Principle and Practice of Image-Guided SRS/SRT

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Moving What for SRS/SRT?

Beam ☐ Skull ☑
Beam ☑ Skull ☐
Beam ☑ Skull ☑
Beam ☐ Skull ☐

State-of-the-Art Platforms
Ideal Design for SRS/SRT

- Short source-focal length (minimizing penumbra)
- Multi-isocenter capability (central targeting)
- High number of beams (sharpening dose gradient)
- No translation and rotation uncertainty (robust tx)

Classic SRS/SRT Example: LGK

[Image: Courtesy of Elekta AB 2006]

Robotic SRS/SRT Example: CKS

[Image: Courtesy of Dr. Chris McGuinness UCSF]
VMAT-based SRT/SBRT Example

- FFF driven output
- HD MLC
- Variable Gantry Rotations

Courtesy of Varian Oncology

Imaging Guidance + Hypofractionation

- High precision delivery leveraging the power of image guided 6DOF alignments
- Hypofractionation leveraging enhanced biological effects

Radiobiological Rationales

- Single fraction
  Small Lesion, No 4Rs
- Hypofractionation
  Larger Lesion; Reoxygenation & Reassortment
Hypofractionation Tissue Effects in Clinic (HyTEC)

Hypofractionated Brain Mets SRS/SRT

<table>
<thead>
<tr>
<th></th>
<th>1 x 15-18 Gy</th>
<th>3 x 9 Gy</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pts</td>
<td>151</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Mets</td>
<td>1-4</td>
<td>1-4</td>
<td>ns</td>
</tr>
<tr>
<td>GTV (cc)</td>
<td>9 (3-24)</td>
<td>13 (4-48)</td>
<td>0.001</td>
</tr>
<tr>
<td>LC (12 mo)</td>
<td>77%</td>
<td>90%</td>
<td>0.01</td>
</tr>
<tr>
<td>RN (12 mo)</td>
<td>18%</td>
<td>9%</td>
<td>0.01</td>
</tr>
</tbody>
</table>


Results

GOLD STANDARD REDEFINED

Precision SRS/SRT via Online Adaptive Dose Control

US Arrival: Spring 2016  Courtesy of Elekta AB

Physical Characteristics

- Integrated kV-CBCT
- Active motion management
- Detector
- Accurate Stere-Definition
- X-ray tube
- Sub-millimeter Patient-Positioning System

Major Workflow Features

- IMMOBILIZATION – frame or frameless
- TREATMENT PARADIGM – single session or fractionation
- TARGET TYPE – volume, number and location
- CLINICAL MODE – radiosurgery or ultra-precise microradiosurgery
Maintain Focusing and Normal Brain Sparing Advantage

Low-Dose Spillage Effect

Multiple Targets: Multiplied Effect

Variable dose interplay effects across radiosurgical apparatus in treating multiple brain metastases
Rotational Misalignment Issue

VMAT

GKSRS

small rotations

Summary

- Image-guided FFF-based modulated beam delivery (e.g., VMAT) has dominated linac-based SRS/SRT
- Image-guided GK Icon is redefining the gold standard for ultra-precise intracranial SRS/SRT