland, OH). The test cases are matched to the Atlas cases using three different techniques: small field of view (SFOV), large FOV (LFOV), and LFOV with the prostate, rectum and bladder set as match constraints. FOV is the box size defining the active fusion anatomy: SFOV is inside the femoral heads, anterior of the bladder and posterior to the rectum, and the LFOV is the entire pelvis. The match process which is based on mutual information and correlation coefficients takes less than one minute.

When the study case CT scans are matched to an "Atlas" CT, the corresponding template Atlas based IMRT is applied to the physician contoured volumes on the study case. Recalculation of each plan takes 3-4 minutes. All plans are scaled for PTV coverage of 95% to the prescribed dose of 7560cGy. Plans were also rescaled for 95% coverage for CTV for secondary analysis of the template Atlas based IMRT .
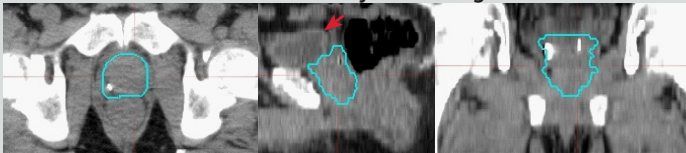
Figure 1
Study Case and Matched Atlas Patient Examples

Study Case with Large and Small FOV Contour Volumes
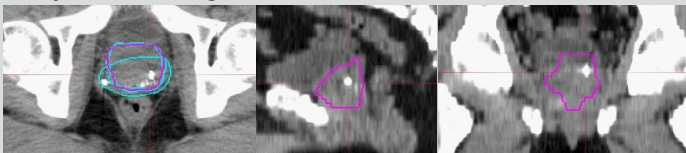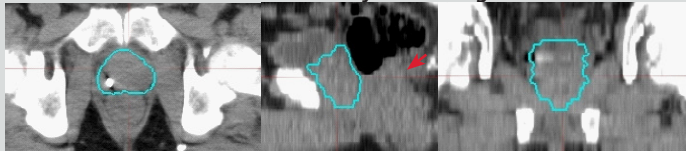
Hand drawn patient specific volume is purple. Teal are copied Atlas volumes.

Atlas Patient #012 Matched to Study Case Using SFOV

Note the variation in bladder filling compared to study case.

**Atlas Patient #004 Matched to Study Case Using LFOV**

Note the variation in rectal prep compared to study case.

Results

Nine test patients are matched with the three different techniques defined above. For a particular patient, the best matched of the three techniques are used for comparison analysis. For most of the cases, the small FOV match is the one chosen. For template plans scaled to cover PTV adequately, dose to 20% of the rectum volume averages 75 Gy (standard deviation (STD) 8 Gy) and percent rectum volume receiving 65 Gy averages 31% (STD 11%). 30% bladder volumes receive doses that average 57 Gy (STD 18 Gy). Percent bladder volume receiving 65 Gy or more averages 26% (STD 14%). With template plans scaled to cover CTV, the above numbers for rectum are 68 Gy (STD 7 Gy) and 26% (STD 11%), for bladders are 52 Gy (STD 18 Gy) and 22% (STD 15%).

Figure 2
Plan Comparison using Individualized and Matched Atlas-Template Plans
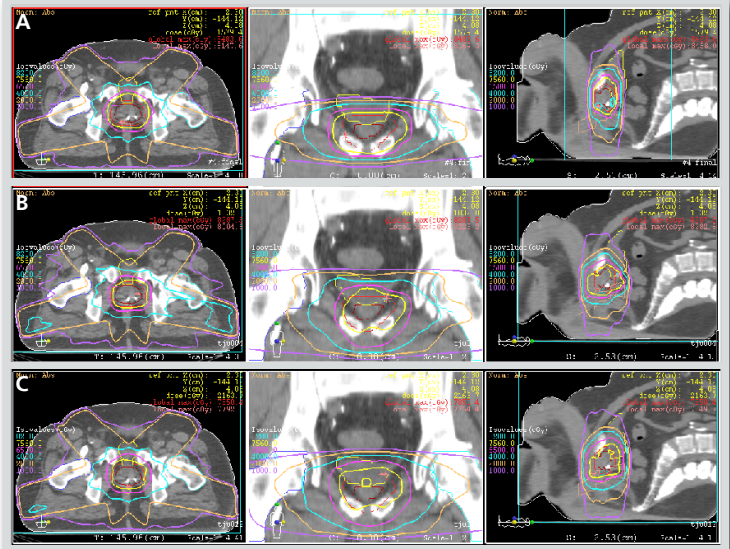
(A) Plan with MD delineated volumes and individualized IMRT plan
(B) Plan with MD delineated volumes and LFOV with constraints-template Atlas based IMRT plan
(C) Plan with MD delineated volumes and small and Large FOV template Atlas based IMRT

Figure 3
DVH Comparison using Matched Atlas-Template Plans
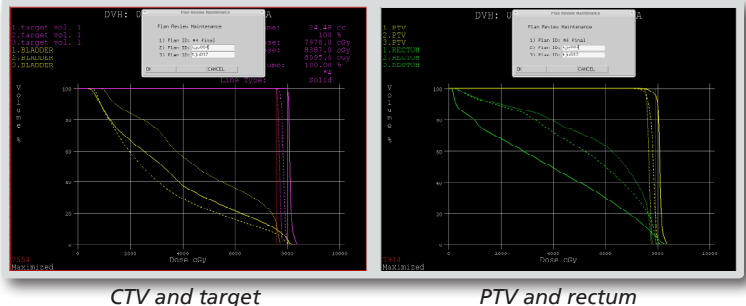
CTV and target   PTV and rectum

Discussion/Conclusion

• In 7 of the 9 cases, the best re-plan was generated with the SFOV match criteria.
• The template plans scaled to deliver adequate dose to CTV have better sparing of critical structures as expected. With IGRT readily available, it is conceivable to reduce margins of PTVs to within millimeters of the CTV. With reduced PTV margins, there could be a higher percentage of template IMRT prostate plans based on Atlas contour matching deemed clinically acceptable.
• With more cases added to the Atlas, it is reasonable to expect to find better matches. More rigid patient preparation may also improve Atlas contour/patient correlation. Patient specific Atlas generation may expedite IMRT template plan applications.
• With only minutes to arrive at a usable IMRT plan, this could be considered as a possible solution to the conundrum of wanting adaptive real-time re-planning and the reality of time and workflow issues.