Image guidance is particularly important in the delivery of external beam radiotherapy for localized prostate cancers because of a demonstrated need for high doses and the increasing interest in hypofractionated regimens. With small field radiation , the impact of inter- and intra-fraction motion and deformation needs to be understood, ideally in individual patients rather that in a population. Multiple imaging and localization techniques are currently available to implement in therapy rooms. Each technique has a particular ability to address the motion and deformation issues. More importantly, the planning and dosimetric impact of such motion and deformation is only starting to be evaluated. Such dosimetric evaluations will be crucial in assessing the adequacy of individual techniques.

Current in-room localization techniques are almost exclusively geared towards imaging prior to treatment, determining target offsets, and modifying the target position by moving the treatment table. It is clear that external marks and bony anatomy are poor proxies for determining the location of the prostate gland. Transabdominal ultrasound is an efficient method of performing daily image guidance, however it suffers from significant interuser variability. Implanted metallic fiducials significantly decrease the interuser variability and have been demonstrated to be stable within the prostate gland, therefore acting as adequate surrogates for prostate position. However, although practically extremely rare, significant deformation in poorly placed markers can result in anatomical changes that could render the markers suboptimal surrogates for prostate anatomy as a whole. Finally, volumetric imaging with different in-room CT options (cone beam or helical kV or MV CT scanning) adds the ability of assessing entire volumes rather than individual points. However, practical consideration coupled with sometimes difficult interpretation of soft tissue images makes the presence of fiducials still desirable. The main advantage of CT imaging is the potential for the evaluation of delivered dose variations in target and normal tissues. Finally, technologies such as electromagtnetic tracking enable the real-time tracking of the location of the prostate throughout the treatment delivery. Such technologies will enable the therapists to interrupt the delivery and realign the target areas.

The clinical processes associated with each imaging technique are different and require different skills, possibly also resulting in different targeting solutions in individual patients. In the absence of actual clinical outcomes in the short term future, these processes will have to be evaluation on their technical merits. However, the accumulation of clinical outcome data (tumor control and toxicity) is crucial in understanding the true impact of these techniques.

Educational Objectives:

1) Review the different technologies used for target localization in the pelvis.

2) Discuss the dosimetric impact of observations made with pelvic target localization during radiation therapy.

3) Discuss the future potential applications of image guidance and adaptive radiotherapy in the treatment of pelvic malignancies, particularly prostate cancers.

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