Purpose: The inter-fraction organ motion/deformation can be conveniently modeled using Bayesian theory with Normal-gamma conjugate prior if signed distance from any fixed point in space to surface of the organ of interest obeys normal distribution. In this study, we investigated whether the inter-fraction motion/deformation of bladder and rectum observed from clinical prostatectomy patients satisfy this normality condition.

Method and Materials: 285 treatment planning CT and daily CT-on-rails scans from 7 prostatectomy patients were used in this study. Both bladder and rectum were contoured on all scans. Each patient's daily CT-on-rails scans were registered to his treatment planning CT and the bladder/rectum contours were mapped into treatment planning CT space for analysis. A cubic box with orientations along treatment planning CT image axes is defined to contain all bladders/rectums with 2cm margin. For each voxel inside this box (size: 2mmx2mmx1.5mm), its distance to the bladder/rectum surfaces was measured. Sign is added to the distance to indicate whether a point is inside or outside of an organ of interest. Now the inter-fraction motion/deformation of bladder/rectum can be characterized by the distance variation from the voxels to the bladder/rectum surface. Jarque-Bera normality statistical test was employed to examine whether the signed distances obey normal distribution.

Results: For each patient, the signed distance to bladder or rectum from at least 99.99% of the voxels passed the Jarque-Bera test with p-value 0.05.

Conclusions: For prostatectomy patients, their bladder or rectum inter-fraction organ motion/deformation can be statistically described by a Gaussian signed distance field. This makes it possible to use Bayesian statistics model with Normal-gamma conjugate prior to predict bladder or rectum daily location and shape during a prostatectomy patient fractionated radiotherapy.