

Computed tomography (CT) simulator combines functionality of a conventional simulator with features and image processing and display tools of a three-dimensional radiation therapy treatment planning (3D RTTP) system. Due to this ability, CT-simulators have significantly increased their presence in radiation oncology centers during the past decade. This refresher course: 1) reviews the development of CT-simulation technology and tools; 2) describes the simulation process with emphasis on patient immobilization and positioning, scan protocols and limits, and simulation techniques specific to individual treatment sites; and 3) discusses the quality assurance requirements and procedures for CT-simulators.

Radiotherapy treatment simulation devices have been an integral component of treatment planning and delivery process for over 30 years. Image-guided three-dimensional radiation therapy is increasingly becoming a standard of care in radiation oncology community. Several manuscripts from 1980s and early 1990s described diagnostic CT-scanners equipped with an external laser alignment system and virtual simulation software capable of replicating functions and geometry of a conventional simulator. Additionally, this software has tools that provide beam's eye view (BEV) and room's eye view (REV) displays, digitally reconstructed radiographs (DRRs), digitally composited radiographs (DCRs), multiplanar reformatted images (MPRs), and a variety of 3D displays. Modern CT-simulators are fully capable of replacing conventional simulators.

Patient positioning and immobilization are critical issues in the CT-simulation process. Patients must be immobilized in a reproducible position so that virtual simulation parameters can be accurately replicated on the treatment machine. Immobilization devices that are registered to treatment table greatly simplify this task.

CT-simulation process is associated with a large number of scans; often 100 to 200 scans are acquired per study. To avoid excessive tube heating and long tube cooling wait times, CT scan protocols are typically a compromise between slice thickness, scanned volume span, mAs, and spiral pitch. kVp is usually kept constant for all studies.

CT-simulation techniques specific to individual treatment sites have been addressed in a number of manuscripts and book chapters. Well-organized and defined virtual simulation process and procedures specific to treatment sites are crucial for success of a CT-simulation program. Site-specific simulation procedures should include: patient positioning, immobilization, scan protocol, slice thickness, slice spacing, scan limits, contrast indications, patient marking, and any special instructions.

Acceptance testing, commissioning, and continuing quality assurance (QA) of CT-simulators are in many aspects similar to procedures for diagnostic CT scanners. However, CT-simulators have certain QA requirements that are not included in procedures for diagnostic scanners. Quality assurance of CT-simulators and virtual simulation software will be addressed in the upcoming AAPM Radiation Therapy Committee Task Group No. 66 report, Quality assurance for CT simulators and for CT simulation process. Meanwhile, several book chapters provide useful guidelines for CT-simulator QA.

CT-simulation process has matured during last several years and along with other imaging modalities will continue to be a crucial component of a conformal radiation therapy process. Proper understanding and implementation of the CT-simulation has a potential for improving efficiency and quality of radiation therapy delivery.