AbstractID: 4147 Title: Multidimensional Dosimetry without Film Processors

Introduction

Radiographic film has been a mainstay for quality assurance procedures within radiation oncology departments. Prior to 3D conformal therapy, treatments were planned using kilovoltage portal films (simulator films). After the introduction of 3D conformal therapy, this function was shifted to digitally reconstructed radiographs which were often printed on radiographic film. Patient positioning verification was conducted using megavoltage portal films, and multidimensional dose distribution quality assurance relied on film-based dosimetry. Many clinics are taking advantage of modern imaging and computer equipment to remove radiographic film from routine clinical operations. This is occurring simultaneous to the wide-spread adoption of intensity modulated radiation therapy (IMRT). The complexity of IMRT has led to the requirement of direct validation of the patient's treatment delivery. This often includes a multidimensional measurement of the dose distribution. Clinics that have removed radiographic film from their routine process may elect to remove the film processors. Radiology is also moving towards a filmless process, so the number of available film processors in hospitals may in the near future be limited. Many medical physicists responsible for IMRT QA will find themselves without a basic dosimetry tools so alternative techniques need to be established.

This symposium will present three alternatives to radiographic film for multidimensional dose distribution measurements; multipoint electronic dosimeters; 3D dosimeters, and radiochromic film. The goal of the symposium is to educate the attendees in the methods, advantages, and challenges inherent to each system.

Multipoint electronic dosimeters

This will be a survey of commercially available multipoint electronic dosimeters that can be used for IMRT quality assurance (QA) work. These devices fall into the following categories: arrays of silicon diodes; unsealed, large area, pixel segmented, air ionization chambers; electron portal imaging devices that use liquid ionization chambers and amorphous silicon detectors; and metal-phosphor-screen imaging systems. The basic operating principles will be presented. The following characteristics will be compared: detector spatial resolution, signal acquisition time, measurement and data storage dead time, system dynamic range, linearity of detector response, measurement of dose or fluence, calibration procedure and its longevity, compatibility with treatment planning systems and linear accelerators, applicability to dynamic and static delivered IMRT, slice- and helical-tomotherapy, analysis software and functionality, ease of use, and overall QA time.

Status of 3D dosimetry techniques

Several 3D dosimetry systems have been proposed in recent years, but their acceptance into widespread clinical use has been slow. Primary reasons include lingering practical difficulties, limited access to specialized equipment, expense, and lack of convenience. Despite slow acceptance in the clinic, the field of 3D dosimetry is accelerating in innovation and promise. Several new 3D dosimetry materials have been proposed with striking performance characteristics. Significant advances have also been made in technologies to image 3D dose distributions, including both optical and MR techniques. In this lecture we will review these and other developments in an attempt to explore the present state of the art.

Radiochromic Film

Radiochromic film (RCF) has been demonstrated to be precise and accurate dosimeter for the acute delivery of high doses (5-100 Gy). RCF provides energy-independent tissue-equivalent dose response in the megavoltage photon range, high spatial resolution, and insensitivity to visible light. RCF is convenient to handle, mark, or cut, and the films can be immersed in water phantoms. Until recently, RCF was inadequate for clinical applications requiring low doses (1-400 cGy), such as the measurement of a single fraction of IMRT delivery for patient specific QA. Due to the fact that multileaf collimator systems behave more accurately when delivering IMRT segments with increasing monitor units, recording doses under clinical conditions is crucial to the validity of the measurement. The practice of scaling up the monitor units of a delivery to better match the sensitivity of a dosimeter is unacceptable as it prevents accurate characterization of the delivery. Very recently, a novel formulation of RCF (trade-named EBT RCF from I.S.P. Inc.) with greatly increased absorbed dose sensitivity has been introduced. This new RCF is based on a novel polymerizing microcrystalline sensitive layer with improved sensitivity for densitometry systems at wavelengths of about 635nm. The sensitivity of the film has been increased to range between 2 and 800 cGy, making it ten times more sensitive than previous RCF and well suited to IMRT QA measurements. This new dose range is comparable to those obtainable with commercial radiographic films; however, RCFs are self-developing and do not require film processors with their associated maintenance and QA. The self-developing nature of RCF makes it potentially more accurate, as well, since it obviates the need for precise chemical and thermal control of post-exposure processing needed with conventional silver-based films. The new film also demonstrates a faster saturation of optical density after irradiation, allowing for rapid scanning and evaluation.