Purpose:
To investigate and characterize the spatial resolution patterns of prostate edema in permanent prostate brachytherapy for accurate post-implant dosimetry.

Methods:
Three patients with prostate cancer received 103Pd seed implant (day-0) and consented to participate in an IRB approved post-implant serial CT imaging study. Patient 1 was scanned on days: -1, 1, 7, 10, 17, 30, 42; Patient 2: -1, 0, 1, 7, 16, 40; and patient 3: -1, 0, 1, 6, 11, 15, 30, 42. The image of patient 1 on day-0 was contoured by a radiation oncologist and set as the template image for registration using a validated deformable image registration algorithm. For all voxel points inside the prostate in the template image, their corresponding coordinates in the subsequent images were obtained by the resulting deformation fields. These point sets were further aligned by rigid shape registration so as to reflect the intrinsic edema resolution. Principle component analysis (PCA) was used to compute the variation pattern among the point sets of each patient, and also among the point sets averaged from all patients on days -1, 1, 6/7, 15/16/17, and 40/42.

Results:
The percentages of the greatest four components of variation over the total variation are 92.0%, 2.9%, 2.1%, 1.2% for patient 1, 43.8%, 32.0%, 10.4%, 8.2% for patient 2, 45.6%, 15.1%, 12.3%, 10.5% for patient 3, and 63.0%, 18.4%, 11.3%, 7.2% for the averaged one. The greatest four components of variation plotted on the surfaces of prostate and of a sphere of similar size provided an easy visualization of major edema resolution patterns.

Conclusions:
Strong anisotropic edema resolution patterns were observed in patients receiving permanent prostate brachytherapy. PCA analysis and visual inspections indicated that different patients have significantly different edema resolution patterns. It suggests that spatial anisotropy of edema resolution should be considered for accurate dosimetry.

Funding Support, Disclosures, and Conflict of Interest:

This research project is currently funded by the NIH grant R01CA134627-01