Tomotherapy is intensity-modulated radiation therapy (IMRT) achieved using a rotating fan beam with its intensity modulated using a binary collimator system. The NOMOS Peacock™ system is a serial (or sequential) tomotherapy device in that the rotational fan beams are delivered one rotation at a time with the patient translated between rotations. The Peacock delivers very highly modulated intensity patterns that can create complex shaped dose distributions that have been shown to avoid overdosing sensitive tissues that abut the target volume.

Helical tomotherapy is an IMRT system whereby the fan beam is continuously rotated as the patient is translated through the bore of the gantry. At the University of Wisconsin (UW) we have developed a helical tomotherapy system by placing a linac into the ring gantry of a helical CT scanner. A Siemens 6 MV linac and magnetron-powered RF system has been married into a General Electric (GE) CT scanner slip-ring gantry with an 85 cm bore. A 64 leaf binary multileaf collimator modulates the fan beam of radiation. Megavoltage tomograms are acquired using a GE xenon ionization CT detector placed on the exit side of the beam from the patient.

The helical tomotherapy system has been installed at the UW Radiotherapy Clinic. The fan beam thickness can be varied continuously between 0.5 and 4 cm. The steepest penumbra gradient at the isocenter is 35% per mm. The collimator leaves, with a resolution of 6.25 mm, are driven in and out of the field pneumatically and take 20 ms to cross the fan beam. The unit does not have a field flattening filter (if desired the field can be modulated to be uniform in intensity) so that the unit output is not wasted and the beam spectrum does not vary appreciably along the length of the field. Megavoltage tomograms have high contrast resolution comparable to conventional kilovoltage CT’s. It is possible to resolve 0.8 mm air cavities in water. At low contrasts it is possible to resolve objects 2.5 cm in diameter that are 1% different in density from their background using a dose of 3.5 cGy.

Software processes that use tomographic capabilities, such as delivery modification and dose reconstruction are being implemented. With a CT image at the time of treatment it is possible to determine if the patient is set up correctly and the organs have not altered in shape. Delivery modification accounts for translations and rotations of the patient by altering the leaf delivery pattern rather than repositioning the patient. Dose reconstruction determines the dose actually delivered to the patient. We anticipate that these processes will provide unprecedented accuracy in the delivery of conformal radiotherapy and enable conformal avoidance radiotherapy whereby high dose to neighboring sensitive structure is avoided.

Learning Objectives
1) To introduce the concept of tomotherapy.
2) To differentiate between serial and helical tomotherapy.
3) To introduce the verification processes of tomotherapy.

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