Treatment Planning Strategies for MLC-based Radiosurgery of Multiple Intracranial Metastases

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LEARNING OBJECTIVES

• Understand the general concept of radiosurgery for multiple intracranial metastases
• Learn about the treatment planning strategy and dose tolerance of critical structure and understand challenges of multiple metastases
• Interactive clinical case planning and evaluation of plan quality metrics
UC SAN DIEGO RADIOSURGERY PROGRAM

Cranial SRS/SRT Procedures

- Metastases
- Resection Cavity
- Benign Tumors
- AVM
- Trigeminal Neuralgia
- Malignant Tumors

DISEASES TREATED WITH SRS

- **Functional disorders**: trigeminal neuralgia, Parkinson’s disease, epilepsy, intractable pain, psychoneurosis
- **Vascular lesions**: arteriovenous malformation (AVM), acoustic neuroma, cavernous angioma, arterial aneurism
- **Primary benign tumors**: pituitary adenoma, meningioma, chordoma, craniopharyngioma, meningioblastoma
- **Primary malignant tumors**: glioblastoma multiforme (GBM), pineal tumor, medulloblastoma, lymphoma
- **Metastatic tumors**
METASTASES

- Ideally minimum doses ≥ 18 Gy
- Reported local control rates
  - Breast: 90-94%, Lung: 81-98%
  - Melanoma: 73 – 90%, Renal cell cancer: 83-96%
- Larger met (>8-10 cc): should be removed surgically
- Smaller met: SRS equally effective as surgical tumor resection
- SRS vs. WBRT

Lippitz et al., Cancer Treatment Reviews, 40, 48–59, (2014)

SRS DOSE (RTOG 90-05)

- Background: Phase I dose escalation study
- Patient Group: Recurrent previously irradiated primary brain tumors and brain mets.
- Endpoint: Maximum tolerated dose

<table>
<thead>
<tr>
<th>Lesion Size</th>
<th>Max. Tolerated Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 20 mm</td>
<td>24 Gy</td>
</tr>
<tr>
<td>21-30 mm</td>
<td>18 Gy</td>
</tr>
<tr>
<td>31-40 mm</td>
<td>15 Gy</td>
</tr>
</tbody>
</table>

Table 1: Incidence of Grade 3, 4, and 5 CNS toxicity by tumor size and treatment arm

<table>
<thead>
<tr>
<th>Lesion Size</th>
<th>Max. Tolerated Dose</th>
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</tr>
<tr>
<td>31-40 mm</td>
<td>15 Gy</td>
</tr>
</tbody>
</table>

POST-OP RADIOSURGERY

C Brennan et al., IJROBP, 88 (1) 130–136, (2014)

A Phase 2 Trial of Stereotactic Radiosurgery Boost After Surgical Resection for Brain Metastases

Cameron Brennan, MD, T. Jonathan Yang, MD, Patrick Hilden, MS, Zhigang Zhang, PhD, Kevin Chan, RT(T), Yoshiya Yamaoda, MD, Timothy A. Chan, MD, PhD, Stella C. Lumberis, MD, Ashwatha Narayana, MD, Viviane Tabar, MD, Philip H. Gutin, MD, Åsa Ballangerud, PhD, Eric Lis, MD, and Kathryn Beal, MD

• 49 patients
• SRS boost: Significant lower local failure
• Tumors ≥3 cm with superficial: higher risk of local failure

G Minnilli et al., IJROBP, 86 (4) 623–629, (2013)

Multidose Stereotactic Radiosurgery (9 Gy × 3) of the Postoperative Resection Cavity for Treatment of Large Brain Metastases

Giuseppe Minnilli, MD, PhD, Vincenzo Esposito, MD, Enrico Clarke, MD, Claudia Scaringi, MD, Gaetano Lanzetta, MD, Maurizio Salvati, MD, Antonino Raco, MD, Alessandro Boccia, MD, and Riccardo Maurizi Enrico

• 101 patients
• >3 cm cavities
• the most effective tx. option for large radioresistant brain met
• V24Gy: radionecrosis

MLC BASED LINAC SRS

• Better conformity for irregular target
• Improved dose homogeneity inside the target
• Comparable dose fall-off outside the target
• Less time-consuming treatment planning
• Shorter treatment time
• Linac is not limited for cranial treatment
ESTABLISHMENT OF RADIOSURGERY PROGRAM

- SRS team (Physician, Physicist, Dosimetrist, Therapist, Nurse)
- Selection of equipment (Linac, Immobilizer, real-time monitoring, QA tools & applications etc.)
- Development of Workflow, Policy & Procedures
- QA program for radiosurgery
- Risk assessment and proper safety barrier

TREATMENT PLANNING

- Imaging
- Registration
- Contouring
- Prescription
- Setting up the fields
- Optimization
- Plan Evaluation
CT SIMULATION

- Slice Size (< 1.5 mm)
  - Spatial resolution of Z axis
  - Thick slices: more partial volume averaging.
- FOV (Pixel = FOV/matrix)
  - Smaller is better
- Body
- Immobilizer / Registration
- Target localization

PLANNING CT
IMAGING

- Metastatic
  - MRI with Gadolinium
    - T1 post contrast (thin slice)
    - Small non-enhancing lesions may be seen on T2
    - T2 Flair showed peritumoral edema
  - CT Head with contrast
    - If MRI unavailable
    - Combine target delineation

- AVM
  - CTA, DSA, MRA
- Trigeminal Neuralgia
  - T1 post, FIESTA

MR DISTORTION

**TG-54**
“MRI contains distortions which impede direct correlation with CT data at the level required for SRS”

**TG-117**
Use of MRI data in Treatment Planning and Stereotactic Procedures – Spatial Accuracy and Quality Control Procedures

Gradient nonlinearity distortion, Siebert et al, PRO 2016
Registration

- Benchmark Test for Cranial CT/MR Registration
  - 45 Institutions and 11 software systems
  - Average error: 1.8 mm
  - MR 2.0 mm Thickness, CT 2.5 mm Thickness
  - Manual registration: significant better result

REGISTRATION

- FMEA study of surface image guided radiosurgery (SIG-RS)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Step</th>
<th>Potential failure modes</th>
<th>Potential cause of failure</th>
<th>Potential effects of failure</th>
<th>O</th>
<th>S</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31. Contour critical structures</td>
<td>Inaccurate contours</td>
<td>Poor image quality</td>
<td>Excessive dose to critical structure</td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>288</td>
</tr>
<tr>
<td>1</td>
<td>79. Apply CBCT couch shifts</td>
<td>Inaccurate CBCT-CT registration</td>
<td>Insufficient training</td>
<td>Geometric miss</td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>288</td>
</tr>
<tr>
<td>3</td>
<td>29. Previous to CT registered to planning CT</td>
<td>Inaccurate CT-CT registration</td>
<td>Failed to save registration</td>
<td>Retract previous target</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>280</td>
</tr>
<tr>
<td>4</td>
<td>29. Review OAR statistics</td>
<td>Critical structure does not checked</td>
<td>Inattention</td>
<td>Excessive dose to critical structure</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>240</td>
</tr>
<tr>
<td>4</td>
<td>29. Previous to CT registered to planning CT</td>
<td>Not done</td>
<td>Inattention</td>
<td>Retract previous target</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>240</td>
</tr>
<tr>
<td>4</td>
<td>33. Insert Rx and contour target volumes</td>
<td>Contours accidentally changed by planner</td>
<td>Contours locked</td>
<td>Underdosing of target volume</td>
<td>6</td>
<td>8</td>
<td>5</td>
<td>240</td>
</tr>
<tr>
<td>7</td>
<td>23. Images labeled with acquisition date and technique</td>
<td>Incorrect date label</td>
<td>Transcription error</td>
<td>May cause confusion and/or affect MD decision making</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>210</td>
</tr>
</tbody>
</table>

Manger et al., Medical Physics, 42 (5), 2449-2461 (2015)
Tested 6 SRS TPS platforms
Phantom study shows -3.6-22% vol. variation
Most of platforms & algorithm overestimated
Large variation: small target < 0.4 cc, near the end slice
NOMENCLATURE

- Follow UCSD nomenclature guideline
  - CT label etc.
- PTV/GTV: PTV “Course number”. “Target number”
- Previous tx CT fused and copied over previous tx PTVs
- Follow-up MR (Plan label: MR date) fused with last tx CT and mark all previous tx PTVs for physician review
- Use structure template

PLANNING TARGET VOLUME

- Randomized Trial to 1-mm versus 3-mm expansion with IG-SRS
- The local recurrence rate was low for both arms (<10% 12 months after SRS)
- Biopsy-proven radionecrosis was more frequently observed in the 3-mm arm
- Suggest a 1-mm margin is appropriate for IG-SRS
### PRESCRIPTION

- Treatment regimens
- Target volume (RTOG 90-05)
- Target location
- Pre-existing edema
- Pre-existing neurologic deficit
- Pathology
- Previous treatment

### Multi-met Planning Strategy

**Multi-iso approach**

- Relatively easier to achieve good plan quality
- Less influenced by setup uncertainty
- Hard to control sum dose
Multi-met Planning Strategy

**Single-iso approach**

- Need better understanding of planning tools
- Requires accurate patient positioning / monitoring method

VMAT OPTIMIZATION FOR MULTIPLE METASTASES

- **< Island blocking problem>**
  - Inner control max dose = 98% of Rx
  - Middle control max dose = 50% of Rx
  - Outer control max dose = 30% of Rx

- **< Shadow>**


PLAN OPTIMIZATION

- Constraints (GTV, CTV, PTV, OARs)
- NTO or Tuning Structures
- MU constraint
- Optimization resolution
- Calc. grid size

CONSTRAINTS

- TG-101

<table>
<thead>
<tr>
<th>Serial Tissue</th>
<th>Max vol. (cc)</th>
<th>One fraction</th>
<th>Three fraction</th>
<th>Five fraction</th>
<th>End point</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>Optic pathway</td>
<td>&lt;0.2</td>
<td>8</td>
<td>10</td>
<td>15.3</td>
<td>17.4</td>
</tr>
<tr>
<td>Cochlea</td>
<td>9</td>
<td>17.1</td>
<td>25</td>
<td>Hearing loss</td>
<td></td>
</tr>
<tr>
<td>Brainstem (not medulla)</td>
<td>&lt;0.5</td>
<td>10</td>
<td>15</td>
<td>18</td>
<td>23.1</td>
</tr>
<tr>
<td>Spinal cord and medulla</td>
<td>&lt;0.35</td>
<td>10</td>
<td>14</td>
<td>18</td>
<td>12.3</td>
</tr>
</tbody>
</table>

- Lens Max. dose <10 Gy (1 fx)
- Normal Brain V10 < 12 cc or V12 < 10 cc
- Cranial Nerves (fifth, seventh and eighth CN) 12.5-15 Gy (Flicker et al., IJROBP 2004)
Table 6: Published dose constraints for SRS, with NTCP estimates

<table>
<thead>
<tr>
<th>Tissues</th>
<th>Dose (Gy)</th>
<th>Volume</th>
<th>Fraction</th>
<th>Endpoint</th>
<th>NTCP</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>14</td>
<td>5.10 cc</td>
<td>1</td>
<td>Necrosis</td>
<td>1-20%</td>
<td>This study</td>
</tr>
<tr>
<td>Brainstem</td>
<td>12.5</td>
<td>max</td>
<td>1</td>
<td>Neurapthy</td>
<td>&lt;5%</td>
<td>QUANTEC</td>
</tr>
<tr>
<td>Optic nerves</td>
<td>12.0</td>
<td>max</td>
<td>1</td>
<td>Neuritis</td>
<td>0.7%</td>
<td>QUANTEC</td>
</tr>
<tr>
<td>Optic nerves</td>
<td>8.0</td>
<td>0.2 cc</td>
<td>1</td>
<td>Neuritis</td>
<td>1.1%</td>
<td>TG 101</td>
</tr>
<tr>
<td>Cochlea</td>
<td>12.0</td>
<td>max</td>
<td>1</td>
<td>Hearing loss</td>
<td>11.8%</td>
<td>Timm. 2008</td>
</tr>
<tr>
<td>Spinal cord</td>
<td>14.0</td>
<td>max</td>
<td>1</td>
<td>Myelitis</td>
<td>1.6%</td>
<td>RTDG 0915</td>
</tr>
</tbody>
</table>

*Notes: (1) Dose constraints from the listed references [3, 41, 63, 65]. (2) Volume effect limits and more details are available [3-7]. (3) NTCP results from Seminars in Radiation Oncology, April 2016 [4-7] or QUANTEC [3]. (4) NTCP depends on the exact circumstances of each dataset [4-7].

Table 7: Published dose constraints for SBRT, with NTCP estimates

<table>
<thead>
<tr>
<th>Tissues</th>
<th>Dose (Gy)</th>
<th>Volume</th>
<th>Fraction</th>
<th>Endpoint</th>
<th>NTCP</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>28.8</td>
<td>5-10 cc</td>
<td>5</td>
<td>Necrosis</td>
<td>1-20%</td>
<td>This study</td>
</tr>
<tr>
<td>Brainstem</td>
<td>31.0</td>
<td>max</td>
<td>5</td>
<td>Neurapthy</td>
<td>Unknown</td>
<td>TG 101</td>
</tr>
<tr>
<td>Brainstem</td>
<td>23.0</td>
<td>0.5 cc</td>
<td>5</td>
<td>Neurapthy</td>
<td>Unknown</td>
<td>TG 101</td>
</tr>
<tr>
<td>Optic nerves</td>
<td>20.0</td>
<td>max</td>
<td>5</td>
<td>Neuritis</td>
<td>0.8%</td>
<td>TG 101</td>
</tr>
<tr>
<td>Optic nerves</td>
<td>20.0</td>
<td>0.2 cc</td>
<td>5</td>
<td>Neuritis</td>
<td>1.7%</td>
<td>Timm. 2008</td>
</tr>
<tr>
<td>Cochlea</td>
<td>25.0</td>
<td>max</td>
<td>5</td>
<td>Hearing loss</td>
<td>13.8%</td>
<td>TG 101</td>
</tr>
<tr>
<td>Spinal cord</td>
<td>30.0</td>
<td>max</td>
<td>5</td>
<td>Myelitis</td>
<td>2.6%</td>
<td>RTDG 0813</td>
</tr>
</tbody>
</table>

*Notes: (1) Dose constraints from the listed references [61, 62, 64]. (2) Volume effect limits and more details are available [3-7]. (3) NTCP results from Seminars in Radiation Oncology, April 2016 [4-7]. (4) NTCP depends on the exact circumstances of each dataset [4-7].

Jinyu Xue et al., Clinical evidence for dose tolerance of the central nervous system in hypofractionated radiotherapy, Journal of Radiation Oncology, Dec, 2018

Plan B

Plan A

<table>
<thead>
<tr>
<th>Field</th>
<th>Arc 1</th>
<th>Arc 2</th>
<th>Arc 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan A</td>
<td>4116</td>
<td>2105</td>
<td>2105</td>
</tr>
<tr>
<td>Plan B</td>
<td>3488 (18% ↓)</td>
<td>1794 (17% ↓)</td>
<td>1794 (17% ↓)</td>
</tr>
</tbody>
</table>
MULTI-MET OPTIMIZATION

- Optimize individual target
- Single ISO, multiple prescription targets

CALCULATION GRID SIZE

- Expected effects for SRS case
- Calculation accuracy
- Max dose
- Conformity Index
- Gradient
- DVH
EVOLUTION OF TECHNOLOGY FOR MLC-BASED RADIOSURGERY

Hardware
- Micro-MLC
- IMRS (Dynamic MLC)
- IGRT
- SGRT
- VMAT
- High-Intensity Beam
- HyperArc Delivery

Software
- Better image quality
- Registration algorithm
- Faster compute power
- Improvement of optimization algorithm
- Small field dosimetry
- HyperArc planning module

CONTRAST: CURRENT RA SRS AND HA SRS

- Simplify the tx planning procedure
- Minimize the variation of plan quality
- Improving the performance of complex SRS planning
- Automation and improved efficiency
- Enforced safety features
- Additional imaging for verification
HYPERARC TREATMENT PLANNING

- Imaging
- Registration
- Contouring
- Prescription
- Setting up the fields
- Optimization
- Plan Evaluation

ENCOMPASS - ATTENUATION

Evaluation and verification of the QFix Encompass™ couch insert for intracranial stereotactic radiosurgery

Karen Chin Snyder | Ilma Xhaferri | Yimei Huang | M. Safin Siddiqui | Indrin J. Chetty | Ning Wen

<table>
<thead>
<tr>
<th>TABLE 3 Summary of components of the QFix Encompass™ SRS immobilization system, corresponding HU value ranges, and whether the component is included in the Encompass TPS model.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HU Range</td>
</tr>
<tr>
<td>Insert (frame)</td>
</tr>
<tr>
<td>Insert (inner layer)</td>
</tr>
<tr>
<td>Alignment Pins</td>
</tr>
<tr>
<td>Clips</td>
</tr>
<tr>
<td>Adjustable Shims</td>
</tr>
<tr>
<td>Mask</td>
</tr>
</tbody>
</table>

Figure 2: Right Axial cross-section of Lucy phantom demonstrating measurement zones used for HU validation. Zone 1 (Stem), Zone 2 (metal), Zone 3 (yellow), and Zone 4 (red). Measured and calculated percent attenuation for Encompass0 and Encompass00 structure sets with Zones 1–4 highlighted to demonstrate areas of high attenuation.
AUTOMATIC LOWER DOSE OBJECTIVE (ALDO)

- Isocenter is automatically defined
- Optimization of collimator rotation
- Optimization of Jaw setting

AUTOMATIC ISOCENTER PLACEMENT

- Place the isocenter at the center of mass of the target(s)
- ISO at Protection Zone a or c: only one half co-planer Arc
- Also detect body contour
COLLIMATOR ANGLE OPTIMIZER

- Max length of field opening: 17 cm
- Max leaf travel: 15 cm
- Max width of field opening: 40 cm if it’s at most 40 cm
- Optimized the angle to avoid island blocking
- Optimized at the end of the fields generation (HyperArc Trajectory)

HYPERARC OPTIMIZATION

- VMAT optimization: PO15.5 or above
- Warning if the target is not converted as a hi-resolution structure
- Use SRS NTO
- Use hi-resolution optimization
- Aperture shaper off
- Use cal. grid to 1.25 mm if use AAA 15.5 or above
PLAN EVALUATION - HYPERARC

- Target coverage
- DVH evaluation
- Location of hot and cold spots
- Dose to Organ at Risk (OAR)
- DVH evaluation
- Conformity, Gradient, Homogeneity
- Normal tissue irradiated
- Delivery efficiency
- Number of MU
- Collision

TREATMENT DELIVERY - AUTOMATION AND EFFICIENCY

Example RA SRS case: Rx = 22 Gy, Total MU = 6922 MU

- Total delivery time 4 arcs: 14 min 31 sec
- Total beam beam-on time: 5 min 22 sec
- G/C Motion + in/out time: 9 min 09 sec
## TREATMENT DELIVERY - COMPARISON

<table>
<thead>
<tr>
<th>HyperArc</th>
<th>8:40</th>
<th>22 Gy (7555MU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 CFG180.1G0</td>
</tr>
<tr>
<td></td>
<td>2 CCWG179C45</td>
<td>13:52 PM</td>
</tr>
<tr>
<td></td>
<td>3 CCWG03C155</td>
<td>13:56 PM</td>
</tr>
<tr>
<td></td>
<td>4 CFG180.1C270</td>
<td>13:58 PM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RapidArc</th>
<th>14:31</th>
<th>22 Gy (6922MU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 FMB PTV1.1</td>
</tr>
<tr>
<td></td>
<td>2RA, CW</td>
<td>11:20 AM</td>
</tr>
<tr>
<td></td>
<td>3RA, CW, C45</td>
<td>11:23 AM</td>
</tr>
<tr>
<td></td>
<td>4RA, CW, C270</td>
<td>12:00 PM</td>
</tr>
</tbody>
</table>

## INITIAL 17 HYPERARC CASES (1 MONTH)

- Treatment disease: 15 metastases, 1 Schwannoma and *1 HN boost
- No. of targets in single isocenter: 1 – 11
- Treatment regime: 1 fx (19 Gy – 24 Gy), 5 fx × 5 Gy, *4 fx × 2.5 Gy
- Target volume: 0.16 – *46.03 cm³ (Median 0.41 cm³)
- Delivery Time: 7:10 – 18:48 (Median 9 min. 01 sec.)
- Total MU/Rx: 2.35 – 4.33 (Median 3.06)
HA CASE 1. SINGLE ISO 2 METS

- PTV 1.1 (0.24 cm³)
  - Rx: 22 Gy × 1 fx
  - Eclipse CI 6.48, GM 0.41 cm
  - RTOG CI 1.07 Paddick CI 0.7, GI 5.84, ICRU83 HI 0.26
- PTV 1.2 (1.08 cm³)
  - Rx: 22 Gy × 1 fx
  - Eclipse CI 1.4, GM 0.41 cm
  - RTOG CI 1.12 Paddick CI 0.96, GI 3.76, ICRU83 HI 0.25
- Normal Brain: $V_{10} = 5$ cm³
- Delivery time 8 min. 38 sec
- Total MU/Rx : 2.59

HA CASE 2. SINGLE ISO 11 METS

- PTV 2.1-11 (0.2 – 1.0 cm³)
  - Rx: 3 mets 19 Gy, 8 mets 20 Gy
  - Eclipse CI 5.16 - 30.99, GM 1.03 cm
  - RTOG CI 1.00 -1.66 Paddick CI 0.59 - 0.73, GI 5.63 - 48.27, ICRU83 HI 0.14 - 0.31
- Normal Brain: $V_{10} = 34.8$ cm³, $D_{mean} = 3.5$ Gy
- Delivery time 14 min. 29 sec (6X)
- Total MU/Rx : 4.26
### 2 FMB Brain

<table>
<thead>
<tr>
<th>Volume</th>
<th>Prescribed Dose/Frac</th>
<th>Number Of Fractions</th>
<th>Total Prescribed Dose</th>
<th>Frequency</th>
<th>Energy</th>
<th>Technique</th>
<th>Linked Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV 1.2</td>
<td>2200.0 cGy</td>
<td>1</td>
<td>2200.0 cGy</td>
<td>Every Day (Once Daily) EX-FFF</td>
<td>SRS (Arc Therapy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTV 1.3</td>
<td>2200.0 cGy</td>
<td>1</td>
<td>2200.0 cGy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTV 1.4</td>
<td>2400.0 cGy</td>
<td>1</td>
<td>2400.0 cGy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTV 1.5</td>
<td>2200.0 cGy</td>
<td>1</td>
<td>2200.0 cGy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>PTV 1.6</td>
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### FMB PTV SUP1.1-1.14 : R0

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<th>Volume</th>
<th>Prescribed Dose/Frac</th>
<th>Number Of Fractions</th>
<th>Total Prescribed Dose</th>
<th>Frequency</th>
<th>Energy</th>
<th>Technique</th>
<th>Linked Plans</th>
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<tbody>
<tr>
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<td>2400.0 cGy</td>
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<td>SRS (Arc Therapy)</td>
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### FMB PTV 1.1 : R0

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<td>2400.0 cGy</td>
<td>Every Day (Once Daily) EX-FFF</td>
<td>SRS (Arc Therapy)</td>
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**BEV (FIXED JAWS VS. JAW TRACKING)**

- Fixed Jaw setting
- Collimator rotation optimized manually
- Jaw tracking on
- HyperArc Collimator Angle Optimizer (CAO)

**DVH (FIXED JAWS VS. JAW TRACKING)**

- Total MU: 7,964, PTVs Dmax = 136.9%
- Brain-PTVs: V12 = 20.86 cm³
- Brainstem Dmax = 651.5 cGy
- Optic Chiasm Dmax = 559.0 cGy
- Optic Nerve LT Dmax = 249.5 cGy
- Optic Nerve RT Dmax = 251.7 cGy

- Total MU: 8,737, PTVs Dmax = 142.7%
- Brain-PTVs: V12 = 10.95 cm³
- Brainstem Dmax = 374.5 cGy
- Optic Chiasm Dmax = 656.6 cGy
- Optic Nerve LT Dmax = 304.0 cGy
- Optic Nerve RT Dmax = 521.4 cGy
Q & A