Purpose: To evaluate the effect of using newly developed directional sources in a prostate brachytherapy treatment plan.

Method and Materials: Directional sources contain a radiation shield in part of its interior that reduces significantly the intensity of radiation emitted in the shielded direction. They have a similar dose distribution as non-directional sources on the unshielded side. We use an adjoint region of interest based optimization system to generate a plan for 0.546 U non-directional \( ^{125}I \) sources to deliver a prescribed dose \( (D_p) \) of 145 Gy to the prostate and then manually replace some sources with the same strength of directional sources. The orientation and position of the directional sources have been selected to maximize \( V_{100} \) (percent of prostate receiving 145 Gy and higher), minimize \( R_{90Gy} \) (percent of rectum receiving 90 Gy and higher) and minimize \( V_{125} \) and eliminate \( V_{150} \) for the central prostate regions including urethra (percent of volume receiving 125\% of \( D_p \) (181 Gy) and 150\% of \( D_p \) (217 Gy), respectively).

Results: \( V_{100} \) of the prostate target region increases from 97.5\% to 98.9\%, the central prostate region including urethra, receives the full uniform prescribed dose, \( V_{125} \) drops from 61.7\% to 49.2\% and the \( V_{150} \) of 2.24\% is eliminated. There is a large reduction in \( R_{90Gy} \) from 53.7\% to 20.6\% for the anterior retal wall, which significantly reduces the probability of rectal morbidity. All treatment plan indicators are improved with use of directional sources.

Conclusion: Directional sources can allow the conflicting goals of increasing prostate target \( V_{100} \), decreasing \( R_{90Gy} \), decreasing \( V_{125} \) and eliminating \( V_{150} \) of the central prostate regions including urethra to be independently optimized, yielding a better treatment to the prostate with less rectal and urethral morbidity.