SRS Plan Quality and Treatment Efficiency: VMAT vs Dynamic Conformal ARCs

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OUTLINE

- History of SRS treatments
- Types of SRS treatments
- Loyola SRS Planning Experience
- VMAT vs DCA
Conflicts of Interest

- I have no conflicts of interest to disclose
Stereotactic Radiosurgery (SRS)

- **Stereotactic:** Use a precise external 3-D reference coordinate system to locate points inside patient.

- **Radiosurgery:** Delivers high dose of radiation in 1/3/5 fractions to benign and malignant intracranial tumors
  - Surgery using radiation
  - Minimally invasive
    - No cutting, very little anesthetic
  - Precise positioning
Historically

- Research focused on clinically relevant dose (1-3Gy), very well known radiobiology

Why now?

- Advancement in Physics
- Lower Cost
- Patient Convenience
- Evidence
- Paper by Linskey et al 2010

  - While both single-dose SRS and WBRT are effective for treating patients with brain mets, single-dose SRS alone appears to be superior to WBRT alone for patients with up to 3 met brain tumors in terms of patient survival advantage
Multiple SRS Radiation Modalities

- X-ray
  - Linac Based SRS
  - Robot-based SRS (Cyberknife)

- γ-ray: Gamma Knife: multiple isocenters, small lesions (<18mm)

Courtesy of Varian, Elekta, and ViewRay
Stereotactic Radiosurgery (SRS)

- Lesions: < 35 cm³ or < 4cm across. (<3cm @LUMC)
- Requires high dosimetric accuracy- small fields
- Positional accuracy: ±1mm
  - Establishing stereotactic coordinate system
  - Delivery to the target
  - Motion of target between localization and treatment
SRS Treatments

- Metastasis
- Retreatments for GBM
- Benign tumors (pituitary, meningioma)
- Vascular lesions (AVM)
- Functional (trigeminal neuralgia)
SRS Treatments

Metastasis
- Most common intracranial tumor in adults
- More than primary (ie lung, breast cancer)
- Optimal doses
  - Depend on location (proximity to prior treated area/critical regions)
  - ~14-24Gy to margin
SRS Treatments

- **Trigeminal Neuralgia**
  - Disorder in CN5
  - Characterized by *sharp, intense, stabbing, electric-shocklike pain* of the lips, eyes, nose, scalp, forehead, upper jaw, and lower jaw.
  - After treatment, a lesion gradually forms in the nerve and blocks the transmission of pain signals along the nerve.
  - Doses
    - 70-90Gy to the margin
SRS Treatments

- **Acoustic Neuroma**
  - Pressure from tumor can cause hearing loss, ringing in the ears, and unsteadiness
  - Close to brainstem
  - Dose
    - 12-13(15Gy)
    - 13Gy @65% isodose volume
SRS Treatments

- AVMs (Arteriovenous Malformation)
  - A complex tangle of arteries and veins that lack the normal intervening capillary bed
  - Usually congenital
  - Can cause hemorrhage, seizures
  - Goal: obliteration while saving brain function
  - Doses
    - 16-25 Gy to the margin

Images demonstrate pre- and post-treatment of Arteriovenous Malformation (AVM).
SRS CLINICAL WORKFLOW
IMMOBILIZATION

- Use an external 3D coordinate system to localize targets inside the brain
- Rigid head frame attached to patient’s skull
- This head frame will define an external reference 3D coordinate system
  - Three axes are anterior, lateral & axial
  - They all intersect at the center of the circular frame
- Frameless: need imaging to detect brain position
Stereotactic frames

Radionics CT

Radionics CT/MR

Brainlab CT/Angio

Accuracy: 0.36±0.2mm

Elekta stereotactic frame
Stereotactic frameless

- Non invasive option
  - Immobilization
    - Masks, bite blocks, vacuum bags…
    - 1~2.5mm localization uncertainties
  - Image guidance
    - Optical
      - IR / Video cameras based, marker or surface tracking
    - Radiographic
      - 2D/3D matching with kV, MV or/and CBCT

Frameless SRS immobilization

2D to 3D kV images
IMAGING

- **CT scans (Treatment planning)**
  - Small slice thickness (1mm slice)
  - Contrast agent
  - Low localization errors (1-1.5mm)

- **MRI (Delineation)**
  - T1 & T2 weighted pre/post contrast
  - Axial/coronal/sagittal
  - Geometric distortions
  - Primary imaging for Gammaknife planning

- **CT Angiography:** AVM, contrast is injected through cerebral vasculature. Orthogonal x-ray images capture cerebral architecture w.r.t a stereotactic coordinate system
IMAGE FUSION
Target Localization: IE
Identifying the coordinate system

- Planning image set: CT, MR
- Precise target coordinate identification with the treatment planning system
- Frame
  - Digitize fiducial rods (Iplan/Novalis, Gamma Knife, Xknife, etc)
- Frameless
  - Tomographic localization (at LUMC)
  - Frameless: CT origin coordinates
  - Isocenter coordinates set at simulation
SRS Planning

- Circular Arcs
- Conformal static beams
- Hybrid Arcs
- IMRT/VMAT
- Dynamic Conformal Arcs
Patient positioning and monitoring

Patient Fixation
- Non-invasive Face Mask
- Fixed Head Frame

Patient Positioning and Monitoring for SRS
- Fixed to System
- Room-based
- Room-based
Intrafraction motion management

- **Orthogonal kV imaging (2D-3D imaging)**
  - ExacTrac (BrainLAB)
  - Cyberknife
  - Proton treatment

- **Optical 3D surface imaging (AlignRT/OSMS)-LUMC**
  - Dual camera system in each pod
  - Point clouds and connected surface triangles to reconstruct surface image
  - Reconstructed 3D surface merged from 3 units
  - Continuously tracks motion, automatically holding beam
Overall Time Factor

- Planning and Treatments are usually scheduled same day as imaging
  - Always for framed patients
  - Next or 2 days after imaging for frameless
- QA must be administered prior to patient treatments
- Time intensive process
- Requires coordinated efforts from neurology, radiation oncologists, physics, dosimetry, therapists
- Must have robust planning and QA methods for this service to flow efficiently
SRS PLANNING AT LUMC
Types of Plans

- BrainLab (Conformal beams)
- Edge and Truebeam with HDMLCs
  - Circular Arcs with cones
  - VMAT
  - Dynamic ConformalArcs

Ipsilateral non coplanar arcs
HDMLC

- 2.5mm width of central leaves
  - Middle 8cm is formed by 32 leaf pairs of 2.5mm leaf width
  - Outer 14cm is formed by 28 leaf pairs of 5mm leaf width
- Improves dose conformality for smaller targets
  - Large targets, less significant differences
- Increase radius of curvature which reduces penumbra
  - Improving conformity index

Figure 8. Schematic of ray lines that determine the form of the edge of the radiation field and light field at the curved end of an MLC leaf. SAD is the distance from the source to isocenter and SCD is the distance from the source to the center of the leaf. R is the radius of curvature of the leaf end.
Prescription Dose

- Factors influencing dose prescription
  - Lesion type
  - Lesion volume
  - Lesion location
- Single fraction (SRS) / multiple fractions (SRT): 1, 3, 5 fx
- Treatment dose
  - Prescribed at the periphery of the target
  - Isodose level (% of max dose): 80% Dmax for single iso. 70% for multi-isos. Gamma knife, 50% of Dmax
- Single fraction:
  - 18-22Gy to 80% of isodoseline. Acoustic neuroma is 12-15Gy to 80%. AVM up to 40Gy
- SRT: 27Gy in 3 fx.
- Trigeminal neuralgia: 80Gy @90% or 90Gy@iso. LUMC: 70Gy@iso

<table>
<thead>
<tr>
<th>GTV diameter</th>
<th>Max tolerable dose</th>
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<tbody>
<tr>
<td>&lt; 2cm</td>
<td>24 Gy</td>
</tr>
<tr>
<td>2 – 3 cm</td>
<td>18 Gy</td>
</tr>
<tr>
<td>3 – 4 cm</td>
<td>15 Gy</td>
</tr>
</tbody>
</table>

RTOG 90-05
Important LUMC planning methods

- Beam arrangement
  - 4-6 Non-coplanar arcs of circular, conformal or dynamically shaped beams
  - Non-overlapping, non-opposing fields
  - Try to avoid going into contralateral brain
  - Every 30~40° gantry/couch angles

Choose your beams wisely
VMAT

- Intensity Modulated Dynamic Arc
- Dynamic MLC and gantry speed, and dose rate
- Patient specific QA required
Dynamic Conformal Arcs (DCA)

- (hd)MLC shaped around PTV and as gantry rotates the aperture changes according to the BEV of PTV. Every 1~10 degrees static open projection of PTV changes
- Static gantry speed or dose rate
SRS Plan Evaluation

- 3D dose distribution and Dose Volume Histogram (DVH)
- Target Coverage
  - >99%-100%
  - Dosimetric Indices (CI100, HI)
- Intermediate dose coverage (CI50)
- Dose fall off (Gradient Index)
- Dosimetric parameters
  - $D_{\text{max}}$, $D_{\text{min}}$ target dose
- Tissue sparing
  - OAR
  - Normal tissue
  - QUANTEC tables
  - V8, V10, V12 for brain

PTV coverage

OAR avoidance
SRS Plan Evaluation

- **Conformity Index (CI)**
  
  \[
  CI = \frac{\text{Volume of prescription dose}}{\text{Volume of PTV}}
  \]

  - Ideally 1, Prefer between 1-2
  - Typically 1.4 for most targets, smaller targets larger conformity index

- **CI50**
  
  \[
  CI50 = \frac{\text{Volume of 50\% prescription isodose volume}}{\text{Volume of PTV}}
  \]

  - The smaller the better, 3-7.5

- **HI**
  
  \[
  HI = \frac{\text{maximum dose}}{\text{minimum dose}}
  \]

  - ≤ 2
  - SRS pt: 1.30-1.10

- **Gradient Index (cm)**
  
  \[
  \Delta \text{equiv sph. Radius of prescription and half prescription isodoses}
  \]

  - The lower the better, (0.3-0.9)
## SRS Plan Evaluation

- OAR sparing dose limits

### TG 101 recommends dose constraints for various critical organs

<table>
<thead>
<tr>
<th>Serial tissue</th>
<th>Max critical volume above threshold</th>
<th>One fraction</th>
<th></th>
<th>Three fractions</th>
<th></th>
<th>Five fractions</th>
<th></th>
<th>End point</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Threshold dose (Gy)</td>
<td>Max point dose (Gy)</td>
<td>Threshold dose (Gy)</td>
<td>Max point dose (Gy)</td>
<td>Threshold dose (Gy)</td>
<td>Max point dose (Gy)</td>
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<tr>
<td>Optic pathway</td>
<td>&lt;0.2 cc</td>
<td>8</td>
<td>10</td>
<td>15.3 (5.1 Gy/fx)</td>
<td>17.4 (5.8 Gy/fx)</td>
<td>23 (4.6 Gy/fx)</td>
<td>25 (5 Gy/fx)</td>
<td>Neuritis Hearing loss</td>
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<tr>
<td>Cochlea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cranial neuropathy</td>
</tr>
<tr>
<td>Brainstem (not medulla)</td>
<td>&lt;0.5 cc</td>
<td>10</td>
<td>15</td>
<td>18 (6 Gy/fx)</td>
<td>23.1 (7.7 Gy/fx)</td>
<td>23 (4.6 Gy/fx)</td>
<td>31 (6.2 Gy/fx)</td>
<td>Myelitis</td>
</tr>
<tr>
<td>Spinal cord and medulla</td>
<td>&lt;0.35 cc</td>
<td>10</td>
<td>14</td>
<td>18 (6 Gy/fx)</td>
<td>21.9 (7.3 Gy/fx)</td>
<td>23 (4.6 Gy/fx)</td>
<td>30 (6 Gy/fx)</td>
<td>Myelitis</td>
</tr>
<tr>
<td>Spinal cord</td>
<td>&lt;1.2 cc</td>
<td>7</td>
<td></td>
<td>12.3 (4.1 Gy/fx)</td>
<td></td>
<td></td>
<td></td>
<td>Myelitis</td>
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</tbody>
</table>
SRS Plan Quality and Treatment Efficiency: VMAT vs Dynamic Conformal ARCs
Overview

Purpose

- To compare dosimetry and treatment efficiency of VMAT and Dynamic Conformal Arc based planning techniques
METHODS

- 12 Patients
- 22 targets
  - 1-4 lesions per patient
- Fractions
  - 1 fraction: 19
  - 3 fractions: 3
- 6FFF, previous VMAT
- Framed and Frameless
- Retrospectively re-planned with DCA
  - (1) Original Arcs (DCA1)
  - (2) Optimized Arc Angles (DCA2)
DCA

- **DCA1**
  - Used same arcs as original VMAT plans
  - Same beam weights

- **DCA2**
  - Adjusted Arc Angles to reduce overlap
  - Different beam weights
Plan Overview

- Retrospective plans followed 2 criteria
  - Followed same prescription dose
  - Must be within 0.5% of VMAT coverage

<table>
<thead>
<tr>
<th></th>
<th>VMAT</th>
<th>DCA1</th>
<th>DCA2</th>
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<tbody>
<tr>
<td>Median</td>
<td>99.1</td>
<td>99.1</td>
<td>99.1</td>
</tr>
<tr>
<td>Min</td>
<td>95</td>
<td>95</td>
<td>95</td>
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<tr>
<td>Max</td>
<td>99.97</td>
<td>99.6</td>
<td>99.8</td>
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</table>
**Targets**

- Near spherical shapes: 20

<table>
<thead>
<tr>
<th>Median V (cc)</th>
<th>Min V (cc)</th>
<th>Max V (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85</td>
<td>0.17</td>
<td>17.8</td>
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</table>

<table>
<thead>
<tr>
<th>Median Rs (cm)</th>
<th>Min Rs (cm)</th>
<th>Max Rs (cm)</th>
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</thead>
<tbody>
<tr>
<td>0.59</td>
<td>0.34</td>
<td>1.62</td>
</tr>
</tbody>
</table>
Plan Overview

- Use mostly ipsilateral angles to keep dose from normal tissues
- Non coplanar
- All plans were checked with secondary calculations to determine validity
  - VMAT: QA
  - DCA: QA
VMAT SRS Plan

4-6 Ipsilaterateral arcs
VMAT SRS

30-40 degrees between arcs

Planned with Rings as high priority
VMAT SRS

- Requires Optimization

<table>
<thead>
<tr>
<th>Type</th>
<th>Color</th>
<th>Structure</th>
<th>Limit</th>
<th>Vol [%]</th>
<th>(cGy)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
<td>Yellow</td>
<td>RingLParietal</td>
<td>upper</td>
<td>0.1</td>
<td>1100.0</td>
<td>110</td>
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<tr>
<td>Point</td>
<td>Red</td>
<td>PTV5mmParietal</td>
<td>upper</td>
<td>0.1</td>
<td>10.0</td>
<td>110</td>
</tr>
<tr>
<td>Point</td>
<td>Green</td>
<td>PTV4mmParietal</td>
<td>upper</td>
<td>0.1</td>
<td>10.0</td>
<td>110</td>
</tr>
<tr>
<td>Point</td>
<td>Green</td>
<td>PTV4mm2mmParietal</td>
<td>upper</td>
<td>0.1</td>
<td>10.0</td>
<td>110</td>
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<tr>
<td>Point</td>
<td>Green</td>
<td>PTV4mmTemporal</td>
<td>upper</td>
<td>0.1</td>
<td>2700.0</td>
<td>110</td>
</tr>
<tr>
<td>Point</td>
<td>Green</td>
<td>PTV3mmParietal</td>
<td>lower</td>
<td>99.9</td>
<td>2200.0</td>
<td>100</td>
</tr>
<tr>
<td>Point</td>
<td>Green</td>
<td>3mmLParietal</td>
<td>upper</td>
<td>0.1</td>
<td>2700.0</td>
<td>110</td>
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<tr>
<td>Point</td>
<td>Green</td>
<td>3mmLParietal</td>
<td>lower</td>
<td>99.9</td>
<td>2600.0</td>
<td>100</td>
</tr>
</tbody>
</table>
VMAT SRS

- Dynamic HDMLC
- Centered at target
- 1 iso per target
- Static jaw/not dynamic
VMAT SRS

Requires fluence and dose QA
Ipsilateral arcs, less overlap with Gantry angles
DCA SRS

- HDMLC
- Conform to PTV
- 0-2 mm margin
- Leaf Edge
  - Middle
  - Inside
  - Outside
DCA SRS (1mm margin)

Inside
- High gradient
- MLC edge overlaps PTV/margin
- Improves CI100, tighter coverage

Middle
- Most used
- Less hot in center
- Allows for some error in setup

Outside
- Less Gradient
- More forgiving during setup
Plan Quality Review

Plan quality were compared

- Total MU
- Target conformity index (CI)
- Intermediate dose coverage (CI50)
- Normal tissue irradiated (V12Gy, V18Gy)
- HLI (Hotspot Location Index)
Hotspot Location Index (HLI)

- Equation created by LUMC to assess the inner target dose distribution
- HLI = 0 is ideal
- The larger the HLI, the more undesirable, the further away the hotspot is from the center of the target

\[
HLI = \frac{\Delta (\text{hotspot location} - \text{target center})}{\text{target equivalent sphere radius}}
\]
KEY RESULTS: CI100

- **RTOG / ICRU definition**
- \[ CI = \frac{TV}{PTV}, \text{for example} = \frac{V(22Gy)}{PTV} \]
- **RTOG:**
  - Normal 1.0-2.0,
  - minor deviation if >2.0 or <1.0,
  - major deviation if >2.5 or <0.9

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<th>DCA1</th>
<th>DCA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.15</td>
<td>1.32</td>
<td>1.24</td>
</tr>
<tr>
<td>Min</td>
<td>0.98</td>
<td>1.14</td>
<td>1.07</td>
</tr>
<tr>
<td>Max</td>
<td>1.54</td>
<td>1.52</td>
<td>1.52</td>
</tr>
<tr>
<td>Mean</td>
<td>1.18</td>
<td>1.32</td>
<td>1.26</td>
</tr>
<tr>
<td>Sigma</td>
<td>0.14</td>
<td>0.12</td>
<td>0.12</td>
</tr>
</tbody>
</table>

VMAT slightly better target conformity
KEY RESULTS: CI50

- **CI50** = \( \frac{\text{Volume of 50\% prescription isodose volume}}{\text{volume of PTV}} \)
- Normal tissue spillage, the smaller the better
- Better for DCA
  - Lower mean/median

<table>
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<th>DCA1</th>
<th>DCA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>5.05</td>
<td>4.50</td>
<td>4.31</td>
</tr>
<tr>
<td>Mean</td>
<td>5.63</td>
<td>4.54</td>
<td>4.30</td>
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<tr>
<td>sigma</td>
<td>1.88</td>
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<td>0.71</td>
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<tr>
<td>Min</td>
<td>3.09</td>
<td>3.43</td>
<td>3.19</td>
</tr>
<tr>
<td>Max</td>
<td>9.65</td>
<td>8.00</td>
<td>5.53</td>
</tr>
</tbody>
</table>

Smaller variance, more consistently lower
KEY RESULTS: CI50

DCA is frequently lower than VMAT
KEY RESULTS: CI50

Even at smaller volumes, CI50 preferable with DCA

Larger volume shows favor to VMAT
KEY RESULTS: V12Gy

- Normal tissue
- Brain – GTV
- For Targets going to 22-24Gy

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<th>DCA1</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>8.97</td>
<td>6.66</td>
<td>6.68</td>
</tr>
<tr>
<td>Mean</td>
<td>10.3</td>
<td>8.55</td>
<td>8.16</td>
</tr>
<tr>
<td>Min</td>
<td>1.87</td>
<td>1.99</td>
<td>1.7</td>
</tr>
</tbody>
</table>

DCA irradiates less normal brain tissue by about 2cc
KEY RESULTS: V12Gy
KEY RESULTS: V12Gy and V18Gy
Gradient Index

- The smaller the target the lower the gradient index

Gradient Index (cm) = $\Delta$ equiv sph. Radius of prescription and half prescription isodoses
- The lower the better, (0.3-0.9)
Normalized Hotspot location

\[ HLI = \frac{\Delta (\text{hotspot location} - \text{target center})}{\text{target equivalent sphere radius}} \]

- HLI = 0 is ideal
- The larger the HLI, the further away the hotspot is from the center of target

Results:
- Wide range of HLI for all plans
- Small HLI for smaller targets
- Some correlation between HLI and distance to bone
Total # MU

![Graph showing frequency distribution of Total plan MU for VMAT, DCA1, and DCA2.]

<table>
<thead>
<tr>
<th></th>
<th>VMAT</th>
<th>DCA1</th>
<th>DCA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4438.1</td>
<td>3458</td>
<td>3537.1</td>
</tr>
<tr>
<td>Median</td>
<td>4512</td>
<td>3703</td>
<td>3806.5</td>
</tr>
<tr>
<td>Min</td>
<td>2319</td>
<td>1317</td>
<td>1386</td>
</tr>
<tr>
<td>Max</td>
<td>5955</td>
<td>4610</td>
<td>4685</td>
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</table>
Total MUs

- Mus typically lower than VMAT plans
  - Mean -24% less than VMAT
  - Max – 56% less than VMAT
- DCA has invariable dose rate, no modulation
- Larger target- less gain for DCA

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<tr>
<td>Max</td>
<td>5955</td>
<td>4610</td>
<td>4685</td>
</tr>
</tbody>
</table>
Total MUs

- For all target sizes, DCA uses less Mus
Total Beam on Time

- Less total Mus leads to less beam on time
  - Less leakage
  - Less potential intra-fraction motion
  - Increases patient comfort

<table>
<thead>
<tr>
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<th>VMAT (minutes)</th>
<th>DCA1 (minutes)</th>
<th>DCA2 (minutes)</th>
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<tbody>
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<td>Median</td>
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<td>2.72</td>
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<td>Mean</td>
<td>3.85</td>
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<td>2.53</td>
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<tr>
<td>Min</td>
<td>1.83</td>
<td>0.94</td>
<td>0.99</td>
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<tr>
<td>Max</td>
<td>7.25</td>
<td>3.29</td>
<td>3.35</td>
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## Results Summary

### VMAT-DCA

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<thead>
<tr>
<th>Plan Quality Parameter</th>
<th>Δ DCA1</th>
<th>Δ DCA2</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Max</td>
</tr>
<tr>
<td>DCA</td>
<td></td>
<td></td>
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<tr>
<td>MU</td>
<td>-24%</td>
<td>-56%</td>
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<tr>
<td>Beam-on Time</td>
<td>-31%</td>
<td>-57%</td>
</tr>
<tr>
<td>VMAT ~ DCA</td>
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<tr>
<td>CI100</td>
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<tr>
<td>DCA</td>
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<tr>
<td>CI50</td>
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<td>VMAT ~ DCA</td>
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<tr>
<td>V(12 Gy)</td>
<td>-2 cc</td>
<td>-6.4 cc</td>
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<td>HLI</td>
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<td>-0.57</td>
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Conclusion

- SRS via VMAT superior in dose conformity
- DCA plans yielded dosimetrically
  - Comparable conformity
  - Reduced dose spillage for most targets
  - Lower V12 for most targets (small peripheral targets)
Conclusion- Workflow

DCA
- Shorter treatment time
- Faster planning times
- Eliminating need for VMAT QA
- Reducing likelihood of intrafraction motion

VMAT
- Longer treatment time due to beam modulation
- Planning time increase due to optimization
- VMAT QA required
- More potential of intrafraction motion
SRS Workflow

- Immobilization and setup
- Appropriate imaging
  - CT (with/out) contrast
  - MRT for co-registration
- Target and normal Structure contouring
- Planning
  - Dose selection
  - constraints
- QA and delivery

DCA may help increase this part of SRS workflow
Take home

- VMAT and DCA yield similar planning for SRS (<20cc)
- DCA can increase workflow efficiency especially in planning (time and dosimetric), QA, and delivery
Future studies

- Include more patients plans
- Include more plans with larger targets
- Create a nomogram per size, location
- Include 1 iso, multiple targets
Special Thanks

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- Edward Melian, MD – Radiation Oncologist
THANK YOU.

QUESTIONS??

We also treat the human spirit.®