Treatment planning and high-dose radiotherapy for lung cancer using slow CT protocol

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CT Scanning techniques

Respiratory motions complicates target volume definition for patients with lung cancer, and represents one of the greatest problems in treatment planning and execution

Two scanning techniques:

- **Standard CT scan**-provides an clear image of the thorax that shows the boundary of the tumour with normal tissue
- **Slow scan**-produce blurred images of moving objects, but provide the information on the extent of motion and help inform the target volume margins

Volume definition

Most important step for meaningful 3D treatment planning and accurate dose delivering

Volumes related to 3-D treatment planning:

- Gross Tumour Volume (GTV)
- Clinical Target Volume (CTV)
- Internal Target Volume (ITV)
- Planning Target Volume (PTV)

Gross Target Volume (GTV)

- Palpable or visible/demonstrable extent and location of malignant growth
- Usually based on information obtained from a combination of imaging modalities (computed tomography, magnetic resonance imaging, ultrasound, etc.), diagnostic modalities (pathology and histological reports, etc.) and clinical examination

Clinical Target Volume (CTV)

- Tissue volume that contains a demonstrable GTV and/or sub-clinical microscopic malignant disease, which has to be eliminated
- Needs to be treated adequately in order to achieve the aim of therapy, cure or palliation
- Anatomical–clinical volume, usually determined by the radiation oncologist
- Usually stated as a fixed or variable margin around the GTV

Internal Target Volume (ITV)

- Consists of the CTV plus an internal margin
- Designed to take into account the variations in the size and position of the CTV relative to the patient's reference frame (usually defined by the bony anatomy)

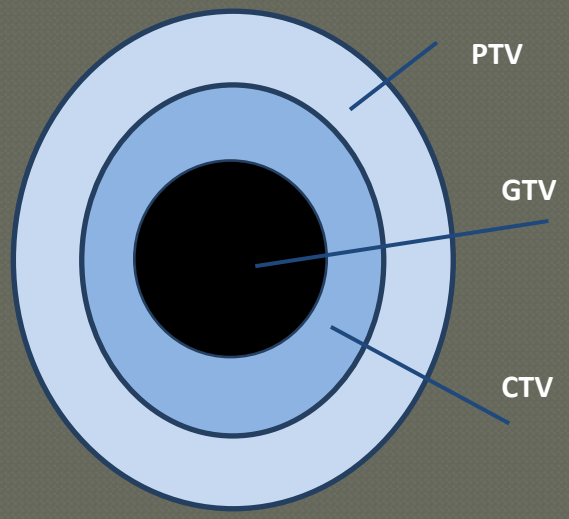
Planning Target Volume (PTV)

- Geometrical concept, defined to select appropriate beam arrangements
- Consideration the net effect of all possible geometrical variations Ensures that the prescribed dose is actually absorbed in the CTV.
- Includes CTV and an additional margin for set-up uncertainties (organ motion, systematic errors caused by inaccuracy of patient positioning and machine tolerances)
- Usually determined by medical physicist

Fast Helical CT protocol

- Free breathing technique and standard scanning parameters
- Very useful for generating accurate images of tumour or organ shape
- Necessary for capturing the moving tumour in active respiratory movement
- Defines the Gross Tumor Volume (GTV) to determine the extent of tumour movement and its displacement in all three directions

Fast Helical CT protocol

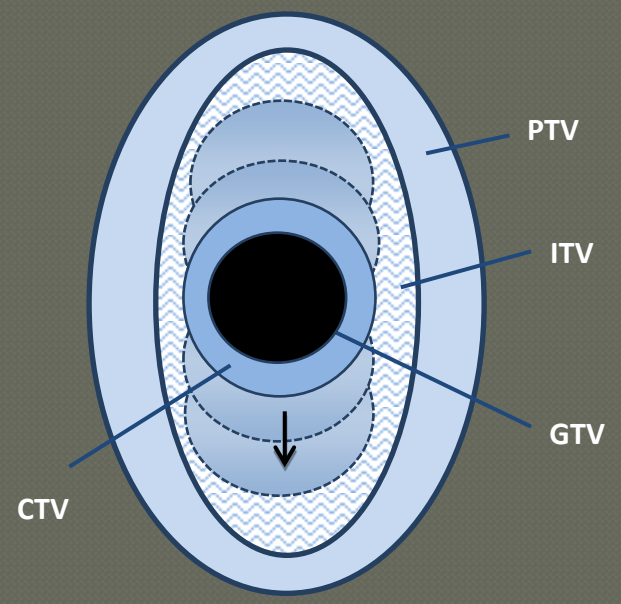


Volumes related to 3-D treatment planning in fast CT protocol

Slow CT Protocol

- Using highest available gantry rotation time of 4 seconds, and pitch 0.568
- Allowing images to be reconstructed theoretically capturing all target motions within 4 seconds, which is the time of average respiratory cycle
- Assessment of threedimensional tumour mobility and ordinate the direction of motion of the moving targets
- Determing the Internal Target Volume (ITV) as the sum of the individual GTVs defined at different phases of respiration and the volume that it travels under normal respiratory and cardiac movement

Slow CT Protocol



Volumes related to 3-D treatment planning in slow CT protocol

Treatment planning

- Fusion of both scans, using vertebral spine as the reference for alignment
- ITV applied from slow to fast CT scan, eventually needs to be manually corrected by radiation oncologist
- ITV is applied on CTV
- PTV is applied on ITV

Immobilization

- The immobilization system represents the crucial component in achieving a high quality radiation therapy
- Using an unique combination of immobilization components, we provide the best possible treatment for our patients

Immobilization

- **Precission**-Good pacient positioning, combined with proper immobilization, should limit the patients movement during treatment
- **Reproducibility**-Consistent daily position of the patient and reduction of daily shifts
- **Patient comfort**-effectively reducing translational and rotational movements by keeping patient relaxed as much as possible

Immobilization

Only by combining these three crucial components, we can achieve our goal and that is to optimise the radiation dose to the target volume, while reducing the dose to the surrounding healthy tissues

Patient positioning

- Position with both hands above the head using 20 or 30 degree armrests and handgrips for greater stability and patient comfort
- 5, 10 or 15 degree angled wedges which lift the upper body of the patient thereby facilitate breathing
- Lateral inserts in the cushions allow the positioning of large patients

Patient positioning

- Appropriate head position using combination of headrests, blocks or wedges
- Knee and ankle support cushions for elevated position to the legs, which reduces stress in the patients back during treatment fractions
- Specially developed thermoplastic masks for encreased treatment precision

Patient positioning

- Reproducible set-up during each fraction
- Greater choice of beam arrangement
- Improved target coverage and spares normal surrounding tissues
- Increased treatment precision

Thanks for your attention