THE UNIVERSITY OF TEXAS
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Evaluation of Trends and Performance Indicators for IROC Houston's SRS Head Phantom
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Purpose:

To evaluate trends and performance indicators on IROC Houston's SRS head phantom. This study is the first large scale, multi-institutional evaluation of SRS practice. It highlights that, while the quality of SRS is improving, there are still shortcomings across radiation oncology practice.

Methods:

The SRS head phantom contains a 1.9 cm spherical PTV where two TLDs and two planes of GAFchromic film are located. Institutions are instructed to deliver a treatment consistent with their clinical practice. Current passing criteria are: TLD/TPS within 0.95 – 1.05 and ≥ 85% of pixels passing a 5%/3mm gamma analysis. SRS phantom data was collected from 2012-2018 (with gamma analysis only fully implemented and available in 2013). The Pearson chi-squared test was utilized to determine statistical significance.
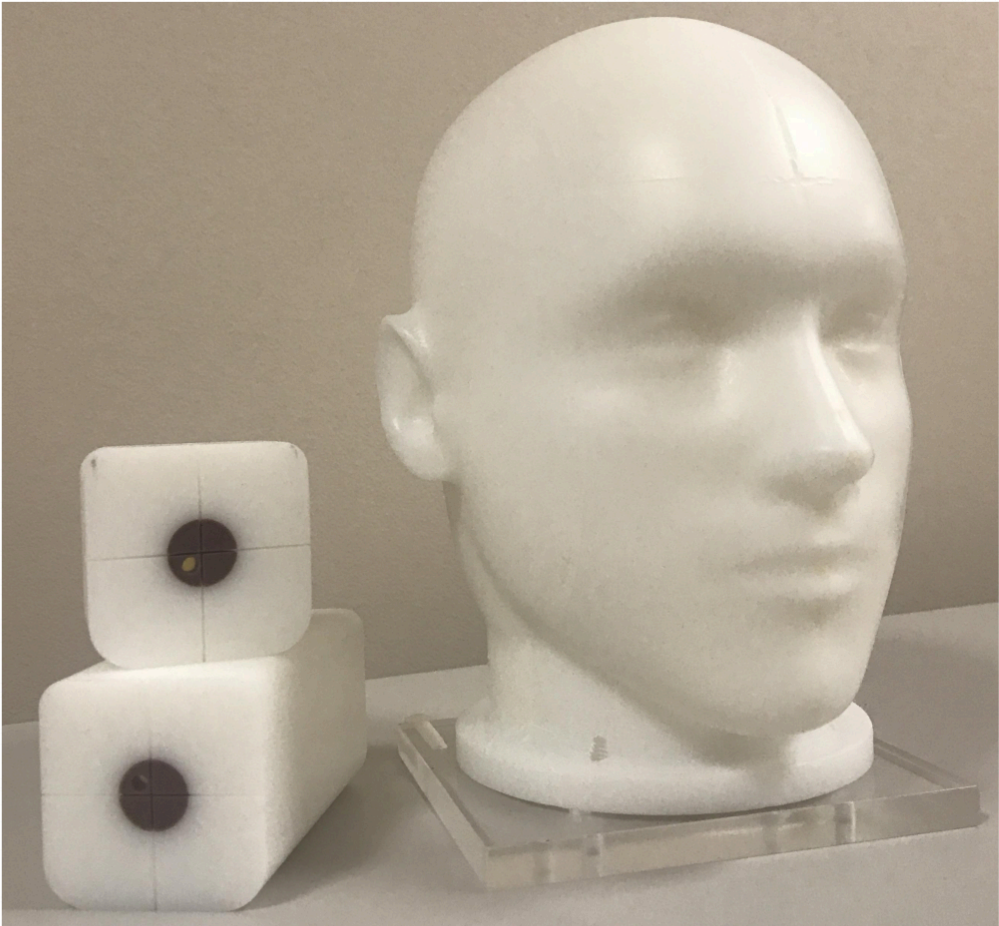
Figure 1: IROC Houston's new solid stereotactic radiosurgery head phantom

Results:

The overall pass rate for the SRS head phantom (N = 793) was 84% with 11% failing TLD (N = 87) and 9% (N = 54) failing gamma analysis where 17 sites failed both. The average PTV TLD ratio was 0.98 and the average gamma showed 95.2% pixels passing. As seen in Table 1, the passing rates were higher for GammaKnife (91%), CyberKnife (91%) and TomoTherapy (90%) as compared to C-arm linacs, for example, TrueBeam (83%) and Trilogy (81%), however, they were not statistically significantly different from one another.

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| Machine Type:	N	Pass Rate (%)	Average TLD	Average Gamma (%)
Trilogy	147	81%	0.968	94.2%
Agility	46	85%	0.970	95.4%
Clinacs	99	81%	0.977	91.8%
TomoTherapy	19	89%	0.981	91.4%
TrueBeam	263	83%	0.983	95.6%
GammaKnife	95	91%	0.987	98.8%
CyberKnife	77	90%	0.994	96.6%
Overall:	**793**	**84%**	**0.980**	**95.2%**

Table 1: Overall and machine breakdown of total number of phantoms, pass rates, average PTV TLD and gamma for SRS phantoms. Only prominent machine types were included. These machine types were not statistically significantly different from one another (p = 0.504).

Beam Energy:	N	% of SRS Phantoms	Pass Rates (%)
6 MV	429	57%	85.5%
6 SRS	48	6%	77.1%
6 FFF	137	18%	82.5%
Co-60	95	13%	89.5%
10 MV	3	0.4%	66.7%
10 FFF	37	5%	78.4%

Table 2: Pass rates and total number of phantoms breakdown for the SRS phantom according to beam energy.

Results (cont.):

Table 2 shows the breakdown of irradiated SRS phantom and their respective pass rates with differing beam energies. They were, also, not statistically significantly different from one another

Through the years, the overall average TLD value has increased steadily towards 1.00. This improvement with time was statistically significant per regression analysis (p=0.037). (Figure 2).

$y = 0.0023x + 0.9707$
$R^2 = 0.6141$
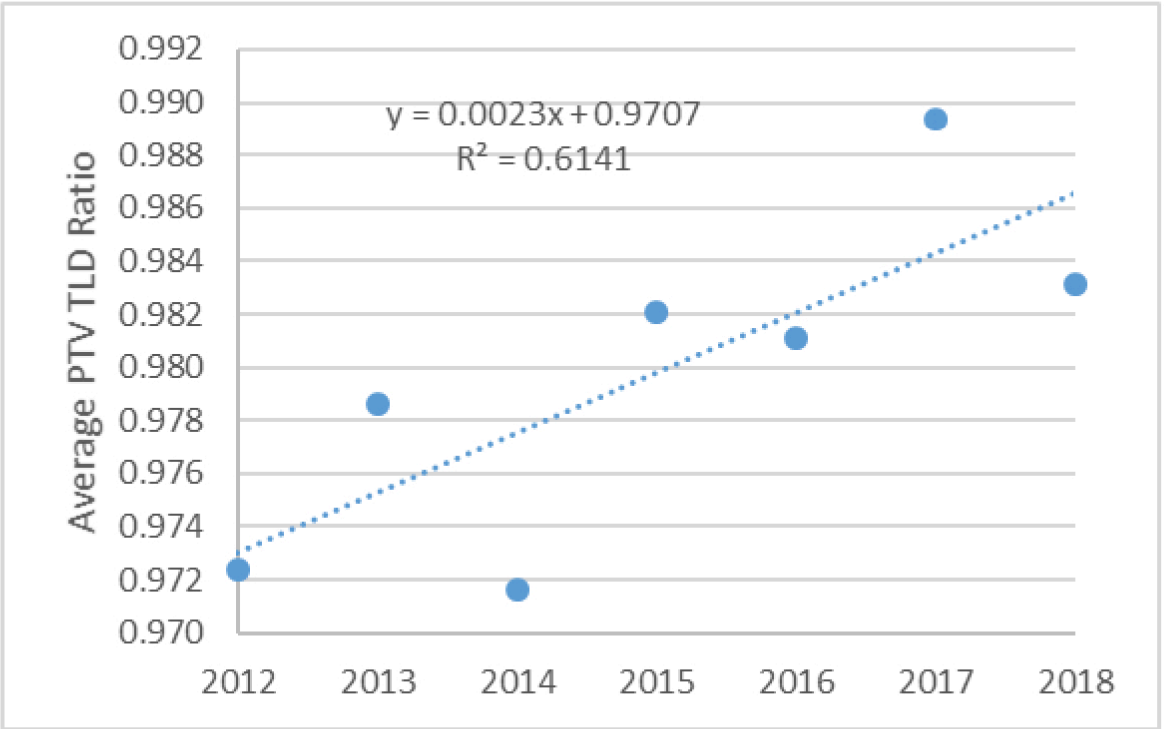
Figure 2: Average PTV TLD ratio versus year for the SRS head phantom. The trend is slowly increasing towards 1.00 as sites improve their ability to irradiate this phantom and deal with small target sizes.

Conclusion:

The SRS head phantom is useful tool for QA of intracranial SRS treatment. While improvement has been made throughout the years, the suboptimal pass rate illustrates that there is further room to improve this practice in radiation oncology.

Support: