Novel Clinical Applications of IMRT

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Advantages of Helical Tomotherapy

- CT component allows real-time imaging of patients to verify set-up and detect variations in positioning
- Relative Simplicity
- An optimal means of delivering co-planar therapy
- Adaptive Radiotherapy
- Conformal Avoidance
- Wide range of IMRT applications

UW Helical Tomotherapy Unit

- MVCT scans obtained on 10 lung and 10 prostate cancer patients
- 9 dogs treated
- 10 human patients treated
- 9 palliative
- 1 definitive

MVCT of an Anesthetized Dog with a Sinus Tumor

Sinus Tumor
Eroded Bone
Advantages of Helical Tomotherapy

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Preliminary Tomotherapy Planning
Conformal Avoidance

- Wide field XRT is frequently employed to target regional micrometastatic extension
- This regional disease extension is not precisely defined in terms of anatomic detail
- As a consequence, normal critical tissues are frequently irradiated and yield toxicities
- Conformal avoidance can “shield” these structures and improve the therapeutic index by decreasing these often permanent and debilitating NTCPs
  - Salivary glands: Xerostomia/Dental hygiene/Osteonecrosis
  - Oto-acoustic apparatus: Hearing/Balance
  - Optic/Lacrimal tissues: Vision/Xerophthalmia/Corneal complications

Rationale for Conformal Avoidance Radiotherapy

- The gross tumor volume (GTV) may not be clearly visible
- Uncertainty in defining the clinical target volume (CTV)
- The planning target volume (PTV) may be uncertain
- The target dose is limited by normal sensitive tissue
- Conformal avoidance is the ideal paradigm to treat suspected regional/nodal involvement

Conformal dose-distribution with tomotherapy

Continuum Between Conformal Therapy and Conformal Avoidance

Know where tumor is and will not harm sensitive tissue

Don’t really know where tumor is
May miss part of target if overly conformal
.....and still harm sensitive tissue
The Mantle

- Successfully used for many decades
- A classic example of the need to treat invisible microscopic regional disease
- Generally not easy to duplicate using conformal therapy
- A potential application of conformal avoidance IMRT
- Can reduce dose to Thyroid, Larynx, Heart, Spinal cord thereby reducing complications
- Can reduce dose to breast in young women (possibly) reducing risk of future breast cancer

Conformal Mantle Field

Conformal Avoidance Radiotherapy for A Mantle Equivalent using Helical Tomotherapy

Subtotal/Total Lymphoid Irradiation

- Inverted Y
- Can be effectively duplicated using IMRT via linac or helical tomotherapy
- Significantly less dose to sensitive normal structures than older techniques is possible
Mesothelioma

ROI slice 27

Dose Rate    Cumulative Dose

Tomotherapy Mesothelioma Dose Distributions

Partial Breast Irradiation

- Good clinical results have been obtained using HDR brachytherapy
- Recent applications of partial breast irradiation using external beam approaches
- Visualization of target and immobilization of breast will be essential for success of this approach

Limited Field Prone Breast
IMRT for complicated tumor volumes

- IMRT can handle complicated tumor volumes using either a conformal therapy or conformal avoidance approach
- High conformity of isodose curves
  - Lower doses to surrounding normal structures
  - Higher dose to tumor volume

Skull Irradiation

Lumbar Spine Treatment

MVCT, Simple Contour, Plan & Treat Palliative Case: 30 Minutes Total
Summary

- Conformal avoidance radiotherapy, the complement to conformal radiotherapy, focuses on avoiding dose to normal tissue
- IMRT, especially helical tomotherapy appears particularly well suited for conformal avoidance
- Many innovative clinical procedures will evolve from conformal avoidance IMRT

Potential Clinical Applications of Conformal Avoidance IMRT

- Improved irradiation of nodal chains using the conformal avoidance strategy
  - Improved “Mantle” and “Inverted-Y”
  - Para-aortic irradiation for GYN, GU and lymphoid malignancies
- Brain-sparing total scalp irradiation
- Pacemaker/defibrillator avoidance
- Bone marrow ablation while sparing visceral organs
- Craniospinal Irradiation

Potential Clinical Applications of Conformal Avoidance IMRT

- Accelerated partial breast irradiation
- Complicated tumor volumes
- Mesothelioma
- Extracranial stereotactic radiotherapy
- Widespread metastatic disease?
  - Visible disease handled with radiotherapy
  - Micrometastatic disease handled by chemotherapy
  - “Intermediate” disease identified by PET and handled by IMRT