Serial tomotherapy, a rotational application of intensity modulated radiation therapy (IMRT), was originally envisioned by Rock Mackie and has been developed as a commercial modality by the NOMOS Corporation. The commercial system consists of a treatment planning and optimization software and a tertiary dynamic multileaf collimator. IMRT, and specifically tomotherapy, has characteristics that are significantly different from conventional conformal therapy and requires the development of new quality assurance (QA) methods. This talk will describe some of the techniques used for commissioning, routine QA, and patient QA, as well as some of the dosimetric characteristics of tomotherapy.

Many dose measurement methods used to validate traditional treatment planning systems cannot be used with dynamically delivered IMRT. In conventional systems, dosimetric validation is conducted using water phantoms and point dosimeters, such as ionization chambers. The radiation dose distribution is assumed to be static, allowing the dosimeter to be moved throughout the phantom to integrate a linear or planar dose distribution. However, because the entire fluence distribution must be delivered for each measurement point, a traditional real-time scanning system cannot be used to collect dose distribution data. The implications of dosimeter limitations and methods to optimize each available dosimeter to gather the most useful data will be discussed. The independent determination of the spatial location of the measured and calculated dose distributions will be stressed.

The patient treatment verification is also different from conventional treatments. Many centers verify the delivered dose to each patient, either through the use of anthropomorphic or geometrically regular phantoms, or using in-vivo measurements. Developing a robust method for the verification of patient positioning is also critically important. Because IMRT provides complex high gradient dose distributions that often conform tightly and surround critical structures, the patient position and orientation relative to the gantry coordinate system must be accurately verified. Some centers use portal images obtained with the open collimator leaves, yielding a narrow portal (e.g., 3.4 x 20 cm^2) which may yield few quantitative anatomical references, so the portal orientations and positions should be selected to maximize anatomical reference data.

Dosimetric tests require the use of target and critical structure volumes to generate treatment plans. Selection criteria for targets and critical structures will be discussed as will phantoms used for dosimetric measurements.

Tomotherapy makes inefficient use of monitor units, each slice is only approximately 1.68 cm long, so the treatment of longer targets requires the use of multiple slices (200 cGy ≈ 3000 MU). The whole-body dose due to leakage radiation is correspondingly greater, and should be considered as part of patient selection. The breakup of treatments into multiple abutted slices requires accurate patient movement between slices as well as good patient immobilization. The accuracy of the patient moving hardware, the dosimetric consequences of inaccurate motion, and intrinsic abutment region dose distributions will be addressed.

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Course Objectives:

To describe:

1. Serial tomotherapy treatment delivery techniques
2. Commissioning and QA procedures
3. Clinical implementation
4. Dosimetry features