Interfraction organ deformation and rotation of the target and/or organs at risk (OAR) cannot be completely accounted for by the current IGRT repositioning. We have developed and implemented an online adaptive radiotherapy (ART) technique to address these interfraction variations in in prostate cancer RT.

The ART technique includes: (i) acquiring daily CT right before the treatment using an in-room CT (e.g., CTVision, Siemens) or kV cone beam CT, (ii) generating contours of target and OARs based on the daily CT by auto-segmentation with manual editing if necessary, (iii) morphing segment apertures based on new contours, (iv) optimizing weights of the new apertures, (v) computing and comparing dose distributions and DVHs between the adaptive plan and the original plan with patient repositioning, (vi) transferring adaptive plan to delivery machine, (vii) performing QA tests (independent MU calculation and validation of planning data transfer) for the adaptive plan with a software tool, (viii) delivering and documenting the adaptive plan. The replanning process (ii-v) was implemented into a planning system (RealArt, Prowess). The entire process is validated with phantom measurements and with retrospective dosimetric analyses for 40 selected cases in various tumor sites including prostate, pancreas and breast.

Our data show that the online ART can effective account for the interfractional variations including severe organ deformation. The plan quality (target coverage and/or OAR sparing) of an adaptive plan is equally or better than that of the repositioning plan. For example, the V70 (dose covered by 70 Gy) for rectum was reduced by a factor of 3 by the adaptive replanning for the 10 prostate cases studied. For the 10 pancreatic cancer cases studied, the mean V50 for duodenum was reduced from 43% for IGRT repositioning to 16% for the adaptive scheme. For prostate RT, the adaptive plans can be generated within 6-8 min and can be ready for delivery within 8-12 min after the CT acquisition. The online replanning process, eliminating the need to shift the patient, can be performed within the similar or slightly longer time frame required for the current IGRT repositioning, fits into the routine clinical workflow, and has been implemented in our clinic. This online scheme enables “image-plan-treat”, a new paradigm for IGRT that permits shrinking PTV margins and can facilitate accurate RT delivery particularly important for hypofractionations (e.g., SBRT) and/or dose escalations.

This lecture will provide an overview of the development and implementation of an online ART in prostate cancer RT and potentials for the online ART in other tumor sites.

Learning Objectives:

1. Understand the development of online ART as an effective solution for interfractional variations
2. Understand the specific issues on hardware, software and workflow for clinical implementation of online ART in prostate RT
3. Understand the safety and QA issues for implementing online ART
4. Understand the potentials for using online ART in other tumor sites including pancreas and breast.