Frameless SRS Using the Varian Linac Platform
Richard Popple

Disclosures

• Research support from Varian Medical Systems
• Intellectual property licensed to Varian Medical Systems through The University of Alabama at Birmingham
• Speaking honoraria from Varian Medical Systems

VMAT Radiosurgery
Planning Challenges

• Many ways to get a sub-optimal plan
• Metrics of plan quality not in the cost function
• Relevance on default NTO to define dose fall-off
• Forced homogeneity
• Restrictive treatment geometry (e.g. axial only)
• Report gradient index when plans differ in conformity
• Poorly considered normalization
• Sequential optimization of multiple isocenters
• “Ring recipe” devised to place all surrogates for plan quality in the cost function
  • Conformity
  • Gradient
  • Normal brain dose

PMIDs:
27612917, 26596914, 27903198, 24748208, 25434937, 28477798, 27614790, 26894335, 26699547, 28297536

Automating Treatment Planning and Delivery

HyperArc™

• Treatment planning software component in Eclipse treatment planning system
• Treatment delivery software on TrueBeam® system or Edge® radiosurgery system
• Process is defined and prescriptive to ensure high quality even if planner is less experienced

HyperArc™ components

• TrueBeam linear accelerator
• Millenium 120 or HDMLC
• Qfix Encompass mask system
• Eclipse TPS
• ARIA ROI

HyperArc™ Treatment Planning
SRS normal tissue objective
- Includes parameters for rapid dose falloff around targets
- Designed for multiple targets
- Designed for radiosurgery
Automated Isocenter Placement Far from Anterior Target

- Placed in center of protection zone
- Increased risk of alignment error due to small rotational error
- Lower resolution MLC leaves used for more of treatment
- Planner needs to manually move it closer

Manual Placement of Isocenter Within Protection Zone as Close as Possible to Target

MLC leaf width

Table 2: Summary of dosimetric and radiobiological indices.

<table>
<thead>
<tr>
<th>MLC Leaf Width</th>
<th>Conformity Index</th>
<th>Gradient Index</th>
<th>NTCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 mm VMAT</td>
<td>0.99 ± 0.01</td>
<td>3.2 ± 0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>5.0 mm VMAT</td>
<td>0.99 ± 0.01</td>
<td>3.2 ± 0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>3.0 mm 4DCA</td>
<td>0.99 ± 0.01</td>
<td>3.2 ± 0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>4.0 mm 4DCA</td>
<td>0.99 ± 0.01</td>
<td>3.2 ± 0.8</td>
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</table>
Other mask systems compatible with OSMS are not compatible with HyperArc™.


Encompass™ SRS Immobilization System

Encompass attenuation

Encompass attenuation
Encompass attenuation

- Significant attenuation (up to 17%) where the mask attaches to the insert.
- Should be included in the TPS model
- Small uncertainties in couch placement do not significantly perturb the dose calculation. However, larger differences can be seen when using few static beams compared to rotational treatment techniques.

HyperArc - QA

*Same as other MLC based SRS*

Quality and Safety Considerations in Stereotactic Radiosurgery and Stereotactic Body Radiation Therapy

Timothy D. Solberg, Ph.D.¹, James M. Balter, Ph.D.², Stanley H. Benedict, Ph.D.³, Benedict A. Fraass, Ph.D.⁴, Brian Kavanagh, M.D.⁵, Curtis Miyamoto, M.D.⁶, Todd Pawlicki, Ph.D.⁷, Louis Potters, M.D.⁸, Yoshiya Yamada, M.D.⁹

End-to-end

MD Anderson Dosimetry Laboratory SRS phantom
MDADL SRS Head Phantom

Table 5. SRS / SBRT-specific linac-related quality assurance requirements, to be performed in addition to the standard linear accelerator tests described in the AAPM Task Group 142 report.

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<td>±1 mm</td>
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<tr>
<td>Dose vernier (DD1)</td>
<td>±1 mm, if available</td>
</tr>
<tr>
<td>Collimator size indicator – both jaws and jaw</td>
<td>±1 mm</td>
</tr>
<tr>
<td>Window test</td>
<td>±0.75 mm average</td>
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<tr>
<td>Gantry-rotation/patient-rotation</td>
<td>±1 mm</td>
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<tr>
<td>Imaging subsystem interlock</td>
<td>Functional</td>
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<td>Senoelectric interlock – output side, backup jaws</td>
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Daily tests

Table 5. SRS / SBRT-specific linac-related quality assurance requirements, to be performed in addition to the standard linear accelerator tests described in the AAPM Task Group 142 report.

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## Monthly tests

<table>
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<tr>
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</tr>
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<tr>
<td>Machine Limit test - Both 2 axes and ULC covering complete range ofantry, couch, collimator positions</td>
<td>± 0.5 mm average</td>
</tr>
<tr>
<td>≤ 1hiro maximum</td>
<td></td>
</tr>
<tr>
<td>Marker target test using VTR linear and/ or HRT system</td>
<td>≤ 1 mm</td>
</tr>
<tr>
<td>Treatment couch position indicators</td>
<td>≤ 1 mm / &lt; 0.5 degrees</td>
</tr>
<tr>
<td>Output constancy at relevant dose rates</td>
<td>±%</td>
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## Machine performance check

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## Machine performance check
EPID-Based Quality Assurance of Linear Accelerators (TG330)

Charge

• To provide comprehensive review of characteristics of EPID as a time-resolved measurement device and dosimeter.
• To summarize the application of EPID for linac QA.
• To provide recommendations on efficient and effective implementations of EPID-based QA techniques.
• To describe hazards associated with use of EPIDs for linac QA and to provide examples how hazard analysis can be used to ensure safe use of EPIDs for linac QA.

Verification of Vendor Provided Data, Tools and Test Procedures (TG332)

Charge

• To define “closed” and “black box” systems in a radiation oncology setting and to provide examples of self-integrated or pre-configured delivery devices, test procedures or data that fall into these categories.
• To provide guidance on the critical evaluation and independent validation of these types of systems. This includes but is not limited to independently validating:
  • Pre-configured devices, tools, and test procedures developed by vendors and provided to the customer that are utilized during acceptance, commissioning or routine QA;
  • Data that is acquired by vendors and provided to the customer and utilized during acceptance, commissioning or routine QA;
• To provide guidance to the medical physicist on how to approach QA of a system that is self-integrated or pre-configured and falls outside of the realm of a traditional radiation delivery device to which guidance documents already exist.
• To provide guidance to the medical physicist and vendor on a collaborative relationship between the two parties to achieve a mutual and shared responsibility for the performance of equipment and quality of the data in use.
• To provide guidance on analyzing the risks associated with implementation of “closed” or “black box” systems.

Treatment delivery

Most cases 12-15 minutes
Motion monitoring for frameless radiosurgery

OSMS includes three pods each with two cameras and a projector to monitor the surface.

Thanks