anterior 6MV one portal was applied to the CT, lMRI, and wMRI .We used 6MV photon beams and a two to five gantry portal depending on the patient's target geometry for the 3D conformal plan.

Results: The dose distributions of the one portal plan generated based CT, lMRI and wMRI .The difference in dose distribution and DVH between the lMRI based and CT based plan was smaller than the wMRI based plan. The maximum dose of the wMRI based plan was lower than the lMRI based plan, because the air cavity was not calculated in the wMRI based plan. The 15 patients average maximum, minimum and mean dose difference between wMRI and lMRI based plans. The reference dose was the CT based plans. Our results showed that the maximum, minimum and mean dose difference between lMRI based plans and CT based plans were smaller than the wMRI based plans and CT based plans. The biggest maximum dose difference was the brain stem dose. There was 91 cGy that dose difference between wMRI based plans and CT based plans. But there was a 57 cGy that dose difference between lMRI based plans and CT based plans. The biggest mean and minimum dose difference were PTV dose. The dose difference were 45 cGy and 94 cGy between wMRI based plans and CT based plans. But dose difference were 22 cGy, 53 cGy between lMRI based plans and CT based plans.

Conclusions: Our results confirm that lMRI based planning was available for brain tumor radiation therapy. Future studies are needed for more MRI based plans. This includes the generation digitally reconstruction radiographs (DRR) using an MRI, and reduction of MRI distortion.

EP-1543

A method for assessing the changes of dose calculation algorithms and irradiation techniques in radiation therapy

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Purpose/Objective: In radiotherapy, the oncologists assess the adequacy of a treatment planning using the dosimetric representation. This work proposes a method based on dosimetric and statistical analysis for assessing the changes of dosimetric and irradiation technique in radiation therapy.

Materials and Method: The method has been applied for the treatment of chest and breast cancer using a small number of patients. We applied this method for the change of dose calculation algorithms for chest cancer and the change of irradiation techniques for breast cancer. The global analysis based on 3D gamma index. The gamma values are signed in order to identify the over and under estimating dosage. The plot of gamma (gamma map) and the cumulative Gamma Voxels Histograms (GVHs) in 3D were generated. The gamma criteria were set to 3 mm for the distance to agreement (DTA) and 3% for the dose. Wilcoxon signed rank test was applied to assess the statically significance.

Results: The concept of gamma map in 3D provided a visual representation of the proportion of voxels which respect the conventional tolerance (3mm, 3%). The GVHs show each pixel according to its gamma value. The analysis based on gamma indexes in 3D showed a significant effect on the dosimetric representation in the thoracic localization when we take into account the tissue heterogeneities. The Wilcoxon test showed a significant difference between the two algorithms. However, no significant difference was demonstrated during the passage of a constant source-surface distance technique to a single iso-centric technique for the treatment of breast cancer.

Conclusions: We proposed a method to quantify the dosimetric variation during the change of dose calculation algorithms and irradiation techniques in radiotherapy. The method consisted in generating gamma maps and GVHs in order to quantify the difference in dose distributions. The Wilcoxon test establishes the significance of the results using a small number of patients.

EP-1544

Dose distributions for CCX, CCA and CIA applicators: Plaque Simulator vs. PENELOPE Monte Carlo code

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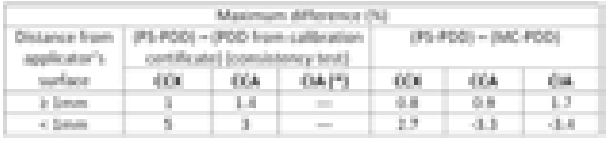
Purpose/Objective: Plaque Simulator (PS) (Eckert & Ziegler BEBIG,GmbH, Berlin, Germany) is a widely used 3D treatment simulation software for ophthalmic brachytherapy. For $^{106}Ru/^{106}Rh$ applicators, it uses a patch source model based on experimental depth dose data provided by the manufacturer for each applicator. This work aimed to compare the dose distributions calculated with Plaque Simulator vs. published PENELOPE Monte Carlo data [Med.Phys. **40**(10), 101705, (2013)], for the CCX, CCA and CIA $^{106}Ru/^{106}Rh$ applicator models.

Materials and Methods: The compared dose distributions were percentage depth dose (PDD) curves along the applicator axis up to 10 mm depth, and transversal dose profiles at 1, 2, 3, 4, 6 and 8 mm depth. For the CIA asymmetric applicator, two sets of profiles were calculated: symmetric and asymmetric cross-section profiles. All data were normalized at 1 mm distance from the applicator.

Results: PDD comparisons (see Table) were analyzed in two separate regions: < 1 mm and ≥ 1mm distance from the applicator. PDD from Plaque Simulator (PS-PDD) and from Monte Carlo (MC-PDD) were consistent within 3.4 % for the analyzed applicators.



(*) For CIA applicator, no calibration certificate was available, so MC data were used to configure the PS calculation algorithm.
Regarding the profile comparison, when the distance to the applicator axis along the profile was < 2 mm, and for all depths, we obtained a maximum difference of 1.5 % for CCX, 0.9 % for CCA and -3.0 % for CIA (symmetric profile).
When the distance to the applicator axis was ≥ 2 mm, we obtained a maximum difference of 10.7 % for CCX profiles near the surface and 2 % for profiles far from the surface; for CCA, a maximum difference of -7.4 % near the surface and 3.5 % far from it; for CIA symmetric profiles the differences found were -11.7 % near the surface and 8.5 % far from it.
Regarding the CIA asymmetric profiles, the maximum differences ranged from 1.2 % at 8 mm to 40.7 % at 1 mm distance from the applicator. Inaccuracies in either PS or MC geometric modeling, which is more challenging for asymmetric applicators, might explain this discrepancy.

Conclusions: The maximum difference for PDD between Plaque Simulator and PENELOPE Monte Carlo code was 3.4 %. This difference shows that both PDD curves would be adequate for the calculation of treatment time, with an acceptable uncertainty for clinical purposes.
For symmetric applicators, the transversal profiles near the applicator's surface differed up to 10.7 % close to the applicator's edges. Hence it would not be advisable to choose an applicator which size is too similar to the tumor size, in order to avoid these areas.
Experimental measurements of CIA profiles would be needed to solve the discrepancy found for this applicator.

EP-1545

A fast Monte Carlo-based calculation algorithm for a Intra-Operative Radiation Therapy TPS : A validation study

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Purpose/Objective: Intra-Operative Electron Radiation Therapy (IOERT) delivers a single high dose to the tumour bed, or to the exposed tumour, directly during surgery. It may use dedicated and mobile electron linear accelerators that can be placed in the operation theatre. Most often, IOERT treatment plan is the result of a sequence of manually handled actions, including collimator and radio protection device positioning. For example, in breast treatments, to shield internal tissues, the surgeon inserts a metal disc between the deep face of the patient's residual breast and the pectoral muscle. Contrary to other radiotherapy techniques with complex treatment plans, such as IMRT, Treatment Planning Systems (TPS) are not yet routinely employed in IOERT. Recently the only one TPS available for IOERT has been extended with Monte Carlo (MC) dose plan capabilities. Treatment parameters can be optimized from a patient CT image data by calculating dose distribution histograms either with a pencil beam algorithm or a fast MC method.
The purpose of this work is to compare the fast MC algorithm employed in the commercial TPS with the dose predicted by a validated GEANT4, in an advanced example.

Materials and Methods: Dose distributions obtained with the TPS were compared with those obtained with a GEANT4 - based application. The GEANT4 application has been validated against experimental measurements, and it has been considered as the reference. The standard setup considered is: a 60mm Ø perspex applicator, a 10 MeV electron beam, a water phantom, and a metal disc inside the water phantom to simulate a radio protection issue.

Percental Depth Dose (PDD) and Lateral Dose (LD) distributions were compared in water. Back Scattering Factors (BSF), defined as the ratio of PDD values with and without shielding disc at the same depth, were estimated for two cases employing the shielding disc in equivalent positions: the first one using a shielding disc of 4 mm thickness of homogeneous material (aluminum, copper, silver, lead), 80 mm diameter; the second one using a double-layer shielding disc made by 2 mm of aluminum and 4 mm of lead. To study electron scattering contribution, the lateral dose distribution was compared simulating a shielding disc of 10 mm thickness of lead and 30 mm diameter, misaligned with respect to the collimator.

Results: The fast MC algorithm PDD and LD distributions in water agree with Geant4 simulation (fig. 1.a). The two methods however exhibit different BSF predictions, with the fast MC predicting larger values than the GEANT4 simulation (fig. 1.b). A maximum difference of 10% is seen for the lead shielding disc.

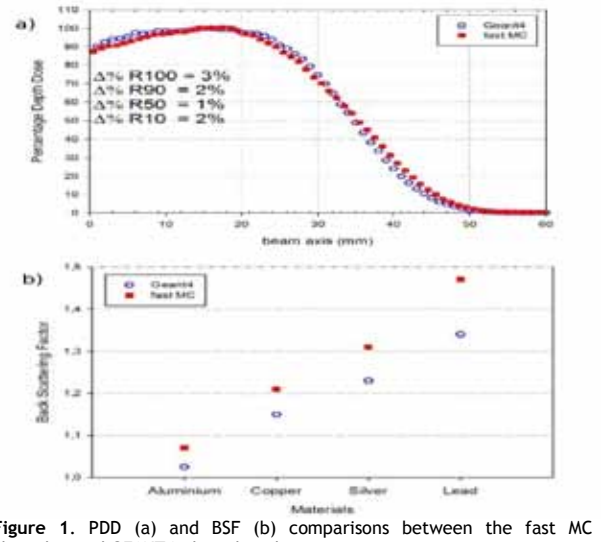

Figure 1. PDD (a) and BSF (b) comparisons between the fast MC algorithm and GEANT4 - based application.

Conclusions: In the water phantom both fast MC and GEANT4 simulations agree. Further evaluations, probably comparing to actual experiments with shielding disk are needed, along with a comparison of simulated doses in clinical patient CT DICOM volumes.

EP-1546

Dose planning of a total body irradiation with Volumetric Modulated Arc Therapy (VMAT)

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Purpose/Objective: The aim of this work was to establish total body irradiation (TBI) with doses of 13.2 Gy in 8 fractions using volumetric modulated arctherapy (VMAT). Inspired by a work of Mancosu et al., we calculated and optimized VMAT using the Varian RapidArc™ software for a target volume covering the whole body. Emphasis was placed on a homogenous treatment of the target volume while selectively reducing the dose to the lungs, and, if necessary, to other organs at risk (OAR).

Materials and Methods: For this complex irradiation technique, it was necessary to split the planning CT into a cranial and a caudal part, which efforts a two step planning procedure, one for the cranial and one for the caudal part of the CT. The overall planning target volume (PTV) had to be split into 8 segments (PTV1…8) with a subsequent multi-isocentric planning. The splitting up into two CT parts and the limitation of the RapidArc™ optimization software to 10 Arcs demanded the calculation of two field alignments, one in the lower mediastinum and the other in the lower abdomen. In the first step the optimization of all the PTV segments was carried out, whereas in the second step all the calculated single dose distributions coming from the segments (PTVi) had to be calculated in an overall plan. In this step it is of crucial to comply the before used constraints and weighting factors for the PTVs and OARs to achieve the final total body dose distribution. The calculation of the two field alignments required a construction of a further 12 dose dependent PTV´s per field alignment, followed by an additional optimization of all the dose dependent PTV´s. The quality assurance comprises the verification of the irradiation plans via Arccheck, followed by an in vivo dosimetry via an appropriate positioning of MOSFET´s on the patient.

Results: With this technique it was possible to achieve a homogeneous total body dose of 13.2 Gy. The efforts in contouring and dose optimization are enormous, nevertheless the great benefit of this complex technique was a reduction of the lung mean dose below 10 Gy. In a particular case we additionally accomplished a dose reduction in parts of the brain and the liver of 50 % or 30 % respectively.

Conclusions: Planninga TBI with Rapid Arc™ allows a homogenous dose distribution within the PTV while selectively reducing the dose to the lungs. If desired, a significant reduction of the dose in the brain and the liver can be achieved.
The additional expenses with regard to treatment and planning time are extensive.

EP-1547

Treatment planning using passive grid block for spatially fractionated GRID radiation therapy

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Purpose/Objective: Spatially Fractionated Grid Radiation Therapy (SFGRT) was developed as a palliative treatment modality for bulky tumors that can be achieved by using planar chess-format beams, i.e. combination of open-closed radiation areas (Fig.1.a). Currently SFGRT is performed by either using commercially available Grid block or a multi-leaf collimator (MLC) of a linear accelerator. In addition to eventually better dosimetric property in terms of maximum to minimum dose modulation, the Grid Block delivery technique is also faster than the widely adopted MLC-based approach. To date, the incorporation of the GridBlock into a treatment planning system (TPS) has not been reported, which is probably due to relatively complex geometrical design of divergent holes within GridBlock. In this work, we inserted the Grid Block into a commercially availableTPS, and we also verified the feasibility of delivering such treatment plan on linear accelerator using Record and Verify (R&V) system.

Materials and Methods: The Grid Block has diverging cylindrical holes arranged in hexagonal patterns (Fig.1.b).Size of the holes and their spacing was determined by irradiating a piece of EBT3 model GAFCHROMIC™ film positioned at the isocenter (Fig.1.c). In order to validate the Grid Block design inserted inTPS, we performed dose measurements using ion chamber in water phantom and EBT3 model GAFCHROMIC™ film within solid water slabs. Ionization chamber was used to measure: output factors, percentage depth dose (PDD) curves, and beam profiles at two depths: zmax and depth of 10 cm. Radiochromic film sheets were used to measure dose profiles at zmax and 10 cm depth. Commissioning of the Grid Block technique was performed for 6 MV photon beam quality on our clinical linear accelerator.

Results: The largest observed percentage difference between output factors for the Grid Block technique calculated by TPS and measured with ion-chamber was 0.78%. Relatively significant discrepancies between measured and calculated PDD (Fig.1.d) appears only in the buildup region, which we found to amount to up to 4% while we observed a good agreement (differences below 2%) at depths beyond z_{max}.