AbstractID: 14048 Title: A Monte Carlo Method for Assessing Targeting Error in an Ophthalmological Stereotactic Radiosurgical Device

Purpose:
To propose and demonstrate a Monte Carlo-based method of assessing the targeting uncertainty of an ophthalmologic-specific stereotactic radiosurgery device that provides a physically realistic assessment of end-to-end uncertainty in targeting accuracy. Using this method, the minimum acceptable separation between optic disc (organ at risk) and fovea (target) was calculated for an ongoing European clinical trial in the treatment of macular degeneration.

Method and Materials:
All sources of uncertainty in targeting were estimated in categories that include mechanical precision, machine alignment, calibration error, patient motion, and biometric uncertainty. These sources were characterized in terms of their magnitude of error as well as the resulting two-dimensional shape of their uncertainty distribution on the retina, such as Gaussian, constant, or random. Once uncertainties were characterized, sample "treatments" were simulated by choosing a random magnitudes and directions for each source of error. After statistical noise was adequately reduced, an uncertainty distribution resulted that described the probabilistic position of the beam on the retina. Armed with this distribution, the probability that the proximal portion of the optic disc could receive a dose greater than a threshold could be calculated and a patient eligibility criterion defined.

Results:
Using this technique, a minimum acceptable fovea to optic disc edge distance was calculated for patients eligible for the radiation treatment of macular degeneration using this SRS device.

Conclusion:
For complex, multi-dimensional systems this method is more straightforward than the traditional Taylor's expansion method of uncertainty propagation. It explicitly takes into account the non-normal distribution of most input uncertainties and, as the result itself is a multi-dimensional probability distribution, provides more insight than a single number like a standard deviation. It allows the user to explicitly select an acceptable risk and tailor the operational parameters to achieve that.

Conflict of Interest:
Research sponsored by Oraya Therapeutics