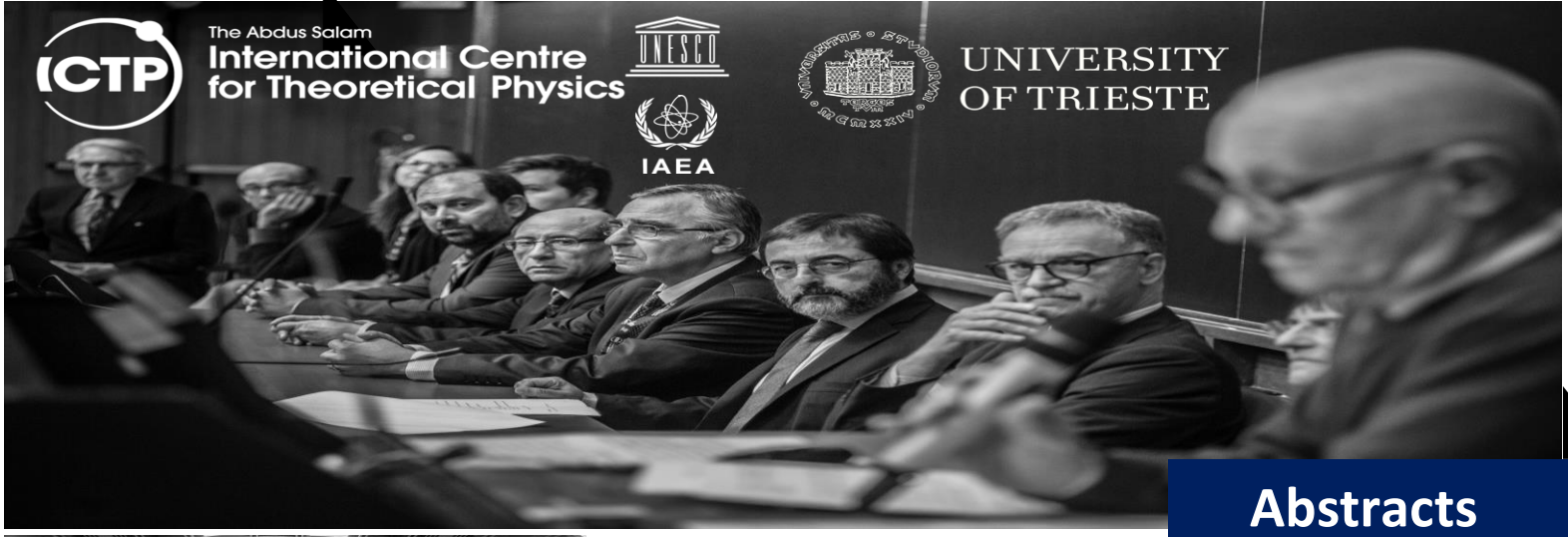

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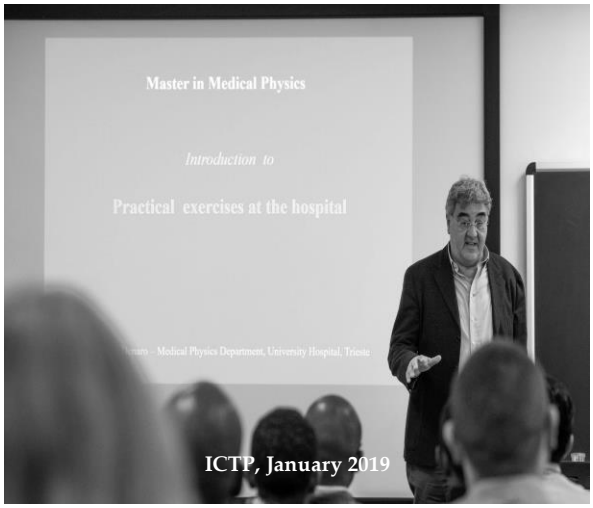

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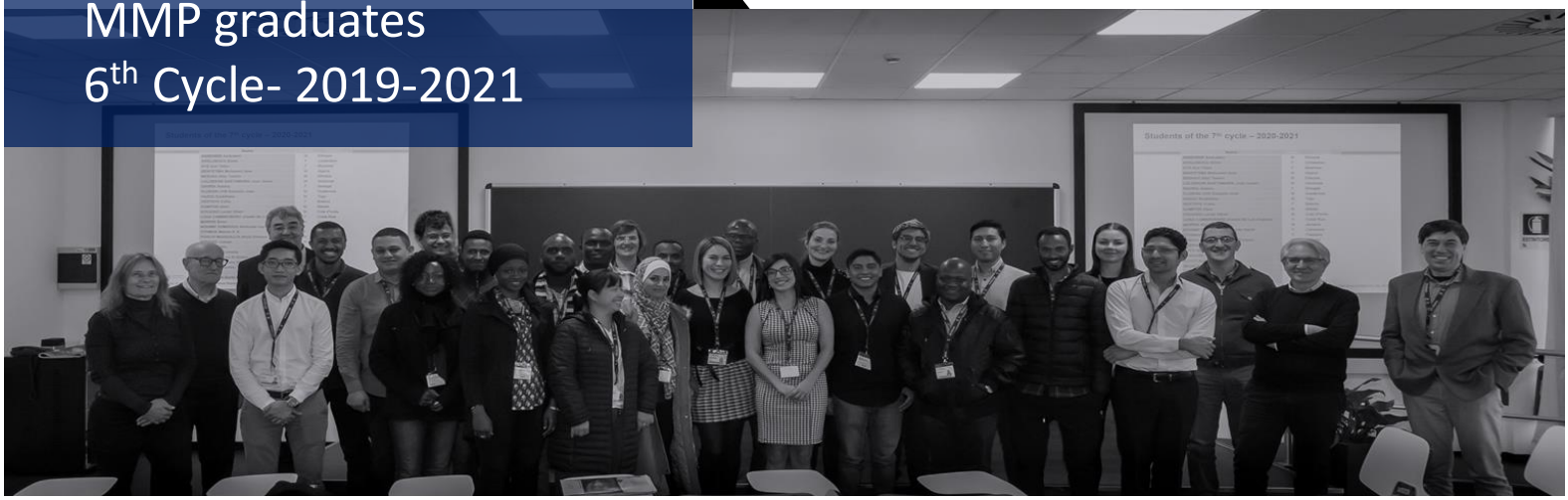

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Dosimetric Study of Fetal Dose during External Beam Radiotherapy using OSLD

Prospective/Objective: Fetal doses must be carefully evaluated if radiotherapy is used during pregnancy, as the fetus is extremely sensitive to radiation and fetal doses as low as 100 mGy can have serious effects. As fetal dose is outside the treatment field, special considerations must be considered. The objective of this study is to calibrate an OSL dosimetric system to measure out of field doses for brain and breast external beam radiotherapy plans, and compare the results to dose calculations from the Eclipse Acuros algorithm.

Materials and methods: A batch of Landauer nanoDots OSLD was calibrated in a 6 MV field on a Varian TrueBeam linac, both in in-field and out-of-field locations. The reader used was the Landauer microStar ii. OSLDs were irradiated in a phantom made of solid water slabs and Rando Alderson Phantom slabs, with a high enough number of MU to achieve sufficient signal even in out-of-field positions. A custom PMMA grid was built to precisely position the OSLDs and avoid air gaps. A Farmer chamber was used as the reference detector for calibration, due to its small energy dependence. A batch of Gafchromic EBT3 film was also calibrated in the 6 MV energy in-field. A 3DCRT breast plan and 3DCRT and VMAT brain plans were calculated on the Eclipse TPS with the Acuros algorithm, and compared to measurements. PMMA grids containing OSL detectors and EBT3 film were placed on the phantom and a total target dose of 60 Gy was irradiated for all plans

Results: Out-of-field doses were measured at different depths for a breast plan and a 3DCRT and VMAT brain plans. For the depth of 10 cm, the resulting dose was 2.5 cGy for the breast plan at a distance of 30 cm from the isocenter. For the brain astrocytoma plans, the doses were 0.8 cGy for the conformal plan and 1.1 for the VMAT plan, at a distance of 52 cm from the isocenter. These values are below the limits and comparable to other values reported in the literature. For the 3DCRT breast plan, the TPS significantly underestimated the dose in all cases. The dose differed by -40% at a depth of 5 cm, -48% at a depth of 10 cm and -67% at a depth of 15 cm, taking the OSLD measurement was the reference dose, and at a distance of 20 cm from the isocenter. For the brain plans, at a distance of 32 cm from the isocenter, no direct comparison was possible, as the TPS calculated zero dose at this point. The distance to agreement was 25 cm for the 3DCRT plan and 19 cm for the VMAT plan.

Conclusion: For fetal dose evaluation measurements before treatment should be done to avoid large errors. Landauer nanoDot dosimeters can be used with a phantom for these measurements by calibrating them in out-of-field conditions against a Farmer chamber. The Acuros calculation algorithm in Eclipse greatly underestimates the out of field dose and can be used only for a rough estimation in points not so far from the central axis of the beam (less than 20 cm).

Statistical Process Control in Tomotherapy pre-treatment QA: Fixing tolerance and action limits for the verification metrics

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Prospective/Objective: We retrospectively applied the SPC methodology to gamma (γ) analysis and dose difference results in helical Tomotherapy™ (Accuray) pre-treatment verifications, using ArcCheck™ (Sun Nuclear) as QA tool, to establish tolerance limits (TLs) and action limits (ALs) for different anatomical sites (abdominal area, head & neck, breast plus suvraclavear nodes and prostate). The final purpose of this research is to evaluate the performances of SPC in the context of Tomotherapy pre-treatment QA in order to develop a methodology able both to promote detection of eventual delivery problems before the treatment and to monitor the system performances over time.

Materials and methods: The parameters selected to determine TLs and ALs in pre-treatment QA measurements were the γ-index passing rate obtained with two criteria: 3%3mm-local normalization (G33L) and 3%2mm-global normalization (G32G). The dose difference measured with an ionization chamber placed in the center of the phantom was also considered. The calculation of the patient plans on ArcCheck™ was done with Tomotherapy ''Delivery Quality Assurance'' method available in the planning station. TLs and ALs at the institution's local level were evaluated with the SPC method proposed in AAPM TG218, a safety standard report for measurements prior to treatment. AAPM proposal requires a minimum of 20 pre-treatment QA measurements. Here, absolute dose measurement and G33L analysis were evaluated on 727 cases (abdominal 166, breast + SVC 165, head & neck 115, and prostate 281); G32G analysis was performed on a subset of 343 measurements (abdominal 71, breast+SVC 79, head & neck 62, and prostate 131). SPC method was applied to evaluate TLs and ALs both starting from the whole dataset and from the first 20 measurements only.

Results: Different TLs and ALs were found for different anatomical locations. The highest Lower Control Limit (LCL) for the G33L criterion were for head & neck (90.69%) and prostate (88.27%), indicating that they are a very stable process in helical Tomotherapy. The lowest LCL were found for breast + SVC (74.59%) and abdomen (77.10%). The action limits determined for G33L also followed the same pattern described above, that is, head &neck (86.85%) and prostate (82.96%) as the highest values, while breast + SVC (59.35%) and abdomen (74.23%) as the lowest values. For the G32G criteria, the highest LCLs were observed for abdominal site (95.57%) and prostate (93.94%); the lowest LCLs were breast + SVC (84.49%) and head & neck (89.92%). The same happened with the action limits, with abdomen (92.67%) and prostate (90.46%) followed by breast + SVC (82.71%) and head & neck (87.42%). As far as the absolute dose difference is concerned, the smallest average difference and CL/AL values were: head & neck (average difference 0.62%), abdominal (0.81%) and prostate (0.81%). For breast + SVC (average difference 0.95%) a very high variability of results was found, producing high control levels. In summary, breast + SVC was found to be the most challenging kind of treatment: indeed, it involves large areas of very low doses and gradients where, especially local gamma analysis, gives not optimal results until you do not apply a high threshold (10% in our analysis). Moreover, these treatments generally involve large treatment volumes, and it may be difficult to position the ArcCheck in order to efficiently cover the entire dose distribution and sample it with the diodes while preserving suitable positioning of the central ionization chamber in a full dose, low gradient region. The high variability of dose difference values that was found reflects the fact that ArcCheck positioning in these cases often results in the ionization chamber placed in a low dose and/or high gradient region. In general, CL and AL calculated from 20 measurements only, gave more stringent tolerances since less variability of data is included.

Conclusion: TLs and ALs for different anatomical sites were successfully established both considering all the acquire statistics and staring from 20 measures only. Setting TLs and ALs locally helped to understand and validate the performance of treatment QA over time. In this way, negative results that may affect patients can be detected, avoided and prevented.

An interesting side result of this study is that results produced by the new AAPM suggested parameter (G32G) are definitively better with respect to the ''storical'' parameter G33L. This denotes how important it is to know the behavior of both parameters when changing from one focus to the other.

Commissioning of VERSA HD linear accelerator for FF and FFF beams: Evaluation of the performances of various detectors in relative small field dosimetry

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Prospective/Objective: The main objective of this work is to evaluate the performances of different detectors in the small fields by using 6 MV FF, 6 MV FFF and 10 MV FF beam energies. The implementation of TRS-483 CoP for field output correction factors was used in this work, together with a comparison of correction factors adopted from literature, in particular for synthetic diamond and PinPoint detectors. To identify the detectors more suitable for dosimetry of small fields by evaluating perturbations and uncertainties associated with the determination of field output factors.

Materials and methods: In this study, the linear accelerator VERSA HD (Elekta, Stockholm, Sweden) of 6 MV FF, 6 MV FFF and 10 MV FF energies was used to obtain the Profiles (crossline and inline), Percentage Depth Doses (PDDs), Output Factors (OFs) with various detectors. The dose rate of 6 MV FF and 6 MVFFF can reach 600 MU/min and 1900 MU/min respectively. Beam Profiles and PDDs were obtained for field sizes from 0.6×0.6 cm2 to 2×2 cm2 with (PTW microDiamond 60019 (mD), PTW Diode 60018, PTW PinPoint 31014, Sun Nuclear EDGE detector 1118), by using all energies. The OF measurements were performed with all detectors including Exradin W1 plastic scintillator, for field sizes from 0.6×0.6 cm2 to 3×3 cm2 by using all energies. The correction factors from IAEA TRS 483 and from literature data (correction factors from (De Coste et al 2017 and Looe et al 2019) for mD for 6 MV FF and correction factors from (Francescon et al 2011) with Monte Carlo (MC) to PinPoint detector for 6 MV FF and FFF) were applied to measured OFs in order to make a useful comparison between detectors and to evaluate their accuracy. The differences between measured and corrected OFs were investigated in this work.

Results: Small differences in PDDs, FWHM and penumbra values were observed between flattened and FFF beams with the different detectors for smallest field size 0.6x0.6 cm2. The standard deviation (SD) calculated on the measured OFs ranged from 0.2% to 3.7%. The application of the IAEA correction factors resulted in a reduced SD, ranging between 0.2% and 2.7% considering all field sizes and energies. Higher differences in OF values before and after the correction were observed in FFF beams than in FF beams as well as in the smallest field (0.6×0.6 cm2) for all detectors, as reported by other studies. The PinPoint detector under-responded for the smallest fields (especially for 0.6×0.6 cm2 and 1×1 cm2) for all energies due to its higher active volume compared to those of the other detectors. For mD, the OFs calculated using the IAEA correction factors were found consistent with those obtained applying both De Coste and Looe correction factors, with differences within 0.7%. For PinPoint, the OFs calculated using the IAEA correction factors and those from Francescon et al., differ within 3% for both 6 MV and 6 MV FFF. The total uncertainties were found to be approximately 3% for 0.6x0.6 cm2 field size.

Conclusion: The outcome of this study demonstrated that all the investigated detectors are suitable for small field dosimetry. The differences in dose response between the detectors used in this study were significantly reduced by implementing the correction factors reported in IAEA TRS 483 and in literature for all investigated small fields and energies. The EDGE, Diode 60018, plastic scintillator and mD detectors need smaller corrections for all field sizes and energies, they can be considered as a preferred choice, if available. The alignment and correction factors uncertainties can be considered as an important source of the OFs variation, especially for the smallest field size. It is worth underlining the importance of properly centering the detector on the central axis of the radiation beam, for small field

measurements. However, further studies are needed to provide correction factors derived from an accurate modelling which may improve the treatment results with enhanced patient safety.

Measurements of planar and tomographic system spatial resolution in SPECT/CT with a home-made phantom

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Prospective/Objective: The spatial resolution of a gamma camera is a critical parameter for the diagnosis, as it affects the ability of the device to detect small lesions and to assess them qualitatively. The aim of this thesis was to characterize the planar and tomographic system spatial resolution performance of a SPECT/CT equipment as the function of different parameters (related both to acquisition conditions and to image reconstruction algorithms) using simple home-made phantoms based on NEMA protocol.

Materials and methods: The equipment that was tested is a dual head Siemens Symbia SPECT/CT system installed in the Nuclear Medicine Department of Cattinara hospital in Trieste. For the planar system resolution, a home-made phantom was prepared with four plastic capillary tubes of internal diameter < 1 mm, filled with a solution of 99mTc and fixed on a polystyrene holder. Two collimators were tested, Low Energy High Resolution (LEHR) and Medium Energy Low Penetration (MELP), with and without a scattering medium (a flat-water plastic tank), positioning the phantom at two distances from the collimator (10 cm and 20 cm) and varying the matrix size (64 x 64, 256 x 256, 1024 x 1024) and the zoom factor (Z = 1, Z = 3.2). On the acquired images, the resolution in the x and y directions and the pixel size were evaluated. For the tomographic system resolution with scatter, a standard PMMA CT head phantom was used, inserting into holes three-line sources previously prepared with plastic capillary tubes of internal diameter < 1 mm, filled with a solution of 99mTc. A tomographic acquisition with matrix 256 x 256, radius 15 cm, 120 views per head was run; the transversal slices were reconstructed with a Filtered Back Projection (FBP) algorithm and an iterative algorithm (3D-OSEM). All the images were analyzed using the free software ImageJ, drawing rectangular ROIs to obtain the profile of the pixel counts perpendicularly to each line source (Line Spread Function) and applying a Gaussian interpolation; the resolution parameter was expressed as Full Width at Half Maximum (FWHM) of the resulting peaks. For the planar system resolution, the IAEA software NMQC Toolkit was also applied.

Results: The results showed that the system planar resolution increases as the source to collimator distance decreases, when no scattering material is interposed and as the matrix size increases, as expected. The tomographic resolution with scattering was found to be better in images reconstructed with the 3D-OSEM iterative algorithm than with the FBP algorithm.

Conclusion: It was found that the system spatial resolution values, both for planar and for tomographic acquisitions, were in agreement or better than the manufacturer specifications. Moreover, it was possible to prepare the phantoms required for the measurements using materials and tools easily available in hospitals, without acquiring commercial phantoms.

Optimization of 18F- FDG oncological examinations on a TOF-PET/CT scanner

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Prospective/Objective: The aim of this study was to Optimize the 18FDG Whole-Body oncological examinations on a TOF-PET/CT Scanner through assessment of image quality dependence on contrast and noise properties change as a function of emission scan duration (ESD) and Body mass index (BMI).

Materials and methods: 38 oncological patients (regardless their gender), 18 with BMI < 25 kg/m2 and 20 with BMI > 25 kg/m2 were selected for this study, which resulted a total of 74 lesions from head and neck, thorax, and abdomen district. The injected activity for all patients was about 3 MBq/kg of 18F-FDG and images were acquired with an Emission Scan Duration (ESD) of 2 min/bed position. Thanks to the list mode acquisition, the 2 min/bed acquisitions were reconstructed to 90, 75, 60, 45 and 30 seconds. Furthermore, the image quality dependency on contrast and noise properties was assessed through Contrast to Noise Ratio (CNR) and Coefficient of Variation (%CV) with respect to ESD and BMI. The Coefficient of Variation (%CV) was evaluated on the liver from any slice with uniform uptake by taking a ratio of standard deviation (SD) and mean activity concentration of 6000 mm3 circular volume of interest (VOI). Moreover, to evaluate Contrast to Noise Ratio (CNR) in each lesion, a volume of interest (VOI) was automatically delineated by using iso-contouring with 50% maximum threshold in the lesion and a U-shaped background ROI drowned around the lesion by using a closed contour, to obtain the mean activity concentrations and standard deviation.

Results: This study proved expected dependence of CNR and %CV on both ESD and BMI at constant 18FDG injected activity concentration of about (2.8±0.3) MBq/Kg.

Conclusion: It is reasonable to adjust the duration of the PET bed with the aim of improving CNR of the lesions while considering the patients' BMI, in the range of the explored values.

Dosimetric verification and comparative analysis of Collapsed Cone Convolution and Irregular Field algorithms for soft tissue, lung, and bone region treatment sites using an anthropomorphic phantom

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Prospective/Objective: Treatment Planning Systems (TPSs) have proven to be an indispensable tool in radiation therapy treatment. The accuracy of any TPS to calculate dose is largely dependent on the mathematical algorithm used and can be well verified using a dedicated phantom. The aim of this study was the dosimetric verification and comparative analysis of three different TPSs (Precise PLAN R2.15, Pinnacle 3 and Monaco 5.11.03) using Collapsed Cone Convolution (CCC) and Irregular Field (IF) algorithms for soft tissue, lung and bone treatment sites using an anthropomorphic phantom, based on the methodology developed by IAEA-TECDOC-1583.

Materials and methods: The study was executed with a CIRS 002LFC IMRT Thorax phantom made of plastic water, lung and bone sections with holes to hold interchangeable rod inserts and an ion-chamber port. The phantom was simulated using a computed tomography (Philips brilliance Big Bore, multi slices) scanner and three TPSs (Precise PLAN R2.15, Pinnacle 3 and Monaco 5.11.03) for application of beam setup parameters. Treatment plans were generated for three megavoltage photons energies (X4, X6 and X10) using Elekta Precise Treatment System Clinical Linear Accelerator and a Pinpoint 3D ion-chamber (TW3101) was used to perform dosimetric verification. The ionization chamber was coupled to a PTW-UNIDOSE-E electrometer which measured the charge collected during irradiation. For each test case measurements were acquired and the deviations between measured and calculated TPSs dose values were analyzed using agreement criteria mentioned in IAEA-TECDOC-1583 report.

Results: A total of 8 clinical test cases for three nominal energies of photons 4, 6 and 10 MV were produced to evaluate the performance of CCC and IF algorithms to calculate the dose in media with homogeneities and heterogeneities. The dose deviations (error%) obtained for the three TPSs, in comparison with the experimental measurements are reliable in most cases with an error in the calculation of the absorbed dose of less than 2% in a homogeneous tissue equivalent medium, with the exception of the IF algorithm values corresponding to four field box (test no. 4), at 270° gantry angle (P5) for the nominal energies of 4 and 6MV which are slightly outside the confidence recommended limit. Good correspondence of the mean deviations of the calculated dose values with respect to the measured dose values were observed for all energies regardless of the algorithm considered. However, the deviations in the bony and lung regions insert regions are largely dependent on one algorithm to another. The results appear to be better for the CCC algorithm. The overall results in heterogeneous lung and bone inserts were 67% and 89% for PrecisePLAN, 100% and 95% for Pinnacle, and 100% and 100% for Monaco, respectively.

Conclusion: The dose prediction capacity of the Irregular Field algorithm appears to be comparable to the Collaspsed Cone Convolution algorithm in soft tissue medium and was found to be 98 % within the agreement criteria. The most significant difference between the two algorithms were found in the bony and lung regions. This comparison shows a good performance on the part of the TPS Monaco and Pinnacle, with in particular a good taking into account of the lack of diffusing volume and a good modeling of the lateral electronic transport. This work could clinically help the user to appreciate the properties, qualities and operational characteristics of the 3 TPS and to better understand their limits.

Internal Radiation Dosimetry Based on Dose Point Convolution Kernel (DPK) for 177Lu-DOTATATE Therapy

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Prospective/Objective: Organ Level Internal Dosimetry and Exponential Modelling (OLINDA/EXM) code is widely used in nuclear medicine internal radiation dose assessment for diagnostics and in targeted radionuclide therapy (TRT). Although OLINDA/EXM lacks adequate patient specific and comprehensive internal radiation dosimetry capacity, it is fast in evaluating mean absorbed doses. The purpose of this study was to implement in a MATLAB (MathWorks, Natick, MA) program, a more patient specific internal dose calculation algorithm based on voxelated dose point convolution kernel (DPK) for 177Lu radionuclide. The DPK in the MATLAB program was used to generate three-dimensional dose distributions in SPECT/CT images for neuroendocrine tumor (NET) patients undergoing 177Lu-DOTATATE therapy.

Materials and methods: Dose Point convolution Kernel (DPK) for 177Lu were pre-calculated in EGSnrc user-code DOSXYZnrc Monte Carlo simulation. The kernel included all the beta energies and the two most prominent gamma energies of the radionuclide, 208 keV (10.4%) and 113 keV (6.2%). Two dose calculation algorithms, namely DPK and local dose deposition (LDP), were implemented in a MATLAB program. A graphical user interface (GUI) was built to load SPECT/CT images and RTstructure DICOM files. Activity evolutions for organs at risk (kidneys, liver and spleen) and lesions were quantified from SPECT/CT images. The SPECT/CT images were acquired at 4, 24, 72 and 168 hours post injection of 177Lu-DOTATATE during first cycle and only one acquisition after 24 hours post injection for each of the three subsequent cycles. Bone marrow dose was estimated from 8 blood samples collected after 0.5, 1, 2.5, 4, 8, 24, 72 and 168 hours post injection. Analysis was based on comparison of mean absorbed doses calculated using OLINDA/EXM, DPK and LDP.

Results: The 50th percentiles at 95% CL for ratios of mean absorbed doses calculated with DPK and LDP algorithms to those calculated with OLINDA/EXM were 0.99 and 1.03 respectively in the first cycle. Bland-Altman statistics at 95% prediction level gave a mean dose bias of 0.77 Gy between DPK and OLINDA/EXM. DPK provided more comprehensive dosimetry information including full 3-dimensional dose distributions and dose volume histograms (DVH). Paired organs like kidneys were found to have variation in radio-pharmacokinetics and subsequently different mean absorbed doses by up to 17.53%. Based on full therapy cycles, the maximum estimated mean absorbed doses to organs at risk; bone marrow, right kidney and left kidney were 0.96±2.00 Gy, 8.96±2.00 Gy and 9.60±2.00 Gy respectively. These mean doses are safely below the recommended limits to bone marrow and kidneys, 2.0 Gy and 23.0 Gy respectively based on external beam radiation therapy (EBRT) experience.

Conclusion: Voxel level internal dosimetry protocol for organs at risk and lesions for NET patients undergoing 177Lu-DOTATATE therapy can be determined based on dose point convolution kernel (DPK). The implemented MATLAB program was easier to use, equally accurate compared to OLINDA/EXM, gave comprehensive 3-dimensional dose distributions and was fast enough for a clinical workflow.

Comparison of different treatment planning techniques for breast cancer

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Prospective/Objective: The aim was to compare different treatment techniques for the breast cancer in order to evaluate if the use of inverse planning vs forward planning lead to improve dosimetry for targets and OARs.

Materials and methods: This study was conducted using CT simulation data sets of 11 right/left-sided breast cancer patients who had been previously treated at Radiotherapy Department of Sant'Anna Hospital - Ferrara. 3DCRT, IMRT, VMAT and VMAT obtained with an automatic planning system were compared retrospectively in terms of dose to target and to OARs. Planning target volume included both breast wall and supraclavicular lymph nodes. All the patients were prescribed a total dose of 50 Gy to the PTV in 25 fx and plans were performed using Pinnacle (Philips) TPS. For each treatment plan, DVH was analyzed to obtain PTV and OAR dosimetric data. For target coverage we compared, for the different techniques, Dmax, Dmean, D95%, V95% and calculated the Homogeneity and Conformity Index (HI and CI). We consider also OARs dose sparing: ipsilateral lung, heart (in case of left breast), contralateral lung and contralateral breast. Paired Student's T-test was finally used for statistical analysis.

Results: Results. For breast PTV D95% coverage was better for inverse planning techniques for all patients, with VMAT and Auto VMAT allowing similar dose coverage. For SVC lymph nodes PTV inverse planning techniques have almost similar D95% coverage. However, in this case D95% is satisfactory for all techniques for what concern V95%, in almost all cases IMRT, VMAT and Auto VMAT had similar coverage, better than 3DCRT one, both for breast and SVC lymph nodes PTVs. HI evaluation demonstrated, as expected, that for almost all plans the dose distribution from inverse planning techniques were more homogenous as compared to 3DCRT. Inverse planning techniques showed better results also for CI for all patient compared to 3DCRT. For what concern normal tissues dosimetry, all techniques allowed to comply with the requested constraints, except for high dose constraints in 3DCRT. Forward planning resulted in better sparing of heart, contralateral lung and contralateral breast in terms of mean dose. Statistical analysis gave significant results in comparing 3DCRT vs inverse planning techniques (IMRT and VMAT) for all dosimetric variables (D95, V95%, HI and CI). The comparison between IMRT and VMAT resulted in differences for CI in breast PTV and for all parameters in SVC lymph nodes target. VMAT and AutoVMAT are statistically different only for D95 and V95% in lymph node PTV.

Conclusion: The difference in dosimetric parameters between 3DCRT, VMAT and IMRT highlighted that the use of inverse planning techniques can significantly improve dose distribution for breast and lymph nodes targets. However, the choice of the better technique must be patient dependent. The use of breath holds systems, essential for VMAT treatments, requires compliant patients otherwise 3DCRT should be considered. In general, VMAT seems to provide the optimal balance between breast and regional node coverage, normal tissue sparing and treatment complexity. Moreover, VMAT techniques with auto planning modules could be a best option in order to reduce the variability of treatment quality standardizing the planning.

6 MV and 6 MV FFF VMAT dosimetric validation based on AAPM TG 119 report using 3D phantoms, and an on board EPID in a Monte Carlo TPS.

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Prospective/Objective: Evaluating the dosimetric accuracy of volumetric modulated arc therapy (VMAT) for a new Versa HD linear accelerator for 6 MV and 6 MV FFF (Flattening Filter Free) photon beams. All measurements were done accordingly the AAPM TG 119 report adapting it to the VMAT technique and two cylindrical phantoms: a Delta4 Wi-Fi and a Matrix phantom and an on board EPID. The cylindrical-shaped phantoms have the advantage that simulates the patient shape, and the EPID has the advantage to be fast and less time-consuming in pre-treatment dose verification procedures. Benchmarks were created in terms of confidence limits (CL) using the statistical methods suggested by the report.

Materials and Methods: VMAT plans were calculated and optimized following the AAPM TG 119 dose prescriptions and planning objectives, using a Monte Carlo based Treatment Planning System (TPS) Monaco 5.51.02 for 6 MV and 6 MV FFF photon beams. The TG 119 report suggests five test plans: Multitarget, Prostate, Head-and-Neck and C-Shape easy and C-Shape hard. Two different approaches measured the delivered dose: composite 3D or 2D dose distribution in the Delta4 and EPID respectively and single point absolute dose in the Matrix phantom. The measured dose was compared with the TPS calculations using gamma criteria of 3%/3 mm and 2%/2mm. Confidence Limits were generated and compared with the TG 119. Delta4 and EPID were also used to verify the dose distributions of the first 26 patients treated with this new linac.

Results: he overall passing rates for 6 MV with 3%/3mm for Delta4 and EPID were 99.57±0.26, 99.44±0.52 respectively and 99.78±0.49, 98.92±1.34 for 6 MV FFF; with CLs, 0.95 for Delta4 and 1.70 for EPID for 6 MV photon beam compared with 1.18, 3.71 for 6 MV FFF respectively. For, 2%/2 mm for Delta4 was 95.87±1.84 for 6 MV and 98.77±0.79 for 6 MV FFF, compared with EPID 95.92±1.32 for 6 MV and 94.28±3.94 for 6 MV FFF. The obtained passing rates with 3%/3 mm for the 6 MV plans were always better than that reported in TG 119 (97.06±1.81%). Gamma passing rates obtained with the Delta4 were usually higher than EPID pass rates due to the higher sensitivity of the EPID to the accumulated dose. Regarding Point Dose Measurements, local CL for VMAT plans evaluated with the Matrix phantom was 0.013 for 6 MV and 0.028 for 6 MV FFF respectively. Regarding the patient measurements, the Delta4 has a passing rate ≥ 97.5% while the EPID has a lower corresponding passing rate ≥ 91.6%.

Conclusion: Even if not specifically designed for VMAT treatments, TG 119 methodology has successfully been used to evaluate the commissioning accuracy of VMAT on a Versa HD linear accelerator, and a dosimetric validation was performed. All results were well inside the acceptable values suggested in the protocol. The methodology of the TG 119 was easily applied to all phantoms and devices proposed in this work. Local institutional CLs were established which can be used as benchmarks for future measurements and as a baseline for future patient-specific pre-treatment quality assurance.

Impact of the detector type on the implementation of an Eclipse treatment planning system.

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Prospective/Objective: The aim of this study was to study the impact of different detectors on an Eclipse treatment planning systems in terms of implementation and dose distribution in planning on clinical patients.

Materials and methods: Two different detectors, the PTW-31010 Semiflex 0.125cc ionization chamber and the PTW-60019 microDiamond, have been used to acquire beam data that we implemented two Eclipse treatment planning systems with.Detectors beam data have beencompared first, then comparison between systems have been done at two levels: configuration data and treatment planning in clinical patients.

Results: It has been found that the detectors beam data are somehow different, with discrepancy lower than 1% in general, for measured PDDs, beam profiles and TPR20/10. As expected, the penumbra showed differences going up to 43%; the semiflex chamber having the largest penumbra. The systems implementations have been found within good agreement, with average gamma errors lower than 1 for both systems. Plan comparison showed few differences that have been found not statistically significant, even if some important dose differences (up to 5%) have been found in some organs at risk. Overall, the differences found in dose distribution in structures, mainly in PTV, were not clinically relevant. The dose coverage was also similar between plans done on both TPSs.

Conclusion: Definitely, from our analysis we can conclude that whatever the kind of detector used for beam data acquisition, if it has been found suitable for measurement for the range of field sizes, it will be able to perform a good system implementation.

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Impact of the detector type on the implementation of an Eclipse treatment planning system.

Prospective/Objective: Purpose of this study is to analyze and to compare results regarding the profile (penumbra, flatness), percentage depth dose (PDD) and output factors (OF). Obtained using different detector size under beams, with various field size and different energy.

Materials and methods: Beam profile, PDD and OF measurement will be performed in standard water phantom (which are the primary tool used for absolute dosimetry and it consist of a transparent plastic tub (about 60cm in all dimensions) filled with distilled water) in Various square fields size for different photon beam energy which I used Elekta SL15 {(6 and 15MV x-ray energies) accelerator equipped with multi leaf collimator(MLC)}, by scanned different detectors such as Semiflex31010, Semiflex31013, Pinpoint31016, Farmer30013, Markus 34045, Diode P Type 60016, and Diode E Type 60017, Micro-L-ion Chamber 31018 .

Results: Our results, evaluated in terms of PDD, OF, profile (penumbra and flatness) will indicate which detectors are appropriate for measuring photon beam depending on the set field size.

Conclusion: Regarding profile, PDD and output factors determination, Microlion31018 detector is stable for both filed, diode60016 detector and diode60017 detector are acceptable for small field, and Semiflex31010 detector are good for collecting data in large field Pinpoint31016 detector is a small detector, it was stable for some measurement, but not for much accuracy in both fields. Parallel plate ionization chambers (Markuse34045) are not appropriate for penumbra and buildup region measurements. In case of inconsistency and improper behavior of data collection from Semiflex31013 and Farmer30013 detectors. We stopped collecting data, after when we checked them in three fields.

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