PLAN EVALUATION IN IMRT

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“A dose plan and treatment delivery that is optimized using inverse or forward planning techniques for modulated beam delivery, using EITHER a binary collimator OR with a conventional MLC system, using either “Sliding Window (DMLC) OR “Step and Shot” (SMLC) modes”

National Cancer Institute Guidelines for IMRT in Clinical Trials
AIM OF RADIATION THERAPY

- TUMORICIDAL DOSE TO TUMOUR
- LEAST DOSE TO SURROUNDING NORMAL TISSUE
CONVENTIONAL RADIOTHERAPY

- RECTANGULAR / SQUARE FIELDS
- LIMITED NO. OF FIELDS
- UNIFORM DOSE INTENSITIES IN THE FIELD
CONVENTIONAL RADIOTHERAPY

NORMAL TISSUE SPARING:

• WEDGE FILTERS
• BEAM MODIFICATION DEVICES
• SHIELDING BLOCKS
• X RAY SIMULATION
• IMMOBILISATION etc…
CRITICAL PARAMETERS

• PRECISION IN DOSE DELIVERY
• REPRODUCIBILITY
• TUMOUR AND NORMAL TISSUE DELINEATION
ADVANCES

• 3D RECONSTRUCTIONS (CT/MRI/PET)
• 3D COMPUTERISED TREATMENT PLANNING SYSTEM
• MULTILEAF / MICROMULTILEAF COLLIMATION
ABILITY NOW TO

- VISUALISE STRUCTURES IN 3D
- SHAPE IRREGULAR RADIATION FIELDS IN 3D
- MATCH THE VISUALISED TUMOUR SHAPE AND RADIATION DOSE SHAPE TO EACH OTHER
LATEST TOOL TO ENHANCE THE MATCH BETWEEN TUMOUR AND DOSE SHAPE AND SPARE NORMAL TISSUE:

INTENSITY MODULATED RADIATION THERAPY (IMRT)
INTENSITY MODULATED RADIATION THERAPY (IMRT) REQUIREMENTS

- LINEAR ACCELERATOR 6 MV
- MULTILEAF/MICROMULTILEAF COLLIMATOR
- 3D TPS WITH CT/ MRI / PET FUSION
- INVERSE – PLANNING SOFTWARE
- IMMOBILISATION
- SPECIALIZED IMRT QA EQUIPMENT
INVERSE PLANNING

COMPUTER ALGORITHM ALLOWS TO SPECIFY DOSE CONSTRAINTS TO NORMAL TISSUE (eg BLADDER, RECTUM, CORD etc) WHILE GIVING TUMOUR REQUIRED DOSE

[Cf Forward planning]
IMRT INDICATIONS

- AS SOLE MODALITY
- AS BOOST TREATMENT

( PROSTATE, HEAD AND NECK, BRAIN, BREAST, CERVIX, PARASPINAL TUMOURS, LUNG, BLADDER etc.. )
PROSTATE CANCER

3D RECONSTRUCTION
PROSTATE CANCER

3D RECONSTRUCTION
PROSTATE CANCER

TREATMENT BEAMS

Skin
bones
intestine
rectum
Bladder
prostate
PROSTATE CANCER

MICRO MULTI LEAF COLLIMATION
Dose Volume Histogram

3D CRT

IMRT

Volume (%)

Dose

Object Name
rectum

Dose relative to:
- Treatment Maximum
- Absolute
- Prescribed

Name | Show
--- | ---
conformal_3d | Show
IMAT11 | Hide
stepandshoot | Hide
IMAT_c | Hide
stepandshoot_c | Hide
IMRT001a | Hide
IMAt_1 | Hide

Max Dose [cGy] | 1939

Print
- To Printer
- To File
IMRT PLAN EVALUATION PARAMETERS

A. CLINICAL PARAMETERS

- Patient selection
- Site, Stage
- Psychology
- 3DCRT Vs IMRT
- Target delineation
- Immobilization
- Dose prescription guidelines
B. PHYSICAL PARAMETERS

- TPS (Algorithms etc.)
- Dose constraints
- DVH
- GTV $\rightarrow$ PTV (setup errors)
- OARs
- QA
IMRT PLAN EVALUATION PARAMETERS

C. EQUIPMENT PARAMETERS

- Linear Accelerator
- Type of MLC / μMLC
- Mould room
- Simulation
- Port films
- MU (DR)
- TPS
CLINICAL CONSIDERATIONS

- IMMOLIZABLE SITE
- IRREGULARLY SHAPED CONCAVE EDGES
- ADJACENT TO CRITICAL ORGANS
- COOPERATIVE PATIENTS

Morbidity: obese, poor immobilization
Claustrophobic patient, moribund

POOR CANDIDATES

IDEAL FOR
IMRT
CLINICAL CONSIDERATIONS

“HOT” and “COLD” SPOTS IN 3D.
• MAGNITUDE
• VOLUME
• LOCATION

“COLD” - NOT WITHIN GTV - AS FAR AWAY.

“HOT” - DESIRED IN-HOMOGENITY
CLINICAL CONSIDERATIONS

FOLLOW GUIDELINES : Egs :

HEAD & NECK : RTOG H-022 TRIAL
95% PTV BY PRESCRIPTION ISODOSE

GYNAEC : RTOG 0418
PHYSICS PARAMETERS
IMRT vs 3DCRT

- LARGE VOLUME OF NORMAL TISSUE RECEIVE LOW DOSES
- ↑ MONITORING UNITS NEEDED FOR DELIVERY
- VERIFICATION PORT FILMS REQUIRED
- ↑ PATIENT EXPOSURE FROM HEAD LEAKAGE, NEUTRON PRODUCTION AND SCATTER

↑ RISK OF 2nd MALIGNANCY
↑ RT PNEUMONITIS IN THORACIC IMRT
PHYSICS PARAMETERS

• BETTER FOR CONCAVE SURFACE $S$
• PLANNING IS LESS DEPENDENT ON BEAM ENERGY
• CONFORMITY AT THE EXPENSE OF LOW DOSE TO LARGE VOLUME.

ie CHECK 30% ISODOSE
PHYSICS PARAMETERS

- PLANNING IS TIME CONSUMING
  - i.e. NOT FOR RAPID PLANS
    - Eg. EMERGENCY Rx etc.
- ALGORITHM FOR ITERATION IMPORTANT
  - HETEROGENITY CORRECTION TO BE USED
PHYSICS PARAMETERS

• AVOID MATCHING TWO IMRT FIELDS OR IMRT + PHOTONS/ELECTRON
• ORGAN MOTION AND SET UP ERRORS CAUSE DOSIMETRIC PROBLEMS
  (PATIENTS MOVES / ORGAN MOVES)
<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>RECTUM</th>
<th>BLADDER</th>
<th>OTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Zelefsky et al</td>
<td>≤30% to get ≥75.6</td>
<td>≤53% to get ≥47</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>≤53% to get ≥47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Ezzell et al</td>
<td>≤40% to get ≥65</td>
<td>≤30% to get ≥75</td>
<td>FH</td>
</tr>
<tr>
<td></td>
<td>≤30% to get ≥70</td>
<td>D max ≤ 81</td>
<td>Dmax ≤ 50</td>
</tr>
<tr>
<td></td>
<td>≤10% to get ≥75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Sethil et al</td>
<td>≤30% to get ≥65</td>
<td>≤30% to get ≥65</td>
<td>PP ≤25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>To get ≥ 40%</td>
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### IMRT PROSTATE TARGET DEFINITIONS

<table>
<thead>
<tr>
<th></th>
<th>CTV</th>
<th>PTV</th>
<th>Prescription (TD/ Fr) Gy</th>
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<tbody>
<tr>
<td>1. Zelefsky</td>
<td>P + SV</td>
<td>CTV + 1 cm UE</td>
<td>PTV 81/1.8 ≥90% to get ≥70</td>
</tr>
<tr>
<td></td>
<td>P + SV</td>
<td></td>
<td>PTV 86.4/1.8 ≥85% to get ≥86.4</td>
</tr>
<tr>
<td>2. Ezzell</td>
<td>P + SV</td>
<td>CTV + 1 cm UE</td>
<td>75.6/1.8 to get ≥95% CTV</td>
</tr>
<tr>
<td>3. Sethil et al</td>
<td>PTV1 = (P + SV) + 1 cm UE</td>
<td></td>
<td>PTV1 55.8/1.8</td>
</tr>
<tr>
<td></td>
<td>PTV2 = (P) + 1 cm UE</td>
<td></td>
<td>PTV2 18/1.8 ; 25.2/1.8</td>
</tr>
</tbody>
</table>
EQUIPMENT PARAMETERS

• BEAM DIRECTION IMPORTANT

• AVOID TREATMENT THROUGH IMMOBILIZATION DEVICES WHICH ATTENUATE BEAM

• AVOID LONG TREATMENT TIME
  - INCOVENIENT
  - ? RADIOBIOLOGICAL

• USE APPROPRIATE TPS
EQUIPMENT PARAMETERS

• STRINGENT QA IS CENTRAL TO SUCCESS OF IMRT
  • PROPER IMMOBILIZATION IS CRUCIAL
  • LASERS IN CT SIMULATOR IS MUST
  • FLAT CT COUCH FOR SIMULATION
• SET UP ERRORS – SYSTEMATIC & RANDOM
• QA OF LINAC AND TPS IS ESSENTIAL
FINALLY

IMRT IS AN EXCELLENT TECHNIQUE IF USED APPROPRIATELY BY A COMPETENT AND EXPERIENCED TEAM USING THE NECESSARY HIGH QUALITY MOULD ROOM AND SIMULATION PARAMETERS AND IMPLIED UNDER A STRINGENT QA PROGRAMME

REMEMBER : G – 1- G.0 !
THANK YOU