Protocol of Radiotherapy for Breast Cancer

- **Indication of radiotherapy**
  - Indications for Post-Mastectomy Radiotherapy
    1. Axillary lymph node ≥ 4 positive
    2. Axillary lymph node 1-3 positive: strongly consider
    3. Primary tumor > 5cm: consider
    4. Close (<1mm in invasive disease, 2mm in DCIS) or positive resection margin: if re-excision is not feasible
    5. If tumor ≤ 5cm and negative axillary nodes and margins ≥ 1 mm, RT may be considered for patients with multiple high-risk recurrence factors, including central/medial tumors or tumors > 2 cm with other high-risk features such as young age and/or extensive LVI.
  - Indications for Post-Breast Conserving Therapy Radiotherapy
    Breast conserving therapy: lumpectomy, partial mastectomy, or quadrantectomy
  - Indications for post neoadjuvant chemotherapy
    Based on maximal disease stage at diagnosis (before preoperative systemic therapy) and pathology results after preoperative systemic therapy
  - Indication for DCIS
    Lumpectomy without lymph node surgery, followed by whole breast radiation therapy with or without boost to tumor bed. The option of lumpectomy alone should be considered only in cases where the patient and the physician view the individual as having a low risk of disease recurrence.
    - Low risk: low to intermediate grade, size < 2.5cm, and margin ≥ 3mm

- **Simulation and Treatment Planning**
  1. Patients are treated in the supine position, recommended with the ipsilateral arm elevated above the head and the head is rotated slightly toward the contralateral side.
  2. A custom-molded immobilization device such as vacuum, wing or T board are typically used to reproduce daily position and minimizing day-to-day set up errors.
  3. CT simulation images were obtained with 2.5-5-mm thickness, extending from the neck through the mid-abdomen to make sure the radiation area is included entirely.
4. The treatment fields are then designed on the CT-simulation data set with the aid of virtual reality type techniques. The goal of the design is to include the target regions while avoiding normal structures, such as the heart, lung and the contralateral breast.

5. Active breathing control may be used to further reduce dose to adjacent normal tissues, in particular heart and lung.

**Radiation Treatment Fields**

*Chest Wall (CW) Radiation (including breast reconstruction):*

- The CTV target includes the ipsilateral chest wall, proximal mastectomy scar, and drain sites where possible. Depending on whether the patient has been reconstructed or not, several techniques using photons and/or electrons are appropriate. CT-based treatment planning is encouraged, in order to identify lung and heart volumes, and minimize exposure of these organs. Special consideration should be given to the use of bolus material when photon fields are used, to ensure the skin dose is adequate. Expanding 0.5-2cm from CTV to form the PTV.

*Whole Breast (WB) Radiation:*

- CTV target delineation includes the majority of the breast tissue, and is best done by both clinical assessment and CT-based treatment planning. Expanding 0.5-2cm from CTV to form the PTV.

*Regional Nodal Radiation:*

- The CTV of regional nodes include supraclavicular (SC), infraclavicular (IC), with/without axillary level I and axillary level II and internal mammary (IM) nodes. The IC lymph nodes mean axillary level III nodes.
- Target delineation is best achieved by the use of CT-based treatment planning.
- If internal mammary lymph nodes are clinically or pathologically positive, radiation therapy should be given to the internal mammary nodes.
- CT treatment planning should be utilized in all cases where radiation therapy is delivered to the internal mammary lymph node field.
- Expanding 0.5-1cm from CTV to form the PTV.
- ≥4 positive axillary nodes: Radiation therapy to infraclavicular region, supraclavicular area, also consider to include internal mammary node or any part of the axillary bed at risk
- 1–3 positive axillary nodes: Strongly consider radiation therapy to infraclavicular region, supraclavicular area, also consider to internal mammary nodes, and any part of the axillary bed at risk.
• Negative axillary nodes: Consider regional nodal radiation in patients with central/medial tumors or tumors >2 cm with other high-risk features (young age or extensive lymphovascular invasion [LVI])

**Radiation dose**

A uniform dose distribution is objective, using compensators such as wedges, forward planning using segments, or IMRT.

- **Whole breast dose:**
  1. The breast should receive a dose of 45-50.4 Gy in 25-28 fractions, five weekly fractions over a 5- to 6-week period of time. Optional: 40-42.5 Gy in 15-16 fractions.
  2. **Boosts**
     1. A boost to the tumor bed is recommended in IDC patients at higher risk for local failure (age < 50, high grade, positive axillary nodes, or close or positive margins).
     2. A boost to the tumor bed is optional in DCIS patients at higher risk for local failure (consider boost if age < 50, high grade, or close (<2 mm) or positive margins).
     3. When used, boost irradiation usually is delivered using electron beam or photon to high risk of recurrent area, such as tumor bed and surgical scar with margins.
     4. The boost dose is approximately 1000-1600 cGy in 4-8 fractionation.

- **PMRT dose:**
  1. The preferred total dose is 45-50.4 Gy in 25-28 fractions, 5 times per week.
  2. **Boosts**
     1. A boost to the tumor bed is recommended in IDC patients at higher risk for local failure (age < 50, high grade, positive axillary nodes, or close or positive margins).
     2. When used, boost irradiation usually is delivered using electron beam or photon to high risk of recurrent area, such as tumor bed and surgical scar with margins.
     3. The boost dose is approximately 1000-1600 cGy in 4-8 fractionation.

- **IORT:**
  Single-dose radiation is delivered to the tumour bed. The surface of the tumour bed typically receives 20 Gy that attenuates to 5–7 Gy at 1 cm depth. (Full patient selection criteria and executive summary are illustrated in the 2016 version of the ASTRO APBI guideline)

- **Accelerated Partial Breast Irradiation (APBI)**
  1. Rates of local control in selected low-risk patients may be comparable to those treated with standard WBRT. However, several studies document an inferior cosmetic outcome with APBI.
  2. A course of 34 Gy in 10 fractions delivered twice per day with brachytherapy or 38.5
Gy in 10 fractions delivered twice per day with external beam therapy

**Special technique statement**
- Active breathing control –
  1. Patients should be amenable to coordination under voice guidance, and to perform breath holding for at least 15 seconds at a time for several cycles.
  2. This technique is effective in lowering radiation dose to heart and lung, it is strongly considered especially in left-sided breast cancer patients.

- SDX® Voluntary Breath Hold –
  1. The patient is introduced to the SDX® System and breathes freely through the spirometer until instructed to take a full inspiration. The SDX® System calculates a target inspiration zone, which is a percentage of the patient’s maximum inspiration capacity. This ensures the patient can comfortably maintain repeated breath holds at least 15 seconds with the same inspiration volume every time.
  2. This technique is effective in lowering radiation dose to heart and lung, it is strongly considered especially in left-sided breast cancer patients.

- DIBH with Vision RT (Surface Guided Radiation Therapy)–
  1. The patient is introduced to deep inspiration breath hold radiotherapy (DIBH) with Vision RT surface guided technique. This ensures the patient can comfortably maintain repeated breath holds at least 15 seconds for several cycles by tracking the patient’s 3D surface in real-time.
  2. This technique is effective in lowering radiation dose to heart and lung, it is strongly considered especially in left-sided breast cancer patients.
### Dose constraints

<table>
<thead>
<tr>
<th>OAR</th>
<th>Constraints in 25-30 Fractions</th>
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<tbody>
<tr>
<td>Spinal cord</td>
<td>Max ≤ 50 Gy</td>
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<tr>
<td>Lung</td>
<td>V20 ≤ 20~30%; V5 ≤ 70%; MLD ≤ 20Gy</td>
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<tr>
<td>Heart</td>
<td>V30 ≤ 46%, V40 ≤ 5%</td>
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<tr>
<td>Esophagus</td>
<td>Mean ≤ 34Gy; Max ≤ 105% of prescription dose</td>
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Vxx=%% of the whole OAR receiving ≥ xx Gy

### Reference

11. Silverstein MJ. The University of Southern California/Van Nuys prognostic


