Purpose: The current standard TG-43 dose calculation method for SAVI-based Accelerated Partial Breast Irradiation (APBI) assumes an ideal geometry of infinite homogeneous water. However, in SAVI treatments, the air cavity inside the device and the short source-to-skin distance raise concerns about the dose accuracy of the TG-43 method. This study is to evaluate TG-43 dose calculation accuracy in SAVI treatments using Monte Carlo (MC) simulations.

Methods: We recalculated the dose distributions of 15 APBI patients treated with SAVI devices, including five cases with a size of 6-1, five with 8-1 and five with 10-1, using our in-house developed fast MC dose package for HDR brachytherapy (gBMC). A phase-space file was used to model the Ir-192 HDR source. For each case, the patient CT was converted into a voxelized phantom and the dwell positions and times were extracted from treatment plans for MC dose calculations. Clinically relevant dosimetric parameters of the recalculated dose were compared to those computed via the TG-43 approach.

Results: A systematic overestimation of doses was found for the 15 cases in TG-43 results, with D90, V150, and V200 for PTV_eval 2.8±1.8%, 2.0±2.2%, and 1.8±3.5% higher than MC results. TG-43 also overestimated the dose to skin with the maximum dose 4.4±8.4% higher on average. The relatively large standard deviation seen in the difference of maximum skin dose is partially ascribed to the statistical uncertainty of MC simulations when computing the maximum dose. It took gBMC ~1 minute to compute dose for a SAVI plan.

Conclusion: The high efficiency of our gBMC package facilitated the studies with a relatively large number of cases. An overestimation of TG-43 doses was found when using this MC package to recompute doses in SAVI cases. Clinical utilization of TG-43 dose calculation method in this scenario should be aware of this fact.