Purpose:

To investigate the dosimetric optimization methods of varied intra-plaque seed strength and radionuclide choice for COMS eye plaque brachytherapy.

Methods:

The COMS plaque Silastic insert arranges seeds about concentric circles (rings) of different radii. Thus, each plaque dose distribution may be considered as the superposition of its constituent rings. The MCNP5 radiation transport code was used to simulate a 16mm COMS plaque populated with $^{103}$Pd, $^{125}$I, and $^{131}$Cs sources. Each constituent source ring was then activated to determine its contribution to the total dose distribution while accounting for the dosimetric influences of inter-seed attenuation and scatter. Tumor dose distributions were generated from $>$10$^6$ permutations of ring weightings and radionuclides for a given apical prescription dose. These dose distributions were analyzed for target dose uniformity and conformity, and compared to that of a uniformly-loaded $^{125}$I plaque.

Results:

Using $^{131}$Cs seeds in only the plaque's outer ring yielded the most homogeneous dose distribution (+16% vs. $^{125}$I). The proximal sclera dose was 42% lower, yet center of the eye and opposite retina doses were 16% and 30% higher, respectively. Combinations with $^{103}$Pd in the plaque inner ring weighted to deliver $>$98% of the prescription dose yielded the most conformal dose distributions ($>$24% vs. $^{125}$I). Though doses to the eye center and opposite retina were $>$32% and $>$55% lower, respectively, the proximal sclera dose was $>$26% higher. Various combinations using only $^{103}$Pd with the outer ring contributing $>$50% of the prescription dose produced dose distributions both more homogeneous and more conformal than $^{125}$I. Proximal sclera, eye center, and opposite retina doses were typically 8-12%, 11-14%, and 38-40% lower, respectively, than using $^{125}$I.

Conclusions:

Intra-plaque radionuclide and seed strength variations produced more homogeneous and conformal dose distributions than uniformly-loaded COMS plaques. This optimization approach is generalizable to all plaque sizes and tumor dimensions.

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<None>