2D - Radiation Treatment Planning in Carcinoma Breast

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PRIMARY TREATMENT OF EARLY CARCINOMA BREAST

Surgery is primary treatment of choice.

THREE SURGICAL OPTIONS

1. Modified radical mastectomy
2. OR
2. Simple mastectomy with axillary clearance

OR

3. Conservative Surgery: Lumpectomy with axillary clearance
# EARLY BREAST CARCINOMA

**MRM vs BCT (Conservative Sx+ RT)**

<table>
<thead>
<tr>
<th></th>
<th>Institut Gustave Roussy</th>
<th>Milan</th>
<th>NSABP B-06</th>
<th>NCI</th>
<th>EORTC</th>
<th>Danish</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of pts</td>
<td>179</td>
<td>701</td>
<td>1219</td>
<td>237</td>
<td>874</td>
<td>904</td>
</tr>
<tr>
<td>Stage</td>
<td>1</td>
<td>1</td>
<td>1&amp;2</td>
<td>1&amp;2</td>
<td>1&amp;2</td>
<td>1,2,3</td>
</tr>
<tr>
<td>Surgery</td>
<td>2cm margin</td>
<td>Quadran tectomy</td>
<td>Lumpectomy</td>
<td>Gross Excision</td>
<td>1cm margin</td>
<td>Wide resection</td>
</tr>
<tr>
<td>FU (yrs)</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>18</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>OS BCT (%)</td>
<td>73</td>
<td>42</td>
<td>46</td>
<td>59</td>
<td>65</td>
<td>79</td>
</tr>
<tr>
<td>OS MRM (%)</td>
<td>65</td>
<td>41</td>
<td>47</td>
<td>58</td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td>LR BCT (%)</td>
<td>9</td>
<td>9</td>
<td>14</td>
<td>22</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>LR MRM (%)</td>
<td>14</td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>12</td>
<td>4</td>
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</tbody>
</table>

Equivalent OS, LR rates, Better Cosmesis
CARCINOMA BREAST: ROLE OF RADIATION

Always in Pos-operative setting

1. As adjuvant to radical surgery.

2. As routine post-operative following SM with axillary clearance.

3. As primary radical radiation following BCS.
CARCINOMA BREAST
POST-OPERATIVE RADIATION

DEFINITION:

It is irradiation of chest wall/ Breast and/or drainage lymph node regions as an adjuvant treatment following definitive surgery – mastectomy or BCS.

RATIONALE:

I) To reduce local and/or regional recurrence.
II) To improve survival.
III) To reduce distant metastatic rate.
IV) Acceptable side effects
Post-operative Radiation in Carcinoma Breast
Indications

1. Pathological involvement or unknown histology of axillary nodes.
2. Grade 2 and 3 histology.
3. Lymphatic invasion
4. Tumour at or near to resection line.
5. Localized skin or muscle invasion.
6. Tumour size 4 cm or more.
7. Advanced local disease-Stage-III.
8. Type of surgery – Simple mastectomy.
9. Inner or central quadrant tumour.
10. Surgeon not happy with resection.
12. Breast Conservative Surgery (BCS)
ROLE OF RADIOTHERAPY

Postop RT - Mastectomy
- Lumpectomy

Postop. RT decreases risk of LRR by treating residual microscopic disease by almost 2/3

<table>
<thead>
<tr>
<th>Stage</th>
<th>Recurrence rate</th>
<th>LR After PORT</th>
</tr>
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<tbody>
<tr>
<td>Stage 1</td>
<td>5-10%</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>Stage 2</td>
<td>10-25%</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Stage 3</td>
<td>50%</td>
<td>10-15%</td>
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</table>
## CARCINOMA BREAST – MASTECTOMY VS. MASTECTOMY + RADIATION

<table>
<thead>
<tr>
<th>Trial</th>
<th>Patient Number</th>
<th>Local Rec. (%)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>RM+RT</td>
<td>RM</td>
</tr>
<tr>
<td>Manchester</td>
<td>1461</td>
<td>9.3</td>
<td>14.5</td>
</tr>
<tr>
<td>Oslo</td>
<td>1115</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>NSABP</td>
<td>1765</td>
<td>1.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Stockholm</td>
<td>960</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>DANA-Farber Inst.</td>
<td>260</td>
<td>1</td>
<td>17</td>
</tr>
</tbody>
</table>

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# BREAST CONSERVATION

## CS. Vs. CS + RT

<table>
<thead>
<tr>
<th>Trial</th>
<th>Local Recurrence Rate (%)</th>
<th>5 Yrs. Survival Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS</td>
<td>CS+RT</td>
</tr>
<tr>
<td>1. NSABP, 1995</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>2. Swedish, 1994</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>3. Ontario, 1992</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>4. Milan III, 1995</td>
<td>19</td>
<td>2</td>
</tr>
</tbody>
</table>
CARCINOMA Breast Radiation as Adjuvant to Surgery + Chemotherapy

<table>
<thead>
<tr>
<th>STUDY</th>
<th>MRM+CT (Pts.)</th>
<th>MRM+CT+RT (Pts.)</th>
<th>5 YEAR SURVIVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia (1989)</td>
<td>155</td>
<td>161</td>
<td>58 Vs. 63%</td>
</tr>
<tr>
<td>Danish Breast Group (1990)</td>
<td>736</td>
<td>737</td>
<td>63 Vs. 68%</td>
</tr>
</tbody>
</table>
Carcinoma Breast

2D – External Radiation Treatment Planning
Anatomy of Breast

Both Morbid and Surface Anatomy is important
Carcinoma Breast

Modalities of External Beam Radiation:

A. Photon Beams
   a) Linear Accelerator Beam – 6MeV
   b) Cobalt beam – Best for post-mastectomy patients.

B. Electron Beam – not usually preferred now a days but can be used for internal mammary lymphnodes radiation to avoid dose to heart.
Ca. Breast – Volume Irradiated

1. **Post-operative radiation** should include Chest wall following mastectomy or whole breast following BCS.

2. **Draining regional nodes** – Supraclavicular and/or Axilla.

3. **Internal mammary** when disease is present in central or medial quadrants otherwise they are not irradiated as they present no clinical problem and one can avoid cardio toxicity more so if disease is present on left side.
Radiotherapy - techniques

Fields & Field Markings

1. Two tangential fields for chest wall or Breast.
2. Supraclavicular field alone.
3. Supraclavicular and axillary field.
4. Internal mammary field
5. Posterior axillary field
Radiotherapy - techniques

Positioning –

• Supine position
• Breast board, to make chest wall surface horizontal, brings arms out of the way of lateral beams.
• Arm abducted at 90° & hand holds handle of arm rest
• Face turned towards opposite side
• For large pendulous breasts – full or partial decubitus position to flatten breast contour over a support & providing homogenous thickness throughout treated volume.
• In some institutions immobilization devices are used
Radiotherapy Fields

Tangential fields to chest wall or breast

• Upper border – 2\textsuperscript{nd} ICS (angle of Louis) when s.c field used
  When s.c field not – head of clavicle
• Medial border – at or 1cm over midline
• Lateral border – 2-3cm beyond all palpable breast tissue – mid axillary line
• Lower border – 2cm below opposite inframammary fold
Radiotherapy Fields

ANTERIOR SUPRACLAVICULAR AND AXILLARY FIELD
- Should cover lower 2/3rd of neck

Field borders –
- **Upper border**: thyrocricoid groove
- **Medial border**: at or 1cm across midline extending upward following medial border of SCM ms to thyrocricoid groove
- **Lateral border**: insertion of deltoid muscle
- **Lower border**: matched with upper boarder of tangential fields

Humeral head shielding:–
- If arm angled $>90^0$: Ax nodes overlap head of humerus anteriorly.
- Larger the angle – less the head of humerus spared in s.c port
Radiotherapy Fields

Internal Mammary Field:

Indicated: When disease is present in the central or medial quadrant more so if axilla is also positive otherwise should be avoided as it irradiates more of lungs and heart and add to late radiation morbidity.

Field Markings

A. Internal mammary lymphnodes may be included in Tangential fields only and hence medial tangent should be marked 2-3 cm across midline on the opposite side.

B. Separate internal mammary field.
   
   a) Upper boarder at supra sternal notch.
   b) Medial boarder 2-3 cm across midline on the opposite side.
   c) Lateral boarder 4-5 cm from midline on the same side.
   d) Inferior boarder at level of xiphisternum
**Posterior Axillary field**

**INDICATIONS:**
- Obese pt. where, thickness of axilla >12cm or extra capsular extension

**BORDERS:**
- **Medial border** – To allow 1.5-2cm of lung on the portal film
- **Inferior border** – at same level of inferior border of s.c field
- **Lateral border** – just blocks fall off across post axillary fold
- **Superior border** – splits the clavicle
- **Superolaterally** – shields or splits humeral head
- **Centre** – at acromial process of scapula
Simulation – Assessment of Tangential Fields Angulations
Radiotherapy techniques

Angle of rotation of gantry for tangential fields:
• Lead wire placed on lateral border
• Field opened at 0° rotation on chest wall and central axis placed along medial border of marked field
• Gantry rotated, until on fluoroscopy, central axis & lead wire intersect – angle of gantry at that pt. note—medial tangent angle

Central lung distance (CLD)
• Perpendicular distance from post. tangential field edge to post part of ant chest wall at centre of field
• Best predictor of %age of ipsilateral lung vol. treated by tangential fields

<table>
<thead>
<tr>
<th>CLD (cm)</th>
<th>%age of lung included</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>6</td>
</tr>
<tr>
<td>2.5</td>
<td>16</td>
</tr>
<tr>
<td>3.5</td>
<td>26</td>
</tr>
</tbody>
</table>
CLD Assessment & Final Field Markings
Manual 2D Treatment Planning using Isodose Curves - Open Fields

Body Contour
Isodose Plotting

Combined Isodoses
Dose Computation
Dose Distribution
Beam modification devices

**Wedges or compensators** – to achieve uniform dose distribution in breast
- Used in intact breast to produce minimal (10% or less) dose variation from base to apex

**Bolus** – increases dose to skin & scar after mastectomy
- Cosmetic results may be inferior
- Universal wax bolus used
- **Asymmetrical Jaws**
Use of Beam Modification Devices

Breast Cone with Cobalt Beam

Wedge Filters
Manual 2D Treatment Planning using Isodose Curves - Wedged Fields

15° Wedge Fields and composite dose distribution

30° Wedge Fields and composite dose distribution
Carcinoma Breast

Computerized 2D - Treatment Planning
2-D computerized treatment planning
Radiation in Ca. Beast – Post-mastectomy
CT Simulation – Contouring – Field placement
Radiation in Ca. Beast- Post-mastectomy
Plotting of Dose Distribution- Open Fields
Radiation in Ca. Beast- Post-mastectomy
Dose Volume Histograms - Open Fields

Dose Volume Histogram

Beam Profiles in different planes
Radiation in Ca. Beast- Post-mastectomy Dose Evaluation - Open Fields

Beam Profiles in different planes

Dose Volume Histogram
Radiation in Ca. Beast- Post-mastectomy
Plotting of Dose Distribution-S&A Open Fields
Radiation in Ca. Beast – Post BCS
CT Simulation – Contouring – Field placement
Radiation in Ca. Beast – Post BCS
Plotting of Dose Distribution- Open Fields
Radiation in Ca. Beast – Post BCS

Plotting of Dose Distribution - Wedged Fields

15° Wedge Fields and composite dose distribution
Radiation in Ca. Beast – Post BCS
Plotting of Dose Distribution- Wedged Fields

30° Wedge Fields and composite dose distribution
Radiation in Ca. Beast- Post- BCS
Dose Evaluation-Wedged Fields
Matching supraclavicular & chest wall fields

- **Angulation of tangential field:**
  - Inferior angulation of tangential fields, eliminating the divergence superiorly
  - Blocking the supraclav field’s inferior half, eliminating its divergence inferiorly

- **Hanging block technique:**
  - Superior edge of tangential beam made vertical by vertical hanging block.
  - The inferior divergence of supraclav field can be eliminated by blocking half beam.

*Asymmetrical Jaws*
Matching supraclavicular & chest wall fields

- **Single isocentre technique:**
  - Isocentre placed at the junction of tangential and supraclav field
  - Inferior portion of field blocked for supraclav treatment and superior portion blocked for tangential field
2 D-Treatment Planning

Dose Calculations

A. SSD Technique: Use of PDD and Dose rate for calculation of time

B. SAD Technique: Use of TAR or TMR and dose rate for calculation of time.
Dose of Radiation

- **Standard dose** – 50Gy/25#/5wks to both fields (post mastectomy & lumpectomy)
- If extracapsular tumor in axilla – boost of 5-10Gy delivered with reduced portals
- **Boost after BCT** or mastectomy as indicated – 10-20Gy
- Total dose – 60-66Gy
- **At PGI** – post mastectomy – 35Gy/40Gy/15# (Hypofractionation Regimen)
  - post lumpectomy – 40Gy/40Gy/16#
- **Advantages** – short t/t time, less t/t breaks, less radiation rxns- t/t completed before reactions appear and less late toxicity.
Execution of Treatment

Treatment on Linac

Treatment on Cobalt Machine
Conclusions

1. 2-D treatment planning is done for most of carcinoma breast patients even at present more so if it is post-mastectomy patients.
2. It is simple, easy and less time consuming.
3. Can be done manually or on orthogonal films or body contours, hence, cheaper.
4. Manual planning is time consuming while computerized planning is quick and fast.

Limitations.
1. Gives dose distribution in one selected plane only.
2. Not possible to know target volume distribution.
3. Difficult to assess dose to normal tissues like lung, heart and opposite breast.
THANK YOU