were measured from daily imaging acquired following setup using external setup marks ('non-IGRT'), and verification imaging obtained after IGRT and repositioning ('IGRT'). Treatment plans were exported from the treatment planning system to Matlab using Computational Environment for Radiotherapy Research (CERR) software tools. For each fraction, the planned dose distribution was shifted by the measured AP, LR, CC offsets (for 'non-IGRT' and 'IGRT' situations). For each patient, the daily dose distributions were summed to produce an estimated composite delivered dose with and without IGRT. These plans were compared to the prescribed plan, evaluating differences in liver effective liver volume (Veff), liver mean dose, minimum dose to the target and maximal duodenum and stomach doses.
Results: 435 images (242 AP: 193 LR) acquired from MV EPIDs (14 patients, 316 images) or kV CBCT (7 patients, 117 images) projections were evaluated. Residual offsets in non-IGRT and IGRT groups are shown in Table 1. Compared to the prescribed plan, the liver Veff was increased in 10 of 21 non-IGRT plans (mean 10.5%) and 6 of 21 IGRT plans (mean 4.8%). The minimum target dose was <93% of prescribed in 14 of 21 (67%) non-IGRT and 5 of 21 (24%) IGRT plans. Mean liver doses were increased >1% in 8 non-IGRT plans (mean 11.6%) and 5 IGRT plans (mean 2.8%). Duodenum max. dose was >5% of prescribed in 8 of 21 non-IGRT and 2 of 21 IGRT. Stomach max. dose was >5% of prescribed in 6 non-IGRT and 2 IGRT plans.
Conclusions: IGRT leads to delivered doses more similar to planned doses compared to a non-IGRT strategy.

Table 1

	Non-IGRT (mm)		IGRT (mm)	
	σ	Σ	σ	Σ
C-C	8.0	6.7	2.2	1.1
A-P	5.4	4.0	2.4	1.4
R-L	5.1	3.8	2.8	2.1

923 POSTER

Collection and comparative analysis of events in a department of radiation oncology

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Radiation treatment (RT) is susceptible of events: errors, incident, and accident. Some of them are of certain gravity; some of them seem to be of little or no importance. It can be also said that what ever the event, it could be of importance because it is premonitory of an incident or an accident. That is why we decided to report on ROSIS data base all the events that we detected in our department. We report here the analysis of the year 2003.
Method: Every event detected during the preparation, the control or the realizations of RT are collected and reported in ROSIS Data Base and are registered in the department. The gravity of the events was according to Macklis (JCO1998) and analysed according to the potential gravity (i.e. if the event was not detected and not corrected) and to the real gravity (ie if detected and corrected or if detected but not corrected).
Results: 609 patients were treated with linacs or cobalt. 13142 sessions of RT were done and 37880 beams treated. 46 patient-events were reported (i.e. 7.5% of the patients treated; 0.35% of sessions. In 4 patients 2 different events were reported. 93 beam-events were reported ie 0.025% of beams. Events were detected by a physician in 33% of the cases, by a physicist or a dosimetrist in 33%, by a technician in 25% and in 10% by other. 48% were detected on the chart; 25% on film-control before the first session; 10% by the record system; 12% at the time of treatment; and 5% in other conditions. All the events were of human origin. The types of events were: dose in 23 cases, blocks in 10 cases, beams in 8 cases, modification of the beam in 1 case, energy in 1 case and in 10 cases other types. The origin of the conditions which impacted on the dose were: physician (5 cases), dosimetry (7 cases), at time of treatment (16 cases). The impact according the Macklis classification was: potential LI 6cases, LII 2 cases, LIIa 8 cases, LIIc 2 cases, LIII 32 cases; the real impact was: L0 9 cases, LI 20 cases, LIIa 18 cases, LIIc 1 cases, LIII 2 cases.
Interpretation: if an event is detected at the beginning of the chain of treatment and precociously, it can be corrected and the treatment is delivered normally. If the event arrived at the time of the treatment it cannot be corrected. In our mind we attributed the left shift of the gravity of the events to our strategy of organization: pluridisciplinary daily meeting, no treatment without control of the dosimetry, of the control film and monitor units calculation by a senior physician and a senior physicist. In the 2 LII cases, this strategy was not respected.
Conclusion: reporting events, even very little, in a radiation department is of great importance to avoid incident or accident and to help continuous improvement of the quality

924 POSTER

Radiosensitization of chlorogenic acid in Lewis lung carcinoma through inhibiting NF-κB mediated cIAP2

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Background: Chlorogenic acid (5-caffeoylquinic acid), the ester of caffeic acid with quinic acid, is one of the most abundant polyphenols in the Chinese herb Coptis chinensis. It has been found to inhibit environmental carcinogen-induced carcinogenesis through suppression of ROS-mediated NF-κB and mitogen-activated protein kinase (MAPK) activation. Radiation activates several intracellular signaling pathway mediators, including MAPK. We aim to clarify the mechanism of chlorogenic acid in radiation sensitization.
Materials and Methods: Lewis lung carcinoma (LLC) cells were used in this study. The cytotoxic effect of chlorogenic acid was analyzed by MTT assay. The apoptotic status of cells was evaluated by annexin-V staining. The levels of protein kinase phosphorylation and cIAP2 (inhibitor of apoptosis 2) were determined by western blot. The NF-κB activity was measured by promoter assay. 1×10^6 LLC cells implanted in right hind limb of C57BL/6J mice were treated with radiotherapy (4 Gy daily for 5 days) in the in vivo test. Chlorogenic acid was administered orally with 2 mg per day (100 mg/kg) three days prior to irradiation for a total of 14 days.
Results: The MTT assay revealed that chlorogenic acid itself did not affect LLC cell growth. However, chlorogenic acid could enhance the cytotoxicity of radiation in LLC cells. The quantitative annexin-V staining showed that chlorogenic acid involved anti-apoptosis signaling for radiosensitization. NF-κB promoter assay demonstrated that radiation activated NF-κB could be reduced by chlorogenic acid. The western blot also showed significant inhibition of the radiation activated NF-κB p65 subunit nuclear translocation by chlorogenic acid. Moreover, chlorogenic acid enhanced the radiation induced LLC cell apoptosis through downregulating the NF-κB mediated anti-apoptosis protein cIAP2 expression. The tumor growth curves with combined radiation and chlorogenic acid on LLC cells implanted in C57BL/6J mice, showed the significantly ($p < 0.01$) reduced LLC tumor size ($702.4\pm64\,mm^3$), as compared to either radiation alone ($2370.8\pm457\,mm^3$), or chlorogenic acid alone ($5{,}038.8\pm632\,mm^3$).
Conclusions: Chlorogenic acid exerts its radiosensitization effect by inhibiting radiation induced NF-κB activation and the downstream anti-apoptosis protein cIAP2 expression in LLC cells.

925 POSTER

MVCT image-guidance derived bony setup accuracy for supine and prone pelvic radiation therapy

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Purpose: To investigate the impact of prone vs. supine patient setup on repositioning accuracy for radiation therapy of pelvic malignancies using volumetric mega-voltage CT (MVCT) imaging on a helical tomotherapy unit (TomoTherapy HiArt).
Materials and Methods: Of 30 patients treated by pelvic IMRT, setup was prone in 11 and supine in 19 patients, respectively. Prone setup always used a belly board. 829 MVCT image-guidance studies (299 prone, 530 supine) were acquired. We assessed corrective shifts for patient setup, based on mutual information fusion biased for bony alignment. Thus, patient and not target setup was assessed. Typical radiation target volumes in relationship to the pelvic bony anatomy included nodal treatments for prostate cancer, as well as rectal and anal cancer. We assessed if a no action level (NAL) protocol would provide for an effective means of limiting subsequent setup variability.
Results: Relative and absolute mean shifts along the x, y, and z axes were 1.5, −6.7, and 8.7 mm as well as 4, 7.9, and 8.9 mm for prone patient setup. The average 3D vector of displacement was 15.2 mm, with 88.5, 58.0, 27.1, and 17.5% of alignments with displacements larger 5, 10, 15, and 20 mm. For supine setup, mean and absolute daily shifts along the x, y, and z-axis were −2.1, −2.1, and 10.6 mm as well as 4.1, 4.1, and 11.1 mm, respectively. Mean length of the 3D corrective vector was 13.4 mm, with 95.1, 70.4, 36.8, and 10% of setups corrected by more than 5, 10, 15, and 20 mm.

Employing the NAL (averaging shifts of the first 3 fractions), the average subsequent 3D vector of correction in prone setups would have been 6 mm. The frequency of respective shifts for subsequent treatment fractions larger than 5, 10, 15 and 20 mm, would have been 57.4, 11.6, 0.4, and 0.4% for prone setup. According mean 3D vector of corrective shifts and frequencies would have been 7.9 mm, and 66.4, 22.6, 8.9, and 3.6% for supine setups, respectively.
Conclusion: In the present study, prone patient setup was found to yield a higher daily repositioning variability than supine positioning. However, following utilization of a NAL protocol to reduce the systematic setup variability component, random setup errors larger 10 mm were significantly more often observed in supine than in prone setups. Thus, if daily image-guidance or NAL protocols are not employed, the potential advantages of removing small bowel from the pelvic region using a supine setup on a belly board and reducing target ventilatory motion may be associated with higher inter-fraction setup variability. Based on the number of clinically relevant corrective shifts observed in the studied population, daily on-line image-guidance is advised. While NAL protocols may provide sufficient systematic setup error reduction to justify off-line image-guidance strategies in prone patient setup, the observed remaining setup variability in supine patient setup warrants further investigation. The present data are especially relevant to future clinical trials of IMRT for rectal and anal malignancies.

926 POSTER

Prospective study of decompression surgery and intraoperative radiation therapy (IORT) for metastatic spinal tumours

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Background: Metastatic spinal tumors often cause spinal cord compression and jeopardize the quality of life of the patients much. To decrease the local symptomatic recurrence rate, we have been adding IORT to decompression surgery.
Materials and Methods: For those patients whose life expectancy was more than 6 months were eligible for this treatment. Posterior decompression by laminectomy of the involved vertebrae was performed. Following decompression, the patient was irradiated the lesions intraoperatively with electrons generated from Microtron by shielding the spinal cord with lead plate. The central aspects of the vertebrae were irradiated by scattered electrons detouring from the edge of the lead shield up to 40% of the administered dose. Following IORT, posterior instrumentation was performed. External beam radiotherapy might be added pre- and/or postoperatively when considered necessary.
Results: 108 patients were treated between 1992–2005. There were 58 males and 50 females. Age ranged from 26 to 85 with a median of 62.5. By primary sites, 26 breast, 24 kidney, 18 colorectum, 17 lung, 12 prostate and 11 thyroid cases were included. Irradiated spines were cervical in 6, thoracic in 76, and lumbar/sacral in 27. Overall median follow-up period was 12.7 months. Median IORT dose was 20 Gy (range 15−26 Gy) and median electron energy was 16MeV (range 11−22 MeV). There were 37 cases with preoperative RT and 41 cases with postoperative RT. Overall median survival time was 14.5 months (breast 15.3, kidney 22.6, colorectum 5.7, lung 6.2, prostate 31.6, thyroid 60.6 months). Neurological response rate was 73.1%. Ambulatory rates were 87.0% for success and 80.6% for rescue by Klimo's definition (2005). There were only 8 symptomatic relapses (7%). As for major complications, only one myelopathy has been observed.
Conclusions: Decompression surgery and IORT for metastatic spinal tumors with impending spinal cord compression was a promising treatment modality with excellent local control and neurological response rate and with minimal toxicity especially for those patients with long-term prognosis.

927 POSTER

Efna1, a radioresistant marker, detected in a murine tumor model by gamma and carbon ion irradiation

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Purpose: This study investigated the genes involved in radioresistance after radiotherapy.
Materials and Methods: Using single-color oligo-microarrays, we analyzed the gene expression profiles of two murine squamous cell carcinomas: NR-S1 (radioresistant) and SCCVII (radiosensitive), after irradiation with 137-Cs gamma rays at doses of 30, 50 and 70 Gy or 290 MeV/u carbon ions at a dose of 30 Gy. Potential genes related to radiosensitivity were selected by comparing the expression values before and after irradiation (with both gamma rays and carbon ions) using a filter for at least 1.5-fold changes. Furthermore, candidate genes which had significantly different ratio values between the two tumors ($P < 0.05$) were detected by unpaired Student's t-tests. Subsequent analysis by quantitative reverse-transcription polymerase chain reaction (RT-PCR) confirmed our microarray data. Protein expression and function were examined by immunohistochemical studies.
Results: Four genes, Efna1, Sprr1a, Srgap3 and Xrra1, were selected as potential genes related to radioresistance after gamma and carbon ion irradiation. RT-PCR confirmed that Efna1 was induced in radioresistant NR-S1. Efna1, a proangiogenic factor, was expressed in the cytoplasm of tumor cells and significant increases in microvascular density were observed in the radioresistant NR-S1.
Conclusions: We found that Efna1 may be a potential molecule related to radioresistance in murine tumors.

928 POSTER

p73 protein expression correlates with radiation-induced apoptosis in the lack of p53 response to radiation therapy for cervical cancer

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Background: p73 belongs to a p53 tumor suppressor family of genes and can inhibit cell growth in p53-like manner by induction of apoptosis or cell cycle arrest. The aim of this study was to investigate whether p73 could compensate for impaired p53 function in apoptosis induced by radiation therapy (RT) for cervical cancer.
Materials and Methods: Sixty-eight patients with squamous cell carcinoma of the cervix who received definitive RT combined with ($n = 37$) or without ($n = 31$) cisplatin were investigated. Biopsy specimens were excised from the cervical tumor before RT and after 9 Gy. All tissues were stained with hematoxylin and eosin, and terminal deoxynucleotidyl transferase mediated dUTP-biotin nick end labeling method assay and immunohistochemical staining for p53 and p73.
Results: Mean Apoptosis Index (AI) was 0.93% before RT and 1.97% after 9 Gy with a significant increase ($p < 0.001$). For all patients, there were significant correlations between AI ratio (AI after 9 Gy/AI before RT) and p73 expression positivity after 9 Gy ($p = 0.021$). Forty-one patients were regarded as p53-responding group according to the expression of p53 after 9 Gy, while the remaining 27 patients were regarded as p53-non-responding group. In the p53-non-responding group, a significant correlation between the AI ratio and p73 expression after 9 Gy was observed ($p < 0.001$) although there was not significant correlation between them in the p53-responding group ($p = 0.940$).
Conclusions: Our results suggested that p73 had an important role in compensating for the lack of p53 function in radiation-induced apoptosis of cervical cancer.

929 POSTER

Cardiac complications after radiation therapy for stage I esophageal cancer patients

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Background: Cardiac complication after chemoradiotherapy (CRT) for esophageal cancer is one of the recent noteworthy topics. However there are few reports about cardiac complications after radiotherapy (RT) alone for comparison with CRT data. The purpose of this study is to assess the cardiac complications after RT alone for stage I esophageal cancer patients.
Material and Methods: Ninety-five patients with stage I esophageal cancer received definitive RT alone between 1992 and 2002. There were 8 females and 87 males. The median age was 70 (43−89) years. Eighty-five percent of patients had tobacco history, 84% had history of drinking alcohol, 15% had diabetes and 20% had hypertension. Fourteen patients (15%) had histories of cardiovascular diseases before RT (ischemic heart disease: 8, arrhythmia: 3 and others: 3). Histologic types were squamous cell carcinoma in 94 (99%) and adenocarcinoma in 1 (1%). Ten patients (11%) had the main lesion in the upper thoracic, 71 (76%) in the middle thoracic and 14 (15%) in the lower thoracic esophagus. Twenty-seven patients (28%) were treated with high-dose-rate brachytherapy (HDR-BT, median 35 Gy/14 fr.) alone, 60 patients (63%) with combined external RT (median 54 Gy/27 fr.) and HDR-BT boost (median 10 Gy/4 fr.) and 8 with external