tissues (solid water: CT#=1012, 0.944<ρ<1.044; Phantom organs: ρ=0.95 and the CT#= 959).
TLDs were threaded and placed on the organs' surface with 1cm resolution. Then whole assembly was placed inside the same water tank and irradiated with ^{60}Co HDR source within a Vienna applicator (Eckert & Ziegler GmbH) to 7Gy prescribed to ICRU38 defined A-points. A TOLEDO TL system was used to readout the TLDs. Percentage difference of mean doses and dose surface histograms (DSH) of measured doses were compared against the TPS for the uterus as clinical target volume (CTV), bladder, rectum and sigmoid as organs at risk (OARs).

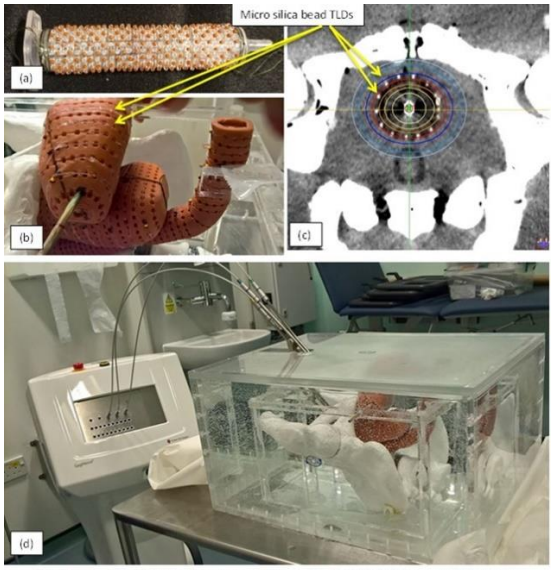

Fig1. (a) Syringe with a 2.5 mm spacing arrangement of silica bead TLDs. (b) 3D printed organs with placement of TLDs at the surface. (c) HDR plan on the CT scan of phantom; each TLD is clearly visible. (d) The anthropomorphic pelvis phantom in the water tank connected to the high dose rate (HDR) unit.

Results
The 2D-γ analysis on the syringe showed more than 99% points passed 3% and 3mm criteria at all source to plane distances which mean TLDs with different SR do not cause any perturbation effect.
Fig 2 shows the DSHs of measured doses with TLDs in comparison with those of the TPS dose calculation. By calculating the integral dose for the organs, % difference were found to be 3%, 4%, 10% and 45% for uterus, rectum, bladder and sigmoid respectively. Results showed, % difference of mean doses in the uterus is <1.4% (SD=0.4) for TLDs up to 4cm distance from the centre of ring vertically, 9% to 22% (SD=10.5) above 6cm which is the low- dose region (<1Gy).

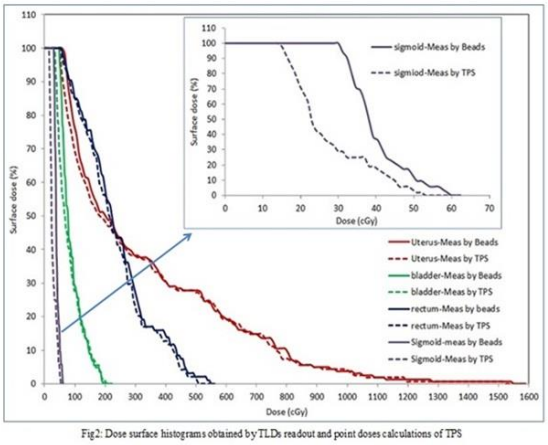

Fig2: Dose surface histograms obtained by TLDs readout and point doses calculations of TPS

Conclusion
A customized anthropomorphic pelvis phantom was successfully built and clinically assessed to confirm properties similar to tissues. The small size of the TLDs together with negligible beam perturbation effect, suggest their further potential use as in-vivo dosimetry system which is the next step of this project. A careful calibration is needed, especially in the region of low doses.

EP-2145 Biological comparison of 60 Co & 192 Irbrachytherapy sources: a possible need for correction factor

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Purpose or Objective
High Dose Rate Brachytherapy (HDR BT) has become a standard treatment as a boost or monotherapy for different tumors such as gynecological malignancies, prostate cancers, sarcomas, and breast cancers. In most of modern clinical studies in BT, one of the commercial Ir-192 sources was employed. Recently though, Co-60 HDR BT sources have been used worldwide. Co-60 with a lower dose rate (about one-half), can deliver the prescribed dose two times longer than Ir-192. Moreover, because of their different photon spectra, these two sources show some discrepancies in dose distributions. Before expanding the Iridium-based results to Cobalt-based clinical treatments, It may be questioned whether these differences can meaningfully influence the biologically effective dose (BED) distributions inside the tumor?
Material and Methods
Dose rate distributions were estimated for Co-60 and Ir-192 sources (Eckert & Ziegler BEBIG) using TG-43 formalism for vaginal cylinder and Tandem-Ovoids used for gynecological tumors and interstitial needles for breast and prostate malignancies. The linear-quadratic (LQ) model was used to investigate probable biological differences made by dose and dose rate distributions of two sources. For the estimation of the incomplete recovery factor g in the LQ model which compares dose rate effects in one irradiation session, mono-exponential repair kinetics was assumed and the repair halftimes ($T_{1/2}$) were extracted from literature. BED distributions were then calculated considering site dependent α/β values.
Results
For all sites, DVH curves of clinical target volumes (CTVs) were in good agreement for two sources however dose distributions varied significantly in some dose points. Considering the physical dose, points on the vaginal cuff received higher dose up to about 40% from Co-60 as compared with Ir-192. In three other cases, discrepancies up to about ±10% can be observed for some few points. For BED analysis, α/β=10 Gy and $T_{1/2}$=1 h were selected for gynecological sites. However, several values of α/β and repair time for prostate (α/β= 1.5 and 3 Gy, $T_{1/2}$=16 min) and breast tumors (α/β=2, 3.5, and 5 Gy, $T_{1/2}$=0.1, 0.5, and 2 h) were examined. For gynecological sites, BED distribution patterns agreed with dose distributions except for the vaginal cuff in which Co-60 caused an increase from +10% to +90% in BEDs as compared with Ir-192. The patterns were different for prostate site because of the faster repair time and lower values of α/β. BED values from Co-60 source showed -20% to -10% reduction in >70% of CTV in comparison with Ir-192. For the breast site, the reduction to -10% can be observed only for $T_{1/2}$=0.1.
Conclusion

The results were in agreement with the previous studies which clinically confirmed Co-60 as an HDR BT source for gynecological tumor management. However, one may be cautious for applying the Iridium-based prescribed dose into the Cobalt-based treatments in some cases such as prostate cancers which using a correction factor of about 1.2 might be reasonable.

EP-2146 Comparison of planning US HDR prostate on transversal or longitudinal ultrasound acquisitions

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Purpose or Objective

To investigate differences in planning using images acquired using different acquisition techniques in US-based HDR prostate brachytherapy.

Material and Methods

We analyzed the records of 20 patients who received real-time transrectal ultrasound (US) guided interstitial high-dose-rate brachytherapy at our institution. For each patient, two sets of US images were acquired with a digital stepper immediately after treatment: transUS using the transversal US transducer, acquired by retracting the TRUS probe during image acquisition; twistUS using the longitudinal US transducer, acquired by rotating the TRUS probe during image acquisition. For all patients, measurement from the template to the connector-end of each needle were recorded and used for relative confirmation of needle tip identification. The DICOM plans were analyzed using MATLAB routines to assess catheter shift (average distances between reciprocal dwell source positions at transUS and twistUS after rigid registration between all dwell positions is performed). Catheters were digitized on the transUS and the twistUS and the identified tip positions were verified against a reference needles using the measurement data. A subset of 13 patient records was recontoured; contours were rigidly registered based on implant geometry. Difference in target volume and kappa statistics were calculated.

Results

The average ± 1 standard deviation of the number of needle tip adjustments per patients performed due to discrepancies with measured data was 4 ± 2 for transUS and 3 ± 3 for twistUS. Average of the distance between reciprocal dwell source position between transverse transUS and twistUS were 0.12 ± 0.04 cm with a range of (-0.03 – 0.03) cm. Difference in Target volumes between tansUS and twisUS were -1.8 ± 7.8 cm^3.

Conclusion

Based on the number of adjustment required to match the physical measurement, physical measurements are required for both twistUS and transUS to accurately identify the needle tips. On average, the digitization geometry was similar using the two imaging techniques, although differences up to 3mm were observed in some cases. This may be due to deformation of the anatomy and implant geometry occurring during retraction of the probe in transUS acquisitions. Further analysis will be performed on more patients and dose distributions to validate these results, which suggest similar dose delivered to the target using both acquisitions.

EP-2147 Commissioning of a novel brachytherapy device for diffusive alpha-particle radiation therapy

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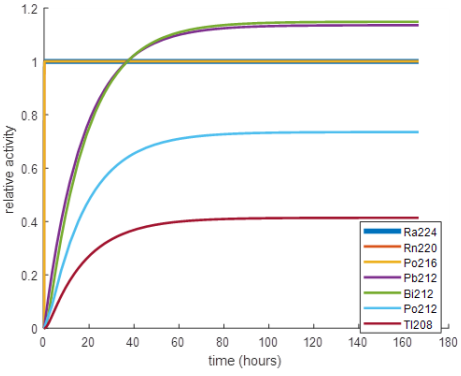
Purpose or Objective

To establish acceptance and commissioning of a novel brachytherapy device (DaRT, Alpha Tau Medical, Tel Aviv, Israel) consisting of needles pre-loaded with stranded Ra224 sources. In the patient, each source delivers alpha radiation up to 3-6 millimeter in tissue through the diffusion of the daughter elements, emitted as a recoil from the source, and its progeny.

Material and Methods

Four devices were obtained, two “flex” (plastic catheters) devices, one with 3 sources and one with 6 sources; and two “needle” devices, one with 1 sources and one with 3 sources. All sources were 1cm long. All devices were sealed against gas leaks at manufacturing and wrapped in sterile packages. The packages were tested upon arrival for contamination and leaks. A handheld Zinc Sulfide (ZnS(Ag)) detector and liquid scintillation counter, equipped with an alpha/beta discriminator, were used for the contamination survey. The gamma spectrum up to 2MeVof all devices were measured in their sterile packaging in a high purity Germanium detector (HPGe) and compared to the expected spectrum with equilibrium assumed (See Figure). Calibration of the HPGe was performed using a NIST calibrated Eu152 source with the same measurement geometry. Absolute calibration of the source activity was obtained from the 241 keV peak of Ra224, which was discriminated from the 238.6 keV peak of Pb212. Radiography of all devices was used to establish internal geometry and location of the active sources. Measurement of the devices in their sterile packaging in a well chamber was performed. The 1 source device was used to determine the sensitivity of the chamber (sweet spot), and correction factors were calculated based on the radiography measurements to account for geometry. Calibration factors were established using the HPGe absolute calibration.



Results

No contamination on the outer shipment packaging or inner shielding material was found. Preliminary measurements with an ionization chamber showed the external exposure rate on contact with the sealed sterile source packages to be 12.8 mR MBq^{-1} hr^{-1} for the metallic “needle” devices and 23.4 mR MBq^{-1} hr^{-1} for the plastic “flex” devices. Discrimination of the 238.6 keV and 241 keV peaks was possible using the HPGe. It was possible to visualize the sources inside the applicator and obtain a geometrical calibration factors for each type of device. Our measurements indicate that the use of a well chamber adds 1.8% uncertainty to source calibration when correction for geometry is used, and 2.5% otherwise.

Conclusion

Commissioning of this novel device is underway. A clinical protocol for routine source assay based in a standard well chamber has been established, using a HPGe measurements as reference. Absolute reference measurements will be performed at regular intervals.

Electronic Poster: Brachytherapy: Anorectal