# Medical Physics

## Oral Presentations:

**0053**

### Validation of an atlas consistent with RTOG for automated contouring in radiotherapy planning for high-risk prostate cancers

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Purpose:
To create a CT-based atlas of high-risk prostate-cancers, and evaluate the performance of a commercially available automated-atlas-based-segmentation (AABS) software in delineation of target-volumes and organs-at-risk (OARs).

Methods and materials:
Treatment planning CT-images of 20 high-risk prostate-cancer patients were retrospectively reviewed. All patients had non-contrast CT-simulation with full bladder and empty rectum. Volumes-of-interest included prostate and pelvic-lymph-nodes (LN) CTVs; OARs (rectum, bladder, left and right femoral heads); and patient's body.
Patients were stratified according to AP-diameter as small (S; AP≤26cm) and large (L; AP>26cm). Multi-patient CT-atlases were generated for each group using a deformable-registration ABAS software. The atlas-predicted-contours were compared against manual contours, using volume-percentage-difference, Dice Similarity Coefficient (DSC) and percentage-overlap (PO).
Correlation of ABAS algorithm performance with patient's body-size was evaluated by a logistic regression test.

Results:
We identified 9 (45%) patients in S-group and 11 (55%) in L-group.
ABAS tended to underestimate the segmented volumes for all structures.
High levels-of-agreement (DSC≥0.9) were found for femoral heads and body, good levels-of-agreement (0.8≤DSC≤0.9) for rectum and bladder, and limited levels-of-agreement (DSC≤0.8) for prostate and pelvic-LN CTVs.
Significant correlation was found between DSC and AP diameter for LN-CTV (p=0.0472), bladder (p=0.0192), femoral heads (p=0.0445), and lateral diameter for rectum (p=0.0195), suggesting that patient's body-size has to be considered in atlas generation.

Conclusion:
If generated according to patient's body-size, CT-based multi-patient atlases for automated-contouring can be reasonably used in treatment planning of high-risk prostate radiotherapy.
However, deformable organs (bladder and rectum), and structures with not clearly defined borders (prostate and pelvic-LN CTVs) need review by a radiation oncologist.

**0062**

## Dose Distribution and Dose Enhancement by Using Gadolinium Nanoparticles Implant in Brain Tumor in Stereotactic Brachytherapy

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*Background*

The photoelectric and pair production processes increase when high-energy photons interact with materials with high atomic numbers *Z*. The energy loss results in a dose enhancement at the target implanted with material of high *Z*. This will lead to a minimum active dose to be delivered to tumor, while sparing healthy tissues around the target volume.

*Objective and method*

The objective of this work was to compute the radial dose enhancement, by using Monte Carlo simulation (GAMOS software), at and near a 1 x 1 x 1 $cm^3$ brain tumor implanted with gadolinium nanoparticles when using $^{137}Cs$, $^{60}Co$, $^{192}Ir$ irradiation sources. For the sake of verification, our results were compared with similar results published in the literature.

*Results*

Our outcomes show an increase of 1.5-fold in dose for $^{60}Co$ source, when a concentration of 0.1 mg/$cm^3$ Gd was used. It was also observed that this dose enhancement increased with gadolinium concentration in the target and with photon beam energy

**0071**

## Patient-specific IMRT verification using dynamic MLCs log file analysis

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Recently, the American College of Radiology (ACR) stated that log files generated from the treatment machine are acceptable "alternative" measurement for IMRT/VMAT for patient QA as long as they are generated using the patient's plan before the start of treatment. In order to simplify the QA procedure and quickly check the IMRT plan, we developed a MATLAB program for patient-specific IMRT QA based on the analysis of the dynamic MLC log files recorded during an IMRT treatment.
Methods: Varian MLC treatment log files for three patients treated with dynamic IMRT were collected and analyzed. Our program extracts the MLC leaf position data and compares the actual delivered MLCs position with the TPS planned MLCs positon. The program calculates the fluence map, the gamma index map and performs the gamma analysis. We compared our gamma analysis with the one obtained from portal dose image prediction (PDIP) algorithm performed using the EPID results.
Results: The γ results of the planned and delivered calculated fluence distributions agree within 3% dose-difference (DD) and 3 mm distance-to-agreement (DTA) criteria for the three patients. The γ analysis obtained using the PDIP algorithm and the one obtained from MLC movement log file were very similar for the three patients.
Conclusions: Patient-specific IMRT QA based on MLC movement log files is a promising method for patient-specific QA. The method is fast, does not require dose measurements in a phantom, can be done

before the treatment and for every fraction, and reduces the workload related to patient-specific IMRT QA.

**0075**

## Tomosynthesis Imaging System Using Gamma radiography

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Tomosynthesis imaging technique has been proven to give a good diagnostic imaging results with dose reduction compared to CT imaging technique. In this work, we used a gamma radioactive source to replace the x-ray tube for generating the photon flux. The advantages of using a radioactive source is that it gives a monenergistic beam and it doesn't need an external power source to generate the x-ray. We simulated, designed and developed a small and portable tomosynthesis imaging system that can be used in places that have a power shortage whether it was in a remote place or in a battel field. We first simulated the system using GATE testing the tomosynthesis imaging technique. We also used GATE to test deferent types of phantoms to decide which one is the best to develop and use during our experiments. The initial obtained results were promising in providing useful diagnostic information.

**0104**

## Dosimetric Verification and Quality Assurance for Intensity Modulated Radiation Therapy UsingGAFCHROMIC® EBT3 Film

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Radiochromic film has become a popular tool for the verification of dose distributions in highly conformal radiation therapy techniques. This study was aimed to examine the dosimetric properties of Gafchromic® EBT3 film such as symmetry, flatness, Central Axis (CAX) and penumbra with calibrated ion chamber results at both energies 6 MV and 15 MV. This study also examined the feasibility of EBT3 film as an IMRT QA. Twenty IMRT (10 Brain and 10 prostate) plans were created and irradiated on Varian dual-energy DHX-S Linac for both energies. The IMRT QA was performed using different gamma analysis criteria. Additionally, reproducibility, stability and face orientation of film were also examined. The films were analyzed using "film Pro QA 2014"software .The dosimetric comparison between EBT3 film and ionization chamber measurement showed that the average deviations of symmetry, flatness, CAX, penumbra (left) and penumbra (right) of dose profile were 0.18%, 1.34%, 0.49%, 3.68 mm and 3.61 mm for 6 MV and 0.10%, 1.3%, 0.45%, 2.65 mm and 2.71 mm for 15 MV respectively at selected field sizes for red channel. The blue and green channel showed greater dose deviation as compared to red channel. The IMRT QA verification passes about 95% at all different criteria. Reproducibility, stability and face orientation of film were within 1.4% for red channel. The results advocate that the film can be used not only for dosimetric assessment but also as reliable IMRT QA tool. The one scan method based, "film Pro QA 2014 software" makes the use of EBT3 film easier for the users by eliminating inter-scan variability which may act as an error source.

**0130**

## ACCURATE AND EASY IMAGE GUIDANCE TRACKING IN CYBERKNIFE PATIENT QA USING NEW CRYSTALIBALL 3D DOSIMETRY SYSTEM

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**Background**

Patient QA in SRS/SBRT poses unique challenges due to extremely high dose gradients and lack of electronic equilibrium. With hypofractionation, even small relative errors can lead to complications/recurrences. Patient QA is critical, and dosimeters with high spatial resolution and 3D capabilities are needed.

**Methods**

The new commercial CrystalBall system (3D Dosimetry, Madison, CT, USA) is designed for patient QA with sub-millimeter resolution in 3D. The system is based on laser CT scanning of tissue-equivalent radiochromic polymer gel spheres (16.6 - 22.3 cm diameter) mounted on special QA phantoms. VOLQA software compares CrystalBall measurements with the QA plan and generates 3D QA reports that feature overlays of isodoses in 3D and 2D, profiles, DVHs, voxel statistics, and pass/fail metrics for distance-to-agreement. Image-guidance markers can be affixed on the phantoms. In this CyberKnife QA study, we compare taping gold fiducial markers and bone-equivalent (6D Skull) glass structures onto the surface of the spheres against affixing them permanently to phantom structures adjacent to the CrystalBall's surface.

**Results and Conclusion**

Affixing the markers to the QA phantom appears to be not only time-saving for the physicist but also more accurate. When taped to the CrystalBall's surface, fiducials yielded 98.1% passing rate for the 3D sigma index (3D gamma-equivalent, normalized to local dose), while glass beads showed 90.6% passing rate (all at 2mm/2% down to 50% IDL). By contrast, with markers affixed to the phantom, both passing rates exceeded 99%. The new marker mounting system improves the performance of 3D CrystalBall patient QA.

**0141**

## Measurement of Co-60 high dose rate brachytherapy (HDRB) source strength using the German in-phantom method

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Introduction:- According to AAPM(report#41) and IAEA(TECDOC#1274), measurement of HDRB source strength, in air-kerma-strength, is done in a well-type chamber or in-air using a thimble chamber. However, ESTRO Physics booklet No.8 and German DGMP(report#13) describe in addition a PMMA phantom setup (the Krieger Phantom) which is favored by the German DIN 6809-2 recommendations. Here we describe the process of measuring the strength of Co-60 source using in-phantom method. Materials and Method:- Co-60 HDR afterloader supplied by Eckert & Ziegler(Bebig), 0.6cc chamber with NDW calibration and Krieger Phantom; a cylindrical PMMA phantom (20cm diameter, 13cm length) with 5 inserts, one at center and four distributed around the perimeter. The average of measurements taken with

the chamber in all 5 inserts, in nC/min, was calculated then multiplied by the NDW and a total correction factor, KT. KT consists of known quantities such as KTP, Kpol and Kion as well as other quantities such as accounting for attenuation difference between air-water and water-PMMA, effect of the finite size of the phantom, chamber volume averaging and other corrections. These corrections are based on Monte Carlo(MC) measurements of the Krieger phantom and are supplied in the German medical physics (DGMP) report#13.
Results and conclusion:- The measured SK agreed to +3.6% from the certificate stated SK. Although phantom setup is reproducible, however, the result depends heavily on tabulated corrections that themselves depend on MC-modelling and expertise of the investigators. We conclude that well-type chamber measurement, which depends only on measured quantities, is a more robust method.

**0149**

## Lu-177 DOTATATE Dosimetry for Neuroendocrine Tumor: Single Center Experience

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Lu-177 label with DOTATOC is widely acceptable to treat Neuroendocrine Tumor (NET) disease and showing patients increase of quality of life since few years ago. The radionuclide toxicity become the main limitation of the (NET) treatment. Therefore, we aimed a pilot study to estimate radiation absorbed doses to dose-limiting organs in order to develop a systemic therapy with Lu-177 with suitable NET patients. In this study, five set of planar whole body images from patients was acquire every 0.5 hour, 4 hour, 24 hour, 48 hour and 72 hour post Lu-177 administrations. The planar image acquisition was done by using Philip Brightview X with MEGP collimator. All Patients images in CV were transfer into PMOD 3.7 Software for Region of Interest (ROI) analysis. The ROI were drawn at selected organs such as Kidneys, liver, spleen and bladder. Mean absorbed dose for kidneys is 0.62 ± 0.26 Gy/GBq, liver 0.63 ± 0.28 Gy/GBq, spleen 0.83 ± 0.73 Gy/GBq and bladder 0.14 ± 0.07 Gy/GBq. The kinetics of Lu-177 DOTATATE at patient's whole body. The radionuclide kinetic for the whole body is 99.7 ± 0.1 percent at 0.5 hours, 79.5 ± 10.7 percent at 4 hours, 56.6 ± 10.3 percent at 24 hours, 43.2 ± 7.9 percent at 48 hours and 37.1 ± 9.0 percent at 72 hours. This study verifies the patient specific dosimetry in radiopharmaceutical routine therapy, as a good approached to ensure the safety of organ at risks assessment of the radionuclide therapy and also to optimize the treatment.

**0154**

## Dosimetry comparison of advanced external beam radiation treatment modalities to brachytherapy treatments in patients with cervical cancer

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**Background:** In this study, we present a retrospective comparison of dose distributions achievable by High dose rate brachytherapy (HDRBT), Helical TomoTherapy® (TOMO), CyberKnife® (CK) and RapidArc® (RA) in locally advanced inoperable cervical cancer patients.

**Methods and Materials:** Five patients with advanced stage cervical carcinoma were selected for this study after a full course of external beam radiotherapy (EBRT), chemotherapy and HDRBT. To highlight any significant similarities/differences in dose distributions, high-risk clinical target volume (HRCTV)

coverage, organs at risk (OAR) sparing, and machine specific delivery limitations, we used D90 as the parameter for HRCTV coverage as recommended by the GEC-ESTRO Working Group. We also compared both integral and differential dose volume histograms (DVH) for HRCTV and OARs.

**Results:** TOMO and RA provided the most conformal dose distributions to HRCTV. Median doses (in Gy) to organs at risk were; for rectal wall: 1.7±0.6, 2.5±0.6,1.2±0.3, and 1.5±0.6, and for bladder wall: 1.6±0.1, 2.4±0.4, 0.8±0.6, and 1.5±0.5, for HDRBT, TOMO, CK, and RA, respectively.

**Conclusions:** Contemporary EBRT modalities might be able to replace brachytherapy treatments. While brachytherapy dose distributions feature high dose gradients, EBRT modalities provide highly conformal dose distributions to the target. However, there is still a remaining question whether a highly conformal dose or high gradient dose is more clinically relevant for the HRCTV in cervix cancer patients

**0159**

## Evaluation of quenching effect in radiochromic film-based proton beam dosimetry

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Many studies reported dose under-response at the Bragg peak (BP) when irradiating radiochromic films with proton beams, which they attributed to a quenching effect that occurs with higher linear energy transfer (LET) particles along an incident track. In this work, the impact of this effect on different film models in a low energy proton beam is demonstrated and evaluated.

Following TRS-398 reference dosimetry protocol, output of a CS30 cyclotron producing 26.5 MeV protons was measured in water at 2.1 mm reference-depth in the plateau upstream from the BP using a Markus ionization chamber. Percent depth dose (PDD) was measured in water using the same setup. The measured signal was normalized to a monitor chamber reading and subsequently scaled by ratio of water-to-air stopping powers at given depth, while the effective depth of measurements was scaled by ratios of material-to-water physical densities and CSDA ranges. Three radiochromic film models (EBT, EBT3 and HD-V2) with sensitive layers thicknesses of 34, 30 and 8 μm, respectively, were calibrated within Lexan phantom positioned at the same water-equivalent depth. Film pieces were positioned within polyethylene phantom along the beam central axis with an angulation of 5° for PDD measurements.

Dose ratios at the BP relative to the reference-depth were 3.88, 2.52, 2.19, and 2.02 for the Markus chamber, HD-V2, EBT3, and EBT film models, respectively. Results at hand suggest that quenching effect is reduced when a radiochromic film model with smaller sensitive layer thickness is used for PDD measurements in proton beams.

**0160**

## Evaluation of background signal correction for radiochromic film dosimetry

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Irradiation of the sensitive layer of radiochromic film changes the film's color due to induced polymerization. However, agents, other than monitored radiation, can also cause polymerization of the sensitive layer (temperature, humidity, UV light) that can be considered as a background signal and can be corrected using a control film piece. In this work, we investigate the impact of using control film pieces on both accuracy and uncertainty of dose measured using radiochromic film-based reference dosimetry protocol.

Control film pieces (EBT3 GAFCHROMIC$^{TM}$ film model) were irradiated to "known" doses in a range of 5–100 cGy, and five film pieces of the same size to 200, 500, 1000, 1500 and 2000 cGy, considered to be "unknown" doses. Depending on dose range, two approaches to incorporate control film piece were investigated: signal- and dose-corrected methods.

For dose values greater than 1000 cGy, the increase in accuracy of 3% led to uncertainty loss of 5% by using dose-corrected approach. On the other hand, at lower doses and signals of the order of 5%, we observed an increase in accuracy of 10% with a loss of uncertainty lower than 1% when using the signal-corrected approach.

A potential background signal correction method was described and evaluated. The Incorporation of this signal into dose measurements should be a judgment call of the user based on a tradeoff between deemed accuracy and acceptable uncertainty for a given dose measurement

## Posters

**0014**

### The use of radiobiological models to compare dose calculation algorithms and readjust the dose prescription

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**Purpose:** This study introduces an advanced method to evaluate the extent of the adjustment of the prescribed dose to maintain the same clinical results, when changing the dose calculation algorithm, i.e changing from density correction method to more recently introduced algorithm, Anisotropic Analytical Algorithm (AAA). **Material and methods**: 10 patients with lung cancer were studied. For each patient, the dose distribution was calculated using the Modified Batho's (MB) density correction method and with AAA. A global analysis based on 2D and 3D gamma (γ) was made to evaluate the under / overestimation of calculated dose. Clinical evaluation was carried out using Tumour Control Probability (TCP) and Normal Tissue Complication Probabilities (NTCP) based on Uniform Equivalent Dose (EUD) model. The Wilcoxon and Spearman's rank test were used. **Results:** The dose calculated with AAA was significantly larger to organs at risks while the delivered dose in MU was reduced, $p < 0.05$. The γ maps confirmed these dosimetric results. Consequently, a significant difference for NTCP for lung and heart is estimated. **Conclusion:** We assessed the prescribed dose using the radiobiological models. The ratio of benefit was significantly changed when moving from former algorithm to AAA. This indicates that the prescribed dose and the optimization of the OAR protection should be readjusted when AAA is implemented in radiation

oncology. A discussion between oncologists and physicists is quite necessary in order to discuss these results and decide how and when to readjust the prescribed doses.

**0042**

## Fabrication of 3D printed bolus for electron beam therapy validated with Monte Carlo simulation

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Bolus has an important role in electron therapy. The purpose of this work is to address the procedures for using a 3D printer for designing boli in order to implement them in our hospital. A nose bolus for a Rando head phantom was printed. The dose distribution was then obtained by “EBT3” Gafchromic films placed vertically in the middle of the bolus and in solid water blocks irradiated with 10 MeV and 15 MeV electron beams with a 10×10 cm2 field size. A Monte Carlo (MC) simulation of the 15 MeV electron beam was carried out and compared with film measurements. The results obtained showed a slight difference in electron beam’s penetration and beam profile flatness in Rando head phantom with a 3D printed bolus compared with those in solid water phantom due to the presence of air gaps and air cavity in the former setup. The MC calculations were found to be in a good agreement with film measurements. The 3D gamma analysis with 3%/3mm distance to point agreement criteria was found to be 99%. 3D printed boli can be easily produced with high accuracy within a short period of time.

**0047**

## Patients Radiation dose and protection status in north kordofan state

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Diagnostic medical exposures make a large contribution to the public exposure to ionizing radiation. It was estimated that diagnostic radiology and nuclear medicine contributed 96% to the collective effective dose from man made source. The current study intended to measure the patients and ambient doses during conventional diagnostic X-ray examinations performed in four hospitals. A total of 299 patients were examined during four months. ESDs were calculated from patient exposure parameters using DosCal software. Effective doses were calculated using software from the National Radiological Protection Board (NRPB). Ambient dose was measured using survey meter (RDS-120). The mean patient ESD per procedure 0.3±0.1 mGy for the chest, 0.96±1.2 mGy for the skull, 0.85±0.2 mGy for the abdomen, 1.3±0.8 mGy for the spine and 0.43±0.2 mGy for the limbs. The mean ambient dose per department was 100µSv/h. patients doses showed wide variation between hospitals. Patient doses are higher than recommended diagnostic reference levels. The current study showed wide variation in ESAK between the four departments. This study showed that there is need optimize patient doses and departmental shielding in order reduces the dose to its minimum value. Regular quality control and staff training in radiation dose and image quality was adopted.

**0054**

## Pylinac: A toolkit for performing TG-142 QA-related tasks on a linear accelerator

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**Purpose:** In a new radiotherapy center, with multi-modality linear accelerator, the QC procedure becomes more complicated and more time consuming as it is necessary to monitor the performance of all linac components. The aim of this work is to automate some of the standard QC procedures.

**Method and Materials:** Current QC procedure is based on visual observation of certain features in an acquired images and be able to detect any deviation such as MLC position in a picket-fence image, isocenter in starshot film or HU values in CBCT image. This approach is also a subjective task as it is depend on the person who is performing the analysis. The method used the Pylinac software to automate the tests. The software will process the images acquired either it is MV image, CBCT or even film and perform all measurements required by the QA protocol, the results were compared with results from the usual analysis way. The tests were automated in this work are MLC picket-fence, radiation isocenter, MLC speed test and CBCT image quality.

**Result and conclusion:** The software was able to perform all the tests and detect any deviation with the same accuracy as manual method. In some of the tests Pylinac provides numerical values that was difficult to predict or calculate manually, also it performs the analysis in a significantly shorter time.

**0057**

## Analysis of lung dosimetry in 3D-CRT planning for hypofractionated breast radiotherapy

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Purpose:
To report the ipsilateral lung dosimetry data of our breast cancer (BC) patients treated with loco-regional hypofractionated radiotherapy (HFRT).

Methods and materials:
Treatment plans of 150 patients treated between January 2012 and March 2015 by HFRT for BC were were retrospectively reviewed. All patients received 42.4 Gy in 16 fractions by tangential and supra-clavicular fields with 6 MV, 18 MV or mixed energies.
Ipsilateral lung dosimetric data V20Gy and mean lung dose (MLD) were recorded.
Correlations between lung dose, patient characteristics and treatment delivery parameters were assessed by a logistic regression test.

Results:
Mean ipsilateral lung V20Gy was 24.6% and mean MLD 11.9 Gy. A weak, but statistically significant correlation was found between lung dose and lung volume ($p=0.043$).
The lung dose was significantly decreasing with patient separation and depth of ALN and SCLN ($p<0.0001$), and increasing with ALN ($p=0.001$) and SCLN ($p=0.003$) dose coverage.
Lung dose significantly decreased with beam energy ($p<0.0001$): mean V20Gy was 27.8%, 25.4% and 21.2% for 6 MV, mixed energy and 18 MV, respectively.
Use of a low breast-board angle appeared to correlate with low lung dose.

Conclusion:
Acceptable ipsilateral lung doses can be achieved in breast HFRT with tangential and supra-clavicular fields.
Our data suggest that the use of high energy photon beams and low breast-board angulation can reduce the lung dose.

**0098**

## The Establishment of Radiotherapy Calibration Facility at the SSDL of KFSH

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The Secondary Standard Dosimetry Laboratory (SSDL) of KFSH&RC is the 1st and so far the only SSDL in the region having a full range of calibration capabilities covering radiation protection, diagnostic radiology and radiotherapy.

The SSDL of KFSH&RC is a full member of the International Atomic Energy Agency / World Health Organization SSDLs network. Its standard instruments were calibrated at the IAEA's Reference Dosimetry Laboratory and hence all the measurements are traceable to the Primary Standard Dosimetry Laboratories (PTB) and to the BIPM through the IAEA.

**0103**

## Dosimetric Study of Three Dimensional Conformal Radiotherapy (3D CRT) of Localized Prostate Cancer using A Custom Made Male Pelvic Phantom

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A male pelvic phantom was constructed to investigate the treatment planning system; three-dimensional conformal radiotherapy (3D CRT) technique for localized prostate cancer treatment as well as the organ at risks (OARs); bladder, rectum and both femoral head using 6 MV photon energy. A CT dataset of a male pelvis was used to define the geometric boundaries of principle tissues - prostate, bladder, rectum and both femoral head. Dose measurements to the target and OARs was obtained from the thermos-luminescent dosimeters (TLD) and Gafchromic external beam therapy (EBT) 2 film. Points of interest were located throughout the dataset to identify appropriate placement of TLD chips. The center of the prostate was identified as the location for point-measurement with seventeen (17) holes to place the TLDs while another eighty three (83) holes were distributed among the organ at risks. A piece of EBT 2 film was located at the center of the 31 pieces of Perspex where the target was located. Teflon was used to construct both femoral head. The pelvic phantom has been constructed with different density materials match well with typical tissues. All calibrated TLD and EBT 2 film displayed a linear response ($R^2$=0.983) with respect to the measured doses at $d_{max}$ from 25 cGy to 250 cGy. The good agreement between planned and measured dose shows that the phantom is a useful and efficient tool for 3D CRT technique dosimetric verification.

The radiotherapy calibration facility at the SSDL of KFSH&RC was established in 2014. The full commissioning of this facility is presented in this paper. This commissioning mainly revolves around three parameters; verification of the radiation safety aspects, testing of various physical and dosimetry

parameters (timer error, verification of the source positioning, beam profile free in air and in water, output and depth dose measurements,...) and establishment of the reference absorbed dose to water.

Last but not least, the SSDL participated in an external audit program managed by the IAEA to confirm that the established reference absorbed dose rate is within the acceptable limits. The results of this audit, which are presented here, were satisfactory.

**0109**

## IMPLEMENTATION OF 3D DOSIMETRY USING MAGIC GEL POLYMER AT EXTERNAL RADIOTHERAPY SERVICE: FEASIBILITY STUDY

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Polymer gel dosimeters are synthesized from radiation sensitive chemicals which, upon irradiation, polymerize as a function of the absorbed dose. These dosimeters are able to record the dose distribution in three-dimensions (3D) which presents specific advantage compared to one-dimensional dosimeters, such as ion chambers and TLD or two-dimensional dosimeters, such as radiochromic films, especially in the case of complex or small field size irradiations. The 3D radiation dose distribution may be obtained using magnetic resonance imaging, optical-computerized tomography, X-ray Tomodensitometry or ultrasound. A feasibility study has been conducted at radiotherapy service using Normoxic polymethacrylic (MAGIC) and CT-scan for the determination of 3D dose distribution. The MAGIC gel preparation and the dose assessment have been performed, in situ, 24 hours before and after irradiation respectively.
The dose calibration curve has been first determined by irradiating the gel Magic dosimeter at different doses ranging from 2 to 30 Gy using 6 and 18 MV photon beams with 10 cm x 10 cm and 3 cm x 3 cm field sizes and evaluating it using a dedicated scanner at a voltage of 120 kV. The reconstructed slices were transferred to an ECLIPS console for determination of the corresponding UH (Hounsfield unit) number.
In this communication, the whole process including the preparation, the calibration, the depth dose and profile determination and the irregular small field size dose evaluation using Magic gel dosimeter with CT reading, is described. The results compared to values given by the conformal radiotherapy planning delivery systems, are also presented.

**0124**

## The correlation between different dose indices and organ doses from cone beam computed tomography (CBCT) scans

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Purpose/Objective: Several dosimetric methods have been proposed for CBCT dosimetry. Two of these methods were proposed by IEC and AAPM. This study aimed to investigate the correlation between organ doses (ODs) resulting from CBCT scans and the IEC and AAPM methods.

Material/methods: The IEC method ($CTDI_{IEC}$) and the AAPM method f(0) were assessed using head, thorax, and pelvic CBCT scans from an OBI system. ODs were evaluated for the same scanning protocols using Monte Carlo simulations on the ICRP-110 adult male and female reference computational phantoms. EGSnrc/BEAMnrc was utilized to simulate the OBI, and EGSnrc/DOSXYZnrc was applied to assess ODs. The correlation was studied in terms of the difference between weighted values of $CTDI_{IEC,w}$ and $f(0)_{w,}$ and ODs.

Results: For head scans, $CTDI_{IEC,w}$ values were smaller than doses to bone marrow, brain, and salivary gland, and $f(0)_w$ was also smaller than doses to bone marrow and salivary gland, but larger than brain dose. For thorax scans, doses to bone marrow, lung, breast, and oesophagus were underestimated by $CTDI_{IEC,w}$ and $f(0)_w$, but doses to stomach and thyroid were overestimated. For pelvic scans, $CTDI_{IEC,w}$ and $f(0)_w$ were smaller than doses to bone marrow and urinary bladder, but were larger than colon and gonads doses for male. For female, however, doses to all the organs were underestimated by $CTDI_{IEC,w}$ and $f(0)_w$.

Conclusion: The correlation between ODs and $CTDI_{IEC,w}$ and $f(0)_w$ were comparable to the majority of organs. However, for the scanning protocols studied, $f(0)_w$ gave better estimations for ODs compared to $CTDI_{IEC,w}$.

**0131**

## Gamma index observations of VMAT patient specific QA using Octavius 4D dosimetric System

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Introduction

Volumetric Modulated Arc Therapy (VMAT) is introduced our clinic in 2014. since it is highly complex treatment planning technique, dosimetric verification using three dimensional dosimetry is necessary. Octavius 4D needs only one data i.e. Percent Depth Dose(PDD). Measurement provides planar dose maxtrix and combined with user given PDD , it provides three dimensional dose model.

Materials and Methods

For planning the VMAT patients, we use Monaco 3.3V treatment planning system. The treatment machines used was Elekta Infinity with Agility MLC. Agility has 160 leaves and width of 5mm each. All the treatment verifications were done with Gamma index of 3% /3mm.The PTW Octavious 4D dosimetric System contains 2D array with 729 vented ion chambers. PTW Verisoft 6.1v evaluation tool is used for dose analysis.

Results

We got , overall average of  cancer sites, passing rate of 97.1% for 3D Gamma Index. It is evaluated with 3% /3mm and 10% threshold level. If we look at the case wise  average passing rates, then Head &Neck  95.2%, Breast 96.3%, Prostate 98.4%  and brain 99.6% . If used more than 200 control points or more than 2 arcs then average passing rates reduces.

Conclusion

Three dimension dose matix evaluation will provide better information about plan quality than two dimensions. Further it allows to create dose volume histograms to compare with treatment plan results. In addition to that passing rate will increases with 3D gamma index.

**0134**

## Characterization of Normal Pancreas in MR Images Using Texture Analysis

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This study was carried out in order to discriminate the Pancreas in Magnetic Resonance Imaging (MRI) techniques by using quantitative texture analysis. Appling this computerized application to the Abdomen tissues represented on MRI will recognize the pancreas from the other abdomen tissues which included: pancreas, liver, kidney and outer wall. The images of this study were done by Toshiba 1.5 Tesla MRI systems. The data have been collected from 50 patients having T2-weighted images axial views that include pancreas. The data were extracted from the image using 3×3 pixels window inside the window. The first order statistics were calculated and used to classify the four Abdomen tissues. The window scans the whole image by interlacing it one pixel horizontally, then start again from the line when the above one was completed till the end of the images. The results of this study showed that the overall accuracy of classification process was79.5%, and for the pancreas the sensitivity was 75.4%, liver and kidney showed classification accuracy of 79.1% and 74.1% and for outer wall was 91.1%.

**0157**

## Dose monitoring system for radiobiological irradiations with low energy proton beams

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This study provides means of controlling the output of a radiopharmaceutical cyclotron and suggests a dosimetry system for MTT colorimetric assay irradiation using a single sheet of EBT3 model GAFCHROMIC™ film based reference dosimetry system, without the need for quenching effect correction.

A calibrated PTW Markus ionization chamber was used to measure the depth dose and beam output of a CS30 cyclotron producing 26.5 MeV protons. A time-controlled aluminum cylinder was added in front of the horizontal beam-exit serving as a radiation shutter. Following the TRS398 reference dosimetry protocol for proton beams, the output was calibrated in water at a reference depth of 3 mm using a Markus plane-parallel ionization chamber. After that, EBT3 film was calibrated for doses of up to 8 Gy at the same depth. To verify the dose distribution for a 96-well MTT assay plate, EBT3 film was placed at the reference depth during cells irradiation and cell doses were scaled by measured depth dose data.

From a single exposure and utilizing the Gaussian shape of the beam, multiple dose points were obtained within the same plate ranging from 6.9 Gy (sigma ~2%) in the central well, and 2 Gy (sigma ~5%) for wells positioned closer to the periphery.

A radiochromic film-based dose monitoring system that can be simply used for MTT radiobiology assays with a low energy proton beam without the need for quenching effect correction was described. Well-specific absorbed dose values can be used to construct the cell proliferation (survival) curves.