Cranial SRS on a Siemens Artiste™ using the BrainLab iPlan® treatment planning system

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Outline

- SRS workflow
- Siemens and BrainLab equipment
- System interdependence
- Bumps on the road
- Experience at AGH
- Conclusion

Objectives

- To assess the safety and usefulness of a multivendor solution for cranial SRS
- To understand the commissioning and QA steps of a Siemens Artiste/BrainLab iPlan hybrid system for cranial SRS
- To understand the limitations of the hybrid system
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SRS workflow at AGH
SRS workflow at AGH

Team work

Outline
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Equipment: The BrainLab SRS system

- Target positioner
- Cone mount
- Localizer
- Head frame
- Cones

Equipment: The BrainLab TPS

- Localize
- Fuse
- Segment
- iPlan Dose

Equipment: the Siemens Artiste™ linac

- 3 mm width at isocenter
- Up to 600 MU/min
- Tilted leaf, single-focus design
- Leakage: 0.17%
- Leaf speed 42.9±0.6 mm/s
- 6X Flat beam: 300 MU/min
- 6ST FFF beam: 1000 MU/min

- 43 cm clearance to isocenter
- Leaf speed 42.9±0.6 mm/s
- Hexapads: 4.1±0.5 mm

With small field-restricting accessory only (SRS cones)
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System interdependence: a simplistic view

Can linac perform in SRS environment?

System dedicated to SRS
System interdependence: a detailed view

- **Treatment setup**
  - Siemens treatment couch
  - Brainlab couch extension
  - Brainlab head frame
  - Brainlab localizer

- **Treatment planning**
  - Siemens MV-CBCT
  - Brainlab SRS cones

- **Treatment localization**
  - Siemens 160-MLC

- **Beam shaping devices**
  - Siemens Artiste™

- **Treatment delivery**
  - Siemens Artiste™

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**Treatment couch**

- **Siemens 550 TxT TT-5 treatment couch**
- **BrainLab couch extension**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Max. load</td>
<td>550 lbs / 250 kg</td>
</tr>
<tr>
<td>Isocentric displacement</td>
<td>±1.0 mm</td>
</tr>
<tr>
<td>Isocentric rotation</td>
<td>±115°</td>
</tr>
<tr>
<td>Absolute position accuracy</td>
<td>±0.5 mm (±1.0 mm vert)</td>
</tr>
<tr>
<td>Corrective position accuracy</td>
<td>±0.2 mm (±1.0 mm vert)</td>
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</tbody>
</table>

- **Locking mechanism**
  - Green locking indicator

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8/2/2012
BrainLab head frame

Immobilization of head in frame

Immobilization of frame on couch extension (linac isocenter)

Head frame = frame of reference
Isocenter calculated in frame of reference

System interdependence: a detailed view

Data acquisition for the 160 MLC

(1) Read instructions

(2) Perform measurements
- Output
- Leakage
- PDD/TMR
- Scatter factors
- Diagonal radial profiles
- Transversal profiles

(3) Send to BrainLab for verification and consistency
(4) Enter in Beam Profile Editor
(5) Take verification measurements
Data acquisition for 160 MLC: absolute output and leakage

SSD=100cm
d=10cm
0.6 cc Farmer chamber

NLo = 0.657 cGy/MU

Leakage measurements:
- Open jaws/closed MLC: 2.1×10^-3
- Closed jaws/closed MLC: 1.1×10^-4

Data acquisition for 160 MLC: PDD

- PDD at SSD=100cm
- 10 square field sizes
- Wellhofer cc01 chamber

Data acquisition for 160 MLC: scatter factors

- MLC-defined square fields
- Different jaw overlap
- Wellhofer cc01 chamber
- PTW photon diode
Data acquisition for 160 MLC: diagonal profile

- SSD=100 cm
- 8 depths (0.5, 1.4, 2.5, 5, 10, 20 and 35 cm)
- Wellhofer cc01 chamber

Data acquisition for 160 MLC: transversal profile

- Isocentric
- 3 different depths (d_{max}, 10 and 20 cm)
- PTW diode
- Purpose: adjust the source function correction and radiological field correction (simulate effects of extended source and other beam smearing effects)

System interdependence: a detailed view

- Treatment setup
- Siemens treatment couch
- Brainlab couch extension
- Brainlab head frame
- Siemens treatment couch
- Brainlab localizer
- Siemens MV-CBCT
- Siemens SRS cones
- Siemens 160-MLC
- Brainlab couch
- Siemens Artiste™
- Brainlab iPlan®
BrainLab cones on the Siemens Artiste

- Accessory interlock (code STEREO in slot 3)
- Detects presence of cone mount, but NOT cone size
- Automatically sets MLC and y-jaws to 5x5 field size

Data acquisition for BrainLab cones

- Scatter factors
- Cone profiles

System interdependence: a detailed view

- Treatment setup
  - Siemens treatment couch
  - Brainlab couch extension
  - Brainlab couch frame

- Treatment planning
  - Siemens MV-CBCT
  - Brainlab localizer

- Brain shaping devices
  - Siemens 160-MLC
  - Brainlab SRS cones

- Treatment delivery
  - Siemens Artiste™
Isocenter verification

Plan isocenter defined with respect to head frame using Brainlab localizer

Room lasers point to isocenter - verified by Winston-Lutz test

Target positioning sheets point to physical location of plan isocenter in frame of reference

Align to lasers

End-to-end accuracy: 1.2mm

System interdependence: a detailed view

Frame/anatomy integrity verification

> Register MV-CBCT with planning CT
> Skull contour from TPS
> Align to MV-CBCT
> Verify head restraint in head frame

No shift = no displacement
Frame/anatomy integrity verification

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Bumps on the road...

1. Original design of accessory mount on Artiste™: the cone mount could not be inserted.

- We filed our mount
- Siemens redesigned mount for Artiste

Bumps on the road...

2. Small field size scatter factor measurement inconsistent with other sites:

- Repeat measurement with careful alignment of stereotactic diode

Cone size safety interlock

- Linac has no knowledge of cone size
- Potential major radiation error
- 2 person check of cone size
- Prompt team to switch cone size
Artiste + BrainLab SRS experience at AGH

(up to July 2011)
- 222 SRS patients

Metastatic disease: 187
Meningioma: 14
Acoustic neuroma: 10
Other: 7
Case example

- 75 year old Caucasian male patient
- Stage IV, T3N3M1b adenocarcinoma of the left lower lobe of the lung with associated bilateral mediastinal and hilar disease
- Brain metastases (3/12)
- Treated with SRS boost to brain mets (July 2012)

MRI
Frame placement
Plan designed on MRI
Frame Adjustment
CT
Plan reviewed on CT and approved
Cross system check and 2nd check
Treatment

Case example

- Right temporal
- Right superior parietal
- Right inferior parietal
- 1600 cGy, 80% isodose line
- 1 mm PTV margin

Conclusion

- Take advantage of industry standards (DICOM, etc...)
- Requires careful cross checking of information between systems
- Centrality of physicist role in proper use of multiplatform system
- "Rigidity" of cranial SRS treatment well suited for multivendor system
  - what you see is what you get
  - no need for adaptive
  - no need for real time adjustment
Acknowledgements

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- Therapists
- The whole department...