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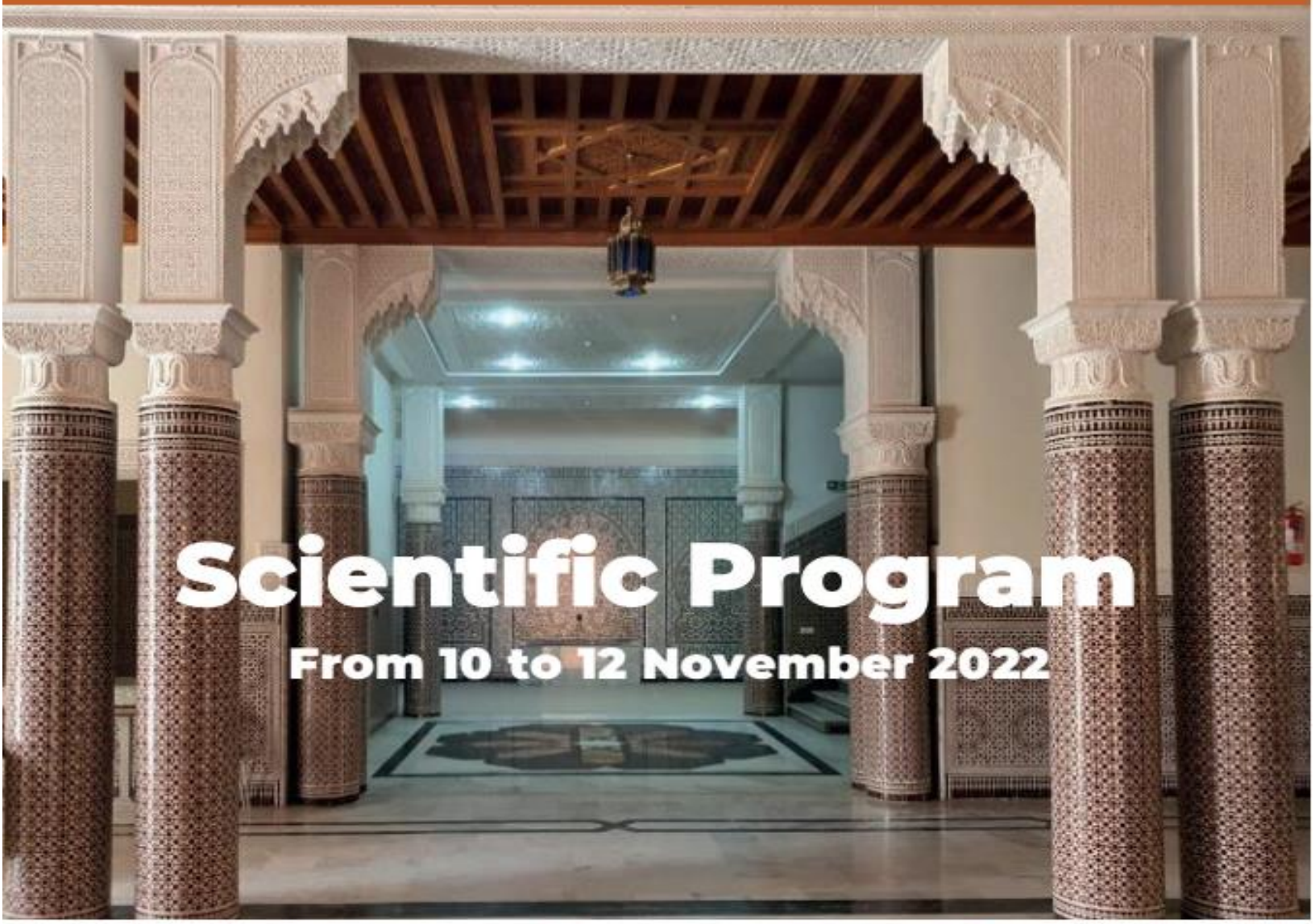
The 1st Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)

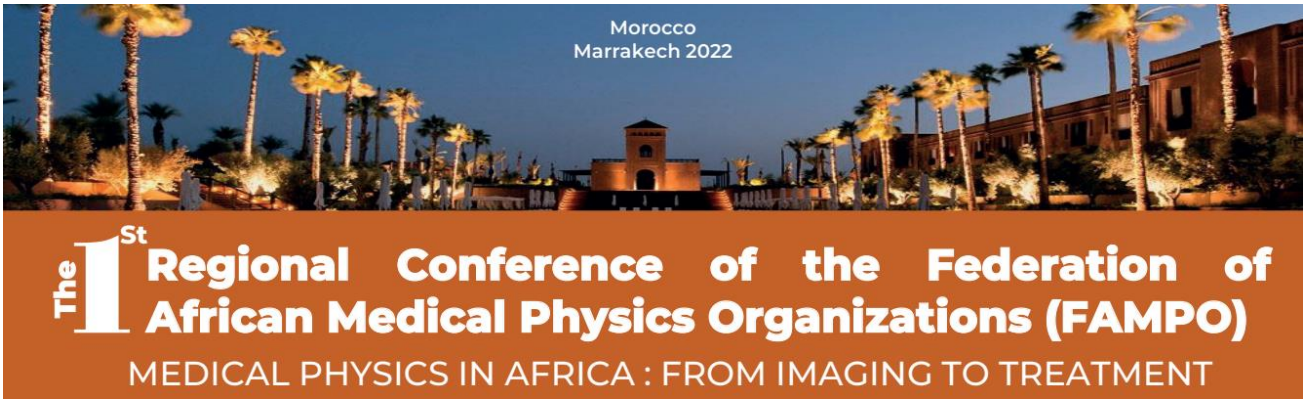
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT



Scientific Program

From 10 to 12 November 2022

His Majesty King **MOHAMMED VI**



The Behaviour of Contamination Particles in 18 MV Beam Breast Treatment

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Abstract

Radiation therapy is one of the most widely used methods of treating solid tumours. The medical accelerators used in radiation therapy have a variable energy beam depending on the depth and position of the tumour. The use of high-energy beams such as 18 MV is usually accompanied by contamination particles, which are not taken into account in treatment planning systems (TPS). This study demonstrates by Monte Carlo simulations the behaviour of contamination particles during the treatment of the left breast. The simulations are based on the transport of contamination particles from the MIRD phantom modelled by the G4Linac_MT code.

Keywords:
MIRD phantom; Monte Carlo simulation; contamination particle; tumour; transport

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Photon Specific Absorbed Fraction Estimation from Internal Irradiation in MIRD Stylized Phantom using DoseCalcs Newly Developed Code

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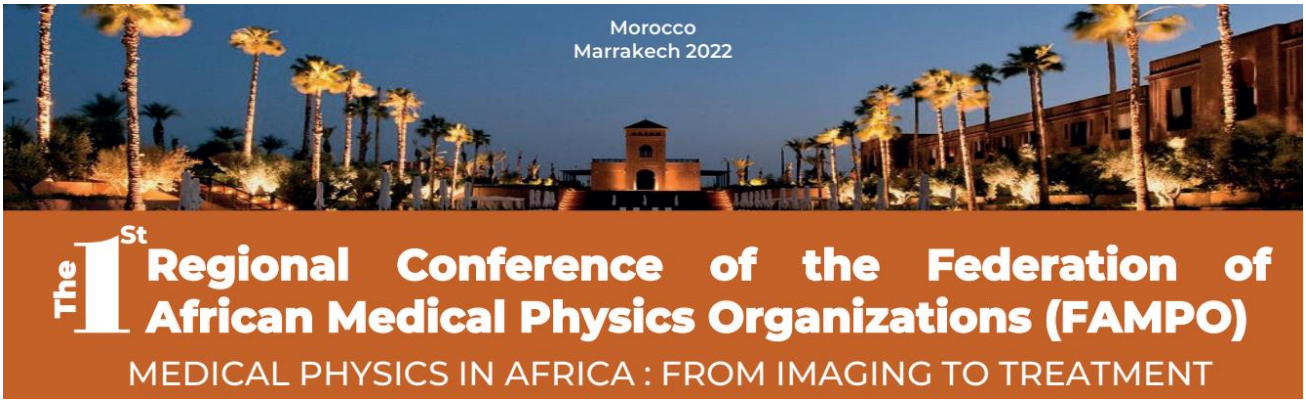
Abstract

The injection of a radiotracer inside a patient's body makes the body of the patient to emit radiation, which could cause biological damage to the patient. It is mandatory to properly estimate the internal radiation dose in order to balance the benefits with the radiological risks associated with the procedure. Free and commercial softwares are available for the estimation of internal radiation dosimetry quantities, such as Absorbed Dose (AD), S value (S), Absorbed Fraction (AF), and Specific Absorbed Fraction (SAF). The use of C++, GDML, TEXT and STL methods for geometry inputs and taking advantage of distributed memory techniques for simulation speedup, is not supported by most of these tools. For these reasons, we developed an open-source Geant4-based code called DoseCalcs to assess the performance of the present applications. The mathematical MIRD phantom input geometry data was implemented with a combination of C++, GDML, TEXT, and STL methods. The organ composition was taken from MIRD reference. Eight discrete monoenergetic photons having energies ranging from 0.01 to 2 MV were considered. In our model, the organs simulated as sources of radiation were the liver, kidney, and adrenal. The comparison between the DoseCalcs obtained SAF values has shown good agreement with MIRD Pamphlet No. 5, which means that DoseCalcs can be used as a powerful tool to well-estimate the involved internal dosimetry quantities.

Keywords:
DoseCalcs, Nuclear Medicine, Monte Carlo, internal dosimetry, Geant4, computational phantom, GDML, STL.



Machine-Generated Radiation Dose Assessment for Common Computed Tomography Examination at the Komfo Anokye Teaching Hospital, Kumasi, Ghana.

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Abstract

The aim of this study was to assess the radiation dose imparted to patients during common computed tomography (CT) examinations with the newly installed 128 slice Siemens CT scanner at the Komfo Anokye Teaching Hospital, Kumasi, Ghana. A quantitative-retrospective study design approach with a purposive sampling technique was used to sample the computed tomography dose data of patients pertinent to the study. Data such as patient demographics, volume CT dose index ($CTDI_{vol}$), dose length product (DLP), pitch and effective dose (ED) were collected from the CT scan control console. A total of 380 computed tomography dose data of the head, chest and abdominal region were retrieved from the CT console area. Out of this number, males were 221 (58.2%) and females were 159 (41.8%). The mean and the standard deviation (SD) of the ages of the patients were 43.49±20.94 years, ranged (1 – 100) years. The mean and standard deviation for $CTDI_{vol}$, DLP and ED for male and female head CT examinations were 28.70 ± 5.00 mGy, 630.33 ± 148.94 mGy.cm,1.45 ± 0.34 mSv and 26.72 ± 6.12 mGy, 542.34 ± 146.33 mGy.cm, 1.25 ± 0.34 mSv respectively. The mean and standard deviation for $CTDI_{vol}$, DLP and ED for male and female chest CT examinations were 4.78 ± 1.35 mGy, 200.45 ± 70.62 mGy.cm, 3.41 ± 1.20 mSv and 6.22 ± 3.53 mGy, 227.12 ± 109.45 mGy, 3.86 ± 1.86 mSv respectively. Again the mean and standard deviation for $CTDI_{vol}$, DLP and ED for male and female abdomen CT examinations were 5.07 ± 1.93 mGy, 244.10 ± 97.42 mGy.cm,3.66 ± 1.46 mSv and 7.39 ± 2.82 mGy, 353.18 ± 137.58 mGy.cm, 5.30 ± 2.06 mSv respectively. The machine generated CT doses that were recorded for the study were within the ICRP recommended dose reference levels and that of other countries suggesting dose optimization.

Keywords:
Computed tomography, paediatric and adult patients, Diagnostic Reference Levels, machine-generated dose, radiation dose.

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

^{23}Na -MRI as a Biomarker for Lung Cancer Diagnosis

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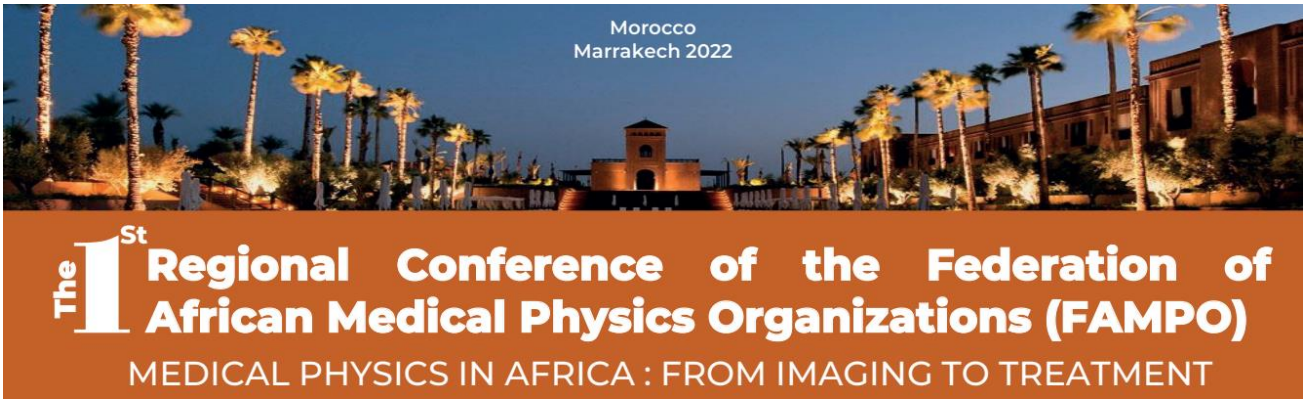
Abstract

The function and expression of the voltage-gated sodium channels (VGSCs) are regulated by the epidermal growth factors (EGF) through phosphoinositide-3-kinase (PI3K) or extracellular signal-regulated protein kinase (ERK1/2) pathways leading to changes in the tissue sodium concentration (TSC), intracellular sodium concentration (ISC) and the extracellular volume fraction (EVF) that promotes cancer metastasis. Sodium (^{23}Na)-MRI offers a unique opportunity to visualize these changes in the sodium biochemical parameters (TSC, ISC, EVF) that reflect cell viability, structural integrity, energy metabolism, and rapid treatment response before morphological changes occur. Here we evaluated the feasibility of non-invasively monitoring the epidermal growth factor receptor (EGFR) mutated non-small cell lung cancer (NSCLC) progression using a combination of ^{23}Na- and diffusion-weighted (DW)-MRI. A 3D radial projection ultra-short echo (UTE) sequence with and without triple quantum filters (TQF) was optimized for ^{23}Na-MR imaging of ISC and TSC. The ^{23}Na signal to concentration conversion was performed with the calibration equations obtained from the linear fitting of the signal intensities and their corresponding known sodium concentrations of the calibration phantoms. A longitudinal ^{23}Na- and DW-MRI studies without intervention were undertaken serially every 2-3 days on mice xenograft NSCLC tumour models with EGFR double mutation T790M/L858R (H1975), EGFR exon 19 del, E746 – A750, (HCC827), and EGFR wild-type (H460) for 21 days. ^{23}Na-, ^{1}H-, and DW- MR images were acquired every day for the first week of therapy and then periodically until sacrifice. The TQF preparation time for maximization of the acquired TQF signal was obtained to be $\tau\_opt = 9.8$ ms. The non-interventional ^{23}Na-MRI studies revealed an overall elevation of the sodium biochemical parameters in the untreated H1975 and H460 tumours at baseline which continued to increase with malignant tumour progression. However, the sodium levels detected in the HCC827 tumour model were similar to that of normal tissues. TSC and ISC levels were observed to be high in H1975, moderate in H460, and low in HCC827. This indicates that T790M mutation in the H1975 (L858R/T790M) xenograft tumours not only confers resistance but also grants a proliferative advantage over HCC827 and H460 tumour types. Hence, the sodium parameters can serve as biomarkers for screening of EGFR T790M mutation status. Though H1975 had a high ADC at baseline, DW-MRI showed an overall reduced and relatively constant ADC values as the H1975, HCC827 and H460 tumours progressed without intervention. Our results indicated that ^{23}Na imaging together with DW-MRI can provide additional information that could be useful in NSCLC treatment personalization and overall outcome. Hence supports the continued clinical testing of ^{23}Na- and DW- MRI for monitoring of NSCLC and demonstrates its complementary insights to 1H-MRI for oncology applications.

Keywords:

^{23}Na-MRI, Biomarkers, TSC, EGFR, Xenograft Tumour, Lung Cancer



Impact of Ionizing Radiation in a Biological Environment: Monte Carlo Simulation Code

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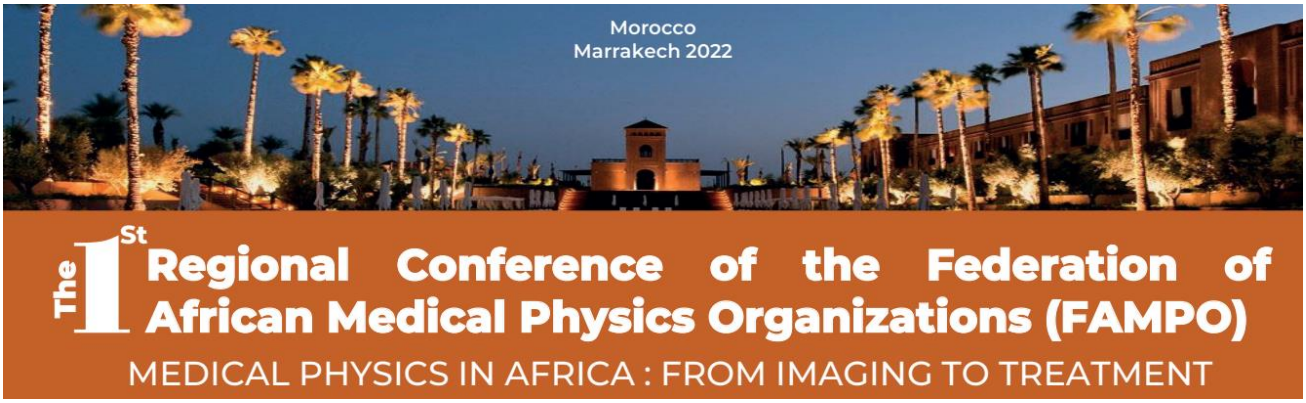
Abstract

The passage of ionizing radiation through matter releases a large number of electrons of various energies depending on the intensity of the incident radiation. The study of transport of ionizing radiation in a biological medium is useful in understanding the mechanisms governing the collision and interpretation of many phenomena. In this study, the effects induced by ionizing radiation on the irradiated medium, such as energy deposits and therefore the dose distribution in a considered medium of interaction were examined using a Monte Carlo program, GEANT4, to simulate the transport of electrons in liquid water, the main constituent of a biological medium. A comparative analysis of our results with the results obtained by other authors on the calculation of the mean free path of an electron in water was made. A good agreement was observed in the comparison.

Keywords:

Dose distribution, GEANT4, electron mean free path.



Dose Metrology: Study of the Performance of the OSL and TLD Dosimetric System

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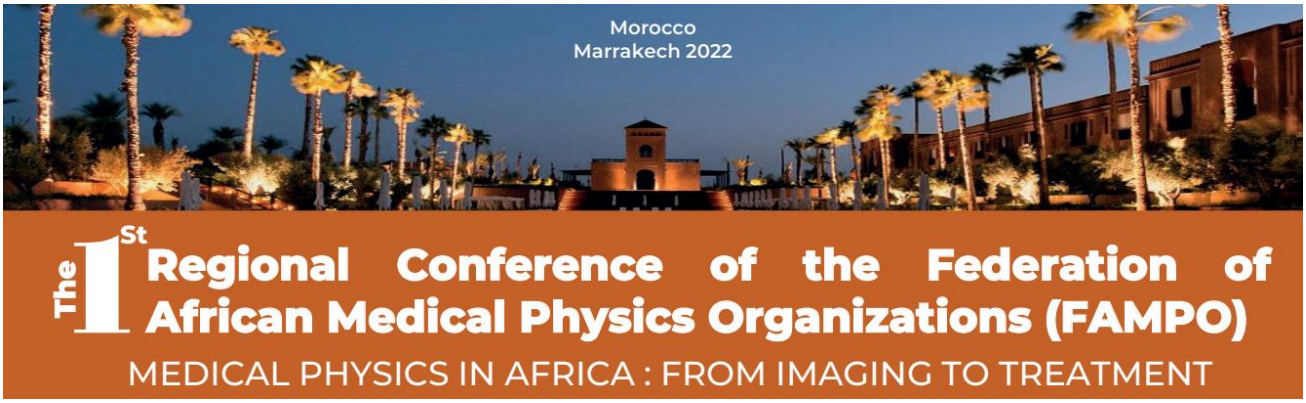
Abstract

Performance evaluation and comparison in terms of measured dose accuracy, energy response, and coefficient of variation between two types of passive radiation dosimeters, thermoluminescent (TLD) and optically stimulated luminescence (OSL), used by radiation workers for individual radiological monitoring and control of external exposure at different times (cumulative dose for 1 month) is very important. It offers the method to determine to judge the quality and identify the dosimetric aspects of TLD/OSL passive dosimeters. This study was set up to determine both the accuracy of the dose measurement R(10) and R(0.07), which is considered as the ratio of the measured dose [Hp(10) or Hp(0.07)] to the delivered dose [Hp(10) or Hp(0.07)] for each photon energy. The validity of the results of this study is based on the acceptance limits of the ICPR and the international standard ISO 62387, the relative energy response which is used to calculate the ratio of measured Hp(10) to delivered Hp(10), and measured Hp(0. 07)/delivered Hp(0.07) normalized to 662 keV (Cs-137) energy to find which energy response is closest to the ideal case, and the coefficient of variation that allows to determine the statistical fluctuation in the doses found. The results obtained for the accuracy test are satisfactory for the OSL and TLD dosimeters as they are within the ICRP limit. The energy response of OSL shows a good performance for Hp(10) and Hp(0. 07) than the TLD, and the coefficient of variation for OSL meets the requirements of the ISO 62387 standard for Hp(10) and Hp(0.07) while the TLD meets the requirements of the same standard only for the measurement of Hp(0.07).

Keywords:
TLD, OSL, radiation protection, Energy dependence, ICPR trumpet graph, Hp(10), Hp(0.07)



The use of LINAC Log File for Patient Specific Quality Assurance in Volumetric Arc Therapy Treatment Plans

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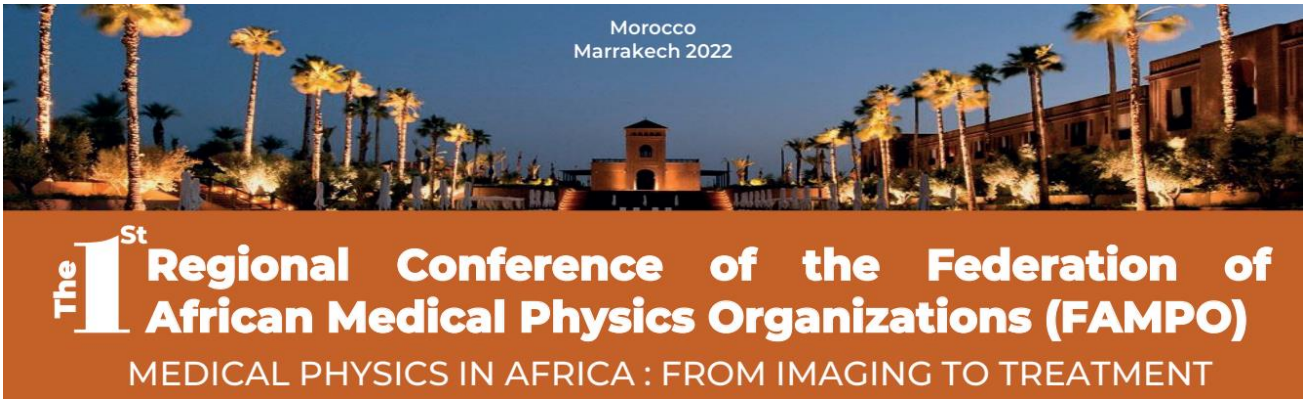
Abstract

Gamma Index analysis is a globally accepted methodology for checking pre-treatment Intensity Modulated Radiation Therapy (IMRT) plans to confirm deliverability of the plans before patients start actual IMRT treatment. Gamma index utilizes the percent dose difference (DD) and distance to agreement (DTA) to evaluate the deliverability of a treatment plan. A number of methods have been described in the literature on how to achieve the gamma index including use of two-dimensional array detector, MV portal dosimeters, films and among others. In this research, the data collected from LINAC treatment console was used to reconstruct DICOM RT files and re-planed the reconstructed DICOM RT files to compare with the original treatment plan that was delivered. The study was conducted Varian Medical Systems (Varian, Pal Alto, California) and some programming languages such as Python to reconstruct the DICOM RT files. A comparison of these results with those of the initial treatment plans will serve as a special in-vivo treatment planning quality assurance. The LINAC log files contain the MLC movements, Gantry movements, instantaneous field sizes and MU delivered at each control point. This information is quite useful for dosimetric quality assurance as it gives the true picture of what was delivered during dynamic volumetric arc treatments.

Keywords:

Deliverability, Treatment planning, in-vivo, Quality assurance, LINAC Log files, volumetric arc treatments



Review of Advances in Nuclear Applications 2019-2022

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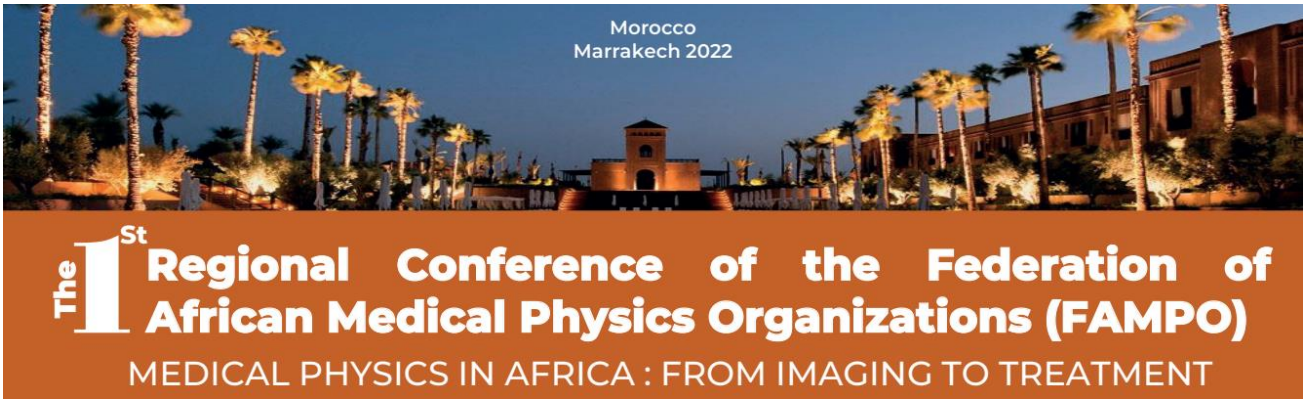
Abstract

The idea that prosperity is linked to health is supported by a prolonged usage of nuclear technology in the medical industry. Between 2019 and 2022, a detailed evaluation of the global and African trends in nuclear application in the health sector was conducted. The most important advancement in the treatment of gyneacological cancer is the introduction of intra-operative instruments like the portable gamma-camera. The IAEA has recently provided Namibia a new machine to tackle the rise in cancer incidences, particularly skin cancer. In order to accomplish SDG 3: Promote well-being, the Peaceful Uses Initiative (PUI) has funded 16 programs that aim to combat cancer on a worldwide scale. It's a great idea to include the electron beam in the IAEA's external audit service. Brazil, Cuba, Germany, Greece, Indonesia, Italy, Malaysia, Mauritius, Mexico, Spain, and the United States of America are among the countries that are advancing the use of SIT for mosquito control.

The participation of Africans in IAEA programs is highly recommended for development.

Keywords:

Nuclear, Health, cancer, radiological, mosquito



Local Diagnostic Reference Levels (LDRLs) for Full-Field Digital Mammography (FFDM) and Digital Breast Tomosynthesis (DBT) Procedures in Morocco

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Abstract

This study was designed to establish local diagnostic reference levels (LDRLs) for full-field digital mammography (FFDM) and digital breast tomosynthesis (DBT) in Moroccan health care facilities. Data from 146 women were collected retrospectively from three facilities. The proposed DRLs were defined as the 75th percentile of the average glandular dose distribution (AGD). The mean AGD recorded in this study for the three centres was 1.47 mGy for all centres, and 1.42 mGy and 1.64 mGy for the CC and MLO projections, respectively. The mean compressed breast thickness (CBT) values recorded in this study were 55 mm, the LDRLs reported for all centres were 1.7 mGy, the CC projection was 1.6 mGy, and the MLO projection was 1.8 mGy. In addition, the LDRLs reported in the current study were compared with previous studies from other countries, including the United Kingdom, Japan, Ghana, and Sri Lanka. This work provides an assessment of local DRLs for mammography in Morocco and is proposed as a starting point for professionals to evaluate and optimize their practice. Furthermore, the definition of national DRLs is a necessary process for the optimization of Moroccan medical exposures, towards which a major project has been implemented by the governmental authority according to the IAEA guidelines.

Keywords:

Full-Field Digital Mammography, Digital Breast Tomosynthesis, local diagnostic reference levels, average glandular dose.

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Influence of Shield and Cold Head 2nd Stage Temperatures on Magnet TN150 Pressure in 4K-GM Cryocooler

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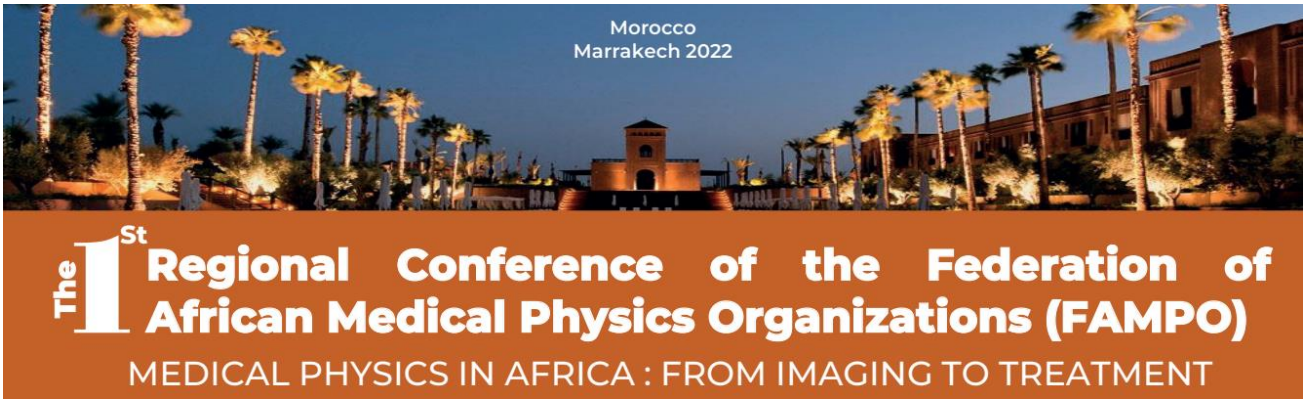
Abstract

In this paper, an experimental analysis was performed to establish the relation between temperatures of shield and cold head (2nd stage) and pressure variations inside the Mitshubishi TN150 Magnet in MRI device. Measurements of these parameters were taken for one month. Two applications were used to extract the data. These applications are: SVU_COM_TOOL software and HyperTerminal. A correlation was used to calculate the optimal values of pressure and temperatures. These values can be applied for good functioning of the MRI device. The geometric programming was used for optimization.

Keywords:

MRI, pressure, Shield temperature, Cold head 2nd stage temperature, correlation, Geometric programming, optimization.



Dosimetric Comparison of Brain Tumour Ballistics Coplanar VMAT and Dynamic Conformal Arc Therapy

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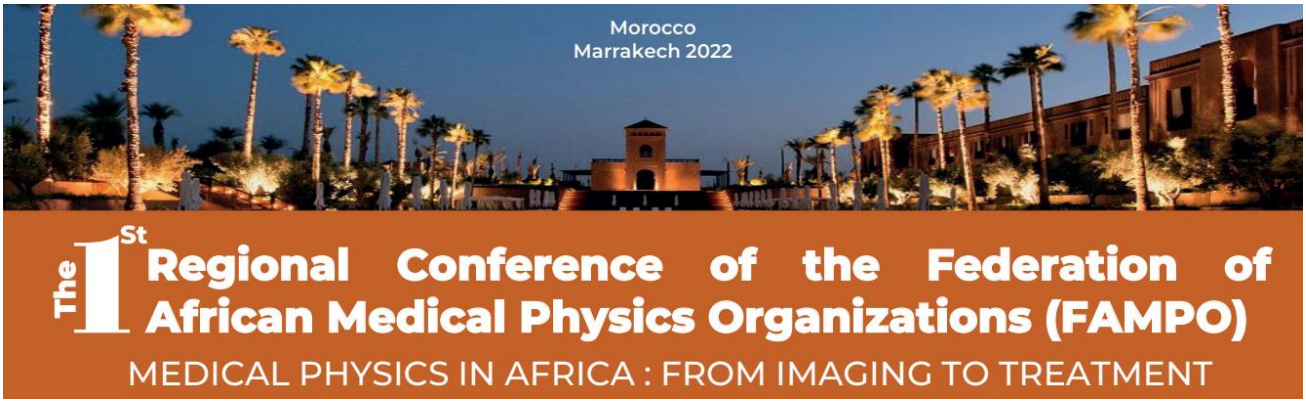
Abstract

Stereotactic radiosurgery (SRS) with a medical linear gas pedal based on the use of dynamic conformal arctherapy (DCAT) for the treatment of brain metastases remains the conventional strategy. However, volumetric modulation arteriotherapy (VMAT) allows a good conformation to the tumour volume, a strong dose gradient and a dose reduction at the level of organs at risk (OAR) which leads to a decrease of early and late complications in order to improve the quality of life of the patients. DCAT and VMAT plans were created for 15 patients. The two modalities were compared in terms of target compliance, target coverage, and dose to normal brain tissue. Both compliance indices (RTOG-CI and IP-CI) and the dose gradient index were significantly better in the VMAT plans than in the DCAT plans. Analysis of dose to normal brain tissue revealed that V23.1Gy, V15Gy, V12Gy, and V5Gy were significantly lower in the VMAT plans than in the DCAT-based plans. In comparison, the VMAT plans significantly improved target compliance and reduced doses to normal brain tissue.

Keywords:

Radiosurgery, metastases, DCAT, VMAT, organ at risk



Measurement of the Radioactivity in Drinking Water Consumed in the Eastern Region of Morocco by Gamma Spectrometry

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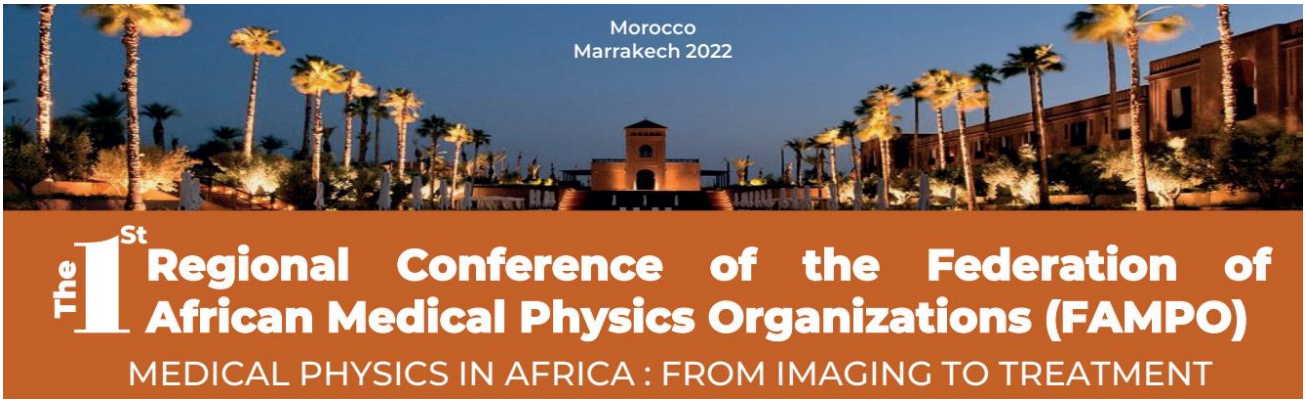
Abstract

This study was developed to determine the activity concentration of the main radionuclides (U-238, Th-232 and K-40) present in mineral water. The identification and quantification of these radionuclides was done using a NaI (Tl) detector coupled to a multichannel MCA analyzer connected to a computer. The activities measured in all samples for U-238, Th-232 and K-40 varied from 0.95 to 3.38 mBq/L with an average of 1.94 mBq/L, 1.55 to 3.56 mBq/L with an average of 2.46 mBq/L and 200.68 to 269.19 mBq/L with an average of 236.6 mBq/L respectively. The annual effective dose evaluated were 1.610 µSv/y, 1.133 µSv/y and 0.925 µSv/y for infant, children and adults respectively, based on the recommendations that are published in guidelines for drinking water quality by the World Health Organization (WHO, 1998), which requires that the maximum annual effective reference dose due to drinking water consumption is 0.1 mSv, this dose presents 10% of the maximum annual dose due to natural sources in ingestion mode received by the living being which is recommended by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) which gives a typical range of 0.2 to 1 mSv per year, it was found that the values measured in our study are lower than those mentioned by UNSCEAR and WHO. The cancer risk index evaluated in this study was a maximum of 5.63×10^{-6}, which is well below the 2.5×10^{-3} recommended by experts' organizations.

Keywords:

Gamma spectrometry, NaI (Tl), Bottled drinking water, Natural radioactivity, Dose assessment.



Over 50 years of IAEA/WHO Postal Dose Audits: Results from African Region

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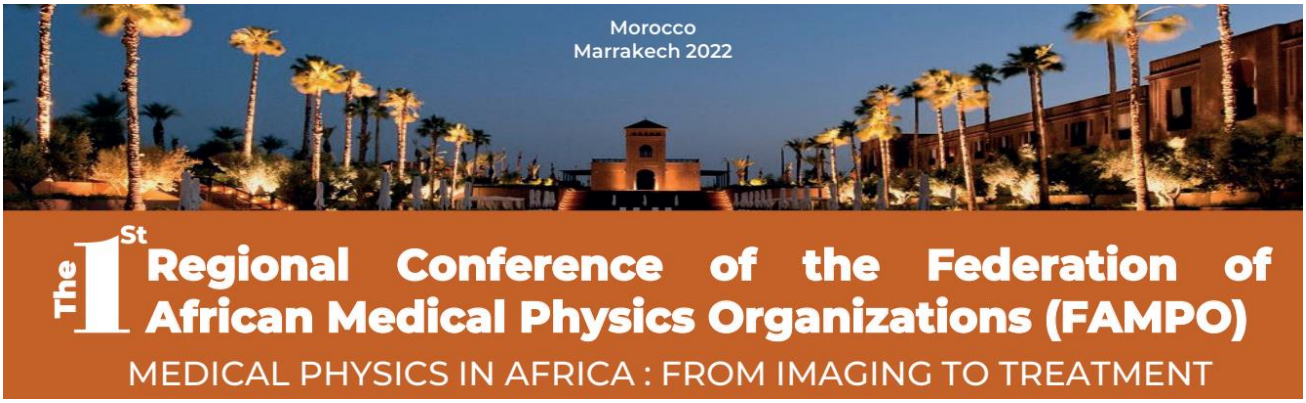
Abstract

The International Atomic Energy Agency (IAEA) in collaboration with the World Health Organization (WHO) provide dosimetry audits for radiotherapy (RT) centres worldwide for over 50 years. Many hospitals in Africa participated in the reference beam postal dosimetry audits, and the aggregated results of their participation are presented in this study. IAEA/WHO dose audits are provided on request free of charge for up to three beams per hospital per year. Each dosimeter set has two capsules to be irradiated in reference conditions with a dose of 2 Gy and one capsule for monitoring background radiation. Upon return, the dose delivered to the dosimeters is evaluated and compared with the user stated dose. Every discrepancy exceeding 5% acceptance limit is followed up with another dosimeter set for a second irradiation and an expert visit if the problem persists. The audit results merged with the radiotherapy infrastructure data from the directory of radiotherapy centres (DIRAC) provides insightful information on the audit coverage and performance of hospitals in the African region (RAF). During the period between 1969 and 2021, 165 hospitals from 29 RAF countries checked 375 their external beam RT units with 1534 dosimeter sets through the IAEA/WHO postal dosimetry audit service. According to DIRAC, 33 RAF countries have 236 RT centres with 425 external beam RT machines to date. Throughout the years, some countries have expanded their RT capacity while in others, some units have been decommissioned, but it is certain that more than half of RAF hospitals benefited from participation in IAEA/WHO dosimetry audits. Averaged over the 50 years, the percentage of acceptable results is 91.9% (95.3%) after the first (second) irradiation attempt respectively. The participation rate has grown from less than 20 beams checked before 1999 to over 100 now. The averaged fraction of acceptable results in the last 10 years reached 94.0% (97.8%), which is comparable to the average worldwide results of 94.8% (98.2%) for the same period. The IAEA/WHO dosimetry audit provision for RAF countries has grown over the past 50 years, and the current audit results are comparable to the average worldwide results. All radiotherapy centres that do not have access to a national audit service are encouraged to request an audit from dosimetry@iaea.org.

Keywords:
Radiotherapy, Dosimetry audits, DIRAC



3D Gynaecological Hybrid Brachytherapy for Cervix

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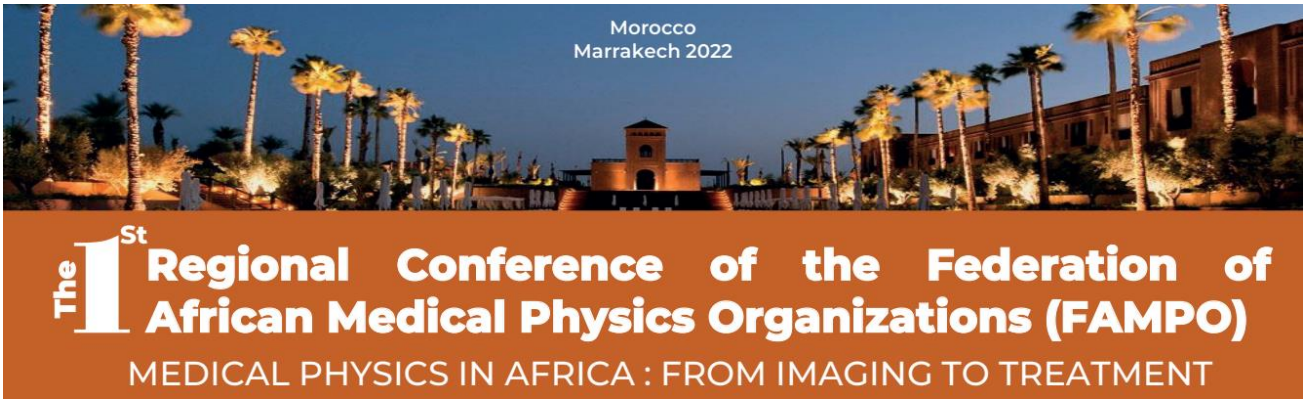
Abstract

Brachytherapy (BT) plays a major role in the therapeutic management of patients with cervix cancer from stage I to IV. The rapid dose fall-off allows a very high dose to the central pelvis, while relatively sparing bladder, rectum, sigmoid and small bowel. Hybrid adaptive and MRI guided brachytherapy is used when intracavitry alone could not cover the volume. This study presents the results of 9 cases in which the technique was used. A dedicated applicator was used for this technique. The application was done at the theatre using CT scan and MRI scan images to place the applicator after contouring the targets and OAR by physicians. This was followed by the reconstruction of applicators, then optimisation and evaluation according to GEC ESTRO recommendations before the actual patient's treatment. Hybrid adaptive and MRI guided brachytherapy significantly improves the coverage of large target volumes, while retaining sufficient organs at risk. In addition, it allows a synchronous parametrial complement which results in a considerable gain on the spreading total of radiotherapy. It constitutes the best all-in-one technical solution available to date for the implementation of interstitial brachytherapy in centres that do not have sufficient expertise to apply a free-hand gynaecological brachytherapy.

Keywords:

Cervix cancer, brachytherapy, Hybrid, OAR



Failure Mode and Effect Analysis for Linear Accelerator-Based Stereotactic Body Radiotherapy

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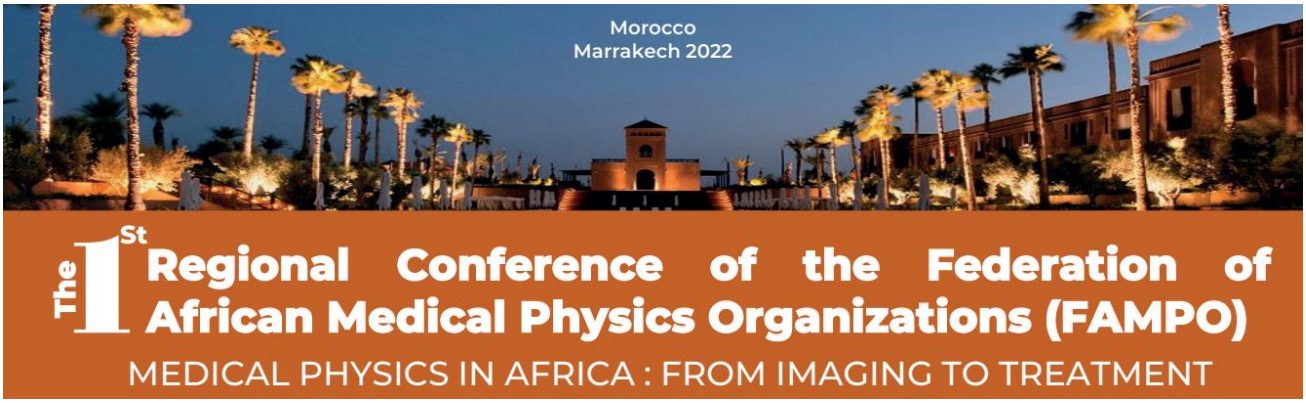
Abstract

Stereotactic body radiation therapy (SBRT) is becoming a very popular choice of treatment due to its effectiveness in controlling early-stage primary and oligometastatic cancer at delicate locations like the abdominopelvic and thoracic cavities, and at spinal and paraspinal sites. Recent Technological advances in respiratory motion management, treatment planning, and image guided treatment delivery, have allowed high doses of radiation per Fraction (≤5 fractions) to be safely delivered and the use of very small beams. Because of targeting very small lesions that usually doesn't require the use of PTV, and delivering high biological effective dose, the accuracy of treatment delivery is therefore an important factor that determines the success of this procedure. However, the use of traditional prescriptive quality management (QM) methods that focuses on monitoring all aspects of the functional performance of radiotherapy equipment by comparing parameters against tolerances set at strict but achievable values, may not be enough to match the increasing complexity of modern radiotherapy planning and to provide the required accuracy for SBRT treatments. Many errors that occur in radiation oncology are not due to device and software failures, but rather to workflow and process failures. Therefore, it seems obvious that an appropriate understanding of the probability and clinical impact of possible errors throughout all the stages of SBRT is necessary to ensure maximum safety and quality of treatment for patients. Considering all these points, we have decided to evaluate the process of SBRT treatment using a risk-based method called Failure Mode and Effect Analysis (FMEA). This method makes it possible to identify and treat the potential causes of failures and errors before they occur, thanks to a complete analysis of the process, and a strategy based on failure anticipation.

We aim to optimize the SBRT workflow and to minimize the frequency of errors using the Failure Mode and Effect Analyze (FMEA), therefore we will try in this project to identify and study the potential failure modes (PFM) from each step of the SBRT process. For each step in the SBRT delivery process, potential failure modes will be derived and three factors assessed: the probability of each occurrence, the severity if the event occurs, and the probability of detection by the treatment team. A rank of 1 to 10 will be assigned to each factor, and then the multiplied ranks of each factor yielded the relative risks (risk priority numbers). The failure modes with the highest risk priority numbers will be then considered to study and to analyze process improving methods. Risk based methods and process analysis are demanding in terms of collaboration with the stereotaxis team and in terms of time, however, they remain highly efficient to evaluate the process and to improve the quality and safety of our practice of stereotactic body radiation therapy (SBRT).



The Effect of Various Treatment Parameters on Neutron Production

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Abstract

To improve the efficacy of treatments, high-energy medical accelerators are commonly used in radiotherapy. However, unavoidable neutrons can be produced during treatment through photonuclear reactions and interaction of high-energy photons with different high-Z nuclei of the materials in the head of the accelerator components. The purpose of this study was to investigate the effect of some treatment parameters (photon beam energy, field size, the distance to the isocentre, etc.) on the production of neutrons. The whole head of the accelerator was simulated using Monte Carlo (MC) Gate/Geant4 code. Thereafter, the obtained MC results were compared with theoretical and experimental results available in the literature. Finally, these results could be useful in finding solutions in protecting patients against the risks of neutrons contamination.

Keywords:

Monte Carlo, photons, accelerator, field size, isocentre

The 1St Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Comparaisons des Trois Techniques Pour L'irradiation des Cancers Tête Et Cou

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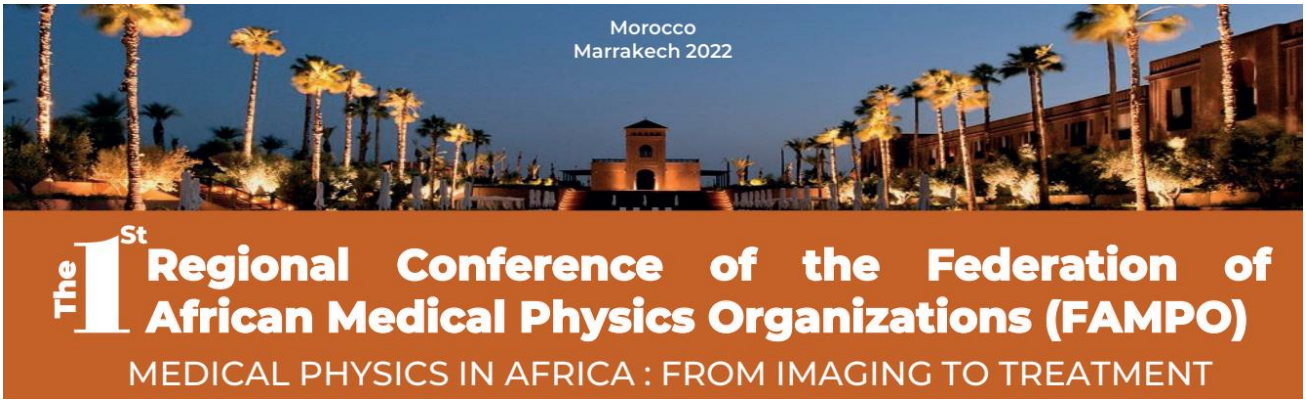
Abstract

Les cancers tête et cou constituent la troisième localisation des cancers traités au Centre National d'Oncologie, Nouakchott (CNO). Ces patients sont souvent diagnostiqué à des stades tardifs ce qui rend difficile leurs irradiations. Nous comparons sur le plan dosimétrique à travers cette étude trois techniques d'irradiation, radiothérapie conformationnelle 3D (RT3D) classique avec ou sans électrons et radiothérapie par Irradiation avec Modulation d'intensité Volumétrique par ArcThérapie (VMAT).
Pour chaque patient et après contourage des volumes cibles, la planification est faite par VMAT et deux plans réalisés en technique conformationnelle 3D avec et sans électrons. La prescription est de 70 Gy en fractionnement et étalement classique sur 95% du volume de planification (PTV). Pour la RT3D classique sans électrons, une première série à la dose de 50 Gy sur les PTV en utilisant des faisceaux multiples en photons. Dans une deuxième série, de 50 à 70Gy on utilise deux champs en photons sur le volume réduit. Pour la RT3D classique avec éléctrons, Un premier temps de 0 à 40Gy sur le PTV avec deux faisceaux latéraux et un faisceau antérieur. Dans un deuxième temps, 50Gy sur le PTV avec deux faisceaux latéraux réduits, deux faisceaux spinaux en électrons. Enfin, le dernier temps la dose de 70Gy est donnée par deux faisceaux latéraux en photons. La planification VMAT repose sur la planification inverse.
50 patients atteints des cancers tête et cou ont été inclus, l'analyse des Histogrammes Dose Volume de 50 patients. La dose de 67Gy est délivrée à 95 % du PTV en VMAT contre 65 Gy en RC3D sans électrons et 63 Gy avec les électrons. Pour 80% des patients les doses maximales à la moelle et au tronc sont respectivement entre 42 et 45 Gy en VMAT contre 45 et 48Gy en RC3D sans électrons et 45 et 49 Gy avec électrons. Les parotides sont épargnées puisqu'on a la dose moyenne pour 90% des patients la dose moyenne inférieure 26Gy en VMAT contre 55 Gy en RC3D sans électrons et 67 Gy en RC3D avec électrons.
A défaut de la technique VMAT, la technique RT3D sans électrons parait meilleur par rapport la technique RT3D avec les électrons pour la réduction de la dose aux organes à risques tels que la moelle épinière et les parotides ainsi avec une meilleure couverture de la dose au niveau du PTV.



Optimizing the CBCT Technique and Analysis for LINAC Synchronized NIPAM 3D Dosimetry

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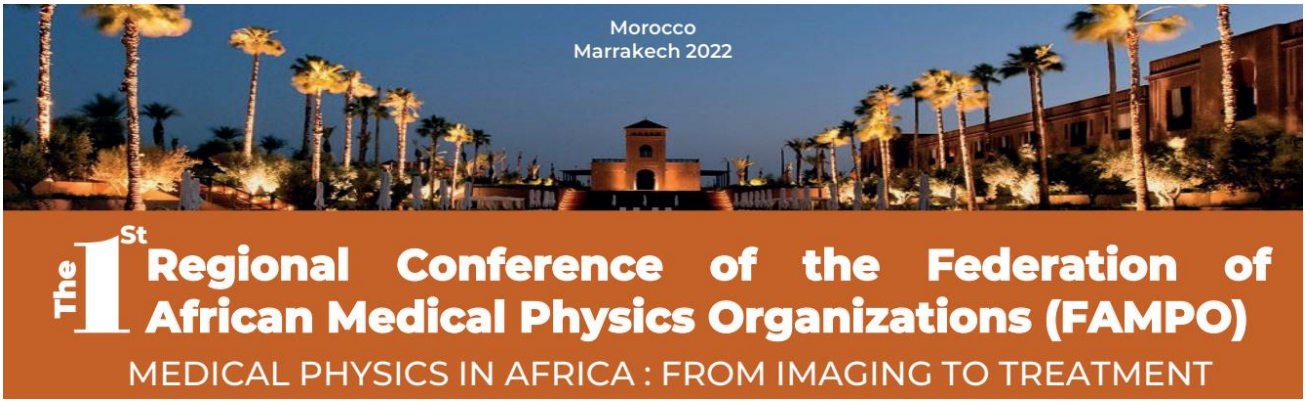
Abstract

The advantage of LINAC Synchronized NIPAM (LS-NIPAM) 3D dosimetry is the possibility of the measured dose being inherently synchronized with the on-board imaging coordinate system. However, the main challenges are the limited signal strength and the lack of robust and widely available tools for the analysis process. Our goal is to optimize a CBCT technique for comprehensive LS-NIPAM 3D dosimetry, and investigate the use of a recently developed clinical 3D dosimetry software (VistaAce) as an analysis tool. A simple 3-field plan (6 MV-FFF, 25 Gy) was delivered to a 1L jar of NIPAM gel dosimeter using the same configuration described in a previous study. Comparison of iterative and standard reconstruction algorithms as well as the impact of a variety of imaging metrics (exposure, tube current, number of projections, etc...) on NIPAM image quality was conducted. VistaAce (v 0.7) was used for data analysis. TG119 C-shape plan was delivered to a large jar (2L) of NIPAM, as a clinical verification of both the adopted CBCT technique and analysis tool. Results show that the Contrast to Noise Ratio increased considerably when the iterative reconstruction algorithm was used (CNR increased from 4.7 to 11.8). The measured dose agreed with the dose from the treatment planning system for the 3-field plan, with a pass rate of 95.626% for 3%3mm and 94.48% for 5%2mm. Line profiles showed a good agreement between the planned and the measured data. The results from VistaAce were verified via a second analysis using MATLAB and 3D Slicer with both analyses methods in agreement. The initial analysis of the TG119 C-Shape plan shows promising results. A CBCT technique was developed for LS-NIPAM 3D dosimetry that demonstrated high CNR and high agreement with TPS dose which uses averaged pre-irradiation CBCTs subtracted from averaged post-irradiation CBCTs and using an iterative reconstruction technique. The VistaAce software could possibly be used as a robust 3D dosimetry analysis tool, including for LS-NIPAM 3D dosimetry.

Keywords:
Dosimetry, VistaAce, CBCT, analysis, imaging



Output Factor Measurement for Non-Square Small Fields using Different Devices and Methods

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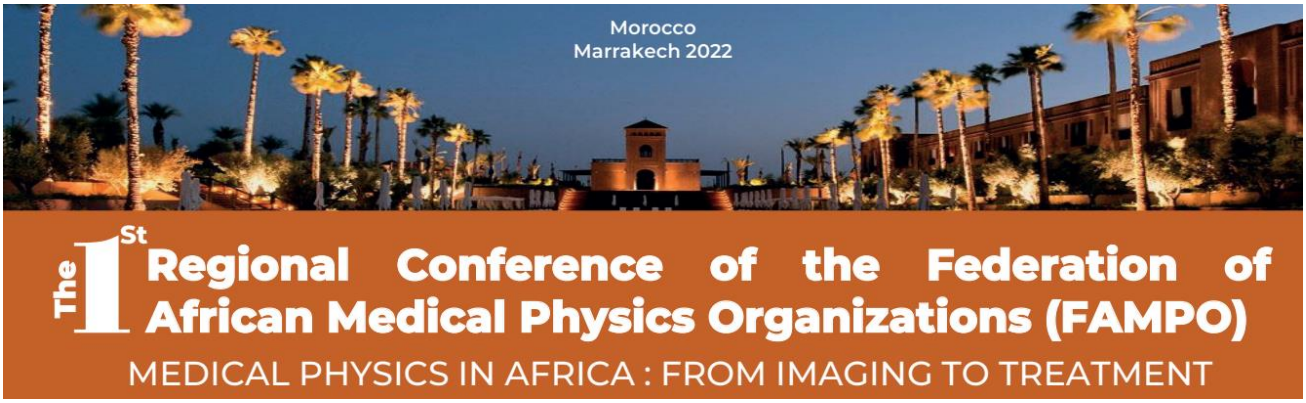
Abstract

The aim of this work is to calculate the output factors for 48 small fields with rectangular shapes. This has been performed using different detectors, such as: Pinpoint 31016, Diode E 60012, Diode P 60008, Diode SRS 60018, Diamond 60019, and as a benchmark the EBT3 Dosimetric Films. The XVMC Monte Carlo code of MONACO 5.11.03 planner used as a reference for the simulation. All measurements were done with an Elekta linear accelerator, Infinity model with Agility head, and 5 mm multilayers with 6 MV photon energy. Two different equivalent-field size methods for calculating the output factor for rectangular shape were used. One of this method is described by formula $S_{eq} = 4\frac{A}{P}$, where A is the area and P is the perimeter. The other one is defined as $S_{eff} = \sqrt{x \cdot y}$, where x and y are the sizes for the rectangular fields, S_{eff} is the side characteristic of the equivalent square of the small field. For these two types of calculations, we applied the Daisy Chaining method and the field output correction factor for fields collimated by an MLC given in Technical Reports Series 483 Table No. 26 and 27.

Keywords:

Photon, energy, calculations, Monte Carlo, XVMC, dosimetric



Evaluation of Iodine-131 Absorbed Dose in Graves's Disease Therapy: A Gate Geant 4 Monte Carlo Simulation Study in Niamey, Niger

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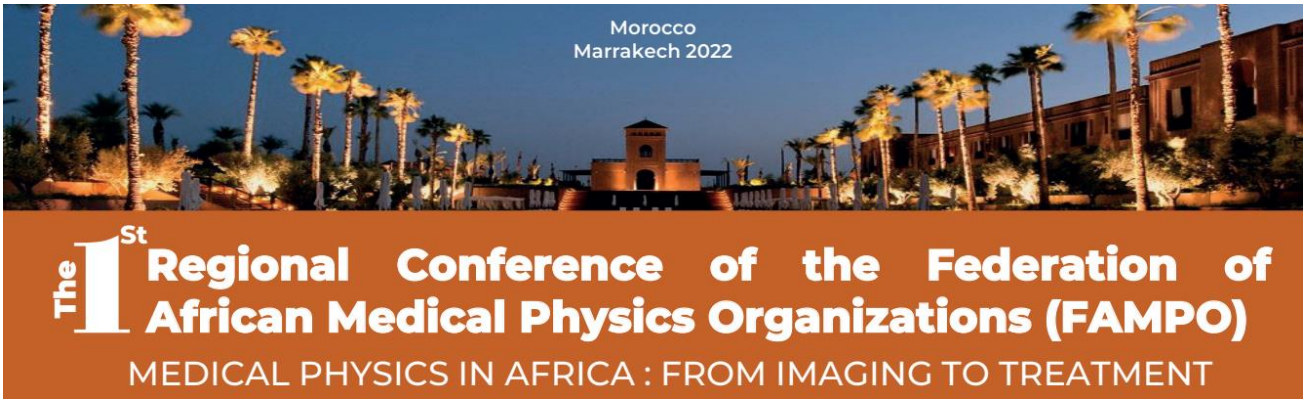
Abstract

A Monte Carlo simulation in Gate Geant4 was applied to calculate the iodine-131 absorbed fractions for electrons and gamma with mean energies of 167 keV and 397 keV respectively. They were uniformly distributed in ellipsoid phantoms made from PMMA material. The simulations for the electrons and gammas sources were thus done separately in order to observe the contribution of each type of radiation. Each patient was simulated with the same activity received and the volume of the ellipsoidal phantom corresponding to the size of his thyroid. The absorbed fractions for electrons and gamma were thus evaluated for all 45 patients referred to the nuclear medicine departments of the IRI in Niger and the University hospital of Bab el Oued, Algiers, for Radioiodine therapy of Graves' disease. The mean beta absorbed fractions were 5.11×10^{-5} and 4.99×10^{-6} for gammas rays. The mean S factor was 1.04×10^{-3} for the absorbed fractions of β and γ. The mean absorbed dose evaluated using MIRD method was 205.01 Gy, while the simulations gave an average absorbed dose of 256.35 Gy. This approach shows that the Gate code GEANT4 is an important tool for dose calculations in internal dosimetry in nuclear medicine applications, as well as in radiation protection dose estimates.

Keywords:

Evaluation, absorbed fractions, Gate GEANT4, Monte Carlo simulation, Graves' disease



Dose and Image Quality Optimization for Computed Radiography (CR): A Phantom Study

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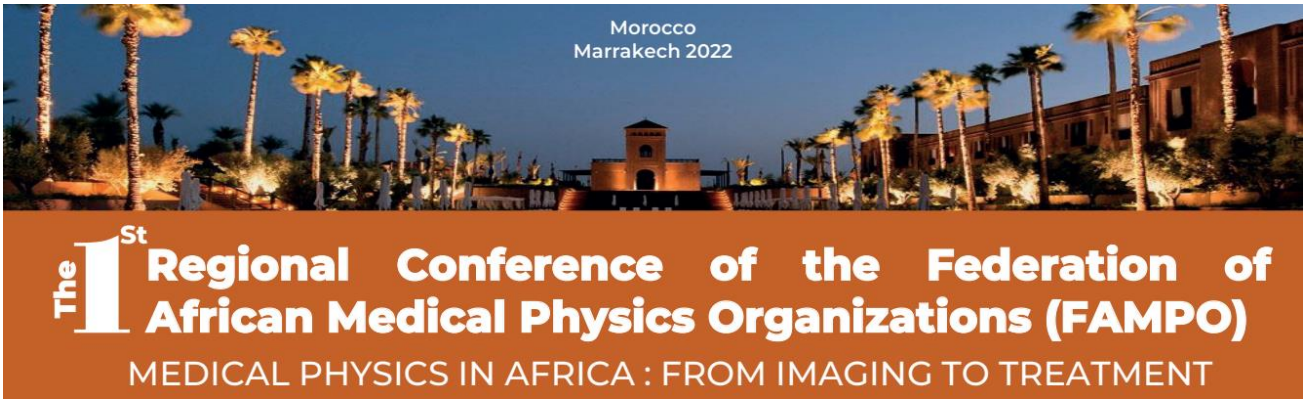
Abstract

The enhancement of radiological diagnosis requires a good image quality, which is automatically affected by the dose, this is a function of the different technical parameters used in the current radiographic procedures. Furthermore, in radiological practice, dose optimization involves the evaluation of all parameters that influence both the dose received by the patient and the image quality of radiographic examinations. The current study is a phantom study that aims to reduce the radiation dose to the patient while maintaining the acceptability of the image quality.

Keywords:

Phantom, image quality, optimization, radiographic procedure, dose, CR



The Impact of Patient Centring Towards the Bowtie Filter on Patient Dose and Image Noise in CT

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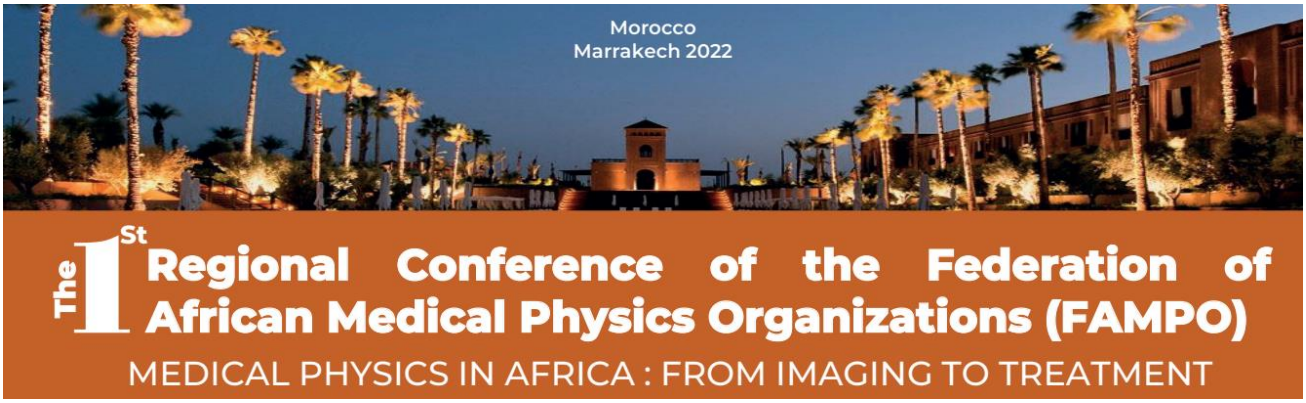
Abstract

Patient dose in CT has called for continued efforts to keep radiation exposure as low as reasonably achievable. A bowtie filter reduces unnecessary radiation dose to the peripheries of a patient and equalizes radiation signal to the detector. To achieve this goal, the patient must be correctly centred in the CT field of view. Otherwise, the region less attenuated by the filter would be exposed to more dose and the noise would be increased in the region that is in the part of the filter that attenuates more. A Catphan® 500 phantom was positioned on the CT table so that its centre was aligned at 0, 2, 4 and 5.75 cm below the isocentre, then at 2, 4, 6, 8, 10, 12 and 14 cm above the isocentre and a PMMA phantom at 0, 2, 4, 5.75 and 8 cm below the isocentre. The clinical centring error was studied on a sample of 10 patients who had a thoracic or abdominal CT using ImageJ software. The more the centre of the Catphan© 500 phantom is placed far from the isocentre, the more the image noise increases. Moving away below from the isocentre, it increases in the upper part which is the most attenuated by the bowtie filter while it increases in the lower part moving away above from the isocentre since it is the most attenuated by the filter in this case. The image noise was increased with a reconstruction filter hard. The correction was done with the ASiR tool. The dose decreases by 12.07% and 27.94% in the centre of the PMMA phantom and in the 12H position respectively, while it increases by 47.88% in the 6H position. On the other hand, there was no significant change at the 3H and 9H position. The increase and decrease tend to be balanced and the impact on the overall $CTDI_w$ dose is negligible when it was calculated using the peripheral mean. The image quality and dose optimization can be improved in CT using the bowtie filter by ensuring a good patient centring.

Keywords:
Patient centring, bowtie, CT, optimization, PMMA,



A Study of the Conformity Index and the Homogeneity Index for Cervical and Prostate Cancer Radiotherapy Plans at Mpilo Central Hospital

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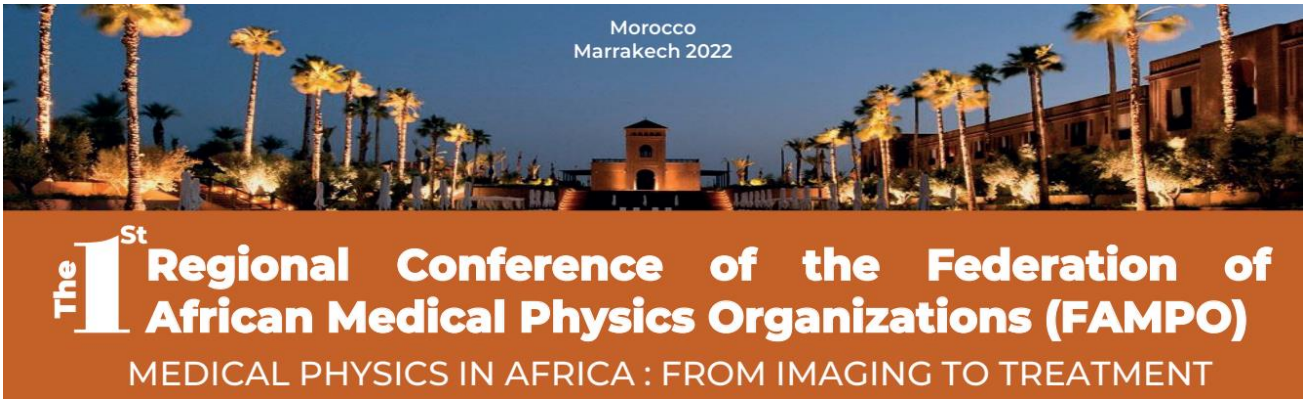
Abstract

The treatment of cervical and prostate cancer involves a multidisciplinary approach in which radiotherapy plays a key role. This study aims to demonstrate the conformity and homogeneity levels achieved by 3D conformal radiation therapy for cervix and prostate malignant tumours patients. Conformity and homogeneity indices are good quantitative tools for assessing and comparing the dose conformity and homogeneity of various treatment plans of one patient. In this study, 60 plans with advanced cervical tumours and 35 prostate plans were selected. The CI and HI mean values were calculated using Microsoft Excel 2016. The prostate cancer had a CI range of 0.98 to 2.5 with a mean value of 1.54, and HI range of -0.083 to 0.016 and mean value of 0.0125. The cervical cancer had a CI range of 0.98 to 5.05 and mean value of 3.03, and the mean HI in the cervical study was 1.124, with a minimum HI of 0.498, maximum HI of 2.684 and standard deviation of 0.476. The CI mean values do not fall within the RTOG range. This is attributed to the late cancer stages that invade uterus, pelvic and lymph nodes. However, improvements need to be made in the beam-delivery techniques and the treatment equipment used at the department.

Keywords:

Radiotherapy, prostate, conformity, homogeneity, tumour



Comparison of Hand and Ocentra Master Plan TPS Monitor Unit Calculations

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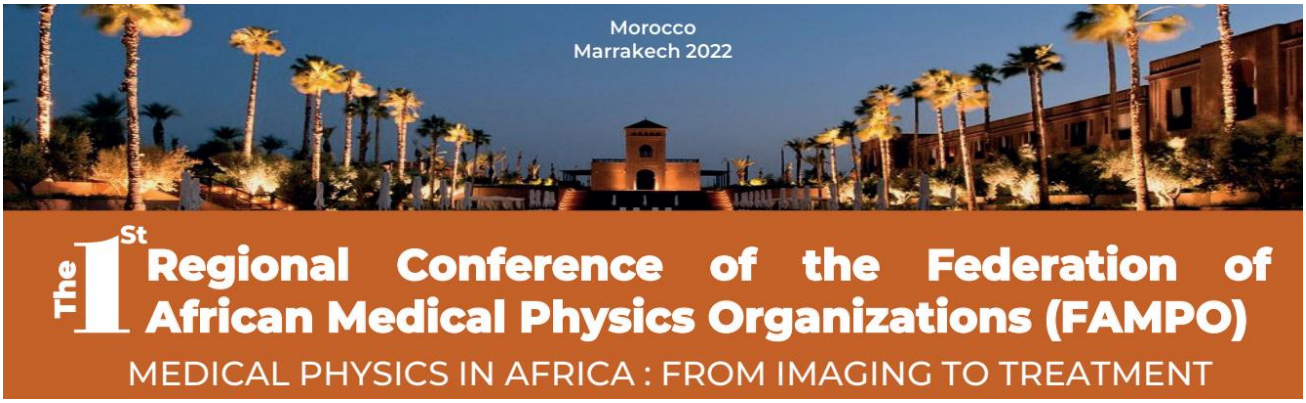
Abstract

A comparison of the monitor unit calculation between TPS and manual calculation is very important in the department of Radiation Oncology. In this paper, we calculated the MU of 3DCRT plans for prostate and breast cancer using the data obtained from the master plan TPS. The MU of each beam was recalculated manually and compared with the TPS values. We obtained that, the manual calculation and TPS values were in good agreement. The MU difference between TPS calculation and manual calculation was ± 0.78 with a standard deviation of 1.83 for the prostate case with a p-value of 0.07 using a t-test which shows that there were no significant differences between re-calculation and TPS. For the breast case, the MU means difference was 2.90 with a standard deviation of 3.38 and a p-value of 0.007 which indicates a significant difference between re-calculation and TPS. In this study Primus TM Linear Accelerator with 6 MV and 15 MV was used. The monitor unit was calculated by Ocentra Master Plan TPS. The hand calculation was performed with aid of a spreadsheet. The excel sheet was developed based on AAPM TG 71 algorithm. Two types of cases were chosen based on their homogeneous and inhomogeneous distribution of the tissues. A total number of eight patients were chosen among them were three with prostate cancer and five were breast cancer. The AAPM TG 71 formalism used for manual calculation. The results show the variation of MU calculated by TPS and hand calculation. The tolerance of variation was recommended to be ± 3.5% as proposed by Mijinheer et al. and Wambersie et al. From our results above, the difference in the means of MU between TPS calculation and hand calculation was ± 0.78 with a standard deviation of 1.83 for the prostate case with a p-value of 0.07 using t-test which shows that there was no significant difference between manual calculation and TPS. Manual calculations are usually used to confirm the TPS calculations of MU. The present study shows good agreement for prostate.

Keywords:
Prostate, manual calculation, MU, TPS, accelerator



Local DRL in Nuclear Medicine Department of Cancerology Institute of Libreville

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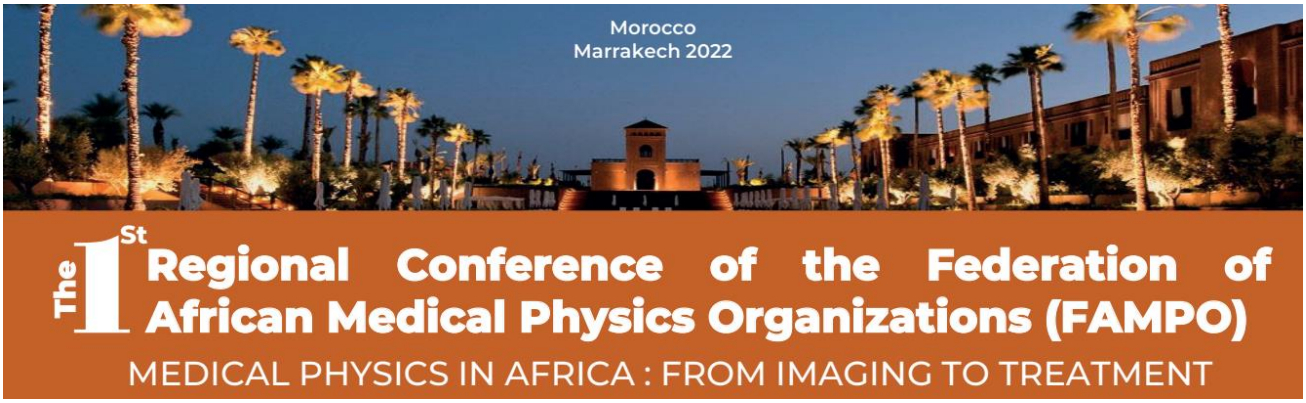
Abstract

Diagnostic Reference Levels (DRLs) have been introduced for assisting the optimization of radiological investigation. There is urgent need to establish DRLs in nuclear medicine imaging studies to reduce unjustified medical radiation exposure and social concerns, as well as to optimize radiation protection. This study was focused precisely on local reference levels in nuclear medicine department. The data of this study were collected from the only nuclear medicine department of Gabon during few months. The nuclear medicine investigations were carried out using a SPECT/CT equipment from Philips brand and 30 adult patients (more than 30 years old) were administered with Tc-99m for bone scan examinations. All datasets of patient weight lower than 45 kg were excluded and less than 20% of the group weighed over 90 kg. Actual administered activities were calculated by the difference between the measured activity and residual activity after injection, the decreasing activity was also considered for actual activities. Then, the median and mean of actual administered activities were evaluated to get local reference levels. DRL values were found within the international range. For bone scan, the DRLs were 700,76 MBq and 686,74 MBq respectively from the median and the mean of administered activities compared to international range of 500 – 1110 MBq. Nevertheless, the patient weight was not considered for the administered activity while the ICRP recommended that such consideration should be given to adjust administered activities based on agreed factors linked to weight. This work presents data on administrated activities used in clinical practice for diagnostic nuclear medicine procedures in Gabon to provide the DRL at a national level. The values obtained are comparable with those reported in other countries. The patient weight factor is not included in this review and should be added in future studies. Local reference levels should continuously be reconsidered to optimize protocols, to ensure best practices and to reduce radiation exposure to patient and workers.

Keywords:
DRL, optimization, nuclear medicine, activity, patient



Pre-treatment Verification of Carcinoma Breast VMAT Plan based on Mono-isocentric Technique: Assessment of the Combined Fields Feature of New 2D MatriXX Arrays Resolution

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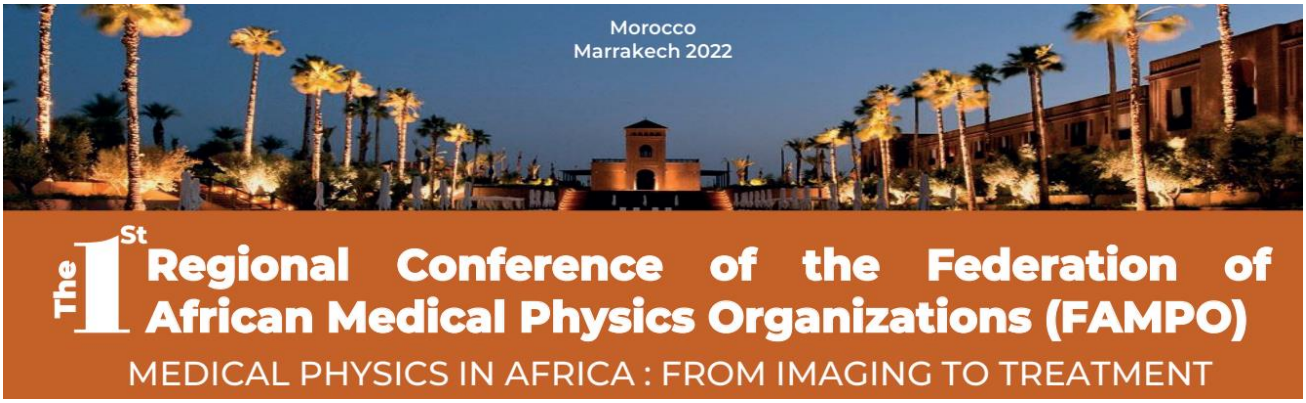
Abstract

This study was set up to verify the Mono-Isocentric technique-based Volumetric Modulated Arc Therapy (VMAT) plan for carcinoma breast and regional nodes employing the new 2D arrays MatriXX Resolution from IBA dosimetry systems, Schwarzenbruck, Germany loaded with the combined field feature. This study included 12 Mono Iso-centric VMAT plans for breast cancer with supraclavicular and axillary nodes. The radiotherapy planning was performed by the Monaco TPS (5.51 Elekta Limited, Crawley, UK) following the departmental planning protocols employing 6 MV photons using the XVMC algorithm for Dose calculation. The plans were optimized using an arc geometry with 25 increments in gantry angle spacing between control points with a 3 mm resolution dose grid size and 1% per calculation dose to medium, minimum segment width 0.5 cm and high fluence smoothing. These plans were delivered clinically by an Elekta Infinity linear accelerator equipped with Agility 160- leaf MLC (Elekta Limited, Crawley, UK). Two CT scans of the MatriXX resolution inserted in the Mini Phantom R were acquired using a CT simulator (GE discovery (General Electricals, USA). Out of these two scans, the first one was taken as the default CT and the second one as the extended CT, to use for large fields combination. In this study, normal and combined fields were compared using myQA patients' software (IBA Dosimetry, Germany) based on the gamma index analysis and point dose measurements with the ion chamber CC04 according to IAEA Protocol TRS398. The new 2D array detector provided good agreement for dose maps without combined field features over the field lengths ranging from 22 cm to 24 cm and excellent agreement for maps with combined fields for lengths ranging from 24 cm to 28 cm. VMAT Clinical cases passed with more than 95% for the set criteria of 3% DD & 3 mm. The absolute point dose measurement agreement was found to be more than 98%. The MatriXX Resolution is a convenient, fast, robust, and practical tool for routine large-field pre-treatment verification in IMRT, VMAT and other advanced techniques.

Keywords:
Patient-Specific Quality Assurance, Combined Field, My QA Software, 2D Array detector.



Computed Tomography Dose Measurements Using RANDO Anthropomorphic Phantom

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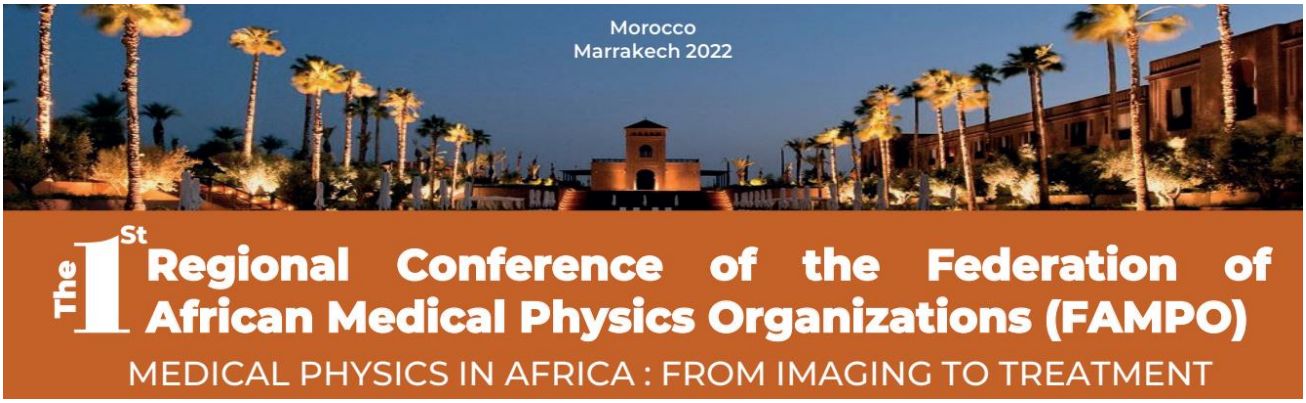
Abstract

In recent years, there has been significant increase in the use of computed tomography (CT) systems in Ghana. Knowledge of the amount of radiation delivered to patients undergoing CT examination is the first step in dose optimization. The aim of this study was to physically measure organ doses using thermoluminescence dosimeters (TLDs) on RANDO anthropomorphic phantom and verify the measured doses with CT-Expo software. A total of 50 TLDs were placed in the phantom and exposure performed using frequently used CT clinical protocols at the facility. Images from the CT examinations were all accepted by the resident Radiologists, hence the dose report were suitable for the study. The TLD measured organ doses varied between 3.97 mGy for oesophagus and 56.22 mGy for brain. High doses were recorded in brain (37.80 - 56.22 mGy) and eye lens (29.94 - 36.16 mGy). Comparing organ dose measurements between TLD and CT-Expo, the maximum organ dose difference was realized in the eye lens (31.60%). For the chest CT examination, the maximum variation was -27.03% for the heart and 26.95 % for the oesophagus. The comparison between the two methods for the other organs were all less than 30% with the least difference being stomach (-0.76%). The mean organ dose for the direct measurement were mostly lower than the simulated, except for brain, heart, bladder and gonads. The effective dose from TLD measurements were 2.78, 6.67 and 17.39 mSv for head, chest and abdominopelvic CT examinations respectively. For CT-Expo, the corresponding effective doses were 2.20, 10.30 and 16.70 mSv. A major reason for the difference in dose measurements between the two methods was the dissimilarity of the organ position in the Rando anthropomorphic phantom and the standard mathematical phantom used by CT-Expo.

Keywords:
Computed Tomography, organ dose, effective dose, TLD, anthropomorphic phantoms



Dosimetric Evaluation of Tungsten Eye Shield Versus Gold Shield with Different Electron Energies in Radiotherapy

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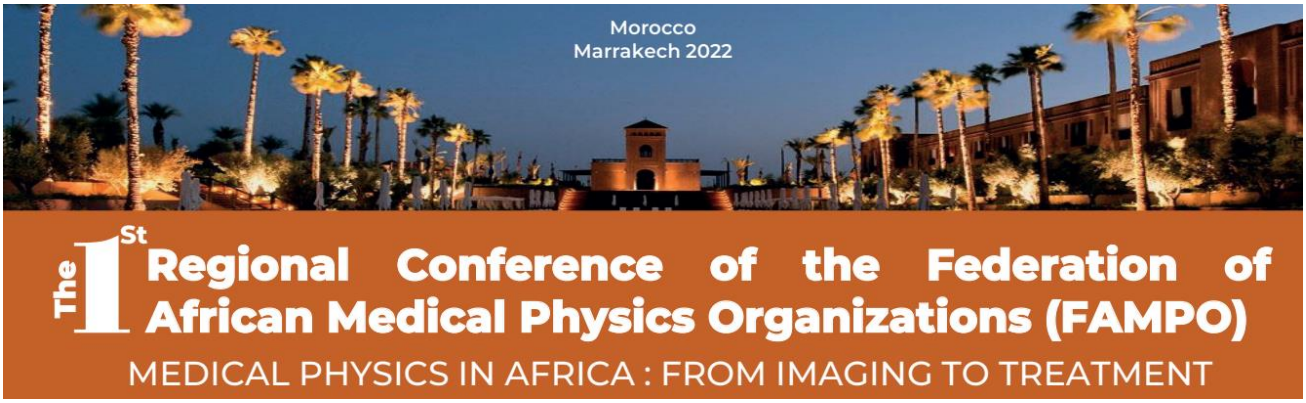
Abstract

For over 50 years, electron beam therapy has been an important radiation therapy modality. A single electron beam delivers a uniform 'plateau' of dose ranging from 90% to 100% of maximum central-axis dose with the dose distribution steeply falling off both laterally and distally This has allowed superficial cancers and disease (within 6 cm of the patient's surface) to be irradiated with little dose to underlying normal tissues and structures. In electron radiotherapy, shields are placed above the patient's body surface to block beams and scattered rays. By appropriately shaping the shield, which is most commonly made of lead or low melting point alloy (LMA), radiation can be concentrated to the appropriate area by forming an irradiation field. This study aims at the evaluation of transmission from tungsten eye shield that used frequently in high percentage of cases that treated with electron beam in radiotherapy as squamous cell carcinoma in eye lid in comparison to local gold eye shield that used in these cases to protect eye from any extra dose can cause damage to the eye. This study was performed with tungsten eye shield and local gold shield using pinpoint ionization chamber detector in the measurement of dose transmission under eye shield with different electron energies 6 MeV, 9 MeV, 12 MeV and 15 MeV at SSD of 100 cm with applicator size 10 × 10 cm^2 in solid phantom as medium of measurement for patient simulation. The results show that the use of tungsten eye shield in protection of eye from any extra dose cause sharp decrease in dose transmission under eye shield in comparison to local gold shield that give bad protection for the eye as shown in figure 1, 2,3 and 4 where the dose transmission decrease from 0.36% with gold shield to 0.021% with tungsten shield at energy 6 MeV, this difference is more clearly shown at energy 15 MeV where the dose transmission under gold shield reached 90% and dropped to 0.08 % under tungsten shield, all figures show significant difference between two types of eye shield at all electron energies 6 MeV, 9 MeV, 12 MeV and 15 MeV (p-value = 0.0066). To sum up the results of this study, it is clear that there is significant difference between tungsten and local gold shield where the tungsten cause less transmission for the dose, hence more protection for the eye in comparison to gold shield that give poor protection for the eye, although the local gold shield is more easy to insert inside the eye in contrast to tungsten eye shield but this advantage can be neglect due to its bad protection, so it is recommended to use tungsten eye shield with electron in radiotherapy when the tumour close to the eye.

Key words:
Tungsten; Gold; Electron; Radiotherapy, eye, carcinoma



Determining the Best Transfer Learning Approach to Multiclass Classification of Glioma, Meningioma and Pituitary Tumour

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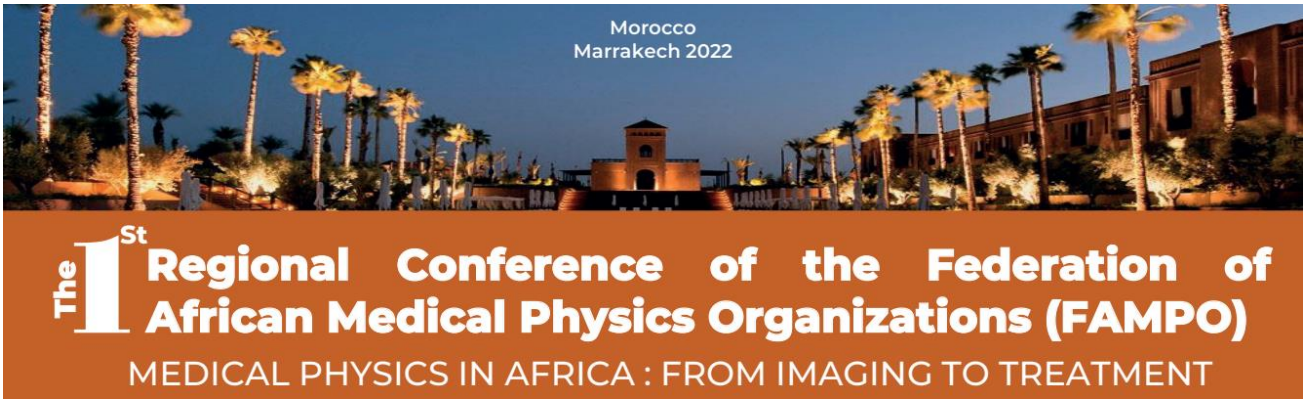
Abstract

Brain tumours are one of the deadliest types of cancers as only 36% of brain tumour patients survive five years after diagnosis. Brain tumours are detected and classified by biopsy, an invasive procedure with the potential to impede brain function and introduce infections. Diagnostic imaging approaches using anatomical magnetic resonance imaging (MRI) have minimized the use of pre-treatment biopsies for detection, but current visual classification of brain tumour images using expert readers have not improved classification accuracy enough to eliminate biopsies. Transfer learning is a machine learning technique where a previously trained model serves as the foundation for a model on a new problem. Recent advances in Convolution Neural Network (CNN), offer promise in using brain MRI to accurately classify brain tumours. Here, we evaluated the performance of 26 Keras applications (CNN models) previously developed for general image classification in the classification of brain tumours. We retrained 3064 T1-weighted contrast-enhanced MR images from 233 patients with either meningioma (708 images), glioma (1426 images), or pituitary tumour (930 images) using pre-trained weights from the ImageNet dataset and compared classification accuracies of the Keras applications. This is an exhaustive evaluation of various state-of-the-art CNN approaches has been performed using a relatively large publicly available multiclass brain MRI dataset. Of the 26 models, EfficientNetB3 classified with an accuracy of 98.98% while DenseNet121, EfficientNetB2, EfficientNetB5 and EfficientNetB4 correctly identified the tumour type with an accuracy of more than 97%.

Keywords:
MRI, convolution central network, meningioma, pituitary tumour, transfer learning



Global Representatives Initiative of the American Association of Physicists in Medicine

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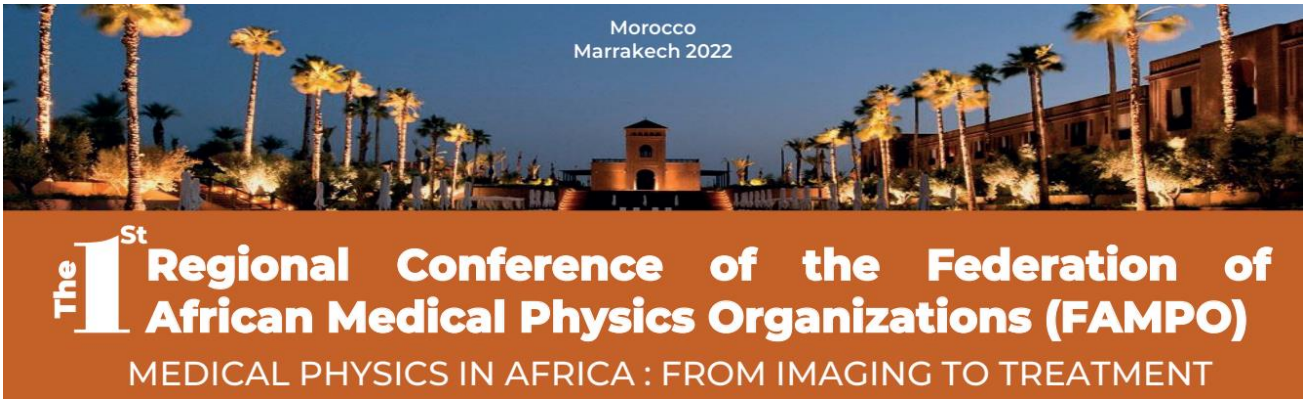
Abstract

In the current structure of the American Association of Physicists in Medicine (AAPM), one of the major divisions is International Council formed few years ago. One of the Committees of this Council is Global Needs Assessment Committee (GNAC) which comprises two Subcommittees: Equipment Donation Subcommittee and Global Representatives Subcommittee (GRSC). The objective of the latter is to establish a network of Global Representatives allowing us to better assess local needs and more efficiently administer our help to our colleagues overseas. Africa is our partner number1. There is a lot that our committee can contribute to the local Medical Physics community. To facilitate this process, we need to establish a reliable network of local representatives with whom AAPM can regularly communicate. Therefore, we will try to arrange roundtable discussions at this meeting to discuss the urgent needs. Once the local representatives are identified, we can include them as guests or consultants to GRSC, so they can participate in our regular online meetings. As a part of our collaboration, we can offer free 2-year AAPM memberships to a certain number of eligible candidates and open access to the AAPM website containing numerous publications and other resources. Part of GNAC work is to provide collaborative microgrants to develop clinical service in some areas of the world that need our support, and there will be another opportunity for African Medical Physicists to participate in the next round of applications at the beginning of 2023.

Keywords:

AAPM, collaborative, microgrants, global needs assessment, medical physics



2021 IAEA Regional Intercomparison Exercise on Individual Monitoring for External Exposure

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Abstract

The organization of this regional intercomparison exercise on individual monitoring in Africa region was implemented under the framework of IAEA Technical Cooperation Project RAF9068. The SSDL of CNRP of Morocco hosted this intercomparison exercise (irradiation of dosimeters sent by participating dosimetry service and evaluation of final results). Results of this intercomparison exercise were discussed during the virtual meeting held on 13-15 December 2021, Vienne – Austria. In this meeting Intercomparison results for each country checked and validated with special interest on consistency, accuracy (trumpet curve criteria compliance); influence of background radiation; unexceptionally too high or too low values; & typographic errors. Results were analysed country by country to identify specific issues or otherwise in each case. The results of the intercomparison study show that some participants have a very satisfactory performance and also that a number of services could improve the quality of their systems by improving the calibration of their systems. Additional information specific to the tested systems and provided by the participants for statistical analysis allowed more detailed analysis of the results with respect to different parameters, e.g. dosemeter type, detector material, and other parameters. The influence of such parameters on the response values of the dosemeters was studied and discussed. With the aid of the intercomparison results the participants can show compliance within their quality management system, compare their results with those from other participants and develop action plans for improvement of their system.

Keywords:
Intercomparison, calibration, dosimetry, IAEA, consistency, accuracy

The 1St Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Preliminary Diagnostic Reference Levels for Conventional Radiography Examinations in Senegal

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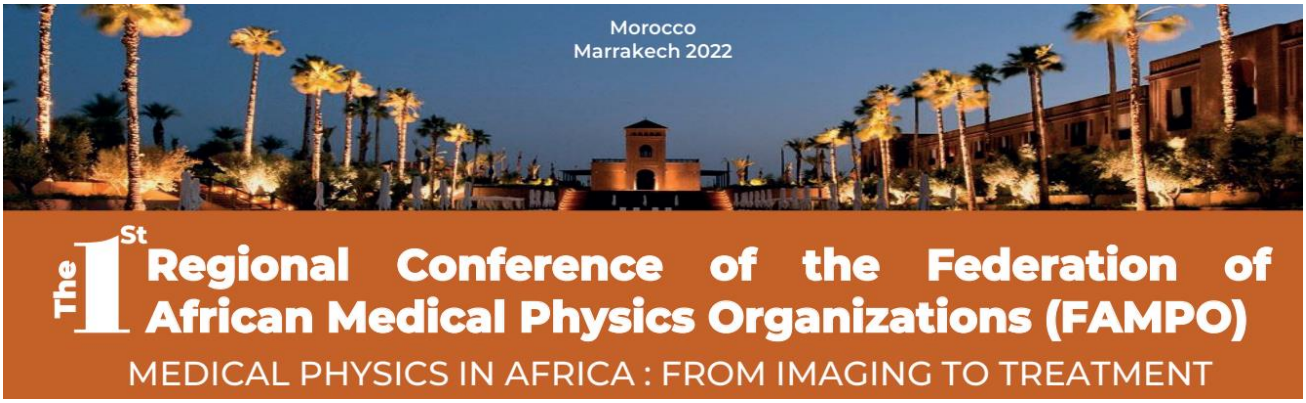
Abstract

The aim of this study is to estimate local reference levels in conventional radiology at six diagnostic centres in Senegal. The purpose is to encourage health professionals to investigate patient radiation doses and to determine whether these doses comply with the principles of radiation protection in medical fields. It is also intended to improve practices by reducing patient exposure without reducing clinical effectiveness. To perform this work, patient effective doses from different radiological examinations have been investigated, including the following nine routine types: chest (PA), abdomen (AP), pelvis (AP), cervical spine (AP), lumbar spine (AP, Lat), hip (AP),), thoracic spine (AP, Lat). Three types of data were collected, X-ray tube machine data, patient data and output measurements. The entrance surface dose and dose area product for each plane radiography were calculated. The data were analysed statistically and the minimum, median, mean, maximum, and third quartile values were calculated. Derived doses were compared with recommended international diagnostic reference levels. Values for the entrance surface dose (0.66 mGy) and dose area product (96.85 mGy.cm^2) for chest PA were up 35% and 76% higher, respectively, than their corresponding European Commission Report RP 180 Part 2. These observations and others, such as poor radiographic techniques, and lack of modern X-ray equipment, have shown the critical need to carry out quality assurance programs in Senegal.

Keywords:
X-rays, diagnostic radiology, entrance surface dose, dose area product, and optimization.



The Sensitivity of the Gamma Analysis Used as a Verification Method for Volumetric Modulated Arc Therapy (VMAT) Plans

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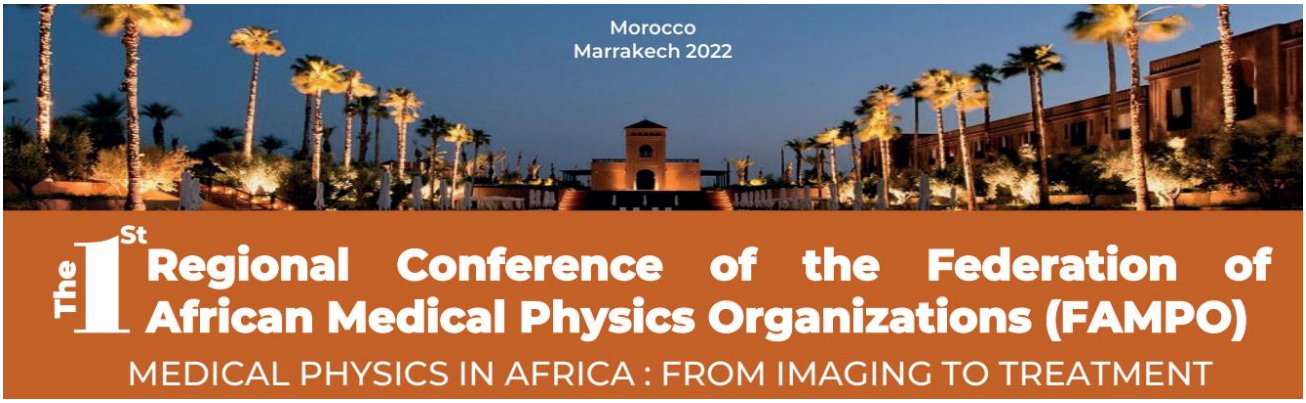
Abstract

Considerable progress in the delivery of radiation for therapeutic purposes has been made over past 30 years. With the evolution of technology, new treatment techniques, such as intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT), were developed. These techniques, however, uses small, non-intuitive in shape beam apertures to create the required modulation. Verifying that the plan parameters are correct can no longer be performed visually. Furthermore, the ability of the dose calculation algorithms to calculate the doses of these small, irregularly shaped beam apertures accurately, and the ability of the treatment machine to deliver the calculated fluence, were called into question. This necessitated the use of physical measurements to verify the dose delivered to the patient prior to the patient's treatment. The most widely used method for patient specific QA is the gamma index analysis. However, recently, some issues with respect to the gamma index analysis have been raised in some studies. The aim of this project was to investigate the sensitivity of the gamma index analysis with the pre-selected DD and DTA criteria used at Tygerberg Hospital. This retrospective study involves using the public domain radiotherapy-plan, radiotherapy-structure and CT data sets available for download on the Varian website (link: https://medicalaffairs.varian.com/halcyon-case-studies-index). The radiation-plan data set was edited to simulate clinically relevant errors in the collimator angle and the dose at the treatment machine. The dose distribution of the edited plan as measured with the EPID was then compared to the dose distribution predicted by the treatment planning system. Various recent studies have found the gamma-index metric to be insensitive to clinically relevant errors when using the commonly used criteria (namely 3%/3mm). The sensitivity of the gamma analysis technique, with the gamma criteria used at Tygerberg Hospital (namely 2%/2 mm), to collimator angle errors and dose errors, was also investigated. The findings of this study corroborates the results of previous studies and highlights the need for a new way of quantifying the error of the delivered plan.

Keywords:
Gamma index, VMAT, treatment planning, calculation algorithm, beam aperture



A New Dosimetric Investigation of a Head Volume Irradiated by Carbon Ions in the Presence of an Axial Magnetic Field

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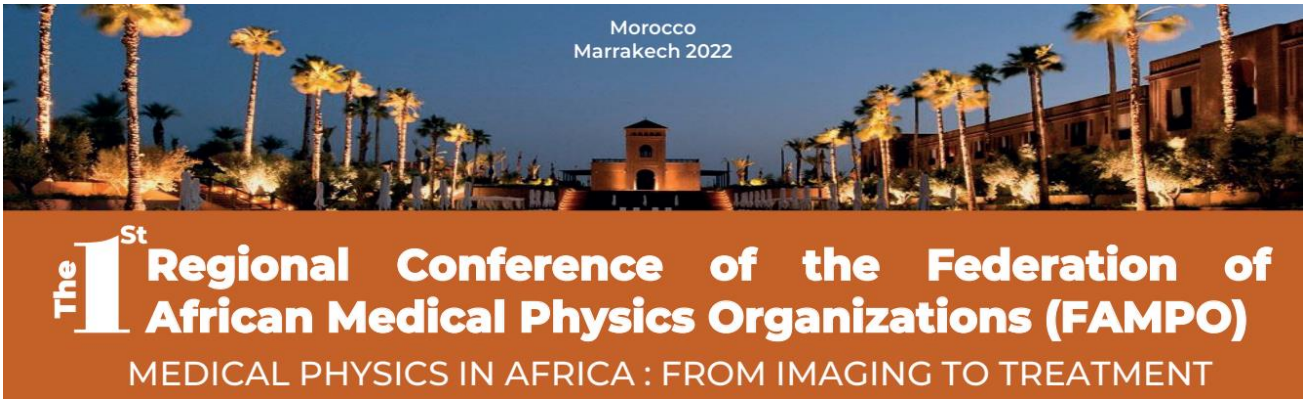
Abstract

To improve the irradiation accuracy in hadron therapy, a lot of studies have been conducted on how to integrate MRI and PET in the treatment of cancer patients. These two future techniques will offer simultaneously the monitoring of the beam during the irradiation. In this study and for the first time, we calculated the dose distribution in a head volume for several carbon ion energies and at different values of the magnetic field B using Fluka MC code. Afterwards, either longitudinal or radial dose deflection was simulated with and without B. Basically, the Z axis is entered by the beam and the radial deflections mean the ones corresponded to the X axis which has the same direction of B. The maximum longitudinal deviation of Bragg pick depth was 0.672 mm at 200 MeV and the maximum radial deflection was almost 4.23 cm at 100 MeV. Both of them are in the presence of B = 1.5 T. Our results are in a good agreement with previous experimental results (a maximum relative error founded of 2.08%). The results of this study will offer the monitoring of the dose deposition with good accuracy in the presence of a magnetic field in carbon ion therapy.

Keywords:

MRI, PET, hadron therapy, dose distribution, MC code



Implementation of IAEA/AFRA Harmonized Quality Control Protocol for Diagnostic Radiology: The Ghana Experience

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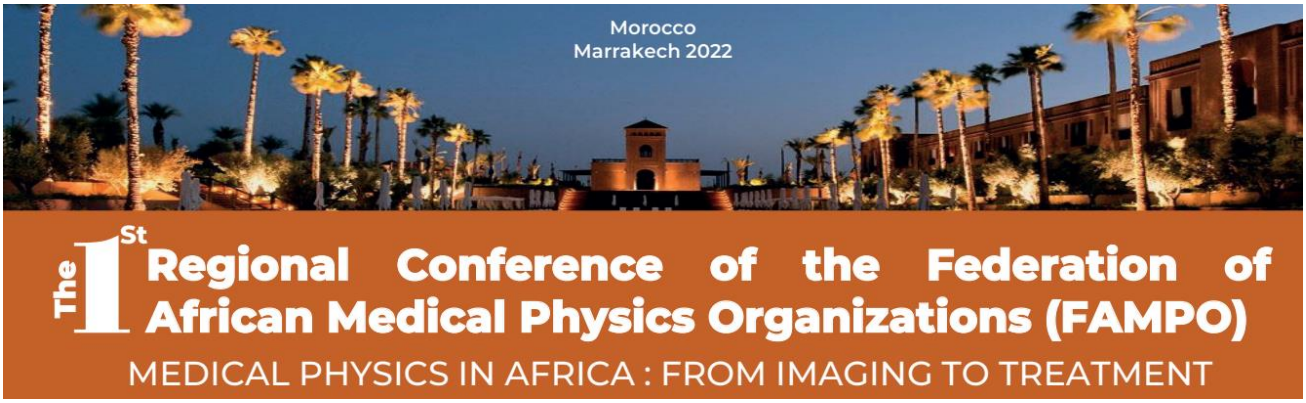
Abstract

Quality control tests have been undertaken in selected public and quasi-government diagnostic radiology Centres in the Greater Accra Region of Ghana, with the aim of improving the overall safety and effectiveness of diagnostic radiology service within those departments' while developing the skills of trained medical physicists who have been recently employed. The tests were performed as part of implementation of the new "IAEA/AFRA Harmonized Diagnostic Radiology Quality Control Manual" developed under the Technical Cooperation Regional Project RAF6/053 entitled: "Enhancing Capacity Building of Medical Physicists to Improve Safety and Effectiveness of Medical Imaging". Test were performed on twenty (20) conventional X-ray, seven (7) CT systems and three (3) mammography systems. The tests were undertaken using the Radcal Multimeter and accessories. Tests performed on the systems include beam perpendicularity, output reproducibility, accuracy, beam quality, leakage, timer accuracy and reproducibility, and dose. Generally, results obtained were with tolerance levels for most of the tests performed. A few of the tests could not be performed on some of the imaging systems due to peculiar challenges such as unavailability of screen-film (cassette) systems, lack of some phantoms and tools, etc. The newly developed QC protocol has been found very important towards improving quality of practices in diagnostic radiology centres. It was observed that the test for entrance surface dose was not included in the manual. It is recommended that protocols for Computed Radiology (CR) systems and other newer imaging modalities should be included in the protocol.

Keywords:
QC protocol, IAEA, computed radiology, accuracy, reproducibility



Re-Evaluation of Dosimetric Treatment Plan of Patients Treated with IMRT for Nasopharyngeal Cancers Using CBCT

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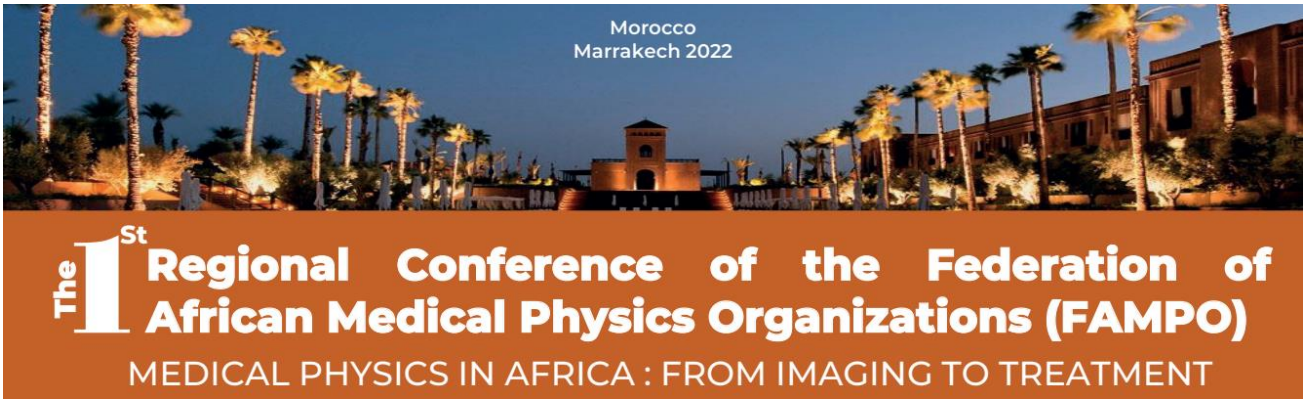
Abstract

Anatomical changes in patients during radiotherapy treatment can have a significant dosimetric impact on target volume coverage or protection of organs at risk. Adaptive radiotherapy can adjust for these variations, but its implementation in clinical routine is hampered by a significant additional workload for medical staff. The aim of this study was to re-evaluate the dose received by the patient from the CBCT images. In this study, we started by simulating the changes on several phantoms. Then, to highlight the importance of adaptive radiotherapy, we focused on the dosimetric re-planification results of 25 patients treated using various methods. With CBCT images obtained at least once during the fourth week of treatment using the OBI®, we were able to track the patient's morphological and dosimetric changes. For the first method, it should be remembered that the TPS starts measuring the dose at the outer contour. Because of this, we were able to re-use the planned CTi and only change the external contour and parotid contour that were imported from the CBCTn. Therefore, we have updated the contour of the CTi to provide a CTn. Since there are no significant modifications, the rest of the OARs are unchanged. The second method of calculating dose is based on CBCT, and it consists of assigning density values to the structures after segmenting the image (1 HU to the whole external contour, -800 HU for air cavities, and +800 HU for bones) to create the forced CBCTn (CBCTn, forced). Using Eclipse version 13.7, regarding CTi, CTn, CTn, forced, CBCT, CBCTn and CBCTn, forced planning, we used the same ballistics with the same processing isocenter. We have noticed that the absolute dose, at a point, for the phantom case may increase by 5% once the volume is reduced by 10 mm, although the difference varies from site to site. Regarding the clinical analysis, it was discovered that the D95% of the PTV varied between CTi and CTn for the initial approach by around 5.5% and 5.0%, respectively, between CTi and CBCTn. The decrease in coverage of the PTV leads us to the importance of adaptive radiotherapy. For the comparison of the D95% of the PTV on CBCTn and CBCTn, forced, we found a mean difference of about 1.03%, and for CTi and CTn, forced, we found a mean dose difference of 5.96%. For the right parotid and the oral cavity, the difference in doses between CBCTn and CTn was 3.2% and -0.5%, respectively. The oral cavity was more responsive, with a difference of 1.5% in the second method, while the right parotid gland exhibited a difference of 2.5% between CBCTn and forced CBCTn, forced. We found that the dose to the OARs varied based on the method used. This is especially apparent in regions where the anatomical changes were more pronounced (especially in the neck, where there is fat). The TNM classification and the tumor's localization both affect the deviations that were detected. The electron density uncertainty for a given pixel could be eliminated using the forcing method. However, it presented a challenge for structures like the lymph node volume that could not be acquired with the KV detector. It is therefore concluded that the modified CT (CTn) method gives a good option for performing dosimetry by removing the uncertainties from the HU and the cut-off CBCT images. Although the two approaches were comparable, the first one was quicker and easier.

Keywords:

IGRT, ART, CBCT, CT, nasopharyngeal, Eclipse, TPS, planification.



Comparative Study Between Calculation Algorithms and Validation by Monte Carlo

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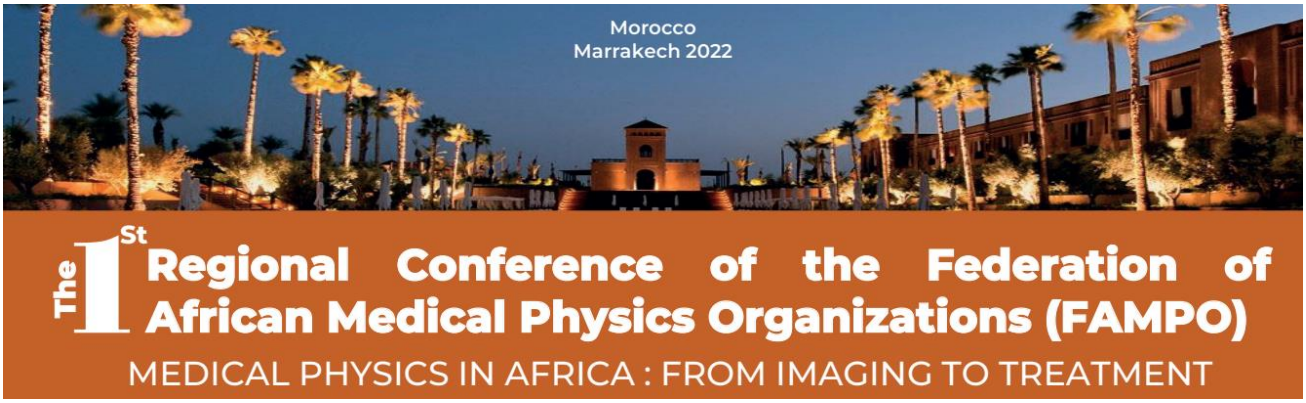
Abstract

In radiotherapy, it is essential to have a precise knowledge of the amount of radiation delivered in target volume and the neighbouring critical bodies. To be useable clinically, the models of calculation must take account of the exact characteristics of the beams used and densities of fabrics. Today, we use more efficient calculation algorithms with a more precise distribution of amount of radiation and with a better knowledge of its distribution. A simulation of the head of irradiation of accelerator UNIQUE in photons mode and a dosimetric study of the amount of radiation in a water phantom and in a heterogeneous medium have been conducted. This study was carried out with Monte Carlo GATE simulation code adapted for applications of medical physics; the results are compared with the data those of the TPS ECLIPSE verison 13.6.

Keywords:

Radiotherapy, volume target, accelerating, head of irradiation, dosimetry, ionizing radiation, TPS



Mathematical Models for Diagnostic and Therapeutic Approaches in the Treatment of Tissue Lesions

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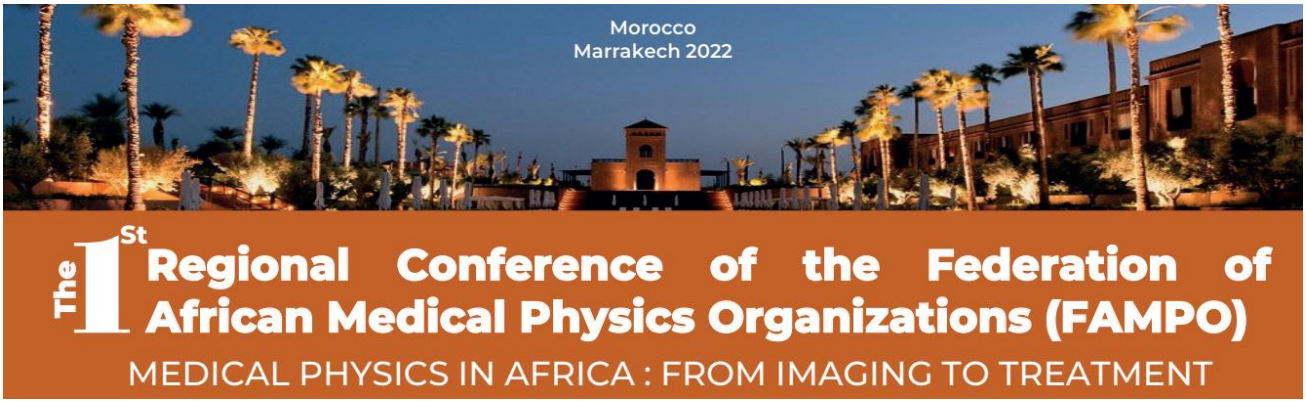
Abstract

Advanced numerical modelling has become a crucial approach in many fields. To accelerate the development of diagnostic and therapeutic methods in medical biophotonic, many approaches are developed, generally based on numerical solutions. The most robust numerical method is Monte Carlo. The Monte Carlo method becomes a benchmark to model the radiation and biological tissue interactions. We used a generic tissue that approximates a real one, using the optical properties of the lesions and healthy tissues. The model was constructed in respect of the anatomy of the studied tissue. We constructed a multilayer tissue model with lesions, by varying the optical and spatial parameters. We explored the effect of these parameters and wavelength of non-ionizing light source, in the strategies of the diagnosis or therapy of the lesions. Results are presented and discussed.



Smart Radiation Shielding Designs for Building Versatile Radiotherapy Treatment Facilities

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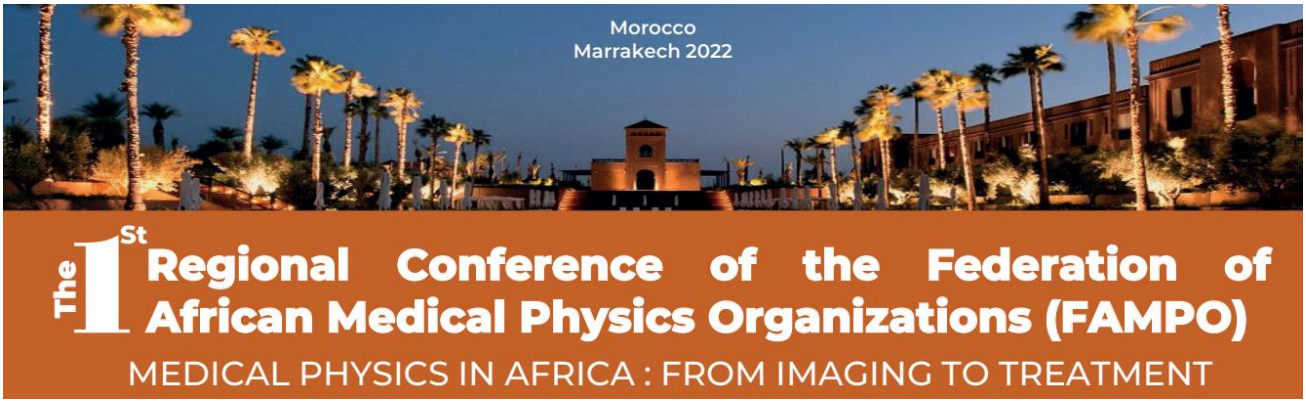
Abstract

The importance of providing accurate, readily available treatment for cancer patients cannot be described in words, but the warranty of providing a safe environment where these treatments take place is as important and deserve to be constantly kept in mind. The advancement of LINACS technology and thus the delivery techniques and methods often cause the needs for the review of the treatment rooms' shielding. In order to offer a radiation shielding that embrace the dynamics and evolution of treatment options, such as the adjusting to high dose rate-based treatment, whether it is simple radiosurgery using FFF beams or using extreme high dose rates such as in Flash radiotherapy treatment, we developed a modulable – Lego-like high density radiation shielding blocks, Verisheilds, that offers a solution to the above problem and simplifies the physics of the radiation shielding as it provide balanced TVLs for both photons and neutrons simultaneously. In addition, thanks to the modules' high density, the treatment rooms' footprint is reduced, saving project realization time and money. In this communication, we will present the underlying physical properties of the high-density shielding blocks that enable their radiation shielding capabilities and present a typical use case to illustrates the pros and cons of building a radiotherapy cancer centre using the Verishields blocks.

Keywords:

Verishield blocks, radiotherapy, shielding, treatment room, high density, physical properties



Large Scale Clinical Implementation of In-Vivo Dosimetry With SUNCHECK: Results and Discussions

Fadoua Raouassi1, Ahmed Taieb Mokaddem[1], Ali Dabach[1], Evy Bossuyt[1], Yawo A.C Fiagan[1], Dirk Verellen[1].

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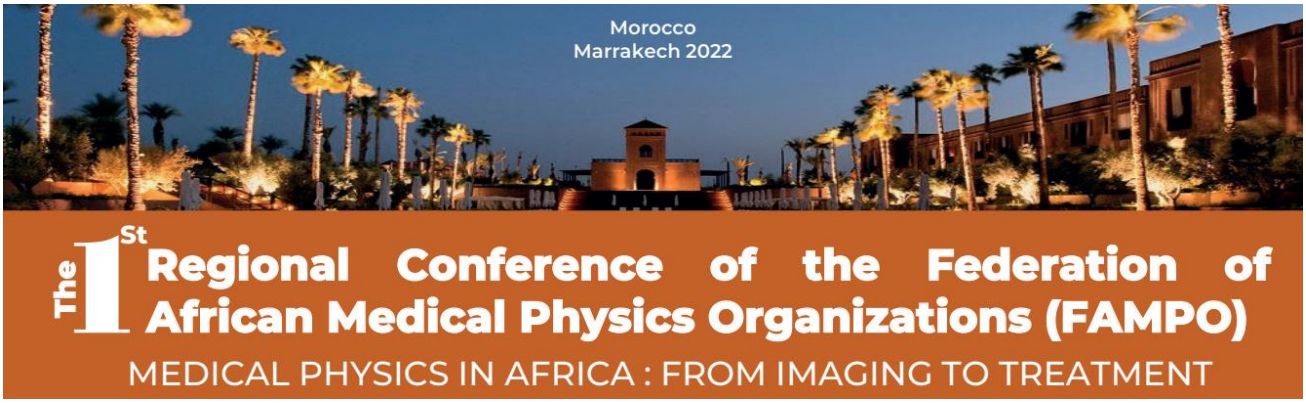
Abstract

Different types of uncertainties (planning, anatomy changes, patient positioning...) that occur during radiotherapy can have a significant impact on the patient's treatment quality. Fully automated EPID-based systems have proved their efficacy as an in-vivo dosimetry QA tool and a potential base for adaptive planning. Since 2018, our Institution has implemented an automated EPID-based system (PerFRACTIONTM, SunCHECKTM, Sun Nuclear Corporation), for pre-treatment and in-vivo dosimetry (EIVD) measurements. To evaluate the impact of this system, a clinical study was conducted on 3709 patients. A further application to the results of this study was comparing treatment uncertainty for ultra- (5fx) vs conventional (15x) hypofractionated breast radiation. EPID based transit dosimetry images were taken during treatment and compared with the calculated predicted dose images. This study was conducted on 18193 fractions measured from September 2020 to August 2021. The analysis was performed by an automated software* using corresponding templates for each treatment region. Tolerance levels and thresholds were adjusted taking the treatment site into account to maintain an accurate ratio between clinically relevant issues and false positive data. The results of the analysis are then investigated by the physicist to determine the cause of failing. Actions in form of decision trees were introduced in the clinical workflow to classify the failed fractions. Causes of the failed fractions were categorized into groups: technical problems (43%), patient anatomical variation (33%) and setup errors (23%) (Figure 1). Actions for failed fractions mainly consisted of performing extra imaging and repeating the measurements. The comparison of the breast standard and ultra-fractionation using daily online IGRT showed more failed fractions 12% vs 3.8% respectively. The causes can be classified into positioning errors (7.4%), technical issues (3.1%) and breast swelling (1.4%) for 15 fractions group vs 2.2%, 1.2% and 0.5% respectively for the 5 fractions group, proving that daily online IGRT can reduce treatment errors. EIVD and the analysis of the failed fractions gives an overview on the potential causes of treatment errors. However, as tolerance levels will vary with new techniques and experience, revision will be required on regular intervals for a correct identification of failed fractions. A further optimization of the workflow would be to use Machine Learning models as a classifier between technical issues (beam interruption, imager calibration, machine related problems...) from patient related issues such as positioning or anatomical changes that might have relevant clinical implications.

Keywords:
Anatomical changes, optimization, automated software, breast, measurement



On the First Experience of Automatic Assistant Contouring Using MIM Maestro in Morocco: Possibilities and Challenges

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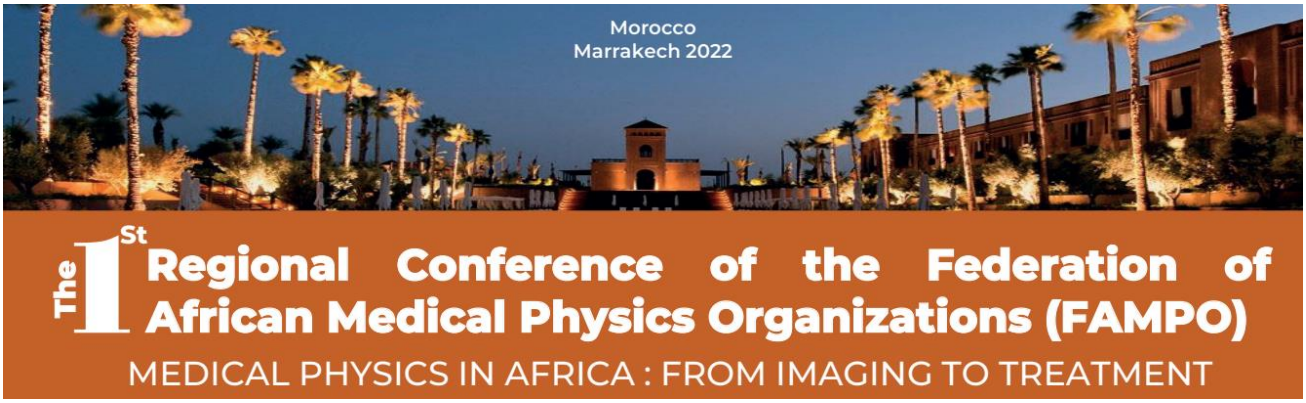
Abstract

Automatic contouring of tumours and organs at risks (OARs) using advanced Atlas and Artificial Intelligence is becoming mainstream in radiotherapy practice. Several radiotherapy software technologies such are leading the way in this rapidly changing field. A premier pilot experience consisting of deploying the MIM Maestro for automatic contouring is on the way at the radiotherapy cancer centre in the Regional Hospital in Agadir – Morocco. In this communication, we will report on the phasing out of the manual contouring on the XIO platform and the rolling out of the MIM Maestro platform for automatic contouring using both atlas and Artificial Intelligence. Several clinical cases, namely, head and neck and thoracic malignancies are presented and discussed. A detailed comparison of the workflow efficiency and production time cost function comparing our previous platform (XIO) and our new platform MIM-Maestro.

Keywords:

Tumour, OAR, artificial intelligence, cost function, MIM



A Novel Curricular Model for Medical Physics and Radiation Protection Education – An Alternative Possible Way Forward for Africa?

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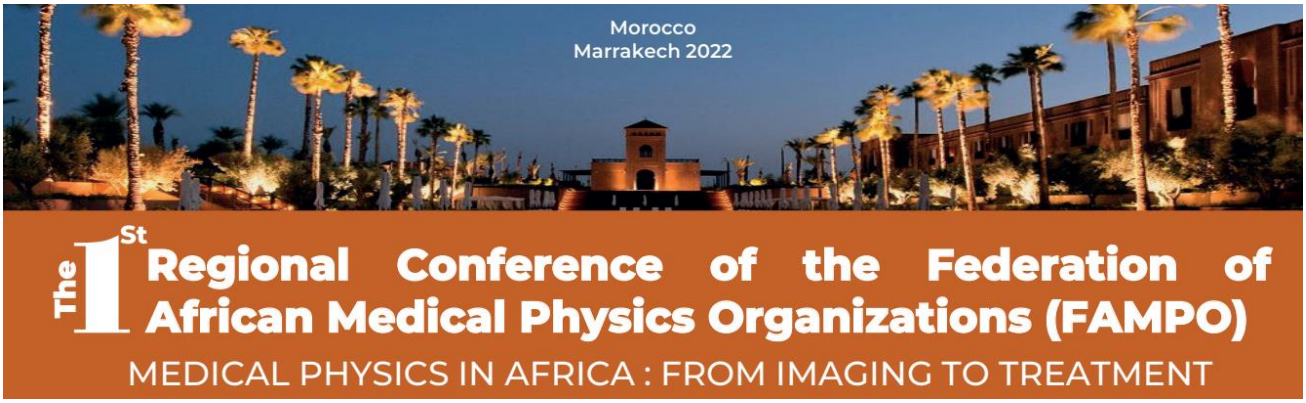
Abstract

In Malta the Medical Physics and Radiation Protection professions have faced an acute shortage of entrants to the professions owing to the low popularity of two-year Master's programmes and the irregular number of physics/engineering graduates. A formula needed to be found to: (a) address the paradox of having to reduce the masters programme to one year at a time when the knowledge-skills-competences required for modern medical physics and radiation protection practice are expanding rapidly (b) ensure that the potential stock of entrants to the profession would be independent of erratic student numbers in other departments and faculties. We also wanted to address what we believe are shortcomings of the present model of medical physics education particularly the low level of medical science and lack of early hospital experience (given that Medical Physics is a healthcare profession). The programme also needed to be cost-effective and very importantly attractive to the young people of today. An extensive literature review and survey of Medical Physics undergraduate and Master's programmes was carried out. Best practices were identified and used as inputs to the model. We have opted for an undergraduate inter-faculty programme that combined physics, medical sciences, medical physics, radiation protection and hospital experience. This ensured that the resulting degree would satisfy the undergraduate requirements for Medical Physicists and Radiation Protection Experts as stipulated by the European Guidelines on the Medical Physics Expert, EFOMP and IAEA guidelines for Medical Physics and the ENETRAP, IRPA and HERCA guidelines for Radiation Protection Experts. The resulting four-year programme consists of 5 parallel strands namely physics/ mathematics/ statistics, medical-sciences, medical-physics, radiation-protection, research and hospital placements. Those opting for a Medical Physics career can then follow with a Masters in Medical Physics. Because of the solid undergraduate background, we can now make the MSc Medical Physics more comprehensive and including all traditional specialties of Medical Physics plus machine learning, pattern recognition, advanced signal and image processing and physiological measurement. This innovative curricular experiment has been a great success and has attracted many students. The inter-faculty nature of the programme (where students share lectures with both physics students from the Faculty of Science and healthcare students of the Faculty of Health Sciences) together with the element of clinical practice have been found to be the most appealing features. We recommend the model to African countries.

Keywords:

Medical physics, curriculum, radiation protection, IAEA



Comparison of Stereotactic Plans Performed on Precision and Eclipse Treatment Planning Systems for Craniopharyngiomas

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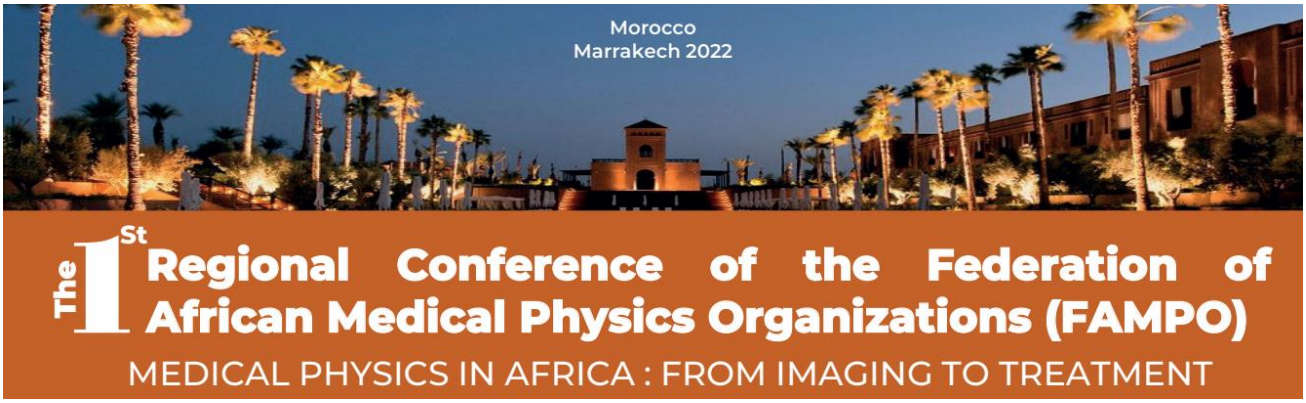
Abstract

Dose escalation or hypofractionation requires a high quality planning and patient setup. The objective of this study was to compare two planning methods for the management of craniopharyngiomas in stereotactic condition. A multi centric study (Saint Quentin Hospital Center and Amiens University Hospital) was conducted to compare the planification performed on the TPS Précision® and the TPS Eclipse®.

Keywords:

Hypofractionation, quality planning, patient setup, craniopharyngiomas



Implementation of AlignRT in Tomotherapy Breast Treatments

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Abstract

The implementation of the Surface Guided Radiation Therapy (SGRT) system in Tomotherapy for the breast treatments aims to improve the patient's setup and reducing MVCT frequency and/or length. The primary objective of this study is to quantify MVCT shifts for two setup methods: Tattoos based setups and AlignRT ® (Vision RT Ltd., UK) based setups.

Keywords:

Surface, radiation therapy, MVCT, SGRT, tattoos

The 1St Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Choice of Reference Isodose for SRS Treatments on a Novalis Machine Using Dynamic and Conformal Arcs

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Abstract

For stereotactic treatments, the normalization method has an impact on the Dosimetry quality. This method should be defined according to the machine, energy and the used collimator. Several studies were carried out regarding Cyberknife and Gammaknife treatments for whom the recommended reference isodoses are 80% for the CK and 50% for the GK. Fewer similar studies were carried out for conventional accelerators, hence our interest for this topic. The aim of this study is to define the most suitable normalization method for intracranial stereotactic using a Varian/Novalis machine with Dynamic Conformal Arcs (DCA) and a 120HD MLC for a 6XSRS energy. The selected normalization isodose should allow the increase of tumour control while decreasing the probability of radionecrosis.

Keywords:

Conformal, cyberknife, gammaknife, dosimetry, arcs

The 1St Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Robustness Comparison Between Two Extended Fluence Methods for Breast Cancer VMAT Treatments

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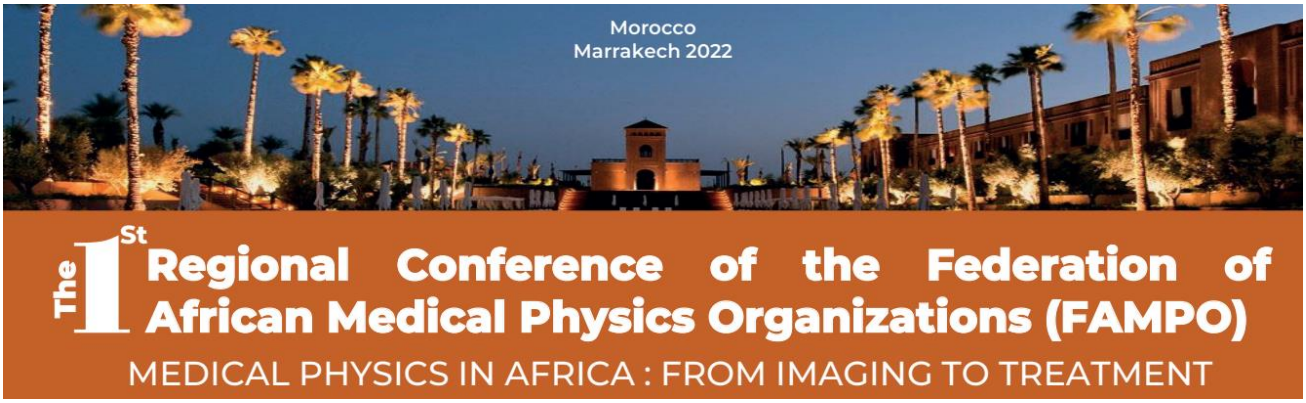
Abstract

One of the challenges in breast cancer treatments using VMAT is to account for breathing movement and morphology changes during treatment. In order to do so, one should extend the fluence beyond the body. The aim of this study is to assess the robustness of a VMAT breast treatment without extended fluence and to compare the robustness of two extended fluency methods. This robustness is assessed by applying a positioning error of 5 mm to the treatment isocenter in the three directions, x, y (antpost, right left) and z. The DVH is then analyzed for those two methods after the error is applied.

Keywords:

VMAT, morphology, fluence, isocentre, cancer treatment



Dosimetric Comparison of VMAT, SWIMRT and DCA in Intracranial Stereotactic Radiotherapy

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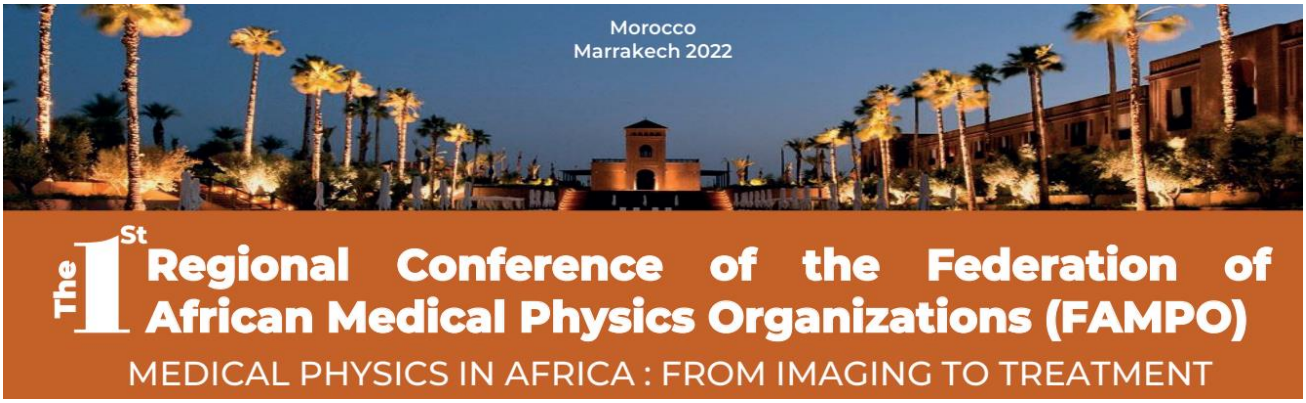
Abstract

Intracranial stereotactic for the brain metastases can be performed using a standard linear accelerator. There are different options for planning and the delivery of intracranial stereotactic treatment. The VMAT technique, newly introduced, is the reference technique used at the Salah Azaïez Institute (ISA). The objective of the study is to compare the dosimetric parameters of brain metastases managed by VMAT with those obtained by intensity modulation Sliding Windows (SW IMRT) and the dynamic conformal arcs (DCA). Eighteen patients were enrolled in this study. The average prescribed dose was 26.96 Gy (range, 23.1-30 Gy) in 3 to 5 fractions. For each patient, three plans were created. The VMAT plans and the SW IMRT plans were optimized and calculated in Eclipse v. 13.7 (Varian, Palo Alto, CA) using a 6 MV X-ray. An AXB algorithm (v. 13.7) was used with a 1 mm grid resolution and an optimization done with the PO algorithm (v. 13.7). The plan realized by the DCA was made by 3-5 non-coplanar arcs. The SW IMRT plan with non-coplanar multi-fields (9-13 non-coplanar beams) was generated for the same plan with the same dose prescription. The dosimetric analysis for the coverage of the planning target volume (PTV) including the parameters and the indexes recommended by the IRCU 91 such the Conformity Index (CI) and the Gradient Index (GI). The healthy brain constraints were reported, as a function of the number of fractions, according to the QUANTEC recommendations. A comparison of the number of Monitor Units (MU) was also performed. The mean volume of the planning target volume was 17.75 cm^3 (range 3.9-32.33 cm^3). The PTV coverage generated by the three techniques met the dosimetric criteria. The mean of the relative Minimum Dose was 95.42% for VMAT, 90.063% (range: 82.35-93.98%) for the DCA plan and 95.248% (range: 89.76-101.5%) for the SW IMRT plan. The mean of the relative Maximum Dose was 118.45% (range: 117.9-123.14%), 130.11% (range: 126.9- 135.16%) and 119.62% (range: 110.22-136.7%) for VMAT, DCA and SW IMRT plans respectively. The CI was 1.27 for VMAT, 1.31 (range 1.18-1.43) for DCA and 1.4 (range 1.28-1.59) for IMRT. The GI was 0.63 (range: 0.5-0.73) for DCA versus 0.73 (0.6-0.78) for VMAT and 0.87 (range: 0.62-1) for SW IMRT ($p<0.001$). For patients treated with the 3-fractions, the V21 Gy of the healthy brain was met (<20.9 cm^3) with an average of 9.006 cm^3 (range: 2.086-15.456 cm^3) and 12.431 cm^3 (range: 1.857-19.8 cm^3) for the DCA and SW IMRT plans respectively. The V24 Gy of the healthy brain was also respected (< 16.8 cm^3) with an average of 5.335 cm^3 (range: 0.649-10.19 cm^3) and 6.972 cm^3 (range: 0.338-13.5 cm^3) and 5.887 cm^3 respectively for the DCA and the VMAT and SW IMRT plans. The number of MU was lower for the conformal dynamic arc technique with a mean of 1187 (range: 948-1484) compared to 1824 (range: 1449-2418) and 2220 (range: 16885-2875) for VMAT and SWIMRT. The homogeneity was similar between these three treatment techniques
The reduction in treatment time by VMAT will allow a rapid delivery of the dose and thus potentially limit the intra-fractional movement. The dynamic conformal arcs (DCA) planning does not differ from VMAT or Sliding Windows IMRT in terms of target coverage and preservation of the OAR, and it have the plan resulted have a better gradient with a significantly lower total number of MUs which may have a clinical impact.

Keywords: VMAT, SWIMRT, DCA, intracranial stereotactic, dynamic conformal



Usefulness of Locally Constructed Phantoms for the Validation of Planned Radiation for Breast Cancer Radiotherapy Treatment

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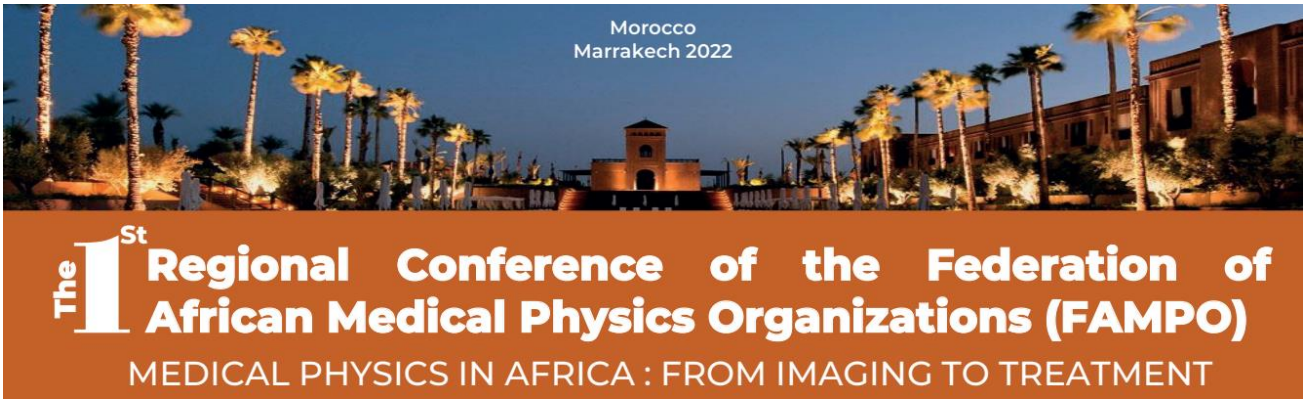
Abstract

GLOBOCAN estimates, indicate that 4482 new cases were diagnosed, and 2055 death occurred due to breast cancer in Ghana in 2021; making it the commonest female cancer and a major public health challenge. To ensure the facilities in Ghana implement quality control measures, this study was designed to determine and compare planned with actual doses delivered to the breast during treatment. To achieve this, the major limitation of the non-availability of phantoms was addressed by the construction of phantoms, using perspex and locally available materials that mimic organs of the female thoracic cavity. Based on scanned images, two phantoms were constructed. Balloons, mango seed, cassava stick, and candle were radiologically assessed and used as surrogates for the lung, heart, spinal cord and glandular tissue of the breast respectively. Higher photon energies from a ^{60}Co and LINAC machine were targeted at the left breast of a standard and the two constructed phantoms. EBT3 film dosimeter was used to measure absorbed doses to the breast and non-target organs. The deviations of delivered doses from planned doses when the standard anthropomorphic phantom, constructed phantoms A and B were used, ranged as follows, -0.05 – 0.03 Gy; -0.08 – 0.01 Gy; -0.14 – 0.01 Gy respectively, when the radiation was delivered by a Cobolt-60 machine. When the radiation was delivered by a linear accelerator system, the deviations were -0.05 – 0.03 Gy; -006 – 0.07 Gy; -0.06 – 0.04 Gy respectively. The left lung and spinal cord received the highest and lowest unintended dose, 0.74±0.04 Gy (Co-60) and 0.78±0.01 Gy (LINAC), and 0.03±0.02 Gy and 0.05±0.01 Gy respectively. The study has demonstrated that local materials are potentially useful for the construction of phantoms, which can be good substitutes for standard commercial phantoms in ensuring the safety of patients under-going radiotherapy treatment for breast cancer.

Keywords:
Phantom, cobolt-60, LINAC, breast, glandular tissue



Elaboration of a Clinical-Economic Guide by Comparison of Three HDR Brachytherapy Technologies

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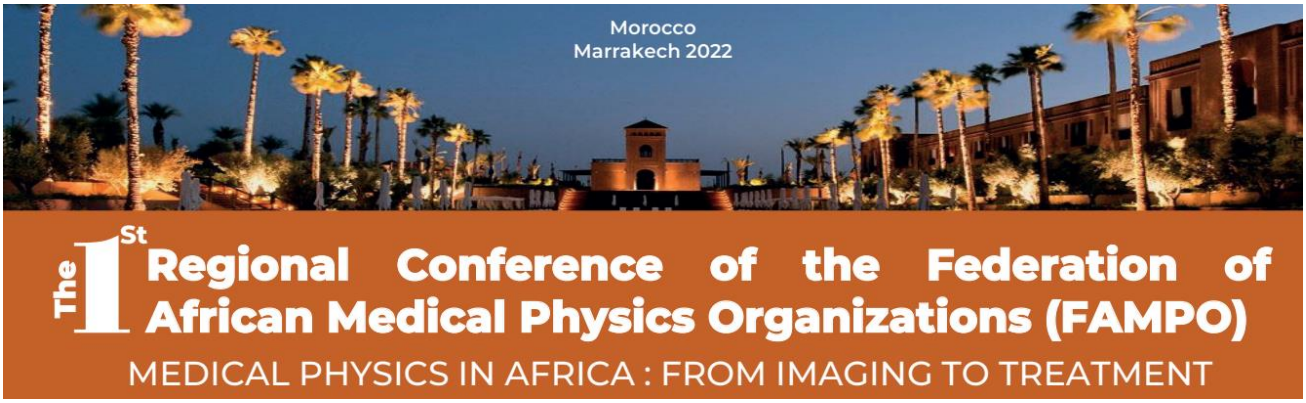
Abstract

This study was set up to establish a Clinical-Economic Guide of HDR brachytherapy Technologies with radionuclide and electronic sources. This guide is intended to help radiotherapy professionals to make educated choice about the appropriate brachytherapy device for their practices. We studied three HDR brachytherapy devices, two of which use radionuclide sources (^{60}Co and ^{192}Ir) and the third uses an electronic source (Axxcent-Xoft e-HDR system). We elaborated to a technical matrix comparing the different technologies with respect to their clinical use and their technical maintenance requirements as well as their financial cost. We also conducted a field survey of various clinics to cross-check our comparative matrix with respects to the actual use of these technologies within the Moroccan radiotherapy clinics. An economic study targeting the capital cost of these various HDR technologies based has also been conducted. Based on the above, we developed a calculator to evaluate the effectiveness of cost versus clinical use of these tree technologies. In Conclusion, the results show that electronic brachytherapy (Axxent Xoft) has superior effectiveness cost function. It proves more advantageous because clinically it provides low dose to organs at risk, offers additional treatment options (IORT, APBI...) and reduces radiation hazard to personnel, no radiation leakage. Economically it requires no radiation bunker, requires no periodic source maintenance and produces no radioactive waste while it provides stable treatment time (no decay).

Keywords:

HDR Brachytherapy, Co-60, Ir-192, Axxent Xoft, System-Calculator, Clinical-Economic Guide.



Determination of the TG-43 Parameters of the Oncoseed 6711 I-125 Seed

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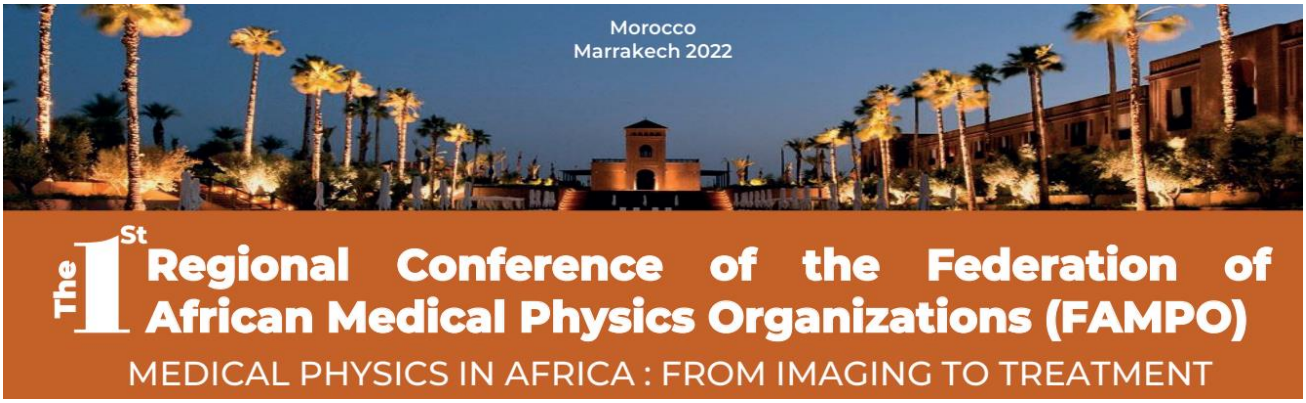
Abstract

The American Association of Physicists in Medicine formed Task Group 43 in 1988 to review the dosimetry of interstitial brachytherapy sources and recommend a dosimetry protocol. The protocol is based on measured or measurable quantities. These include the anisotropy function, the dose rate constant, the geometry factor, the radial dose function, and the air kerma strength. The OncoSeed 6711 seed contains iodine-125 that is adsorbed on a silver rod, which is encapsulated in a titanium capsule. The aim of this study was to accurately determine the various dosimetric and physical characteristics of a single I-125 seed. The geometry function was determined by measuring seed dimensions with a vernier caliper. Dosimetric measurements were done in two specially designed solid water phantoms using calibrated thermoluminescent dosimeters (TLDs). The TLDs were supplied as 3x3x0.9 mm chips. These measurements, in conjunction with the obtained geometry function, were used to determine the radial dose function and anisotropy. The measured dose rate at the reference point was divided by the manufacturer supplied air kerma strength to obtain the dose rate constant, taking into account the radioactive decay of the seed during the measurement. Air kerma strength / apparent activity was verified with a calibrated Sourcecheck 4π chamber. The geometry function matched nominal seed data within 1% at 5mm and better at larger distances. The ratio of measured apparent activity vs manufacturer stated activity was 0.999±0.031 over seven batches of seeds. The calculated dose rate constant was 0.96±0.20 cGy/h/U. The measured anisotropy and radial dose function were well within one standard deviation from published data. TG-43 seed parameters were obtained for the OncoSeed 6711 I-125 seed. The solid water phantoms can now be used to determine these parameters for other commercially available seeds.

Keywords:

Kerma strength, geometry function, interstitial brachytherapy, anisotropy function



Assessment of PTV Margin Before and After the Treatment Using CBCT on Halcyon LINAC

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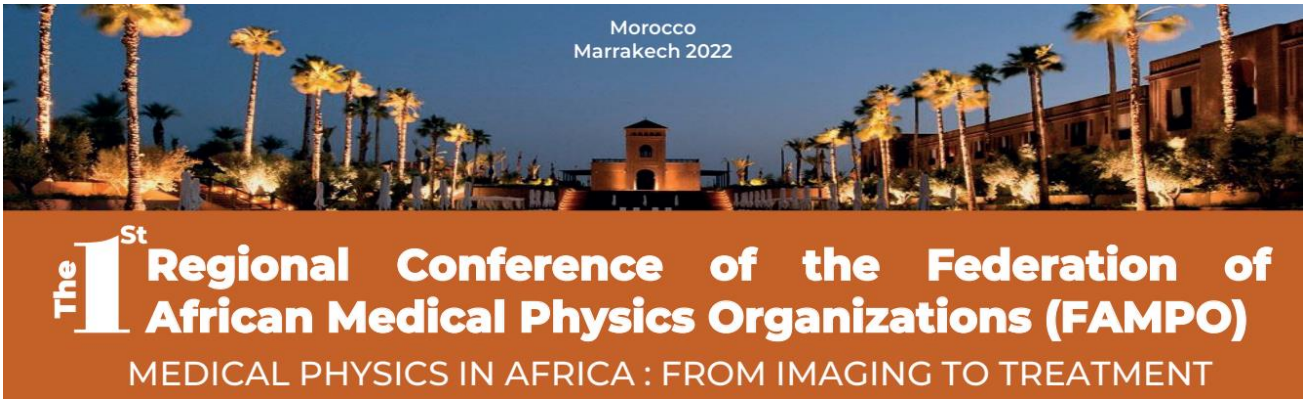
Abstract

In this work we evaluated planning target volume (PTV) before and after treatment for breast Cancer using CBCT imaging modality and VMAT technique. Set-up and random errors were calculated for 10 patients presented for breast cancer treatment with VMAT technique. CBCT images were carried out for each patient before and after treatment to evaluate intrafraction motion. CTV was contoured by radiation oncologist according to our clinical protocol for breast cancer Van Herk formula (PTV margin = $2.5\sum+0.7\sigma$). With respect to systematic error along the lateral axis, longitudinal and vertical was 0.22, 0.24 and 0.4 respectively before treatment and 0.01, 0.01 and 0.4 respectively after treatment. The Random error was 0.52, 0.52 and 0.31 along lateral axis, longitudinal and anterior-posterior respectively before treatment and 0.07, 0.18 and 0.07 respectively after treatment. The calculated safety margin to cover clinical target volume (CTV) taking the breast variability into account measured 1.26, 0.98 and 0.34 cm for lateral, longitudinal and anterior posterior respectively before treatment and 0.09, 0.25 and 0.16 respectively after treatment. The calculated safety margin smaller than 1 cm for all direction except in the lateral direction that was 1.26 cm before the treatment. The PTV margin after treatment was not the same as expected.

Keyword:
Margin, CBCT, Van Herk formula, cancer,



Application of the IAEA Staffing Model in Diagnostic Radiology and Nuclear Medicine in Africa

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Abstract

Within the framework of the regional project RAF6/053 a survey was done based on a staffing model developed by the International Atomic Energy Agency (IAEA). This model takes into account the number and complexity of equipment, patient numbers, radiation protection and safety related activities, service-related activities, clinical training of medical physicists, as well as time dedicated to teaching, training and research, to estimate the number of medical physicists required in diagnostic and interventional radiology, as well as nuclear medicine. This was done to investigate the adequacy of current medical physics staffing levels across Africa. Results of the survey were published open access in “Health and Technology”. However, they will also be presented at the first FAMPO conference. A survey based on the IAEA staffing model was conducted for five months. This was followed by data verification and evaluation. 82 responses were received from 21 countries, including data from 97 diagnostic radiology and 40 nuclear medicine departments, as well as 75 interventional radiology departments and/or catheterization laboratories. Only 26.8% of surveyed centres employed an adequate number of medical physicists. 63 imaging medical physicists were employed at the surveyed centres, but 134.3 were required according to the algorithm. Data analysis indicated that the number of imaging medical physicists is largely inadequate, at least by a factor of 20 in almost all countries in Africa. This was the first study to investigate the use of the IAEA staffing survey across a whole region. Results indicate that the number of medical physicists in Africa is insufficient and needs urgent addressing.

Keywords:
Medical physicist, radiology, nuclear medicine, staffing model, survey

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Performance of Different Strength Aperture Shape Controller in Optimization with VMAT Technique for Head and Neck, Pelvic and Breast Cancer Using Halcyon Machine.

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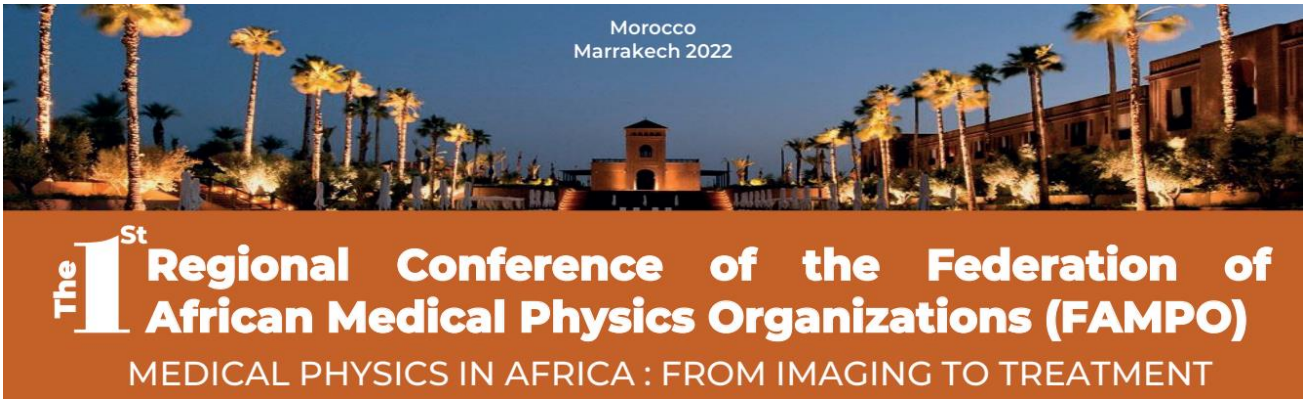
Abstract

Before starting optimization for VMAT technique, the choice of the convenient strength aperture shape controller can be one of the most important factor that affect the plan quality. It is necessary to evaluate different optimization options for different localizations. Three different clinical cases including head and Neck, Pelvic (Prostate, Cervix and Endometrium) and Breast Cancer treated using VMAT technique were chosen. Treatment plans were generated with Eclipse TM treatment planning software (v16.1.0) using a 6X flattening filter free energy and 600 MU/min dose rate. By keeping the same conditions, plans were re-optimized by varying aperture shape controller (OFF, VERYLOW, LOW, MODERATE, HIGH, VERY HIGH). For plan evaluation, homogeneity index, conformity index, target coverage, dose maximum and near maximum and the treatment time delivery (HI, CI, D98%, DMAX, D2%, MUs and gamma index passing rate) were analyzed. Dose coverage for pelvic was very close, between 96.5% and 97% for D98% and for V98% was between 95% and 96% for all optimization techniques, except in VERY HIGH that was under 95%. The best results for maximum and near maximum dose obtained in VERY LOW with 106.5% and 103.75% respectively. For Breast treatment, DMAX was between 110% and 110.5% for all techniques, and between 106% and 106.5% for D2% always with 0.5% lower in VERY LOW optimization technique. An improvement of 5% to 6% in dose coverage for in Head and Neck treatment is obtained by HIGH and VERY HIGH optimization techniques, and only 106% maximum dose is achieved as the best value for HIGH optimization technique. The best results in MUs calculation achieved by OFF optimization technique for Pelvic and Breast, for Head and Neck it was by VERY HIGH optimization technique. Changing the strength aperture shape controller before starting optimization for VMAT technique can significantly affect the plan quality.

Keywords:
VMAT, optimization, MU calculation, pelvic, gamma index,strength aperture



MIRD Human Phantom External Exposure Scenarios to Ionizing Radiation: Modelling with Geant4

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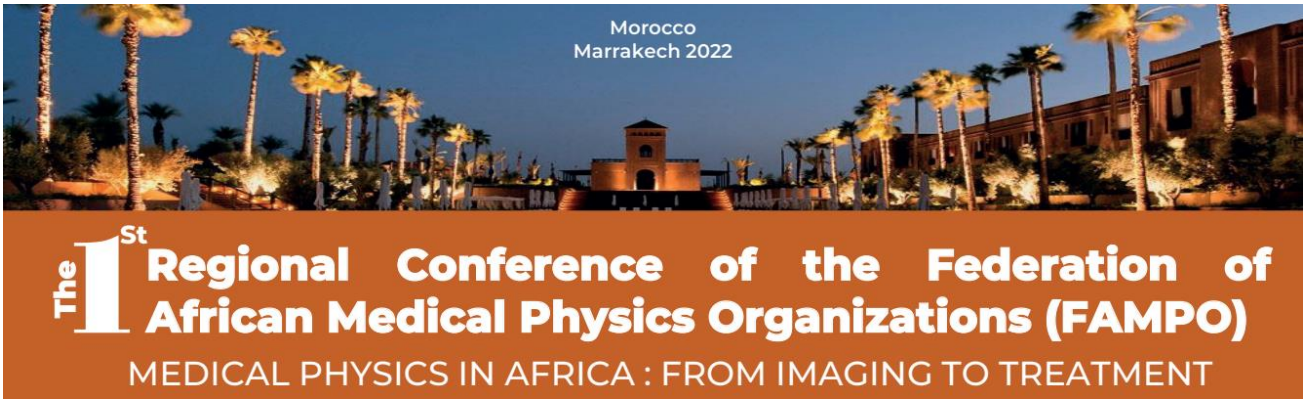
Abstract

From radiation protection perspectives, the availability of a database collecting dose factors for different types of exposure to radioactive sources is fundamental for the prediction and prevention against the harmful effects of ionizing radiation. In this context, the use of Monte Carlo codes in general and Geant4 in particular, whose basic principle is based on the random choice of the interaction of radiation with matter, seems at first sight, inconsistent with the rigor and precision required for during metrology measurements. Nevertheless, the considerable benefits that they are supposed to bring, in particular the very comprehensive consideration of the elementary physical phenomena involved in each interaction and the possibility of a very precise description of the geometry and chemical composition of the detector or dosimeter in its real environment, allow us to expect a precise and targeted determination of the physical quantities required, in particularly those items that are inaccessible to the experiment. In this study, we introduce a scenario of external exposure to ionizing radiation simulated by Geant4 (Monte Carlo code C++ developed at CERN in the form of a data library and tools that the user can assemble according to his specific needs), where a person (MIRD human phantom provided by Geant4 toolkit) will be exposed to different configurations of radioactive sources that may actually occur as mentioned in reference. The objective is to evaluate the absorbed dose as well as the equivalent dose of each configuration adopted in this scenario.

Keywords:
Absorbed dose, Equivalent dose, Geant4 code, Radiation protection.



Calculation of Bremsstrahlung and Photoneutron Spectra from Tungsten and Gold Targets using EGSnrc, GATE/GEANT4 and MCNP6 Monte Carlo Codes

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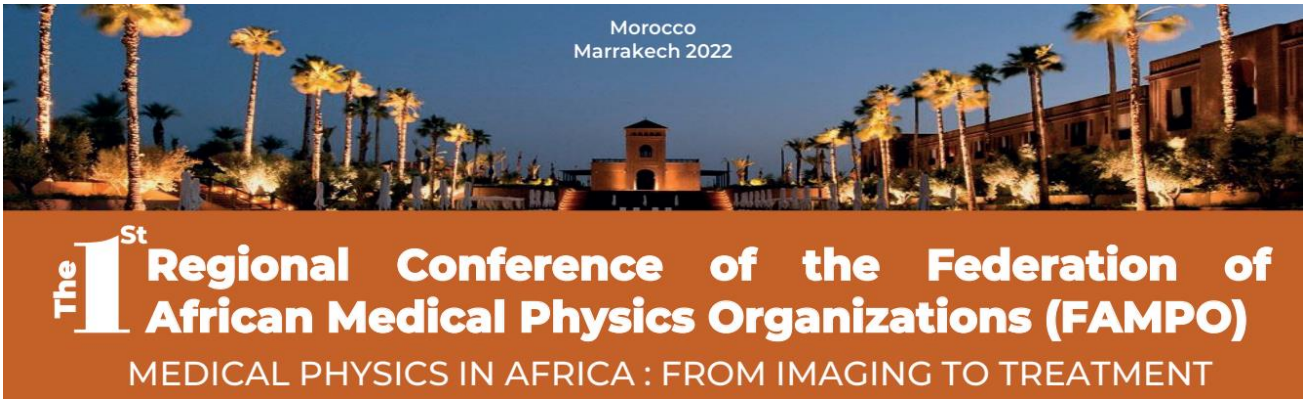
Abstract

High-energy photon beams produced by linear accelerators are widely used in radiation therapy. These photon beams, called Bremsstrahlung radiation, are the result of bombarding a thick target by high-energy electrons. In this study, the spectral distribution of Bremsstrahlung from tick targets of tungsten and gold was calculated using EGSnrc, GATE/GEANT4 and MNCP6 Monte Carlo simulation codes. The influence of target thickness and incident electron energy was investigated. The photoneutron spectra, generated in the target by photonuclear reactions, have also been evaluated for different incident electron energies as well as different thicknesses for both targets with GATE/GEANT4 and MNCP6 Monte Carlo codes. All calculations have been performed at the isocentre in a standard 10×10 cm^2 field with a statistical uncertainty less than 2%. The simulation results, generally, show a good agreement between different simulation codes.

Keywords:

Target, Bremsstrahlung, Photoneutron, EGSnrc, GATE/GEANT4, MCNP6



Dosimetric Analysis of Three Volumetric Modulated Arc Therapy Plans for Prostate Cancer

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Abstract

This study sets out to determine the dosimetric difference between three plans of Volumetric Modulated Arc Therapy (VMAT) by evaluating the dosimetric influence of increasing the number of arcs and using different collimator angles for prostate cancer. We studied thirteen patients with prostate cancer, who received 76 Gy in 38 fractions in our centre between 2017 and 2022. They were treated by VMAT technique with two, three or four Arcs. The photon beams were delivered by Varian UNIQUE™ linear accelerator. The treatment parameters are set as: two full arcs with collimator rotation (20° and 340°), three full arcs with collimator in (20°, 340° and 15°) and four full arcs with collimator rotated in (0°- 90°), using an Eclipse treatment planning system. Different indexes were calculated as homogeneity index HI and conformity index CI to compare and analyze the difference between the three VMAT plans. Results show that the three plans were clinically acceptable, but there were significant differences in the Monitor Units (Mus) obtained. In fact, plans of 2 and 3 arcs reduced the monitor units from 809 to 494. The p value of D95% and D50% were < 0.05 in 4 arcs versus 3 and 2 arcs, indeed 4 arcs conducted to ameliorated PTV parameters. The 4 arcs plan resulted also in decreasing V60% of bladder and rectum.

Key words:
Prostate cancer, radiotherapy, VMAT, HI, CI, p value.

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Assessment of Entrance Skin Dose for Adult Patients Undergoing Diagnostic X-Ray Examinations in the Souss Massa Region of Morocco

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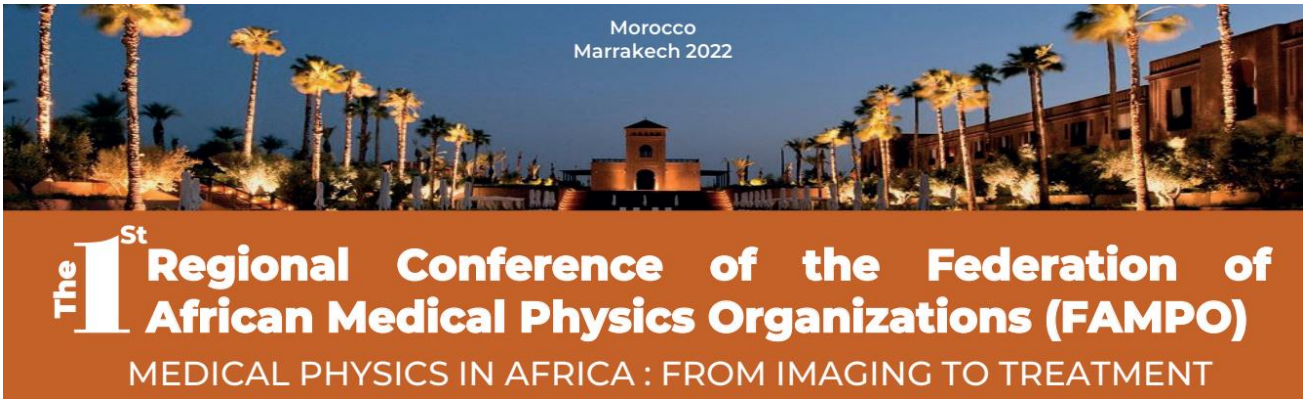
Abstract

The entrance skin dose (ESD) is one of the basic quantities for measuring the patient dose and as well for optimizing the patient dose in conventional radiography. It is recommended as an additional diagnostic reference levels quantity. The objective of this study was to evaluate the entrance skin doses for adult patients undergoing diagnostic X-ray Examinations in the Souss Massa Region of Morocco. Data from 720 adult patients in four radiology departments in the Souss Massa region were collected (The regional hospital of Agadir, the provincial hospitals of Inzegane, Chtouka Ait Baha and Taroudant). The data concerned the following examinations: Thorax posterior anterior (PA), unprepared abdominal x-ray, pelvis, hip, cervical spine anterior-posterior (AP) and lateral (Lat), lumbar spine anterior-posterior (AP) and lateral (Lat). The following parameters were reported for each examination: Age, weight, patient thickness, voltage (kV), electrical charge (mAs), and the skin source distance. The Entrance Skin Dose (ESD) and the Diagnostic Reference Levels (DRL) are calculated for each X-ray examination. DRLs in terms of ESD for the same x-ray examination differ widely from one hospital to another. They ranged from 3 to 14 mGy for the unprepared abdominal x-ray, from 2.6 to 9.4 mGy for the pelvis, from 3.1 to 17 mGy for the hip, from 1 to 49.2 mGy for the cervical spine Lat, from 2 to 32.6 mGy for the lumbar spine AP, and from 18.1 to 50 mGy for the lumbar spine Lat. The variation of doses received by patients in the four hospitals calls into question radiological procedures and practices and calls for a standardization of guidelines for each radiological examination.

Keywords:
Entrance skin dose (ESD), diagnostic reference levels (DRLs), X-ray Examinations, radiation doses.



Cross-Sectional Survey of Physicians' Knowledge about the Computer Tomography Radiation Risk in Morocco

Bouchra Amaoui[1], Fatima Safini[2], Mohamed El Fahssi[3], Laila Lahlou[1] and Slimane Semghouli[3]

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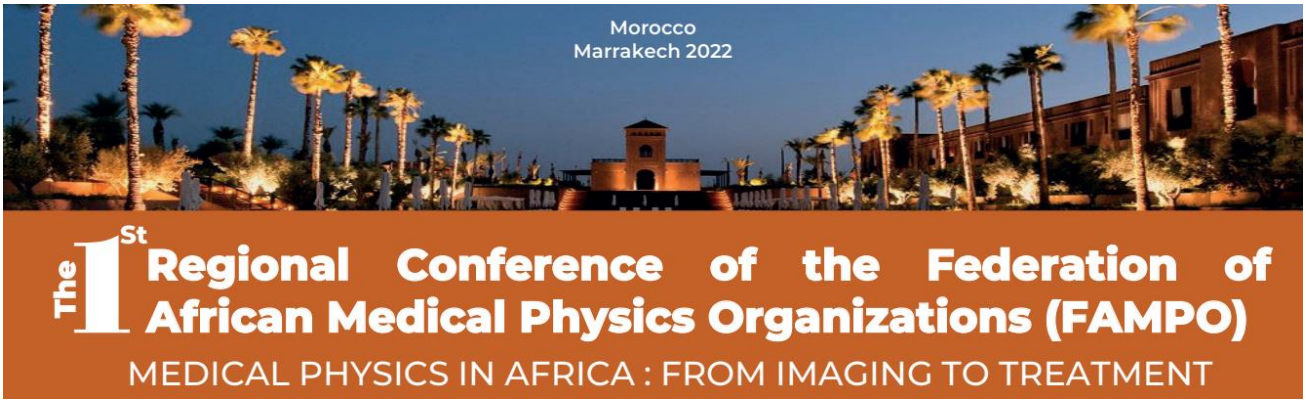
Abstract

The aim of this study was to evaluate the Moroccan Physicians' knowledge about the doses received by patients, and to estimate the eventual risk from exposure to ionizing radiation during computed tomography (CT) procedures. This is a cross-sectional study. A questionnaire with 27 multiple-choice questions was addressed to CT prescribers such as general practitioners, residents, specialists and radiation therapists. The first eight questions asked about the demographics of the participants, and the remaining questions explored their knowledge of ionizing radiation, patient dose, relative risk, and radiation protection of patients training. Data analysis was performed using Excel 2010 software. Statistical tests were calculated by the Statistical Package for the Social Sciences (SPSS version 07.0). A total of 223 physicians participated in this survey were analyzed. Radiation therapists, considered as the reference group, had a better knowledge of ionizing radiation and non-ionizing radiation from medical imaging compared to the other groups (p=0.00330). 67% of the reference group declared to take into account the number of scans performed by the patient during the last year, unlike the other groups (p=0.001998). Furthermore, the knowledge of the different groups on the risk from exposure to ionizing radiation was globally low (2%) with a p-value of 0.73. Regardless of their specialties and seniority, only 12% of the participants informed the patient at the time of prescription about the risk of ionizing radiation. Finally, only 21% of the participants declared having had training in radiation protection, with no significant differences between the subgroups (p=0.832). The results obtained are similar to those reported by previous studies. They showed that Moroccan prescribers have a low level of knowledge about the risks associated ionizing radiation exposure from CT. Training on patient radiation protection should be included in the initial curriculum of interns, and the continuing professional development of physicians should be reinforced.

Keywords:
CT scan; ionizing radiation exposure; patients' radiation protection; X-ray risk.



Comparison of Photon Beam Absolute Dose Calibration Protocols in External Radiotherapy: A Local Study of IAEA TRS 398, AAPM TG 51 and DIN 6800-2

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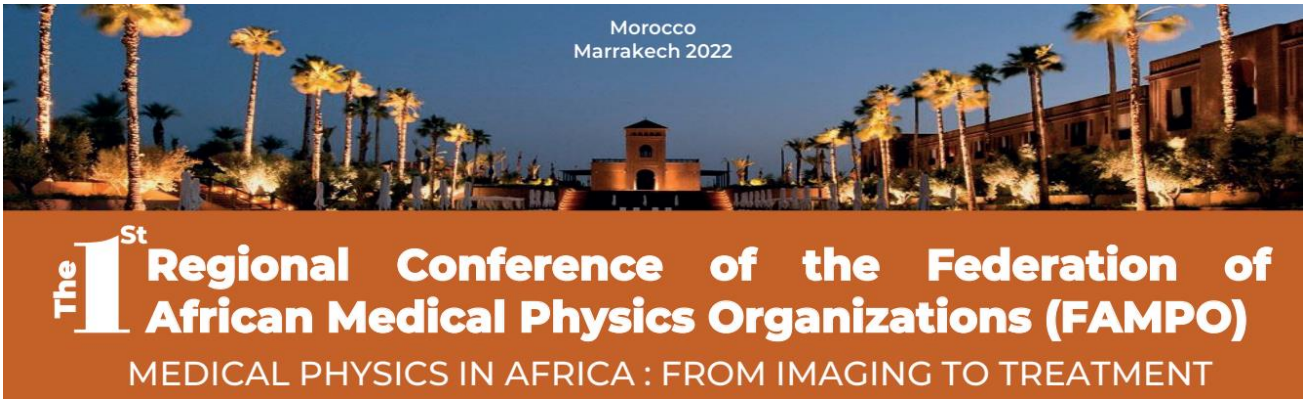
Abstract

The present work reports comparisons of procedures and results in absorbed dose determination according to the IAEA TRS-398 protocol, the American AAPM TG-51 protocol, and the German DIN6800-2 protocol for photon energies of 6 MV and 18 MV. The absorbed dose to water measurements under reference conditions according to TG-51 and DIN6800-2 are very close to those of IAEA TRS-398. The difference in absorbed dose to water between TRS-398 and TG-51 was 0.65% and 0.76% for 6 MV and 18 MV photons, respectively. Thus, the differences between TRS-398 and DIN6800-2 were 0.36% and 0.64% for 6 MV and 18 MV photons, respectively. We then concluded that the TRS-398 protocol is the most advantageous because it contains procedures more suitable for our hospital environment.

Keywords:

Absorbed dose, photon, reference condition, measurement



Evaluation of Set-Up Errors Observed on Daily Image Guidance during SRS and Lung SBRT Treatment

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Abstract

Small malignant tumours can now be treated non-invasively with high doses of radiation using stereotactic radiotherapy (SRT). It is based on the convergence of small photon beams obtained by collimation. Several modalities exist and differ according to the location of the tumour (intracranial or extracranial), the fractionation (unfractionated SRT or radiosurgery and hypo-fractionated SRT), and the type of radiotherapy machine. The success of this therapy is hampered by the many sources of error and geometric inaccuracy that can potentially deviate the delivered dose from the planned one. The aim of our study is to report our experience with the use of stereotactic radiosurgery (SRS) and stereotactic body radiation therapy (SBRT) to treat lung cancer. For this study, 21 patients with DCA plans and 2 IMRT plans (16 SRS and SBRT lung patients) treated in our clinic were selected. For SRS localization, patients were positioned using BrainLab masks, and for the SBRT group, Orfit immobilization sets were used. These patients' treatment positions were manually restored in the kV-CBCTs using the associated planned CTs to align bone with bone and tumour with tumour. A CBCT or KV is performed for each patient during the session to confirm the intrafraction displacement. The difference between the treatment table value (reference) from the initial session and the next session is determined as the deviation. Plans were produced using 5 arcs for 68% of SRS patients and 14% of SBRT patients. 21% of SRS patients and 14% of SBRT patients selected three arcs. Plans were created using two arcs for 11% of SRS patients and 29% of SBRT patients. The only two SBRT patients who receive IMRT receive a ballistic of 7 fields for 14% of them, and 9 fields for 29% of them. Throughout the course of the study, all patients had a total of 153 CBCTs and 425 KV images acquired. Our patients receive an average of 4 KV and 2 CBCT per session. For SRS patients, the mean values and standard deviations of the setup errors in the vertical, longitudinal, and lateral directions were, respectively, -0.1±1.3 mm, 0.2±1.5 mm, and -0.6±1.5 mm. The results for the SBRT group in the vertical, longitudinal, and lateral directions were -0.2±1.5 mm, 2±11 mm, and -2.3±5.2 mm. Between imaging, setup, and treatment, it takes an average of 35 minutes. Some sessions could last an hour, with the imaging and adjustments taking up most of the time. For SBRT localization, the repeatability of the immobilization sets position on the sofa is insufficient. The main challenge is figuring out how to move the patient underneath. the high value of the table shifts for the SBRT instance is explained by this. Reduced imaging time before to radiation treatment is possible with the use of markers and indications.

Keywords:

CBCT, KV, uncertainties; Radiotherapy; SRS, SBRT

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

3-D Printed Modified S-Tube for Treatment of Cervical Cancer with High Dose Rate Brachytherapy (HDR-BT)

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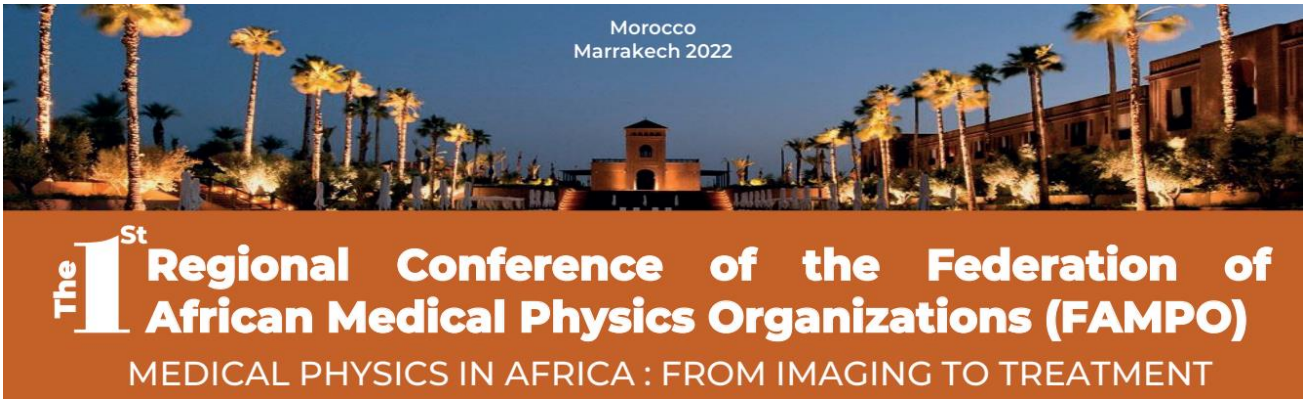
Abstract

The indwelling intrauterine tube (IIUT) was first designed at Tygerberg hospital in 1990 and named the S-Tube, in honour of its designer Prof Ben Smit, then head of oncology. Since then it has been successfully used in our hospital, allowing easy and safe administration of multiple fractions of HDR-BT, while eliminating the need for anaesthetics doses with each fraction. Recently new ring applicators were purchased, together with vendor-specific S-Tubes. The oncologists found these S-Tubes to be too flexible and frequently slipping out of position. Unfortunately, stitching the S-Tubes in place is often not possible because of the extent of the disease. The existing S-Tubes could not house the new ring applicators, which needed a larger diameter tube. The division recently obtained a Creality 3-D printer. The original S-Tubes were drawn as computer-aided design drawings and converted into a recognizable printer format. The diameter was increased from 3 to 4 mm in the design. After experimenting with different materials, it was decided to use Polyethylene Terephthalate Glycol (PETG), a non-toxic thermoplastic printer filament, as printing material. This material provided a good compromise between rigidity and brittleness and had good visibility on the patient CT scans following insertion. Six small pillars were added to the outside surface of the S-Tube to provide a ribbed surface and thus an improved grip in the patient. During the design process it was established that the IU tube of the ring applicator had a 6 mm offset at tip of the applicator, meaning the first source position starts lower than the tip of the IU applicator. Therefore, the S-Tube design was changed to incorporate this offset. The S-Tubes were placed in a Hibataine solution for 3 days to determine the durability as part of the quality control process. The new universal printed S-Tubes were named T-Tubes, to keep the honour at Tygerberg hospital. The new design T-Tube accommodates both the straight applicator that is commonly used for 2D brachytherapy treatments at Tygerberg hospital, as well as the IU applicator of the ring applicator sets. Our oncologists are pleased with the new design and the new T-Tubes are clearly visible on the patients' CT data sets. The T-Tubes have been used on three patients to date, without slipping out of position or any other side-effects. The 3-D printed T-Tubes are manufactured on-site and on demand, this is ideal in a low-resource setting. The ribbed surface helps to keep the tube in position during all five treatment fractions. The design of the T-Tube has undergone a number of iterations to get to the existing model. The design is easily adaptable should this become necessary in the future.

Keywords:

Brachytherapy, Cervical cancer, Treatment Planning, S-Tube.



Published Diagnostic Reference Level Data from South Africa until 2021

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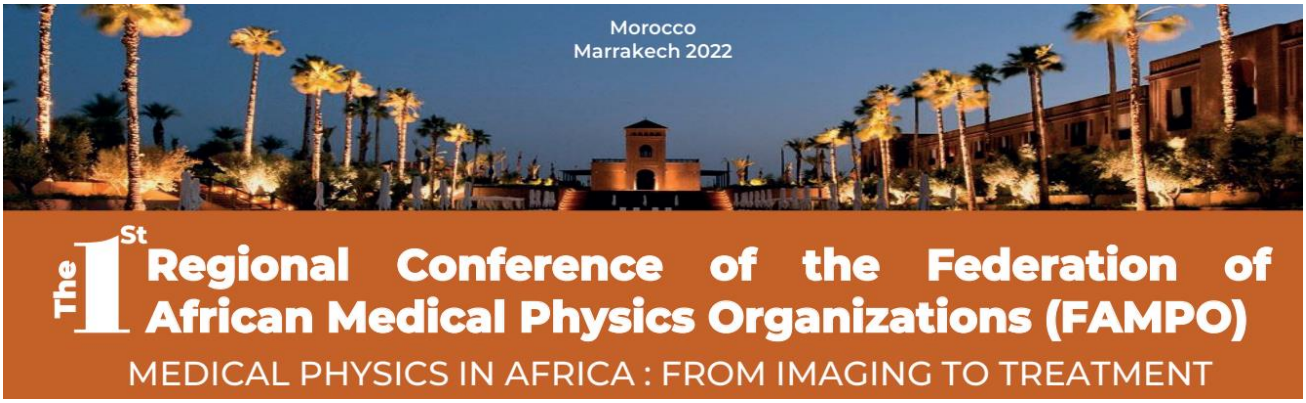
Abstract

Diagnostic reference levels (DRLs) are accepted as a dose optimisation tool in X-ray imaging and are required by South African legislation for 26 fluoroscopically guided procedures. The aim of this project was to collect all published DRL data from the country until 2021. This data was already published in the Journal of Radiological Protection, but will be presented at the FAMPO congress. Systematic searches were conducted of applicable databases and all research that proposed a DRL for any imaging procedure was included. Twenty-one works met inclusion criteria, dating back to 2001. These included 11 full-length publications, seven published conference abstracts and three theses. Two-thirds of all work reported DRLs for fluoroscopically guided procedures, providing DRLs for 39 adult investigations. Five studies proposed DRLs for computed tomography. Three studies proposed DRLs for paediatric procedures; no data on mammography or dental radiography was found. Data was collected in six public hospitals and two private hospital groups. Thirty-six authors contributed to the various publications. The data suggests that there is much room for increased interdisciplinary work. There should also be more rigorous standardization of reported parameters, as well as more cogent descriptions of the procedures.

Keywords:
DRL, x-ray imaging, optimization, paediatric procedure



Radiation Oncology in the Land of the Pyramids: How Sudan Continues to Push the Frontiers of Cancer Care in Eastern Africa

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Abstract

When faced with illness, Sudanese patients have traditionally relied primarily on folklore healers. In the recent past, Sudan increased its health care spending and placed ever-greater importance on medical education. Although traditional remedies still play an important role, Sudanese patients increasingly consult conventional medicine. Not only infectious diseases but also a rising burden of non-communicable conditions, including cancer, represent major health care challenges. Therefore, Sudan will need to make the best out of the limited resources available and further increase investment in health care to confront these trends successfully. Sudan was one of the first African countries to recognize the importance of radiation oncology in multidisciplinary cancer care and began investing in it in the 1960s. Today, there are 4 comprehensive cancer centres in the country, which offer radiation therapy and employ 10 radiation therapy machines for a population of about 45 million people. This proportion is an indication that Sudan still has an underfunded health care system with a lack of infrastructure and human resources. The present manuscript intends to provide a well-rounded overview of radiation oncology in Sudan today. This abstract has previously been published in Elsevier and also presented in FAMPO conference.

Keywords:
Cancer, Sudan, radiation therapy, oncology, conventional medicine

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MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

National Diagnostic Reference Levels for Paediatric Computed Tomography of the Head in Cameroon

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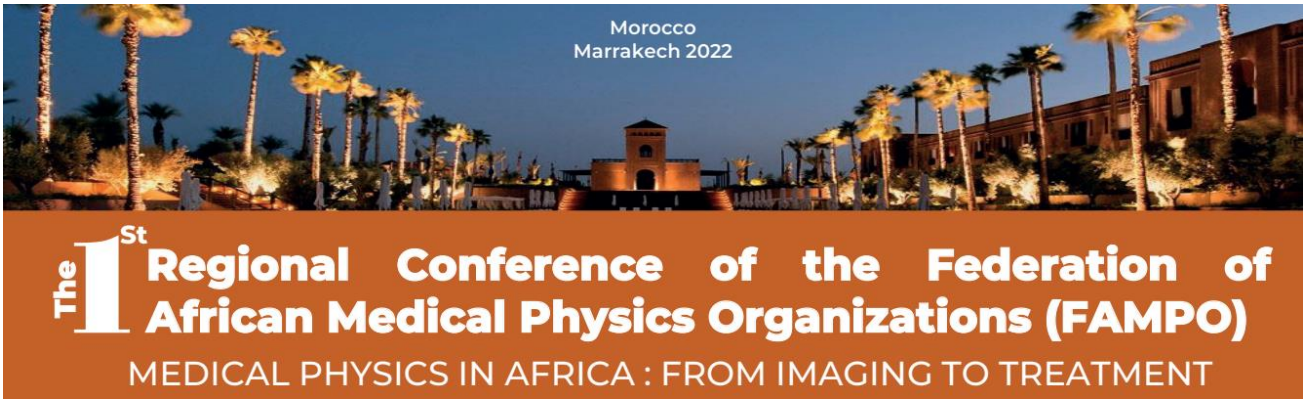
Abstract

The aim of this work is to present the National Diagnostic Reference Level (NDRL) values for paediatric Computed Tomography (CT) Departments located in this developing country, Cameroon. For this purpose, data have been collected and analyzed, only from head CT examinations to optimize medical practice. The data have been analyzed by age groups ≤1-, 1–5-, 5–10- and 10–15-y-old in order to compare to those described on previous national researches from Portuguese, Iran, Switzerland, Morocco, South Africa, Thailand and some published researches. Volume CT Dose Indexes (CTDIvol) and Dose Length Product (DLP) were recorded and their 75th percentile were calculated and set as NDRL. The results showed that NDRLs using CTDIvol are 34.2, 36.6, 39.5 and 49.6 mGy and 710.1, 838.4, 964 and 1177.2 mGy.cm for DLP respectively. DLP values were superior than other national and international studies. DRL can be defined locally and nationally in a country to check absorbed dose from patients. This national research reports helpful data for optimization paediatric CT scan.

Keywords:
Reference level, CTDI, DLP, CT, paediatric



Monte Carlo Simulation Study using Gate Code on Dose Enhancement by Gold Nanoparticles in Brachytherapy

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Abstract

Brachytherapy is a cancer treatment technique that uses radiation to kill cancer cells and prevent them from spreading. It can be used as a monotherapy. The main goal of radiotherapy is to focus adequate radiation doses on tumours while protecting healthy tissue. However, to reduce the absorbed dose and better protect the tissues surrounding the tumour, gold nanoparticles (GNP) are injected into the tumour to increase the probability of the absorbing photon emitted from a brachytherapy source. This study was aimed to estimate dose increase during brachytherapy in different GNP-loaded tissues, dose rate constant, and dose-improving factors for GNPs with a 7 mg/ml concentration of iodine source -125 by Monte Carlo GATE V8.2 simulations. All results show that nanoparticles use, such as GNP, could be beneficial in topical therapy due to their dose-enhancing efficacy in cancer cells. GATE V8.2 code can also be used as a fit tool for measuring the dose in nanoparticles presence accurately and obtained results have been validated by comparing them with reference data.

Keywords:

Brachytherapy. GATEv8.2, Nanoparticles, Dosage rate, Monte Carlo.

The 1St Regional Conference of the Federation of African Medical Physics Organizations (FAMPO)
MEDICAL PHYSICS IN AFRICA : FROM IMAGING TO TREATMENT

Monte Carlo Simulation of Novalis-Tx Linear Accelerator using GATE/Geant4 Code for Dosimetry Analysis

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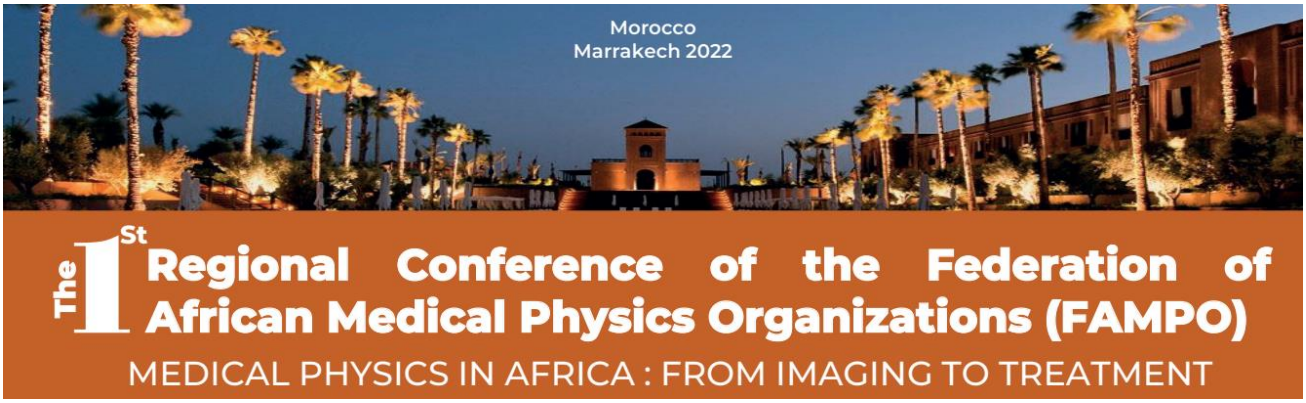
Abstract

External radiotherapy is among the modalities for cancer treatment, which uses intense radiation in the form of a prescribed dose emitted by a medical linear accelerator in order to sterilize the tumour while sparing nearby organs that are not at risk. Simulation by the Monte Carlo method is an important technique for studying the physical process of radiation-matter interaction and is widely used in radiotherapy for dose calculation, which achieves realistic accuracy even in complex cases. In this study, the 6 MV beam from the Novalis-Tx accelerator was modeled by the GATE/Geant4 v8.2 code in a homogeneous water phantom. The simulation was performed by applying the phase space and the variance reduction techniques to speed up the calculation time without losing accuracy. The calculations were performed with different field sizes from 3x3 to 20x20 cm^2 at a distance of 100 cm from the source for the measurements of percent depth dose, lateral profile with different depths and phantom-tissue ratio for assessment of the dose distribution. The simulation results were analyzed by the ROOT platform. Good agreement was obtained between the measured and calculated dose distribution for all field sizes; for a mean dose error of less than 1% and more than 98% of the points passed the 2%/2mm gamma index criterion.



Thyroid Ultrasound: Diagnostic Criteria and Artificial Intelligence Techniques

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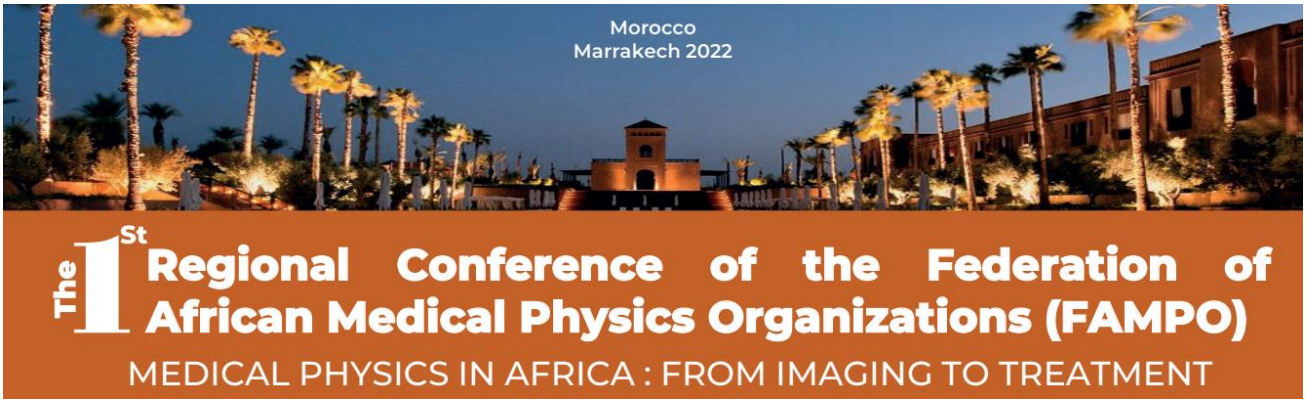
Abstract

Thyroid nodules are found in up to 68% of asymptomatic adults in the general population. Approximately 7–15% of thyroid nodules are thyroid cancer, which is the most rapidly increasing malignancy in all populations. The large number of thyroid nodules, with only a fraction being cancerous, calls for a reliable method to accurately differentiate malignant from benign nodules. Routine decision making for patients with thyroid nodules depends on ultrasound or invasive fine needle aspiration. However, the assessment of ultrasound features is time consuming, subjective, and often dependent on a radiologist's experience and the available ultrasound devices. Ultrasound conclusions are often inconsistent and even with fine needle aspirations 15–30% of the samples still yield indeterminate cytological findings. Additional robust methods are needed to improve diagnosis and fine needle aspiration strategies to adapt to the exponential growth of patient needs and burden on medical services. This research could significantly improve the diagnostic performance of radiologists and help reduce the number of unnecessary fine needle aspirations for thyroid nodules. On the basis of our findings, AI diagnostic programmes should be rolled out to clinical practice of thyroid nodule management.

Keywords:
AI, diagnostic programme, thyroid, malignancy, benign nodules



Preliminary Investigation of Rice Husk Ash Concrete for Shielding of Diagnostic Radiology Facilities

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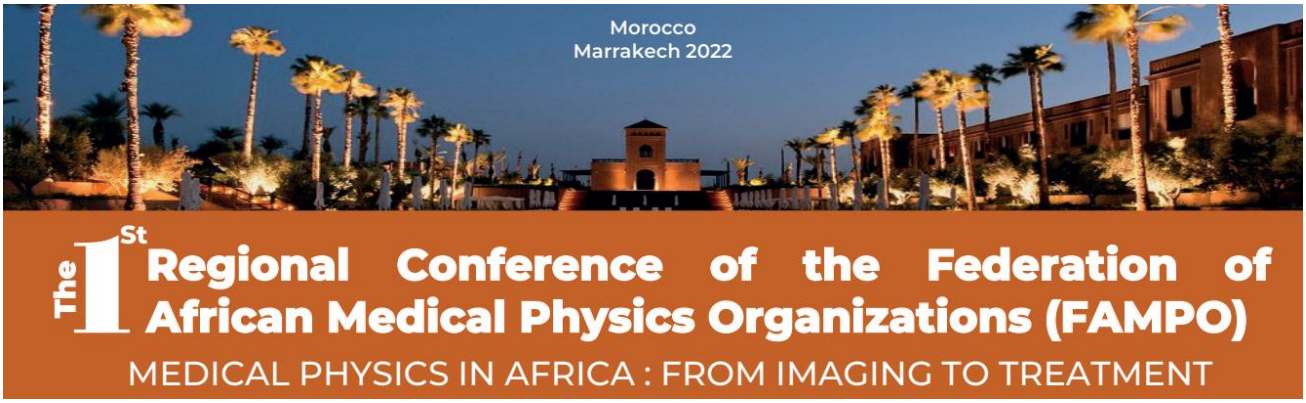
Abstract

Lead and high density concrete are the major materials used for the shielding of diagnostic radiology facilities to enhance radiation protection of the public, staff and patients. The cost of procuring these materials could be high for most facilities in developing nations. This study was therefore set up to investigate the possibility of replacing cement with rice husk ash (RHA) in the casting of concrete used in the shielding of diagnostic radiology facilities. RHA has been used as replacement for cement in other engineering work but the feasibility of using RHA concrete for shielding in diagnostic radiology has not been investigated. Concretes were produced by replacing cement with 5, 10, 15, 20 and 25%wt RHA before mixing with sand, gravel and water at known ratios. The concrete mixtures were placed in 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 cm thick moulds for the concrete to cure. The concrete samples were exposed to x-ray at different kVp and the transmitted doses recorded. Analysis of results (linear attenuation coefficient, half value layer, tenth value layer) show that concrete samples with 10%wt RHA replacement for cement offered a more efficient shielding in diagnostic radiology than the standard density concrete.

Keywords:
Shielding, concrete, lead, radiation protection, radiology



Tomotherapy in Breast Cancer Treatment: The Sidi Abdellah Center Experience

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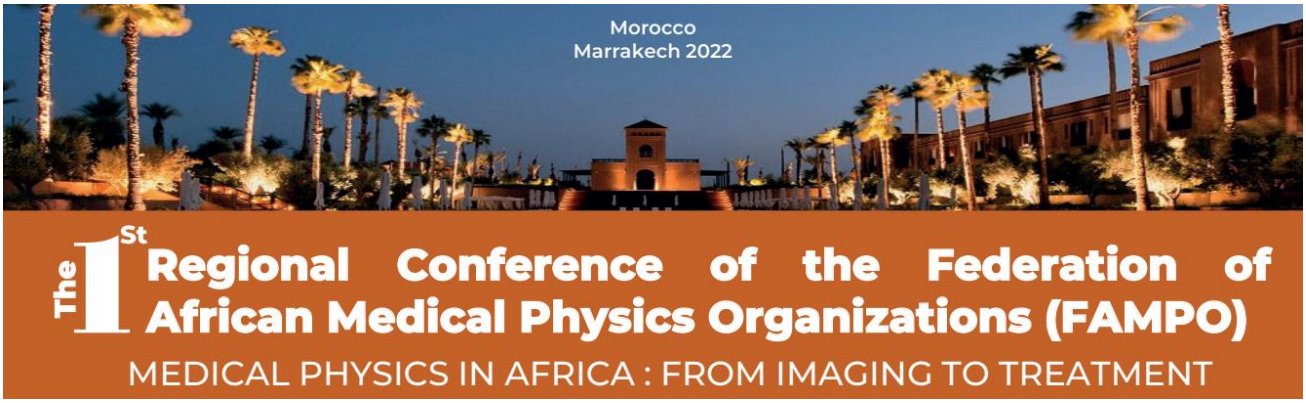
Abstract:

125 patients with breast cancer were treated with tomotherapy (Helical 53% and Direct 47%), were randomly selected from our database (wall/breast only 18%; wall/breast and supraclavicular, axillary and internal mammary lymph nodes 46%, Breast and boost 36%). The treatment planning objectives were to cover 95% of the planning target volume using a 95% isodose, with a minimum dose of 90% and a maximum dose of 107%. Our Results 96.92% of the PTV isodose to cover 47.5 Gy for the PTV 50 Gy, 97.28% of the PTV45 to cover 42.75Gy for the PTV 45Gy. The organs at risk (OAR), The average dose for the heart was 3.37 Gy for the Right Breast cancer, and 6.04 Gy for the left side breast cancer. The median V20 for the same side lung were 21.06 % right side and 22.11% left side. The median V5 for the contralateral lung were 26,92 % Right side and 30,09 % left side. Tomotherapy plans provide excellent coverage of planning target volume and improved dose conformity and homogeneity in target volumes with decreasing the high doses to OAR.

Keywords:

Breast cancer, Tomotherapy, OAR.



Commissioning of a 6 MV Elekta Synergy Platform Linear Accelerator using the FLUKA Monte Carlo Model

Karim Bahhous[1,2], Zakaria Aboulbanine[1], Samir Didi[3,4], Youssef Madkouri[5], Hassan Ouhadda[3] and Mustapha Zerfaoui[3]

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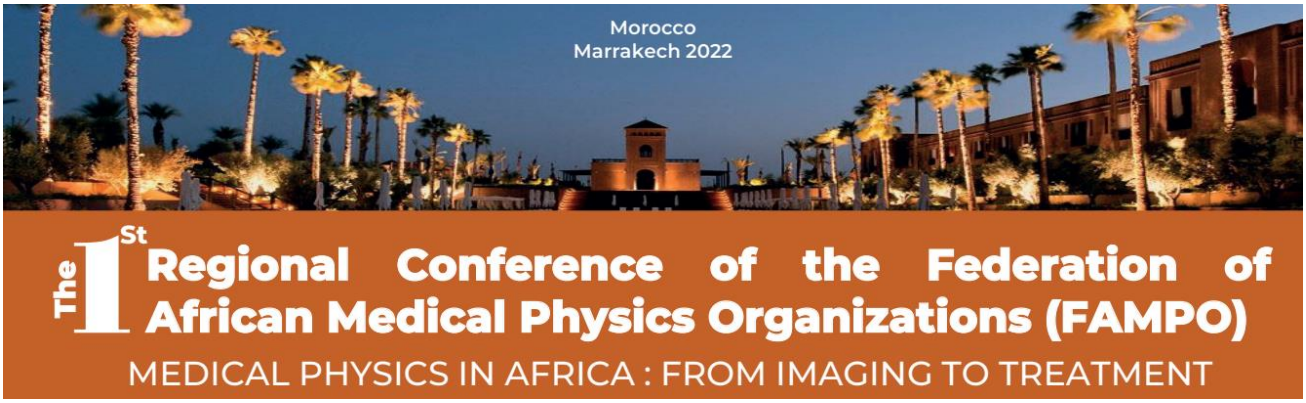
Abstract

This study aims to reproduce the therapeutic dose distribution for an Elekta Synergy accelerator using Monte Carlo (MC) simulations. The FLUKA MC was used to simulate the Linac head and the water phantom dedicated to dose calculation. The percentage depth doses (PDDs) and off-axis dose profiles were calculated for field sizes of 2×2 cm^2, 3×3 cm^2, 10×10 cm^2 and 20×20 cm^2. Dose distributions were calculated for a 6 MV high-energy X-ray beam at a source-to-surface distance of 90 cm. Over 95% of the points for all simulations meet the restrictive acceptability criteria of 2%/2 mm. We have demonstrated that it is possible to build an accurate Monte Carlo model of the Linac head for dose distribution simulations and quality assurance, and thus to use it for small field dosimetry, where the MC is one of the key tools.

Keywords:

Radiation therapy, Fluka MC, linac head simulation, Elekta Synergy



Pressure Dependence of Water 1H Spin Relaxation Rates in Model Hydrogel and Intervertebral Spinal Discs

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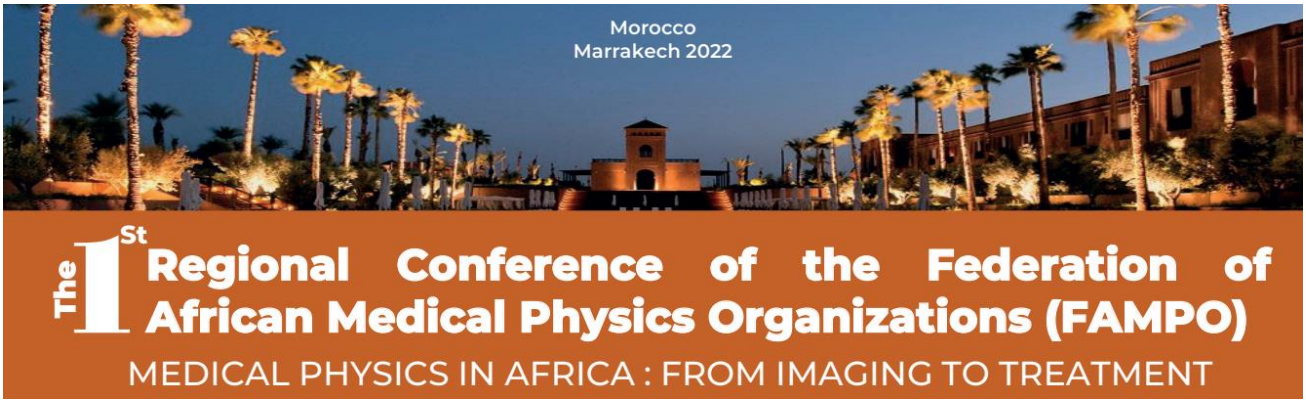
Queensland University of Technology, Kenya.

Abstract

Back pain is a major cause of disability. It is estimated that around 540 million people are currently suffering from back pains. This numbers are likely to increase especially in the low- and middle-income countries which are experiencing an increase in life expectancy. It is projected that 70–90% of people will have to experience some form of back pain in their lifetime with 10% experiencing disability as a result. Spine stiffness, neck and low back ache are the most common forms of back pain. Most cases of lower back pain have been shown to be associated with inter-vertebral disc (IVD) degeneration. MRI is a tool used to qualitatively detect structural deformities to the IVD resulting from degeneration. However, these deformities manifest in the terminal stages of degeneration. A method is needed to improve the sensitivity of MRI to quantitatively measure progression of degeneration from the onset of the disease which can vastly improve treatment outcomes. It has been observed that a reduction in Nucleus Pulpous (NP) hydrostatic pressure is one indicator of disc degeneration and that there is a direct correlation between fluid pressure inside the Nucleus Pulposus and the axial load on the disc. The NP hydrostatic pressure is currently measured using discography; an invasive procedure with the potential to further damages the IVD. Previous studies have also shown that MR spin relaxations rates of water protons are sensitive to mechanical stress on the Nucleus Pulposus. However, it is still not clear whether this is due to changes in the chemical composition due to water efflux or if it is due to hydrostatic pressure per se. In this project, the dependence of spin relaxation times in model connective tissue on the hydrostatic pressure is presented. Samples of gelatine hydrogen 90% w/w and 10% w/w and oxtail Nucleus Pulpous were separately subjected to confined axial compressive stresses and analysis of their relaxation rates made. Measurement was done using NMR relaxation imaging and validated using NMR spectroscopy R1 measurements by inversion recovery technique. R2 measurements were done by Spin Echo technique, FOV 12.8 mm × 12.8 mm, Sync 3 pulse acquired a series of free induction decays then Fourier transformed. The area in each spectrum indicated the level of magnetization left after polarization pulse. The integration was by Bruker Topspin 1.5 software. Plotting areas as a function of time and fitting done using custom made Mathematica 4.1 (Wolfram research, Inc.) program to the equations. The measurement outcomes were inconclusive, with most parts of the experimental results showing that within physiological pressure alone, in the absence of compositional chemical changes, it is not capable of inducing significant changes in relaxation rates. Further studies are proposed to confirm the results.

Keywords:

MRI, Nucleus Pulposus, Hydrostatic pressure, Spin Relaxation



Dosimetric Effect of Carbon Fibre Treatment Couch With and Without Immobilization Devices on Radiotherapy Dose Calculation

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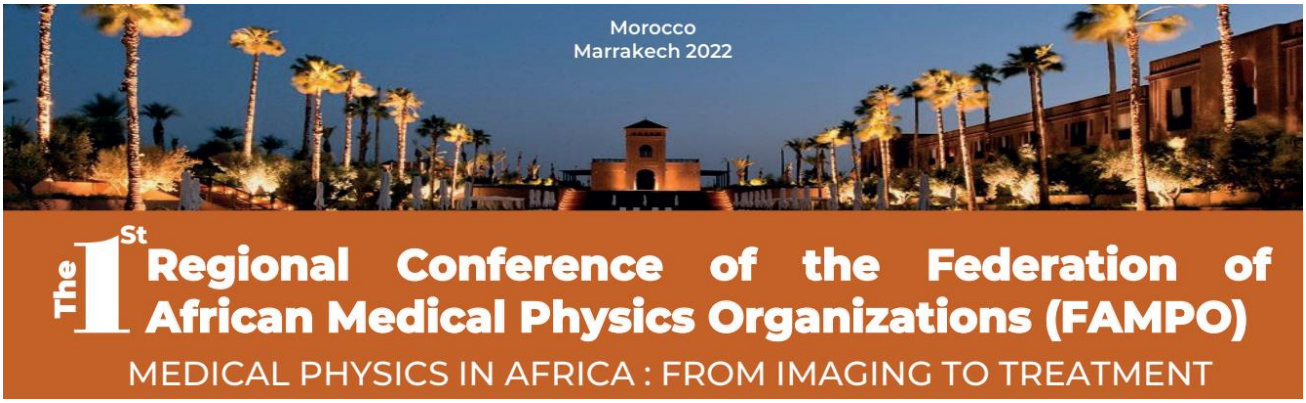
Abstract

The objective of radiotherapy immobilization devices is to improve the reproducibility of patient positioning during treatment sessions. The inclusion of these devices in the treatment protocol may increase the skin dose. In practice, these devices are not systematically taken into account in the dose calculation. In this study, the dosimetric effects of the carbon fibre couch iBEAM Evo Extension 415, with and without three different immobilization devices (a Klarity Breastboard R610-2ECF, a Bionix Butterfly Board, and CIVCO Vac-Lok vacuum bag); were calculated and evaluated on the dose calculation for conformal three-dimensional radiation therapy. The measurements were carried out by comparing the measured dose with the one calculated for three different algorithms, FFT convolution, fast superposition, and superposition algorithms, which are implemented in Xio treatment planning system (TPS). Dosimetric tolerance levels have been respected for specific dose calculations, which do not include the fibre couch with or without immobilization devices. Errors of up to 8% in the dose calculation were obtained for the beams passing through the fibre couch and the breast board base support region. According to the significant attenuation differences of the beam by the fibre couch and immobilization devices, it was concluded that ignoring the device in the dose calculation can change patient's skin and target doses. The fibre couch and immobilization device should be included within external body contour to account for the TPS calculation algorithms dose attenuation.

Keywords:
TPS, radiotherapy, immobilization, patient positioning, treatment planning, FFT convolution



The IAEA/WHO TLD Postal Dose Quality Audits: Ghana's Experience

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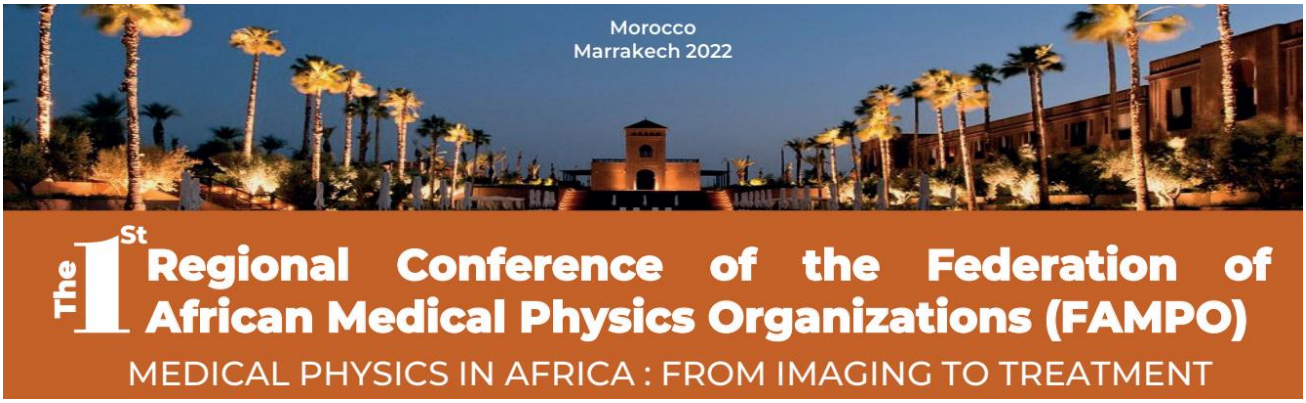
Abstract

Over the past years, the IAEA's dosimetry programme has operated a service to validate the calibration of radiation beams in developing Member States using the IAEA/WHO TLD postal dose quality audits. Since 1998, Ghana has been involved in the IAEA/WHO TLD audit programme. This paper gives a summary of various studies performed during the period of involvement, and provides the results of a survey conducted by the IAEA. The survey had the aim of checking the dose delivered by the radiotherapy unit of the National Centre for Radiotherapy and Nuclear Medicine Department. The testing for the accuracy and consistency of basic dosimetric – calibration of radiotherapy beams with an ionization chamber, was done in reference conditions. The maximum acceptable discrepancy between the dose stated by the centre and the dose evaluated by the IAEA is ±5%. In Ghana, the National Centre for Radiotherapy and Nuclear Medicine Department over 15 years, has verified the calibration of its radiotherapy beams. The results from the entire period of study confirmed the high standards in dosimetry and quality assurance, and further gives hope that such high standards may be maintained in the Centre. Only one result was found to be outside the acceptable limit of ±5%.

Keywords:
Radiotherapy, IAEA, WHO, TLD, dosimetry programme



Dosimetric Feasibility Study of a Novel Dynamic Applicator Dedicated to Intensity Modulated Brachytherapy (IMB)

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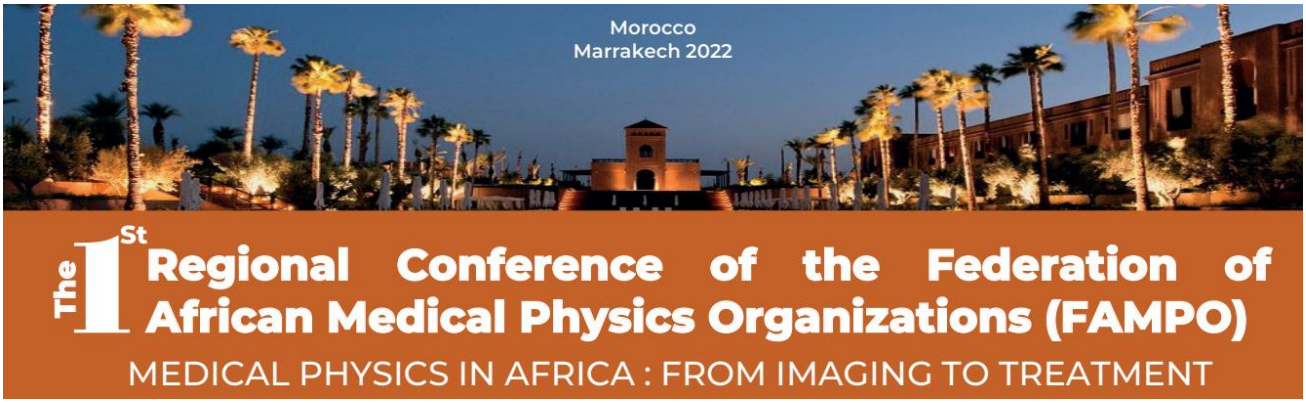
Abstract

Intensity modulated brachytherapy (IMB) is a cancer treatment technique where shielding is used to protect organs at risk from unwanted exposure. The aim of this study is to develop a novel dynamic and guided applicator in tungsten of different geometries to treat complicated cancer cases in high dose rate brachytherapy by intensity modulated brachytherapy. The results obtained in this GATE/GEANT4 Monte Carlo simulation show an optimum dosimetry compared to conventional brachytherapy, wherein we have significantly minimized the doses received by organs at risk (OAR), including surrounding healthy tissues.

Keywords:

IMB; applicator; Monte Carlo simulation; OAR.



A New Design of an Experimental Prototype for Calibrating Medical Radiation Detectors: DetCal

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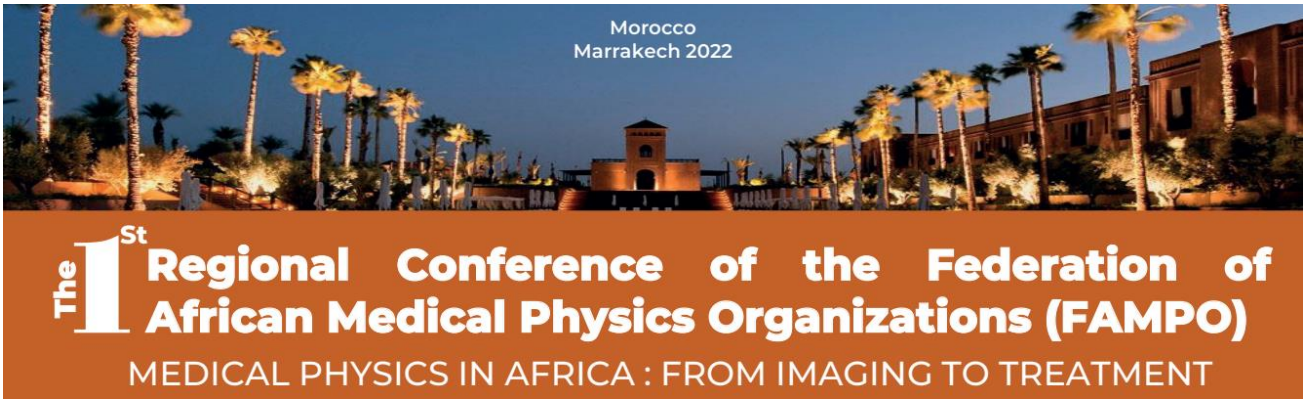
Abstract

Dose assessment is an important and sensitive task in patient radiation protection. A calibrated ionization chamber is crucial for radiation monitoring. Tunisia does not have a reference laboratory for calibrating detectors. Therefore, considering the development of this field of research is of great importance to the Country. Tunisia has 5 public and 8 private radiotherapy centres. In all, there are 15 Linear accelerators, 10 Cobalt-60 devices (3 non-exploitable sources), 2 low and 2 high dose rate brachytherapy sources, 4 dedicated radiotherapy scanners, and 10/15 accelerators equipped with Cone Beam Computed Tomography-CBCT, 3/15 Accelerators are equipped with Free Flattering Filter-FFF mode. All these instruments need preventive and curative maintenance to keep a good performance and to do that we need calibrated detectors. A detector that no longer functions correctly would therefore no longer allow correct detection. To ensure that the detector we are using, detects correctly. it should be calibrated periodically. Correction factors must be provided to users considering the correction of several phenomena and parameters. After studying the geometric design of the Cobalt-60 facility installed in CNSTN, we attempted to develop an experimental prototype (accommodating multiple ionizing radiation detectors). To study the optimal design of the experimental prototype, we used Solidworks, a proprietary 3D computer-aided design software running on Windows. Since the Cobalt-60 source is cylindrical and the dose rate distribution in the vicinity is uniform, the shape of the experimental prototype must be cylindrical. The distance between the source and the reference point was set to 100 cm (the standard distance used in the radiotherapy department which is between 80 cm and 100 cm). The experimental prototype requires a flexible and deformable material to easily adjust the setting of the dosimeters, ensure the desired shape, and minimize interaction between photons and the material. Therefore, wood is the best choice to meet these requirements. Among different types of wood materials, plywood is the most suitable material for our prototype. It is a bendable malleable wood. In addition, to maintain the cylindrical stance of the device, we add iron bars. The prototype is cylindrical and measures 4 mm thick, 1 m radius, and 2 m in height. It is mobile prototype with wheels for easy movement. The following parameters will be checked: leakage current, stabilization time, polarizing potential and polarity, ion recombination, directional dependence, electrometer calibration, charge or current calibration, range change factors, linearity, loaded leakage, stability and maintenance, correction factors for photon attenuation and scattering, the electron loses to the chamber wall and quantify these factors through Monte Carlo simulation.

Keywords: Calibration, prototype, dosimeter, Monte Carlo, ion recombination



Radiation Dose from Three-Phase X-Ray Machines: A Comparison between Different Models

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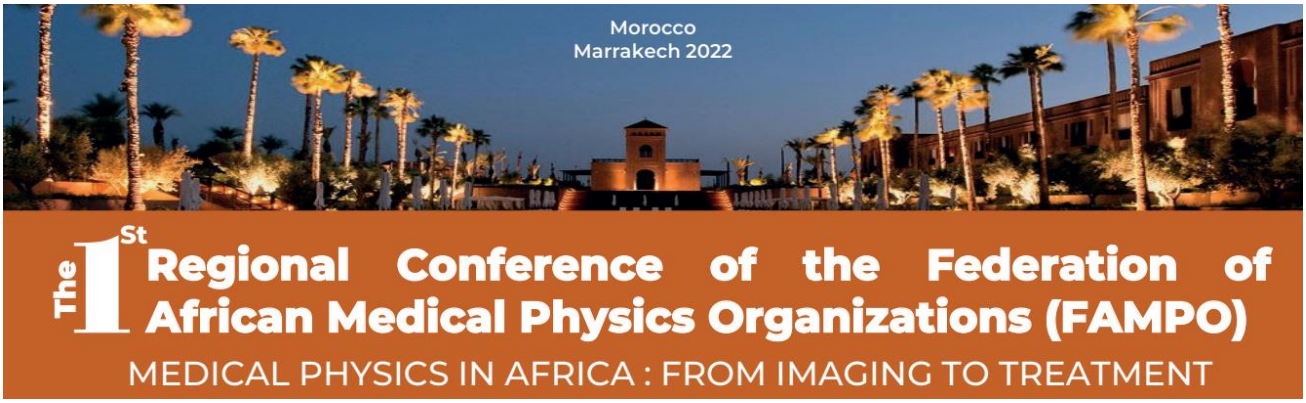
Abstract

The assessment of radiation dose is of great importance in the optimization process. It is crucial to develop strategies for dose estimation in developing countries in lack of dosimeters. The Entrance Skin Dose (ESD) of 731 patients was calculated using the Davies model. Eight radiological procedures: Chest PA and LAT, lumbar spine AP and LAT, Spine AP and LAT, skull PA and LAT and three-phase X-ray machines were considered. Based on the mathematical estimation of the radiation output of X-ray machines, a modified Davies model was proposed. The model was compared to others (Edmonds, Tung and Tsai) using their Mean Relative Errors (MRE) with respect to the reference Davies model and the Student's test of comparison of means. The 3rd quartile values were also compared to those found in Cameroon, Nigeria, Iran, France and UK. The MRE of the proposed model in this work (1.9%) was significantly less than the MRE of the Tung and Tsai model (7.1%), which was in turn significantly less than the MRE of the Edmonds model (55.0%). Results also show that, the 3rd quartile values were mostly higher than reference level in UK. High values of doses are attributable to short Focus to Skin Distance (FSD) and high values of charges. The model proposed in this study is a better alternative to the Davies model in the case of absence of dosimeter. An adjustment of technical parameters (FSD and charge) could help reduce high doses.

Keywords:

Three-phase X-ray machines, Modified Davies model, Dose optimization.



Stimulating the Passion of Medical Physics in Africa's Young Generation: Experience Sharing on the Rise to the Top

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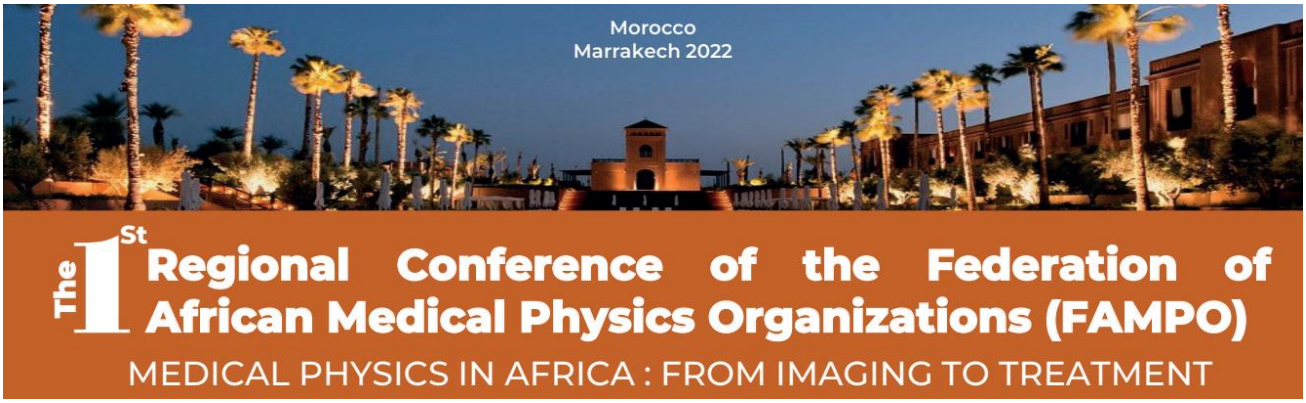
Abstract

Finding myself in the field of Medical Physics could be described as accidental or divine orchestration. Gaining admission in the late 90's to enrol for undergraduate bachelor's degree in Physics came to me with big excitement and at the same time puzzling. My mind was like, how possible can this opportunity of reading "raw physics" at the university offer me satisfactory professional career in the medical field? What seemed like my confusion in thoughts some twenty years ago has fast grown and is becoming a "wonderland" for many young colleagues in Africa. The journey up the road of "Medical Physics Lane" in Africa has been one fit to be described as lengthy, strenuous and challenging, but above all these it has been exciting, inspiring and fulfilling! Working as medical physicist in academia, clinical and research fields for the past fifteen years in Ghana and having had the opportunity to collaborate on several projects in the African region, I am convinced beyond all doubts that Africa is the "next big thing" in Medical Physics globally. The opportunities abound but it will take Africans to make Africa realize this "next big thing". Leaders and policy makers need to urgently tap into the rich pool of young science graduates produced from universities across the region for enrolment and training in medical physics education and training programmes to acquire useful competencies needed to drive cancer and radiation medicine service delivery in Africa. This talk seeks to stimulate the passion of Medical Physics in the young generation of medical physicists, scientists and students from Africa. It will highlight my experiences as student from the LMIC region, rising to become academic head of medical physics at the University of Ghana, deputy director of a medical research institute at the Ghana Atomic Energy Commission, serving in high executive positions of medical physics professional organizations like IOMP and FAMPO and coordinating projects of an international agency like IAEA.

Keywords:
IAEA, FAMPO, Medical Physics, professional, training programme



Implementation of a routine quality control program for radiology facilities at the Abidjan Cardiology Institute (Côte d'Ivoire)

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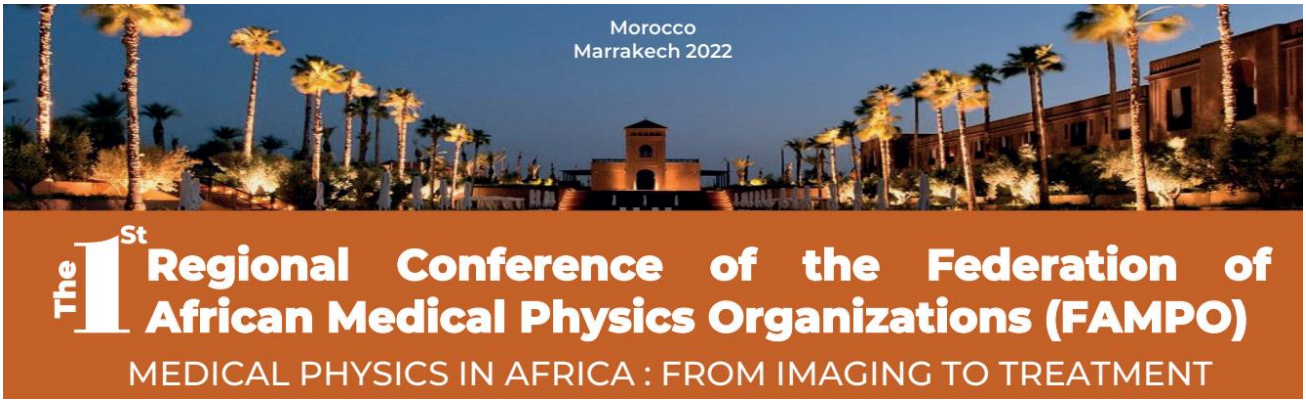
Abstract

The Abidjan Heart Institute (ICA) is a public hospital dedicated to the treatment of cardiovascular and thoracic pathologies. ICA has been certified to ISO 9001 version 2015 since 2018. The implementation of a routine quality control program for radiology facilities is an opportunity to improve care for patients and practitioners. Quality control is aimed at maintaining the quality of diagnostic images, minimizing patient and staff radiation exposure and making radiological facilities profitable. This presentation will cover the regulations in force, assess the requests for radiodiagnosis and future prospects for quality control in Côte d'Ivoire.

Keywords:

Quality control, radiodiagnosis, thoracic pathologies, cardiovascular, treatment



Norwegian Partnership Programme for Global Academic Cooperation (NORPART) on Ghana-Norway Collaboration in Medical Physics and Radiography Education

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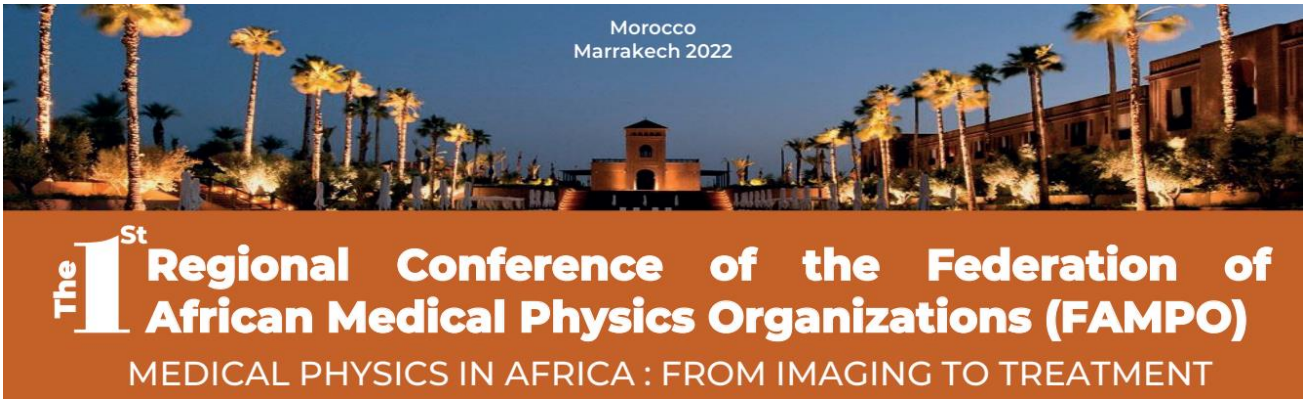
Abstract

Norwegian University of Science and Technology (NTNU) and Universities in Ghana have had a long time collaboration regarding quota students from Ghana at NTNU. The School of Nuclear and Allied Sciences of the University of Ghana and the Norwegian University of Science and Technology (NTNU), and other partner Institutions have been involved in a Norwegian Partnership Programme for Global Academic Cooperation (NORPART) project since 2017. NORPART Project was funded by the Norwegian Ministry of Education and Research and Norwegian Ministry of Foreign Affairs with a grant of NOK 4,950, 000 (US$ 600,000.00). The main goal of this project was to establish a partnership for education and research between institutions in Ghana and Norway within the fields of Medical Physics, Radiation Protection and Radiography. Under the project, two main activities were proposed, namely; (i) Annual Summer School in Ghana and (ii) A student exchange program at master and PhD levels. This paper highlights the experiences of the project after 5 years of implementation. The Ghana Norway Summer School in Diagnostic Imaging and Radiotherapy was held at different locations in Ghana for students and practitioners of Medical Physics, Radiation Protection and Radiography. It included theoretical presentations and practical sessions at the hospital. Under the students' exchange, students from Ghana undertook part of their thesis research in Norway under joint supervision from experienced researchers from the partner institutions. There have been 4 successful editions (2016-2019) of the Summer School with 262 students and Lecturers/Facilitators from Ghana and Norway taking part. 18 exchange students (13 Masters and 5 PhDs) from Ghana to Norway have benefited from the project. A digital mobile X-ray equipment and Quality Assurance kit was donated to GAEC. It is anticipated that at the end of the project cycle, there would be increased mobility, contact, quality and internationalization between staff and students among the partner institutions.

Keywords:

NORPART project, medical physics, radiography, radiation protection



Strengthening the Capacities for Medical Physics in Tunisia: Gaps and Challenges

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Abstract

Medical physicists have long played an integral role in medical imaging, radiation therapy and radiation protection. In Tunisia, the status of the profession is flawed, the most important of which are the system of obtaining certificates and the legislative framework that regulates the sector. Most importantly, this situation can negatively impact treatment quality, patient, and worker safety, whether through reluctance or relocation of staff. Statistical studies were conducted on the number and location of medical physicists and a national report on the status of medical physicists was prepared. Gaps have been identified and solutions presented to relevant decision-makers in the form of recommendations to advance the health care system. Medical physicists exist only in the field of radiation therapy, absent in the fields of medical imaging (diagnostic nuclear medicine and radiology) and radiation protection. Therefore, we will give only statistics on radiotherapy equipment. Since the number of medical physicists is related to the number of devices emitting ionizing radiation. Tunisia has 5 public and 8 private radiotherapy centres with 15 linear accelerators, 10 Cobalt-60 sources (3 sources not usable), 4 brachytherapy sources (2 low dose rate and 2 high dose rate) and 4 scanners dedicated to radiotherapy. However, not all radiation therapy centres have their own scanners. About 33 physicists with hospital technician status and no residency program render the required medical physics services. However, most of those rendering medical physics services have no medical physics background. Since 2011, the Higher Institute of Medical Technologies of Tunis has been running a Master's Degree in medical physics to meet the demands of the Country. About 6-7 medical physics degrees (radiation therapy) are awarded each year. Despite the efforts, there are still quantitative and qualitative deficiencies; some modules are missing compared to international medical physics courses. There is no accredited centre that offers residency programme to train certified clinical medical physicists. Residency program in medical physics is somehow compensated by a PhD thesis supervised by Non-Certified Clinical Medical Physicists. The Organizations of Medical Physics (FAMPO, EFOMP, IOMP …) is hereby requested to assist the Country in capacity building, empowerment and training of medical physicists. Masters and Ph.D. students seeking supervision and guidance often have difficulty finding specific expertise needed for their research in Tunisia. Contribution of IAEA in providing technical support in the field of medical physics is very much desirable. We commend the regional project RAF6058 "Strengthening the capacities for Radiopharmacy and Medical Physics and Radiology for expansion and sustainability of Medical Imaging Services", the Master's Program in Medical Physics from the Abdus Salam International Centre for Theoretical Physics in Italy and the ICTP-IAEA Sandwich Training Educational Programme (STEP). Medical physics in Tunisia should meet the need of hospitals and the current legislative framework must be updated.

Keywords: medical physics, residency, FAMPO, IAEA, radiotherapy