modulated radiotherapy technique that is used to minimize the dose applied to lung and heart by evaluating the use of the number of beams, beam direction, and virtual organ delineation in order to optimize radiotherapy treatment plans.
Materials and Methods: The subject in this paper were five patients with lung cancer who represent relatively small errors caused by organ motions by penetrating tumors into mediastinum. The number of beams and beam direction used in a treatment plan were 5, 7, 9, and 14 portals ranged from 200 to 160 in an equispaced field and 7 and 9 portals (non-equispaced and arbitrary fields), respectively. The dose constraint (V20 and V25) was configured based on references. Also, the optimized treatment plan can be obtained using a certain proper use in virtual organs. Dose-volume histogram (DVH), isodose line, and dose statistics were used to evaluate the radiotherapy treatment plan. In particular, the utility of the virtual organ delineation was evaluated by analyzing the results before and after applying it.
Results: The nine portals equispaced field-IMRT and 7 portals non-equispaced field-IMRT method demonstrated desirable results within 20% in the PTV (planning target volume), dose homogeneity, mean lung dose, V20, and V25 and showed the same results in these methods due to the application of the virtual organ delineation. Also, it is able to complement possible errors in a treatment process by applying a lung cancer intensity modulated radiotherapy protocol to clinics.
Conclusions: This study designed such a lung cancer intensity modulated radiotherapy protocol and obtained the optimal radiotherapy treatment plan based on the virtual organ delineation and irradiation plan.

938 POSTER

Development of a new normoxic polymer gel dosimeter (TENOMAG)

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Background: In recent years, the verification of the three-dimensional (3-D) dose distribution in tumor volume has been significantly considered in a radiation therapy treatment plan. Because the conventional dosimeter including an ion chamber doesn't represent 3-D dose distribution, this study attempts to develop a gel dosimeter that performs 3-D dose analysis using MR images for the chemical change caused by the radiation in tissue equivalent gel in order to overcome this problem.
Materials and Methods: This study produced polymer gel that can be produced in a normoxic condition using anti-oxidants instead of using a polymer gel dosimeter that can only be applied in a hypoxic condition using nitrogen gas. Also, this study investigated the characteristics of normoxic polymer gel according to the composition of gel compound samples to produce practical polymer gel and composited polymer gel with five different compositions. A glass bottle filled with gel that was fabricated to measure dose was produced to investigate the relationship between the amount of radiation and the transverse relaxation time in MR images whereas the MR image of the glass bottle was obtained after applying irradiation. MR images, R2 mapping image, dose-R2 response curves in accordance with composition ratios, and dose distribution were analyzed as evaluation elements.
Results: This study showed the polymer gel that was composited using the combination of a 6% gelatin and 9% MAA applied in this study demonstrated excellent characteristics in the radiation dose. Also, it was evident that it showed very high radiation sensitivity due to the strong oxygen removal reaction of the applied anti-oxidant. The gradients of the sets were 0.60, 0.775, 0.683, and 0.954, respectively, and the intercepts of the curve were 0.322, 0.473, 0.611, and 1.032, respectively. In the case of the set 3, it showed better results in the linearity, such as 0.9491, than other groups.
Conclusion: This study composited polymer gel (Tetrakis hydroxymethyl phosphonium chloride-Normoxic-Methacrylic acid-Gelatin, TENOMAG) in a normoxic condition using anti-oxidants and obtained a composition ratio that can be practically applied to clinics.

939 POSTER

Administered dose to the rectum and colon in prostate cancer patients treated with curative radiotherapy presenting a secondary intestinal cancer

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Background: Radiotherapy (RT) is a known strong risk factor for cancer development. Controversy still exists, however, on the possible carcinogenic hazard on colon and rectum derived from the irradiation of a prostate cancer. This study aims to evaluate the administered dose to the rectum-colon and technique characteristics of patients presenting an intestinal tumor after curative RT for prostate cancer.
Materials and Methods: Using data from the population-based cancer registry, 11/264 (4.2%) prostate cancer patients treated with curative RT presented a rectal or colon cancer. These tumors were diagnosed at a median time of 96.5 months (range, 75–145) after RT. Three secondary cancers were located at the recto-sigmoid and transverse colon, respectively. Other location were sigmoid colon (n = 2), caecum (n = 2) ascendant colon (n = 1). Median delivered dose to the pelvis was 50 Gy (range, 45−54). Median delivered dose to the prostate was 66 Gy (range, 50−70). All patients were treated with high-energy photons (10 MV, 9 patients; 18 MV, 2 patients). Eleven CT datasets were selected to match the patient's clinical characteristics (weight, patient thickness) so as to reconstruct the dose deposition of the curative RT.
Results: All but 2 patients were treated with a 4 field box technique for the pelvic fields. One patient interrupted the RT before the boost delivery. The prostate boost was delivered by a 2, 6 and 4 field technique in 7, 2 and 1 patients, respectively. The dose to the intestinal tractus will be detailed at the ECCO meeting.
Conclusions: Secondary cancers after curative RT for prostate cancer occur out of the treatment fields in a substantial number of cases.

940 POSTER

Body immobilization systems: gadgets or tools?

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Background: There are cases that highlight the importance of eliminating researcher bias, this is one of them. Fortunately the rigours of proper testing reassert the self-correcting nature of science.
With the introduction of new technology such as intensity modulated radiotherapy (IMRT), image-guided radiotherapy (IGRT), TomoTherapy® etc. small misalignments can result in treatment failure. This prompted the question as to whether immobilization systems are indispensable tools. The purpose of this study is to evaluate the BodyFix® System.
Materials & Methods: This device consists of a body size bag (shell) filled with Styrofoam pellets, which moulds to the patient's form as air is removed via a vacuum pump. The patient lies in this shell and is immobilized for treatment. Biweekly anterior and lateral set-up check films (CF) were taken for the duration of treatment for eleven patients undergoing pelvic irradiation with six of them randomly selected to be mobilized with this system. To evaluate the quality of the immobilization, two therapists measured, compared and recorded the distance between the field edge and two bony landmarks for each (CF) and corresponding digitally reconstructed radiograph (DRR). If the measurement on the (CF) differed from those of the (DRR), the patient was realigned, (CF) verified and treatment given. Set up times were recorded biweekly to evaluate the practicality of the product.
Results: Our data showed that the immobilized patients were misaligned on average by 0.8 ± 0.3 mm while the non-immobilized patients were misaligned on average by 4 ± 8 mm. Thus, our data shows that this device does provide adequate immobilization. The patient set-up time was virtually unaffected as it increased only by about one minute when the device was used. We found that the major disadvantage of this immobilization system is that a significant amount of space is required to store the shells.
Conclusion: Our results suggest that what we thought would be a useless gadget, actually proved to be a helpful tool. Regrettably, due to space restrictions, only a limited number of patients can realistically be treated with this immobilization system. We therefore propose comparative multicenter trials so more systems can be simultaneously tested and results shared. This will help us to soon find an adequate immobilization system that could benefit all patients.

941 POSTER

Individual superficial applicators – geometric optimization of treatment plans

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Aim: to analyze dosimetric parameters of dose distributions calculated for surface applicators in order to optimize the geometry of the individual applicators for small irradiated areas (about 9 cm^2), to meet requirements of conformal brachytherapy. Treatment plans for individual surface applicators, where temporal and geometrical optimization was employed, are presented in this paper to introduce it's usefulness in treating different localization of skin cancers.

Materials and Methods: Individual applicators are rigid plates adjusted to anatomical shapes of patients. On it's surface catheters are placed on the preplanned positions. However the positions of the catheters are planed according to the rules established on the basis of pattern-treatment plans, prepared to learn about the influence of implant geometry (number of the catheters, thickness of the applicator) on the dosimetric parameters (maximum dose value on the surface of the applicator (Dmax), area of the 150% of isodose on the surface of the applicator). 9 pattern – treatment plans for irradiated surface 9 cm^2 were calculated. Pattern-plans were prepared for 3, 4 and 5 equidistant, parallel catheters and assumed thickness of the applicator: 3, 5 and 8 mm.
Results: It's difficult to obtain satisfactory dose distribution for small irradiated surface (below 9cm2). In order to avoid high dose values on the applicator's surface the distance between catheters should be 1 cm and applicator's thickness should be 8 mm while for 3 mm applicator plates is better to use 1.5 cm space between catheters to minimize the area of 150% isodose on the applicator's surface. Dose distributions calculated for individual applicators, prepared on the basis of those rules were used to treat different localizations of tumors e.g.: nose, cheek, forehead, ear even trachea.
Conclusion: Individual applicators allow to adjust the shape of isodoses to the dimension of PTV and to protect OAR. However, performed analysis showed how to improve applicator's geometry in order to avoid overdosed areas on the surface of the applicators. Geometric optimization allow not only to irradiate required area but also to obtain satisfactory dose profile from the applicator's surface to reference depth.

942 POSTER

Superficial dosimetry for helical tomotherapy

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Background: For examination of the feasibility of radiation therapy on a wide curved area of the skin by the helical tomotherapy and its accuracy to calculate the absorbed dose in the superficial region.
Materials and Methods: Two types of radiation therapy treatment plan were made with the 'cheese phantom' which is cylinder-shaped with diameter 30 cm. In the first trial, 2 Gy was prescribed from the surface to depth 1 cm. In the other trial, 2 Gy was prescribed from the external side of the surface by 5 mm to 1 cm depth. Additionally, the inner part of the phantom below depth 2 cm was selected to be completely blocked. To measure the surface dose and the depth dose profile, an EDR2 film was inserted into the phantom, and 6 TLD chips were attached to the surface.
Results: After irradiation, from the film, the surface dose of the former case was 118.7 cGy and the latter case was 130.9 cGy. From TLD chips, the surface dose was higher than these, but it was due to the finite thickness of TLD chips. In the former case, 95% of the prescribed dose could be obtained at 2.1 mm depth, and at 2.2 mm in the latter case. The maximum dose was about 110% of the prescribed dose. As the depth became deeper, the dose decreased rapidly, and at 2 cm depth, it became 20% of the prescribed dose.
Conclusions: As a result, it was found that helical tomography could be applied usefully to treat a wide area of the skin with curvature. However, up to 2 mm depth, the planning system overestimated superficial dose, and thus it was found that for the treatment of more shallow targets, to use a compensator such as bolus is required.

943 POSTER

IMRT based radiosurgery – a planning study

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Background: Radiotherapy is a mainstay for the treatment of brain metastasis regardless of the underlying type of cancer. In case of limited metastases to the brain radiosurgical procedures either alone or in combination with whole brain irradiation comprise the state of the art. Adequate coverage frequently requires more than one isocenter especially in those cases where more than one lesion has to be treated. The availability of IMRT technology prompted us to address the question in how far an IMRT based approach could be used to treat multiple metastases with one isocenter.
Methods: Using the CT and MRT data set of five different patients we generated individual treatment plans employing the IMRT-planning program "Hyperion" for an Elekta Synergy S LINAC. All dose distributions were calculated based on Monte Carlo algorithms and optimized using EUD models. The selected patients had one or three brain metastases with diameters between 5 mm and 27 mm. Dose prescriptions were: 15 to 20 Gy (depending on tumor size) on the tumor enclosing isodose. The steepness of the gradient was controlled by defining a 20 mm margin around the GTV in which the dose was restricted to a mean of 3−4 Gy. The maximum dose inside of the lesions was restricted to 120% of the prescribed dose
Results: Optimal dose distributions were obtained for all patients with six couch angles (30° apart from each other) and 9 gantry angles (20° apart from each other) as preset values for IMRT planning. After planning 29−51 beams, with 78–112 segments and total MUs from 3,240.4 to 4,948.8 were required for an adequate IMRT solution. Calculated radiation time was around 60 min.
Conclusions: Using the described technology single fraction IMRT for one up to three brain lesions seems easily feasible.

944 POSTER

Therapeutic outcome of patients with lytic, mixed and sclerotic bone metastases managed with combined radiotherapy and ibandronate

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Background: To investigate the therapeutic response of patients suffering from different types of bone metastases, managed with combined radiotherapy and bisphosphonates.
Patients and Methods: By using computed tomography (CT), 52 patients were grouped into groups of lytic, mixed and sclerotic bone lesions. All patients were treated with concomitant radiotherapy and ibandronate (10 monthly cycles) and underwent clinical and radiological evaluations prior to therapy and at 3, 6 and 10 months post the onset of therapy.
Results: At baseline there were statistically significant differences between the 3 groups for all the evaluated parameters. At 3 months all differences were leveled out. Statistically significant improvements were noted at all time points of evaluation for all groups in parameters such as pain (0−10), quality of life (QOL-physical functioning, 0–100) and Karnofsky performance status (KPS). The average pain score for the lytic group was reduced from 8.1 to 1.5 points at 3 months. The corresponding reductions for the mixed and sclerotic groups were from 6.2 to 0.5 and from 4.4 to 0.3 points respectively. Complete pain responses (pain score of zero with no increase in analgesic consumption) were >76.4% at all time points for all groups. The percentage of patients requiring opioids for pain relief, as well as the mean opioid consumption per patient measured in oral morphine equivalents, were also markedly reduced at all time points. Overall, the highest clinical response was noted for the lytic group, even though the mean values of pain, QOL and KPS were worse than those of the two other groups at all time points (apart from pain score at 10 months). The percentage of patients of the lytic group experiencing a complete pain response was the least of the three groups during follow up. At 10 months bone density was almost tripled for the lytic and almost doubled for the mixed group.
Conclusions: Even though the therapeutic outcome for the three groups was similar, the degree of clinical response and reossification differed.

945 POSTER

High dose spatially fractionated radiotherapy (SFR) using a megavoltage GRID in advanced lung tumours. A pilot study in the UK

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Background: With increasing tumour size, the ability of conventional EBRT to achieve local control decreases. Normal tissue toxicity is one of the main limiting factors in dose escalation. Grid therapy represents fractionation in space not time. This concept was routinely used in the ortho-voltage era to deliver high doses of RT to deep seated tumours while minimizing superficial normal tissue damage. Recently, the principles of SFR have been adapted to megavoltage beams using a specially constructed grid to deliver large single fractions [1]. The local cell kill after a high-dose fraction is expected to improve reoxygenation during subsequent conventional RT. A cytokine-based bystander effect may also lead to enhanced cell kill in regions adjacent to those receiving high doses. In this phase 2 study, 10 patients with locally advanced NSCLC >6 cm in size were treated as part of a feasibility study to evaluate the tolerability of adding a grid boost to conventional palliative RT.