Use of Four Gantry Angles to Reduce V105 and Increase Homogenity in 3D Breast Plans

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Learning Objectives

• Realize the importance of limiting the maximum point dose and reducing V105 for breast plans
• Learn how using supplemental angles in addition to the traditional tangent fields can improve dose homogeneity and help to decrease hot spots
• Understand how using extra angles can help reduce the cold triangle in plans with matching photon tangents and electron IM nodes
Outline

• Radiation Therapy for Breast Patients

• Example 1: Large Breast Patient

• Example 2: Small Chestwall and Supraclav Patient

• Example 3: Chestwall and IM Node Patient with Photon and Electron

Radiation Therapy Treatment Options:  
IntraOperative (IORT) Radiation Therapy

- No treatment planning needed
- Patient receives radiation during lumpectomy surgery
- 50 kV x-ray source
- One fraction of 20 Gy delivered to the surface of the balloon
- Must meet protocol criteria to be a candidate
Radiation Therapy Treatment Options:
High Dose Radiation (HDR) Therapy

- Brachytherapy treatment with Ir-192
- Shortened treatment course ~5 days
- Intracavitary treatment using a single or multi-channel balloon based applicator
- Interstitial treatment via a strut based applicator or implanted flexible catheters

Breast Cancer Treatment Options:
External Beam Radiation Therapy
External Beam Planning Goals

✔ Adequate Coverage
✔ Protect Normal Tissue
✔ Appropriate ‘hot spot’
✔ Homogenous dose

*Must have a balance!*

Coverage: What is our target for external beam?

Breast Cancer Atlas for Radiation Therapy Planning: Consensus Definitions

[Link to RTOG website](https://www.rtog.org/LinkClick.aspx?fileticket=vzJFhPaBipE%3d&tabid=236)
What planning methods do you use?

**POLL THE AUDIENCE**

- Wedges
- Field-in-Field
- Compensator
- VMAT/IMRT

**Treatment Planning Techniques:**
Hard Wedges or Enhanced Dynamic Wedges (EDW)

- Simple plans that are fast to produce
- Hard wedges produce additional scatter inside and out of the field
- Used less frequently now due to emergence of other techniques
Treatment Planning Techniques: Field-in-Field

- Technique delivers dose using approximately 80% open field and 20% subfields
- Setup uncertainty and breathing motion have less of an effect on dose distribution
- Can verify monitor units using hand calculations or software

Treatment Planning Techniques: Irregular Surface Compensator (ISC)

- MLCs constantly moving during treatment
- Setup uncertainty and breathing motion effect the dose distribution more, but this is thought to be blurred out over the course of treatment
- Either a physical machine QA measurement or software needed to verify dose calculation
Treatment Planning Techniques:
Intensity Modulated Radiation Therapy (IMRT)

VMAT

Fixed Field IMRT

MemorialCare

Treatment Planning Techniques:
Prone Breasts

MemorialCare
Treatment Planning Techniques:
Deep Inspiration Breath Hold (DIBH)

- Requires multiple CT scans and a system to monitor breathing
- Can significantly reduce the heart and volumetric lung dose
- Must have a compliant patient

Prescription

- Traditional Doses:
  - 180 cGy x 28 fractions → 5040 cGy
  - 200 cGy x 25 fractions → 5000 cGy
- Hypofractionated treatment (shortened course):
  - 267.6 cGy x 15 fractions → 4000 cGy [British START trial]
  - 265.6 cGy x 16 fractions → 4250 cGy [Canadian trial]
- Woman with invasive breast cancer, treated by lumpectomy, having pathologically clear margins and negative axilla nodes
- Excluded patients with > 25cm separation
- No difference in cosmetic outcome, late toxicities or disease free survival after 3 years, 5 years or 10 years
2018 ASTRO Hypofraction Guidelines

- Age – no limitations based on age
- Stage – maybe be used in patients with DCIS
- Histology – conventional fractions may be preferred for rare histologies
- Collagen vascular disease and other relative contraindications to radiation – patients with implants are eligible for hypofractionation

Breast Size and dose homogeneity - hypofractionation recommended regardless of size provided dose homogeneity goals are met

200cc >105%
2cc >107%

How hot is too hot?

**Study Aim:** to test three dimensional (3D) intensity modulated radiotherapy (IMRT) against 2D dosimetry using standard wedge compensators in terms of late adverse effects after whole breast radiotherapy

**Results:** control arm patients were 1.7 times more likely to have a change in breast appearance than the IMRT arm patients

**This study references high dose volumes receiving greater than 107% of the prescription**

What is the maximum point dose allowed at your center?

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115%  110%  107%  105%

Beyond Max Point Dose:
Why is homogeneity important?

• Breast V105% and V110% were found to be associated with increase in acute skin toxicity
  V110% less than 200cc: 31% grade >2 skin toxicity
  V110% greater than 200cc: 61% grade >2 skin toxicity

• Dermatitis, edema, pain, hyperpigmentation, moist desquamation, fat necrosis or fibrosis

Do you have limits for V105 on breast plans?

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YES  NO

Reducing V105

- Better able to reduce V105 with field-in-field or irregular surface compensator plans
- Goal: reduce higher doses at the apex of the breast
- Limit higher doses to regions where it is necessary for coverage
- Reduce fluence of the beam that goes through the lung
- Look at the ~102.5% isodose line to gauge if further dose reduction is possible
When is adding extra fields helpful?

- Patients with a larger separation
  - Larger water equivalent distance vs physical distance
- Those with denser breast tissue
- Patients with implants that attenuate the beam significantly
- Depends on coverage desired by the physicians of breast tissue near the chestwall – Acuros or AAA vs pencil beam

What coverage do your physicians prefer near the chestwall?

Poll the audience

- 100%
- 95%
- < 95%
Breast Planning Goals at our Centers

<table>
<thead>
<tr>
<th></th>
<th>Conventional Fractionation</th>
<th>Hypofractionation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast Coverage</td>
<td>100% (95% close to chest wall acceptable if large)</td>
<td></td>
</tr>
<tr>
<td>Max Point Dose</td>
<td>109% (if large)</td>
<td>107%</td>
</tr>
<tr>
<td>V105</td>
<td>&lt; 10% of Rx volume</td>
<td>&lt; 7.5% of Rx volume</td>
</tr>
<tr>
<td>Heart (mean dose)</td>
<td>4 Gy (5 Gy acceptable)</td>
<td>3 Gy</td>
</tr>
<tr>
<td>Contralateral Breast</td>
<td>5 Gy max point (V5Gy ≤ 15% possibly accepted)</td>
<td></td>
</tr>
<tr>
<td>Ipsilateral Lung</td>
<td>V20 Gy ≤ 45% &amp; mean ≤ 20 Gy</td>
<td></td>
</tr>
<tr>
<td>Whole Lung</td>
<td>V20 Gy ≤ 25% &amp; V30 Gy ≤ 20%</td>
<td></td>
</tr>
</tbody>
</table>

Outline

- Radiation Therapy for Breast Patients
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Example Breast Plan where Homogeneity can be Improved

Four fields, two per gantry angle

- 50% 6MV
- 50% 23 MV

Cavity is superficial – be conscious of the amount of high energy used.

Max Point
Dose: 109.4%

23.2% of breast target getting > 105% Rx

V105 = 602cc

Choice of Extra Gantry Angles

- Typically between 8-20 degrees offset from the primary tangents
- Angled above high dose regions in the corners of the target
- Possible additional exit dose to the contralateral breast and the ipsilateral lung
- Weight extra fields lightly – about 7-10 monitor units
Zero weighting on extra angles; normalize to a calc point

Extra Field Contributions

- Change to plan normalization
- Change the Field Weight for the two extra gantry angles
- Increase the plan normalization value as necessary to reduce high dose, but maintaining adequate coverage
- Start planning as usual with field in field-in-field or irregular surface compensator
Comparing the Plans

Four Gantry Angles

Traditional Tangents

<table>
<thead>
<tr>
<th></th>
<th>Four Gantry Angles</th>
<th>Traditional Tangents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx Volume</td>
<td>2219.5 cc</td>
<td>2405.2 cc</td>
</tr>
<tr>
<td>V105</td>
<td>62.3 cc</td>
<td>606.9 cc</td>
</tr>
<tr>
<td>Maximum Dose</td>
<td>106.7%</td>
<td>109.4%</td>
</tr>
<tr>
<td>Volume &gt; 106.7%</td>
<td>0 cc</td>
<td>299.5 cc</td>
</tr>
<tr>
<td>Contralateral Breast</td>
<td>Max: 510.9 cGy</td>
<td>Max: 445.6 cGy</td>
</tr>
<tr>
<td></td>
<td>Mean: 10.2 cGy</td>
<td>Mean: 5.6 cGy</td>
</tr>
<tr>
<td>Ipsilateral Lung</td>
<td>Max: 5197.7 cGy</td>
<td>Max: 5277.6 cGy</td>
</tr>
<tr>
<td></td>
<td>Mean: 650 cGy</td>
<td>Mean: 654.7 cGy</td>
</tr>
</tbody>
</table>
Comparing the Plans:
Rx Volume

4 Gantry Angles  Traditional Tangents

Comparing the Plans:
V105

4 Gantry Angles  Traditional Tangents
Comparing the Plans: Low Dose Spread

4 Gantry Angles

Traditional Tangents

Another Example: Field Setup and Contralateral Breast Dose

Global Hot Spot 107.2%
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Do you use high energy photons for chestwall plans?

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YES

NO
Another Example: Small Chestwall Patient

- If using high energy, try to limit its weighting to ensure adequate skin dose
- Instead of using a higher energy beam to cover tissue down to the chestwall at the superior portion of the field, the planner can use an additional medial 6 MV beam

Plan Comparison

3 Gantry Angle Plan  Traditional Tangents
### Comparing the Plans

<table>
<thead>
<tr>
<th></th>
<th>Three Gantry Angles</th>
<th>Traditional Tangents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx Volume</td>
<td>1044.5 cc</td>
<td>983.0 cc</td>
</tr>
<tr>
<td>V105 (including Sclav)</td>
<td>65.3 cc</td>
<td>92.3 cc</td>
</tr>
<tr>
<td>Maximum Dose</td>
<td>107.4%</td>
<td>111.9%</td>
</tr>
<tr>
<td>Volume &gt; 107.4%</td>
<td>0 cc</td>
<td>23.7 cc</td>
</tr>
<tr>
<td>Contralateral Breast</td>
<td>Max: 459.4 cGy</td>
<td>Max: 459.0 cGy</td>
</tr>
<tr>
<td></td>
<td>Mean: 9.1 cGy</td>
<td>Mean: 9.1 cGy</td>
</tr>
<tr>
<td>Ipsilateral Lung</td>
<td>Max: 5120.3 cGy</td>
<td>Max: 5134.1 cGy</td>
</tr>
<tr>
<td></td>
<td>Mean: 1402.3 cGy</td>
<td>Mean: 1391.0 cGy</td>
</tr>
</tbody>
</table>

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Matching IM Nodes with Tangents

- Often times IM node patients have medial tumors
- Using two medial gantry angles can help reduce the size of the cold triangle
- Increases lung dose because second angle is steeper

Matching IM Nodes with Tangents

- The field aperture on the skin for both fields should look very similar
- Approximately a 7 – 10 degree offset between the two medial photon fields
- If treating with bolus every other day, you can alternate between which medial field is used instead of treating both medial fields everyday since two plans need to be made anyways
Comparison Plans

3 Gantry Angle Plan  Traditional Tangents

DVH Comparison: Trade-off
Planning Tips

- Add the extra fields before starting field-in-field or compensator planning
- Do not heavily weight the extra fields – approximately 5-10 monitor units each will suffice
- Use a subfield or modulation in the supplemental oblique fields

Pros & Cons

✔ Increased homogeneity and thus lower toxicity when compared with traditional tangent breast plans
✔ No insurance issues that may be present when requesting authorization for IMRT
❌ Higher integral dose and increased doses to the contralateral breast and ipsilateral lung when compared with traditional tangents; however these values are lower than those delivered with VMAT/IMRT
Important Takeaways

- Breast planning has improved greatly and become more complicated in the last 10-15 years
- Dose homogeneity is especially important in hypofractionated breast plans; increase in the frequency of hypofractionated treatment plans to lessen the burden on patients and for insurance reasons
- Patient compliance and any extra time on the table should be considered when determining the optimal treatment method
- There should to be a balance between ideal coverage of the breast tissue and delivering higher dose to organs at risk

Thank you.