Conclusion: PO-0967 at risk.

Material and Methods: A total of six patients were included in this study. Each patient was scanned with one of two T2-weighted sequences, inversion recovery fast spin echo (IR FSE) or fast recovery fast spin echo (FRFSE). To reduce the motion artefacts in the images, the scanning was only triggered when the diaphragm was at the end-exhale position. The imaging was performed on a 3.0 T MR (GE Healthcare). Dose planning on the obtained MR images was performed using two different methods 1) dose was prescribed at 10 mm from the applicator’s centre, which is the method currently used at Skåne University Hospital for treatment based on 2D images 2) dose planning was performed by manual optimisation, i.e. the dwell times were manually adjusted until adequate tumour coverage was reached. To our knowledge, an MR-safe esophageal applicator could not be found at the time of this study. Instead a modified duodenal tube was used. Different contrast agents were studied with the purpose to render the tube’s visibility on the MR images.

Results: The esophageal tumour was successfully visualised and delineated on T2-weighted images with the FRFSE sequences, whereas the tumour in the MR images from the IR FSE sequences was difficult to visualise due to poor image quality. Furthermore, improved dose coverage to the tumour was observed when the dose planning was manually optimised to the tumour volume, where V100% to the tumour was increased from 70% to 95% and D90% was increased by 34%. Moreover, the esophageal applicator (duodenal tube) was filled with a saline solution, which was successfully visualised on the MR images.

Conclusion: Brachytherapy dose planning for esophageal cancer with MR imaging enhances tumour visibility and the ability to optimise the dose to the tumour volume and organs at risk.

PO-0967 Current practice in quality assurance of the Papillon50 contact X-ray brachytherapy system in the UK

L. Humbert-Vidan1, T. Sander2, C. Clark3,4

1Guy’s & St Thomas’ NHS Foundation Trust, Radiotherapy Physics, London, United Kingdom
2National Physical Laboratory, Radiotherapy Physics, Teddington, United Kingdom
3National Physical Laboratory, Radiotherapy Physics, Teddington, United Kingdom
4Royal Surrey County Hospital, Radiotherapy Physics, Guildford, United Kingdom

Purpose or Objective: Papillon50 contact brachytherapy has been used for early rectal cancer treatment in the UK since 1993. Currently there are four centres treating and a few more are in the process of implementation. The National Institute for Health and Care Excellence has issued guidance on safety and efficacy from a clinical perspective. However, there is currently no guidance on quality assurance (QA) testing. This review assessed any significant differences in machine QA practice between the current UK Papillon50 users. This is the first step towards standardising QA tests, tolerances and procedures in order to ensure that the accuracy of this technique is maintained at a high level across the UK.

Material and Methods: Each centre provided in-depth information regarding their QA programme. Details on machine-specific design characteristics were also taken into account. An inter-departmental comparison was made with regards to the QA tests performed, the frequency of each test, the accepted accuracy of the results with respect to the set baselines, the setup for each test and the equipment used.

Results: Significant differences were seen between centres in the QA tests in terms of types of test, frequency and acceptable accuracy. A tolerance variation of 10% versus 2% in the beam quality check and a difference of 2 mm versus 0.5 mm in the radiation field size check were observed. The manufacturer provides a calibration jig with which all four centres carry out radiation output measurements. However, each centre uses its own HVL jig design. There are significant design differences between these jigs with respect to the source-to-detector distance (SDD), the narrow beam geometry achieved and the backscatter conditions. All centres use the 1996 IPEMB CoP for the determination of absorbed dose for x-rays below 300 kV generating potential and its Addendum (2005) as a reference for the determination of the radiation output. However, the reference conditions stated in the CoP were generally not met due to the inherent design of the calibration jig used.

Conclusion: Significant differences exist between centres in the level of accuracy and extent of the QA programme. The very-low energy and short SDD in the Papillon50 system result in a very rapid dose fall-off. Differences in the design of the HVL jig may play an important role in the definition of the beam quality in such conditions. An extension of the CoP Addendum may be needed to include the achievable Papillon50 measurement conditions. This review highlights the need to carry out an independent audit in order to assess whether the inter-departmental variations observed could result in differences in the treatment received by patients.

PO-0968 Development of a fluorescent screen based QA system for dose verification of afterloading HDR unit

T.L. Chiu1, B. Yang1, H. Geng1, W.W. Lam2, C.W. Kong1, K.Y. Cheung1, S.K. Yu1

1Hong Kong Sanatorium & Hospital, Medical Physics & Research Department, Happy Valley, Hong Kong SAR China

Purpose or Objective: To develop and assess the feasibility of an in-house developed fluorescent screen based system on dose distribution verification of HDR brachytherapy treatment delivery.

Material and Methods: The QA system consisted of a solid water block with various thicknesses on top of a fluorescent screen (Kodak, Lanex regular screen) and a PMMA block below the screen. The fluorescent signal light was reflected by a mirror below the transparent PMMA to a CCD camera. The whole system was contained in a light tight box. Dose linearity was examined in a previous experiment. In measurement, an Ir-192 source was loaded to an applicator positioned on top of the solid water block. Single source dose distribution without entrance dose effect was first acquired to help obtain a universal light deconvolution kernel. It will then be used in subsequent image processing. Two source dwell positions were placed in each measurement with equal weighting. Source intervals were 5 mm and 10 mm. Four different measurement distances were selected, ranging from 5 mm to 30 mm away from the applicator. Various dwell times ranging from 0.8s to 8s were assigned at different depth to produce the optimal light output. Captured images were then processed by applying a median-filter and the deconvolution kernel to remove radiation induced noise and deconvolute the acquired image, respectively. After the image processing, images were normalized and a region of interest (ROI) (16 cm²) was selected. Gamma index comparisons were performed between acquired dose distributions and the respective depth calculated by TPS (Elekta, Oncentra). Two profiles which cross the central line of the source dwell positions were obtained.

Results: The system can obtain a dose distribution with resolution 0.257 mm per pixel. Gamma index comparisons, (3% dose difference/1 mm DTA) were performed on all 8 conditions. Results were tabulated in Table 1.
All gamma indexes have passing rate above 95%. At measurement distances 10 mm to 30 mm, areas which failed to meet the gamma index criteria were, mostly, on the peripheral of the ROI. Gamma index near the source dwell position is well below 1. At measurement distance 5 mm away from source, the discrepancy between measurement and TPS calculation is the most severe. Both cases have points fail to meet the gamma criteria on the entrance path of the source. In particular, for 10 mm source separation, while assigning equal weighting for both dwell positions, measured data has two uneven signal peaks, as shown in Fig. 1 (d)-(f).

Conclusion: The system measured dose distributions agreed closely with TPS calculations, gamma index (3% dose difference/1 mm DTA) passing rates are all above 95% despite a high dose gradient near the source. Hence, this system can serve as a dose verification tool in afterloading brachytherapy. Besides, transit dose is detectable by this system but insignificant in a brachytherapy treatment.

Material and Methods: After an analysis of the distance dependent spectral changes of the radiation field surrounding a brachytherapy source, the energy dependent response of a number of typical brachytherapy detectors was examined with Monte Carlo simulations. A dosimetric formalism was developed which allows the correction of the energy dependence as a function of the source distance for a Co-60 calibrated detector. A number of phantom materials were examined with Monte Carlo calculations for their specific influence on the brachytherapy photon spectrum and on their water equivalence.

Results: A simple description of the energy dependence of a detector in the vicinity of a brachytherapy source was found by defining an energy correction factor $k_Q$ for brachytherapy in the same manner as in existing dosimetry protocols. The factor can be calculated as a polynomial of the distance from the source. Volume averaging and radiation field distortion by the detector are incorporated into $k_Q$. Materials for solid phantoms were identified which allow precise positioning of a detector close to a source together with small correctable deviations from absorbed dose to water. Recommendations for the selection of detectors and phantom materials are being developed for different measurements in brachytherapy.

Conclusion: The introduction of an energy correction factor $k_Q$ for brachytherapy sources may allow more systematic and comparable dose measurements. In principle, the corrections can be verified or even determined by measurement in a water phantom and comparison with dose distributions calculated using the TG43 dosimetry formalism.

PO-0970 On the water equivalence of thirteen commercially available phantom materials in 192Ir brachytherapy

A. Schoenfeld1, D. Harder2, B. Poppe3, N. Chofor4

1Carl von Ossietzky Universität Oldenburg, Medizinische Strahlenphysik, Oldenburg, Germany
2Georg-August University Goettingen, Medical Physics and Biophysics, Goettingen, Germany

Purpose or Objective: Thirteen commercially available phantom materials have been tested by Monte Carlo simulations of a typical 192Ir therapy source with regard to their suitability as water substitutes in high energy brachytherapy.

Material and Methods: The radial dose-to-water profiles in differently sized cylindrical water substitute phantoms surrounding a centric and coaxially arranged Varian GammaMed afterloading 192Ir brachytherapy source were compared to the corresponding dose-to-water profiles in equally sized water phantoms in order to evaluate the water equivalence of each phantom material within the clinically relevant source center distances up to 10 cm in the transversal plane. Monte Carlo simulations were performed in EGSnrc. The studied phantom materials are RW1, RW3 (both PTW, Germany), Plastic Water (as of 1995), Original Plastic Water (as of 2015), Plastic Water DT, Plastic Water LR (all CIRS, USA), Solid Water, HE Solid Water (both Gammex, USA), Virtual Water (Med-Cal, USA), Blue Water (Standard Imaging, USA), polyethylene, polystyrene and PMMA.

Phantom sizes were varied between diameters and heights of 10 cm and 60 cm to study the effect on the dose contribution by scattered photons. The radial variations of the total recommendations for experimental measurements are traditionally part of dosimetry protocols which in Germany are formulated in DIN standards. Within the revision of the outdated DIN standard for clinical brachytherapy dosimetry a working group (DIN 6803-3) was charged to formulate recommendations for brachytherapy dosimetry incorporating recent developments in brachytherapy in the description of radiation fields as well as new detectors and phantom materials. The Goal is to prepare methods and instruments e.g. to verify the emerging new dose calculation algorithms, for clinical dose verification and for in-vivo dosimetry.