Low Cost Radiochromic Film Based QA Device for Brachytherapy Afterloader

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INTRODUCTION

While HDR afterloader quality assurance is a well established routine in most user facilities, the means of preforming such tasks can vary as techniques and technologies evolve. It is the goal of this work to introduce a low-cost HDR brachytherapy QA device combining clinical relevance, vender independence, source position verification, source step accuracy, and scalability.

METHODS

- CAD software was used to design and develop the QA device.
- Additive manufacturing (FDM 3D-printing) of PLA plastic was used to create the general structure.
- Radiochromic (EBT3) film was used as a means of recording dose.
- Brass rod was placed within the device to provide dose-shadowing at set intervals.
- The source travel is contained within an interstitial needle that is affixed within the device with epoxy.
- The use of this needle additionally allows for viability testing of the clinically used transfer tubes.
- Rare-earth magnets are used to provide a clamping force between film and device, reducing shifting during testing.
- Openings through the device at typical dwell position intervals allow for digital camera systems to monitor the progress of the source wire during testing

RESULTS

Figure 1.
A. 3D-printed HDR QA Device in final form with brass and magnetic inserts. Interstitial needle used to contain source in mock clinical setting with fixed length and start position for repeated "set distance" verification.

B. Initial CAD rendering of design.

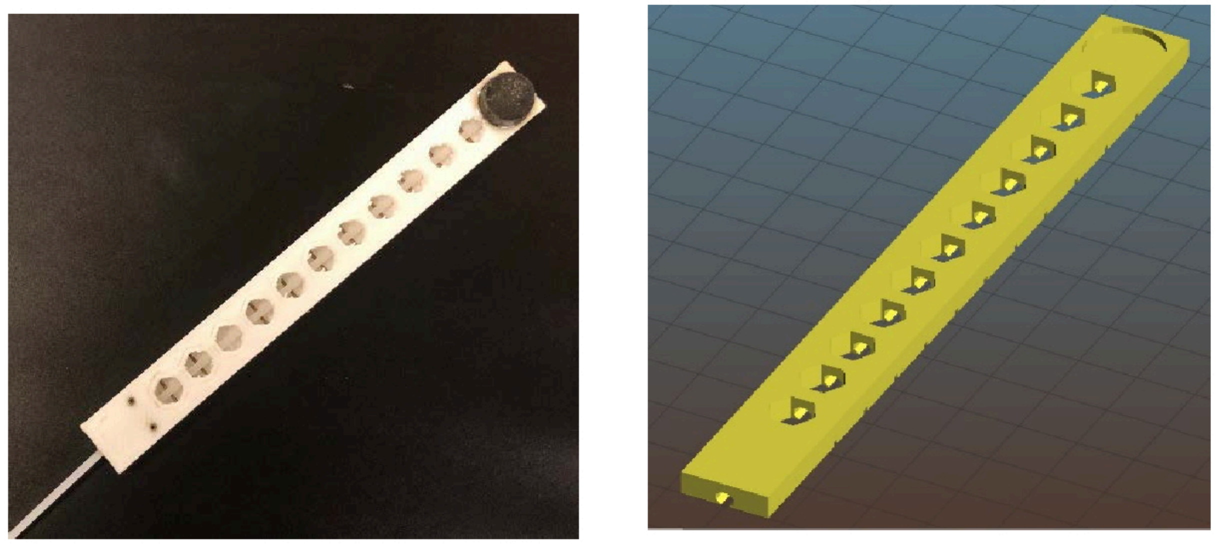
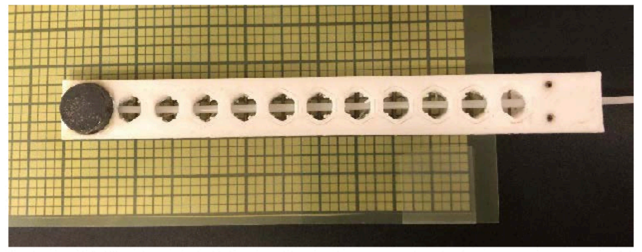


Figure 2.
A. QA Device in use with EBT3 film. Graph paper placed for secondary verification of dose distribution.



B. Film post QA. Note shadowing indicating distance of seed. Profile provides a digital measure of brass pin placement relative to set seed position.

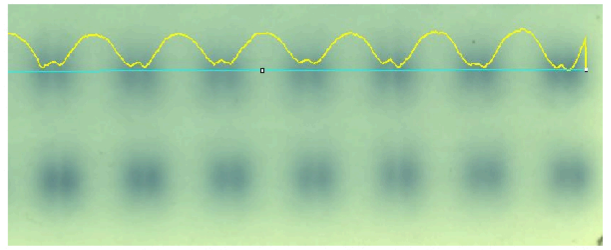
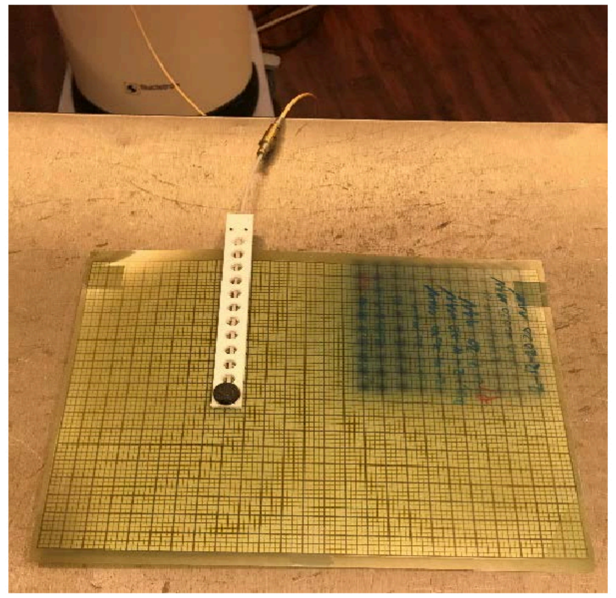


Figure 3.
Film with device demonstrating multiple QAs per film. Multiple devices placed on single film an available option for simultaneous multi-channel testing.



The total cost of the QA device is less than a single sheet of the radiochromic film used in its implementation. 36 months of clinical/daily use show minimal signs of degradation. The accuracy of the positions and repeatability of the source step length can be visually verified or digitized and recorded electronically. QA processes that rely on digital video for verification remain capable of verifying source position due to open-cell design. The design maybe further modified to accommodate CR based systems or 2D detector arrays.

CONCLUSIONS

Design, customization and implementation of QA devices is no longer limited to those institutions with deep pockets and vendor collaborations. The low cost of the device allows for scalability for simultaneous QA of multiple afterloader channels without repeating initial setup conditions. Affordable 3D printing options are readily available for any clinic with limited budgets that desire to implement an affordable solution for HDR brachytherapy QA.

CONTACT INFORMATION

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