Purpose:
To investigate the use of various breast tissue segmentation models in Monte Carlo calculations for low-energy brachytherapy.
Methods:
The EGSnrc user-code BrachyDose is used to perform Monte Carlo simulations of a breast brachytherapy treatment using TheraSeed Pd-103 seeds with various breast tissue segmentation models. Models used include a phantom where voxels are randomly assigned to be gland or adipose (randomly segmented), a phantom where a single tissue of averaged gland and adipose is present (averaged tissue) and a realistically segmented phantom created from numerical phantoms in the literature. Transporting photons in averaged tissue and scoring in gland is investigated. The inclusion of calcifications in the breast is also studied in averaged tissue and randomly segmented phantoms.
Results:
In randomly segmented and averaged tissue phantoms, the photon energy fluence is approximately equal; however, differences occur in the DVHs as a result of scoring in gland and adipose (whose mass energy absorption coefficients differ by 30%) or averaged tissue. A realistically segmented phantom is shown to significantly change the photon energy fluence compared to that in an averaged tissue or randomly segmented phantom. Despite this, resulting DVHs agree reasonably because fluence differences are compensated by dose scoring differences. Calcifications affect photon energy fluence to such a degree that the effects cannot be overcome by dose scoring differences in averaged tissue phantoms.
Conclusions:
For low-energy brachytherapy, if photon transport and dose scoring both occur in an averaged tissue, the resulting DVH is reasonably accurate because inaccuracies in photon energy fluence are compensated for by inaccuracies in localized dose scoring. Scoring dose in a separate medium (water/gland) when transporting in the averaged tissue phantom causes inaccuracies in resulting DVHs because of inaccurate photon energy fluence. Including calcifications necessitates the use of proper tissue segmentation.