Material and methods: The records of 208 patients irradiated with tangential photon fields for breast cancer with more than 2 follow-up visits over 6 months were reviewed. Data on clinical factors previously reported to be associated with RP were collected. Actual and percent irradiated lung volumes receiving more than 20Gy were measured from CT-based treatment plan.

Results: Average (± standard deviation) actual and percent irradiated lung volume for breast/chest wall irradiation were 169 (± 14.9) cc and 14.9 (± 3.8) %, respectively. Addition of regional lymph node irradiation resulted in increase of 183 (±80.2) cc in actual irradiated lung volume and 16.5 (±6.2) % in percent irradiated lung volume. RP developed in 11/208 (5.3%) patients. There was an increased incidence of RP among patients treated with loco-regional radiotherapy (10.3%) vs. those receiving local radiotherapy only (2.5%) (p = 0.02). Previously reported clinical factors associated with RP, such as smoking, underlying lung disease, chemotherapy exposure, use of tamoxifen, failed to show statistical significance in this study. Radiotherapy related parameters, such as actual irradiated lung volume and percent irradiated lung volume were also not statistically related to development of RP.

Conclusions: RP was a rare complication, both with local and loco-regional RT. The addition of regional lymph node irradiation increased the incidence of RP. Failure to show correlation between actual or percent irradiated lung volume and RP may be due to majority of the patients receiving radiotherapy to less then significant actual or percent lung volume.

520 POSTER

Estimation of dose constraints using biologically-normalized dose-volume histogram (BN-DVH) for hypofractionated radiotherapy in the treatment of prostate cancer

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Background: Improvements in prostate cancer treatment techniques have allowed dose-escalation to be achieved by non-conventional fraction sizes (e.g. > 2.4 Gy/fraction), reducing the overall number of fractions from 35-44 to 20-28. The aim of this study is to determine the equivalent range of dose-constraints for rectum and bladder between conventional fractionation and hypofractionation treatment plans.

Materials and Methods: Dose volume histograms (DVHs) for bladder and rectum from ten treatment plans for T1-T2 prostate cancer patients treated with 73.5 Gy (isocentre)/35 fractions/7 wks are exported from ADAC Pinnacle planning system into a spreadsheet with 500 bins per DVH. Each dose-bin is converted to its biological equivalent dose based on the linear quadratic model using alpha/beta ratio of 3. Cumulative biologically-normalized DVHs (BN-DVH) based on this conversion are generated and collated. The average BED D50, D35, D25, and D15 from the BN-DVH and their equivalent doses as given over 16 fractions are calculated using the linear-quadratic formula.

Results: Preliminary results from the first five rectal and bladder DVHs show wide ranges of D50, D35,&etc, for treatment given over 35 fractions (Table 1). The range of values seen at each volume-dose bin is amplified after conversion to BN-DVH.

Table 1: Preliminary results of DVH constraints for conventional fractionation vs. hypofractionation using BN-DVH calculations

	Average Dose over 35# (range)	Average Dose per BN-DVH (range)	Average Dose over 16# (range)
Rectum D50	46 Gy (38-56)	67 Gy (52-85)	37 Gy (31-45)
D35	55 Gy (41-66)	85 Gy (58-107)	44 Gy (34-52)
D25	62 Gy (51-70)	100 Gy (77-117)	49 Gy (41-55)
D15	70 Gy (68-72)	117 Gy (112-122)	55 Gy (53-56)
Bladder D50	38 Gy (25-51)	52 Gy (31-76)	31 Gy (21-41)
D35	49 Gy (39-60)	73 Gy (54-95)	40 Gy (32-48)
D25	56 Gy (41-68)	87 Gy (58-112)	45 Gy (34-53)
D15	66 Gy (59-71)	108 Gy (93-119)	52 Gy (47-55)

Discussion: The BN-DVHs seen in this sample of patients suggest a prescribed dose of 55 Gy/16 fractions would achieve dose-constraints similar to conventional treatment over 35 fractions. The influence of the number of fractions (e.g. 16 vs. 20 vs. 28), the value assigned to the alpha/beta ratio (e.g. 2.5, 3.0, 3.5, 4.0), and the potential advantage in normal organ sparing using IMRT over 3D conformal planning will be examined and presented.

521 POSTER

The use of electronic portal image device (EPID) in the isocenter verification in stereotactic radiosurgery

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Background: The Winston-Lutz test (W-L test) is used as a standard method of isocenter verification in Stereotactic Radiosurgery (SRS). The W-L test is based on x-ray portal image that disable direct digital analyze. The aim of the paper is to present the new method of isocenter verification based on EPID.

Methods and Materials: Linear accelerator Clinac 2300C/D (Varian) equipped with EPID and BrainLab stereotactic accessory including micro-Multileaf Collimator (mMLC) and EPID were used. Digital verification method is based on W-L test, however in digital verification method it is EPID that collects images in order to precise verification of isocenter. During digital verification method mMLC leaves are set to H' shaped field (two pairs of leaves in the middle of the field form small square gap). Then first two portal images are taken. Using laser positioners a small metal phantom ball is located in isocenter. To check isocenter invariability several portal images are obtained at various collimator, gantry and couch positions. After each portal field acquisition a quick visual and digital check is done to control if ball is inside square formed by mMLC. The idea of digital analysis is to subtract two portal images: one with phantom ball and second without ball in the same collimator position. Digital check is performed by independent computer program WinIzo'; developed in Treatment Planning Unit in Center of Oncology Institute in Gliwice, Poland. Digital analyze subtract two portal images (first without ball, second with ball, both with the same collimator position) and shows optical density symmetry distribution.

Results: Isocenter verification method based on EPID and WinIzo application enables to obtain and compare results presented in visual and digital form. Moreover, images analyze is improved. The correction of ball position can be done after each single portal acquisition and there is no need to wait till the whole test is preformed (as in basic W-L method).

Conclusions: Comparing to standard W-L test, presented method is faster, less expensive and more precise. The EPID based method is a standard Quality Assurance procedure in Center of Oncology Institute in Gliwice, Poland.

522 POSTER

Safe integration of high dose rate endoluminal brachytherapy in the conservative treatment of patients with esophagus cancer and external beam radiation with or without chemotherapy

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Background: The current study addresses the feasibility and outcome of treatment with high dose rate endoluminal brachytherapy as a boost and external beam radiation with or without chemotherapy for patients with oesophagus cancer from a single institution experience.

Material and Methods: Patients with either squamous or adenocarcinoma and no metastatic disease were eligible. Brachytherapy was given once or twice weekly to a dose of 20 Gy in 5 fractions prescribed at 1 cm in combination with external beam therapy. The dose prescription was either 50 Gy in 25 fractions with 2 cycles of concurrent chemotherapy using 5-Fluorouracil at 1000mg per Meter Square per day, 96-h continuous perfusion and Cis-platinum at 75 mg per Meter Square on day one, on weeks 1 and 5; or 35Gy in14 fractions alone for patients with karnosky performance of $\leq$ 70. Toxicity was scored using the RTOG acute toxicity scoring system. The primary outcomes were: treatment related toxicity, local control and the functional results prior to local recurrence. Statistical analyses were done using Kadplan-Meir methods.

Results: 45 patients were treated with radical intent. There was an equal distribution between adenocarcinoma and squamous cancer. The mean age was 70 years (range: 45-89). Thirteen patients received brachytherapy and external beam radiation and 32 patients were treated with brachytherapy, chemotherapy and external beam radiation. No patient developed a perforation or fistula during our study. There was no treatment related death. The incidence of Grade 2 toxicity for esophagus was 85%, for bone marrow 55% and Grade 3 hematological toxicity was seen in 15% of patients. The mean follow up was 20 months (range 6-70 months). The actual 2 year and 5 year local recurrence rates documented by biopsy were 33%

and 46% respectively. Squamous cell carcinoma was associated with a better outcome than adenocarcinoma (p=0.0189). Chemotherapy was not found to be a significant factor predicting for local control (p=0.59). Normal swallowing function was observed in 60% of patients, intermittent dilatation required in 29% of the patients and 11% patients continued with PEG feeding.

Conclusions: High dose rate endoluminal brachytherapy combined with external beam radiation with or without chemotherapy can be safely used as an effective boost. The local control rate and the functional results are encouraging.

523 POSTER

Aminothiol WR-1065, the active metabolite of Amifostine (Ethyol), protects in vitro lens epithelial cells against X-ray exposure

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Background: Lens epithelium disorganization is considered as one of the radiation-induced cataract cytopathomechanisms. Epithelial cell death is involved in cataractogenesis process after X-ray irradiation. Our objective was to test the capacity of aminothiol WR-1065, active metabolite of amifostine (or WR-2721) to protect *in vitro* bovine lens epithelial cells against X-ray exposure.

Material and methods: WR-1065 was used for cultures pretreatment at a concentration of 20 μ M. A single dose of 10 Gy was delivered using a dose rate of 2 Gy/min. To evaluate radioprotective effect we used cold light cytoflurimetric assays. Cell viability and membrane damage were evaluated with neutral red probe assay. To evaluate cell proliferation, we used Hoechst 33342 probe (HO) assay followed by an inverted fluorescence microscopic examination for nuclear apoptotic morphology changes of the HO-labeled cells. Monobromobimane probe assay was used for GSH pool evaluation.

Results: Twenty-four hours after irradiation, WR-1065 pretreated cells showed a significant increase of the GSH levels, which was associated with an improvement of cell viability, a decrease of the HO fluorescence and a reduction of the proportion of cells with nuclear changes related to apoptotic cell death. The difference was also significant at 48h and 96h after exposure. Statistical analyses showed a highly significant difference between irradiated and control cultures.

Conclusion: In this study, using cold light cytofluorimetric assays, we showed that WR-1065, can protect *in vitro* lens epithelial cells from X-ray injury. The fluorimetric assays revealed better cell viability, fewer nuclear changes related to *apoptosis* and an increase of the GSH pool in the pretreated cells as compared to non pretreated cells. Thus, we postulate that amifostine is potentially interesting in the view of lens protection against radiocataractogenesis.

524 POSTER

Radiotherapy vs. radiotherapy + chemotherapy of advanced cervical cancer (IIb - IVa): Regression of tumour and early sequelae

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A prospective randomised Study of 200 patients with advanced cervical cancer (st. IIb IVa) treated with ether radio-therapy alone (RT group) or radiotherapy + chemotherapy (RT + CH group) was started at the beginning of May, 2002 and the last patient of this series was treated in March 2003. (Project N° 1683 of Ministry of Science, Technology and Development of Rep. Serbia). The aim of this study is to show comparison of results of treatment of advanced cervical cancer using ether RT or RT + CT.

Clinical material of 200 cervical cancers randomised in two groups: RT 98 (49%) pts and RT + CT 102 (51%) pts. Distribution of patients by stages (FIGO), hystopatological type (and gradus) and age was very similar in both groups.

Treatment regimes were:

1. RT group: - CBT 46Gy/22 fractions, 2 parallel oposite fields without central Pb shields + HDR brachytherapy 5x7 Gy/.A (Ut. tube + 2 vag. ovoids)
2. RT + CT group: RT vs. first group + CT using cisplatin (5 cycles during radiotherapy, one's week).

525 POSTER

Evaluation of polymer gels and laser-beam optical CT scanner as a 3-D dosimeter for IMRT

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Purpose/objctive: Dose distributions generated from IMRT treatment planning present high dose gradient regions in the boundaries among target and surrounding critical organs. Dose accuracy in these areas can be critical, and may affect the treatment. With the increasing use of IMRT in radiotherapy, there is an increased need for a dosimeter that allows high resolution, precise, and accurate determination of 3-dimentional dose distributions. In this study, 3-D dose verification for IMRT has been implemented using polymer gel dosimeters and a laser-beam optical CT scanner.

Material and Methods: A 17 cm diameter x13 cm height plastic cylinder filled with BANG® polymer gel, modified to optimal dose-response characteristics, was used for IMRT dose verification. The cylindrical gel phantom was immersed in a 24x24x20 cm water tank for IMRT irradiation. The irradiated gel sample was then mounted in the prototype optical CT scanner developed by MGS Research Inc., utilizing a single He-Ne laser beam and a single photodiode detector. Similar to the CT process, filtered backprojection was used to reconstruct the 3-D dose distribution. The gel was scanned using 20x20 cm field of view and 200x200 image matrix, which produced 1 mm pixel resolution. Image slices were acquired 1mm apart. The dose distributions measured from the gel was compared with those from the IMRT treatment planning system. For comparative dosimetry, a solid water phantom of 24x24x20 cm, having the same geometry as the water tank for the gel phantom, was used for radiographic film and ion chamber measurements.

Results: Comparison of planar dose distributions among gel dosimeters, film, and a treatment planning system showed that the isodose lines agreed to within 2 mm on transverse and coronal slices. Absolute point-dose verification was performed at 5 different points, varying from 65% to 110% of the prescribed dose. Comparing ion chamber measurements and the dose calculation from the treatment plan, the agreement was found to be within 3%.

Conclusions: Polymer gel dosimeters and laser-beam optical CT scanner provides a high resolution, accurate, 3-dimentional tool for IMRT dose distribution verification.

526 POSTER

Circulating lipid peroxide, glutathione and nitric oxide levels in cancer patients irradiated on different anatomic fields

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Background: Irradiation is known to produce free radicals that damage cells. The effect of ionizing radiation on surrounding normal cells may differ in various irradiated sites. The aim of this study was both to evaluate the effect of radiotherapy (RT) on plasma malondialdehyde (MDA) level as the last step of lipid peroxidation, glutathione (GSH) and nitric oxide (NO) levels of cancer patients treated on different RT field localizations, and to compare the results with control subjects.

Material and Methods: A prospective, controlled study was designed to examine the influence of different irradiation portals.The study design was approved by the Ethics Committee of our University. The effect of RT on MDA, GSH and NO were evaluated in the irradiated cancer patients (n=89), mean age 51.24 years and control subjects (n=33), mean age 52.61 years. The grouping of the irradiation procedure was: Group 1 (n=12) head & neck RT, group 2 (n=13) thoracic RT, group 3 (n=32) breast RT, group 4 (n=17) abdominal RT, group 5 (n=15) pelvic RT. There were two blood samples collected from patients before receiving radiotherapy and the next day after the completion of the fifth week of radiotherapy. Serum was seperated by centrifugation and stored at -20 °C until further assay. MDA and GSH levels were measured by spectrophometrical, and NO levels were measured by Gress' method.

Results: When compared to control, MDA levels of all cancer patients before irradiation was initiated were found significantly higher in all groups (Mann Whitney U, $p<0,05$). After RT, the levels of MDA were found significantly increased by thoracic, breast, abdominal and pelvic irradiation (Wilcoxon signed rank test, $p<0,05$). Although pretreatment NO levels of all cancer patients in all groups were found significantly higher than control