

The

Optical Guidance for Multi-Target Brain SRS/SBRT

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Leverage our Tech for Frameless SRS

- Move from frame based laser alignment to CBCT frame less alignment
- Possibility of intrafraction motion with mask based SRS setup
- Use optical system to monitor patient motions



Surgery vs SRS vs WB RT

Tsao MN, Rades D, Wirth A, et al. Radiotherapeutic and surgical management for newly diagnosed brain metastasis(es): An American Society for Radiation Oncology evidence-based guideline. *PRRO*. 2012;2(3):210–225

- 1) What prognostic factors are important ...?
- 4) Survival benefit for WBRT alone vs WBRT and SRS Boost?

In good prognosis patients with multiple brain metastases (all less than 4 cm in size and up to 4 brain metastases in number), radiosurgery boost when added to WBRT improves treated brain lesion and overall brain control as compared with WBRT alone. As there is no survival advantage with radiosurgery added to WBRT in patients with multiple brain metastases, WBRT alone may be considered.





- 62 yo F with metastatic NSCLC
- Whole Brain RT in Fall 2014
- 6 Met's Spring 2015

30.00

15.00 10.00 5.00 2.00

- 5Gy x 5 fx
- 2X per week







• Daily Positioning using 4 DOF couch











Open Face Immobilization

- Open faced mask system
 - Allows visibility of patient surface
 - Evaluated quality of immobilization
 - Clinical work flow for using OG for patient setup





FIG. 3. Demonstration of the forced motion in four directions of a volunteer subject wearing the open-face mask. The colored lines are movements in vertical (D.VRT), longitudinal (D.LNG), and lateral (D.LAT) directions or rotational axes. The gray line is the motion amplitude. Note that after a forced motion, the subject's position tends to fall back to within 1.5 mm of its original baseline.

Li et al. Migration from full-head mask to "open-face" mask for immobilization of patients with head and neck cancer. *JACMP* 2013;14(5):243–254.



Open Face Immobilization



Pan et. al. Frameless, real-time, surface imaging-guided radiosurgery: clinical outcomes for brain metastases. *Neurosurgery*. 2012;71(4):844–851



Qfix Emcompass Couch Insert



Multi-Target Planning

- U Mass Initial Experience
 - 10 single iso, 2 two iso
 - Compared well to other frameless
- UAB Multi-target Guidance on ...
 - Number of beams / Arcs
 - Structures for optimization
 - Optimization strategies
 - Expected CI GI HI values



Mayo et al. Initial experience with volumetric IMRT (RapidArc) for intracranial stereotactic radiosurgery. *Red Journal*. 2010;78(5):1457–1466

Clark GM et al. Plan quality and treatment planning technique for single isocenter cranial radiosurgery with volumetric modulated arc therapy. *PRRO*. 2012;2(4):306–313.





6-DOF Couch

Commission accuracy of translations and rotations



| | Distance to | | | | |
|-------------|-------------|-----------------|------------|-----------|---------|
| Pitch angle | wall | offset distance | tan(angle) | Angle | % Error |
| (degrees) | (mm) | (mm) | | (Degrees) | |
| -3 | 2520 | 132.5 | 0.053 | -3.01 | -0.98% |
| -2 | 2520 | 88.5 | 0.035 | -2.01 | -1.13% |
| -1 | 2520 | 43.5 | 0.017 | -0.99 | 1.11% |
| 0 | 2520 | 0.0 | 0.000 | 0.00 | 0.00% |
| 1 | 2520 | 44.5 | 0.018 | 1.01 | 1.17% |
| 2 | 2520 | 89.0 | 0.035 | 2.02 | 2.27% |
| 3 | 2520 | 132.0 | 0.052 | 3.00 | -0.15% |





- CBCT Alignment
 - Various starting couch positions with phantom
 - 3 three translations, roll, pitch
 - Geometric phantom and table under load
 - CBCT→ Align → Shift → CBCT → Align → Res' Error?

| | | 6 | 99.96 | 999.8 | 1 2.4 | 42 - | -0.37 | -10.27 | 7 -0.0 |)8 | 0.15 |
|--|-----|-------------|--------|----------------|-------|-------|--------|--------|----------------------------|----|------|
| | | | Initia | l table Coordi | nates | | shift | | residuals (after shift) | | |
| | | Test Number | long | lat | vert | long | lat | vert | Radius | | |
| | | | cm | cm | cm | cm | cm | cm | cm | | |
| | | 1 | 100 | 0 | 2.5 | 0.03 | -0.02 | 0.044 | 0.02 | | |
| | | 2 | 100 | 0 | 2.5 | 0 | 0 | 0 | 0.02 | | |
| | | 3 | 100.02 | 999.39 | 2.39 | 0.06 | -0.42 | -0.02 | 0.04 | | |
| | | 4 | 100.02 | 999.39 | 2.39 | 0.06 | -0.42 | -0.02 | 0.05 | | |
| | | 5 | 100.02 | 999.39 | 2.39 | 0.06 | -0.42 | -0.02 | 0.05 | | |
| | N N | 6 | 99.96 | 999.81 | 2.42 | -0.37 | -10.27 | -0.08 | 0.15 | | |
| | | 7 | 100.33 | 10.08 | 2.5 | 0.08 | 0.02 | 0.13 | 0.02 | | |
| | | 8 | 100.25 | 10.06 | 2.37 | 0 | 0 | 0 | 0.05 | | |
| | | 9 | 100.25 | 10.06 | 2.37 | 0 | 0 | 0 | 0.07 | | |



Align RT Commissioning

- Optical System
 - Test object for testing
 - 32 offset positions
 - Measure residual error
- Average 0.06 cm
- Standard Deviation 0.11cm





Treatment Delivery Workflow

- Optical System for initial setup
 - If >2° rotation, unlock immobilization and redo
- Use CBCT for target localization using 6DOF
- Acquire High Res' Static Image of Position
 - Used as reference for Real Time monitoring
- Monitor motion for duration of treatment

Li G, Lovelock DM, Mechalakos J, et al. Migration from full-head mask to "open-face" mask for immobilization of patients with head and neck cancer. *J Appl Clin Med Phys.* 2013;14(5):243–254.



4 Step Frameless SRS Rollout

1. Frame based with Laser Alignment

- 1. One plan per target
- 2. CBCT verification of isocenter
- 3. Monitor patient with surface camera
- 4. Three patients

2. Frame based with CBCT Alignment

- 1. One plan per target
- 2. Laser verification on frame
- 3. Monitor Patient with surface camera
- 4. Three patients



4 Step Frameless SRS Rollout

3. Frameless with Surface Camera setup

- 1. One plan per target
- 2. CBCT alignment
- 3. Monitor patient with surface camera
- 4. Three patients

4. Frameless with Single Plan Multi-Target

- 1. One Plan with Multi-targets
- 2. Surface Camera setup
- 3. CBCT alignment
- 4. We're done





- Frame to Frameless transition opens up possibility of patient motion during treatment
- CBCT will remain standard for positioning
- Optical Guidance can be used for
 - Patient Setup
 - Monitoring During treatment
 - Verify couch rotations