BASICS OF CONTOURING
CONTOURING OF REGIONAL LNS
3 D CT BASED PLANNING OF BCT AND PLAN EVALUATION

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Why do we need Contouring?

• RT to breast - reduces local recurrences and is a/w improved survival
• Concern- T/t related morbidity in breast and shoulder
  - Long term risk of heart disease and secondary cancer
• Need to Optimize RT to obtain max effect and minimize morbidity
• Transition from 2D to 3D RT– shift from bony land mark based RT to
  *individualised* target
• Target volume delineation is the weakest link in quality chain of RT and there are large inter observer variations
Basics are still basics!

• Study Pre operative Clinical findings and diagrams well
  Location of tumour
  Size of tumour
  +/- Tumour involving Nipple areola complex
  PDO- Present/absent and its extent
  Axillary/ SC LNs

• Read HPR with due attention
Model HPR Post MRM

- 6x4 cm tumour located in UIQ of Rt Breast
- IDC Grade III
- LVI present
- Deep Margin free and 1.5 cm away from tumour
- Tumour reaching up to Dermis
- Dermal lymphatic emboli present
- DCIS absent
- 4/18 LNs Positive; largest LN 2.5 cm, ECE Present
- Triple Negative
Basics are still basics!

- Understand your patient’s body habitus well
- High BMI- sometimes helps you decide arm position/ elevation
- Check for arm’s movement
- If any lymphedema- document it
- Type of Breast-
  - Atrophic – careful palpation
  - Pendulous breast -identify and try to reduce folds
- Location of tumour- Tumour in Lower quadrant or inner quadrant- need to modify conventional borders
CT Simulation

- Position- Comfortable and reproducible
- Supine
- Breast wedge
- Both arms above head
- IV Contrast Optional (we use IV Contrast only in patients with Positive SCF nodes)
• Wires-Important Step- Do not hurry!!
• Palpate Breast well, look for skin folds, mark with pen both breasts
• Wire around- I/L Breast
  Scar
  Opposite Breast
  Provisional field borders
Use copper wires to reduce artefacts
Free Breathing
3- 5 mm scans from neck to L1-2

Pic Courtesy Dr Ashwini Budrukar
Terminology

• Medial, Lateral, Cranial, Caudal, Ventral, Dorsal
• G- Guideline
• MS- My Submission
Normal Anatomy
Scalene Ms – Deep Neck Ms

- Transverse process of C3-6
- First Rib
Major- Thick fan shaped

1) Clavicular head
   Sternocostal head-
   Anterior surface of
   sternum and superior six
   costal cartilage
   Humerus
Minor - Thin triangular Ms
3-5th Rib
Coracoid process of scapula
Scapulae - Large flat

Scapula
3rd or 4th Rib
D7-L5 Vertebrae
Iliac Crest

Humerus
Origin:
Left CCA- Aortic Arch
Right CCA- Right Brachiocephalic A
SCA- Aortic arch
SCA- Brachiocephalic Trunk
After Crossing Lateral Border of first rib it comes axillary A
Axillary A- Three parts medial, posterior and lateral to P Minor Ms
Major veins superior to the heart

- Right internal jugular vein
- Right external jugular vein
- Right subclavian vein
- Left internal jugular vein
- Left external jugular vein
- Left subclavian vein
- Left axillary vein
- Right brachiocephalic vein
- Left brachiocephalic vein
- Superior vena cava
- Azygous vein
- Left brachial vein
Axillary Artery Relations

Medial to short head of biceps & coracobrachialis
Lateral to Axillary Vein

Axillary V – Drains in Subclavian V
IJV- Unites with Subclavian V to form Brachiocephalic V
Why wires around Breast?

- Large differences are reported b/w CTV localization using standard anatomic borders, palpation and USG
- Hurkmans et al - study in 2001 with palpable breast glandular tissue was marked by lead wire before Planning CT in 6 pts Vs. 4 patients without lead wire
- CTV was delineated by 4 RO
- Deviations in PTV extent were greater in Posterior, Cranial and medial directions
- Interobserver variation in volume was decreased by a factor of 4 on scans with lead wire
RTOG Atlas

- 9 RO from eight institutions independently delineated targets (Lumpectomy cavity, boost PTV, Breast, SCF, Axillary, IMCLN and chest wall) and OARs (heart and lungs) on same CT images of three representative breast cancer pts

To reduce inconsistencies RTOG proposed a breast cancer atlas

IJRBOP Vol 73(3), 944-51; 2009
Delineation of target volumes and organs at risk in adjuvant radiotherapy of early breast cancer: National guidelines and contouring atlas by the Danish Breast Cancer Cooperative Group
Guidelines only Guide!!

- Guidelines serve as base on which CTV can be individually adapted
- Not applicable for T/t in prone position
- RTOG – EBC and LABC
- ESTRO and Danish - EBC
- All Contours are shown- does not mean that all volumes have to be treated
CTV Breast

CTV - Total glandular breast tissues

Cranial - Uppermost level of Palpable/ Visible Breast tissue
Maximally up to inferior edge of sternoclavicular joint (G)

In high BMI patients or patients with large breast, sometimes breast tissue goes above...
Caudal- Most Caudal CT slice with visible breast tissue (G)

In obese patients, CTV P Breast is positioned more ventrally in the caudal part of breast due to fatty tissue (G, ESTRO)

This is actually extension of abdominal wall fat

Helps decreasing dose to heart
• **Dorsal** – Pectoral muscle or intercostal muscle where there is no P Major muscle (G)

• **RTOG** – to include chest wall also in LABC
Ventral- 5mm under skin

ABC with BCS - in cases with T4b,c,d cancer where full dose up to skin is advised (bolus may be added) (G, ESTRO, RTOG)
• In a thin atrophic breast one may consider keeping skin volumes may be 3mm below skin (MS)

• In superficially located tumours; skin is also a target; one may consider a small patch of bolus around scar (MS)
Medial- Clinical Reference / Wire
Maximal to edge of sternum
TV P Breast is positioned lateral to mammary branch of internal thoracic A (G, ESTRO)
• **Lateral**- Most difficult to delineate (varies according to breast ptosis)
  - Mid Axillary Line or 1.5-2 cm beyond palpable breast tissue (Traditional)

• Medial to lateral thoracic A, Breast fold (G, ESTRO, DBCG)

• Exclude Lat Dorsi Ms (RTOG)
Internal Thoracic A is a branch of subclavian A

Lateral Thoracic A is a branch of Axillary A
Words of Caution - Individualization!!

Compass primary tumor bed adequately, including relevant margins around it.

In patients with tumors placed too medially/laterally, one needs to modify conventional borders.

Apply wires carefully even on opposite breast as you keep comparing your contours with opposite breast.
CTV Chest Wall

• Place radio opaque wires around imaginary- original site of breast and also on MRM scar
• Generally same as breast
CTV Chest Wall

Dorsal-

RTOG guidelines- Rib Pleural interface (including ribs, IC ms and pectroalis ms)

ESTRO- Unless invasion was demonstrated (tumour stage T4 a-c), no reason to routinely include major pectoral muscle and ribs

Impacts Lung and Heart Doses!
Most common site of chest wall recurrence from surgical series (72-100%) is within skin and subcutaneous tissue anterior to pectoralis musculature. Second MC site is within pectoralis musculature.

MS- Individualisation
CTV Thoracic Wall

Ventral-
RTOG- Skin

ESTRO- 5 mm under skin surface

Skin Bolus of 3-5mm may be applied for very thin CW (ESTRO is only for EBC)

MS -Skin

Inflammatory breast cancer- Up to skin Bolus for all fractions
NODAL CONTOURING
Vessel based delineation guidelines for the elective lymph node regions in breast cancer radiation therapy – PROCAB guidelines

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a University Hospitals Leuven/KU Leuven; b Clinique Sainte Elisabeth (AMPR), Namur; c Ghent University Hospital; and d Catholic University of Louvain, Brussels, Belgium

National project to improve quality of Breast Radiation Therapy, PROCAB (PROject on CAncer of the Breast)
Supra (Infra + Retroclavicular+ Periclavicular) LN

- Cranial - TOG - Caudal Edge Cricoid cartilage
- ROCAB - Cranial Edge of Subclavian A Arch
- If LABC, up to level of transverse cervical vessels
- Lower Border of Cricoid cartilage (MS)
Caudal

- RTOG-caudal edge of Clavicle
- Junction of Brachiocephalic V and Axillary V

- **MS- Lower border of medial head of Clavicle**
Exclude thyroid and trachea

Medial Edge of Int carotid A and IJV

PROcab
Lateral

- **RTOG** - Cranially- Scalene ms
  Caudally- Junction of first rib and clavicle

- **DBCG** - Medial edge of P Minor and Clavicle
Ventral

- **Ventral**- SCM, Clavicle, 5 mm below skin

- **Dorsal**- Cranially- Posterior to ICA and Anterior to scalene medius ms

- Caudally- Lung
Delineation of Supraclavicular Target Volumes in Breast Cancer Radiation Therapy

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Patterns of SCLNs

- To map location of gross supraclavicular LNs in patients with breast cancer
- 62 patients with 161 SCLNs (at diagnosis or recurrence) were eligible for this study
- Location of SC LNs were mapped on CT/MR/PETCT
- Location of LNs were then transferred on to axial CT scan of a representative patient with both arms abducted in a typical breast RT position
- All LNs were plotted on left side with a circle of diameter 5mm
Distribution of LNs at Diagnosis-

- 35-40% LNs were outside RTOG SCF Volume
- Location of LNs outside RTOG volumes were
  1. at level of thyroid cartilage - Cranial to RTOG boundaries
  2. Posterolateral to RTOG volumes in posterior triangle
  3. Lateral low SCF below level of transverse cervical vessels and lateral to scalene ms or between anterior and middle scalene muscle.
- No recurrences occurred medial to medial border of ICA
• More generous coverage of SCF in patients with SCLNs at presentation

• Posterior triangle

• Cranial border above cricoid cartilage
PET CT- Laterally and posteriorly located SCLNs– Posterior Triangle
SCF and Posterior Triangle Volumes
Indications of Axillary RT

• Not everyone needs it!

• Heavy Axillary burden with ECE

• Soft tissue deposits present in dissected axillary fat

• Inadequate axillary Dissection

• Positive SLN and AC not done
Anatomy of Axilla

- Axillary nodes
  - Level III
  - Level II
  - Level I

- Axillary vein
- Pectoralis minor muscle
- Latissimus dorsi muscle
# Level III Axilla

<table>
<thead>
<tr>
<th>Direction</th>
<th>Description</th>
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<tbody>
<tr>
<td>Cranial</td>
<td>P Minor inserts on Coracoid</td>
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<tr>
<td>Caudal</td>
<td>Axillary A/V crosses medial edge of P Minor</td>
</tr>
<tr>
<td>Ventral</td>
<td>Dorsal surface of P Major</td>
</tr>
<tr>
<td>Dorsal</td>
<td>Ribs and IC Ms</td>
</tr>
<tr>
<td>Medial</td>
<td>Thoracic Inlet</td>
</tr>
<tr>
<td>Lateral</td>
<td>Medial border of P Minor</td>
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Level II Axilla

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<tr>
<td>Medial</td>
<td>Axillary A/V crosses medial edge of P Minor</td>
</tr>
<tr>
<td>Lateral</td>
<td>Axillary A/V crosses lateral edge of P Minor</td>
</tr>
<tr>
<td>Ventral</td>
<td>Anterior surface of P minor</td>
</tr>
<tr>
<td>Dorsal</td>
<td>Ribs and IC Ms</td>
</tr>
<tr>
<td>Medial</td>
<td>Medial border of P Minor</td>
</tr>
<tr>
<td>Lateral</td>
<td>Lateral border of P Minor</td>
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<tr>
<td>Orientation</td>
<td>Description</td>
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<tr>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Cranial</td>
<td>Axillary A crosses lateral edge of P Minor</td>
</tr>
<tr>
<td>Caudal</td>
<td>P major inserts into ribs</td>
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<tr>
<td>Ventral</td>
<td>Plane defined by anterior surface of P major and L Dorsi</td>
</tr>
<tr>
<td>Dorsal</td>
<td>Subscapularis</td>
</tr>
<tr>
<td>Lateral</td>
<td>Lateral border of P Minor</td>
</tr>
<tr>
<td>Medial</td>
<td>Medial border of Lat Dorsi</td>
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## Interpectoral LNs

<table>
<thead>
<tr>
<th>Caudal</th>
<th>Axillary A crosses medial edge of P Minor</th>
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<tbody>
<tr>
<td>Caudal</td>
<td>Caudal border of P Minor</td>
</tr>
<tr>
<td>Dorsal</td>
<td>Dorsal surface of P major</td>
</tr>
<tr>
<td>Ventral</td>
<td>Ventral surface of P Minor</td>
</tr>
<tr>
<td>Medial</td>
<td>Medial border of P Minor</td>
</tr>
<tr>
<td>Lateral</td>
<td>Lateral border of P Major</td>
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I/C of IMC LN

- Presence Of IMC LNs
- Central or Medial Quadrant tumour with Heavy axillary LN positivity
### Internal Mammary LNs

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<th>Orientation</th>
<th>Description</th>
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<tbody>
<tr>
<td>Cranial</td>
<td>Junction of SCV and Juglar V/ cranial aspect of 1&lt;sup&gt;st&lt;/sup&gt; Rib (and Caudal border of SCF)</td>
</tr>
<tr>
<td>Caudal</td>
<td>Cranial aspect of 4&lt;sup&gt;th&lt;/sup&gt; Rib</td>
</tr>
</tbody>
</table>
| Medial      | Cranially- Manubrium Sterni  
              Caudally- Dorsal surface of IC Ms |
| Lateral     | 5 mm space dorsal of IM Vessels, not beyond pleura |
| Medial      | 5 mm space medial of IM Vessels |
| Lateral     | 5 mm space lateral of IM Vessels |
OARS

- Heart- Contoured below pulmonary trunk bifurcation
- Coronaries
- All mediastinal tissue below this level should be contoured including great vessels
- I/L and C/L Lungs
- Opposite Breast
- Head of Humerus
• Plan Generation
• 3 DCRT
• Forward IMRT - Field in Field
• Hybrid IMRT
Set user origin

Join medial and lateral markers

Slide Courtesy Dr Ashwini Budrukar
Lateral tangent

Slide Courtesy Dr Ashwini Budrukar
COBALT -2 field, no wedge

Slide Courtesy Dr Ashwini Budrukar
BAD PLANS
COBALT with WEDGE

Slide Courtesy Dr Ashwini Budrukar
6 MV, 2-field showing dose inhomogeneity superiorly and inferiorly

Slide Courtesy
Ashwini Budrukar
6 MV photons with 15 degree wedge in lateral tangent
Forward IMRT

Field-in-field technique:

• Medial and lateral tangents are first planned and dose distribution noted.
• Areas of high dose are then contoured/delineated.
• A new field is created within the existing tangential field with an appropriate MLC configuration so as to reduce the inhomogeneity in these areas.
• These fields are finally fused by the treatment planning system.
Forward Planned IMRT

Multiple subfields in each tangent

All the subfields merged to form dynamic MLC motion
Hybrid IMRT

- Add Bilateral open Tangential fields
- Add Bilateral IMRT Tangential Fields to reduce dose inhomogeneity and reduce high doses to ipsilateral lung and heart
### DVH

- Evaluate both CTV and PTV –

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<tr>
<th>PTV</th>
<th>Ideal</th>
<th>Acceptable</th>
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<tr>
<td>D95%</td>
<td>95%</td>
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<tr>
<td>D90%</td>
<td></td>
<td>90%</td>
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<tr>
<td>Dmax</td>
<td>&lt; 115%</td>
<td>&lt; 120%</td>
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# OAR Doses

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<tr>
<th>C/L Breast D max</th>
<th>&lt;3Gy</th>
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<tbody>
<tr>
<td>I/L Lung V 20Gy</td>
<td>&lt;15 -20%</td>
</tr>
<tr>
<td>I/L Lung V 10Gy</td>
<td>&lt;35 -40%</td>
</tr>
<tr>
<td>I/L Lung V 5Gy</td>
<td>&lt;50 -55%</td>
</tr>
<tr>
<td>C/L Lung V5 Gy</td>
<td>&lt;10% -15%</td>
</tr>
<tr>
<td>Heart (Left Breast Cancer) V20Gy</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Heart (Left Breast Cancer) V10Gy</td>
<td>&lt;30%</td>
</tr>
<tr>
<td>Heart (Right Breast Cancer) V20Gy</td>
<td>0%</td>
</tr>
<tr>
<td>Heart (Right Breast Cancer) V10Gy</td>
<td>&lt;10 -15%</td>
</tr>
<tr>
<td>Mean</td>
<td>&lt;4 -5Gy</td>
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## OAR Doses -HF

<table>
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<tr>
<th></th>
<th>CF</th>
<th>HF</th>
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<tbody>
<tr>
<td>/L Lung</td>
<td>V 20Gy</td>
<td>V 16Gy</td>
</tr>
<tr>
<td></td>
<td>V 10 Gy</td>
<td>V 8 Gy</td>
</tr>
<tr>
<td></td>
<td>V 5Gy</td>
<td>V 4Gy</td>
</tr>
<tr>
<td>Heart</td>
<td>V 25Gy</td>
<td>V 20 Gy</td>
</tr>
<tr>
<td></td>
<td>V 20Gy</td>
<td>V 16Gy</td>
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THANKS