Poster Session : P6

Breast thickness based DRLs in screening mammography

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The motivation for use of dose audit and DRLs is to promote continuing optimisation. General radiology practice quotes a DRL for an average patient and has been widely adopted for standard imaging examinations. However, for mammography, the range of breast sizes encountered in clinical practice limits the utility of DRLs. For a number of years, we have been conducting an annual clinical dose survey based on 100 consecutive client examinations collected over a contemporaneous time period. A MATLAB programme was developed to extract demographic and exposure data from the DICOM image headers. This was subsequently compiled in a database for calculation of mean glandular dose (MGD) developed for the UK breast screening programme. In order to improve the utility of DRLs for routine audit without adding significant complexity, we have determined three distinct DRLs based on the 95th percentile of the distribution of MGD values within three bands of compressed breast thickness; Average breast (50 mm–70 mm), Small breast (<40 mm) and Large breast (>80 mm). Completing the dose audit cycle requires dissemination of results in a relatable way and in order to achieve this, we have produced a poster for display in each mammography room which radiographers can use to reference against any examination performed. This provides a more meaningful comparison of their practice with the norm. We anticipate that as radiographers become accustomed to viewing and evaluating MGDs, they will become more familiar with the expected behaviour of a system and differences between systems.

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Poster Session : P7

A phantom based study on the effects of contrast agents and kilovoltage and on standardised uptake value in PET/CT

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Standardised Uptake Value (SUV) is an important parameter used in PET. It is based on a calculated volume of interest from an attenuated corrected PET/CT image. The attenuation coefficient is generated from a CT scan, in an attempt to provide dose performance and diagnostic image quality of the scan. Both oral and intravenous iodinated contrast are used as part of these scans. In an attempt to reduce dose from the diagnostic CT scan, a reduction in kilo-voltage (kV) can be done. However, literature on this topic is either unavailable or and is not widely published. The aim of this thesis is to evaluate the effect of iodinated contrast agents and varying kV on SUV's with a phantom on a conventional PET/CT scanner. A set of phantoms were constructed based on the NEMA 2012/IEC 2008 PET Phantom to simulate FDG anatomically and physiologically in an abdomen. The phantom consists of three versions of an adapted NEMA 2012/IEC 2008 phantom. SUV and FDG concentrations were calculated for different contrast concentrations and over ranges of CT kVp energies. Images were evaluated for artifacts and the kBq/ml was measured for each version. The studies showed that there was a dependence on the contrast used and the energy level. When there was a presence of contrast in the phantom, the measured kBq/ml was higher than the theoretical kBq/ml as the attenuated image was over correcting for the activity.

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Poster Session : P8

Objective QA assessment of ultrasound

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Ultrasound is an important imaging modality for the work-up and biopsy of breast lesions. Subjective ultrasound QA using a standard phantom has been performed according to a protocol for some time. However, the inherent nature of these tests combined with operator variability make it difficult to assess system performance over time or to facilitate inter-system comparison. As a result, we evaluated software (QA4US) for objective evaluation of ultrasound performance in order to facilitate these aims. A measurement protocol has been developed and implemented in the QA4US software by the MUSIC group at Radboud University Medical Center, Nijmegen, NL. QA4US is a freeware application developed in MATLAB to enable users to perform tests outlined in the European Guidelines. A standard tissue mimicking phantom is required and the software analyses stored B-mode ultrasound images. Objective assessment is based on relative echo level, therefore the dB scale is used for the estimation of most quality measures; overall dynamic range, contrast resolution, contrast sensitivity, spatial resolution and overall system sensitivity. Initial trial use of QA4US informed many useful tips to enable efficient assessment which are outlined and would benefit new users. Results have enabled observation of trends over time, showing generally consistent results but some have also highlighted transducer element failure and surface damage. QA4US is proving a useful tool for monitoring system and probe image quality and generated reports aid liaison with vendors in relation to quality issues. However, the initial set-up and familiarisation period can be time consuming.

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Poster Session : P9

A deep learning approach for identifying focal prostate cancer from multi-parametric MRI

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There are no technical barriers to delivering radiotherapy to small focal lesions within the prostate, however, reliably identifying

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.

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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.

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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 $\times$784 pixels for 40 $\times$30 cm^2 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 quantitatively analysis of the tests and an early detection of errors.

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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)