A national dosimetric audit of VMAT and Tomotherapy in the UK

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Background

- Previous national audit of static-beam IMRT 2009 [1]
- Surveyed UK cancer centres in 2010
- Around 30% were already treating with some form of rotational radiotherapy (RRT)
- Varian RapidArc, Elekta VMAT or Helical Tomotherapy
- This rapid uptake led to the need for a national dosimetry audit for RRT.

Background

We have previously
• Investigated the use of a commercial detector array for national audit
• Developed a methodology for planning and measurement [2].

Octavius II phantom with various detectors

PTW Semiflex ion chambers

PTW 729 2D array

Gafchromic film

Alanine
Introduction

Measurements were made in 30 centres
These included:

- 20 x Varian (17 Eclipse, 2 OMP, 1 Pinnacle TPS)
- 6 x Elekta (4 Monaco, 1 OMP, 1 Pinnacle TPS)
- 4 x Helical Tomotherapy
Introduction

Planning requirements:
Generic plan: 3DTPS [3]
UK clinical trial portfolio plan
- Prostate and pelvic nodes
- Head and Neck
- Breast

3DTPS test plan and measurement planes

Sagittal Plane, through PTVs and OAR

1\textsuperscript{st} Coronal Plane, through multiple PTVs

2\textsuperscript{nd} Coronal Plane, through PTVs and OAR
Measurement planes for 3DTPS test
Head and Neck plan measurements

- Typical coronal and sagittal planes
Analysis

- Verisoft
- Global gamma index ($\gamma$) calculations
  - 20% threshold
  - 100% point in high dose low gradient
- Dose point differences
  - PTVs and OARs
Results

A total of:

- 155 dose planes were measured
- 283 dose point differences were calculated
Point dose differences in PTVs - 3DTPS plan

Mean 0.3%
SD 2.0%
Point dose differences in PTVs - clinical plans

Mean -0.3%
SD 1.7%

Frequency

Percentage difference between measured and calculated

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

16
14
12
10
8
6
4
2
0
3DTPS gamma analysis

Frequency

% pixels passing

4%/4mm
3%/3mm
2%/2mm
## Gamma analysis results

<table>
<thead>
<tr>
<th>mean pass rate</th>
<th>Clinical</th>
<th>3DTPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%/2mm</td>
<td>93.6%</td>
<td>93.2%</td>
</tr>
<tr>
<td>3%/2mm</td>
<td>97.5%</td>
<td>97.0%</td>
</tr>
<tr>
<td>3%/3mm</td>
<td>99.2%</td>
<td>98.7%</td>
</tr>
<tr>
<td>4%/4mm</td>
<td>99.9%</td>
<td>99.8%</td>
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</table>
## Gamma analysis results

<table>
<thead>
<tr>
<th></th>
<th>mean pass rate</th>
<th>percentage of planes &gt;95% of $\gamma&lt;1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clinical</td>
<td>3DTPS</td>
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<td>2%/2mm</td>
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<tr>
<td></td>
<td>Clinical</td>
<td>3DTPS</td>
</tr>
<tr>
<td>2%/2mm</td>
<td>62.5%</td>
<td>45.7%</td>
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<tr>
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<td>82.8%</td>
<td>71.4%</td>
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<tr>
<td>3%/3mm</td>
<td>95.3%</td>
<td>88.6%</td>
</tr>
<tr>
<td>4%/4mm</td>
<td>100%</td>
<td>100%</td>
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</tbody>
</table>
Issues identified

- Lack of couch modelling
- Use of small minimum field gap
- High modulation / high MUs
- Effect of variable dose rate
- Lack of information as to what particular TPS/Linac combinations are capable of achieving
Conclusions

• A national audit of rotational radiotherapy has been undertaken

• More than 93% of analysed planes achieved more than 95% pass rates for gamma parameters of 3%/3mm

• The majority of centres achieved accurate implementation of TPS modelling and delivery for VMAT and Tomotherapy
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Leicester Royal Infirmary
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