HDR Brachytherapy Technique Commissioning Using the HYPERSCINT Plastic Scintillation Detector

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INTRODUCTION

Accurate dosimetry in HDR brachytherapy is not an easy task, as most detectors exhibit volume averaging effects or energy dependence reducing their usability. Free from these limitations are plastic scintillation detectors (PSDs), which makes them well suited for brachytherapy applications, either for in vivo dosimetry or commissioning.

AIM

This work aims to determine if the HYPERSCINT scintillation dosimetry research platform (Medscint inc., Quebec City, Canada) can be used for HDR brachytherapy dose measurement in the context of commissioning a new brachytherapy technique.

METHOD

A custom-made, 3D-printed phantom (**Fig 1**) was designed to house vaginal CT/MR applicators (Elekta, Stockholm, Sweden) of multiple diameters, as well as a HYPERSCINT PSD probe and an EBT3 gafchromic film (Ashland, Bridgewater, NJ). Both detectors are maintained at a fixed distance of 5 mm from the cylinder surface. The phantom was 3D printed in PLA using an S5 3D printer (Ultimaker, Utrecht, Netherlands).

A total of 30 cylinder plans for varying cylinder diameter and treatment length were planned in Oncentra Brachy (Elekta, TG-43 formalism), delivered using a Flexitron Ir-192 source projector (Elekta) and measured using the PSD. 5 of those plans were also simultaneously measured on an EBT3 film.

Differences between planned and measured dose were computed for both detectors and the results were compared between them for consistency.

RESULTS

Dose difference between the measured and planned dose for the HYPERSCINT was (0.3±0.7)% (average ±1 standard deviation). Of the 30 cases measured, 24 were inside 1% of the TG-43 dose (**Fig 2**). For the EBT3 films these differences stand as (-3.2±1.6)%.

When comparing pairs of measurements (PSD vs film, for the same delivered plan), it was found that the film underestimated the PSD dose by (3.8±1.4)% (**Table 1**). The source of this offset is still to be investigated, but is suspected to originate from an error in film handling (storage conditions, residual film calibration error at high dose, or intra batch variation).

Figure 1: A and B : Sectional view of the phantom made to house the CT/MR vaginal cylinders. C : actual view of the phantom. Blue arrows indicate the HYPERSCINT insertion hole while the red arrows indicate the EBT3 film slot.

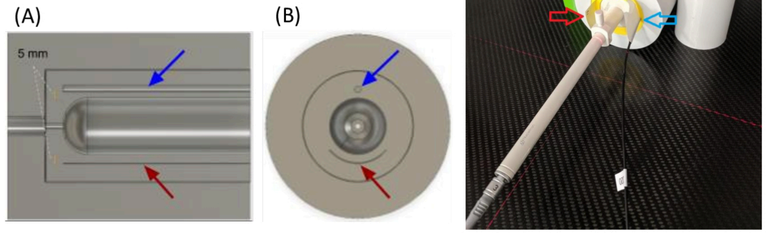

Figure 2: Difference between TG-43 planned dose and measured dose, for both detectors under investigation. Deviations typically range from -1.0% to 1.0% for the HYPERSCINT.

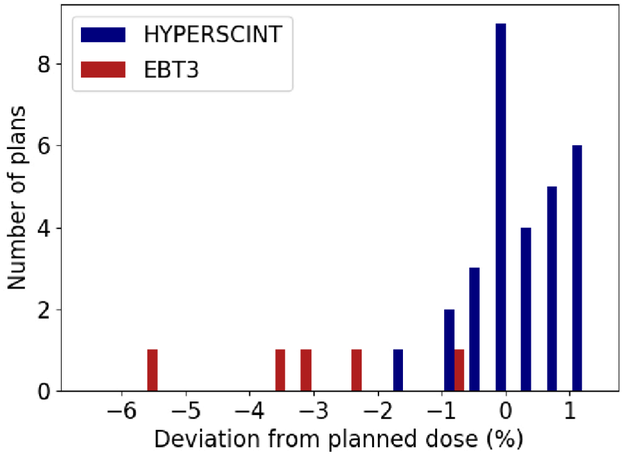

Table 1: Difference between HYPERSCINT and EBT3 measured dose difference. On average a 3.8% underestimate in dose is observed for the film compared to the PSD.

Case #	HYPERSCINT measured dose difference (%)	Film measured dose difference (%)	HYPERSCINT – EBT3 difference (%)
1	0.2	-2.3	2.5
2	0.3	-5.7	5.9
3	0.9	-3.8	4.7
4	0.4	-3.2	3.6
5	1.3	-0.9	2.2

CONCLUSIONS

Results show that the HYPERSCINT scintillation dosimetry platform can achieve better than 1% accuracy in Ir-192 HDR brachytherapy. This detector has potential for accurate dose measurement of high gradient, HDR brachytherapy, like in the context of technique commissioning or in vivo measurement.

ACKNOWLEDGEMENTS

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REFERENCES

To learn more about plastic scintillation detector dosimetry :

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See also : poster #PO-GeP-T-629, Patient Specific QA for External Beam Radiotherapy Using the HYPERSCINT Plastic Scintillation Detector, by the same authors.

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