# IROC Houston and MDAPL SRS Anthropomorphic Phantom Results

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**Purpose:** To report the results of SRS phantom irradiations that were analyzed using gamma criteria.

**Method:** Anthropomorphic SRS head phantoms (Figure 1) were sent to institutions participating in NCI sponsored SRS clinical trials and institutions interested in verifying SRS treatment delivery. The phantom shell was purchased from The Phantom Laboratory (Salem, NY) and altered to house dosimetry and imaging inserts. The imaging insert has 1.9 cm diameter spherical target. The dosimetry insert holds two TLD capsules and radiochromic film in the coronal and sagittal planes through the center of the target. Institutions were asked to image, plan and treat the phantom as they would an SRS patient. GammaKnife, CyberKnife and c-arm accelerator institutions were asked to cover the target with 15 Gy, 20 Gy and 25 Gy, respectively. Following these guidelines and typical planning protocols for these three types of machines gives roughly 30 Gy to the center of the target for all units. Submission of the DICOM digital data set was required for analysis. Criteria of 5% for TLD results and 85% of pixels passing 5%/3mm gamma analysis were applied beginning in 2013. Figure 2 shows a gamma analysis. Figure 3 shows a profile through the center of the target.

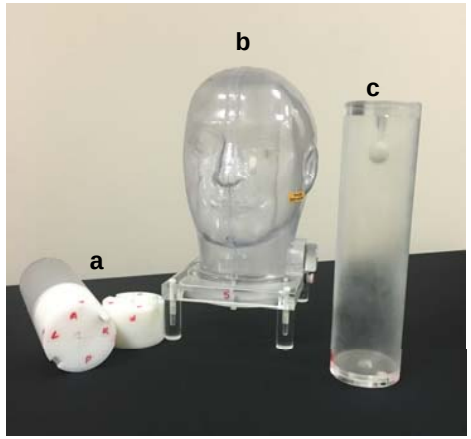


Figure 1 SRS Phantom a) dosimetry insert that houses film and TLD b) water fillable head shell c) imaging insert with visible target

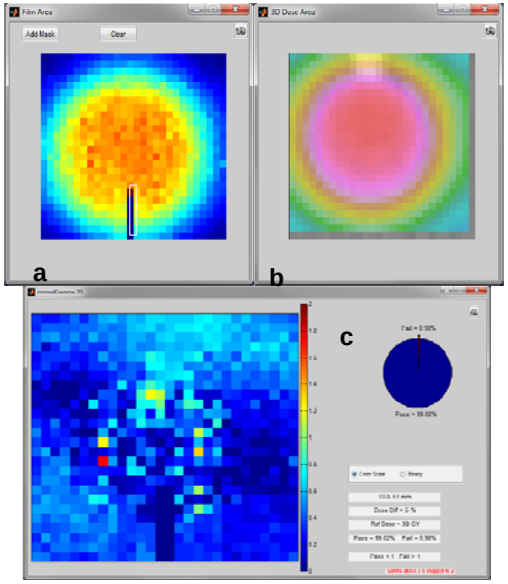


Figure 2 a)The area on the coronal film that was used for gamma analysis. Artifacts have been masked and are not included in the gamma analysis. b) The corresponding area in the coronal plane from the treatment planning system. c) The resulting gamma analysis.

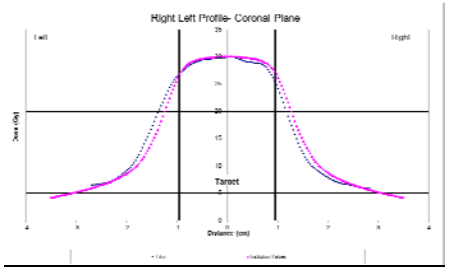


Figure 3. Right left profile through center of target.

| Machine | Number of Irradiations | Pass Rate |
|---|---|---|
| GammaKnife | 23 | 0.96 |
| CyberKnife | 32 | 0.88 |
| c-arm | 211 | 0.79 |

Table 1. Pass rates for 3 most commonly used machine types.

**Results:** The phantom was analyzed 269 times between the beginning of 2013 to present. The pass rate is 81%. Nineteen of the irradiation results failed only the TLD criteria, 19 failed only the film criteria and 12 failed both. Irradiations included 32 CyberKnife , 23 GammaKnife, 3 TomoTherapy and 211 c-arm units. Planning systems included Eclipse, Ergo, GammaPlan, Hi-Art, iPlan, Monoco, MultiPlan, Pinnacle, RayStation, XiO and XKnife. Irradiations that were not accompanied with DICOM data were not included in this analysis.

Table 1 shows pass rates for the commonly used machine types. No significant difference was found between types (p=0.248). Table 2 shows the pass rates for 3 common c-arm planning machines. No significant difference was found between types (p=0.1). Table 3 shows the average TLD results for each.

| Planning System | Number of Irradiations | Pass Rate |
|---|---|---|
| Eclipse | 96 | 0.80 |
| iPlan | 73 | 0.73 |
| Pinnacle | 24 | 0.88 |

Table 2 Pass rates for 3 most commonly used c-arm planning systems.

| | Average TLD results |
|---|---|
| All irradiations | 0.98 |
| GammaKnife | 0.99 |
| CyberKnife | 0.99 |
| Eclipse | 0.98 |
| iPlan | 0.96 |
| Pinnacle | 0.98 |

Table 3. Average TLD results.

**Conclusions:** The phantom is a valuable end-to-end test used to independently verify the accuracy of SRS treatment delivery.

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