Results

The recordings showed that the planner generally works iteratively on lowering OAR dose and increasing target dose. This process visualizes as a zig-zag pattern in the bi-objective problem formulation where both objectives are eventually improved (Fig. 1a). In the bi-objective problem formulation, all clinical plans were inferior to the Pareto front plans obtained with the MOEA (Fig. 1b). In the observer study, in all cases the observers chose a plan from the Pareto front as the best plan, and appreciated to directly see the trade-offs for that particular patient (Fig. 1b). The clinical plan was in 4/20 cases considered to be the worst plan. The observers agreed on the best plan for 2 patients, which was the plan with the highest possible coverage while still satisfying all OAR criteria.

Conclusion

Our novel bi-objective brachytherapy planning method is parameterless and directly optimizes treatment plans on the evaluation criteria of a clinical protocol. It results in a set of high-quality plans to intuitively select from. In all cases, such a plan was preferred over the clinical plan.

Material and Methods

PO-1021 HDR Brachytherapy dosimetry: clinical use of micro-silica bead TLD & Gafchromic EBT3 film

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Purpose or Objective

To develop a novel high resolution experimental method for validating Monte Carlo-derived TG-43 brachytherapy source data, and model-based treatment planning systems. Experimental verification is recommended in the “Report of the High Energy Brachytherapy Source Dosimetry (HEBD) Working Group, 2012”, however, the steep dose gradients with a wide dynamic dose range and rapid change in dose rate has been a limitation for the ability of common detectors to obtain accurate measurements. In this study, we tested a micro silica bead TLDs recently developed at University of Surrey for suitability to perform accurate dose measurements around 60Co and 192Ir clinical HDR brachytherapy sources. The micro silica beads proven dosimetric characteristics (independency from dose rate and angle of radiation incidence) accompanied by small ‘donut shape’ physical dimensions (1.2 mm diameter and 0.9 mm thickness (Fig. 1 (a)) along with chemically inert nature, ease of use and reusability were considered as a very promising detectors for this application.

Material and Methods

Novel dosimeter positioning templates were designed and produced using AutoCAD software. The micro silica bead TLDs were threaded using cotton yarns and stitched onto the template to accurately position the dosimeters within ± 0.1 mm, in a full-scatter water tank (Fig 1(b) and 1(c)). Measurement setup for radial dose distribution and dose linearity is shown on (Fig 1(c)) and (Fig 1(b)). The used dose rates were form 10 to 4000 cGy/min and dose ranged from 0.5 to 40 Gy. The results of dose distribution measurements around the sources were compared to TG-43 tabulated data and simultaneously irradiated EBT3 Gafchromic film. A TOLADO TL system was employed for read out of the TLDs. Triple-channel dosimetry using FilmQAPro with uncertainty reduction technique was used for film dosimetry
A novel, high spatial resolution experimental method was developed for validating brachytherapy dosimetry using micro silica bead TLDs on high precision templates. The measured radial dose distributions around both of the $^{60}$Co and $^{192}$Ir sources were comparable within the experimental uncertainty to the relevant TG-43 data and superior to that of EBT3 Gafchromic film measurement in terms of the dynamic dose range evaluated. The experimental method presented is suitable to address the challenge of HDR brachytherapy dosimetry.

PO-1022 Use of GaN dosimeter in brachytherapy: A new approach of machines and patients quality controls

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Purpose or Objective
Brachytherapy uses sealed radioactive sources into the tumor to deliver the radiation dose. Due to the high dose per fraction and strong gradients in High dose rate brachytherapy (HDR-BT), consequences on dose delivery may be significant if errors occur in the treatment workflow. Therefore, in order to verify and ensure that the dose is correctly delivered, periodic quality controls (QC) are carried out on machines according to the recommendations of the ESTRO BOOKLET 8 (1). Many tools, complex to use, are required. We therefore developed an integrated quality assurance (QA) tool to check the mandatory machine parameters as well as the dose delivered. Within this project, Gallium Nitride (GaN) dosimeters (2) were studied.

Material and Methods
First, dosilab Company has designed a phantom based on four GaN dosimeters with different inserts for machine QA: 1 and 2 channels. Specific calculation methods based on GaN dosimeter responses are used to accurately determination of dwell times and dwell position (Fig. 1).

For this study, we validated the software development and check the accuracy on the source dwell position and on the measured dose (ESTRO guidelines 2mm and 5% respectively). Ten measurements were acquired for a prescribe dose of 5Gy and by using different inserts. Then we introduced an error on the source dwell positions from 1 to 10 mm to test the robustness of the system on the measured dose. Finally, we developed a 6-channel insert (Fig. 1) to perform quantitative patient quality control measurements in comparison with treatment plans.

Results
After ten successive measurements, errors between the measured and planned source dwell positions are not significant and respect the ESTRO guidelines of 2mm (mean values of 0.21mm [range -0.47;0.45], 0.14mm [range -0.53;0.38] and 0.06mm [range -0.59;0.33] for inserts with 1, 2 and 6-channels respectively). Taking into account the dose delivered, mean differences between measured and planned dose are 0.24% [range -3.24;2.69], -1.64% [range -7.42;1.47] and -1.2% [range -2.93;2.72] for inserts with 1, 2 and 6-channels respectively. Results respect the ESTRO guidelines of 5%.

Finally, if we consider the error detection threshold with the GaN phantom, we notice that a dose greater than 5% is visible with an error of 2mm for insert 1 channel and 3mm for inserts 2 and 6-channels (Fig. 2).