

Helical tomotherapy is a rotational radiation therapy delivery technique that combines pre-treatment CT-based image-guidance and Intensity-Modulated Radiation Therapy (IMRT) using a fan-beam delivery. Helical tomotherapy treatments are delivered by a continually rotating gantry mounted on a slip ring system, which permits power and communications to be passed from the rotating to stationary sub-systems. Treatments are delivered with both the gantry and the couch in continuous simultaneous motion. Thus, helical tomotherapy can continuously deliver intensity-modulated radiation from 360° in a transverse plane about the patient.

In addition to its ability to deliver IMRT, helical tomotherapy systems also have the ability to obtain Megavoltage CT (MVCT) images of the patient in the treatment position prior to each treatment fraction. Daily positional uncertainties and anatomical changes (such as weight loss, tumor response, etc...) can be minimized by utilizing CT-based pre-treatment imaging. As such, the position of the tumor relative to the treatment beam can be corrected prior to treatment by moving the patient with appropriate superior-inferior, anterior-posterior, lateral, pitch, roll, and/or yaw offsets.

The combination of precise positioning of the target volume and the rotational nature of the delivery make helical tomotherapy well suited for simultaneously delivering differential doses to multiple targets. Treatment sites that are large in the superior-inferior direction are easily treated with helical tomotherapy. Multiple target volumes up to meter in length can be treated in a single helical tomotherapy delivery sequence. This can be useful for treating multiple metastases throughout the body while avoiding nearby critical structures. Head and Neck patients can be treated with integrated boosts with minimal dose spillover, dumping, hot spots, or critical structure problems. Shrinking lung tumors can be treated with a simultaneous integrated volume-adapted boost (SIVAB) that allows dose escalation to the residual tumor mass without compromising normal tissue tolerance and dose to areas at risk for microscopic tumor spread. For prostate patients that are at risk for nodal involvement, the regional lymph nodes, the seminal vesicles, and the prostate can be simultaneously targeted and treated to different doses.

This lecture will provide an overview of clinical scenarios utilizing differential dose delivery with helical tomotherapy. The advantages and disadvantages of helical tomotherapy will be discussed for each clinical example.

Educational Objectives:

- 1) Provide a brief overview of the helical tomotherapy system's imaging and treatment capabilities
- 2) Present clinical scenarios for utilizing differential dose delivery with helical tomotherapy
- 3) Discuss potential applications of adaptive differential dose delivery