Table 1. Fractions where CTV is displaced outside the PTV

	Centre of markers			Bony anatomy		
	LR	SI	AP	LR	SI	AP
Before off-line (Number)	3	6	48	59	20	121
Percentage	0.8%	1.6%	12.4%	15.1%	5.1%	31%
After off-line (Number)	0	0	10	34	20	27
Percentage	0%	0%	2.6%	8.7%	5.2%	7%
After on-line (Number)	1	0	0	4	9	10
Percentage	0.3%	0%	0%	1.0%	2.3%	3%

4057 POSTER

Tomotherapy in patients with prostate cancer

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Background: Tomotherapy is a new technique for image guided radiotherapy in patients with prostate cancer. By this technique dose escalation up to 80 Gy is possible.The treatment of patients with tomotherapy was analysed.
Material and Methods: Since December 2006 13 patients with prostate cancer were treated with tomotherapy, nine of them for primary tumors and four patients for salvage after prostatectomy. In 8 cases small volumes (prostate +/− seminal vesicles) and in 5 cases also larger volumes including the pelvis were treated. A comparative treatment planning was done for tomotherapy, 3D-conformal and intensity modulated radiotherapy (IMRT). Daily adjustments in the optimisation process by matching KV-CT and MV-CT and table and treatment times were analysed. Acute toxicity was documented.
Results: In all cases tomotherapy showed a reduction of dose to the rectum and the femoral heads in the dose-volume-analyses in comparison to 3D-conformal and intensity-modulated radiotherapy. By these dose-reductions a dose-escalation of 76−80 Gy was possible in primary radiotherapy. Tabletimes and treatment times were 26 and 4 minutes for small volumes and 28 and 6.7 minutes for large volumes. Daily adjustments for translations (*x, y, z*, roll) were 4.9±3.4 mm, 2.1±1.3 mm, 7.3±3 mm, 0.350±0.30 for small volumes and 3.1±2.1 mm, 1.4±1.4 mm, 5.5±2.7 mm, 0.250±0.230. Acute toxicity (CTC-score) for rectum and bladder was maximal grade 2.
Conclusions: Tomotherapy had better dose-volume-parameters in comparison to IMRT and 3d-conformal radiotherapy. Median table times for the patients were 26 and 28 minutes. Median adjustments for *x, y, z* were under 10 mm. Acute toxicity was tolerable.

4058 POSTER

Survival and PSA relapse data after hypofractionated radiotherapy for early stage prostate cancer

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Background: Radiotherapy is often used for localised early stage prostate cancer. Radiation schedules vary and hypofractionated regimes aim to exploit a potential radiobiological advantage of low α/β ratio. The use of neoadjuvant hormone treatment has been shown to increase control. We report the results from radical treatment of early prostate carcinoma (T 1 and 2) with 3 months of neoadjuvant hormone therapy and then 5250 cGy in 20 fractions to prostate +/− seminal vesicles.
Methods: Using the Edinburgh database we identified 201 patients treated for T1/T2 prostate cancer from 1996 to 2001. Results were analysed for survival and PSA relapse free survival. The results were analysed according to pre-treatment prognostic groups – good (PSA $\leqslant$ 10, Gleason $\leqslant$ 6), poor (PSA $\geqslant$ 10, Gleason $\geqslant$ 6) or intermediate (one of prognostic indicators raised).
Results: *Survival*: Minimum follow up was 47 months. 64 patients have died, giving an overall actuarial 5-year survival rate of 77.6%, 56.5% at 10 years. Good Prognostic group 97.1% (95% CI 91.1–100.0); Intermediate 92.2% (86.6−97.8); Poor 75.4% (64.8−85.9).
PSA Relapse: 110 patients have had a PSA relapse. The actuarial rates were 6.0%, 21.1%, 34.5%, 44.7% and 48.8% at 1, 2, 3, 4 and 5 years, respectively. The 5-year relapse rate was 22.8% for the good prognosis group, 44.2% for the intermediate prognosis group and 71.0% for the poor prognosis group.

PSA relapse 5 years

Group	Relapse	95% CI
Overall	48.8%	41.6−55.9
Prognostic group		
Good	22.8%	8.9−36.7
Intermediate	43.2%	32.9−53.5
Poor	71.0	59.8−82.3

Discussion: Overall PSA relapse free survival and overall survival is poorer in this series compared to other series using longer fractionation. It is likely that the hypofractionated dose used may be too low (equivalent dose in 2 Gy fractions is 61.9 Gy if α/β ratio is 1.5). The use of neoadjuvant hormones does not seem to compensate for this low dose.
Compared to the Canadian study (Lukka et al) that used the same dose fractionation in one arm but without neoadjuvant hormone treatment, our results are worse [their PSA relapse rate (defined by Houston criteria) at 5 years was 42%, ours is 49%]. The Gleason score were similar in both studies (60% had Gleason $\leqslant$6) though mean PSA was less in Canadian study (10.6 vs 23.6).
The margins in the Canadian study were larger (1.5 cm compared to 1 cm anteriorly and laterally) and (1 and 0.6 cm posteriorly) respectively. Also all the patients were CT planned in the Canadian study, whilst only 30% were CT planned in our series in this time period. These differences and the higher average PSA may explain the lack of improvement in our series despite the addition of neoadjuvant hormone treatment.
Conclusion: The results of this series are not as good as other published results and we have subsequently increased our radiotherapy dose to 55 Gy in 20 fractions. We also now CT plan all radical prostate patients.

4059 POSTER

Confirmation of proton beam by positron emission tomography apparatus in patients with prostate cancer

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Background: Proton therapy is promising and sophisticated treatment modalities against prostate cancer and other malignancies. The proton-irradiated area can be confirmed by coincidence detection of pair annihilation gamma rays from positron emitting isotopes generated by nuclear reaction of irradiated proton nuclei and nuclei in the irradiation target, called autoactivation. Thus, the purposes of this study are to investigate which positron emitting isotopes are detected in our clinical settings, and to evaluate whether anatomical or physiological factors affected or not in patients with prostate cancer treated with proton therapy.
Methods and Materials: Autoactivation data were evaluated in thirty patients treated with 210 MeV proton beam to a fraction dose of 2 Gy equivalent (GyE). Those patients were received totally 74 GyE. Doses were calculated on the basis of the pencil beam algorithm. Beam parameters including width of spread-out Bragg peak (SOBP) and degrader thickness were adequately selected with 3D treatment-planning system. Calculation of radioactivity induced by the autoactivation started at 5 min after proton irradiation for 10 min by using a PET apparatus and a vendor-provided software for interpreting image data. Regions of interest were set in following 5 portions; PTV center, urinary bladder within PTV, urinary bladder outside PTV, rectum (outside PTV), and contra-lateral femoral head (outside PTV). Experimentally, 6 GyE of proton beam was irradiated to following materials containing certain percentage of several target nuclei for positron emitting: Tough water phantom (^{12}C, ^{16}O), charcoal (^{12}C), blood sample (^{12}C, ^{16}O). Diffusion effect of water in the autoactivation was compared to that of ice-block ($20\times20\times20$ cm^3) both with setting a 6 cm width of SOBP.
Result: Isodose curve (95%) and distribution of the autoactivation were well-matched in terms of beam range in axial image of PTV center level in all patients. However, in sagital and coronal image, and axial image of bladder level, the autoactivation spread out of 95% of the isodose curve. Mean calculated radioactivities in those 30 patients with prostate cancer were 39 Bq in PTV center, 36 Bq in urinary bladder within PTV, 19 Bq in urinary bladder outside PTV, 4 in rectum (outside PTV), and 2 in contra-lateral femoral head, respectively. From this result, urine in the urinary bladder seemed to be a major diffusion mediator of autoactivation after the proton irradiation. In our experimental setting and time point, the major

component detected as a positron emitting isotopes by the PET apparatus was defined as ^{15}O, not only ^{11}C.
Conclusion: Imaging of the autoactivation has an impact to confirm a proton beam in patients with prostate cancer. However, physiological factors, especially urine in the urinary bladder, need to be taken into account for the comparison to the dose distribution in the future.

4060 POSTER

Annual ibandronic acid to prevent gonadotropin included bone loss in men with prostate cancer

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Background: Gonadotropin decrease bone mineral density (BMD) and increase fracture risk in men with prostate cancer. Ibandronic acid (6 mg IV every 3 months) increases BMD in GnRH agonist treated men. Intermittent ibandronic acid (6 mg IV once annually) increases BMD in postmenopausal women with osteoporosis but the efficacy of the annual treatment schedule in hypogonadal men is unknown.
Patients and Methods: Én a 12-month open-label study, men with nonmetastatic prostate cancer (n = 44) who were receiving a GnRH agonist were assigned randomly to ibandronic acid (6 mg IV $\times$ 1) or placebo. BMD of the posteroanterior lumbar spine and total hip were measured by dual energy x-ray absorptiometry at baseline and month 12.
Results: Mean (+SE) BMD of the posteroanterior lumbar spine increased by 4.0+0.9 in men treated with ibandronic acid and decreased by 3.1$\pm$0.9 percent in men who received placebo ($p < 0.001$ for between-group comparison). BMD of the total hip decreased by 0.7+0.6 percent in men treated with ibandronic acid and decreased by 1.9+0.7 percent in men who received placebo ($p = 0.005$).
Conclusions: In men receiving a GnRH agonist for prostate cancer, a single treatment of ibandronic acid significantly increased bone mineral density of the total hip and spine at 12 months. ÁnnuaÉ ibandronic acid may provide a convenient and effective strategy to prevent bone loss in hypogonadal men.

4061 POSTER

Intensity modulated radiation therapy with ultrasound-based daily target localization for clinically localized prostate cancer: institutional experience and acute toxicity outcomes

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Background: The I-BEAM ultrasound (US) based system provides a real-time, non invasive and rapid means of patient alignment, to take into account the prostate positional variations during IMRT treatments. This investigation reports our experience on the daily use of I-BEAM and the analysis of 947 US procedures in 42 consecutive patients treated with IMRT for prostate cancer. In addition, the impact of this technology on acute toxicity is assessed.
Methods and Materials: From September 2005 to March 2007, 42 patients were treated using I-BEAM. All patients underwent to a 3D simulation-CT, the target and critical organs were delineated using Focal Contouring Software and treatment plans were calculated using XiO Planning System. Patients were classified into risk groups according with their T stage, PSA level and Gleason Score. Prostate and seminal vesicles were treated with a IMRT to 78 and 62.4 Gy respectively, and whole pelvis, when required, was treated with a 3D-CRT to 45 Gy. During the treatment, the position of all patients was controlled using orthogonal portal images for accounting to set-up variations, and a daily US procedure was performed to correct the organ motion displacements. The individual I-BEAM shifts were charted in each of the 3 principal directions. Acute toxicity was scored for all patients according to RTOG genitourinary (GU), gastrointestinal (GI), anal and cutaneous acute toxicity scales.
Results: The mean shift in each direction, averaged over all patients, was −0.09, 0.84 and −2.51 mm in the lateral (RL), antero–posterior (AP) and superior–inferior (SI) dimensions, respectively. Interfraction standard deviation of prostate position was 3.35, 4.87 and 4.25 mm in the RL, AP and SI dimensions, respectively. The GU toxicity rates were grade 0: 35.7% and grade 1: 64.3% (no toxicities $\geqslant$ grade 2 were reported). The GI toxicity rates were grade 0: 57.1%, grade 1: 30.9% and grade 2: 11.9%. The anal toxicity rates were grade 0: 66.7% and grade 1: 33.3%, and the cutaneous toxicity rates were grade 0: 83.3% and grade 1: 16.7%.
Conclusions: Organ motion is the main obstacle to correctly delivering IMRT, so an alignment system is necessary to ensure the prostate position before each IMRT fraction. US-based IGRT is relatively simple, fast and feasible, and permits the safe delivery of high doses of radiation. When available, this technology makes possible a margin reduction and reduces the acute toxicities, especially rectal complications.

4062 POSTER

Risk-adapted high-dose 3D-radiotherapy combined with hormonal treatment for prostate cancer

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Introduction: Based on risk-group (MSKCC classification), we designed in 2001 our protocol of treatment for patients with prostate cancer. We present our preliminary results.
Material and Method: According to MSKCC risk-group, there were 3 groups: Group A (low-risk), Group B (intermediate risk) and Group C (high risk). Treatment by groups: Group A, radiation therapy (RT) confined to the prostate (P) to a total dose of 72 Gy; Group B, RT to the prostate and seminal vesicle (SV), 54 Gy, followed by prostate boost to a dose of 76 Gy, combined hormonal treatment (CHT) during 6 months; and Group C, RT to the pelvis 45 Gy followed by RT to P+SV (54 Gy) and a final boost over P to 76 Gy, hormonal treatment consisted of 3-months neoadjuvant CHT, concomitant CHT with RT, and 2 years of adjuvant treatment with LH-RH analogous.
Results: There were 142 patients (pts) (2001–2003). Aged from 58 to 81 (median 70 years). Group A 31 pts (22%);Group B 46 pts (32%), and Group C 65 pts (46%). Follow-up: smallest 36 months (median: months).
Protocol compliance: Of the group C, 6 pts received less dose of RT than scheduled and other 6 adjuvant hormonal therapy only for 6 months (intolerance).
Acute toxicity (RTOG): Grade 2: dysuria 49 pts (34%); urinary frequency 38 pts (26%), stool frequency 14 pts (9.9%), rectal 62 pts (43%). Grade 3: dysuria 3 pts (2%); urinary frequency 23 pts (16%), stool frequency 0%, rectal 0%. Grade 4: urinary frequency 1 pt (0.7%).
Late toxicity: Grade 2: genitourinary: 8 pts (5.6%), gastrointestinal 31 pts (22%); Grade 3: genitourinary 7 pts (4.9%), gastrointestinal 5 pts (3.5%); Grade 4: genitourinary 1 pt (0.7%). Actuarial toxicity 5 years grade 2−4: genitourinary 14%; gastrointestinal 5.5%.
Survival: Five-year biochemical disease-free survival (BDFS): Group A: 100%, Group B: 95%, Group C: 87%. Five-year clinical disease-free survival (CDFS): Group A: 100%, Group B: 85%, Group C: 91%. Five-year disease-specific survival (DES): Group A: 100%, Group B 100%, Group C: 95%.
Conclusions:
1. The compliance of the treatment has been acceptable in general, with only minor deviations.
2. Acute and late effects have been moderated and according to the literature.
3. Preliminary data BDFS, CDFS and DES are promising.

4063 POSTER

78 Gy prostrate cancer dose escalation programme: dosimetry and acute toxicity

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Background: Radiotherapy dose escalation in prostate cancer improves outcome. Precision radiotherapy techniques such as 3D CRT and IMRT that incorporate appropriate target dose and normal tissue dose goals and constraints are required to deliver these higher doses safely. This paper presents the dosimetry and acute toxicity of the prospective 78 Gy dose escalation study at Austin Health.
Material and Methods: The patient cohort includes the first fifty patients treated for localised prostate cancer to a dose of 78 Gy in 2 Gy per fraction at the Austin Health. The cohort consists of mainly locally advanced prostate cancer patients: 5% low risk, 10% intermediate and 85% high-risk patients (NCCN criteria). The mean PSA was 18 (2−83). The majority received 3 months of neoadjuvant and then concurrent hormonal therapy with LHRH agonists. All patients underwent planning with a CT scan co-registered with an MRI unless there was a contraindication for MRI.
Volumes were marked and planned according to the dose goals and limits listed in table 1. We delivered all treatments re using IMRT. Toxicity was scored according to the RTOG acute toxicity grading criteria.