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### Intensity Modulated Proton and Photon Therapy for Early Prostate Cancer with or without Transperineal injection of a Polyethylen Glycol Spacer: a Treatment Planning Comparison Study

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#### Abstract : Purpose/Objective(s):

Rectal toxicity is a serious adverse effect for early stage prostate cancer patients treated with curative radiation therapy (RT). Injecting a Spacer between Denonvilliers' fascia increases the distance between the prostate and the anterior rectal wall and may thus decrease the rectal radiation-induced toxicity. We assessed the dosimetric impact of this Spacer with advanced delivery RT techniques, including intensity modulated (IM) RT (IMRT), intensity-volumetric arc RT (RA) and IM proton beam RT (IMPT).

#### Materials/Methods:

Eight prostate cancer patients were simulated for RT with or without Spacer. Plans were computed for IMRT, RA and IMPT using the Eclipse treatment planning system using both CT *Spacer+* and *Spacer-* datasets. Prostate ± seminal vesicle (PTV) and organs at risk (OARs) DVHs were calculated. Results were analyzed using dose and volume metrics for comparative planning.

#### Results:

Regardless of the radiation technique, Spacer injection decreased significantly the rectal dose in the 60 - 70 Gy range. Mean  $V_{70\text{ Gy}}$  and  $V_{60\text{ Gy}}$  with IMRT, RA and IMPT planning were 5.3±3.3% / 13.9±10.0%, 3.9±3.2% / 9.7±5.7% and 5.0±3.5% / 9.5±4.7% after Spacer injection. Prior to Spacer administration, the corresponding values were 9.8±5.4% ( $p=0.012$ ) / 24.8±7.8% ( $p=0.012$ ), 10.1±3.0% ( $p=0.002$ ) / 17.9±3.9% ( $p=0.003$ ) and 9.7±2.6% ( $p=0.003$ ) / 14.7%±2.7% ( $p=0.003$ ). Importantly, Spacer injection usually improved the PTV coverage for IMRT. With this technique, mean  $V_{70.2\text{ Gy}}$  and  $V_{74.1\text{ Gy}}$  were 100±0% - 99.8±0.2% and 99.1±1.2% - 95.8±4.6% with ( $p=0.07$ ) and without ( $p=0.03$ ) Spacer, respectively. As a result of Spacer injection, bladder doses were usually higher but not significantly so. Only IMPT managed to decrease the rectal dose after Spacer injection for all dose levels, generally with no observed increase to the bladder dose.

#### Conclusions:

This study assesses the dosimetric impact of gel injection between the rectum and prostate using the best available photon and proton treatment techniques applied to a total of 8 patients with localized prostate cancer.