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Green, S. and Phoenix, B. and Mill, A. J. and Hill, M. and Charles, M. W. and Thompson, J. and Jones, B. and Ngoga, D. and Detta, A. and James, N. D. and Doran, J. and Graham, N. and Ghani, Z. and Wojnecki, C. and Halbert, G. and Elliott, M. and Ford, S. and Sheehan, T. M. T. and Vickerman, J. and Lockyer, N. and Croswell, G. and Boddy, A. and King, A. and Cruickshank, G. S. (2011) *The Birmingham Boron Neutron Capture Therapy (BNCT) project : developments towards selective internal particle therapy.* Clinical Oncology, 23 (3). S23-S24. ISSN 0936-6555

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Results: Ninety-seven patients (median age 50 years, range 23 to 89) were included. All received external beam radiotherapy (50 Gy in 5 weeks) with concurrent weekly cisplatin (40 mg/m^2) followed by high dose rate brachytherapy. During the 5 weeks of chemoradiation the median fall in lymphocyte count was 1.28×10^9/l. Those with a fall in lymphocyte count greater than the median had a statistically significant improved DFS (74.5% vs 40% at 5 years, $P = 0.001$), LRFS (74.5% vs 46% at 5 years, $P = 0.01$), and OS (75.5% vs 49% at 5 years, $P = 0.02$). In the multivariate analysis a fall in lymphocyte count was associated with a significant improvement in DFS (HR 0.35; 95% CI 0.18–0.64; $P = 0.0002$), LRFS (HR 0.33; 95% CI 0.16–0.6; $P = 0.0002$) and OS (HR 0.30; 95% CI 0.14–0.57; $P = 0.0001$), respectively.
Conclusions: Fall in lymphocyte count during chemoradiation for cervical carcinoma is an independent predictor for treatment outcome.

36 Induction TPF Combined with Concurrent Cisplatin Chemoradiotherapy for Stage IV Head and Neck Squamous Cell Cancer

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Aim: The feasibility and efficacy of combining induction taxane-based chemotherapy with concurrent cisplatin chemoradiotherapy for locally advanced head and neck squamous cell carcinoma (HNSCC) has been uncertain.
Methods: Between March 2006 and February 2010, 66 patients with non-metastatic stage IV HNSCC were treated in a single institution with three cycles of induction TPF (docetaxel 75 mg/m^2, cisplatin 75 mg/m^2, 5-FU 750 mg/m^2 days 2–5) followed by radical radiotherapy with concurrent cisplatin 100 mg/m^2.
Results: Median age was 54 (range 33–69). Median follow-up was 21 months (range 4–55). During TPF grade 3 toxicity occurred in 18 (27%), dose modifications in 10 (15%), delays in three (5%) and unplanned admissions in six (9%) patients; a clinical tumour response was documented in 60 (91%) patients. Median time from the final cycle of TPF to commencing radiotherapy was 22 days. Sixty-two (94%) patients received radical radiotherapy, and all completed treatment with no delays $\geq$3 days. One, two and three cycles of concurrent cisplatin were delivered to 18 (29%), 38 (61%) and three (5%) patients, respectively. Ninety-two per cent of patients received enteral feeding; median weight loss during treatment was 7%. Forty-two (68%) patients had unplanned admissions with no on-treatment deaths. Three unrelated deaths occurred post-treatment. At 1 year post-treatment 21% of patients without disease progression remained gastrostomy dependent. 50/58 (86%) assessable patients achieved a complete response post-treatment. One and 2 year progression free survival (PFS), cause-specific survival (CSS) and overall survival (OS) were 88%, 92%, 86% and 80%, 85%, 80%, respectively.
Conclusion: The combination of induction TPF with concurrent cisplatin chemoradiotherapy is feasible with encouraging efficacy.

37 Correlation of HPV Status to Treatment Outcomes Post Radiotherapy in Tonsillar Carcinoma: a UK Regional Centre Experience

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Aim: We performed a single centre, retrospective audit to evaluate radiotherapy treatment outcomes for HPV positive and negative patients with tonsillar carcinoma.
Methods: Case notes of 45 patients treated at the Newcastle upon Tyne Hospitals NHS Trust, between January 2000 and December 2003 with tonsillar cancers were analysed. Data were collected for patient demographics, risk factors, treatment details and outcomes. HPV status was determined using a combination of p16 immunohistochemistry and *in situ* hybridisation.
Results: Median follow-up was 40.37 months (range 2.5–106.5); 62.5% of patients were HPV positive. Seven-six per cent of this group were male, median age 49 years (range 40–71), 92% were stage III/IV and 60% were smokers. This compared with 80% male in the HPV negative group, median age 60 years (range 15–76), 86.7% stage III/IV, 73.3% smokers. Eighty per cent of the HPV postitive group underwent surgery followed by adjuvant radiotherapy. Twenty per cent had primary radiotherapy $\pm$ chemotherapy compared to 73.3% and 20% in the HPV negative group. After 3 years 60% of HPV positive patients were alive; 16% had local recurrences; 8% died from other primary cancers. At 5 years, 48% were still alive. In the HPV negative group 40% were alive at 3 years; 30% locally recurred, one was treated with surgery; 13.3% died with other primaries. At 5 years, 33% were alive.
Conclusions: HPV positive patients were younger and had weaker association with smoking compared to HPV negative cases. HPV negative patients had worse local control and overall survival on a stage by stage comparison. This raises the question about the rationality of certain de-escalation strategies advocated for HPV positive oropharyngeal cancer cases. On the other hand, dose escalation in locally advanced patients could be explored within clinical trials and prospective stratified HPV data analysed further to ascertain the two groups in order to identify subgroups that could benefit from such approaches.

38 The Birmingham Boron Neutron Capture Therapy (BNCT) Project: Developments towards Selective Internal Particle Therapy

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Introduction: This paper will review progress on two aspects of the Birmingham BNCT project. Firstly on evaluation of the effects of high and low LET radiations when delivered simultaneously, and secondly on attempts to optimise delivery of the boron carrier compound BPA through pharmacokinetic studies.
Methods: Simultaneous or non-simultaneous irradiations of V79 cells with alpha-particle and X-ray irradiations were performed. Alpha doses of 2 and 2.5 Gy were chosen and the impact on survival when delivered separately or simultaneously with variable doses of X-rays was evaluated. The pharmacokinetics of the delivery of a new formulation of BPA (BPA-mannitol) are being investigated in brain tumour patients through a study with 2×2 design featuring intravenous and intracarotid artery infusion of BPA, with or without a mannitol bolus.
Results: On the combined effect of low and high LET radiations, a synergistic effect was observed when alpha and X-ray doses are delivered simultaneously. The effect is only present at the 2.5 Gy alpha dose and is a very substantial effect on both the shape of the survival curve and the level of cell killing. This indicates that the alpha component may have the effect of inhibiting the repair of damage from the low LET radiation dose delivered simultaneously. On the pharmacokinetics of BPA, data on the first three cohorts indicate that bioavailability of BPA in brain ECF is increased substantially through the addition of a mannitol bolus, as well as by the use

of intracarotid artery route of infusion. In both cases, for some patients the levels after infusion approach those seen in blood, whereas the ECF levels for intravenous infusion without mannitol are typically less than 10% of the blood values.
Conclusion: The magnitude of the synergistic effect between high and low LET radiations delivered simultaneously has been quantified. Tumour-selective uptake of boron in a new formulation of BPA has been confirmed.

39 Immunological Profiling of T Cell Functional Changes during Prostate and Pelvic Nodal Radiotherapy

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Background: Cancer vaccines are new treatments that have entered the early clinical trial phase as single agents and in combination with conventional therapies. For such novel treatment combinations it is important to characterise the immune status of patients receiving conventional therapies alone. We carried out sequential multiparameter immunological monitoring of prostate cancer (PCa) patients with locally advanced disease undergoing hormone therapy (HT) and radiotherapy (RT).
Methods: Blood samples from 12 patients, receiving 3–6 months of neo-adjuvant HT prior to radical RT, which consisted of a single phase delivering 55 Gy in 20 fractions to the prostate and 44 Gy in 20 fractions to the pelvic nodes were collected at baseline (0–4 weeks after initiation of ADT), RT_0 (day 0 of RT), RT_1 (after one fraction of RT), RT_{20} (during week 4 of RT) and post-RT_4 (4 weeks post RT). Mononuclear cells and plasma for immunological assays were isolated by Histopaque density gradient centrifugation.
Results: Longitudinal follow-up of patients revealed several significant immunological changes during RT. Both the numbers of T cells in peripheral blood and the ability of these T cells to undergo proliferation *in vitro* were impaired. T cell proliferation was completely rescued by exogenous IL-2 post-RT. There was significantly more loss of naive and early memory T cells compared to more differentiated T cells in the blood of patients during RT. Furthermore, memory T cell responses to common viral antigens, measured by IFN-g production, were little affected by RT and anti-tumour $CD4^+$ and $CD8^+$ T cell responses became detectable after RT.
Conclusions: RT triggers complex immunological changes in PCa patients resulting in a preferential impairment of naive compared to memory T cells. The appearance of tumour-specific T cell activity suggests a potential immunological element in tumour-responses. These results can inform the scheduling of radio-immunotherapy in PCa.

40 Implementation of Volumetric Arc Therapy (VMAT) for Head and Neck Cancer

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Aim: The Varian VMAT solution, RapidArc, was retrospectively installed on two of the 11 linacs at the BWoSCC in May 2010. The first VMAT treatment was delivered within 4 weeks of installation. This study compares initial planned dose distributions for conventional intensity modulated radiotherapy (IMRT) and VMAT, and also considers the dosimetric effects of weight loss for head and neck cancer.
Method: Ten patients with floor of mouth PTVs who were previously treated with IMRT were retrospectively planned for single and double arc VMAT plans. The patients received 68 Gy and 61.2 Gy to primary and nodal PTVs, respectively, in 34 fractions. Calculated dose to the PTVs and organs at risk (OAR) were compared. V_{3Gy}, V_{5Gy}, V_{10Gy}, V_{20Gy} and total plan monitor units were also compared. Following implementation, CBCT scans were obtained weekly for 15 patients. The CBCTs were used to recalculate the treatment plans and assess the impact of weight loss on central nervous system (CNS) dose.
Results: The mean conformity index (CI) = 0.93 and 0.96 and the mean sigma index (SI) = 4.2 and 3.8 for IMRT and double arc VMAT plans, respectively. The OAR dose was comparable and there was a 60% reduction in MU. The V_{3Gy} and V_{5Gy} were increased by an average of 30% and 10%, respectively, for VMAT plans. There was no significant difference in V_{10Gy} and V_{20Gy} between both planning techniques. The assessment of weekly CBCTs showed that weight loss increased the CNS maximum dose by up to 9%.
Conclusions: VMAT for head and neck cancer can be implemented smoothly and quickly into a large, busy cancer centre. Double arc planning gives comparable OAR and improved PTV doses. VMAT plans give a reduction in MU but have a dose bathing effect at V_{3Gy} and V_{5Gy}. An evaluation of weight loss must be performed during treatment for VMAT patients.

41 Imaged Guided Intensity Modulated Radiotherapy for Head and Neck Cancers

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Background: Delivery time can be prolonged with 'step and shoot' intensity-modulated radiotherapy (IMRT) for head and neck cancers. Although inter-fraction displacement has helped to define reduced PTV margins in many departments, estimation of intrafraction displacement is more difficult to evaluate and has often not been taken into account.
Methods: Twenty-six patients were treated with IMRT using an Elekta Synergy linear accelerator. Immobilisation was provided by a thermoplastic shell. A margin of 5 mm was used to grow the PTV from the CTV. Cone beam computed tomography (CBCT) imaging was performed and compared to the planning CT to calculate the positional errors in setting-up the patient. Translational corrections (couch shifts) were applied if the discrepancy between CBCT and planning CT was outside local protocol tolerance levels of 2 mm. It was not possible to correct for rotations. The van Herk formula was used to calculate the PTV margin.
Results: Twenty-six patients have been studied to date. The mean inter-fraction shifts derived from 246 CBCT images were 0.36 ± 0.08, 0.38 ± 0.11 and 0.29 ± 0.11 mm in the medial–lateral, superior–inferior and anterior–posterior dimensions, respectively, with 70% of all shifts within 2 mm from the planning CT. Following couch corrections, only one patient had post-CBCT images with more than 2 mm shifts from the planning CT. Data will be presented on the ability to reduce PTV margins using daily online correction.
Conclusions: Daily IGRT with online correction can be used to deliver head and neck IMRT. Correction data vary according to the defined region of interest for the CBCT co-registration with the planning CT images and is operator dependent. Based on RBE of 1.1 for KV X-ray imaging, the estimated additional biological effective dose of daily CBCT delivering 1.5 mGy with a schedule of 55 Gy in 20 fractions is 77.8 mGy_3.

42 Volumetric Modulated Arc Therapy vs Intensity Modulated Radiotherapy for Three Dose Level Prostate Treatments

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Aims: The aim of this study was to compare single arc VMAT against fixed field IMRT for multiple dose-level prostate treatments.
Methods: Ten patients previously treated with five field IMRT were re-planned using the Philips SmartArc planning module. The prescription was 57 Gy mean dose to the prostate in 19 fractions, with dose constraints on three planning target volumes (PTVs). The VMAT plans consisted of a single 360° arc with a spacing of 4° between each control point. Comparisons were made between the IMRT and VMAT plans by analysing dose volume characteristics. Plans were delivered on the linear accelerator to assess the delivery time, and verification was performed using the Scandidos Delta[4].
Results: For the target volumes, the VMAT plans provided better coverage to PTV1 (a two-tailed *t*-test gives $P << 0.05$). PTV2 and PTV3 coverage was similar between IMRT and VMAT ($P > 0.5$ in both cases). The volume of rectum receiving a high dose (V54Gy) was reduced with VMAT ($P << 0.05$), whereas the intermediate to low dose volumes were similar. VMAT plans required an average of 494 MU whereas IMRT required 509 MU ($P > 0.5$). Planning time with SmartArc was approximately 2 h (including contouring