and antineoplastic properties. The aim of this study was to evaluate radioprotective effect of RGZ on a murine model of late pulmonary damage and of acute intestinal damage.
Materials and Methods: *Lung fibrosis*: C57BL/6 mice were treated with the radiomimetic agent bleomycin 40 mg/kg every 2 days for 5 administrations, with or without RGZ(5 mg/kg/day) started 24h before bleomycin treatment. To obtain an independent qualitative and quantitative measure for lung fibrosis we used high resolution CT, performed twice a week during the entire observation period. Hounsfield Units (HU) of section slides from the upper and lower lung region were determined. On day 31 mice were sacrificed and lungs collected for histopathological analysis.
Acute intestinal damage: mice underwent 12 Gy total body irradiation (TBI) with or without RGZ(5 mg/kg/day) started 24h before TBI. Mice were sacrificed 24 or 72h after TBI and ileum and colon segments were collected for histopathological analysis.
Results: *Lung fibrosis:*starting from 10th day of bleomycin treatment, mice showed typical CT features of lung fibrosis including irregular septal thickening, and patchy peripheral reticular abnormalities with intralobular linear opacities, Accordingly HU lung density was dramatically increased. RGZ markedly attenuated the radiological signs of fibrosis and strongly inhibited HU lung density increase (60% inhibition at the end of the observation period). Histological analysis revealed that in bleomycin-treated mice fibrosis involved 50−55% of pulmonary parenchyma and caused an alteration of the alveolar structures in 10% of parenchyma, while in RGZ-treated mice fibrosis involved only 20−25% of pulmonary parenchyma without alterations of the alveolar structures.
Acute intestinal damage: 24h after 12 Gy TBI intestinal mucosa showed villi shortening, mucosal thickness and crypt necrotic changes; chorion showed oedema and inflammatory infiltrate. RGZ showed an histological improvement of tissue structure, with villi and crypts normalization and oedema reduction.
Conclusions: These results demonstrate that RGZ displays a protective effect on pulmonary fibrosis and radiation-induced intestinal toxicity in mice, and although further investigations are necessary, it could be proposed as radioprotective agent.

2005 ORAL

Dose per Pulse Is a Relevant Factor That Impacts Radiation Response on Two Glioblastoma Cancer Cell Lines

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Background: The question to what extent delivery time or dose rate impact tumour cell survival has a long history in radiation therapy. While there is increasing evidence in the recent literature that extended delivery time might impact cancer cell survival, we are short of studies investigating the potential effect of modified dose rate on cancer cells, mostly due to technical challenges.
Material and Methods: To perform our experiments, we used the TrueBeam STx linear accelerator (Varian Medical Systems, Palo Alto, CA, USA), which allows generating a pulsed photon beam of the nominal energy of 10 MV with the flattening filter in place (X10) as well as flattening filter-free, referred to as X10 and X10 FFF, respectively. Removing of the flattening filter leads to a decrease of the beam's mean energy and to an increase of dose delivered per pulse (DPP) of radiation. To validate the radiobiological effect of these two beams on cancer cells, we treated two glioblastoma cell lines, T98G and U87-MG, with either 5 or 10 Gy single dosage using different dose rates (with flattening filter: 20 and 400 MU/min; without flattening filter: 400 and 2400 MU/min) and tested their potential effect on cancer cell survival with the colony formation assay. To better understand the molecular mechanism we performed microarray chip analysis.
Results: In our experimental setting dose delivered per pulse seemed to be a crucial factor that influences cancer cell survival. Comparing the effect on cancer cells of the radiation with 400 MU/min using X10 to 400 MU/min using X10 FFF, the X10 FFF beam was more efficient in reducing cancer cell survival than the X10. Throughout this treatment, delivery time was kept the same while dose per pulse was significantly higher in the treatment using X10 FFF. This effect became more relevant the higher the single dose. In addition, treatment with X10 FFF comparing 400 MU/min to 2400 MU/min did not show any significant difference. In this experiment, delivery time was significantly faster using 2400 MU/min, while the dose per pulse was kept the same.
Conclusions: The results presented here show that dose per pulse might become a crucial factor which influences cancer cell survival. Understanding the mechanisms by which dose rate and dose per pulse influence cancer cell survival might lead to new approaches for the therapy of treatment-resistant tumours and is currently a topic of investigation in our laboratory.

2006 ORAL

Novel Technology of Laser Driven Proton Beams for a Potential Application in Cancer Therapy: in Vitro Dose Response Studies

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Background: The development of the new technology of proton and ion acceleration by ultra-high intensity lasers for cancer therapy is the goal of the German joint research project "onCOOPtics". The laser based acceleration promises compact and economic therapy facilities that are suitable for already existing clinics. In contrast to conventional particle acceleration the laser based method results in beams of very short pulses with ultra-high pulse dose and correspondingly peak dose rate. Within the project multidisciplinary issues like development and optimization of high-intensity laser systems, efficient proton acceleration schemes and proton beam transport are handled. Moreover, the physical and real-time dosimetric characterization as well as the investigation of radiobiological consequences of laser accelerated beams are essential. These imply translational investigations starting from *in vitro* cell irradiation.
Material and Methods: Systematic *in vitro* cell experiments were performed at the 150 terawatt laser facility DRACO at HZDR. Proton pulses up to 20 MeV were accelerated, whereas the broad proton spectrum was downward limited to 6 MeV using an energy-filter-system. An in-house developed integrated dosimetry and cell irradiation system (IDOCIS) was tested and calibrated allowing precise dosimetry as well as the exact positioning of each cell sample. Cell survival and residual DNA double strand breaks were determined after irradiation of the tumour cell line SKX in a dose range from 0.5 Gy to 4.3 Gy. Additionally, reference irradiation were performed with continuous proton beam at a conventional Tandem accelerator and with a 200 kVp X-ray tube.
Results: A stable and reproducible laser driven proton beam was achieved for experiments over weeks including real-time dose and energy spectrum monitoring as well as precise absolute dosimetry. The comparison of the radiobiological effectiveness of conventional and laser accelerated proton beams show no significant difference for *in vitro* cell irradiation.
Conclusions: These first systematic *in vitro* cell response studies with precise dosimetry of laser driven protons represent an important step toward the development of laser accelerated particles for radiotherapeutic application. Further experiments with other human cell lines and *in vivo* studies are under way.
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Poster Presentations (Mon, 26 Sep, 09:30−12:00) **Radiobiology/Radiation Physics/Radiotherapy**

2007 POSTER

Study on Liver Cancer Target Volume Variations Between 4D-CT and 3D-CT Associated With Active Breathing Control Device

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Background: The study aimed to observe and analyze the variations of liver cancer GTV between 4D-CT and 3D-CT associated with active breathing control device (ABC).
Methods: 13 cases with primary liver cancer were selected and underwent CT simulation and localization. Each case underwent 4D-CT scanning first, with ABC device working on to monitor and analyzes the breath wave. Afterwards, 3D-CT scanning were underwent, respectively when patient breathing freely, at the end of inspiration and expiration. GTVs were contoured, according the same criterion by one radiologist and one radiation oncologist jointly, respectively on 6 CT series: CT0 series (4D-CT end-exhale), CT50 series (4D-CT end-inhale), 4D-CT MIP series, 3D-CT free breathing CT series, 3D-CT end-exhale series, and 3D-CT end-inhale series, which were named GTV4D-0, GTV4D-50, GTVMIP, GTVFB, GTVEE, GTVEI. Afterwards, GTV4D-M were obtained by merging GTV4D-0 and GTV4D-50, meanwhile GTV3D-M were obtained by merging GTVEE and GTVEI. The volume of all GTVs were measured and analyzed using SPSS software. Paired Wilcoxson test was applied.
Results: There was no significant difference between GTVEI and GTVEE ($P = 0.325$), as well as GTVEI and GTV4D-0 ($P = 0.125$), GTVEE and GTV4D-50 ($P = 0.325$), GTV4D-0 and GTV4D-50 ($P = 0.125$), GTV4D-M