BOOK OF ABSTRACTS

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PART 1: RADIOTHERAPY

INTERSTITIAL HIGH DOSE RATE (HDR) BRACHYTHERAPY WITH MICROSELECTRON HDR FOR EARLY BREAST CANCERS

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Introduction

Treatments for early breast cancers have evolved from radical mastectomy towards breast conserving surgery (BCS) and radiotherapy. In high risk patients, a boost dose to tumor bed, 15-20 Gy is required, by high energy electrons or by interstitial brachytherapy (BT). From the year 2017, interstitial BT for BCS patients are carried out at our center with microSelectron (M/s Nucletron).

Purpose

The pattern of care followed at our center in early breast cancers and biologically effective doses (BED), efficacy of treatment, needs documentation.

Materials and Methods

A 2 plane template is used to implant needles with treating 'distance' 1.2 cm. 10mm on either side of the catheter was kept cold to avoid excess skin/subcutaneous excess dose, maintain cosmoses and prevent skin spots. 2 regimens, 1) HDR BT and External Beam Radiotherapy (EBRT) and 2) Accelerated Partial Breast Irradiation (APBI) with only BT as mono-therapy is followed. 78 patients were treated in 6 years. In 73 patients, doses to 100% covering line was delivered with 6h inter-fraction BT as 8Gy x 2 fractions(n=1), 4Gy x 4fr (n=27), 3.65Gyx4fr (n=24), 3Gyx4fr (n=19), 3Gyx3fr (n=2) along with EBRT by Tele-cobalt tangential fields, 5fr/week, breast cone, 40Gy/15 fr equivalent of 46.7Gy in 2Gy/fr. Second group (mono-therapy) had 5 patients, 3.65Gy x10fr (n=1), 3.40Gy x10fr (n=3) and 5.88Gyx10fr, completing treatment in 5 days.

Results

BED_{10} for BT = 19.93 Gy for 3.65Gy x 4Fr; This BT dose equal to EBRT dose In 2Gy/fr 8.3 = 16.61 Gy. 40Gy/15Fr @ 2.67Gy/Fr is equal to dose of 42.3Gy at 2Gy/fr. Total dose of whole regimen is 58.9Gy (<1.5% to 60Gy). BED_{10} for BT of 3.65Gy x 10Fr is 49.83G, which is equivalent of 41.5Gy EBRT total dose at 2Gy/fr, 5 fr/week. There was no toxicity recorded on short term follow up. An earlier study in a non- randomized pilot group of 10 patients (Parthasarathy et al 2005) reported 100% local control in treated patients.

Conclusion

As more cancer patients are treated with breast conservation, HDR BT can be practiced, with available facilities. Treatment times are very short in breast interstitial BT, and patients tolerate these treatments well.

GLOBAL TO LOCAL AND LOCAL TO VOCAL…LESSONS LEARNED FROM PANDEMIC TOWARDS PROCUREMENT OF LOCAL DOSIMETER FOR DAY-TO-DAY USE IN RADIOTHERAPY QUALITY ASSURANCE PROCESS

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Purpose

Present study conducts the performance check and determination of relative electrometer calibration constant for a local electrometer (make in India)

Materials & Methods

Three local electrometers (SureDose, Rosalina Instruments, Mumbai)) were procured in the pandemic period for meeting daily QA frequency as per regulatory requirement. It was tested for linearity, stability, sensitivity, high impedance and low leakage dose etc) against two reference class electrometers. End to end tests were also carried out on the user beam including output measurements (photon and electron), sweeping field output and Enhanced Dynamic Wedge (EDW) factor measurement. Total 13 Patient specific QA were carried out for the dose verification of complex ten Volumetric-modulated arc therapy (VMAT) and five stereotactic radio-surgery (SRS) plans.

Results

Linearity coefficient was found to be unity for the charges of measured for four different modes of photon energies for Monitor Unit range 10 to 300. Dependency of meter reading on dose rate (200MU/min – 2000MU/min) was found to be negligible. Relative electrometer calibration constant for this electrometer, PTW UNIDOS and Tomo-electrometer against Scanditronix Dose1 (reference class electrometer) were found to be 0.9976, 0.9997 and 1.0047 respectively. All dosimetric output measurements carried out for various range of photon and electron energies were found to be well within ±3% tolerance as stated in TRS 398. Variation in TPS calculated dose and delivered dose as measured for PSQA for 4 SRS patient's plans was found to be within ±2% and for 10 VMAT patient's plans were found to be within ±3%.

Conclusions

Procured local electrometer is found satisfactory, accurate and hence recommended to use it for daily QA of high precision RT equipment. An attempt was made to show positive evidence that the time has come to move from Global to Local and be vocal.

THE EFFICIENCY OF GAMMA KNIFE STEREOTACTIC RADIOSURGERY IN THE TREATMENT OF GLIOMA

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Introduction

Malignant glioma poses a significant challenge in the field of neurosurgery. The current standard treatment for this disease involves maximal resection followed by chemotherapy and radiation therapy. Despite these efforts, tumor recurrence frequently occurs within 2 cm of the original lesion, highlighting the critical need for local tumor control. To address this issue, stereotactic radiosurgery presents a potential solution. However, effectiveness of Gamma Knife radiosurgery (GKRS) in treating glioma remains controversial in the medical community.

Purpose

The objective of this study was to assess the treatment plans for glioma tumors that underwent stereotactic radiosurgery using the Icon version of the gamma knife device**.**

Materials and Methods

Thirty patients with glial tumors were treated at the gamma knife center of Al-Taj Hospital, Baghdad. An oncologist or neurosurgeon diagnoses forwarded patients for gamma knife therapy. The patients were divided into two groups according to glial tumor type high-grade glioma and glioblastoma. Each patient's brain is imaged using CT and MRI to explore tumor features better. The neurosurgeon prescribed the dose depending on the tumor volume, ranging from 12–24 Gy. The gamma knife device with the Icon version manufactured from Elekta was used in this study.

Results

The result shows that the mean volume of patients with glioma was 2.9±0.34 cm^3 (0.3–3.4) cm^3, while the glioblastoma volume was 2.5 ± 0.33 cm^3 (0.6–3.1) cm^3. Findings indicate that coverage and gradient index evaluation parameters were statistically significant in high-grade glioma than (97%), (3.1±0.15) in glioblastoma (92%), (2.79±0.32), respectively. In contrast, glioblastoma exhibited superior selectivity and Paddick conformity index (PCI) values (0.76±0.054, and 0.77±0.09, respectively) than the high-grade glioma (0.71±0.04, 0.72±0.06, respectively). Treatment duration was found to be longer for high-grade glioma (37.22±11.54 minutes) cases compared to glioblastoma (29.54±9.53 minutes). Nonetheless, the efficiency index demonstrated that the gamma knife technique is a viable option for both tumor types, with significant benefits observed in high-grade glioma (0.68±0.032) compared to glioblastoma (0.66±0.051).

Conclusion

The gamma knife procedure is proficient in administering stereotactic gamma radiation to patients diagnosed with high-grade glioma and glioblastoma. However, its effectiveness is comparatively superior in the treatment of high-grade glioma.

DETERMINATION OF SMALL FIELD OUTPUT FACTOR FOR VARIOUS COLLIMATORS USING DIFFERENT DETECTORS

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Introduction

The aim of radiotherapy is the delivery of a maximum dose to the tumor and minimum dose to the surrounding normal tissues which may be comfortably achieved using advanced techniques. The small segments dosimetry should be very accurate in the TPS then only the expected clinical outcome can be achieved. The small segments field dosimetry is more complicated compared to other conventional fields. The small field measuring detectors are having very small volume, high spatial resolution and should satisfy the detector's ideal characteristic studies. The IAEA TRS 483 recommended output correction factor is used in this study to determine corrected output factor for small fields.

Purpose

In this study the 6MV Flattening Filter (FF) and 6MV Flattening Filter Free (FFF) photon beams small-field Output Factor (OF) was measured with various collimators using different detectors. The corrected OFs were compared with the Treatment planning system (TPS) calculated OFs**.**

Material and Methods

The OF measurements were performed with four different types of collimators like Varian millennium Multi-Leaf Collimator (MLC), Elekta Agility MLC, Apex micro-MLC and stereotactic cone. There are ten detectors (four ionization chambers and six diode) were used to perform the OF measurements at 10 cm depth with 90 cm Source to Surface Distance (SSD). The corrected and uncorrected OFs were calculated from the measurement. The corrected OFs were compared with the existing TPS generated OFs.

Results

The uncorrected OF was overestimated for the diodes than the ionization chamber. The use of detector-specific output correction factor (OCF) in PTW diode P detector was reduced the OF uncertainty by less than 4.1% for 1x1 cm^2 $\mathbf{S_{clin}}$ field size. The corrected OF was compared with TPS calculated OF, the maximum variation with IBA CC01 chamber was 3.75 %, 3.72%, 1.16%, and 0.90 % for 5 mm stereotactic cone, 0.49X0.49 cm^2 Apex mMLC, 1x 1 cm^2 Agility MLC, and 1x 1 cm^2 Millennium MLC respectively.

Conclusion

The TRS 483 protocol recommended detector-specific OCF was used to calculate the corrected OF from uncorrected OF. The implementation OCF in the TPS commissioning will reduce the overall uncertainty less than 3% for any type of detectors.

OPTIMIZED SILICON DETECTORS FOR BEAM MONITORING IN ADVANCED RADIOTHERAPY

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Purpose

This study presents results from tests on Low Gain Avalanche Detectors (LGADs) and thin planar silicon sensors segmented in strips with different therapeutic particle beams to prove their performances for monitoring protons, carbon ions and electrons delivered at conventional and FLASH dose rates.

Materials and Methods

The University and the National Institute for Nuclear Physics of Turin collaborated with Fondazione Bruno Kessler (FBK, Trento, Italy) to design and optimize LGAD and planar strip sensors featuring various geometries, thicknesses, and gain layer doses for a beam energy detector based on time-of-flight and for a fast particle counter based on a custom front-end multi-channel readout chip. The detectors were characterized in the laboratory and then tested with proton and carbon ion beams at the Italian National Center of Oncological Hadron Therapy (CNAO).
Concurrently, planar silicon sensors with different active areas and thicknesses were developed and tested with pulsed electron FLASH beams at SIT ElectronFLASH Linac of the Centro Pisano di Flash Radiotherapy in Pisa (funded by Fondazione Pisa).

Results

Absolute beam energy measurements agree with the nominal ones within the clinically significant 1 mm range difference. The counting error without pile-up corrections is less than 2% for a mean fluence rate up to 100 MHz/cm^2. The beam width measured as FWHM of the profile achieved over 144 strips overlaps with the expected value at isocenter for narrow beams and the reproducibility over 20 identical spills was better than 1% for all the clinical beam energies.
Finally, the dose per pulse response linearity for thin planar silicon sensors was also investigated with FLASH beams, and the maximum deviation is of a few %.

Conclusion

Preliminary tests of LGADs and planar silicon sensors confirmed their potential to control online the fluence, position and energy of therapeutic particle beams. Additionally, they showed potential for monitoring ultra-high dose rate electron beams up to a few Gy/pulse.

COMPARISON OF FOUR COMMERCIAL DOSE CALCULATION ALGORITHMS IN DIFFERENT EVALUATION TESTS

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Purpose

The aim of this paper is to describe performance accuracy of four different dose calculation algorithms include Anisotropic Analytical Algorithm(AAA), Acuros (AXB), collapsed cone convolution(CCC) and Monte Carlo(MC) available in two TPSs, Varian Eclipse and RaySearch Laboratories RayStation.

Methods

The dosimetric performance of AAA, AXB, CCC and MC algorithms was evaluated in homogenous medium based on IAEA-TECDOCE 1540 and heterogeneous medium based on IAEA-TECDOC 1583. In addition, performance accuracy of these dose calculation algorithms was evaluated for volumetric modulated arc therapy (VMAT) plans based on the AAPM TG-119 test cases. Also profile and depth dose comparisons against measurement were carried out in relative mode using the gamma index as a quantitative measure of similarity within the central high dose regions for all evaluated algorithms.

Results

Testing in homogeneous media and in heterogeneous geometries has demonstrated a high level of agreement between measurements and calculations for both treatment-planning systems. The results of gamma index pass rate (GIPR) for dose calculation algorithms in VMAT plans showed that GIPR (3%/3mm) for all the algorithms (AAA, AXB, CCC and MC) in all evaluated tests based on TG119, were greater than 97%

Conclusions

The result of this study showed that generally, dose calculation algorithms which calculate dose in medium (AXB and MC) have better accuracy than dose calculation algorithms that calculate dose to water (CCC and AAA).

VERIFICATION OF DOSE CALCULATION ALGORITHMS BASED ON THE IAEA-TECDOCE-1583 WITH CONSIDERATION APPLY MEDIUM DEPENDENCY CORRECTION FACTOR (K_{MED})

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Purpose

This study evaluated the measurement of dose in clinical commissioning tests described in TECDOCE-1530 with the application of Monte Carlo (MC) modelled correction factors for bone and lung materials in the 002LFC CIRS thorax phantom (Norfolk, USA) for $D_{m,m}$ and $D_{w,w}$ dose calculation algorithms.

Materials and Methods

In this study, we applied BEAMnrc codes to carry out simulation of radiation source and modelling radiation transport for 6MV and 15MV photon beam. DICOM CT scan images of CIRS phantom converted to a MC compatible phantom using the stand-alone code, CTCREATE, which converts the patient's CT data to the desired dimension, material type and mass density. PTW 30013 farmer chamber (0.6cc) utilized for each point of measurement in the modeled CIRS phantom. While using farmer chamber, the correction factors were determined from the average of four central voxels in the sensitive volume of the simulated farmer chamber in point of measurement. In both media (bone and Lung) for 6MV and 15MV photon beams, medium dependency correction factor calculated for $D_{m,m}$ and $D_{w,w}$ algorithms.

Results

In bone media: for $D_{m,m}$ calculations using farmer, the average modelled correction factors for 6MV and 15MV were 0.976(±0.1%) and 0.979(±0.1) respectively. Also for $D_{w,w}$ calculations, the correction factors were 0.99(±0.3%) and 0.992(±0.4%), respectively. In lung, for the $D_{m,m}$ calculations, the average modelled correction factors for 6MV and 15MV were 1.02(±0.3%) and 1.022(±0.4%) respectively. For $D_{w,w}$ calculations, corrections factors were 1.01(±0.3%) and 1.012(±0.2%), respectively. In the audit, application of the medium dependency correction factors for bone, improves the mean agreement between treatment plans and measured dose from 2.5%(±2.9%) to 0.5%(±1.8%) and for lung from 1.7% (±1.8%) to 0.3 %(±1.2%).

Conclusion

This study provides a correction factor to correct the measured dose in bony and lung materials for accurate validation of dose calculation algorithms base TECDOCE-1583.

MR GEOMETRIC DISTORTION: OUR EXPERIENCE AND FINDINGS

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Introduction

Measuring MR geometric distortion with a large field of view is crucial for accurate image acquisition in radiotherapy.

Purpose

This abstract presents our experience with MR geometric distortion for large field of view using both existing phantoms and custom-built phantoms.

Materials & Methods

We first developed a purpose-built phantom consisting of 357 rods of polymethyl-methacrylate separated by 20 mm intervals, which provided a 3D array of control points at known spatial locations covering a large field of view up to a diameter of 420 mm. One of its constraints was its weight, which resulted from its composition of water-based materials. Additionally, the phantom's architecture did not allow for an assessment of the through-plane distortion.
To address this limitation, we used an existing phantom developed by GE Healthcare, which consisted of layers of foam embedded with a matrix of ellipsoidal markers and covered a large field of view of 500 mm. We evaluated the in-plane and through-plane geometric distortions and the correction algorithms provided by the vendor. The main limitation of this phantom is that it cannot fit in all types of coils due to the size of its layers.

Finally, we proposed a new design of a customizable phantom composed of 3D printed plastic blocks containing holes that can hold glass tubes filled with any liquid, which can fit any type of RF coil and measure distortion in three dimensions.

Results

The customizable phantom we proposed is not only robust and lightweight, but also modular, making it a practical tool for measuring distortion in three dimensions and able to fit any type of RF coil. proved to be a robust, lightweight, modular, and practical tool for measuring distortion. The measured mean distortion for our MR was less than 1 mm and less than 2.5 mm over radial distances of 150 mm and 250 mm, respectively.

Conclusion

These tools will be part of a quality assurance program aimed at monitoring the image quality of MRI scanners used to guide radiation therapy.

TOWARDS CBCT-ONLY ADAPTIVE RADIOTHERAPY OF THE HEAD&NECK: GENERATION OF SYNTHETIC CT USING DEEP RESIDUAL U-NET

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Purpose

To create a synthetic-CT (sCT) from Head&Neck (H&N) CBCT using Deep Residual U-net (DRU-net). It can be used for adaptive radiotherapy.

Materials and Methods

A database of 93 H&N patients having deformably co-registered CT and day one CBCT with a resolution of 1.26×1.26×3mm^3 was considered. It was divided into training and test sets of 68 and 25 patients respectively. Image slices were cropped to 256×256 and H&N masks were applied.
2D DRU-net was designed. 2D DRU-net learns a mapping function that converts a CBCT slice to its corresponding sCT slice based on a training set composed of paired CBCT/CT slices. DRU-net has a symmetric hierarchical structure composed of encoding, bridge, and decoding parts. The encoding part down-samples images to extract larger number of features at different scales in the image spatial domain using a stack of deep residual units (DRU). The bridge connects the encoding and decoding parts and is composed of one DRU. The decoding part propagates information from coarser to fine resolution through upsampling layers. At each level, a copy of the output at the corresponding encoding part is concatenated with the upsampling output and fed to DRU to generate denser representations. After the last level of decoding part, a 1x1 convolution is applied with sigmoid as activation function to map each 64-component feature vector from the previous layer to a CT number.
The performances of DRU-net were assessed on the test set using the mean absolute error (MAE), the mean error (ME), the peak signal-to-noise ratio (PSNR), and the structural similarity index (SSIM) metric.

Results

The mean and deviation values for sCT evaluation measurements were MAE=67.88 (σ=8.39), ME=-0.06(σ=10.7), PSNR=-36.92(σ=1.4), SSIM=0.95 (σ=0.01).

Conclusion

A promising study on the generation of synthetic CT from CBCT was presented. Further work will be done to assess the method dosimetrically.

PREDICTING PATIENT-SPECIFIC QUALITY ASSURANCE RESULTS OF VOLUMETRIC MODULATED ARC THERAPY USING DEEP LEARNING

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Introduction

Automatic patient-specific quality assurance (PSQA) is recently explored using artificial intelligence approaches, and several studies reported the development of machine learning models for predicting the gamma pass rate (GPR) index only.

Purpose

The purpose of this work was to develop a deep learning (DL) approach to generate the synthetic measured fluence using a generative adversarial network (GAN).

Materials and Methods

Two DL models based on conditional GAN (c-GAN) and cycle GAN (cycle-GAN) were developed to generate the synthetic EPID-measured fluence. A total of 164 VMAT treatment plans, including 344 arcs (training data: 262, validation data: 30, and testing data: 52) from various treatment sites, were included for prediction model development. For each patient, portal-dose-image-prediction fluence from TPS was used as input, and measured fluence from EPID was used as output/response for model training. Predicted GPR was derived by comparing the TPS fluence with the synthetic measured fluence generated by the DL models using gamma evaluation of criteria 2%/2 mm (global normalization, 10% threshold).

Results

The synthetic measured fluence predicted by c-GAN demonstrated better accuracy compared to cycle-GAN. The reference GPR (2%/2 mm) was 96.5±2.4% and the cycle-GAN and c-GAN predicted GPR were 98.5±4.90% and 98.1±1.60%. Overall, the GPR prediction accuracy was within 3% for 71.2% of fields and 78.8% of fields for cycle-GAN and c-GAN, respectively.

Conclusion

A method was developed to generate the synthetic measured fluence using GAN. The c-GAN can accurately predict the measured fluence for VMAT PSQA and it has the potential to identify the error locations. The proposed PSQA prediction strategy will pave the way for the virtual PSQA.

GENERATING SYNTHETIC CT FROM DAILY CONE BEAM CT USING DEEP LEARNING

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Introduction

Cone beam CT (CBCT) Hounsfield units (HU) accuracy is one of the important parameters for accurate dose calculation for online adaptive Radiotherapy (OART).

Purpose

The purpose of this study was to generate synthetic CT (sCT) from the daily cone beam CT (CBCT) using deep learning models.

Materials and Methods

A novel 2D convolutional neural network called 'self-attention residual U-Net' (SA-ResU-Net) was designed to generate accurate synthetic CT. The SA-ResU-Net is similar to the traditional U-Net but equipped with a special self-attention mechanism in the long skip connections to learn the important information between the encoder and decoder. A total of 93 head-neck patient images who had pair of planning CT (pCT) and first-day CBCT images were included in this work. The patient data were randomly split into training data (58), validation data (10), and testing data (25). The accuracy of prediction was evaluated on testing data using the quantitative metrics including mean absolute error (MAE), peak-signal-to-noise ratio (PSNR), and structural similarity index (SSIM) which were calculated between the sCT and pCT images. The performance of the proposed architecture 'SA-ResU-Net' was also compared with traditional U-Net.

Results

The average MAE, PSNR and SSIM between pCT and CBCT were 163.35±28.62, 60.12±1.80 and 0.56±0.07. Overall the sCT images generated by both models showed reduced artifact, image noise, and improved image quality. The sCT generated by SA-ResU-Net demonstrated significantly ($p<0.001$) improved images compared to the U-Net in terms of mean MAE (48.4±7.1 vs 54.7±8.5), PSNR (66±1.9 vs 64.8±1.7) and SSIM (0.79±0.04 vs 0.77±0.05) respectively.

Conclusion

The proposed SA-ResU-Net improved the HU accuracy and image quality of sCT and it outperforms the U-Net for synthetic CT generation from CBCT. Our method has the potential to generate accurate sCT for OART planning.

IMPACT OF USING DIFFERENT IMAGE GUIDED BASED BRACHYTHERAPY ON ORGANS AT RISK EQUIVALENT DOSE

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Introduction

Utilizing of two types of image guided Brachytherapy in the treatment workflow can improve the quality of target delineation and applicator reconstruction but on the other hand it can has an impact on organs at risk (OAR).

Purpose

To evaluate the comparison between using different types of image guided based brachytherapy (IGBT) in OAR and their effects on equivalent dose in 2Gy Fractions (EQD2).

Materials and Methods

Thirteen retrospective cases data with gynecological malignancies were collected for this study. Planning CT and MRI scans were performed after the preparation of rectal and bladder and implant procedure. CT and MRI scans were fused focusing on implant applicator. OAR were independently contoured on the different image modalities.

Results

Between the CT and MRI images, a mean of 28 minutes was recorded. 88% of patients' bladder volumes increased with an average of 38% while in 58% of patients, sigmoid volume increased with an average of 5.6%. In 91% of patients, volume of rectum decreased with an average of 14%. During the analysis, on average, the center of the bladder & rectum moved 0.4 & 0. 1 cm shift away from direction from target. Furthermore, the average increase in D2cc, observed in bladder is 2.3%, while there was average decrease of 1.3% & 2.8% in rectum & sigmoid respectively. On the other hand, for EQ2 of bladder, rectum and sigmoid average dose changed by 1.2% (CT 71.4 Gy, VS MRI 72.2 Gy), 0.4% (CT 69.8 Gy, VS MRI 69.5 Gy) & 0.6% (CT 55.6 Gy, VS MRI 55.9 Gy), respectively.

Conclusion

Our institute's time dependent analysis of IGBT pretreatment CT and MRI scans revealed OAR motion between images. OARs deviated from the target due to these modifications, resulting in D2cc variations that did not translate in terms of EQD2 calculation.

OUT-OF-FIELD MEASUREMENTS FOR O-RING LINAC USING OPTICALLY STIMULATED LUMINESCENCE DOSIMETERS

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Purpose

Accurate radiation dose measurement at out-of-field is important in modern external beam radiation therapy due to the increased survival of cancer patients. The purpose of this study was to assess the out-of-field dose of the O-Ring linac equipped with a new dual-layer MLC, compared to the conventional C-arm linac equipped with a standard single-layer MLC using optically stimulated luminescence dosimeters (OSLD).

Materials and Methods

The OSLD nanoDots were calibrated using a solid water phantom with a standard setup for an O-ring linac (Ethos, 6MV flattening filter-free beam) and a C-arm linac (Clinac iX, 6MV-flattened beam). The surface doses were measured for different field sizes (5x5cm^2, 10x10cm^2, and 20x20cm^2) at the central axis and three locations outside the field edge (1cm, 5cm, and 10cm from the field edge). Out-of-field measured doses were normalized to the central axis and a comparison was carried out between two Linacs.

Results

Overall, the out-of-field dose increased considerably with increasing field sizes for both the MLC designs, and the dual layer MLC of Ethos delivered a lesser dose. The out-of-field dose on Ethos measured for field sizes 5x5cm^2 to 20x20cm^2 varied from 7.6-19.3%, 1.9-10.5%, and 0.9-7.0% for the locations 1cm, 5cm, and 10cm from the field edge respectively. Similar results for Clinac iX were 15.2-32.9%, 3.1-15.0%, and 1.1-8.8% for the locations 1cm, 5cm, and 10cm from the field edge respectively.

Conclusion

The O-Ring linac with a dual-layer MLC design demonstrated a lower overall out-of-field dose than the C-arm linac with a single-layer MLC. The results presented in this study can be used to optimize the out-of-field doses for special clinical situations such as pediatric cases, cardiac implants, etc.

AN IMAGE PROCESSING ECLIPSE SCRIPTING API ALGORITHM TO INSERT OR MOVE THE VARIAN COUCH TO CORRECT POSITION

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Introduction

The Varian Truebeam's carbon fiber IGRT couch can attenuate radiation beam up to 4%. To ensure accurate dose calculation and avoid couch-gantry collision, it is essential to position the couch structure correctly. However, the ECLIPSE algorithm inserts the couch structure below the lowest point of the body structure, which needs to be moved to the correct position.

Purpose

In this study, an Eclipse Scripting API algorithm was developed to insert and move the couch structure to the correct position using image processing.

Materials and Methods

The vertical line profile of the CT image of the CT scanner couch was acquired as a reference. After inserting the couch structure of medium thickness, the line profile below the top surface of the inserted couch structure was compared against the reference. A loss function was implemented to calculate the difference in the line profiles. Two iterations - a coarse and a fine tune were used to compare line profiles below the inserted couch structure to a maximum range of 15 cm. If the loss of line profile against the reference was comparable to the average loss, the shift returned was used to move the couch structure and associated couch interior.

Results

The algorithm was tested on 20 patient scans and compared against manually placed couch structure. A separate script was prepared to locate the center of the couch structure for evaluation. The standard deviation of the vertical variation between manually placed and algorithm placed couch positions was 0.56 mm, with a maximum difference observed as 2.39 mm. Minor distortion on the couch surface contour was observed due to the algorithm.

Conclusion

This study developed a simple image processing algorithm to automate the mundane task of moving the couch structure to the correct position. The distortion of the contour for the couch surface was observed, which will be investigated further.

ROLE OF PAPILLON SYSTEMS (CONTACT X-RAY BRACHYTHERAPY 50 KV) IN ONCOLOGY IN 2023

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Introduction
Radiotherapy (RT) in 90% of cases is performed using linear accelerators (≥6 MV). However, a niche exists for low energy X-ray beams (50 kV) in contact X-ray brachytherapy (CXB). CXB was developed in France in the 1970s by Papillon, currently is performed mainly in France and UK, using the Papillon systems.

Purpose
To present the results of this ambulatory treatment in small accessible tumors.

Materials and Methods
CXB is used in three main indications:
Skin cancer: basal cell and squamous cell skin cancers (T1-T2N0). Also, as adjuvant treatment after surgical excision.
Rectal cancer: lower-mid rectum with main indication T2-T3 ab N0≤4cm (organ preservation and "watch and wait", in case of clinical complete response. Endocavitary approach in the knee-chest position, always combined with chemoradiotherapy. Ideal for tumors 3 cm or less. Also prescribed as adjuvant treatment after local excision of T1N0 tumor with pejorative features on the pathological specimen.
Breast cancer (T1N0): intraoperative approach (Targit trial). A 20Gy dose (single fraction) is delivered in the tumor bed after lumpectomy (single session).

Results
Skin cancer: Local control in ~90% of the cases, with good cosmetic results. Very low toxicity rate in eyelid tumor, with no eye or lacrimal side effects.
Rectal cancer: European OPERA trial demonstrated the significant benefit of adding CXB to RT, with 81% 3-year rectal preservation for T2-T3a/b, and good bowel function in 80% of cases. The preservation rate is 95% for tumor <3 cm diameter treated first with CXB. For adjuvant strategy, 94% 5-year local control rate.
Breast cancer: Results of Papillon IORT (Centre Antoine Lacassagne) in a group of 26 patients, showed up 100% breast preservation (3-year follow-up), with good cosmetic result and no grade 3 toxicity. A complementary external beam RT was necessary in 3 patients (positive nodes).

Conclusion
CXB is associated with a very low rate of toxicity because the volume irradiated is very small (5 cm^3). The skin and breast IORT are easy for the radiation oncologist to perform. For rectal intracavitary irradiation a learning curve of 6 months/12 patients is necessary to master rigid rectoscopy and applicator tumor targeting.

SINGLE VERSUS MULTICHANNEL APPLICATOR IN VAGINAL HDR BRACHYTHERAPY

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Purpose

High dose rate brachytherapy (HDR) is a critical radiotherapy treatment that includes the insertion of radioactive sources through special type of applicator to deliver high doses of radiation directly to the cancer tumor.

Single-channel and multichannel are two types of HDR applicators which can used to deliver this type of treatment.

The aim of this study is to evaluate the dosimetric effect of using these two different applicators in intracavitary vaginal brachytherapy on organs at risk (OAR).

Materials and Methods

Retrospective endometrial carcinoma patients that were treated using cylindrical applicator are included in this study.
Two plans were created for each insertion with dose prescription is 7Gy to volume-based CTV high risk, one plan using single channel applicator while the other plan using multichannel with the same diameter size. Plans are created and performed by Varian's HDR Treatment Planning system and brachytherapy software. For each brachytherapy fraction a single and multichannel loading plans were generated with inverse treatment planning optimization.
To evaluate the effect of using different applicators on OAR, reference condition of CTV coverage D90 (dose to 90 percent of the volume) was set to be same in both plans.

Results

The study analysis data showed that the average dose for the 2 cc (D_{2cc}) in single channel applicator plans are (5.83, 6.23, 2.85, and 2.83 Gy) for bladder, rectum, sigmoid, small bowel, respectively. On the other hand, the result presents the D_{2cc} in multichannel applicator are (5.47, 5.32, 2.57, and 2.61 Gy) for bladder, rectum, sigmoid, small bowel, respectively.
Furthermore, the average variance percentage between both applicators are (6.2%, 14%, 10.6, and 9.2%) for bladder, rectum, sigmoid, small bowel, respectively.

Conclusion

High dose rate brachytherapy has different applicator modalities can be used, both applicators used in this study produce an acceptable plan but the multichannel applicator has the upper hand in decreasing the dose to normal structures.

STUDY OF CYBERKNIFE SYNCHRONY SYSTEM FOR IRRADIATING MOVING TARGET AT SULTAN QABOOS CANCER CENTER

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Introduction

In radiation therapy, treating moving targets is always a big challenge. Different methodologies have been used to overcome this problem. Among them are treating tumor with ITV, maximum intensity projection or irradiating tumor in a particular breathing phase.

CyberKnife System introduced a Synchrony method that made it possible to track and treat the tumor in a 4D real time motion while the patient is berating normally.

CIRS Dynamic Thorax phantom is used in this study.
This phantom can produce 3D complex target motion within the lung in conjunction with the Surrogate breathing platform.

Purpose

The aim of this study is to measure the accuracy of the CyberKnife Synchrony System that targets the tumor while it is in motion.

Material and Methods

CyberKnife system that includes the X-rays imaging system and the Optical Tracking system. We used CIRS Phantom for scanning and delivering the dose to the target (tumor), Gafchromic EBT^3 films were used.
The phantom was scanned as we scanned the real patient with Inhale and Exhale position (described by the Accuracy) followed by the simulation process and then planning was done by Precision TPS.
The same plan was executed 5-times with the following Phantom parameters to simulate the target motion during the treatment.
4 setups were used in this study with vertical motion ranging from 12-14 mm, lateral motion ranging 2-4mm at a cycle of 3-4/sec. The simulated depth of breathing (surrogate) ranged from 8mm to 10mm, and a phase shift of 0 and 90 degrees.
Automatic Synchrony model was used to track the tumor with breathing cycle.
After delivering the dose to the target, the film was scanned and analyzed by the E2E software provided by accuracy.

Results

Single plan was delivered 5 times with the above setups.
Results for target accuracy ranged from 0.25mm to 1.08mm

Conclusion

The moving targets can be treated with 1.08mm of accuracy.
All possible combinations of the tumor motion were produced, and the most complex motion result was in 0.29 mm target accuracy.

LOW DOSE RATE (LDR) PROSTATE PERMANENT IMPLANT ROLE AND IMPORTANCE OF MEDICAL PHYSICIST

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Purpose

To discuss the role and importance of physicist in setting up prostate permanent seed implant clinical procedures and implement the related safety polices, includes commissioning, customizing the quality checking (QA) protocols, planning evaluation &reporting and radiation safety polices.

Materials and Methods

The entire procedure is based on TRUS images, Ex-3 stepper (CIVCO-USA) assembly and mechanical grids. It is vital to check the routine quality on regular image quality and reconstruction geometry of ultrasound images. The stepper assembly with the image coordinates system and the physical grid positioning with respect to software grid alignment should be checked as a part of commissioning and reported. To perform routine and commissioning procedure, in-house QA phantom was designed and routine QA protocols are planned.

Results

Six patients have been treated and the results are as follows:

1. Activity Dosimetry

Calibration factor from single calibration seed (mean +STDEV) = 0.0092787+0.00007018 U/pc). Activity deviation for clinical seeds for four studies (Max deviation, mean deviation in %) are (-2.2,0.42%), (4.07,0.38%), (4.92,3.77%),(-2.68,-0.34%).

Our clinical data are relatively much lower to other institute for estimating the linear regression calculation. The regression factor (R^2=0.9964) and slope (a)=0.4624 and b=15.955 which is comparable with published data of another institute (a=0.52: b=10.5).

2. Dose reporting

V90% prostate &plan indices

All Initial (day-0) V90 > 100 % - V90 % dose for all plans (day-0, CT day-0, CT day30), 73 % of plans covers more than 98% prostate volume, 93.3% plans more than 90%.

Plan quality indices for all plans (v90/v150) is noted (mean $\pm$STD) as 1.656165 $\pm$ 0.161 (> 1.4 -Our set indices).

3. Segment analysis

out of 180 segments, 86.7 % segments, prostate V90 >98%, 88.3% of segments> 90 % and 5 % segments below 80%.

Comparatively base segments are poor coverage (ant and left) than other segments and plan quality indices (V90/V150 < 1.2) fails mid and apex segment due to hot dose volume.

Conclusion

Six patients' data are undersized data for a clinical conclusion but it would help to improve our work practice. The routine quality checking is an essential step to improve our work practice.

ESTABLISHING A LOW DOSE RATE (LDR) BRACHYTHERAPY TREATMENT IN PROSTATE CANCER PROGRAM IN AN EMERGING ECONOMY

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Purpose

Prostate cancer accounts for about 5% of new cancer diagnosed in Oman. This is in absence of the prostate cancer screening program.
LDR prostate brachytherapy alone or in combination with External Beam Radiotherapy (EBRT) is a standard curative treatment option for localized prostate cancer patients. It is also used for salvage treatment option for local failure after EBRT.
Our institute successfully launched the first LDR brachytherapy program in the Middle East and Region.

Materials and Methods:

Establishing a new service in countries with minimal experience and exposure is challenging. The following requirements and steps to acquire them was identified to initiate the program:

- Equipment: VariSeed software, BK ultrasound system with trans-rectal probe, CIVCO stepper and table mount, penile clamp and other disposable items.
- Personnel: Qualified and experienced staffs with in-house training was provided by internal and external expertise.
- Regulatory requirements: obtaining the license to import radioactive from Government officials.
- Quality assurance: all equipment QA, radioactive seeds calibrations and brachytherapy plans were performed by Medical Physicists.
- Timeline: about 15 months from concept to start the program was due to the above-mentioned challenges.
- Seeds delivery: seeds were ordered and supplied from USA through protected item shipment and cleared by customs in Oman. On time seeds delivery was challenging in the first few cases due to this new process. After collaborating with stakeholders, transport and shipment is now delivered in a timely manner with minimal complications.

Results

Program function was successful after challenges were met. Five patients were treated so far including a salvage treatment case.
Regulatory services are not well established, necessitating extra work with government agencies to get approvals. Dummy seeds were ordered and dry runs were conducted to remove any potential obstacle before ordering actual radioactive seeds for treatment.
Challenges related to logistics and custom clearances of radioactive seeds were resolved by communication with airline and organizing shipment delivery during working hours.

Conclusions:

The LDR brachytherapy treatment was successfully launched in Oman. This abstract provides a glimpse of some of the challenges and how it was resolved in a country where this program was not already established.

GATE MONTE CARLO APPROACH TO HETEROGENEITY DOSE DISTRIBUTION IN SMALL FIELDS USED IN RADIATION THERAPY

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Introduction

External beam radiation therapy is a widely used technique for cancer treatment, aiming to deliver a maximum absorbed dose to the tumor while minimizing damage to healthy organs. Treatment techniques have evolved to improve dose accuracy and reduce toxicity. However, current analytical methods used in treatment planning systems (TPS) have limitations, especially in the presence of heterogeneities.

Purpose

The objective of this study is to compare the accuracy of MC dose calculations with the Acuros algorithm, a rapid calculation method employed in external radiotherapy treatments. The focus is on evaluating dose variations in heterogeneous regions of the chest, specifically in lung, bone, and heart tissues, using two different phantoms.

Materials and Methods

The study utilizes GATE simulation platform, specifically version 9.2, which offers enhanced capabilities for modeling radiotherapy systems. The simulations were performed on a supercomputer, considering a 6MV photonic energy in Flattening Filter (FF) and without Flattening Filter (FFF) modes. Two phantoms, representing the chest region, were used to verify dose calculation algorithms along the depth axis.

Results

The results of this study provide detailed insights into the comparison between GATE and Acuros in terms of percentage depth dose (PDD) calculations for different field sizes and heterogeneous regions. In the right part of the chest phantom, the comparison of PDD curves revealed significant differences between GATE and Acuros in the heterogeneous regions (upper bone, lung, and lower bone) as well as in the surrounding homogeneous regions. The discrepancy between the two algorithms was more pronounced in the smallest field size and gradually decreased as the field size increased.

Conclusion

Monte Carlo (MC) calculations demonstrated better accuracy in dose predictions compared to the Acuros algorithm, particularly in the presence of heterogeneities. The findings support the use of MC calculations for improving treatment planning accuracy and optimizing external beam radiation therapy. Further research and validation are necessary to fully integrate MC methods into clinical routine.

A CLOUD-BASED MONITOR UNITS (MU) CALCULATOR FOR CLINICAL ELECTRON BEAMS

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Purpose

The aim of this program is to establish a user-friendly web application to help clinicians and physicists to execute electron beam treatments automatically as a second check software for manual conventional MU calculations.

Materials and Methods

A python-based environment (Stream lit) was used to make a user-interface which consists of several factors used to calculate the MU of the clinical electron beams. These factors include prescribed dose, output factor, the effective SSD, cut outs and the prescribed isodose line. The program went for validation under different conditions, namely, different SSDs, different output factors (i.e. with different applicator sizes and different energies), and different prescribed doses to examine expected dose from the program with the measured one.

Results

The primary measurements were taken at 90% depth dose and 100 SSD for 100 cGy dose with different electron energies and applicator sizes. The differences between the expected dose and the measured one was within 3% - 4% for 9 MeV and 15 MeV respectively. The smallest difference was found with 20 MeV, due to its extended PDD peak. However, the most notable difference was found with the 6 MeV energy when using small applicators (e.g. 6x6 cm^2 and 6×10 cm^2) where it reached 4.4% and 4.3% difference, respectively.

Conclusion

Based on the results we conclude that this web application is valid to perform electron monitor unit calculations. Future work will be done by using integral algorithm to account the dose at several points rather than at one point.

DEVELOPMENT OF BLUETOOTH WIRELESS 1D AUTOMATIC MOTORIZED WATER PHANTOM FOR ABSOLUTE DOSE MEASUREMENT

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Purpose
Main purpose of this study was to develop indigenously Bluetooth wireless 1D automatic motorized Water Phantom for absolute dose measurement and hence to make a comparison of the result with the IAEA recommendation (TRS 398) for daily QA of Linac.

Material and Methods
Bluetooth wireless 1D automatic motorized water sensor-based water phantom has been fabricated. The X-direction chamber movement was operated by the DC stepper motor. The chamber movement was controlled by the computer software programme based microcontroller used to accurately move the chamber with 0.01mm steps. The water phantom was fabricated with 10mm tissue equivalent material 30x30x30cm^3. Bluetooth hand controller provided to make the accurate chamber movement very easily with touch screen. Once switch ON the device all the displays will be appeared and the chamber will be aligned in the preset home position. Once touch the water sensor button, the chamber assembly will start to move and stop the movement when it touches the water. Mechanical motor movement assembly was made of acrylic sheet and stainless-steel. The automatic motorization feature allows for precise movement and positioning of the water phantom, reducing human error and improving reproducibility.

Results
We have measured and compared the absorbed dose, PDD, Isodose profile for different filed sizes and Off-axis ratio data of the ID phantom with PTW beamscan RFA. This study revealed that the Bluetooth 1D water phantom is equally good positional accuracy when compared with the PTW RFA. Furthermore, we will explore the practical benefits of this technology in absolute dose measurement. The automation and wireless connectivity eliminate the need for manual adjustments and measurements, resulting in time savings and increased throughput in clinical settings.

Conclusion
The development of the Bluetooth wireless 1D automatic motorized water phantom represents a significant leap forward in the field of radiation therapy. By combining automation, wireless connectivity, and precise motorization, this technology offers a convenient and accurate solution for absolute dose measurement. It is also known that the newly developed1D water phantom is low cost, fast, accurate, simple, easy set-up, which have the provision to Scan in stepping or continuous motion and user-friendly software.

EVALUATION OF A NOVEL SOLID MRI AND CT FIDUCIAL MARKER FOR MRI FUSION IMAGING AND IMAGE REGISTRATIONS IN RADIATION THERAPY

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Introduction

The objective of this study is to introduce and highlight the innovative features and capabilities of the indigenously developed solid MRI and CT fiducial marker for MRI fusion imaging. This marker system represents a remarkable achievement in research and development, showcasing the capabilities of local expertise in medical technology innovation.

Purpose

The purpose of this work was to develop a novel biocompatible solid MRI, CT fiducial marker that prevents radiopaque imaging artifacts and maintains high imaging contrast for MRI fusion imaging and image registrations in radiation therapy.

Material and Methods

A novel solid MRI and CT fiducial marker was fabricated indigenously from the natural plants extract and used to assess the higher visibility in different types of the MRI imaging sequences and CT imaging to find the best suitability for the kilovoltage CT image registration in radiation therapy. The natural plants extract has been collected from many plants and mixed in different combinations with different percentage. All the different percentage extracts were made like 4mm solid ball and placed over the circular water phantom. Image artifacts were quantitatively assessed in terms of the metal artifact index (MAI) on kilovoltage computed tomography (CT). Marker visibility was evaluated on two types of kilovoltage planar X-ray images in terms of the contrast-to-background ratio (CBR).

Results

The basic characteristics of this marker system were investigated by assessing major sources of image contrast in all the modalities like density and T1 & T2- weighted image and CT image in comparison with commercially available markers. The natural plants extract had good contrast similar to that of the commercially available MRI and CT fiducial marker.

Conclusion

We developed biocompatible natural plants extract MRI and CT fiducial marker, artifact-robust, higher visibility and compatibility in the multimodality fusion imaging. It represents a significant advancement in the field of medical imaging, particularly in the context of MRI fusion imaging. Its unique characteristics and compatibility with both MRI and CT scanners make it a promising tool for enhancing the accuracy and precision of image registration. The natural plants extract solid fiducial markers are cost effective, non-radioactive, easy to handle and environmentally friendly.

CLINICAL EVALUATION OF IN-HOUSE HDR SURFACE APPLICATOR AND FLEXIBLE CATHETER FOR BRACHYTHERAPY

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Introduction

The present study was to clinically evaluate the indigenously fabricated human tissue equivalent HDR surface applicator and flexible catheter for brachytherapy.

Purpose

The main purpose of the study was to fabricate indigenously the human tissue equivalent HDR surface applicator and flexible catheter for HDR brachytherapy and evaluate clinically.

Materials and Methods

The HDR surface applicator has been fabricated indigenously using different combination of polymer, silicon and paraffin oil in well predetermined ratio to achieve the flexibility and tissue equivalence. Self-cutting lines were made each 1cm, this will help to customize the applicator for the individual size of the tumour. The size of the applicator fabricated in different sizes with different dimensions of 10x10cm^2, 20x20cm^2 and ^{30}x30cm^2 with the thickness of 1cm and 0.8cm. HDR flexible catheters were fabricated using polyurethane Tube and placed inside the applicator at the middle. This allows the HDR remote afterloader to maintain a consistent source-to-tissue spacing of 5 mm.

Results

HDR surface applicator has the maximum of 30x30cm size and 30 possible treatment channels with a potential for 100 dwell positions per channel and a wire positioning accuracy of ±1mm. This can be cut to match the target size and ideally suited for large lesions that are difficult to cover, such as on the skull, face, chest wall. Both were used placed over the tissue equivalent phantom and connected with the HDR machine. Source transferring tubes were connected with the catheter. Gafchromic film were placed above and below to the applicator. Gafchromic film was scanned after the HDR treatment completed. The scanned film dose was compared with TPS calculated dose distribution and dwell position also compared. We found that, all the results were comparable and the percentage deviation is ±1.8.

Conclusion

Indigenously fabricated human tissue equivalent HDR surface applicators and flexible catheters are cost effective, transparent, sticky in nature, biocompatibility, dimensional stability, non-toxicity to tissue, flexibility and easily curved to match the target surface.

EVALUATION OF THE LOW DOSE FOR VMAT AND IMRT TECHNIQUES WHICH USED IN BREAST CANCER TREATMENT

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Introduction

The most common malignant tumors in women are breast cancer. The three primary treatment modalities for breast cancer are surgery, chemotherapy, and radiation therapy. External beam radiotherapy has an effective role in local recurrence control. In clinical photon beams, the dose outside the geometrical field limits is produced by photons originating from (i) head leakage, (ii)scattering at the beam collimators and the flattening filter (head scatter) and (iii) scattering from the directly irradiated region of the patient or phantom (internal scatter).

Purpose

The main aim of this work is to compare the low doses absorbed during the treatment of a breast lesion delivered using (VMAT) and (IMRT) techniques.

Materials and Methods

Twelve patients with right-sided breast cancer who underwent modified radical mastectomy were eligible for the study.

Results

DVH used to examine the dose distribution for the planning target volume, organs at risk and low dose (V2, V5). VMAT plans increase dose for PTV where 95% of prescribed dose cover 95% (V95) of Chest wall (PTV C. W) when compared with IMRT plans (P-Value 0.02476). Mean dose of heart was significantly decreased in IMRT plans when compared with VMAT plans (P – Value 0.00608). VMAT plans was equivalent or superior to IMRT plans in dose distribution, and was associated with highly advantage in sparing of the ipsilateral lung (P – Value 0.00028). VMAT plans decrease low dose (V2, V5) for normal soft tissue when compared with IMRT plans (P-Value 0.0002) (P-Value 0.0374).

Conclusion

Based on our data, VMAT present a significant advantage among the competing techniques. Oncologist should be alert of the possibility of significantly increasing the secondary cancer risk. Our results revealed that VMAT should be the first choice for patients with right-sided breast cancer.

INVESTIGATING THE USE OF OCTAVIUS 4D PHANTOM FOR PATIENT PRE-TREATMENT VERIFICATION OF MODERN RADIOTHERAPY TECHNIQUES DELIVERED BY VARIAN HALCYON ACCELERATOR

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Introduction

The individual patient quality assurance (QA) process becomes a vital step to assess the radiation dose distribution delivered to the patient during modern radiotherapy techniques such as intensity-modulated radiation therapy (IMRT) and volume modulated arc therapy (VMAT).

Purpose

This work aims to investigate the patient dose verification of IMRT and VMAT delivered by Varian Halcyon accelerator using a commercially available PTW Octavius 4D-729 system equipped with Verisoft software.

Materials and Methods

The Octavius 729 2D detector array is consisted of a matrix of 729 ionization chambers separated by a 10 mm distance from center to center, embedded in a 27×27 array. Each chamber has the cubic size of 5×5×5 mm^3 and the effective measuring point is 7.5 mm below the surface of the detector array.
Twenty complex IMRT and VMAT cases (lung (7), breast (6), head and neck (H&N) (4) and prostate (3)) were planned using Eclipse treatment planning system (TPS). Measured and calculated dose distributions were compared using both 2D and 3D global Gamma index method. The comparison was performed using 3%/3 mm and 2%/2mm as acceptance criterion. VeriSoft software package was used to perform the gamma analysis, where Gamma index was calculated for reconstructed dose distribution in all three axes, 2D, and 3D.

Results

A good correlation was observed between the measured and calculated dose distributions in most of the treatment plans. The obtained results show that the percentage of the success agreement of the Gamma index is (all 20 cases) (98.0±1.8) % for 3D compared to (95.0±4.3) % for 2D for the 3%/3mm criterion. While, for the 2%/2mm criterion, the percentage of the success agreement of the Gamma index decreased to be (90.0±5.4) % for 3D and (85.0±8.1) % for 2D Gamma index analysis.

Conclusion

The results showed that Octavius 4D phantom, with 2D-Array 729, can be an effective and efficient verification system for patient specific QA. The Octavius 4D phantom is a suitable tool in the dosimetric verification of the IMRT and VMAT delivered by Varian Halcyon accelerator. However, these results reflected the need for a deeper investigation about the criterion requested for the acceptance of the modern radiotherapy techniques.

TOWARDS EQUITABLE TREATMENT PLANNING TASKS DISTRIBUTION: KING FAHAD SPECIALIST HOSPITAL, DAMMAM EXPERIENCE

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Introduction

At our institution, treatment planning is carried out by five physicists and 2 dosimetrists. In addition to treatment planning, dosimetrists are involved in contouring of organs and in treatment planning quality assurance. Physicists, also, perform routine equipment quality assurance tests, administration, and teaching and training.

Purpose

The aim of this work is to create an application for distributing planning tasks among staff based on a points-earned system.

Materials and Methods

An inhouse web-based application was developed that randomly assigns new treatment planning requests to a planner following a “gaussian-like” sampling distribution. The application is hosted on a server within our local-area network and accessible from all other computers through a web browser. The sampling distribution is based on a points-earned system that individuals acquired from previous completed plans treatment plans and completed tasks. Each plan-type and site weigh a defined score depending on plan complexity and urgency. None-planning tasks, such as quality assurances tests and teaching/training activities are also assigned a score that is defined based on estimated times required to complete a specific task.

Results

In our department, we have been using the application for distributing treatment planning requests since Feb 2021. Currently, there are 131 tasks available that fall under 16 Groups covering quality assurance, administration, education, and development. Also, there are 176 plan types that cover 70 treatment sites. Several aspects were taken into consideration when developing our application; (1) logging of data needs to be simple and efficient (utilize dropdown menus and buttons); (2) expandable and dynamic; (3) availably at every workstation in the department; (4) logged data is transparent; and (5) creative to suit our needs. Moreover, individuals are able to obtain their “portfolio” with records of all plans and tasks done by them. The logged data also illustrates the dynamic role of medical physicists in the clinic that is usually not apparent to the hospital administration.

Conclusion

The use of our in-house developed application has considerably reduced stress and conflicts within our staff. It has also created a “gamification” environment that enhanced productivity and made work more enjoyable.

THE ROLE OF DOSE RATE AND GANTRY SPEED VARIATIONS IN PROGRESSIVE RESOLUTION OPTIMIZER (PRO) AND PHOTON OPTIMIZER (PO) ALGORITHMS FOR RAPIDARC™ VOLUMETRIC MODULATED ARC THERAPY DELIVERY

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Introduction

The study was performed to assess and compare the performance of two different RapidArc™ optimization algorithms such as PRO and PO by changing the Gantry speed and Dose Rate technical parameters. Additionally, the study aimed to assess the plan quality, agreement between plan delivery and TPS calculation, technical delivery performance using with trajectory log files.

Materials and Methods

Total five patients selected for this study from each site: Brain, Head and Neck, Hodgkin's Lymphoma, Advanced Right Lung, Ca cervix. The RapidArc™ plans were generated using Varian Eclipse TPS v15.6 PRO and PO algorithms with maximum range of Dose Rates (DR) from 100 to 600 MU/min, minimum 0.5 and maximum Gantry Speed (GS) fixed at 6.0 deg/sec. The reference plans were created for all patients by PO algorithm with GS 6.0 deg/sec and DR 600 MU/min, other plans were re-optimized using same dose constraints and objectives, for each patient 24 plans were generated and total 120 plans were created. Pretreatment gamma verification were performed using Portal dosimetry and ArcCheck to assess deliverability and accuracy. Plan quality scores were analyzed using target and OAR's values. Trajectory log files from Truebeam LINAC controllers were collected and analyzed to verify delivery performance.

Results

The result of the study shows: (i) Plan quality values both algorithms achieved similar results and no significant differences were observed; (ii) Closely similar results of dynamic range MU/deg is achieved across all dose rates with both gantry speed modulation and the values range from 2.244±0.38 and 2.027±0.35 (iii) Total mean Monitor Units (MU) for PO maximum is 14 % higher than the PRO; (iv) Reduced total beam on time is a major benefit of high DR and GS compare to constant DR and GS; (v) DR has higher priority over GS modulation and compensation mechanism adjustment between both algorithms are different for higher DRs. (vi) Pretreatment quality assurance in gamma evaluation (1 % & 1 mm) using Portal dose and ArcCheck analysis shows a maximum difference of 15 % in slow GS compare to max. GS. For both PO and PRO (vii) Trajectory log files maximum deviations observed for gantry positions, MU and DR results for PO and PRO were -0.1 deg, -0.03, 88.17 MU/min and -0.12 deg, -0.03, 83.84 MU/min respectively.

Conclusion

These results show that new PO algorithm is either clinically beneficial or neutral in terms of plan quality and efficiency in comparison to PRO. The parameters GS and DR in optimization engine might be undeviating for those variables and capable of generating plans unaided from the limits chosen. The pattern of DR variation between adjacent Control Points in PO was significantly different than PRO.

VERIFICATION OF THE ACCURACY OF DOSE CALCULATION ACCORDING TO THE DPM CODE COMPARED TO THE PENELOPE CODE USING THE PRIMO PROGRAM

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Introduction

The PRIMO program simulates the dose distribution in the field of external radiotherapy. It provides the calculation of the dose distribution in a water phantom and in a multi-layer phantom which is comprised of different materials and in computerized tomography. It also contains a set of various tools for analyzing and representing the data that was created. PRIMO has two engines PENELOPE and the Dose Planning Method (DPM). DPM represents one of Monte Carlo fast codes compared to PENELOPE.

Purpose

In this study, we evaluated the accuracy of dose calculation using the DPM compared to Penelope in the PRIMO program and assessed the impact of bin size dimensions on the accuracy of the dose distribution.

Materials and Methods

The Varian Clinac 2100 with 6 MV energy was simulated using PRIMO. The dose calculation was performed using both DPM and Penelope. The percentage depth-dose (PDD) curves in water and multi-layer phantom were compared for irradiation field sizes between (1x1 – 10x10) cm^2. The lateral dose profiles were compared using gamma index 1%, 1 mm. Also, an experiment was conducted within a water and multi-layer phantom using a field size (10x10) cm^2 to compare the effect of bin size on the accuracy of dose distribution for bin sizes (0.2 – 2) cm^3.

Results

Our results showed that there was a 99% correlation between Penelope and DPM when comparing the PDD curves in water and the multi-layer phantom. The lateral dose profiles showed a similarity of 95.45% to 100% for all field sizes and depths studied, except for the 10x10 cm^2 field size where we noticed a similarity of 92.93% and 93.94% at depths of 30 cm and 20 cm, respectively. Within the multi-layer phantom, the average difference between the two codes did not exceed 0.5% for all field sizes except for the 1x1 cm^2 field size, where the average difference was 1.49%.

Conclusion

We concluded that DPM can be used as a fast and accurate method for dose calculation compared to Penelope. However, an increase in bin size dimension resulted in an overestimation of the dose within the build-up and heterogeneous regions.

COLLECTION OF PERCENTAGE DEPTH DOSE FOR PINNACLE TREATMENT PLANNING SYSTEM FOR USE WITH VARIAN LINEAR ACCELERATOR

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Introduction

One step in the commissioning process of a linear accelerators (LINAC) is to collect and validate beam data of the LINAC with the treatment planning system (TPS). In many cancer research centres worldwide, Pinnacle TPS is the preferred products since it is a fast, accurate and interactive treatment planning tool. Percentage depth dose (PDD), profile output and output factors are the data required for commissioning Pinnacle TPS. The measurement of PDD is an essential parameter in the commissioning process of the LINAC.

Purpose

A validation measurements of beam PDD were carried out on Pinnacle TPS in a local hospital in Oman.

Materials and Methods

The PDD value was measured for a LINAC (Varian Truebeam) with 6 MV photon energy field defined by two methods: changing the jaws (3×3, 5×5, 10×10, 20×20, 30×30, and 40×40) cm^2 while fixing the multileaf collimator (MLC) retracted and by changing the MLC (3×3, 5×5, 10×10 and 15×15) cm^2 while fixing the jaws at (20×20) cm^2. The other parameters: energy = 6MV, dose rate = 600 Gy/h, source-to-surface distance = 100 cm, and highest monitor unit (maximum) were fixed. Two ionization chambers were used: field and reference ionization chambers (PTW Semiflex 3D Ion Chamber), and with using PTW water tank phantom. The analysis were carried out using PTW MEDPYSTO software. The PDD from the above-mentioned field sizes were compared with the golden beam data provided by the LINAC manufacturer.

Results

The results reported a PDD value of 66.2% at 10-cm depth for reference field size of 10×10 cm^2, which is within 0.3% of the limit (66.4%). Additionally, reported PDD for other field sizes were: 60.4% for 3×3 cm^2, 62.5% for 5×5 cm^2, 69.3% for 20×20 cm^2, 71.0% for 30×30 cm^2 and 71.7% for 40×40 cm^2.

Conclusion

All measured value were withing golden beam data limits. To conclude, the measured PDD have a good agreement with the manufacturer guideline.

HIGH RESOLUTION 3D INVIVO DOSIMETRY FOR ADAPTIVE RADIOTHERAPY

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Purpose

To enable adaptive radiotherapy high-resolution 1D/2D/3D Dosemappers recently proposed using micro-silica bead thermoluminiscent detectors (TLDs) for invivo dosimetry. Measurements made inside or on the patient's body as recommended by IAEA.

Materials and Methods

Characterization measurements performed utilizing a range of modalities and energies of clinical beams: photons, electrons, proton, neutron, carbon ions and HDR brachytherapy sources of Co-60 and Ir-192. Results encouraged investigation into their different clinical dosimetric applications including small-field dosimetry, patient specific treatment plan dosimetry verification by performing line profile dosimetry, a postal dosimetry audit program of lung SBR techniques within 20 radiotherapy departments in the UK, and 1D, 2D and 3D Dosemapperse created for high-resolution direct in vivo dosimetry for patients' treatment with kV x-ray beams and Co-60 HDR brachytherapy.

A fully automated reader also designed, prototyped and CE marked. All the bead arrangements and the reader are patented.

Results

The results in many cases offer better performance in comparison with other commonly available TL dosimeters including batch homogeneity, linear response from mGy to 100 Gy, independent response from dose rate and angle of incident beam, lower fading high precision (±3%, k=2) and high resolution (down to 1mm) dose mapping enable adaptive radiotherapy.

The speed of readout is some 10-fold greater than that of commercially available TLD readers.

Conclusion

Micro-silica beads dosimetrically characterized as TLDs. Multidimensional Dosemappers and a fully automated reader are made and CE-marked to allow for adaptive radiotherapy. Relevant patients in USA, EU, China, and India. These innovations have won a series of UK awards and grants.

COMPARISON OF BLADDER AND RECTAL DOSES USING SINGLE CHANNEL AND MIAMI MULTICHANNEL VAGINAL APPLICATOR IN HDR BRACHYTHERAPY

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Purpose

To retrospectively compare the potential dosimetric advantages of a multichannel vaginal applicator vs. a single channel one in intracavitary vaginal high-dose-rate (HDR) brachytherapy after hysterectomy, and evaluate the biological effective dose and equivalent dose 2 Gy per fraction.

Materials and Methods

We randomly selected 10 patients for single channel and 10 patients for Miami multichannel applicator with endometrial carcinoma, who received adjuvant vaginal cuff HDR brachytherapy. The diameter of both applicators was 25 mm. The treatments were planned by CT simulation in each fraction of vaginal brachytherapy. Firstly, a standard single channel treatment plan was carried out to the prescribed depth with the goal of providing maximal coverage to the tumor bed i.e. 5mm CTV typically. Doses to the bladder and rectum were also recorded by the Dose Volume Histogram (DVH). A second treatment plan was generated using a miami multichannel approach. The brachyvision brachytherapy planning system was used to generate both single and Miami multichannel inverse treatment plans. The target coverage percentage and doses to the bladder and rectum were optimized.

Results

Dose-volume-histogram (DVH) improved the dose coverage for clinical-target-volume in Miami multichannel approaches comparing to single channel applicator. For the organs-at-risk rectum and bladder, the use of multichannel applicator demonstrated a noticeable dose reduction, when compared to single channel. For D2cc of rectum, an average fractional dose of 549 ± 4.15 cGy resulted for single channel vs. 538 ± 3.09 cGy for multichannel. For D2cc of bladder, an average fractional dose of 555 ± 4.50 cGy resulted for single channel vs. 548 ± 2.60 cGy for multichannel. The dosimetric benefit of each fractional planning was demonstrated.

Conclusions

Endometrial HDR brachytherapy using a multichannel vaginal applicator and inverse planning provides dosimetric advantages over single channel cylinder, by reducing the dose to organs at risk without compromising the target volume coverage, but at the expense of an increased vaginal mucosa dose.

IMPROVING PATIENT POSITIONING ACCURACY IN IMAGE-GUIDED RADIOTHERAPY USING ALIGNRT INBORE

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Introduction

Image-guided radiotherapy (IGRT) requires precise patient positioning to ensure optimal target coverage while minimizing exposure to healthy tissues

Purpose

The absence of couch rotation correction capability in bore-based Linacs, such as Ethos, might challenge achieving accurate patient alignment. Surface-guided radiotherapy (SGRT) on closed-bore Linacs can potentially overcome this challenge. This study aimed to evaluate the effectiveness of AlignRT InBore, a novel SGRT solution, in conjunction with IGRT to improve patient positioning accuracy and consistency during treatment on Ethos.

Materials and Methods

AlignRT InBore consists of two sets of cameras, including three ceiling-mounted cameras for initial patient setup outside the bore and a ring-mounted camera system inside the bore for intra-fraction monitoring during beam delivery. The study included one rectal cancer patient with a challenging setup who underwent 28 fractions of treatment with a total dose of 50.4Gy. To assess the impact of SGRT, six fractions were administered without AlignRT InBore, utilizing standard laser-based positioning. On the other hand, AlignRT InBore was used to position the patient during six other fractions without relying on tattoos. Following the initial setup, a CBCT was performed to match the patient's position and –when using SGRT– a reference capture was taken to monitor the patient using the ring-mounted camera throughout the treatment.

Results

The results indicated that using AlignRT InBore slightly reduced the average translational magnitude of CBCT shifts and significantly reduced the residual rotation misalignment, particularly in the pitch axis by 3.7°. Additionally, the total treatment time was reduced by an average of 25%. Notably, using SGRT during patient setup eliminated the need for repeated setup or CBCT imaging in all six treatment fractions. In contrast, three out of six fractions administered without surface guidance required repeated setup and imaging due to significant patient misalignment.

Conclusion

These findings suggest that AlignRT InBore could improve patient positioning accuracy and consistency during treatment on Ethos, particularly for patients with challenging setups. In addition, the results of this study offer a proof of concept for future research involving larger patient cohorts and diverse treatment sites to improve the quality of radiation therapy treatments as a whole.

ROBOTIC SRS OF MULTIPLE BRAIN CAVERNOMAS: PERSONALIZED PATIENT SPECIFIC QA WITH A 3D PRINTED GEL DOSIMETRY PHANTOM.

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Introduction

A female patient with multiple brain cavernous malformations (CM) has been referred to NSH CyberKnife® Cancer Center, Dubai, for consultation. Four CMs were identified in T1 MRI scan with contrast. One CM located in the brainstem, two located in the right occipital lobe and one in the right temporal lobe. The hospital's Tumor Board evaluated that all CMs were surgically unresectable, and the patient should be treated with robotic radiosurgery in CyberKnife® M6, Accuray Inc.

Purpose

The aim of the study is to implement a novel personalized PSQA method with a 3D personalized gel dosimetry phantom to verify accurate and safe radiation dose delivery in robotic SRS treatment of multiple brain cavernomas.

Materials and Methods

Treatment plans were created using fixed collimators (5mm, 7.5mm) for each of the four brain cavernomas. A personalized head phantom, manufactured from the patient's planning CT scan using 3D printing technology and bone mimicking material (RTSafe Ltd), was used for PSQA. The replica of the patient's head was filled with polymer gel as 3D dosimeter. The phantom was positioned on the robotic treatment couch using exactly the same immobilization devices used for the patient's setup. PSQA plans were delivered using the 6D skull tracking method. A T2 MRI scan of the phantom was acquired (1.5T Aero SIEMENS), 24 hours post irradiation. The phantom's MRI scan and the calculated GelDose were registered with the patient's DICOMRT dataset. PSQA was evaluated on 3D Gamma Index analysis with passing criteria DTA(1.5mm)/DD(2%)/DT=1%.

Results

Four targets were evaluated. Mean GI passing rate was measured 97.3% (min=95.9%, max=98.6%) indicating very good agreement between the calculated RTDose and the measured GELDose datasets.

Conclusion

Based on the results of the presented study, robotic SRS of multiple brain cavernomas can be delivered accurately and safely as it was planned. The 3D printed gel dosimetry personalized phantom has been a valuable and accurate 3D dosimetry tool for pre-treatment verification in robotic SRS treatments.

DOSIMETRIC VALIDATION OF TOTAL BODY IRRADIATION (TBI) COMMISSIONED BEAM DATA

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Purpose

The purpose of this study was to validate the measured TBI beam data by comparing it with the calculated extended SSD beam parameters.

Materials and Methods

The validation was done using 10 MV at 380 cm SSD. A PTW 0.6CC farmer chamber, Markus Parallel Plate chamber, and mobile MOSFET were used in solid water phantom to measure Percentage Depth Dose (PDD), Tissue Phantom Ratio (TPR), profile, and pointe dose measurements. The following dosimetic parameters were calculated and compared with the measured values: PDD (using Mayneord formula), TPR (from the standard PDD), output. Beam Profile (10 cm depth) was measured along the gantry target direction. Monitor Unit (MU) was calculated for point doses (100 cGy) at 5, 10, and 13 cm depths at field center and two off central axis points at equal distances (30 cm). Effect of spoiler (1 cm thickness) was also investigated for transmission factor, PDD and profile to find the spoiler effect on depth doses and off axis scattering effect.

Results

PDD and TPR variations were within 2% and 1% respectively. The measured doses per MU at 10 cm depth and Dmax were 0.0672 and 0.0765 cGy/MU, respectively. The variation within the calculated and the measured outputs was 10% (0.008 cGy/MU difference). Profile flatness along patient plane for TBI condition and standard beam were found to be 110% and 110.1%, respectively. Point doses variation were within the expected doses at different depths. The deviation of farmer chamber and MOSFET measurements with the expected doses were 2.5%, and 6%, respectively. The measured point doses o off central axis deviations were 0.4% which is like the standard beam symmetry. Transmission factor was found to be 87% which matched transmission of 1 cm solid water. PDD difference with spoiler and without spoiler plus 1 cm water slab was found to be within 0.3%. The flatness of TBI condition with and without spoiler were found to be 109% and 110%, respectively. All found to be within 1%.

Conclusion

The validation of TBI beam data was carried out successfully. The measurements will be set as a baseline for future Quality Assurance of TBI.

ASSESSMENT OF DIFFERENT METHODS OF HEAD FIXATION FOR LEKSELL GAMMA KNIFE PATIENTS

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Introduction

A family of disorders known as cancer are characterized by uncontrolled cell development and have the ability to spread or metastasis throughout the body. An essential and crucial part of cancer treatment is radiation therapy. High-energy radiation is used to the cancerous tissues during radiation therapy to destroy the cancerous cells. Various intracranial targets have been treated with stereotactic radiosurgery with the Leksell Gamma Knife for many years.

Purpose

With regard to therapy, the most recent Leksell Gamma Knife (GK) generation supports both frame-based and frameless techniques. In current research the findings of retrospective research comparing thermoplastic mask fixation and 3D mask fixation for GK treatment of brain metastases.

Materials and Methods

Thirty patients with trigeminal neuralgia (TN) underwent GK radiosurgery employing the GK version 11.3.1(Icon) Elekta. In the present research, the decision for 3D mask fixation or thermoplastic mask was made on a case-by-case basis with patients' preferences taken into consideration. The 3D mask's material is checked to make sure it won't cause problems with treatment before it is put on the patients. The Elekta spherical phantom is used with an Ionization Chamber Device (PTW Semi flex 3D 31021) applied to it in order to assess the dose rate for each fixation tool.

Results

The ionization devices (PTW Semi flex 3D 31021) was used to compare dose rate for air and the materials 3D mask and thermoplastic. The dose rate for 3D and air are 0.0133, for thermoplastic and air are 0.0131, and for the 3D mask and thermoplastic are 0.0131, so that's a significant difference at level ≤0.05.

Conclusion

In this study, using a 3D mask during gamma knife treatment did not lead to worse results or higher rates of movement.

BEYOND EQUIPMENT & DEVICES: MEDICAL PHYSICISTS CONTRIBUTION TOWARDS PERSON CENTERED CARE AND BUILDING SAFER RADIOTHERAPY PRACTICES.

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Introduction

Traditional Quality Assurance (QA) focuses on functional performance of equipment and is important for physical safety of patients. However, majority of incidences are not due to failure in machines but involves Man, Method and Measurements. Also, patient safety concerns do not limit to physical safety and need to consider Cultural, emotional, and psychological safety elements.

Purpose

Expanding the role of Medical Physicists in contributing towards person centered care (PCC) and overall improvement of Quality and Safety standards of the department by mitigating the major gaps identified Viz, lack of cultural competence, psychological safety, challenges with language barrier and communication.

Materials and Methods

Initiatives began with training programs on PCC, Cultural awareness, sensitivity, and competency followed by team engagement and brainstorming sessions, initiatives for enhancing internal communications, review and revision of Standard Operating Procedures adopting elements of PCC, identify methods to motivate staff and formation of committees and working groups.

Results

We could identify areas for enhancing patient safety by actively engaging Medical Physicists. We introduced Induction Buddy program and various awards including safety champion award, Voice of Customer award and Patient centric staff award. Various departmental committees and working groups were formed with active engagement of Medical Physicists including Near Miss and Incident reporting Committee and enrolled to Safety in Radiation Oncology (SAFRON) by IAEA. Failure Mode Effect Analysis is utilized for prospective risk analysis. “Connect for a purpose” is an initiative implemented, aimed at enhancing internal communication and learning cultural diversity from internal resources.

We are exploring role of Medical Physicist in transition towards PCC by Pretreatment Medical Physicist consultation and building language bank to mitigate language barrier. Tattoos are taboo in some beliefs and Medical Physicists have piloted in Surface Guided Radiotherapy for elimination of tattoos for patients who prefer tattoo less treatment.

Conclusion

Safety includes Physical, Emotional and Cultural safety and are of equal importance for healthy wellbeing. Medical Physicists, being an integral part of healthcare chain can significantly contribute to overall QA at various dimensions including person centeredness, enhance team engagement, culture of safety and prospective risk analysis besides equipment QA for safer RT practice.

PART 2:

Diagnostic Radiology

BINARY TUMOR CLASSIFICATION USING MACHINE LEARNING

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Purpose

To investigate radiomics and deep convolutional neural networks (DCNN) approaches for the classification of tumors in seven publicly available datasets.

Materials and Methods

Seven public datasets with two classes of tumors were considered: 1) low-grade glioma or high-grade glioma (369 patients, BraTS'20) 2) well-differentiated liposarcoma or lipoma (115, LIPO); 3) desmoid-type fibromatosis or extremity soft-tissue sarcomas (203, Desmoid); 4) primary solid liver tumors, either malignant or benign (186, LIVER); 5) gastrointestinal stromal tumors (GISTs) or intra-abdominal gastrointestinal tumors radiologically resembling GISTs (246, GIST); 6) colorectal liver metastases with either a 100% desmoplastic histopathological growth patterns (HGP) or 100% replacement HGP (77, CRLM); and 7) lung metastases with BRAF mutated or BRAF wild type metastatic melanoma (103, Melanoma).

Radiomic analysis was performed on 464 (2016) radiomic features for the BraTS'20 (other) datasets respectively. Random forests (RF), Extreme Gradient Boosting (XGBOOST) and a voting algorithm comprising both classifiers were tested. The parameters of the classifiers were optimized using a repeated nested stratified cross-validation process.

DCNN was performed on 2D axial and sagittal slices encompassing the tumor. A balanced database was created, when necessary, using subsampling. ResNet50, Xception, EficientNetB0, and EfficientNetB3 were transferred from the ImageNet application to the tumor classification and were fine-tuned. Five-fold stratified cross-validation was performed to evaluate the models.
The classification performance of the models was measured using multiple indices including area under the receiver operating characteristic curve (AUC).

Results

The best radiomic approach was based on XGBOOST for all datasets; AUC was 0.934 (BraTS'20), 0.86 (LIPO), 0.73 (LIVER), (0.844) Desmoid, 0.76 (GIST), 0.664 (CRLM), and 0.577 (Melanoma). The best DCNN was based on EfficientNetB0; AUC was 0.99 (BraTS'20), 0.982 (LIPO), 0.977 (LIVER), (0.961) Desmoid, 0.926 (GIST), 0.901 (CRLM), and 0.89 (Melanoma).

Conclusion

Tumor classification can be accurately performed by adapting state-of-the-art deep learning algorithms to medical contexts.

THE RADIO PROTECTIVE ROLE OF VITAMIN C IN IRRADIATED MODEL USING γH2AX MARKER FOR DNA DAMAGE IN SPLEEN TISSUE

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Introduction

The variety of lesions induced by ionizing radiation, especially γ and X-rays as a DNA damaging factor, is an intriguing feature. Biomarker for radiation-induced damage, γH2AX foci have been reported to reflect DNA double strand break (DSBs).

Purpose

To improved that the use of vitamin C was efficient in reducing cell damage by reducing free radicals and the effect of both (γ, X rays) with the same dose and variant in energy in vivo and debate to find the difference between them in statistical and practical results and to show their biological impact.

Materials and Methods

Study research 42 adult male Albino BALB/c mice randomly divided into six groups of seven mice each. Group 1 given a normal saline solution that had not been treated and exposed to radiation. Group 2 mice received intraperitoneally (i.p.) injections of vitamin C (VC) (200 mg/kg.day) for 8 days without exposed to radiation. Group 3 given radiation as a control. Group 4 exposed to X-ray radiation as a control group. Group 5 mice given the same dose of VC as group 2 mice for 8 days before being exposed to (4 Gy) of γ ray. Group 6 given a VC dose over the same time as group 1 and then exposed to 4 Gy of X-ray. All groups had been sacrificed by cervical dislocation at (1, 3, and 24 h). Post radiation mice spleen were collected.

Results

A significant difference ($P < 0.05$) between the group of VC and with a control group exposed to both (γ, X-rays) in foci forming, but there is no significant difference ($P > 0.05$) between γ and X-rays for the control and VC groups.

Conclusion

The results demonstrate that VC is a good radioprotective agent for spleen mice; the effect of (γ and X-rays) had almost the same results on the spleen with the same dose.

ESTABLISH FACILITY DRLs BASED ON CLINICAL INDICATION AND BMI CATEGORIES FOR CT SCAN

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Introduction

This study regroups most factors affecting radiation dose in CT scan examinations to establish DRLs in order to enhance the sensitivity of dose monitoring software.

Purpose

To study the effects of patient size on the CT dose indices $CTDI_{vol}$ and DLP, to develop facility dose reference values (50th percentile) based on BMI as per Qatar obesity guidelines for 5 different organ-specific Clinical Indications.

Materials and Methods

CT exams were classified into 5 different BMI categories based on Clinical Indication. The examined patient was classified as normal, overweight, obese class I, class II, and class III. The dose data were collected from the RDM (dose management software) for each Clinical indication and the image quality was confirmed as adequate for the clinical purpose. The median radiation dose indices $CTDI_{vol}$ and DLP for each BMI category, CT exam, and each CT unit were estimated.

Results

About 1743 CT exams from 2 different CT models (same vendor) in the ACC at HMC in Qatar were retrospectively collected and analyzed. 20 cases were collected per BMI, per CT unit, and per clinical indication (CT Chest, KUB, Pathology search1/G, Follow up staging, and staging), and taking normal BMI as a reference (100%), the $CTDI_{vol}$ values were increasing as the body mass index increased: overweight (~140%), obese class I (~180%), obese class II (~240%), and obese class III (~310%).In summary, overweight patients required about 40% more dose compared to normal weight patients, while obese classes I-II had about double the dose. The 50thpercentile values are presented for $CTDI_{vol}$, and DLP for each of the 5 CT exams, for different BMI categories and different CT scanner models.

Conclusion

A new classification scheme considering BMI, CI, and CT scan models provides a tool to perceive differences in dose metrics among patient sizes on CT body exams.

DEEP LEARNING APPROACHES FOR AUTOMATIC QUALITY ASSURANCE OF MAGNETIC RESONANCE IMAGES USING ACR PHANTOM

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Introduction

In recent years, there has been a growing trend towards utilizing Artificial Intelligence (AI) techniques in medical imaging, including for the purpose of automating quality assurance.

Purpose

In this research, we aimed to develop and evaluate various deep learning-based approaches for automatic quality assurance of Magnetic Resonance (MR) images using the American College of Radiology (ACR) standards. We trained and tested models and explored the use of pretrained models for transfer learning.

Materials and Methods

We used two-class classification models for spatial resolution and geometric distortion, and evaluated several approaches for the low contrast test, including classifying the image into 10 classes representing the number of spokes visible in the image and classifying each spoke individually as visible or not visible.
Several models, including VGG16, VGG19, Resnet50, InceptionV3, EfficientNetB0 and EfficientNetB5 were trained and tested using the corresponding slice containing the parameter measurement as input. We also explored the use of pretrained models, such as those trained on the ImageNet dataset, for transfer learning.

Results

Our results showed that deep learning-based methods can be effectively used for MR image quality assurance. Overall, for geometric distortion and spatial resolution, all of the deep learning models tested produced prediction accuracy of 80% or higher. The study also revealed that training the models from scratch performed slightly better compared to transfer learning. For the low contrast, our study found that the InceptionV3 architecture outperformed other networks in terms of accuracy, albeit by a slight margin.

Conclusion

This research contributes to the field of medical imaging by providing a promising automated solution for MR image quality assurance using deep learning.

DCE-CT PERFUSION PARAMETRIC COLOUR IMAGE USING STEEPEST GRADIENT BASED ON TIME FRAME

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Introduction

Radiologists have utilized technological advancements in medical imaging modality, including improved special and temporal resolution, to assist in the diagnosis, prognosis, and subsequently management of brain tumours.

Purpose

The goal of this research is to use the steepest gradient technique, which is based on the timing of tracer transit, to create a pixel-by-pixel perfusion map colour image of brain.

Materials and Methods

Dicom pictures were created after injecting a tracer. Several hemodynamic parameters, such as blood perfusion, used to describe the microvasculature within a specific region of interest (ROI) are evaluated using CT scanning and the steepest gradient technique.

Results

A parametric blood perfusion image that was divided based on high and low blood flow within the brain map was effectively created through the application of the steepest gradient approach.

Conclusion

According to the results of this study, the blood flow colour image may be created using the steepest gradient approach, enabling radiologists to make diagnoses, predict outcomes, and determine if a brain tumour would respond favorably to a certain type of therapy. The perfusion pixel-wise perfusion map image functions as a fingerprint of ROI irregularity inside the brains, assisting radiologists in differentiating between necrotic and neoplastic tumour locations and preventing arterial partial-volume averaging.

GENDER-BASED VARIATIONS IN SCAN LENGTH AND CENTERING FOR CHEST AND ABDOMINAL CT EXAMINATIONS IN HMC

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Introduction

In phase 1 of the project, chest and abdominal CT reviewed to record scan length (from scout/topogram) and actual scan acquisition along with patient centering. These parameters were recorded from consecutive male and female patients. Optimal practices in length and centering can help reduce dose and improve image quality.
Purpose The purpose of phase 2 is to measure if training and baseline data can help to improve centering related issues which happened in >80% of the patients in Phase 1.

Materials and Methods

For each patient, in phase 1 we recorded the following information at the time of scanning: date of CT examination, body part imaged, patient age, gender, body weight, and height. In phase 2 we will add Scout length, Scout start and end locations (anatomic locations), Scan length and Scan start and end locations (anatomic locations).

Results

In phase 1, more than three-fourths of the patients (76%; 760/ 1000) were off-centered, and 24% were centered correctly (240/1000). The median off-centering distance and interquartile range (IQR) for chest CT exams (22 mm, IQR) 19) was more significant than for abdominal CT (15 mm, IQR 13) ($p = 0.003$). In addition, off-centering below the gantry isocenter (55.9%; 559/1000) was more frequent than above the gantry isocenter (20.1%, 201/1000). Off-centering was slightly but statistically more common in chest CT (92/114; 80.7%) than in abdomen CT (668/886; 75.4%). In phase 2 we are expecting that the new data will not only assess the impact of training but also establish a reward system for the technologists who perform at a higher level with good patient positioning skills. Patients centered above the gantry isocenter also received higher CTDIvol, DLP, and SSDE than those scanned at low table height (centered below the gantry isocenter) ($p<0.01$).

Conclusion

Radiology department will be recommended to invest in upgrading the scanners with 3D mounted AI driven devices which have been reported in several studies as superior to manual patient positioning.

PATIENT RADIATION DOSE ASSESSMENT FROM DENTAL PANORAMIC RADIOLOGY: A PILOT STUDY

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Introduction

Panoramic dental x-ray is an important tool, which uses ionizing radiation to produce the entire mouth in one image. Depending on the patient size, the thyroid gland and the eyes may also become irradiated during dental panoramic imaging due to the scattered radiation. While the radiation dose received is low, the cumulative effect of small doses on sensitive tissues could lead to both gene mutations and chromosomal aberrations.

Purpose

The present study was performed to evaluate the radiation exposure from panoramic radiography.

Materials and Methods

The examinations were performed using digital dental panoramic unit (FONA ART PLUS, Slovak Republic). The organ radiation dose values were measured using an adult Alderson-Rando anthropomorphic head phantom. A set of 20 thermoluminescence dosimeters (type MTS-N (LiF: Mg, Ti)) were used to assess the organs radiation doses, 15 of them were positioned on different sites representing: Eye, internal ear, salivary gland, thyroid inside the phantom while the others were superposed on the phantom surface on the positions of thyroid, eyes, mouth and forehead. Three identical acquisitions were performed in order to obtain the mean value for each TLD. The applied exposure parameters were 76 kVp, 6.3 mA and the DAP value was 119 $mGy.cm^2$. The RadPro TLD Manual Reader and a TLD Furnace Type LAB-10/400 for annealing the TL elements were used. The TLD's calibration curve was plotted after irradiating the TLDs using an X-ray calibrated Beam type RQR6 in the Syrian (SSDL).

Results

The mean organ doses for Thyroid, Eye, Salivary gland, Internal ear were 425, 257, 896, 317 µSv respectively, while the mean surface doses for Thyroid, Eye, Mouth, and Forehead were 129, 127, 56, 255 µGy respectively. The organ doses are higher than surface doses for direct irradiation with low energy X-rays, which correlates with the fact that the internal scatter is more important than external one.

Conclusion

In spite of the low values of the measured organs' doses, it is recommended to strengthen the justification for the dental panoramic imaging in order to minimize the stochastic risk of radiation to the patient sensitive organs.

QUALITY CONTROL FOR DENTAL X-RAY UNITS IN HAMAD MEDICAL CORPORATION

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Introduction

In Hamad Medical Corporation (HMC) all QC tests in dental intraoral procedures are performed using our in-house designed smart electronic QC forms (eQC-forms). eQC-forms allow all measurements to be compared automatically to the performance limits, as well as to the baseline values acquired during commissioning, so that consistency of performance is also monitored.

Purpose

To review the Quality Control (QC) reports of QC tests performed in Hamad Medical Corporation (HMC) dental intraoral (DI) units and identify common problems and fail causes.

Materials and Methods

Data from the 2022 QC reports of 38 DI units, from six different manufacturers (Sirona, Planmeca, KaVo, Trident, Kodak and Philips) installed in 6 HMC hospitals, were included in this study. QC procedures and performance limits are according to the recently published book titled “Quality control procedures for diagnostic X-ray equipment”, 2022, written by our medical physics team.

Results

The QC tests performed include tube potential accuracy, output repeatability/reproducibility and linearity, exposure time accuracy, HVL and image quality (IQ). The incidence air kerma for molar view is also compared to the respective limit. The IQ test is performed using the Leeds Test Objects TOR DEN digital phantom and the preset clinical protocol for the molar tooth of adults. The only test that failed to comply with the limits was the exposure time accuracy (in two old units). However, the interesting finding of this study was the occasional differences observed between the output and HVL values of QC tests and the baseline. This was attributed to differences in the position of the dosimeter within the radiation field, and it was verified by additional measurements.

Conclusion

Performance of the majority of DI units is within limits. Some differences observed were due to changes in the position of the dosimeter (heel effect) and not to changes of unit’s performance. To avoid this, the dosimeter must be always positioned as closely as possible to the center of the radiation field.

DIGITAL RADIOGRAPH REJECTION ANALYSIS DURING "CORONAVIRUS DISEASE 2019 (COVID-19) PANDEMIC" IN A TERTIARY CARE PUBLIC SECTOR HOSPITAL IN KHYBER PAKHTUNKHWA PROVINCE OF PAKISTAN

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Introduction

Ionizing radiations are employed in diagnostic imaging to perform various procedures of patients to produce good quality radiographs which help in diagnosis and treatments of various diseases. The employment of reject analysis as part of overall Quality Assurance program in clinical radiography services is to produce consistent high- quality radiographs at a minimum exposure to the patient. Reject analysis not only reveals the basic causes of rejection but also highlight the technical gaps as well which can be addressed effectively by conducting skill enhancement trainings as per modern trends and techniques.

Purpose

Evaluation of X-ray reject analysis is an important quality parameter in diagnostic facility. The aim of this study was to find out the radiograph rejection and its causes during the coronavirus disease 2019 (COVID-19) pandemic as there was fear of coronavirus disease infection among the technical staff from the incoming patients in a busy, high volume public sector tertiary care hospital.

Materials and Methods

This descriptive study was conducted at Radiology Department, Lady Reading Hospital, Peshawar from August to November 2020. The rejected radiographs and their causes were analyzed.

Results

A total of 15,000 X-ray procedures were conducted during study period out of which 2550 cases were repeated making the total rejection 17%. Rejection in male and female were 74.3 and 25.7% respectively, while rejection in adults was (80.1%) and (19.9%) in pediatric age group of the total rejection. The main cause of rejection was positioning (30.5%), followed by artifacts (22.4%), motion (12.1%), improper collimation (10%), wrong labeling (8.4%), exposure errors (6.9%), detector errors (3.7%), machine faults (2.8%), re-request from referring physician (1.7%), and PACS issues (1.5%). In terms of body anatomical parts, the highest rejection was observed in extremities (44.1%), followed by chest radiography (23.3%), spine (11.4%), abdomen (6.4%), skull (5.9%), pelvis (4.7%), KUB (3.7%), and neck (0.6%), respectively.

Conclusion

Radiograph rejection is common problem in every diagnostic facility but significant increase in rejection was observed during the COVID-19 pandemics in our center due to positioning errors specifically because of the fear of coronavirus infection among the technical staff.

IMPLEMENTATION OF RADIATION PROTECTION PROGRAM (RPP) IN ACCORDANCE WITH REGULATORY REQUIREMENT IN A HIGH-VOLUME RADIOLOGY DEPARTMENT OF A PUBLIC SECTOR HOSPITAL IN PESHAWAR, PAKISTAN

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Introduction

The use of ionizing radiations hav47e revolutionized the modern era of medicine with greater degree of precision and accuracy but at the same its un-judicious uses pose certain biological threats to occupational staff, patients and public. Hence, to ensure safe culture towards radiation practice, implementation of radiation program within the facility plays a pivotal role both in protection of the patients, staff and public but also to fulfill the regulatory guidelines as well. The issues of radiation safety were identified by the Medical Physicists which were compiled collectively by the concerned authorities and their implementation was ensured through frequents audits and safety rounds.

Purpose

Basic purpose was to highlight the radiation safety measures taken in a public sector hospital towards the implementation of radiation protection program to ensure safe radiation culture both for staff, patients and public.

Materials and Methods

Descriptive analysis was carried out in the largest public sector hospital of KPK to highlight the radiation safety measures taken in order to implement the radiation protection program in developing safe culture toward radiation practice. The first step taken started with the operation of Medical Physics services by induction of Medical Physicists to look after issues related to radiation safety within the hospital, matters were discussed with higher authorities, immediate actions were taken and achieved considerable success towards the implementations of safe radiation culture in accordance with regulatory requirements.

Results

All the deficiencies were identified and safety measures were taken and addressed accordingly. Radiation safety culture is emerging in its true sense according to regulatory standards and radiation protection program (RPP) has been implemented in the Radiology department of LRH and its true enforcement is ensured by daily safety rounds by observing various operational aspects of RPP and technical training of radiation workers is being conducted to develop their skills regarding safe culture of radiation practice.

Conclusion

Radiation protection program has been implemented through team effort of all stakeholders as per regulatory guidelines, safety standards are being followed regarding safety of radiation workers, doctors, patients and public in general.

INTERVENTIONAL RADIOLOGISTS' RADIATION EXPOSURE DURING CT GUIDED PROCEDURES

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Introduction

In HMC a variety of CT guided interventional procedures (IP) is routinely performed, using CT fluoroscopy. During fluoroscopy, interventional radiologists (IR) remain within the CT room and close to the patient, to visualize in real-time the result of their manipulations, and the successful access of the IP target.

Purpose

The study's purpose was to quantify the radiation exposure of IRs.

Materials and Methods

Secondary radiation measurements were performed in the Siemens Somatom Sensation 64 room, using the designated RaySafe X2 detector. A QC phantom was used to mimic the patient and the CT table was lowered, as in clinical practice (to facilitate manipulations). Measurements were performed at the waist level, in four positions around the gantry that represent: A) the position where the waist of an 180 cm tall IR would be during manipulations [at a distance (SSD) 60cm from the isocenter], B) just outside gantry (SSD=80cm), C) to the edge of the gantry (SSD=110cm) and D) behind the gantry (SSD=125cm), using an axial scan protocol. In position A, measurements were performed at eye (SSD=80cm), chest (SSD=70cm) and lower leg (SSD=90cm) level, using the routine fluoroscopy protocol.

Results

1 min of CT fluoroscopy would result in about 0.27 mGy dose (IAK) at the level of the IR waist (without accounting for backscatter and lead apron attenuation). The respective values for eyes, chest and legs will be 0.17, 0.22 and 0.12 mGy. If the IR moves two steps back to the side of the gantry (D, C), its exposure reduces to 3-5% of that at position A, while staying within the room.

Conclusion

About two hours of CT fluoroscopy (100-200 IP procedures), will be required to exceed the dose limit for the eye, without lead glasses' protection. Moving two steps back when not performing manipulations remarkedly reduces the IR's exposure.

QUALITY CONTROL SERVICES IN DIAGNOSTIC RADIOLOGY AND MOLECULAR IMAGING DEPARTMENT AT SULTAN QABOOS UNIVERSITY HOSPITAL: EXPERIENCES AND ACHIEVEMENTS

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Introduction

The Medical Physics Unit at Sultan Qaboos University was established with the objective, among others, to control the quality of diagnostic imaging modalities in Department of Radiology and Molecular Imaging. Since then, the Quality Control (QC) service gradually developed in proportion to the department's expansion having state of the art imaging equipment including general X-ray, fluoroscopy, mammography, computed tomography, SPECT/CT and PET/CT.

Purpose

This work shares the journey of the QC services over the last decade driven by the medical physics team including their achievements, challenges and future plans.

Materials and Methods

Inventories of imaging equipment, QC test tools, QC reports and QC protocols, over the past 10 years, were reviewed. Number of medical physicists and faced challenges during this period were identified.

Results

The outcome of this review showed remarkable improvements in services provided to patients within the department. Sophisticated QC test tools were introduced and equipment were tested comprehensively according to international guidelines. Some old units were replaced and new equipment were introduced, led to an increase in the number of equipment over the years. Radiographers were trained and are currently performing daily and weekly QC tests. Protocols were updated and tailored to suit the technology advancements. The overall activities showed that medical physics support to radiology and molecular imaging department is necessary and shall raise the standards of the radiology quality management system.

Conclusion

Continuous review of QC program is required in the modern era of diagnostic radiology and molecular imaging with the introduction of new equipment and radionuclide therapies. Medical Physicists are the core and the strength of providing continuous quality control services within the department. This in return will promote the clinical services and research activities to align with Oman Vision 2040. It is our strong believe that we should strive for certified accreditation for our services to regulate the profession of Medical Physics in Oman and to maintain international standards of practice.

LOCAL CLINICAL DIAGNOSTIC REFERENCE LEVEL ESTABLISHMENT FROM ROUTING COMPUTED TOMOGRAPHY AT BLACK LION SPECIALIZED HOSPITAL

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Purpose

Medical exposure level of individuals as part of their diagnosis or treatment from routing computed tomography has been fluctuating. Thus, diagnostic reference level definition becomes a prime point to provide guidance on what is achievable in the day-to-day radiological practice to implement as low as reasonably achievable principle that is compatible with attaining the required image quality goals. The purpose of the study is to define local clinical diagnostic reference levels of four most recurrent scanning procedures of adult patients in Black Lion
Specialized Hospital.

Materials and Methods

A retrospective study was conducted on 400 adult patients posed for anatomic body region medical diagnosis. Patient related data were collected in terms of CTDIvol and DLP from the scanners dose-reporting page as of February 10 to June 10, 2020. The mean, St. Error of mean, range, standard deviation (Std), and quartiles (25th, 50th, and 75th) of the DLP for body regions: brain, chest, abdomen, and pelvis were computed and analyzed using IBM SPSS software version 20. The DRL labelled as the 75th percentile of DLP as to the suggestion of universal legal authorities and it compared to up to dated international dose reports.

Results

This study analyzes, medium sized (50-90 kg) adult patients having mean age of 53 (18-85) years. The local clinical DRLs of the body regions brain, chest, abdomen and pelvic were computed as 1487.30, 410.72, 688.26, and 867.90 respectively.

Conclusion

The local clinical DRLs computed divulges considerably higher for brain and pelvic diagnostic imaging procedure comparing to international DRLs. These can be reason of biological detriment, and needs optimization into the clinically needed level to realize as low as reasonably achievable principle.

SIZE-SPECIFIC DOSE ESTIMATION (SSDE) AND ITS RELATION WITH PATIENT BODY FAT USING BIOELECTRICAL IMPEDANCE ANALYSIS

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Introduction

Monitoring radiation exposure to patients experiencing CT is an ongoing concern to the scientific community. Using SSDE is more feasible than CTDIvol for setting reference levels for diagnostics. The negligence of volume in CTDIvol makes it challenging to check the reasonableness of its values when comparing thin or obese patients, so CTDIvol must be compared with SSDE to inspect the reasonableness of the CTDIvol value output by the scanner.

Purpose

The aim of this research is to efficiently estimate the SSDE index of a patient's body fat (BF) in both the chest and abdominal CT scans.

Materials and Methods

The SSDE of a patient's BF% has been assessed by measuring it with Hand-to-Hand Bioelectrical Impedance Analysis for both chest (15) and abdominal (40) scans. The SSDE values identified from CTDIvol were compared with SSDEBF% and SSDE.

Results

A good agreement was found between SSDEBF% and SSDE for chest regions. A lower correlation was observed in the abdominal region.

Conclusion

The results were not very encouraging regarding SSDEBF, especially for the abdominal regions, in comparison with the other useful approach (SSDEBMI) for both the chest and abdomen regions. Accordingly, it is recommended to use (multi-frequency) bio-impedance spectroscopy instead of single-frequency bioelectrical impedance devices, which can be more accurate for measuring BF% values.

QUALITY CONTROL OF MRI SCANNERS USING ACR MRI LARGE PHANTOM.

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Introduction

Magnetic Resonance Imaging **(**MRI) Quality Control in Hamad Medical Corporation (HMC) was started in the last 5 years by medical physics section, eight important assessments of MR image quality are included: geometric accuracy, high-contrast resolution, slice thickness accuracy, slice position accuracy, image intensity uniformity, percent signal ghosting, low-contrast object detectability, and Magnetic Field Homogeneity. In addition, signal-to-noise ratio and central frequency are monitored as well, and all the Radiofrequency Coils are checked.

Purpose

To ensure appropriate MR scanner performance with high-quality diagnostic images

Materials and Methods

The MRI QC testing procedures were applied to sixteen MRI scanners in HMC, annually. In this report, the large MRI phantom from the American College of Radiology (ACR) accreditation program is used as the essential part of the MRI QC protocol. The specific procedures for the Quality Control Program are those specified in the most current ACR MRI QC Manual.

Results

All the MRI scanners has passed the annual QC tests, and this is due to two reasons, the first one that the QC tests are done on the day or the day after the vendors preventive maintenance (PPM) has been performed and the second reason is the established monthly QC program which helps in discovering any faulty issues before the annual testing schedule and any necessary correction of repair will be reported the vendor's engineers to do his part to repair and fix any issues such as the geometric accuracy and the image intensity uniformity. When evaluating the MRI performance using the ACR protocol, only the RF head coil is used for the monthly and annual QC testing procedures. The most common failing items are the radiofrequency coils because none of the coils was tested before the implementation of the MRI QC program, and the most important test is the Signal to Noise (SNR) for all receiving channels and compare it with the one measured during the acceptance testing of the RF coils base data.

Conclusion

The success of MRI depends on the production of high-quality images. These images must faithfully represent the anatomy, pathology and physiologic function of patients imaged.

DEVELOPMENT OF A MULTI-AGENT SYSTEM MODEL FOR OBJECT DETECTION FROM MRI IMAGES

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Purpose

To improve diagnosis accuracy and speed while reducing the time and cost of processing medical images, and therefore to treat patients more quickly to avoid disease progression, we conducted this work in which an artificial intelligence model was developed with the help of a multi-agent system (MAS).

Materials and Methods

We treated the set of cerebral IRM. The MAS are used to divide an IRM brain into several regions such as gray matter, white matter, ventricules, and tumors.

Results

Each agent may be induced to segment a certain visual region. Agents can be trained to recognize the unique characteristics of each area of a picture, such as texture, pixel density, shape, and size. The agents can communicate in order to integrate the segmentation results and generate the final picture segmentation. The agents can communicate in order to integrate the segmentation results and produce the final picture segmentation. SMAs are employed in the treatment of cerebral tumors. Agents can be created that look for abnormalities in medical images, such as masses or lesions. The agents can work together and communicate to combine the results of the tumor detection and provide the final diagnosis.

Conclusion

This model gave us good results in terms of detecting tumors and following up on their spread.

DETECTION OF STAGE OF LUNG CHANGES IN COVID-19 DISEASE BASED ON CT IMAGES: A RADIOMICS APPROACH

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Purpose

The aim of this study is to classify patients suspected from COVID-19 to five stages as normal, early, progressive, peak, and absorption stages using radiomics approach based on lung computed tomography images.

Materials and Methods

Lung CT scans of 683 people were evaluated. A set of statistical texture features was extracted from each CT image. The people were classified using the random forest algorithm as an ensemble method based on the decision trees outputs to five stages of COVID-19 disease.

Results

The proposed method attains the highest result with an accuracy of 93.55% (96.25% in normal, 74.39% in early, 100% in progressive, 82.19% in peak, and 96% in absorption stage) compared to the other three common classifiers.

Conclusion

Radiomics method can be used for the classification of the stage of COVID-19 disease with good accuracy to help decide the length of time required to hospitalize patients, determine the type of treatment process required for patients in each category, and reduce the cost of care and treatment for hospitalized individuals.

HOW THE PENUMBRA AFFECTS THE MEASUREMENT OF RADIATION FIELD SIZE AND KAP ACCURACY TEST?

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Introduction

Testing the accuracy of the displayed KAP values is very important. KAP is constant at any distance for the X-ray tube focus, and it is calculated as the product of radiation field size and the air kerma at any chosen distance. The problem is that when the image receptor is used to record the radiation field, due to the penumbra and the linear response of digital image receptors, its boundaries are not well-defined.

Purpose

The purpose of this study is to study the effect of the penumbra on the measurement of the radiation field size and DAP accuracy test.

Materials and Methods

Measurements were carried out in a Siemens Ysio radiographic unit with the distance between the focus and the portable image receptor (SID) set to 100 cm. The Air-kerma at the SID was measured using a calibrated RaySafe X2 dosimeter. To measure the radiation field size, two different tools: the Gammex 161-B plate and a commercial 50-cm ruler with radiopaque scale marks (1 mm step) were used. The X-ray field area was set to 18cm x 14cm (the standard field size of the Gammex 161-B plate). The radiation field sizes were visually assessed using DICOM images by seven medical physicists, and the mean values were used. Then the KAP values were calculated and compared with the displayed values. An external calibrated KAP meter (attached at the collimator) was used as a gold standard for testing the accuracy of the displayed KAP values. Various tube potential (kVp) and tube loading (mAs) settings were used.

Results

The maximum differences observed between the displayed and the measured/calculated KAP values were 3% for the external KAP meter, 32% for the Gammex 161-B plate and 19% for ruler. Deviations increased considerably with lower kVp settings and slightly with decreasing mAs. The minimum and maximum deviations were at 50 kV:11%- 32% for Gammex 161-B, and 8%-19% for the ruler. The respective differences at 80 kV were: 8%-27% and 5%-12%, and at 100 kV: 3%-23% and 0%- 8% for the ruler.

Conclusion

In absence of the gold standard, using a ruler and settings 100 kV, 10 mAs, provide accurate radiation field size measurements.

ASSESSMENT OF THIOL-CAPPED AuNPs AS CONTRAST AGENTS IN A MARS SPECTRA CT

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Introduction

Nanomaterials have become a promising diagnostics tool. They are used as contrast agents in imaging modalities such as computed tomography. High-Z nanomaterials such as Au are mostly used in CT imaging due to the advantage of K-edge imaging. In this work, we investigated the potential of gold nanoparticles (AuNPs) to generate contrast in spectra photon-counting CT in different energy windows.

Purpose

The purpose of this study is to assess the performance of AuNPs as contrast agents in a MARS Spectral CT scanner.

Materials and Methods

A chemical method was used to synthesize thiol-AuNPs by the reduction of gold salt with sodium citrate. The nanoparticles were characterized and scanned in a material phantom using a MARS CT scanner to obtain images corresponding to five energy windows.

Results

The TEM analysis shows AuNPs with an average size of 20 nm. The UV-vis spectrum gave a maximum absorbance at 527 nm while the crystal structure from XRD shows the characteristic peaks of gold. In the reconstructed CT images, AuNPs with the highest concentration show the highest contrast. The contrast however decreases with a decrease in the concentration of the nanoparticles. Hence, a linear relationship was observed between the Hounsfield unit and the concentration of AuNPs. The contrast from concentrations below 5mg /ml cannot be distinguished from that of water. Hence, 5 mg/ml is the minimum concentration that was visually perceived.

Conclusion

In conclusion, the synthesized AuNPs can enhance contrast in spectral CT at all energy windows. However, the minimum concentration of 5 mg/ml should be used to achieve a visible contrast. Further studies are necessary to optimize the use of AuNPs as contrast agents in vivo.

ESTIMATION OF METASTATIC LESION ON MRI IMAGES BASED ON MR SPECTROSCOPY

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Introduction

The goal of MRS (magnetic resonance spectroscopy) is to obtain metabolic biochemical information from normal and pathological brain parenchyma in a non-invasive and quick manner. It is one of the methods for obtaining metabolic data by determining the molecular structures of viable brain tissues.

Purpose

The purpose of the research was to see how accurate magnetic resonance spectroscopy (MRS) was at predicting Metastatic lesions.

Materials and Methods

A Popular Diagnostic Centre Limited enrolled patients with neuroepithelial tumors. Using the ^{1}H CSI MRS of the brain, changes were detected in the concentration of specific metabolites caused by metastatic lesions. These metabolites include N-acetyl-aspartate (NNA), creatine (Cr), and choline (Cho). The metabolic ratio was calculated using the division method for Cho, NAA, Cr, and Cr_2.

Results

The range of NAA for tumor cells was 0.63 and 5.65, 1.86 and 5.66 for normal cells 1, 1.84 and 10.6 for normal cells 2. In the tumor cell, Cho was in the range of 0.8 and 10.53, compared to 1.12 and 2.7 for normal cell 1 and 1.24 and 6.36 for normal cell 2, respectively. Cho/Cr2 was only marginally different from the other ratios in terms of significance. For tumor cells, the Cho/NAA, Cho/Cr_2, NAA/Cho, and NAA/Cr2 ratios were significant. Normal cell 1 had significant Cho/NAA, Cho/Cr, NAA/Cho, and NAA/Cr ratios.

Conclusion

^{1}H-MRSI can help improve the clinical outcome of metastatic lesions by guiding the extent of resection. MRS has the robustness to identify the presence of a tumor.

PART 3:

Nuclear Medicine

COMPARISON OF DIFFERENT THEORETICAL DOSE ESTIMATION WITH PRACTICAL PATIENT EFFECTIVE DOSE IN PET-CT ONCOLOGY SCANNING

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Introduction

Patients receive radiation doses from the radiopharmaceuticals and the CT scan during PET/CT exams. Radiopharmaceutical is administered to the patients via an automatic-injector.

Purpose

Our goal is to determine patients effective dose (ED) from the autoinjector (Intego) database and to compare the ED for each individual patient with ED values from software that is approved by the International Societies of Nuclear Medicine.

Materials and Methods

The study was conducted by collecting 146 PET/CT oncology patients undergoing whole body (18F-FDG and 18F-NAF) exams in Adan Hospital. Administered radiopharmaceutical, activities and effective dose were collected from (Intego) database, and the absorbed radiation dose. Radsis software and the SNMMI online calculator were used to calculate ED for comparison. The ED for CT was calculated using NCICT adopted software.

Results

There were 106 female patients and 39 male. For the comparison, we used the 3 softwares to calculate the PET/CT exams ED. Using the (Intego) database the ED for 18F-FDG and 18F-NaF exams for male patients was 9.82 ±1.64 and 11.2 ± 3.44 mSv respectively, for female patients the ED was 10.4 ± 3.64 and 11.8 ± 3.84 mSv respectively. Comparatively, using Radsis, the ED for 18F-FDG and 18F-NaF exams for male was 9.2 ± 2.8 and 8.82 ± 2.37 mSv and for female was 9.97 ± 3.14 and 10.37 ± 3.34 mSv. For the SNMMI calculator the ED was 9.32 ± 2.77 and 4.0± 0.7 mSv for male from 18F-FDG and 18F-NaF, and ED for female from 18F-FDG and 18F-NaF was 9.97 ± 3.14 and 8.91 ± 3.34 mSv.

Conclusion

For the Whole Body PET/CT the total ED for male using(Intego) database for 18F-FDG was close to the ED for the two other softwares while the ED for 18F-NaF was higher. The ED for 18F-FDG and 18F-NaF for female using Intego was higher with compare with the other softwares.

RADIATION DOSE REDUCTION STRATEGY FOR SPECT/CT BONE SCAN

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Introduction

The goal of optimizing the patient`s radiation dose in medical diagnostics is to achieve high quality image in the most efficient manner. The CT is justified or appropriated for the stated clinical indication and is, without doubt, the most important aspect of radiation dose optimization for SPECT/CT system.

Purpose

The aim of this study is to introduce the optimization method of CT parameters to reduce patient radiation exposure in bone SPECT/CT while maintaining image quality.

Materials and Methods

First part: Using Deluxe Jaszczak Phantom. The cylindrical phantom consisted of six bottles in a pie arrangement. These bottles were placed in the source tank. SPECT/CT scans were carried out with different x-ray tube current values at three different slices of thicknesses. The contrast ratio (CR) and coefficients of variation (COV) in the SPECT images as well as the signal-to-noise ratio (SNR) and
$CTDI_{vol}$ were all measured.

Second part: The study was done on patients who required a SPECT/CT bone scan of the spine area (thoracic spine (T1-T12) and lumbar spine (L1-L5)). Some patients were excluded from this study because of the image quality that was affected by several factors.

Different parameters obtained from the new reduced protocol were compared to old historical data saved in the system for patients who did the same image using the old standard protocol. The difference between the two systems was only in the current of the X-ray tube (the old 60 mA versus the new 40 mA).

Results

The optimal set of parameters for bone SPECT/CT was determined based on a phantom part that has been implemented in clinical practice. Two groups of patients were examined according to the baseline and optimized protocols, respectively.

The new SPECT/CT protocol substantially reduced patients' radiation exposure as compared to the old protocol, while also maintaining the required diagnostic quality of SPECT and CT images.

Conclusion

The newly established bone scan SPECT/CT protocol was implemented into clinical practice. It has significantly reduced patients' exposure dose as compared to the old protocol while maintaining the required diagnostic quality of SPECT and CT images.

3D PHANTOM MODELLING AND PRINTING FOR USE IN NUCLEAR MEDICINE QUALITY CONTROL

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Purpose

Quality control (QC) is a critical aspect of nuclear medicine practice ensuring that equipment and procedures used to diagnose and treat patients are accurate and reliable. This includes acceptance testing as well as regular calibrations. Acceptance and annual testing are usually based on international guidelines from National Electrical Manufacturers Association (NEMA) and use different types of phantoms acquired within clinical conditions. Some of these phantoms are available commercially but are sometimes expensive and some of them need to be fabricated in house. The goal of this study is to use 3D printing in order to create one phantom to be used in the System Alignment NEMA test (Center of Rotation).

Materials and Methods

A 3D phantom was designed based on NEMA specifications and printed using the MakerBot Replicator Z18 3D printer. The phantom, as shown in figure 1, contains 3 bars that can fit one capillary tube each. Horizontal distances between the end point of the tallest bar and the other two bars are 5 and 10 cm respectively. The vertical distance between bars were 7.5 cm. We tested the 3D printed phantom on a GE SPECT CT (870 DR) installed in the MINM department in Hamad General Hospital. 3-point sources (around 2 mCi each), with a maximum dimension of 2 mm was prepared inside three capillary tubes which were placed inside the three bars. The printed phantom was positioned in the plane of the three-point source holders parallel to the plane of the table and the central point source at the center of field of view (figure 2). A SPECT acquisition is then performed, and the Center of Rotation is calculated based on NEMA guidelines.

Results

Using the phantom, System alignment / COR results indicate a COR error of 3.22 mm, a COR deviation between heads of 5.94 mm, an axial deviation 0.43 mm and a relative axial misalignment of 0.32mm. These values fit within machine specifications.

Conclusion

Our 3D printed phantom is a valuable and cost-effective tool for measuring system alignment/COR. It represents an economical solution, and its straightforward design makes it easy to print.

OPTIMIZATION OF SCANNING TIME IN DYNAMIC ^{18}F-FDG PET IMAGES USING PRINCIPAL COMPONENT ANALYSIS

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Introduction

Dynamic PET imaging technique plays a key role in improving cancer diagnosis, assessing therapy response, and characterizing tumour lesions. However, it suffers from several limitations such as longer data acquisition time.

Purpose

This study aimed at shortening the total duration of ^{18}F-FDG scan while preserving the detectability of lesions.

Materials and Methods

The PET dynamic frames were generated using the 4D-XCAT anthropomorphic phantom combined with time activity curves calculated using a standard ^{18}F-FDG 3-compartment model and ^{18}F-FDG kinetic micro-parameters of different tissues. A 9 mm spherical liver lesion was inserted in the 4D-XACT phantom. The widely used STIR image reconstruction software was utilized. The principal component analysis method was applied to the simulated dynamic ^{18}F-FDG-PET images generated at different scanning times (11, 13, 15, 20, 25, 35, 40, 45, 50, and 55 min). The estimated Principal Component Images (PCIs) were visually assessed and compared to the SUMmed images (from t=35-55min). The Tumor-to-Background-Ratio (TBR) was considered in the quantitative assessment.

Results

The visual assessment of the 3 estimated PCIs and SUM images shows that PCI3 has better detectability of the tumour lesion regardless of scanning time. PCI2 shows good lesion detectability at all timing expect at 11 and 13 min, whereas PCI1 shows lower lesion detectability for all times. Quantitatively, TBR estimated on PCI3 is similar to the SUM images (TBR on PCI3 is 2.49±0.72 and 3,08±0.49 on the SUM images) but higher than on PCI1 and PCI2 from timing 11 to 35 min. TBR on PCI1 decreases with the increase in scanning time. On PCI2, TBR increases with scanning time (maximum of 3.87±1.11 at 55min).

Conclusion

The above findings suggest using PCI3 to optimize scanning time in dynamic ^{18}F-FDG PET while preserving lesion detectability. This study demonstrates that PCA allow reduction of scanning time, hence increasing patient comfort, and minimizing motion effects.

DIAGNOSTIC ADVANTAGE OF SESTAMIBI SPECT/CT OVER DUAL-PHASE PLANAR SCINTIGRAPHY IN PATIENTS WITH PRIMARY HYPERPARATHYROIDISM

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Purpose

Primary hyperparathyroidism is the 3rd most common neuroendocrine disorder. Parathyroid adenoma is the most common pathology for hyperparathyroidism. The goal of this study is to find the potential advantage of SPECT CT imaging in detecting parathyroid adenoma over planar imaging.

Materials and Methods

109 patients with suspected parathyroid adenoma underwent Tc99m Sestamibi scintigraphy during the period between Aug 2021 to Aug 2022. 9 patients were excluded from the study as SPECT CT was not done due to patient related reasons (claustrophobia, refusal) and only planar imaging was available.
Department clinical **imaging** protocol was used including neck and chest planar imaging acquired at 20 min and 2h and one SPECT CT acquired at 1 h. The reporting was done based on all information including planar and SPECT CT images. However, a separate Physician was asked to do a blinded review for planar imaging only to indicate the presence of parathyroid adenoma and then to compare that with the inclusion of SPECT CT. At a second step, he was asked to mark the advantage of SPECT CT in localizing parathyroid adenoma.

Results

Planar imaging was sufficient in detecting parathyroid adenoma in all the 100 study cases. 63 cases were positive, and 37 cases were negative. However, SPECT CT helped in a better localization in 92.08% (58/63) of the cases.

Conclusion

Although planar imaging may be sufficient in centers where they have no access on SPECT CT imaging, SPECT CT is still a valuable tool for increasing confidence in accurate localization of Parathyroid adenoma in patients with primary hyperparathyroidism. It facilitates surgical planning for minimally invasive parathyroid surgery.

CAN RADIOMICS HELP IN CHARACTERIZING METASTATIC LESIONS IN THE SPINE USING F-18 FDG PET/CT IMAGING?

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Introduction

PET/CT imaging is widely used for the diagnosis, staging, and follow-up of cancer, cardiac diseases and brain disorders. The deployment of radiomics and artificial intelligence (AI) in the medical field has grown exponentially since the year 2016. The combination of extracting radiomic features with machine learning algorithms could reveal pathological and metabolic characteristics of tumor lesions.

Purpose

The purpose of this study was to investigate the potential of radiomics to characterize metastatic lesions in the spine using F-18 FDG PET/CT imaging.

Materials and Methods

Ten breast cancer patients with multiple metastatic lesions in the spine were included in this study. Patients have undergone whole body F-18 FDG PET/CT scanning (baseline and follow-up scans). All scans were performed on the Siemens Biograph mCT 128 slice scanner. Image series were reconstructed using the iterative 'Ordered Subsets Expectation Maximization Time-of-Flight Point-Spread-Function' (OSEM-TOF-PSF) reconstruction, available on the scanner. For the extraction and selection of radiomic features, the 3D slicer tool was used to segment the vertebrae and outline the spine region on the CT images in order to extract and select the features. The segmented regions from the CT scan were projected onto the PET images. Radiomic features were extracted using the standardized 'Pyradiomics' tool. Principal Component Analysis (PCA) was used for features selection.

Results

A total of 107 radiomic features were extracted from image series; falling into six categories: shape features, first order features, gray-level co-occurrence matrix (GLCM), gray level-run-length matrix (GLRLM), gray level-size-zone matrix (GLSZM), gray level-dependence matrix (GLDM), and neighboring gray-tone-difference matrix (NGTDM). The number of features was reduced to 39 features using PCA: 14 shape, 13 GLDM, 10 GLRLM, and 2 first order features. The PCA method showed that the selected features account for 63.9% of the overall variation within patients.

Conclusion

The preliminary findings of this study suggest that the selected 39 features are the most pertinent features that characterize the F-18 FDG PET bone lesions. These findings are compelling enough support to assess this methodology on a large patient population.

BLOOD MICRO-SAMPLING: AN ALTERNATIVE BLOOD COLLECTION METHOD FOR BLOOD AND BONE MARROW DOSIMETRY FOR THYROID CANCER PATIENTS

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Introduction

I-131 is used for remnant ablation of differentiated thyroid cancer (DTC). Personalising I-131 treatment is therapeutically advantageous, however, when pretherapeutic dosimetry measurements are not possible, during-therapy dosimetry can be performed to retrospectively assess critical organs' absorbed doses, and can be used as a basis for planning future treatment. The European Association of Nuclear Medicine (EANM) dosimetry protocol, which ensures that a safe limit to the critical organs is not exceeded, mandate collecting blood sample and whole-body measurement at various time points post I-131 administration, where the blood provides a more accurate and reliable assessment. While centres employed remote monitoring for the whole-body measurements post-therapeutic administration of I-131, collecting the blood samples requires close proximity to the patient and carries the risk of high radiation exposure to staff collecting blood, especially in busy centres. Capillary blood collection is less invasive and less stressful alternative to venous or arterial blood collection, while also reducing collection time, increasing repeatability, not requiring post-collection processing, facilitating easier transport and storage, and lowering biohazard risks.

Purpose

This work proposed to establish whether venous blood withdrawal, as suggested by the EANM dosimetry protocol, may be replaced by a finger-prick blood sampling method, while maintaining the 5% acceptable uncertainty of counts required by the protocol.

Materials and Methods

Sixteen DTC patients were recruited in this study, all patients were referred to St James's hospital, Ireland, for I-131 therapeutic ablation, or thyroid cancer surveillance scanning. Thirty blood samples (finger prick and standard venepuncture) were taken post-administration of I-131.

Results

The findings show no significant difference found either between the count-rate of venous vs capillary blood types (-0.98±4.31%, p=0.223), or between 1.0-ml-blood versus blood-droplet geometries (-3.42±9.97%, p=0.070), or between their combination (-1.76±8.86%, p=0.286). The 1-ml venous-blood count-rate required by the EANM protocol can be estimated using the finger-prick blood count-rate with 94.5% predictability.

Conclusion

This study validated the use of finger-tip sampling as an alternative method of blood collection when blood radioactivity quantification is required for DTC patients. It is a faster, safer and more convenient method and, once validated, could be performed by the patient themselves.

PREDICTIVE PRETHERAPY IN BLOOD AND BONE MARROW DOSIMETRY FOR THYROID CANCER PATIENTS PREPARED WITH RHTSH INJECTION

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Introduction

Radioactive iodine (I-131) is used for remnant ablation in differentiated thyroid cancer post thyroidectomy. Tumour biokinetics have been demonstrated to alter with repeated treatments, leading to target cells becoming radio-resistant. Hence, maximising the administered activity for the first treatment is advantageous. The European Association of Nuclear Medicine (EANM) published a dosimetry procedure for differentiated thyroid cancer (DTC) patients, which allows maximising the remnant dose while ensuring that the dose received to critical organs is not exceeded, hence, reducing the risk of inducing toxicity. The administration of I-131 occurs after high Thyroid Stimulating Hormone (TSH) levels are achieved either by hormone withdrawal or by intramuscular injection of recombinant human TSH (rhTSH). Both have been shown to have equivalent results with the rhTSH approach reported to reduce morbidity and hypothyroidism symptoms. There is limited number of centres that use rhTSH as hormone withdrawal is widely implemented. Hence, there is scant literature on implementing dosimetry in patients prepared with rhTSH and the predictive power of pretherapy dosimetry has not been fully demonstrated

Purpose

This study developed an adapted version of EANM dosimetry-based treatment planning to investigate the predictive power of pre-therapy dosimetry in patients prepared with rhTSH injection

Materials and Methods

A clinical cohort study was carried out at St James's Hospital, Ireland. Maximum therapeutic activity (MTA) was estimated by whole-body counting and blood sampling at various time points post-administration of pre-therapeutic (PT) I-131 tracers (6.1±2.5 MBq). The measurements were repeated during-therapeutic (DT) post-administration of 3.9±0.2 GBq and compared. Thirteen thyroid cancer patients were recruited in this study.

Results

The findings show that the PT whole-body residence-time overestimated the DT with a -7.7±8.1% difference (p=0.007) while no significant difference is reported in PT vs DT blood residence-time (1.13±6.49%, p=0.559). There was no significant difference in the MTA between PT and DT with a reported difference of 1.7±4.8% (p=0.241).

Conclusion

In conclusion, pretherapy dosimetry using the EANM protocol was predictive of DT dosimetry in the cohort of this study. A larger sample is needed to increase the power of the results. The study suggests that dosimetry is feasible for all patients, irrespective of therapy preparation method.

PHANTOM BASED COMPARISON BETWEEN 18F-PSMA AND 68GA-PSMA PET/CT

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Purpose

Prostate cancer is one of the most common types of cancer in men. In order to diagnose/follow up prostate cancer patients, Positron emission tomography/Computed tomography (PET/CT) imaging is used. **Prostate-specific membrane antigen** (PSMA) is highly expressed on most prostate cancer cells. There are several isotopes that can be labelled with PSMA, for instance, 68-Ga or 18-F. In this study we will investigate the potential quantitative difference between PET/CT images acquired using either 68-Ga or 18-F.

Materials and Methods

The NEMA IEC body phantom containing 6 spheres of different sizes (ranging from 37mm diameter to 10 mm diameter) was either injected with 68-Ga or 18-F using a sphere to background ratio of around 4:1. The phantom was placed on the patient couch and imaged on the Siemens Biograph Vision 600 for 5 min (1 bed). 12 regions of interest (ROIs) and 1 ROI per sphere (covering 95% of the sphere) were drawn on the background and the 6 spheres respectively. Two parameters were then evaluated for both 68-Ga and 18-F based images. The first is the percent contrast for each sphere and the second is the background variability.

Results

For 18-F the percent contrast range was between 94.3% for the largest sphere and 86.6% for the smallest one. Regarding 68-Ga the percent contrast was between 70.4% and 37.6% respectively. For the background variability, the mean percentage was 3.9% and 2.1% for 18-F and 68-Ga respectively.

Conclusion

This study demonstrates that in 18-F PET based images, the recovered contrast was better than in 68-Ga based images. However, 18-F PET has the worst background variability. Future work will concentrate on a more complete comparison between 18-F and 68-Ga by measuring both sensitivity and spatial resolution. Moreover, patients 18-F and 68-Ga PET based images will be compared and evaluated to either have a patient specific decision on the choice between 18-F and 68-Ga or to prove the superiority of any of them.

A NEW GEANT4-BASED TOOL FOR INTERNAL DOSIMETRY CALCULATIONS: DOSECALCS

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Purpose

Specific absorbed fractions (SAF) and S-values (S), which are related to internal dosimetry, can currently be estimated using a variety of Monte Carlo tools, including MCNP and GATE, in order to prevent biological damage from being done to tissues and organs after they have been exposed to ionizing radiation. For physicists with coding skills, such tools make physics easier. However, programming and/or simulation inputs continue to be labor-intensive and time-consuming tasks.

Materials and Methods

In this study, we introduce a newly created Geant4-based code called “DoseCalcs” for internal dosimetry calculations. This code offers a variety of geometrical methods (STL, GDML, TEXT, STL, C++, voxelized, DICOM, and tetrahedral) that can be used to build the simulation geometry, as well as computational capabilities such as running with MPI or multi-threading mode.

Results

The SAFs for eight discrete mono-energetic protons which energies ranging from 0.01 to 2 MeV were estimated using the stylized ORNL female and voxelized ICRP adult female phantoms, and S-values for 18F were determined using DoseCalcs.

Conclusion

The accuracy is shown by the two phantoms’ good agreement with both references, which shows its suitability for application in the estimation of internal dosimetry quantities using a variety of geometrical methods.

INVESTIGATING THE EFFECTS OF VOXEL SIZE ON RADIATION DOSE DISTRIBUTION IN ^{131}I INTERNAL DOSIMETRY USING MONTE CARLO SIMULATION

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Introduction

Iodine-131 has been a successfully and widely used treatment regimen for thyroid diseases. While conventional empirical dose calculation methods are currently used for treatment planning, they are limited in accuracy. As a result, Monte Carlo (MC)-based treatment planning systems have gained momentum.

Purpose

Due to 131I post therapy imaging being performed on a wide range of scanners from different manufacturers, a plethora of "best" voxel sizes are possible. This study primarily explores using MC simulations of a computational phantom to investigate the effects of voxel size on the radiation dose distribution in the thyroid, pancreas, kidney, heart, lung, and liver post-administration of ^{131}I in an adult female XCAT phantom.

Materials and Methods

Simulations were performed using the GATE software. Voxel dimensions in the range of 1-7 mm in the x and y directions are investigated with a matrix array size of 400 x 400 x 1600, reflective of the range of current clinical and preclinical SPECT systems. The number of events simulated was kept consistent, ($1x10^6$) for each simulation and the absorbed dose per voxel scored.

Results

The results demonstrate the dose per voxel for all organs studied decreases with increasing voxel size at voxel sizes of up to 2 mm. However, at voxel sizes larger than 2 mm this pattern becomes less evident and a convergence in the dose per voxel is observed in all the organs studied with the exception of the thyroid. At smaller voxel sizes the computation time was greater, with 358 s for the 1x1x1 mm^3 voxel dimensions and a lower 208 s for voxel dimensions 7x7x4 mm^3. Similarly, at smaller voxel sizes larger uncertainties were found illustrating the importance of the choice of voxel size in internal dosimetry.

Conclusion

Voxel dimensions have a clear influence on the calculation of absorbed radiation dose in small organs such as the thyroid. Small voxel sizes are required for imaging dosimetry studies in order to accurately calculate self dose to the thyroid. Harmonization attempts should be made in order to enable comparison of doses calculated from clinical SPECT systems.

EVALUATION OF THE PERFORMANCE PARAMETERS ON THE BIOGRAPH VISION PET/CT SCANNER USING THE NU2- 2012

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Introduction

The introduction of fast lutetium oxyorthosilicate crystals allowed for shorter coincidence timing windows for time-of-flight (TOF) imaging, and an enlarged axial field of view (FOV) increased volume sensitivity.

Evaluation of PET systems' physical performance using NEMA NU 2-2012 provides for reliable and acceptable comparisons.

Siemens Healthineers' digital Biograph Vision PET/CT system uses silicon photomultiplier (SiPM)–based detectors with 3.2-mm lutetium oxyorthosilicate crystals and complete coverage between the crystal and SiPMs.

Purpose

The Vision's performance was assessed using NEMA NU 2-2012 standards including spatial resolution, sensitivity, scatter percentage, noise-equivalent count-rate (NECR), image quality, and attenuation and scatter correction accuracy.

Materials and Methods

Silicon photomultiplier detectors with 3.2-mm lutetium oxyorthosilicate crystals complete the scintillator region in the new digital PET/CT system. PET components include 8 rings of 38 detector blocks, each with 4 × 2 small blocks. Each mini block has an axial field of vision of 26.1 cm due to a 5 × 5 lutetium oxyorthosilicate array of 3.2 × 3.2 × 20 mm crystals connected to a 16 × 16 silicon photomultiplier array. The study evaluated PET/CT system performance according to the NEMA NU 2-2012 standard. We measured spatial resolution, sensitivity, count-rate performance, attenuation and scatter correction accuracy, image quality, co-registration accuracy, and time-of-flight performance. Measurements and their manufacturer's findings were directly compared.

Results

The Biograph Vision shows a NEMA sensitivity of 15.1 kcps/ MBq, an axial spatial resolution at Full Width Half Maximum (FWHM) of 3.5 mm at 1 cm offset of the center of the FOV, a NEMA peak NECR of 259 kcps at 32 kBq/mL and TOF timing resolution was 213.7 ps. The overall image contrast seen with the NEMA image quality phantom ranged from 80.79% to 90.86%.

Conclusion

The Biograph Vision is able to meet NEMA standards and manufacturer values.

EFFECT OF PSF+TOF (UHD) AND TOF ON FDG UPTAKE MEASUREMENTS IN CANCER PATIENTS' LESIONS USING OSEM

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Introduction

In cancer 18F-2-Fluoro-2-Deoxyglucose Positron Emission Tomography scans (F18-FDG PET), the maximum standardized uptake value (SUVmax), Metabolic Tumor Volume (MTV), and Total Lesion Glycolysis (TLG) are frequently used for further diagnosis and lesions staging. For centers with established protocols for lesion categorization based on SUVmax thresholds, point spread function (PSF) modelling and time-of-flight (TOF) reconstructions have a considerable impact on SUVmax & MTV. This may be the reason why these reconstructions have been adopted slowly.

Purpose

In this study, the effects of two alternative post-filtering strategies on SUVmax, MTV, and TLG were assessed.

Materials and Methods

With the help of Siemens Biograph Vision 600 and the two post-filter sets, images from 20 cancer patients were reconstructed using PSF+TOF (UHD) and TOF with OSEM. Lesions for each reconstruction were used to quantify SUVmax, MTV, and TLG. Measures of uptake were compared relative to one another, and any alterations were evaluated for their potential clinical effects.

Results

While MTV reduced by 21% for UHD in contrast to TOF, SUVmax & TLG increased significantly when voxel variance was matched, increasing by 21% and 8.4% respectively for UHD in contrast to TOF. This could have an effect on the majority of patients' outcomes.

Conclusion

Matching image voxel variance with UHD and/or TOF reconstructions led to significant increases in SUVmax & decrease in MTV, particularly with UHD modelling, which prevented the application of established techniques for lesion categorization based on SUVmax & MTV. The ability to detect lesions may, however, be improved by diminished partial volume effects for UHD in contrast to TOF. Last but not least, compared to SUVmax & MTV, TLG might be less sensitive to reconstruction techniques.

SyrMan MODEL FOR INTERNAL DOSIMETRY CALCULATIONS

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Introduction

The MIRD Phantom was based on data of the ‘‘Reference Man’’ created by ICRP for radiation protection purposes. The reference man was originally defined as being 20–30-year-old Caucasian, weighing 70 kg and 170 cm height. The “voxel models”, representing the diversity of human anatomy, were built using tomographic images for real humans. Later, many ethnic voxel models were constructed and simulated by Monte Carlo codes for radiation dosimetry calculations.

Purpose

Reconstruction of human voxel model from CT images for a person from the Middle East region to calculate the radiation dose using Monte Carlo code. The model was used for internal dosimetry.

Materials and Methods

The CT images of a volunteer (33-year-old male, 172 cm height, and 75 kg weight) were used to reconstruct a head-to-knee voxel model, named SyrMan. The volunteer represents the average, in weight and height, of a group of 262 males aged between 25 and 50 years. The SyrMan model was used for internal dosimetry calculations using two Monte Carlo codes: MCNP4C2 and GATE. The deposited energy and Specific Absorbed Fractions (SAFs) were calculated in target organs from source organs containing monoenergetic photons or electrons. The SAFs of SyrMan model were compared with those of previous published models.

Results

The comparison of organ masses between ‘‘SyrMan’’ model versus those of ICRP23, VIP-man, GOLEM, and Visible Human models showed that separate organ masses were considerably different in many cases. Even though with phantoms whose weight and height are close to that of SyrMan such like Zubal phantom, the relative differences ranged from -36% for pancreas to +37% for kidneys. Due to the differences in masses and anatomy, the values of self SAFs and cross SAFs were different. For example, for photons of 100 keV, SAF (Liver ‹- Liver) differs -16% and SAF(Pancreas ‹- Kidneys) differs +25% between SyrMan and Zubal models.
The differences in SAFs between both Monte Carlo codes were less than 3% in most cases.

Conclusion

SyrMan model represents a real middle-east human body. It was used for internal dosimetry and can be used for various radiation dosimetry applications.

ROYAL HOSPITAL EXPERIENCE OF LIQUID RADIOACTIVE WASTE MANAGEMENT

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Introduction

Various radioactive nuclides are used in Nuclear Medicine for both diagnostic and therapeutic procedures. Safe disposal of the generated radioactive waste is a critical element of the hospital waste management. The liquid wastes are generated from the iodine isolation therapy toilets and from general nuclear medicine department which is collected in the two delay tanks. In Royal Hospital, the liquid radioactive waste is managed according to delay and decay concept. Iodine-131 is an essential example of a radioactive nuclide has been used since 2006. According to radiotoxic classification, I-131 is one of the group 2 element and decay with gamma and beta. Hence, a liquid radioactive waste management regime is required to guarantee that the radiation exposure does not exceed safe limits which is 22.2 MBq /m^3. The effluent of the tank was released into public sewage about six times per year.

Purpose

This study aimed to review Royal Hospital experience of liquid radioactive waste management, to ensure that the radiation exposure to an individual (Public, Radiation worker, Patient) and the environment does not exceed the prescribed safe limits and address the challenges to review the current guidelines.

Materials and Methods

Data from 2006 to 2023 of liquid waste management at Royal Hospital was collected, reviewed and analyzed.

Results

All measurements are within the acceptable limit 22.2 MBq/m^3. Some challenges are appeared from this reviewed study like: after the COVID-19 pandemic the number of treated patients was doubled, the disposed liquid waste treated in local water planet and the absence of National Radiation Authority. Special recommendations were taken to approach the acceptable limit once the challenges were faced.

Conclusion

Medical Physicists at nuclear medicine and engineers play a key role in the waste disposal operations at Royal Hospital. All challenges were discussed to review the situation and to update the local guidelines.

CORRELATION OF EXTERNAL EXPOSURE AND BMI IN RADIOIODINE(I-131) THERAPY

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Introduction

Radioiodine (I-131) therapy is used since mid of last decade for treatment of patients who had undergone total thyroidectomy for differentiated thyroid carcinoma. Benefits to patients treated with radioiodine–131 must be balanced beside external radiation exposure to the surrounded persons.

Purpose

This study planned to investigate the correlation of external radiation exposure at one meter with the BMI (Body Mass Index) in thyroid cancer patients treated with radio-iodine I-131 capsule.

Materials and Methods

The present study carried out 70 patients treated with I-131 at Royal Hospital, Oman. The involved patients were enrolled randomly and separated based to their administrated activity into three groups which are 3.7 GBq, 5.5 GBq and 7.4 GBq. BMI (weight divided by square of height) was calculated for each patient at the day of I-131 capsule administration. The external radiation exposure from the patients was measured using calibrated survey meter, CoMo-170, from a distance of one meter parallel to the patient's thyroid gland directly after Iodine-131 administration.

Results

The relation of external radiation exposure values with BMI were analyzed statically. The external radiation exposure was inversely correlated with the BMI.

Conclusion

The BMI values is an important factor that help to expect the external radiation exposure before radio-iodine therapy, predicting the time of discharge and control the isolation room. Moreover, the BMI values of patient treated by I-131 can help for optimization of radiation hazard.

ASSESSMENT OF RADIOACTIVE CONTAMINATION IN NUCLEAR MEDICINE, ROYAL HOSPITAL, SULTANATE OF OMAN

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Introduction

The most common adverse event that can occur in nuclear medicine is radioactive contamination due to the use of unsealed radioactive materials. Radioactive contamination checks should be performed frequently among nuclear medicine facilities for good radiation safety practice. Wipe test is an important test that helps for assessment of radioactive contamination.

Purpose

Assessment of radioactive contamination in different places at nuclear medicine facility

Materials and Methods

Wipe- test was performed for different locations in the nuclear medicine department and Molecular Imaging Center (MIC) including controlled areas, supervised areas and public areas. The selection of the wipe tests locations were based on the high chance availability of radioactive contamination. Area of (10×10) cm^2 wipes were used for the wipe-test samples. All wipe samples were placed on test tubes and were measured in well-counter (Capintec CR 25) for one minute. The Background (BG) levels were measured before each wipe measurement. After that, the mean counts were calculated and counting activities in Bq/ cm^2 were recorded. The curve of counting-activity was plotted to specify measured counts equaled to activities.

Results

The Study shows that 10 of 300 locations in the Nuclear Medicine department and Molecular imaging center exceed the surface contamination limit. This assessment shows that the most contaminated area is the Hot Lab especially the preparation area in the bio-safety cabinet, door knob and the pen that used in the Hot Lab.

Conclusion

The occurrence of radioactive contamination is very minimal in the nuclear medicine department and Molecular Imaging Center based on the assessment findings of this study. Sometimes some items in the Hot Lab are found contaminated due to preparation and dispensing of radiopharmaceuticals.

OPTIMIZING PET SCANNER DESIGNS FOR PEDIATRIC APPLICATIONS: SMALLER BORE DIAMETERS AND CRYSTAL SELECTION

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Introduction

Positron emission tomography (PET) imaging has been widely used for diagnosing, staging, and monitoring various diseases due to its ability to detect molecular changes in vivo. The clinical use of PET imaging in pediatric patients has always been a concern due to their smaller body size and lower tolerance to radiation exposure. However, it's worth noting that the pediatric population has an advantage compared to adults because their attenuation levels are significantly lower. As a result, per injected dose (MBq/kg), relatively fewer scattered events and more trues can be measured due to reduced attenuation.

Purpose

This study proposes and simulates PET designs based on the Biograph Vision 600 PET/CT scanner with smaller bore diameters for pediatric applications. Different crystals are also studied to optimize the cost of such a design without losing spatial resolution and image quality.

Materials and Methods

The Biograph Vision 600 scanner incorporates a PET device that includes a detector with Optiso Ultra Dynamic Range (UDR) technology, which is fitted with lutetium oxyorthosilicate (LSO) crystals and digital silicon photomultiplier (SiPM) sensors. The scanner is modeled in GATE, and the NEMA sensitivity of the different designs is e valuated with BGO and LSO crystals.

Results

Generally, BGO yielded higher sensitivity than LSO, and reducing the bore diameter increased the system sensitivity for both crystals. The findings of this study have implications for making more effective PET scanners after lowering the administered activity of the radioactive tracer to the patient, which leads to a safer procedure for pediatric applications.

Conclusion

The next step is evaluating the proposed designs' spatial resolution and image quality to optimize the scanner parameters such as bore/crystal size and type of crystal. A further step is extending the axial field of view (aFOV) of the designs to propose a cost-efficient Total Body – PET (TB-PET) design for pediatric applications, which would allow for comprehensive whole-body imaging, reducing the scan time and the administered dose and improving patient comfort.

THE CLASSIFICATION OF BREAST CANCER USING 18-FDG PET/CT BASED ON AN ARTIFICIAL NEURAL NETWORK

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Introduction

PET/CT is a routine procedure for the measurement of breast cancer, but it does not classify histological subtypes automatically.

Purpose

This research aims to evaluate the clinical classification of breast cancer based on the value of tumor marker using an artificial neural network.

Materials and Methods

One hundred forty-two breast cancer patients (Training, Testing) who underwent ^{18}F-FDG PET/CT to diagnose the classification of breast cancer in our nuclear medical center. Before the scanning procedure, the patients were given ^{18}F-FDG-18 injections. We followed the routine procedure for the scan. The softmax function with cross-entropy loss is used in the output layer of the artificial neural network to diagnose subtypes of breast cancer based on the value of the tumor marker.

Results

The result demonstrates the ANN model for k-fold cross validation including accuracy of 95.77%. The average sensitivity and specificity were 0.958 and 0.955 respectively. The average AUC was 0.985.

Conclusion

The proposed model can classify breast cancer subtypes. Following the clinical implementation of the proposed model, the PET/CT may be upgraded to diagnose breast cancer classification using the appropriate tumor maker value.

PART 2:

Health Physics

INVESTIGATION OF MEDICAL DIAGNOSTIC X-RAY SHIELDING BY PPLYMER COMPOSITE

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Introduction

Radiation shields protect patients and workers from unintentional exposure. The properties of shielding materials depend on the type and energy of radiation. Nowadays, researchers are studying various polymers for radiation protection.

Purpose

Studying the shielding properties of polymer composites against the diagnostic X- rays emitted with a voltage range (80-135) kV.

Materials and Methods

The composite samples were prepared with different thicknesses from Epoxy Resin EUXIT 50, polyurethane EUXIT TG10, Polyurethane EUXIT 101 and Lead of a ratio (40, 50, 60 ,70) %wt for different sizes lead particles (Nano, powder and shot/ball). Samples were characterized according to the blend code, lead weight percentage and size as (N-Y, P-Y, K-Y, H-Y, Z-Y, F-Y, and D-Y). Shielding properties of samples have been determined using narrow beam transmission method. The exposure was set at 10 mA in 0.1 sec, and the X-ray beam was collimated relative to the center of detector as (3x3) cm according to samples' size. The exposure to the primary and transmitted X-ray beams were measured with and without the samples. Lightness of each sample was evaluated in comparison to lead heaviness which is considered as a standard.

Results

The average attenuation for the lead composite was (90.25% to 99.17%). The (P-Y) composite of the thickness 10mm, and 70% lead powder showed the most effective shielding for the voltage range (80 to 135) kV, very low transmission with attenuation percent of (99.17%, r=0.95). A higher X-ray transmission was with the (P-B) composite which was loaded by 70% lead powder, where the average attenuation percentage was (98.3%, r= 0.9856). The excellent attenuation (99.15% , r=0.90453) was with (H-G) composite (4mm thickness,70% Nano lead particles), it had a density effect of 3.105 g/cm^3. The lightest composite was (F-Y) of 40% lead particles.

Conclusion

Polymer composite is preference attenuation than pure polymer blend.

EFFECTS OF PORE-FORMING PEPTIDES (MELITTIN AND MAGAININ 2) ON THE PHOSPHOLIPID BILAYER INTERIOR

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Introduction

In this research, we investigated the interaction of melittin and magainin 2 with three models of cell membranes: 80% POPC 20% POPG, 40%POPC 40% POPE and 20% POPG, and 80%POPC 20%POPG plus 30% mole fraction of cholesterol. Time-resolved fluorescence anisotropy of 1,6-diphenyl-1,3,5-hexatriene (DPH) was employed to investigate the dynamics and acyl chain ensemble order in the core of the membrane bilayers. The results of anisotropy decay provide information about the orientational order and motion of DPH. These physical parameters information of DPH provide an accurate picture of the ensemble of acyl chains throughout the depth of the phospholipid bilayer interior which is not well known from previous studies.

Purpose

The objective of this research is to study the effect of headgroup and the interior bilayer composition on peptides-lipid bilayer interactions.

Materials and Methods

Samples for all fluorescence measurements were prepared at a concentration of 150 µM phospholipid. Samples were prepared in 1.5 ml quartz spectrophotometer cuvettes with magnetic stir bars. For samples containing 0.5 µM of DPH stock solution was added to each cuvette to yield a final DPH to phospholipid molar ratio of 1:300.

Results

Melittin more active than Mag2 with respect to disrupting the bilayer in the range of the peptide to lipids studied in this research. Melittin has about twice the number of cationic residues as Mag2, therefore the electrostatic interaction between the cationic residues of peptides and zwitterionic lipid bilayers is stronger in the case of melittin.

Conclusion

The effects were found to vary widely across the two peptides examined and the three bilayer compositions. The cholesterol in the bilayer hydrophobic core has measurable and distinct effects on the ways peptides alter processes generally associated with the bilayer headgroup region. However, the addition of PE to the bilayer headgroup has distinct effects on the ability of peptides to alter aspects of the bilayer interior such as ensemble acyl chain order.

BIOLOGICAL DOSIMETRY RETROSPECTIVELY IN SCENARIOS OF OVER-EXPOSURE TO IONIZING RADIATION OCCUPATIONALLY/ACCIDENTALLY

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Introduction

Biological and physical dosimetry are recognised as key techniques to provide individual estimates of dose following unplanned exposures to ionizing radiation. Biological dosimetry directs and offers assessment provision for screening (scenarios of mass casualties), therapeutic management, and long-term risk assessment. Consequently, it is being considered as an essential parameter for the radiation -protection and -emergency programs. The radiation-induced changes in human lymphocytes can be studied using different cytogenetic assays. Among these translocations as stable type aberrations have shown the potential to be applied for assessing the dose retrospectively. This presentation summarises the existing data on estimating the dose on different cohorts exposed to ionizing radiation accidentally/occupationally.

Purpose

To apply Fluorescence in situ hybridization (FISH)-based translocation assay to detect translocations in different cohorts exposed in the past to radiation of different qualities. This is of a great importance to improve the quality of life based on risk assessment.

Materials and Methods

Multi-colour FISH for different chromosomes and a pancentromeric probe were applied to detect translocations for assessing the dose retrospectively at several scenarios of exposure (occupationally/accidentally) to ionizing radiation (such as gamma-rays, X-rays, 89Sr, 90Sr and 239Pu), at different intervals in different cohorts such as, Goiania- Gomel-, Techa river-, Mayakand Fukushima- populations.

Results

Calibration data based on exposing human lymphocytes (in vitro) to X- or gamma-rays were generated and used for determining the dose. It was also found that translocation frequency is increasing with age. In all cohorts under these studies, it is found that the FISH translocation assay can be usefully applied for detecting internal and combined external radiation and internal doses albeit with fairly large uncertainties.

Conclusion

For retrospective dosimetry, FISH-based translocation assay is the most reliable biological assay that can be applied. However, it became also evident that more studies are needed in order to elucidate the influence of several factors, such as the dose, interindividual sensitivity, chronic and acute exposure as well as whole- and partial- body exposure on the stability of translocations.

COMPARISON OF INSTITUTIONAL DIAGNOSTIC REFERENCE LEVELS FOR CERVICAL SPINE X-RAY EXAMINATIONS IN ADULT PATIENTS IN SRI LANKA

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Introduction

Cervical spine X-rays are routinely performed to diagnose spinal complaints, tumors, fractures, and degenerative pathologies. These examinations are well known to utilize varying radiation doses for patients. To improve patient protection, it is imperative to optimize radiation doses in cervical spine X-ray examinations by implementing Diagnostic Reference Levels (DRLs).

Purpose

To compare institutional DRLs (IDRLs) in adult patients referred for cervical spine anteroposterior (AP) and lateral (LAT) X-ray examinations in five public hospitals in Sri Lanka.

Materials and Methods

The hospitals selected for this study were labeled as I, II, III, IV, and V. Data on patient demographics (age, sex, weight, and BMI), exposure parameters (kVp and mAs), and kerma-area product (KAP) measurements were collected from 275 adult patients (58±20 kg). The normality of the KAP distributions was assessed using the Shapiro-Wilk test ($p<0.05$).

Results

The median values of the KAP distributions for each hospital were proposed as the IDRLs. The mean BMI in $kg.m^{-2}$ of patients was comparable between hospitals, ranging from 22.9 to 24.8 for cervical spine AP and 23.1 to 25.1 for LAT examinations. The IDRLs of hospitals I, II, III, IV, and V were 0.44, 0.21, 0.26, 0.24, and 0.22 $Gy.cm^2$ for cervical spine AP and 0.35, 0.32, 0.21, 0.16, and 0.31 $Gy.cm^2$ for LAT examinations, respectively. The highest IDRLs for cervical spine AP and LAT examinations were reported in hospital I due to high mAs values. The median kVp used for cervical spine AP examinations ranged from 60 (hospital III) to 70 (hospital IV), while for LAT examinations, it ranged from 64 (hospital III) to 70 (hospital I, IV). The median mAs for cervical spine AP examinations varied from 12.5 (hospital II) to 18.0 (hospitals I, III, V), while for LAT examinations, it varied from 14.0 (hospital II) to 20.0 (hospitals I, III, V).

Conclusion

The IDRLs reported in this study can serve as a baseline for establishing national DRLs for cervical spine X-ray examinations in Sri Lanka. Owing to the large variations observed in KAP values and exposure parameters, this study recommends reviewing current practices, including the selection of exposure parameters and collimation.

MONTE CARLO SIMULATION OF ORGAN DOSES AND RELATED RISK FOR CANCER IN ALGERIA FROM SECONDARY RADIATION IN PROSTATE TREATMENT INVOLVING 3D-CRT

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Purpose

The present study aimed to evaluate organ doses and related risk for cancer from secondary radiation involving 3D Conformational Radiotherapy (3D-CRT) for patients with prostate cancer in Algeria base

Materials and Methods

A detailed geometric Monte Carlo (MC) modeling of the LINAC benchmarked against experimentally measured depth dose data, combined with a hybrid whole-body phantom XCAT phantom was carried out. The secondary radiation doses were calculated out of field of patient's organs. The obtained doses were used to estimate the Lifetime Attributable Risks (LARs) for cancer incidence out of field organs. LARs was evaluated assuming Biological Effects of Ionizing Radiation VII (BEIR VII) risk model for exposure age in the range 35-70 years, according to the interval's age of treated patients in Algeria. The baselines cancer risks and survival data were associated with the statistical data for the Algerian population.

Results

The results showed that secondary radiation equivalent doses per prescribed dose (Photon Dose) mostly depend on the distance of organs from the treated volume. The highest and lowest equivalent doses of 5.77 mSv/Gy and 0.24 mSv/Gy were recorded in the small intestine and ocular lens, respectively. The highest estimated lifetime attributable risk per 100,000 populations was found for 35 yrs' exposure age in colon 19.66, intestine 15.14 and lung 13.60. The lowest risks were found for 70 yrs' age, in spine 0.06 and thyroid 0.14. The results showed that LARs values decrease with the increase of the exposure age and cancer incidence risk is lower than the baseline cancer risk incidence for all organs.

Conclusion

The present study may help in providing a database on the impact of radiotherapy-induced secondary cancer incidence during 3D-CRT for prostate cancer in Algeria and other developing countries.

DISTRIBUTION OF OCCUPATIONAL DOSES AMONG NUCLEAR MEDICINE PROFESSIONALS IN OMAN

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Introduction

The introduction of hybrid imaging systems and new radionuclide therapies has led to increase of radiation doses both to patients and radiology healthcare professionals. Several studies have reported significant increase in radiation doses to nuclear medicine professionals due to day-to-day handling of radiopharmaceuticals used for diagnosis and treatments.

Purpose

The aim of this study was to investigate the distribution of occupational radiation doses for nuclear medicine radiation workers at Sultan Qaboos University Hospital (SQUH).

Materials and Methods

Dose records (whole body Hp(10), and extremities Hp(0.07)) from 19 radiation workers were collected from the local dosimetry service over period of 7 years (2015-2021). Four staff categories (technologists, medical physicists, NM physicians, and nurses) were considered. Doses were measured using calibrated thermo-luminescence dosimeters (TLD-100 (LiF:Mg,Ti)). Two Thermo Scientific Harshaw TLD Automated Readers (Model 6600 and Model 6000 Plus) were used with a computer program (WinRems) and a personalized dose management software (Dosibase; Sia Enterprise) to measure the TLD readings. The minimum, maximum, and average cumulative doses were estimated and compared with the annual whole body and extremities dose limits (20 mSv and 500 mSv per year, respectively) and the local dose investigation level (6 mSv per year).

Results

Personal whole body Hp(10) doses are given as (minimum:maximum:average) for technologists, medical physicists, NM physicians, and nurses, and found to be 0.3:7.8:1.8, 0.3:0.4:0.3, 0.1:0.2:0.1, and 0.1:0.2:0.1 mSv, respectively. For the three occupational categories (technologists, medical physicists, and NM physicians) personal doses measured using fingers ring dosimeters Hp(0.07) for the left and right hands [Right-hand min-dose, Right-hand max-dose, Right-hand average-dose; Left-hand min-dose, Left-hand max-dose, Left-hand average-dose] were [1.4, 17.5, 7.7; 1.4, 18.1, 8.7] for technologists, [2.5, 3.0, 2.7; 2.0, 2.3, 2.1] for medical physicists, and [1.7, 3.7, 2.4; 1.2, 3.8, 2.3] for nurses.

Conclusion

Personal radiation doses distribution for whole body and extremity doses were well below the ICRP recommended limits and dose investigation level, at the exception of technologists. Technologists recorded the highest occupational dose followed by medical physicists, nurses, whilst NM physicians showed the lowest dose. This study suggests lowering dose investigation level for all professional categories except for technologists.

RADIATION AWARENESS AMONGST RADIATION WORKERS WORKING IN DIAGNOSTIC RADIOLOGY OF A PUBLIC SECTOR HOSPITAL IN KHYBERPAKHTUNKHA

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Introduction

As radiation workers are working in close proximity with ionizing radiations, so they prone to the detrimental effect of radiations. In order to ensure their and patient safety, they should be well trained in their field of work through frequent training sessions and awareness sessions to groom their skills regarding radiation safety. This will not only boost their skills but also will a sense of responsibility towards radiation protection.

Purpose

To determine the level of improvement amongst radiation workers regarding knowledge of ionizing radiations and principles of radiation protection while performing routine diagnostic procedures after attending a dedicated refresher course of one month on radiation awareness and protection.

Materials and Methods

Forty-six (46) radiation workers (38 males and 08 female) out a total sixty radiation workers participated in this refresher course and filled the pre and post performa comprising twenty questions on basics aspects of ionizing radiations, cellular interaction, biological effects and radiation protection to check their existing knowledge and improvement respectively.

Results

Mean scores of all radiation workers in pre-sessions assessment was 39.35% which improved to 61.95% after attending the dedicated course designed with a mean difference of 22.6% ($p< 0.0000001$). The female radiation worker's awareness level improved a bit high (pre: 36.25%, post: 59.38%) than male workers (pre: 40.0%, post: 62.5%). The workers having inter and higher qualification did better (pre: 38.42%, post: 61.45%) than the ones who have only metric (pre: 43.75%, post: 64.38%) and workers having relevant diploma in radiology scored (pre: 42.86%, post: 65.48%) than the workers who haven't got diploma (pre: 37.0%, post: 59.0%).

Conclusion

The knowledge about basics of ionizing radiations and protection of both staff & patients before the sessions was not satisfactory as it should be. An improvement was found amongst the radiation workers about their knowledge and understanding after attending the dedicated course on radiation awareness designed according to their needs and it can be achieved through concurrent efforts and streamlined coordination between licensee and regulatory body.

INVESTIGATION INTO DISTRIBUTION OF PATIENT DOSES IN SPECT/CT AND PET/CT SCANS IN OMAN

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Introduction

Optimization of radiation exposures of patients and healthcare workers is a one of the pilar of radiation protection. The assessment of the distribution and radiation doses delivered to patients and the establishment of Diagnostic Reference Levels (DRLs) is an effective way towards optimizing exposures.

Purpose

The purpose of this study was to estimate patient dose distributions and DRLs for the most frequent SPECT/CT and PET/CT imaging examinations performed at our institution.

Materials and Methods

Radiation doses from 961 adults patients who have undergone SPECT/CT and PET/CT imaging examinations over a period of 4 years (2018 – 2021), were included. Patients' scans consisted of: 227 whole body PET/CT scans, 130 brain PET/CT scans, 44 cardiac PET/CT scans, 160 SPECT/CT bonestatic, 300 myocardial perfusion imaging SPECT/CT, 118 thyroid post-ablation scans, 81 thyroid uptake scans and 69 parathyroid SPECT/CT scans. The low-dose CT dosimetry data (CT dose index (CTDIvol), dose length product (DLP)) and radiopharmaceutical activity, were collected. The minimum, maximum and third quartile were calculated for CTDIvol (mGy), DLP (mGy.cm) and administrated activity for each examination category. The effective doses (mSv) of all examinations were also estimated.

Results

The estimated DRLs are given as follows (third quartile CTDIvol (mGy), minimum:maximum:third quartile DLP (mGy.cm), minimum:maximum:third quartile administrative activity (MBq)): whole body PET/CT: 2.37, 52.6:499:219.5, 177:452:298; brain PET/CT: 12.86, 301.7:301.7:301.7 (same doses for all patients), 128:392:270; cardiac PET/CT: 1.79, 17.2:68.3:42.5, 206:600:383; bone SPECT/CT: 3.18, 54:225:135.3, 500:989:814; MPI SPECT/CT (stress-rest): 1.8, 28:90:60, 602:987:821-1.8, 28:104:60, 365:901:809; parathyroid SPECT/CT: 3.52, 56:200:140, 180:968:815; thyroid uptake (with I-131) SPECT/CT: 4.36, 81:268:189.5, 100:266:207; thyroid post-ablation 4.7, 63:256:190. The estimated total ED (mSv) (male:female) was: 7.5:7.8, 7.9:7.9, 6.9:7.2 , 5.2:5.2, 7.4:7.8-7.3:7.7, 7.6:7.9, 4555:4555, 1.5:1.9 for whole body PET/CT, Cardiac PET/CT, Brain PET/CT, bone SPECT/CT, MPI SPECT/CT (stress-rest), parathyroid SPECT/CT, thyroid-uptake (with I-131) SPECT/CT, and thyroid post ablation SPECT/CT, respectively.

Conclusion

The estimated patients' doses distribution and established local DRLs are comparable to published DRLs. The derived DRLs has facilitated monitoring of doses and will result in reduction of patients' doses distribution.

DISTRIBUTION OF PATIENTS' DOSES IN COMPUTED TOMOGRAPHY IMAGING AT THE TWO LARGEST HOSPITALS IN OMAN

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Introduction

Computed Tomography (CT) is currently considered as the workhorse in diagnostic radiology. However, it delivers high radiation dose to patients compared to other imaging modalities.

Purpose

The aim of this study was to investigate the distribution of patients' radiation doses in the most frequent CT imaging examinations and estimate Diagnostic Reference Levels (DRLs) and effective doses in each examination category in order to monitor and have better control of radiation doses delivered to patients.

Materials and Methods

The study included the seven most frequent CT examinations that are performed over a period of 12 months. This included, CT Head, CT Chest, CT Chest High Resolution, CT Abdomen Pelvis, CT Chest Abdomen Pelvis, CT kidneys Ureters Bladder and CT Cardiac. Patients' scans were performed either on the Siemens Sensation 64 slice or Dual CT SOMATOM Force 256 slice. CT dosimetric quantities (DLP, exposure settings (kVp and mAs)) and patient demographics (age, gender and weight) were collected from the PACS/RIS radiology systems. The minimum and maximum and 3rd quartile doses were calculated for DLP (mGy.cm). The Effective doses (in mSv) were also estimated.

Results

The dose distributions and DRLs are given as follows (minimum:maximum (mGy), third quartile DLP (mGy.cm)): CT Head: 357:986 715; CT Chest: 19:1212, 570; CT Chest High Resolution: 19:807, 313; CT Abdomen Pelvis: 76:1539, 708; CT Chest Abdomen Pelvis: 331:2412, 1134; CT Kidneys Ureters Bladder: 75: 1040, 473; and CT Cardiac: 2.8:123, 39. The estimated effective doses for CT Head, Chest, Chest High Resolution, Abdomen Pelvis, Chest Abdomen Pelvis, Kidneys Ureters Bladder and Cardiac were 1.4, 6.1, 3.2, 9.4, 12.8, 4.8, and 0.5 mSv, respectively. The estimated local DRLs are lower than UK DRLs for CT Head, CT Abdomen Pelvis, CT Chest Abdomen Pelvis and CT Kidneys Ureters Bladder while CT Chest and CT Chest High Resolution have higher values.

Conclusion

The findings of our study show that the estimated patients' doses distributions and estimated local DRLs are comparable to published DRLs. The established local DRLs for the most frequent CT examinations will act as guidance doses and trigger investigations to prevent systematic excess of patient doses.

SEMICONDUCTOR LASER INHABIT CANCER CELLS

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Introduction

The biological responses of cells to visible and near infrared IR laser radiation, occur due to physical and/or chemical changes in photo acceptor molecules, component of respiratory chains in mitochondria.

Purpose

To evaluate the effect of low level laser therapy (LLLT) on increasing the response of immune system by stimulating the lymph nodules action in case of diseased mice in order to inhabit cancer cells activity which leads to decrease the tumor size without using drugs by using different duration times on the same area in each irradiation with the same power densities.

Material and method

Thirty mice were randomly assigned to two groups A, B each of fifteen mice, female, 60 days age, 100gm main weight subjects transplanted with mammary gland carcinoma in the Iraqi center of Cancer Research and Medical Genetic.

Results

The reason behind using wave length of 905nm was that it is suitable for stimulating the mitochondria (the energy source of the cells) in order to stimulate the immune cells activity t-cell and macrophage to attack the cancer cells, this was first step, the other step was to release energy from the cell that come out from the mitochondria (ATP) this energy stimulate the cell to release heat according to the law of energy of conservation that states that the outcome energy must equal the inters one, which is the main cause of cancer cells killing.

Conclusion

The increasing of the immune response resulting in the decreasing or limiting the size of the tumor that measured before and after laser irradiation. The results of this study suggest that soft laser therapy has a significant role in promoting faster healing, particularly in the early stages of cancer at multiple sites, and in stimulating the immune system to damage or limit the growth of tumors by activating immune blast cells discovered in lymph nodes near the cancer sites.

STATUS OF RADIATION SAFETY TRAINING IN HAMAD MEDICAL CORPORATION

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Introduction

The radiation safety program at HMC (SA1066), Article 3.4 “Education and training requirements for radiation workers” states that radiation workers shall follow the HMC accredited radiation protection training course. This training course is beneficial not only for renewing the participant’s personal radiation license but also to use the accredited CPD points to renew their professional medical license.

Purpose

To provide information about status of radiation safety training in HMC, Qatar.

Materials and Methods

Radiation safety training in Hamad Medical Corporation(HMC) started on 2002 and has been developed from small lecture into full training program in addition to training for different speciality. Data were collected from 2019 up to 1st quarter of 2023, the total number of participants were 2541. Attendees were of different disciplines which includes Radiology and Non Radiology Doctors, medical physicist, technologists, technicians, nurses, therapist including dental and admin staff. Department of Healthcare Professions (DHP) has standard form, this form includes many requirements to get the accreditation approval such as educational standards (need assessment, learning objectives and interactivity and evaluation), and ethical standards.

Results

The total number of participants was decreased by almost 83 % from year of 2019 up to year 2021 due to the Covid 19 outbreak and restrictions on face-to-face trainings. The number of participants were increased by almost 41 % from 196 in the year of 2021 to 477 in 2022 due to that the situation was improved due to COVID-19 pandemic.

MPS-OHS in partnership with the HMC Corporate Communications Web Team, launched an online Certification and Verification System for all the training courses given by MPS-OHS and this includes the Radiation Safety Training. The participants can download their certificates after they completed the training. Early 2023, the certificates will be verified of its authenticity through verification site by scanning the QR code embedded on each certificate. This will help on the approval process of the Ministry of Environment (MoE); which is the regulatory body of personal radiation license application.

Conclusion

Radiation protection courses should includes specific session for other health professionals such as, referring doctors, administrators, and managers within HMC.

LASER SAFETY MANAGEMENT AT HAMAD MEDICAL CORPORATION - QATAR RISKS, CONTROL MEASURES, AND REGULATIONS

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Introduction

Medical lasers are used for numerous applications: in surgery, dermatology, for promoting wound healing and many others. Despite the important role that laser plays in the medical field, lasers can pose a risk to both the user and the patient due to the large and intense energy laser rays carry, that may cause damage to the eyes and burns to the skin in addition to the risk of fires when directed at flammable materials. This makes it necessary to implement protection measures in accordance with international standards. Hamad Medical Corporation (HMC) is one of the largest medical institutions in the world in terms of the use of lasers in different medical specialties, with fifteen hospitals and more than hundred high-power laser devices, including dermatology, urology, ophthalmology, physiotherapy, and surgery.

Purpose

This work presents the development of the laser safety management at HMC in the last few years, starting from establishing laser safety program to implementing control procedures, namely administrative and engineering controls, and ending with conducting a risk assessment as well as an annual audit.

Materials and Methods

A comprehensive laser safety program is established in line with the Joint Commission International (JCI) requirements and based on the American National Standards Institute (ANSI), British Medicines and Healthcare products Regulatory Agency (MHRA).

Results

Laser risk assessment for 98 machines in 11 hospitals have been conducted (80 high power lasers - class 4, 14 medium power lasers - class 3B, and 4 intense pulsed light - IPL machines). This included assessment of the risk associated with the equipment safety, environment, personal protection equipment, administrative arrangements, and training. In addition, 5 laser safety training courses were organized during which 301 workers were trained (68% in 2021-22 and 38% in 2023).

Conclusion

To fully characterize laser related risks, risk assessment must be done regularly to quantify the risks in order to protect patients and users from the harmful effects of the medical lasers.

SYNCHRONOUS FLUORESCENCE SPECTROSCOPY FOR DIAGNOSIS OF ORAL SUBMUCOUS FIBROSIS

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Introduction

Most of the invasive oral cancers arise from pre-cancerous lesions such as leukoplakia, erythroplakia, and Oral Submucous Fibrosis (OSF). The conventional clinical OSF diagnostic methods, namely, maximum mouth opening (MMO), tongue protrusion (TP) and quantitative evaluation of burning sensation, are quite indirect and do not provide information about the histological condition of the oral mucosa. Among various fluorescence spectroscopic techniques, Synchronous Fluorescence Spectroscopy (SFS), also referred as stokes shift spectroscopy (SSS) technique provides highly resolved spectra of the endogenous fluorophores even in complex systems.

Purpose

Synchronous Fluorescence Spectroscopy (SFS) was studied for diagnosis of Oral Submucous Fibrosis (OSF).

Materials and Methods

20 patients having a premalignant lesion condition of Oral Submucous Fibrosis (OSF) from the Tamilnadu Government Dental College and Meenakshi Ammal Dental College in Chennai, India, were included in this study. The in vivo SF spectra were recorded using a Fluoromax-2 (ISA Jobin Yvon-Spex, Edison, New Jersey) spectrofluorometer coupled with optical fiber.

Results

The average SF spectrum of normal subjects shows three major peaks around 300, 350 and 397 nm which attributed to tryptophan, collagen and NADH respectively. Still the exact biochemical and structural changes responsible for altered spectral signatures at different sites in the oral cavity as well as under different tissue transformation conditions, especially under different premalignant conditions are not known. However, it is reported that the structural protein, collagen, and the coenzymes NADH and FAD are responsible for altered fluorescence when normal tissues are transformed into neoplastic. The increase in fluorescence of tryptophan from OSF cases compared with that of normal may be attributed to this HSP. It is further reported that emission due to NADH from cancerous oral tissues is higher than that of collagen, and vice versa for normal.

Conclusion

The results demonstrate that spectral changes due to tryptophan, collagen and NADH. Statistical analysis reveals that normal subjects are discriminated from OSF with 100% sensitivity and 95% specificity. Further, more studies of different oral pathological conditions are needed to optimize the parameters for SFS before using it as a real- time in vivo clinical diagnosis of cancer.