

focal disease is challenging. Multi-parametric magnetic resonance imaging (mp-MRI) has potential for this and because of its improved image resolution it may be combined with machine learning to assist with delineation. The aim of this work was to combine information from T2 weighted, apparent diffusion coefficient (ADC), and diffusion weighted MRI to train machine learning models to identify focal disease within the prostate. Two datasets were utilised from previously treated patients with localised prostate cancer. The first included 16 patients with diagnostic T2 MRI, the second included 12 patients with diagnostic T2 and ADC studies. The planning CT, T2 and ADC images, where available, were registered rigidly and a clinician contoured the prostate and focal lesion on each image. Using MATLAB, sub-images were extracted from each before 32 texture features were calculated and used to train four different classification algorithms. In addition, a pre-trained convolution neural network was fine-tuned to classify each sub-image as healthy or diseased tissue. The performance of each model was assessed in terms of sensitivity, specificity and AUC. Results demonstrate that mp-MRI images can be successfully combined to identify focal disease using machine learning. This novel approach achieved a high classification performance when tested on T2 images with an AUC of 0.935 compared to 0.663 found using single sequence MRI studies. These results are promising, yet a larger data set is required to further develop these approaches.

<https://doi.org/10.1016/j.ejmp.2019.09.207>

Poster Session : P10

A feasibility study to investigate the introduction of HDR intraluminal brachytherapy for oesophageal cancer at university hospital galway

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Intraluminal high-dose rate (HDR) brachytherapy is considered to be one of the most valuable options for the treatment of oesophageal cancer. This radiotherapy technique involves the insertion of specific types of plastic applicators into the body through the oesophagus. The aim of this project is to assess the feasibility of establishing an HDR intraluminal brachytherapy procedure for oesophageal cancer at University Hospital Galway (UHG). Commissioning was performed for applicators with diameters of 8 mm, 12 mm, and 14 mm. Applicators were provided by Varian Medical Systems. The most distal position of each applicator was determined using a gafchromic film (EBT3). Within this context, there is a dead space for each bougie where the source cannot be loaded. Consequently, the first position available is determined from the end of the dead space. The dead space for the applicators of 8, 12 and 14 mm diameter was found to be at 10 cm, 15 cm and 17 cm from the tip of each applicator, respectively. The most distal source position of the bougies (with diameters of 8 mm, 12 mm or 14 mm) was found to be 50 mm from the end of the dead space. Successful collaboration among specialists working in enormously diverse disciplines (e.g., radiation physicists, oncologists, nurses, and therapists) is the fundamental aspect that will determine the success of establishing HDR intraluminal brachytherapy at UHG. Structures must be developed to assist everyone working in these diverse disciplines to coordinate and safely implement this procedure.

<https://doi.org/10.1016/j.ejmp.2019.09.208>

Poster Session : P11

Dynamic MLC quality assurance program using EPID

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The introduction of intensity modulated radiotherapy (IMRT) allowed delivering high uniform dose distributions in the target, while sparing the surrounding healthy tissue. This technique is performed thanks to multileaf collimators (MLCs) in continuous motion. Therefore, it is crucial for patient safety to carry out a routinely quality assurance (QA) program of the MLC to ensure that leaf motion is precise, smooth and reproducible on every fraction. In this work a set of tests was gathered in order to quantitatively examine the stability of the electronic portal imaging device (EPID) signal, the accuracy of leaf positioning, the steadiness of leaf velocity and gap sizes and the influence of gravity for different gantry angles. These tests were accomplished using EPID (amorphous silicon aS1000, Varian) calibrated for dosimetric purposes for a 120-leaf Millennium MLC. The detector consists of matrix of 1024 × 784 pixels for 40 × 30 cm² area at the isocenter, providing a resolution of 0.39 mm/pixel. Hence, the EPID not only presents an adequate resolution to detect potential faults in the MLC performance but it is also agile and accessible. Additionally, it allows exporting .dxf files for each of the tests to be quantitatively assessed with help of a series of routines developed in Matlab. Corroboration of the implemented routines was performed using a detector array. Both methods showed an exceptional agreement. In conclusion, a MLCQA program using the EPID was presented to provide a reduction in time of quantitative analysis of the tests and an early detection of errors.

<https://doi.org/10.1016/j.ejmp.2019.09.209>

Poster Session : P12

Extended CT density range: Acuros XB algorithm performance

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Modern treatment planning systems (TPS) offer photon algorithms capable of enhanced performance in heterogeneous media and high density materials, such as metal implants. Acuros XB was implemented by Varian Medical Systems in their Eclipse TPS. Computed tomography (CT) reconstruction can be performed in two ways: a 16 bits depth for HU or 12 bits. A 12 bit study would have a reduced HU scale, describing normal tissues accurately, but underestimating metal objects. Whenever metal objects can be found in the images, 16 bits are needed to have a realistic estimate of their densities. This work addresses the calculation differences between Acuros XB 13.6 using these two CT configurations. A Philips Brilliant Big Bore CT scanner has been used to scan phantoms with different inserts mimicking different metal implants and both configurations. Head and Neck VMAT and conformal plans (two full arc plans, as per local protocol) were prepared and optimized in Eclipse v13.6. Coverage and dose figures of merit were assessed, and DVH curves compared. Dose to water was used throughout this study. Acuros XB results show an increase in maximum dose for distributions obtained in 16 bits image sets: for instance, from 111.0% (12 bits) to 138.2% for PTV60, in a phantom with Ti dental implants (insert)

along the mandible. Differences between Accuros XB results with 12 or 16 bits reconstructions are statistically significant (Student's T test, $p = 0.05$). Therefore, the use of extended HU ranges helps address the effect of metal objects inside a patient.

<https://doi.org/10.1016/j.ejmp.2019.09.210>

Poster Session : P13

X-ray microscopy, investigation into tomographic soft tissue imaging at a micron scale

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When looking at the implementation of x-ray microscopy for the diagnosis of most cancers, the nucleus and surrounding structures of the cell need to be discernible. This is far beyond the capabilities of most x-ray equipment in terms of limiting spatial resolution and the necessary output to resolve soft tissue structures at that scale. Phase contrast Imaging (PCI) methods can be utilised to improve low contrast detectability. PCI is a relatively new range of techniques that measures the phase shift induced by the sample to produce an image. This results in a soft tissue image signal at certain photon energies that can be thousands of times higher than absorption, greatly reducing the required exposure. Even with this reduction a high output source is still required. Typically to achieve such high resolution and output a synchrotron source would be used. Given the excessive cost of synchrotrons it is not a practical x-ray source in a clinical environment. Recently developed alternative sources such as Plasma wakefield accelerators could be used. They utilise a petawatt laser pulse, which ionise specific gases to create a "bubble" of high gradient charge differential to accelerate an electron bunch of sub micron diameter to high energy levels. The electron bunch can then be oscillated through undulators to generate the required x-rays. This presentation will discuss the initial work done through a collaboration between UHG, NUIG and Diamond Synchrotron on the potential of a novel PCI method and also discuss future planned work with the Central Laser Facility.

<https://doi.org/10.1016/j.ejmp.2019.09.211>

Poster Session : 14

TomoTherapy® System repositioning accuracy according to treatment localization

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We analyzed the Image-guided radiotherapy method used by the TomoTherapy® System (Accuray Corp.) for patient repositioning in clinical routine. The TomoTherapy® System computes X, Y, Z and roll displacements to match the reference CT, on which the dosimetry has been performed, with the pre-treatment MV CT. The accuracy of the repositioning method has been studied according to the treatment localization. For this, a database of 18774 treatment sessions, performed during 2 consecutive years (2016–2017 period) has been used. The database includes the X, Y, Z and roll displacements proposed by TomoTherapy® System as well as the manual correction of these proposals applied by the radiation therapist. This manual

correction aims to further improve the repositioning based on the clinical situation and depends on the structures surrounding the target tumor tissue. The statistical analysis performed on the database aims to define reference repositioning values to be used as security and guiding tool for the manual adjustment implemented by the radiation therapist. This tool will participate not only to notify potential repositioning errors but also to further improve patient positioning for optimal treatment.

<https://doi.org/10.1016/j.ejmp.2019.09.212>

Poster Session : P15

Ultrasound elastography: A novel user-independent quasi-static method

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Quasi-static ultrasound elastography is a popular clinical ultrasound modality which can give measures of the relative stiffness of a region of interest [1]. Tumours have been well documented to have different mechanical properties than the surrounding healthy tissue [2]. Ultrasound elastography techniques take advantage of this contrast to create stiffness maps of soft tissue called elastograms, with these, the tumours can be easily distinguished from the healthy tissue [1]. Current quasi-static methods require the user to manually palpate the region of interest with the ultrasound probe, which can lead to user-user variability when imaging [3]. We propose a novel, user-independent method where external palpation is provided by means of a stepper motor via the perineum. A tissue-mimicking agar phantom of the prostate was created and imaged using a transrectal probe. An elastography algorithm was then developed using MATLAB and inclusions of varying stiffness and sizes were successfully delineated from the surrounding soft tissue. References: Bamber, J., Cosgrove, D., Dietrich, C., Fromageau, J., Bojunga, J., Calliada, F et al. (2013). EFSUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography. Part 1: Basic Principles and Technology. *Ultraschall in der Medizin - European Journal of Ultrasound*, 34(02), pp.169-184. Hoyt, K., Castaneda, B., Zhang, M., Nigwekar, P., di Sant'Agnese, P., Joseph, J et al. (2008). Tissue elasticity properties as biomarkers for prostate cancer. *Cancer Biomarkers*, 4(4-5), pp.213-225. Varghese T. (2009). Quasi-Static Ultrasound Elastography. *Ultrasound Clinics*, 4(3), 323-338.

<https://doi.org/10.1016/j.ejmp.2019.09.213>

Poster Session : P16

The fabrication and validation of patient specific Maxillo-facial prostheses using 3D printing

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Personalised medicine aims to optimise patient outcome by tailoring treatments and interventions to the individual. While this approach can offer a number of benefits, it can be accompanied by significant overheads in terms of resources. Prostheses exist in order to restore and replicate normal functions and appearance of the body but if these are not individually tailored to the patient then a true restoration cannot be achieved. Traditionally a labour intensive pro-