risk p = 0.09). The patients with low or intermediate risks had a 95% DFS and patients with high risk had a 89% DFS.
Conclusion: Three-dimensional computed tomography-guided brachytherapy of prostate cancer is a feasible method of treatment which provides the possibility of treating efficiently even difficult cases of prostate cancer.

823 POSTER

The use of intra-prostatic gold markers for verification of position of the prostate gland in dose escalated external beam radiotherapy (EBRT) in prostate cancer (PC)

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Purpose: To examine and correct for day to day movement of the prostate gland, to secure safe margins in dose escalated EBRT and to record treatment results.
Methods and Materials: During 2004, 52 patients (pts) with PC had 4 gold markers implanted transperineally in local anaesthesia under transrectal UL-guidance. Two markers were placed ventrally and two dorsally in the right re-spectively left side of the prostate. After CT-scan for dose planning, DRR-images were used at the simulator to localise the prostate. EPID and simulation images were matched at the first 3 fractions, thereafter twice a week. If alignment differed >1 mm in the vertical (ver) or 2 mm in longitudinal (long) or lateral (lat) directions, pts were moved to a new position according to the match result. All pts have completed EBRT to a mean dose of 78.7 Gy (74–80 Gy). Mean age was 67 years (50–71). T1c-, T2-, and T3-tumors were seen in 27%, 38% and 35% respec-tively, and Gleason score 5/6/7/8 in 9.5%/60%/21%/9.5% of tumors. Mean PSA was 16 (2–89). Androgen deprivation before EBRT was given to 69% of pts in mean 5 months (mo). PSA-response, time of appearance of complications and required treatment were recorded at follow up. Three and six or more mo of follow up after EBRT were reached in 29 and 11 pts respectively.
Results: Minimum 1900 images were analyzed. The frequencies of pts-movements 5 mm or more were 22%, 19% and 12% in the vertical, longitudinal and latitudinal directions (SD 3.8 mm, 3.4 mm and 3.0 mm respectively).
PSA-relapse and distant metastases were seen in one pt. Urologic grade (gr) 1 symptoms were seen in 35% and gr 2 in 19% of pts before EBRT. Similar figures after 3 months were 21% and 72%. Early rectal complications gr 1 and 2 were seen in 31% and 52% of pts, and late gr 1 urologic- and rectal complications in 4/11. No. pts developed gr 3 morbidity. Erectile dysfunction (ED) before and after EBRT occurred in 13% and 36% of pts. All except one of pts with ED at 3 months had androgen deprivation before EBRT.
Conclusion: Intra-prostatic gold markers is an accurate method to assess intra-individually differences in prostate movements during EBRT in PC. EBRT was well tolerated. If the observed low grade morbidity is persisting, the total dose of EBRT may be further escalated.

824 POSTER

Hypofractionation using a concomitant intensity modulated radiotherapy (IMRT) boost for localized high risk prostate cancer: acute toxicity results

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The potential benefits of radiation dose escalation in high risk prostate cancer patients who receive elective nodal irradiation and adjuvant hormone ablation therapy are unknown. Hypofractionation as a means of dose intensification may offer even greater radiobiologic and practical benefits than simple dose escalation. The objectives of this prospective phase 1/2 study were to assess the toxicities and efficacy of delivering a concomitant hypofractionated IMRT boost.
Patients with localized high risk prostate cancer (any one of T3a, Gleason Score $\geqslant 8$, PSA >20) were eligible. Elective nodal irradiation to a dose of 45 Gy in 25 fractions was delivered using a conventional 4-field technique. At the same time, a concomitant IMRT boost of 22.5 Gy in 25 fractions was delivered to the prostate, resulting in a total dose of 67.5 Gy in 25 fractions to the prostate gland. This is equivalent to a dose of 77 Gy to 81 Gy in 2 Gy per fraction, assuming an alpha/beta value between 1.5 and 3 for prostate cancer. Daily on-line correction of prostate position using implanted fiducial markers was performed. A 4 mm planning target volume margin was used during the IMRT boost to take into account intrafraction prostate motion (based on previous intrafraction prostate motion measurements). Following radiotherapy, 3 years of adjuvant hormone ablation will be given. Acute toxicity during and within 3 months after radiotherapy was measured using the Common Terminology Criteria for Adverse Events version 3.0.
At the time of abstract preparation, 35 patients have completed the radiotherapy portion of the treatment with complete acute toxicity assessments. Median age of the patients was 71. Median PSA prior to treatment was 20. None of the patients developed any acute grade 3 gastrointestinal toxicity. 1 patient (3%) developed grade 3 urinary incontinence, 2 patients (6%) developed grade 3 urinary frequency/urgency, and 1 patient (3%) developed grade 3 urinary retention. Acute toxicities from this ongoing concomitant hypofractionated IMRT boost trial appear to be acceptable.

825 POSTER

Intensity modulated radiotherapy for high risk prostate cancer based on sentinel node optimized target volume definition

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Introduction and Objectives: Whereas cure rates for patients (pts.) with low/intermediate risk prostate cancer (PC) are good, the situation is much more problematic in high risk PC. In parallel with risk of distant seeding, the probability of locoregional lymph node metastasis increases. The RTOG 94–13 trial provided evidence that pts. with high risk of pelvic node involvement (estimated risk >15%) benefit from an additional radiotherapy to the pelvic nodes combined with concomitant hormonal ablation. Since the physiological lymphatic drainage is highly variable, the optimal target volume definition for the adjuvant nodes is problematic. To overcome this limitation, we tried to optimize our target volume definition by including information derived from pelvic sentinel nodes (SN) identification.
Material and methods: Pts. with histologically proven high risk PC, but cN0 stage, were included. To permit a three-dimensional (3D) localisation of SN transmission- and emission data were acquired using a double-headed gamma camera with an integrated X-Ray device (Millennium VG & Hawkeye®, GE) 1.5–3 hours after injection of 250 MBq ^{99m}Tc-Nanocoll. Numbers and 3D-localisations of SN were analysed. IMRT planning was done with Hyperion® based on 3 CT's, definition of clinical/planning target volumes (CTV/PTV) and risk organs (rectum, colon, small bowel, bladder, hips) with image fusion of 3 data sets. All SN localisations were included into the pelvic CTV additionally. Dose prescriptions were 50.4 Gy (1,8 Gy daily) to the pelvis and 70.0 Gy (2 Gy daily) to the prostate/seminal vesicles.
Results: Since 08/2003 6 pts. with cT1c-3b stage were treated. No. pts. had undergone a staging lymphadenectomy. All pts. had detectable SN, the numbers of SN per patient ranged from 2 to 9. A total of 29 SN could be identified for all 6 pts. together. Most common localisations were ext. iliac (9), followed by int. iliac (6), perirectal lymph. plexus (6), comm. iliac (2), sacral (2), int. pudendal (1), seminal vesicle lymph. plexus (1), superior rectal (1) and left paraaortic (1). IMRT planning could be completed in all pts. with acceptable doses to risk organs and prescribed doses to the target volumes. 4 of 6 pts. showed SN localisations (total 10 SN) that would not have been treated adequately with only CT-based planning ('geographical miss'). The comparison between dose-volume-histograms of IMRT- and conventional CT-planning in regard to the risk organs demonstrated clear superiority of IMRT when all SN were included. No gastrointestinal or genitourinary acute toxicity Grade 3 or 4 (RTOG) occurred.
Conclusions: IMRT based on sentinel lymph node identification is feasible and reduces the probability of a geographical miss. Furthermore IMRT allows a pronounced sparing of normal tissue irradiation. Thus the chosen approach will help to increase the curative potential of radiotherapy in high risk prostate cancer patients.

826 POSTER

Impact of internal fiducial markers with daily on-line realignment on TCP and rectal toxicity for dose-escalated prostate radiotherapy: Monte Carlo simulation with Dose-Population Histogram analysis

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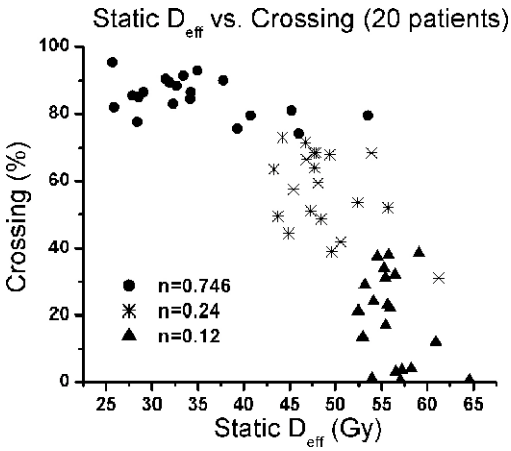
Background: By using internal fiducial markers with Electronic Portal Imaging (EPI) for patient repositioning prior to the delivery of each fraction, the geometrical errors in prostate radiotherapy can be reduced allowing for a tighter planning target volume (PTV) and dose escalation. We simulated effects of full (no repositioning) and reduced (repositioning) uncertainties,

using the Monte Carlo method, to look at the impact of dose escalation on TCP and rectal toxicity.
Material and methods: 20 prostate patients' anatomies were chosen. Reference Plan (RP: 10 mm PTV margin, 70 Gy/35 fx, full uncertainty) and the Escalated Plan (EP: 5 mm PTV margin, 78 Gy/39 fx, reduced uncertainty) were generated. Setup and organ motion uncertainties were modeled in a stochastic manner, and the dose to organs was recorded. TCP for prostate and effective doses (D_{eff}) to rectum were calculated. Different volume dependence factors available from literature were tested for D_{eff}: n = 0.12 (serial), 0.24, and 0.746(parallel). To compare the rectal toxicity, dose-population histograms (DPH) were generated. We deemed EP acceptable as long as the currently observed complication rate (15% grade II toxicity) was not exceeded; this is defined as the reference point on the RP's DPH. If the crossing point between the EP's DPH and the RP's DPH was at >20%, then the DPH was deemed to be acceptable. This was assumed to lead to a lower risk of complication.
Results: With reduced positioning uncertainties using fiducials, compared to the RP, the EP leads to an increased TCP from ~60% to ~80% for intermediate risk patients. The location of the crossing points for each patient with different n values are shown in the graph. If we consider rectum as a parallel organ, a majority of patients would have reduced complication risk from EP; even if serial model is considered, only a small proportion of patients are at increased risk compared to RP.



Conclusion: Reduced geometrical errors using fiducial markers and EPID allow us to reduce PTV margin to 5mm and escalate dose to 78Gy with lower rectal toxicity rates provided rectum has a strong dose-volume dependence (n=0.24).

827 POSTER

Quantification of organ intra-fractional motion during IMRT for prostate cancer

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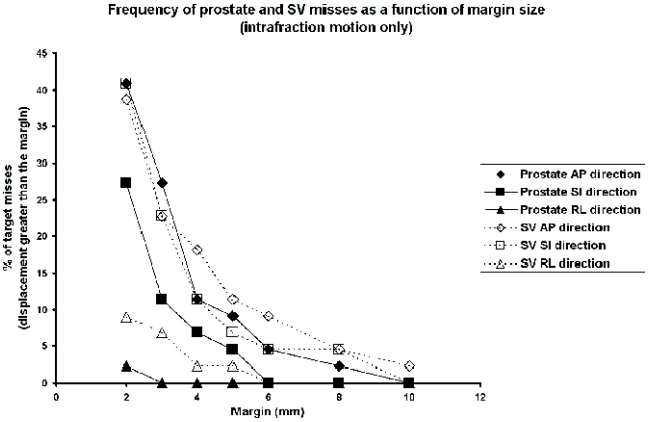
Background/Purpose: Recent advances in image-guided radiation therapy have allowed safely decreasing the PTV margin around the prostate by minimizing the effects of inter-fractional prostate motion and setup variation. However, most of the image-guided procedures acquire target information prior to the start of treatment and therefore don't address the remaining intrafraction variation in prostate position. The purpose of the study is to quantify the variability in prostate and seminal vesicle (SV) position during an IMRT treatment and to assess the impact of rectal and bladder variation.
Material and methods: Forty-four prostate cancer patients receiving IMRT for prostate carcinoma were treated using a commercial integrated CT-LINAC system (EXaCT, Varian Oncology Systems) that allows CT imaging while the patient remains immobilized in the treatment position. On one of the treatment days for each patient, two CT scans were acquired: one before starting an ultrasound-guided prostate localization procedure and the other was immediately after the IMRT fraction. A single physician performed the organ contouring. The two CT images before/after the treatment fraction were registered using in-house CT-to-CT 3D image registration software based on bony structures in the pelvic region. After bony alignment, the displacement of the prostate and seminal vesicles (SV) over the treatment fraction was calculated in the anterior-posterior (AP), superior-inferior (SI) and right-left (RL) directions.
Results: The mean time elapsed between two CT image scans ±1SD was 21.3±4.3 minutes. The mean values of the prostate shifts±1SD were 1.1±2.6 mm (range: −3.4 to 8.6 mm) in the AP, −0.4±2.1 mm (range: −5.9 to 3.4 mm) in the SI, and 0.03±0.7 mm (range: −2.6 to 1.3 mm) in the RL axes. A 3-mm margin would successfully cover the intra-fractional prostate motion in 73%, 89%, and 100% of the patients in the AP, SI, and RL directions, respectively. The risk of prostate and SV misses as a function of margin size is presented in the Figure. The bladder volume had a systematic increase (±1SD) of 126±80 cc (range: 21 to 303 cc). The volume of rectum varied more in a random fashion with an averaged net volume increase of 5.5±18.5 cc (range: −12.1 to 78.4 cc). The rectal volume and the rectal gas volume were highly correlated with the anterior prostate shifts ($p < 0.001$) and anterior SVs shifts ($p < 0.001$). The bladder volume variation showed a lesser correlation with the inferior prostate shifts ($p = 0.016$).



Conclusions: Intra-fractional prostate motion remains significant in AP and SI direction (SD = 2–3 mm, up to 9 mm), emphasizing the need for a PTV margin around the prostate in case of image-guided radiation therapy. AP prostate motion is highly correlated with rectal volume variation.

828 POSTER

Co-morbidity impact on survival in irradiated prostate cancer patients

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Purpose: To evaluate co-morbidity impact at diagnosis on survival prostate cancer selected for radiation therapy in clinical practice.
Patients and method: Two hundred sixty four patients from a general hospital influence area treated with radiation for prostate cancer from 1993 to 2003 were included. Median follow-up was 38 months and median age was 70 years old. Dose for adjuvant therapy or therapeutic postoperative dose was 66 Gy, and 70 Gy was indicated for radical intention. One hundred five patients received neoadjuvant and concomitant hormonal treatment. A univariate by Kaplan-Meier method with log-rank and Breslow comparison test and multivariate analysis by Cox model were done to detect prognostic factors on survival.
Results: Clincal stages were distributed as follows: T1 29% of patients, 51% for T2, 19.5% were T3 and 1% T4. Mean PSA concentration value was 11.5 ng/ml. Gleason score was 6–10 in 37% of patients. Patients median age was 70 years old. Comorbidity at diagnosis was present in 65.5% of patients. Overall survival was 97.7%, 89.2% and 66.9% at 2, 5 and 7 years respectively. Overall survival by co-morbidity decreased from 97.6% at 2 years and 96% at 5 and 7 years without co-morbity to 97.7%, 84.3% and 75.2% at 2, 5 and 7 years respectively with co-morbid diseases. Overall survival by comorbidity status show a significant increase at 30 months. Breslow test: $p = 0.1612$; Log-Rank test $p = 0.0217$.
Conclusions: Co-morbidty has an impact on survival for prostate cancer patients send for radiation therapy. Careful selection should be recommended in scalating prostate dose delivery.