Purpose:A new multi-scale deformable registration method is proposed by combining edge preserving scale space with the multi-level free form deformation (FFD) grids for CBCT based on adaptive image guided radiation therapy (AIGRT) system.

Methods:The edge preserving scale space which is able to select edges and contours of the image according to their geometric size is derived from the total variation model with the L1 norm (TV-L1). At each scale, despite of the noise and contrast resolution differences between the planning CT and CBCT, the selected edges and contours are sufficiently strong to drive the deformation using the FFD grid, and the edge preserving property ensures more meaningful spatial information for mutual information based registration. At last the deformation fields are gained by a coarse to fine manner. Furthermore, considering clinical application we design an optimal estimation of the TV-L1 parameters by minimizing the defined offset function for automated registration.

Results: The deformation differences gained by EFFD are always smaller than the NFFD, which indicate that EFFD is more accurate than the NFFD for three level of deformation. H&N case is the easiest one to recover the deformation, which is indicated by the smallest deformation difference. The rectum and prostate cases are in the same level when recovering the deformation, and the breast and chest are also in the same level to recover the deformation. The lung case is the most difficult type to recover the deformation.

Conclusions: We can conclude that EFFD is more robust than NFFD method with more stable lower DDs for six kinds of cancer registration and three levels of deformation.We prove the significance of our proposed registration method both quantitatively and qualitatively with ground-truth known.