Contouring of the breast, cavity and nodal regions

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Desirable to deliver a relatively uniform dose distribution inside the breast volume.

Excessive hot spots in the patient result in poorer cosmetic outcome.

Conformal RT/IMRT, has become an option for breast irradiation...offers reduced hot spots, increased normal tissue sparing.
Why is this issue important?

- Recently available image-guided RT (IGRT) can significantly improved accuracy of conformal treatment delivery.

- Accurate delineation of volumes of the targets and OARs (heart, lung) is a prerequisite of and critical for conformal RT.

- Emerging evidence for Hypofractionated radiotherapy schedules.
Why is this issue important?
Why is this issue important?

Allen X, IJROBP 2009
Patient position/Immobilisation

- Depends on the facilities available and the treatment technique
- Most common – Breast board (keeps the chest wall parallel to the couch and avoids too much collimation)
- Advantages- excellent for conventional simulator, 2 D planning
- Disadvantages- issue of getting a good clearance during CT based planning
Patient position/Immobilisation

CT based simulation

- Should have
  - Wide bore CT preferably
- Can circumvent breast board if we used MLC’s for posterior border delineation
- While contouring, keep window width at 600 and window center at 40
Inclination of patient/Breast board less relevant with modern MLC based machines
A Munshi et al, Med Dosim 2008

Breast size

Dose difference

1.197
3.42
4.17

Small Breast
Medium Breast
Large Breast

Lung
Useful aids at CT cuts

- Use copper wire to demarcate whole breast
- Laser to match with 2 lateral and one ant marker
- Ant marker also a surrogate for midline, lateral a surrogate for mid axillary line
- Place additional marker to be placed at a) 1.5 cm below inframammary fold
- Wire on the scar
Caudal
Medial
Cranial
Lateral
CT simulation
Gross tumour volume (GTV) - Breast

- Not relevant for breast cancers
- All cases present to the radiation oncologist after lumpectomy or mastectomy
- Even if cut margins are positive (usually microscopic), difficult to image the gross disease
- May have relevance in selected nodal regions
Clinical target volume (CTV) - Breast

- Aim to include all breast tissue

- Challenges
  - Except posteriorly, the rest of the margins are difficult to define precisely
  - CT too not helpful to delineate breast tissue
  - Often breast tissue merges with fat, especially laterally in thick patients
Breast tissue boundaries

- Medially lateral edge of sternum
- Cranially sternoclavicular joint
- Usually ends within 5 mm of skin surface (CAUTION - do not extrapolate this to the post mastectomy contouring!)
- Caudally inframammary fold
Special tips!

- Remember to contour the tumour bed/cavity even while planning whole breast radiotherapy.
- For cardiac sparing - Careful and smart alteration of the lateral border (less commonly medial) or MLC’s (Don’t shield the target!)
- Remember to make use of back up markers at the “clinical borders” while placing tangents.
Nodal Contouring
SCF/ Axillary irradiation issues
Internal Mammary

Level I nodes

Level II nodes

Interpectoral
Internal mammary nodal contouring
Uniqueness of position of IMC
51 patients with breast conservation and IMC catheterisation at Tata Memorial Hospital

A Munshi et al BJR 2007
Contouring the Brachial plexus

1. Identify and contour C5 to T2
2. Identify and contour anterior and middle scalene muscles from C5 to insertion onto the first rib
3. Contour the brachial plexus OAR use a 5-mm diameter paint tool.
4. Contour from lateral aspect of the spinal canal to the small space between the anterior and middle scalene muscles
5. Contour inferiorly and laterally to one to two CT slices below the clavicular head
6. The first and second ribs serve as the medial limit of the OAR contour

Hall W, IJROBP 2008
Tumour bed/cavity contouring
<table>
<thead>
<tr>
<th>Author</th>
<th>No. of pts/Specimens</th>
<th>No MCF*</th>
<th>MCF in index quadrant/tumor bed</th>
<th>MCF elsewhere in ipsilateral breast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holland et al.</td>
<td>Cancer 1985</td>
<td>282</td>
<td>37%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43%</td>
</tr>
<tr>
<td>Vicini et al.</td>
<td>IJROBP 2004</td>
<td>441</td>
<td>36%</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td>Vaidya et al.</td>
<td>BJC 1996</td>
<td>30</td>
<td>37%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
</tr>
</tbody>
</table>

*MCF: Multicentric tumour foci; pts: patients; Tumor: tumour.
Vaidya et al, Br J Cancer 1996
Recurrence patterns

Ipsilateral breast tumour recurrence (IBTR) in the tumour bed and at margins has been found to be as high as 50-60% of all local recurrences.

<table>
<thead>
<tr>
<th></th>
<th>Tumour Bed/Scar</th>
<th>In same quadrant</th>
<th>Diffuse throughout</th>
</tr>
</thead>
<tbody>
<tr>
<td>EORTC Trial</td>
<td>56%</td>
<td>29%</td>
<td>27%</td>
</tr>
<tr>
<td>NSABP -06</td>
<td>95%</td>
<td></td>
<td>5%</td>
</tr>
</tbody>
</table>
Boost target delineation

- Imaging modalities- mammography, USG, CT, MRI
- Useful aids in CT based contouring- clips, external scar, internal scar tissue, seroma
- Immediately after surgery- cavity contains seroma + Air
- Need to give suitable margin to it (1-2 cm) to generate final CTV
## Comparison of various techniques of boost delineation

<table>
<thead>
<tr>
<th>Technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Scar</td>
<td>1. Feasible.</td>
<td>1. Depends on placement of scar.</td>
</tr>
<tr>
<td></td>
<td>2. No additional costs.</td>
<td>2. Highly subjective.</td>
</tr>
<tr>
<td></td>
<td>3. Non invasive.</td>
<td></td>
</tr>
<tr>
<td>Clips &amp; Fluoroscopy</td>
<td>1. Feasible.</td>
<td>1. Mobility of clips in the lumpectomy cavity.</td>
</tr>
<tr>
<td></td>
<td>2. Inexpensive.</td>
<td>2. Variable position and numbers.</td>
</tr>
<tr>
<td>Ultrasonography</td>
<td>1. Can be used intra as well as post-operatively.</td>
<td>2. Definition hampered by healing process.</td>
</tr>
<tr>
<td></td>
<td>2. Images are compatible with RT planning systems.</td>
<td>3. Poor definition 6–8 weeks post-operatively.</td>
</tr>
<tr>
<td></td>
<td>3. Is relatively inexpensive.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Reproducible images.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Tumour bed is directly visualised.</td>
<td></td>
</tr>
<tr>
<td>Clips &amp; Computerised Tomography</td>
<td>1. Accuracy same as that of clips and fluoroscopy.</td>
<td>1. Glandular tissues not well defined.</td>
</tr>
<tr>
<td></td>
<td>2. Can be planned in treatment position.</td>
<td>2. Clips necessary for definition.</td>
</tr>
<tr>
<td></td>
<td>3. Excellent definition of breast tissues.</td>
<td>3. Varies with window settings.</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>1. Accurate localisation of target volume.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Accurate localisation of organs at risk.</td>
<td></td>
</tr>
</tbody>
</table>

*R Jalali et al, Acta Oncologica 1997*
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Margin given to scar</th>
<th>Incomplete coverage of clips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denham et al, Cl oncol 1991</td>
<td>27</td>
<td>1.5-2 cm</td>
<td>42%</td>
</tr>
<tr>
<td>Bedwinek et al, IJROBP, 1993</td>
<td>35</td>
<td>2-3 cm</td>
<td>54%</td>
</tr>
<tr>
<td>Machatay et al, IJROBP 1994</td>
<td>316</td>
<td>3-4 cm</td>
<td>10-36%</td>
</tr>
</tbody>
</table>
Of 31 excision cavities, 29 (93.5%) were reduced in volume. The average change was 22.5%, $p = 0.0001$.
Effect of Time!

R Upreti et al, unpublished data, TMH
Breast Boost irradiation techniques
Brachytherapy target vs XRT target for cavity

Extra PTV margin
Boost target - other challenges

- Patient having received neoadjuvant chemotherapy
- Proximity of the cavity to the skin and chest wall
- Oncoplastic surgery
Conclusions

- Proper contouring of the breast is critical for 3DCRT and Forward Planning IMRT plans.
- Proper delineation of boost target/cavity volume (using all appropriate modalities) is critical.
- Use correct window width and level.
Conclusions

- Need to be aware of uncertainties in contouring aids
- Beware of geographical misses, especially in the present precision era
- Emerging role of 4D CT and gated treatment planning for decreasing dose to OAR’s
To reduce or eliminate interobserver variability in contouring, RTOG is working to establish a systematic consensus. This consensus would include anatomic boundaries of targets and OARs and serve as a guideline for prospective studies of breast RT, particularly involving IMRT and IGRT. A breast RT atlas will be generated as a part of this effort and would be available online.

Thank you.