

## 2164 Localization of the Prostatic Apex using Comparative Ultrasound and Urethrogram Imaging

A. Youssef<sup>1,2</sup>, F. Nichini<sup>2,1</sup>, M. Zhang<sup>1,2</sup>, A.M. Kinney<sup>2,1</sup>, N. Black<sup>2,1</sup>, S. Stuhlman<sup>2,1</sup>

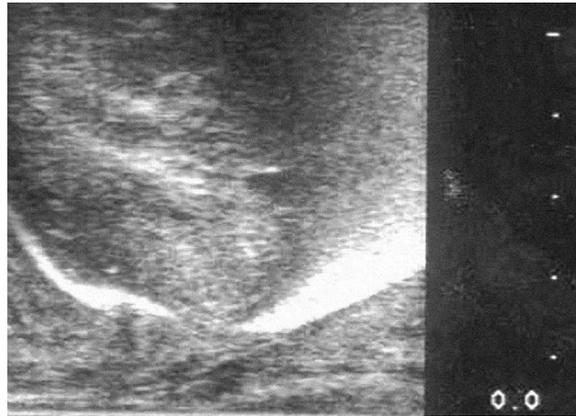
<sup>1</sup>Radiation Oncology, Hahnemann University Hospital, Philadelphia, PA, <sup>2</sup>Radiation Oncology, Graduate Hospital, Philadelphia, PA

**Purpose:** The prostatic apex is often radiographically indistinct from the urogenital diaphragm and difficult to identify with certainty using Computed tomography (CT) scans. Autopsy and pathology studies have shown that the caudal portion of the prostate gland harbors tumor in 64-75% of specimens examined. The optimal method of localizing the prostatic apex is still controversial. Yet the prostatic apex can be easily identified on the sagittal images of Trans Rectal Ultrasound (TRUS). The purpose of this study is to evaluate the position of the lowest part of the prostate gland in relation to the tip of the urethrogram.

**Materials and Methods:** 25 consecutive patients with prostate cancer who were undergoing a volume study (TRUS) for prostate seed implant were enrolled in this study. After each volume study a urethrogram was done using hypaque mixed with gel rich in small air bubbles. The mixture was designed to work as a contrast for ultrasound and X-rays. Ultrasound sagittal views were obtained and the distance between the tip of the urethrogram and the prostate apex was measured. Ultrasound view prints were compared to lateral simulation films.

**Results:** The prostatic apex was clearly identified in all 25 patients using ultrasound images in the mid sagittal plan. The apex was seen abutting the pointing tip of the urethrogram in 16 patients (64%), in 6 patients (24%) the distance was 5mm or less, and in 3 patients (12%) the distance was 10 mm or less.

**Conclusion:** Prostatic apex is much closer to the urethrogram tip than what is usually conceptualized. Caution should be applied in designing the lower border of the radiation therapy field. Ultrasound sagittal views are a reliable and accurate tool to identify the prostatic apex with high accuracy.



## 2165 Late Gastrointestinal (GI) and Genitourinary (GU) Toxicity following Intensity Modulated Radiation Therapy (IMRT) for Prostate Cancer

B.S. Teh<sup>1,2</sup>, W.Y. Mai<sup>1,2</sup>, E. Huang<sup>1</sup>, L.S. Carpenter<sup>1,2</sup>, H.H. Lu<sup>1,2</sup>, J.K. Chiu<sup>1,2</sup>, S.Y. Woo<sup>1,2</sup>, W.H. Grant<sup>1,2</sup>, E.B. Butler<sup>1,2</sup>

<sup>1</sup>Radiation Oncology, Baylor College of Medicine, Houston, TX, <sup>2</sup>Radiation Therapy, The Methodist Hospital, Houston, TX

**Purpose:** IMRT using a rectal catheter/balloon for prostate immobilization has been shown to decrease acute GI and GU toxicity. (Int J Radiat Oncol Biol Phys 49(3):705-712;2001) To report the late GI and GU toxicity in patients with localized prostate cancer treated with IMRT to a moderate dose escalation

**Materials and Methods:** From February 1997 to March 1999, a total of 116 patients were treated with IMRT utilizing the PeacockTM system (NOMOS Corporation, Sewickley, PA). All patients had localized prostate cancer. Patients' ages ranged from 51 to 85. Clinical palpation stage ranged from T1 to T3 (49 patients with T1, 59 with T2 and 8 with T3). The median and mean pretreatment PSA were 7.25 and 14.1 respectively. Gleason combined scores (GCS) ranged from 4 to 9 (56 patients with GCS<7, 49 with GCS=7 and 11 with GCS>7). All patients received IMRT throughout the entire course of radiotherapy. IMRT as a boost is not part of the treatment strategy. All patients were treated in the prone position, immobilized with a customized Vac-LokTM (MED-TEC, Orange City, IO) bag and box combination system. A rectal catheter with an inflatable balloon of 100cc of air was placed during IMRT daily to minimize prostate motion. The patients were treated to a prescribed dose of 70Gy over 35 fractions. 60 patients (51.7%) of the patients used hormonal ablation. GI and GU toxicity were assessed using RTOG scoring criteria. Mean doses to prostate, seminal vesicles, bladder and rectum were recorded. Average irradiated bladder and rectal volumes above 65, 70 and 75Gy were assessed. A relationship between dose volume and clinical toxicity was evaluated. Median follow-up was 31.3 months.

**Results:** Mean doses to the prostate and seminal vesicles were 76 and 74Gy. This represents a moderate dose escalation with a daily mean dose of 2.17Gy. Mean doses to the rectum and bladder were 35 and 24Gy. There were no grade 4 late GI or GU toxicity. The rates of late GI toxicity scores 0, 1, 2 and 3 were 81%, 10.3%, 6.9% and 1.7%. The two patients with grade 3 GI

toxicity also carried the diagnosis of thalassemia and poliomyelitis respectively. There was no patient with more than 25% of the rectum receiving 70Gy or greater. No relationship was found between late GI toxicity and mean rectal dose or irradiated rectal volumes receiving more than 65, 70 and 75Gy. The rates of late GU toxicity scores 0, 1, 2 and 3 were 70.7%, 10.3%, 16.4% and 2.6%. There is no statistically significant relationship between late GU toxicity and mean bladder dose or irradiated bladder volumes receiving more than 65, 70 and 75Gy.

**Conclusion:** IMRT for prostate cancer with the use of a rectal catheter/balloon for prostate immobilization had an acceptable late GI and GU toxicity profiles despite a moderate total dose escalation (76Gy) and higher than conventional fraction size (2.17Gy). No patient had more than 25% of the rectum receiving 70Gy or greater. The initial concern of local ano-rectal irritation by rectal catheter/balloon leading to higher incidence and more severe GI toxicity did not hold. More work to investigate predictors of clinical GI and GU toxicity is warranted such as assessment of the urethral dose with the use of IMRT.

## 2166 Magnetic Resonance Spectroscopic Imaging-Guided Brachytherapy for Localized Prostate Cancer

S. DiBiase, K. Hosseinzadeh, R. Gullapalli, S. Jacobs, M. Naslund, G. Sklar, R. Alexander, C. Yu

*Radiation Oncology, University of Maryland, Baltimore, MD*

**Purpose:** Prostate brachytherapy (PB) entails the placement of radioactive sources throughout the entire prostate gland in order to treat localized cancer. Typically, the target volume in PB encompasses the entire prostate gland due to the inability to localize the cancer and the multifocal nature of this malignancy. However, because of the unique biochemical nature of the prostate gland, recent advances in magnetic resonance spectroscopic imaging (MRSI) of the prostate have allowed precise delineation of the cancer location within the prostate gland. This report reveals our initial experience of MRSI-guided PB.

**Materials and Methods:** A MRSI study was obtained in 15 favorable-risk (PSA  $\leq$  10, Gleason score  $\leq$  6, and clinical stage T2a or less) patients prior to their scheduled PB and the results of this study were used to internally map 7mm x 7mm x 9mm volumes of prostate tissue in order to assign cancerous areas a higher dose of radiation. Such tumor bearing areas had a low citrate/choline ratio consistent with cancer. Based on both anatomic MRI and MRSI correlation, 3-dimensional coordinates were assigned to the locations of MRSI-defined cancer. The entire target volume was treated to 145Gy using Iodine-125. Low citrate regions, termed the biologic tumor volume (BTV)[1], were prescribed a dose of 130% of the target volume dose (188Gy) in order to dose escalate in low citrate regions while respecting the normal radiation tolerances of the surrounding areas. Three-dimensional treatment planning was utilized to perform the implant.

**Results:** Of the 15 prostate cancer patients evaluated, all had a successful 3-dimensional MRSI acquisition prior to their scheduled PB procedure. In 14 of the 15 patients planned with MRSI, the data was successfully incorporated into their treatment planning and was used to increase the radiation dose prescription to 130% in the MRSI-defined volumes. In one patient, MRSI revealed significant multifocal disease that made focal boosts impractical. Post-implant dosimetry confirmed a median V100 of 95% (range: 89%-98%) in the 15 evaluated patients for the prescription dose of 145Gy to the target volume. Furthermore, the median BTV100 for the low citrate region was 90% (range: 80-100%) as determined by post-implant dosimetry. Urethral and rectal DVHs were within normal limits. Morbidity was comparable to conventionally treated patients.

**Conclusion:** Magnetic resonance spectroscopic imaging offers a promising new approach for the delivery of ionizing radiation in PB. Although this series is small and with short follow up, MRSI-guided implants are feasible and warrant further investigation as a means of improving the therapeutic ratio in PB.

## 2167 Optimal Brachytherapy for Prostate Cancer: LDR versus HDR - The View from Radiobiological Models, or "You Take the High Road and I'll Take the Low Road"

C.R. King<sup>1</sup>, C.S. Mayo<sup>2</sup>

<sup>1</sup>*Radiation Oncology, Stanford University School of Medicine, Stanford, CA,* <sup>2</sup>*Radiation Oncology, Univ. of Massachusetts School of Medicine, Worcester, MA*

**Purpose:** Clinical evidence points to superior outcome with dose-escalation and suggests that brachytherapy may achieve superior dose-escalation when compared with external-beam for localized prostate cancer. We explore optimal brachytherapy regimens on the basis of radiobiologic models.

**Materials and Methods:** An algorithm based on the LQ model is constructed for fractionated and protracted irradiation. It includes tumor cell-line derived LQ parameters, repopulation, repair kinetics and isotope decay. Dose inhomogeneities for LDR (I-125 and Pd-103) and HDR (Ir-192) from patient-derived DVHs are incorporated. Three risk groups are defined in terms of radiobiological parameters to correspond to clinical risk: Favorable - iPSA  $\leq$  10 and bGS  $\leq$  6 and stage T2, Intermediate - one parameter increased, and Unfavorable - two parameters increased. Tumor control probabilities (TCP) are predicted for LDR monotherapy and for LDR or HDR boost after 45Gy EBRT. Several HDR regimens in clinical usage are compared.

**Results:** LDR brachytherapy is less susceptible to uncertainties in  $\alpha/\beta$  than EBRT or HDR and more susceptible to clonogen potential doubling time (Tpot). Model TCP for each regimen and risk groups are shown in Table 1 where they are compared with clinical series. Details of model results with respect to biologic input variables will be presented.

**Conclusion:** 1) LDR brachytherapy as monotherapy predicts superior tumor control as compared with EBRT to conventional doses and equivalent to escalated doses, 2) both LDR and HDR in combination with EBRT predict superior tumor control when compared with either modality alone, 3) for Favorable cancers, both LDR and HDR predict equivalent tumor control, however, 4) for Intermediate and Unfavorable cancers LDR predicts superior tumor control compared with HDR. These model conclusions are supported by long-term clinical outcome, and suggest potentially improved dose escalation with LDR brachytherapy.