Target definition in partial breast irradiation
GEC-ESTRO consensus

V. Strnad

GEC ESTRO Recommendations

Recommendations from GEC ESTRO Breast Cancer Working Group (I): Target definition and target delineation for accelerated or boost Partial Breast Irradiation using multicatheter interstitial brachytherapy after breast conserving closed cavity surgery


Recommendations from GEC ESTRO Breast Cancer Working Group (II): Target definition and target delineation for accelerated or boost partial breast irradiation using multicatheter interstitial brachytherapy after breast conserving open cavity surgery

Key to success of APBI

3 pillars

Patient selection  Target definition  Appropriate technique
GEC-ESTRO guidelines for target definition in breast brachytherapy

GUIDELINES

Target localization

Target definition
GEC-ESTRO guidelines for target definition in breast brachytherapy

GUIDELINES

BACKGROUND

Target localization
Target definition

AVAILABLE INFORMATIONS
GEC-ESTRO guidelines for target definition in breast brachytherapy

**GUIDELINES**

**BACKGROUND**

**AVAILABLE INFORMATION**

- Target localization
- Target definition
Target definition and delineation

What we can use?

1. Scar - skin
2. Imaging (Ultrasound, Mammography, MRI, CT)
3. Surgical report
4. Surgical clips
5. Scar inside of breast
Skin scar

Only entrance point for surgeon!
Mammography before surgery

- Tumor size
- Localization (Quadrant)

…but:

- Squeezing of tissue must be respected
- Distances – only limited value
Mammography before surgery

✓ No absolute distance values!
Ultrasound and mammography after surgery

- no value after CLOSED CAVITY surgery
- useful after OPEN CAVITY surgery
CT after surgery

Target localization - BACKGROUND
**CT after surgery**

### Cavity Visualization Score

<table>
<thead>
<tr>
<th>CVS 1</th>
<th>CVS2</th>
<th>CVS3</th>
<th>CVS4</th>
<th>CVS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cavity</td>
<td>Heterogenous cavity with indistinct margins</td>
<td>Heterogenous cavity with some indistinct margins</td>
<td>Mildly heterogenous cavity with mostly distinct margins</td>
<td>Homogenous cavity with clearly identified margins</td>
</tr>
</tbody>
</table>

DM Landis et al., IJROBP, 2007, 67, 1299-1308
Surgical report

Where and how ...

Surgical report:
- Closed cavity
- Open cavity
- Plastic reconstructions
- Clips – yes/no

Quadrantectomy

Plastic reconstruction

Wide excision

Target localization - BACKGROUND
Recommendations from GEC ESTRO Breast Cancer Working Group (I): Target definition and target delineation for accelerated or boost Partial Breast Irradiation using multicatheter interstitial brachytherapy after breast conserving closed cavity surgery.

Vratislav Strnad¹, Erik Van Limbergen², Jean-Michel Hannoun-Levi³, Jose-Luis Guinot⁴, Kristine Lössl⁵, Daniela Kauer-Dorner⁶, Alexandra Resch⁷, György Kovács⁷, Tibor Major⁸, Csaba Polgár⁹ on behalf of Working Group Breast Cancer of GEC-ESTRO
Target delineation – needs:

Basic informations

Surgical report:
1. Closed cavity
2. Open cavity
3. Plastic reconstructions
4. Clips – yes/no

Pathology:
1. Tumor size
2. Resection margins in all 6 directions!
TWO KEY QUESTIONS

1. How large should be the **size of the safety margin**?
   (existing resection margin + „brachytherapy“ safety margin)

2. What we know about **the accuracy of estimation of position of the resection margins** in corresponding directions.

   Consequently, how should we respect the possible inaccuracy by our definition of size of safety margins?
Margin size?

(resection margin + "brachytherapy“ safety margin)??
Resection margin and residual disease

European point of view

APBI relevant summary:

**Breast Carcinoma of Limited Extent** (≤2cm, no EIC, L0, pN0, absent of calcifications) ... 

...might be a potential candidate for breast surgery alone if the tumor is excided with a macroscopically **free margins of approximately 2 cm.**

**Breast Carcinomas of Limited Extent**
*Frequency, Radiologic-Pathologic Characteristics, and Surgical Margin Requirements*

Daniel R. G. Farrow, M.D.\(^1,2\)  CANCER  February 15, 2001 / Volume 91 / Number 4

Jan H. C. L. Hendriks, M.D.\(^3,4\)
Roland Holland, M.D.\(^1,2\)
APBI relevant summary of computer assisted tumor mapping:

1. Distance of intraductal tumor extension:
   - 22.7 mm for pts. <30 y.
   - 14.3 mm for pts. 30-40 y.
   - 6.7-7.7 mm for pts. >40 y.

2. The average maximum distance of extension was 11.9 mm. (Patients 50 years of age had a maximum extension of 8 mm.)

3. In contrast to Holland’s study, the mean tumor size in this study was only 1.7 cm.
The differences in extension of the intraductal components
- 324 cases with invasive ductal breast carcinoma

Figure 1. Representative map of cancer spread. Intraductal component extension was measured in four directions in every case [nip: nipple side; dor: dorsal side; cep: cephalad side; cau: caudal side]. Right: In this case intraductal component extension was greatest on the nipple side [≤ 15 mm], and MXDS was therefore recorded as 15 mm. Left: In this case intraductal component extension was greatest on the caudal side [≤ 5 mm], and MXDS was therefore recorded as 5 mm.
Despite median extension of 9 mm, 35% of cases had a ductal tumour spread in the distance between 10-30 mm!
Target definition

Margin size?  
(resection margin + „brachytherapy“ safety margin)

Answers:

<table>
<thead>
<tr>
<th></th>
<th>pts. (n)</th>
<th>needed safety margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faverly:</td>
<td>135</td>
<td>20 mm</td>
</tr>
<tr>
<td>Ohtake:</td>
<td>20</td>
<td>8 mm</td>
</tr>
<tr>
<td>Imamura:</td>
<td>324</td>
<td>30 mm</td>
</tr>
<tr>
<td>Vicini/Goldstein:</td>
<td>333</td>
<td>10 mm</td>
</tr>
</tbody>
</table>
Margin size?
(resection margin + "brachytherapy“ safety margin)

**Summary:**

The size of "safety margin’s“ (existing resection margin + "brachytherapy“ safety margin) should be by 2 cm in all directions.
TWO KEY QUESTIONS

1. How large should be the size of the safety margin (existing resection margin + “brachytherapy” safety margin)?

2. What we know about the accuracy of estimation of position of the resection margins in corresponding directions.

Consequently, how should we respect the possible inaccuracy by our definition of size of safety margins?
Value of type of surgery

...and the precision of surgical clips...?

Precision of clips
1. Variability during the time.
2. Random-variability.
Value of type of surgery

...and the precision of surgical clips...

Precision of clips:
Random-variability – no data
min. ± 3-5mm
GEC ESTRO Recommendations

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1. The target delineation is to be made **CT based** – without contrast agent.

2. Please visualize the **skin scar** and delineate **surgical clips**.

3. Delineate **Whole Surgical Scar – WS** (between skin scar and surgical clips).

4. Delineate **Imaging related target volume – ImTV**.

5. Delineate **Estimated tumour bed - ETB**.

6. Delineate **Clinical target volume - CTV**.

7. Delineate, **only if necessary and useful** (!), **Planning target volume – PTV**.
Perform a CT with a mark on the middle of the **skin scar**

**Delineation of clips**

Two kinds of clips: intraparenchymal and on thoracic wall

- The clinician decides which clips are relevant for delineating the surgical bed and which clips are considered as part of the target clinically **“target relevant surgical clips”**.

- We need **a precise surgical report** in which the surgeon describes the number and the position of the clips and what are the “relevant” and “non relevant”.

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1. **Guidelines**

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2. Delineation of the surgical bed (Whole Scar, WS) inside the breast

- Delineate the surgical bed that is the visible scar of the closed cavity, including the whole scar and all the clips.

- Whenever the scar is not visible, the space between the skin scar and clips on the thoracic wall can be delineated as virtual scar (depending of the breast size).

- If there are no clips and the scar is not visible, tumor bed cannot be delineated.
Guidelines

WHOLE SCARE
Guidelines

Definition and delineation of ImTV (Imaging correlated Target Volume) by using preoperative mammography, ultrasound, MRI.

1. Take the **relative distance between the center of the visible tumor** on the mammograms to the skin and chest wall.

2. In this relative distance and position delineate the projection of the largest tumor size on the scan.
Definition and delineation of ImTV (Imaging correlated Target Volume) by using preoperative mammography, ultrasound, MRI.

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ImTV Guidelines

AXIAL

COR/ROTATED

SAG

3-D
Definition and delineation of ETB (Estimated Tumour Bed)

In consideration of three factors:

1. clinically “target relevant surgical clips”,
2. whole scar (WS) and
3. ImTV

The physician delineate ETB as part of the whole surgical scar that is considered as related to the tumor position and tumor size.
Guidelines

ESTIMATED TUMOUR BED
Definition and delineation of CTV (Clinical Target Volume)

- **CTV = ETB plus adapted safety margins:** 20 mm minus surgical margin, but at least 10 mm (a surgical margin of 3 mm requires a safety margin of 17 mm).
- Thoracic wall and skin (thickness 5 mm) are not the part of CTV.
Delineation of PTV (Planning target volume) - clinical decision, if reasonable
PTV = CTV + 5 (10) mm

- To respect the random inaccuracy of positioning of surgical clips.
- Whenever there is uncertainty in the definition of the scar (CVS1, Landis)
- For External Beam Radiation Therapy another safety margin will be required, as usual.
### Target size

**Brachy vs. EBRT**

<table>
<thead>
<tr>
<th>Name</th>
<th>Series</th>
<th>Volum...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clip 1</td>
<td>CT ...</td>
<td>0.05</td>
</tr>
<tr>
<td>Clip 2</td>
<td>CT ...</td>
<td>0.08</td>
</tr>
<tr>
<td>Clip 3</td>
<td>CT ...</td>
<td>0.19</td>
</tr>
<tr>
<td>Clip 4</td>
<td>CT ...</td>
<td>0.19</td>
</tr>
<tr>
<td>CTV</td>
<td>CT ...</td>
<td>35.50</td>
</tr>
<tr>
<td>ETB</td>
<td>CT ...</td>
<td>1.41</td>
</tr>
<tr>
<td>ImTV</td>
<td>CT ...</td>
<td>1.22</td>
</tr>
<tr>
<td>PTV (EBRT)</td>
<td>CT ...</td>
<td>197.47</td>
</tr>
<tr>
<td>PTV_Brachytherapy</td>
<td>CT ...</td>
<td>58.99</td>
</tr>
<tr>
<td>PTV_EVAL (EBRT)</td>
<td>CT ...</td>
<td>153.20</td>
</tr>
<tr>
<td>Skin mark</td>
<td>CT ...</td>
<td>0.13</td>
</tr>
<tr>
<td>WS</td>
<td>CT ...</td>
<td>4.72</td>
</tr>
</tbody>
</table>
1. **CTV** is defined as the **sum of the clipped area (CA) and the distance of 20 mm** minus the smallest surgical free margin (SFM) defined by the pathologist (CTV = CA + (20 - SFM)).

2. **PTV** is defined as the **CTV + 10 mm**. The additional distance of 10 mm resulting from the interobserver delineation variability is not influenced by setting clip markers.
Summary
Recommendations for daily routine

1. Discuss with pathologists:
   1. Please respect margins in all directions.

2. Discuss with surgeons:
   1. Please reconstruct the breast tissue.
   2. Make the scar at the location of the tumor, and/or place clips.
   3. Please cautiously orient the specimen.

3. Explore possibilities for further imaging (e.g. MRI, US).

4. Follow guidelines and use common sense!
Secret of success of APBI

3 pillars

Patient selection  Target definition  Appropriate technique