An overview of Electronic tissue Compensation (ECOMP) for breast Radiotherapy

Poster No.: R-0170
Congress: 2014 CSM
Type: Scientific Exhibit
Authors: M. Friend; MELBOURNE/AU
Keywords: Breast, CT, Radiation therapy / Oncology, Radiotherapy techniques
DOI: 10.1594/ranzcr2014/R-0170

This PDF document has been automatically generated from a digital poster submitted online, and is meant for personal use only. Copyright restrictions might apply. Certain materials like for example videos - or multimedia files other than images in general, are not included in this PDF.
Aim

- To provide an overview of Electronic tissue Compensation, (ECOMP), by exploring current literature as well as clinical perspectives from William Buckland Radiation Oncology (WBRO).
- To explain some basic concepts of tissue compensation and clinical procedures utilised at both the WBRO Centres in Victoria.

Electronic tissue compensation (ECOMP) is a forward planning IMRT technique which delivers a homogenous dose distribution to irregular surfaces via dynamic multi-leaf collimators (dMLC).
Fig. 1: ECOMP treatment for a right breast

References: William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU
Methods and materials

Background:

- Breast cancer is the most commonly occurring cancer and leading cause of cancer death in Australian women, with approximately 13,000 women diagnosed annually [1].
- Standard treatments include conservative surgery, chemotherapy and whole breast irradiation.
- Conventional radiotherapy is administered with two tangential beams using wedges and segmented fields to improve dose homogeneity.
- However, due to the steep contour change that happens with breasts, dose homogeneity can be difficult to achieve, especially in women with a large post edge separation [2].

Accounting for tissue inhomogeneities

<table>
<thead>
<tr>
<th>Physical beam attenuators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Wedges</td>
</tr>
<tr>
<td>- dMLCs</td>
</tr>
<tr>
<td>- lead blocks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weightings</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Multiple Beams</th>
</tr>
</thead>
</table>

- Like IMRT, ECOMP uses dynamic multileaf collimators (dMLCs) to distribute the dose according to the fluence (Fig. 2 on page 9) created. Therefore ECOMP it could be said that ECOMP is a type of IMRT.
- Each leaf moves independently of the others, therefore it can account for tissue variation in the superior/inferior direction in addition to the anterior-posterior direction. This is one of the greatest advantages of dMLC techniques for breast radiotherapy.
- Conventional standard wedges can only account for tissue variation in the ant-post direction.

Features of ECOMP and IMRT

<table>
<thead>
<tr>
<th>ECOMP</th>
<th>IMRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward planned</td>
<td>Inverse planned</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>dMLCs used for dose delivery</td>
<td>dMLCs used for dose delivery</td>
</tr>
<tr>
<td><strong>Parallel opposed field arrangement</strong></td>
<td><strong>Can not have 180 opposing fields</strong></td>
</tr>
<tr>
<td>Decreased MU</td>
<td>Multiple fields</td>
</tr>
<tr>
<td>Decreased dose rate</td>
<td>Decreased dose rate</td>
</tr>
</tbody>
</table>

**Advantages and Disadvantages of ECOMP**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorter planning time</td>
<td>No critical structure avoidance</td>
</tr>
<tr>
<td>Shorter treatment time</td>
<td>More work for physics (QA)</td>
</tr>
<tr>
<td>Reduced time on couch for patients</td>
<td>Can not do long field QA</td>
</tr>
<tr>
<td>Increased dose homogeneity</td>
<td></td>
</tr>
<tr>
<td>Accounts for tissue variation in the sup-inf as well as ant-post</td>
<td></td>
</tr>
</tbody>
</table>

**How does it work?**

- The software creates a fluence by converting the beam into a grid of small pencil beams (beamlet). It then uses a pre-determined tissue penetration depth (TPD) to calculate the intensity required to achieve the desired dose to that point (see figure 3) [2]
- TPD is a percentage of the geometric path length of a beamlet and describes the point along the path that the tissue compensation occurs. A reduced penetration depth brings the compensation plane closer to the skin [2].
Fig. 3: TPD is a percentage of the geometric path length a beamlet traverses. 

References: William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU

- A dose profile is then created using every beamlet in the field. The dose profile that is created takes into account tissue variation through each beamlet.
- The resultant dose profile is then inverted to create an intensity profile. The intensity profile determines the length of exposure time required to achieve dose through the tissue. This then determines the speed and position of the dMLCs.
Fig. 4: dMLC movement is determined by the calculated Intensity of the beam. Intensity takes into account the different density of the patient contour.

**References:** William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU

**Procedure at the WBRO:**

- Scan patient supine with arms up.
- Export CT dataset to Varian Eclipse planning system.
- Adjust weightings evenly (18X contribution may be required to achieve dose at depth) and enter an appropriate TPD.

- TPD is determined by post edge separation:
  - PA sep <24 = 50%
  - PA sep =24 = 45%
  - PA sep ≥24 = 40%

- Once fluence is calculated, erase lung shielding (block) from the fluence in the "Fluence Editor" window (Fig. 5 on page 9), so that no dose will be calculated over that area, therefore sparing the lung.
• Add a "skin flash region" (Fig. 6 on page 10) of 1.5-3cm along the anterior portion of the breast. This provides an extra fluence margin so the breast is still covered by dose when the patient breathes.
• If distribution looks good with no hot spots there is no need to further optimize.
• If hot spots still occur, use paintbrush tool in the same edit window to reduce transmission factor over hot spots. Reducing the transmission factor shortens the time that region of the field is open and therefore decreases the dose.
• Re-calculation is required after each fluence modification.
• Continue adjusting fluence until plan constraints are achieved.
Images for this section:

**Fig. 2:** Fluence - ECOMP dose modudulation occurs through dMLCs. Individual leaves move across the field at different speeds according to the different tissue densities. The fluence is therefore a coloured representation of how long each region of the field is "open" to radiation. The fluence is an estimation of dose distribution before the field is calculated. It is also known as a "dose map". The warmer colours denote a longer exposure time.

© William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU
Fig. 5: Fluence editor window.

© William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU
Fig. 6: A "skin flash" is added along the anterior portion of the breast. This process "paints" fluence outside the patient contour to account for breast movement due to respiration.

© William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU
Results

ECOMP is routinely employed at the WBRO for breast and axilla patients. Recently it has also been adapted to treat a modified mantle technique.

![Modified mantle technique](image)

**Fig. 7**: Modified mantle technique

**References**: William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU

**Dosimetric comparison**:

- There is a notable difference in dose distribution delivered from ECOMP compared to conventional techniques. This is supported by articles which have found ECOMP for breast radiotherapy to deliver a more homogenous dose to a volume. It has the added advantage of reducing lung and cardiac dose in left sided breast cancer, reduced MU's and overall planning time [3].
**Fig. 8**: Dose comparison of ECOMP (left) and conventional (right) treatments.

**References**: William Buckland Radiotherapy Centre Gippsland (Traralgon) - MELBOURNE/AU

**Literature**:

**BRAIN**:

- ECOMP has been proven to provide dosimetric benefits in whole brain radiotherapy (WBRT). When compared to IMRT and conventional WBRT, ECOMP resulted in more homogenous dose distribution with a reduction in hot spots inside the treatment volume [4]. This is of particular benefit in paediatric radiotherapy where long-term side effects are a greater consideration [4].
- A reduction in planning time was also seen when compared to IMRT [4].

**ABDOMEN**:

- ECOMP is a versatile technique that has the ability to potentially replace convoluted practices such as cerrobend (lead) blocking. Whilst lead blocking is effective, it is laborious. When ECOMP was used as a kidney block it produced equivalent dosimetric outcomes and was a lot less involved than the traditional lead blocking method [5].
- Planning time is much the same for conventional vs ECOMP.
- Treatment time for this technique has not been assessed directly. However, a time reduction could be predicted because physical blocks do not need to be positioned in the treatment head.
Conclusion

- ECOMP is an effective solution to the dosimetric difficulties that can arise in radiotherapy when treating an irregular surface (ie. breast).
- ECOMP is currently utilised at both WBRO sites to improve dose homogeneity and reduce planning and treatment times. It is used routinely for both breast and axilla patients.
- ECOMP is not widely employed and literature citations are limited.
- Clinical experiences with the technique are positive and demonstrate potential expansion of the technique. WBRO has used ECOMP as a substitute for personalised lead compensators and multiple segmented fields in the mantle technique.
- ECOMP has been able to replace beam modifiers such as wedges and is able to compensate for depth differences in the cranio-caudal as well as anterior-posterior directions.
Personal information

Mia Friend
Radiation Therapist

William Buckland Radiotherapy Gippsland (WBRG)

University Graduate School of Medical Science, RMIT, Australia

Email: mfriend@lrh.com.au
References


