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Preclinical application of Electronic portal imaging device

A ANVARI,[1,2] A SAWANT[1]

1 Department of Radiation Oncology, University of Maryland School of Medicine, Baltimore, USA

2 Department of Radiation Oncology, University of Pennsylvania, Philadelphia, PA, USA

Perelman School of Medicine UNIVERSITY of PENNSYLVANIA

INTRODUCTION

Electronic portal imaging device (EPIDs) have had a role in routine QA tests in clinical radiotherapy for more than a decade. These devices have been also used for animal position verification in preclinical radiotherapy. Here, we developed EPID-based suite of tests to improve accuracy of small animal image-guided radiotherapy (SA-IGRT) systems performance.

METHOD

An EPID-based tests were developed to perform

i. Dosimetric QA
ii. Geometric QA
iii. Verify delivered dose to the animal

on the small animal radiation research platform (SARRP; Xstrahl, Atlanta, GA) system.

Dosimetric QA tests namely constancy of beam quality in terms of half-value layer (HVL) and tube peak potential (kVp), constancy of output, profile (symmetry/flatness).

Geometric QA tests including accuracy and symmetry of field size, accuracy of collimator alignment, gantry rotation, stage rotation and translation.

EPID was also used to estimate delivered dose to animal. Film and ion chamber were used as reference to validate EPID measurements.

RESULTS

HVL values measured with the EPID agreed with ion chamber measurements within 7.1%. Results showed that size of the gantry rotation isocenter was 1.45 ± 0.15 mm. The stage translational accuracies were 0.015, 0.010, and 0 mm in the X, Y, and Z directions, respectively. The size of the stage rotation runout was 2.73 ± 0.3 mm. Displacements of intended and actual delivery isocenters were 0.24 ± 0.10, 0.12 ± 0.62, and 0.12 ± 0.42 mm in the X, Y, and Z directions, respectively.

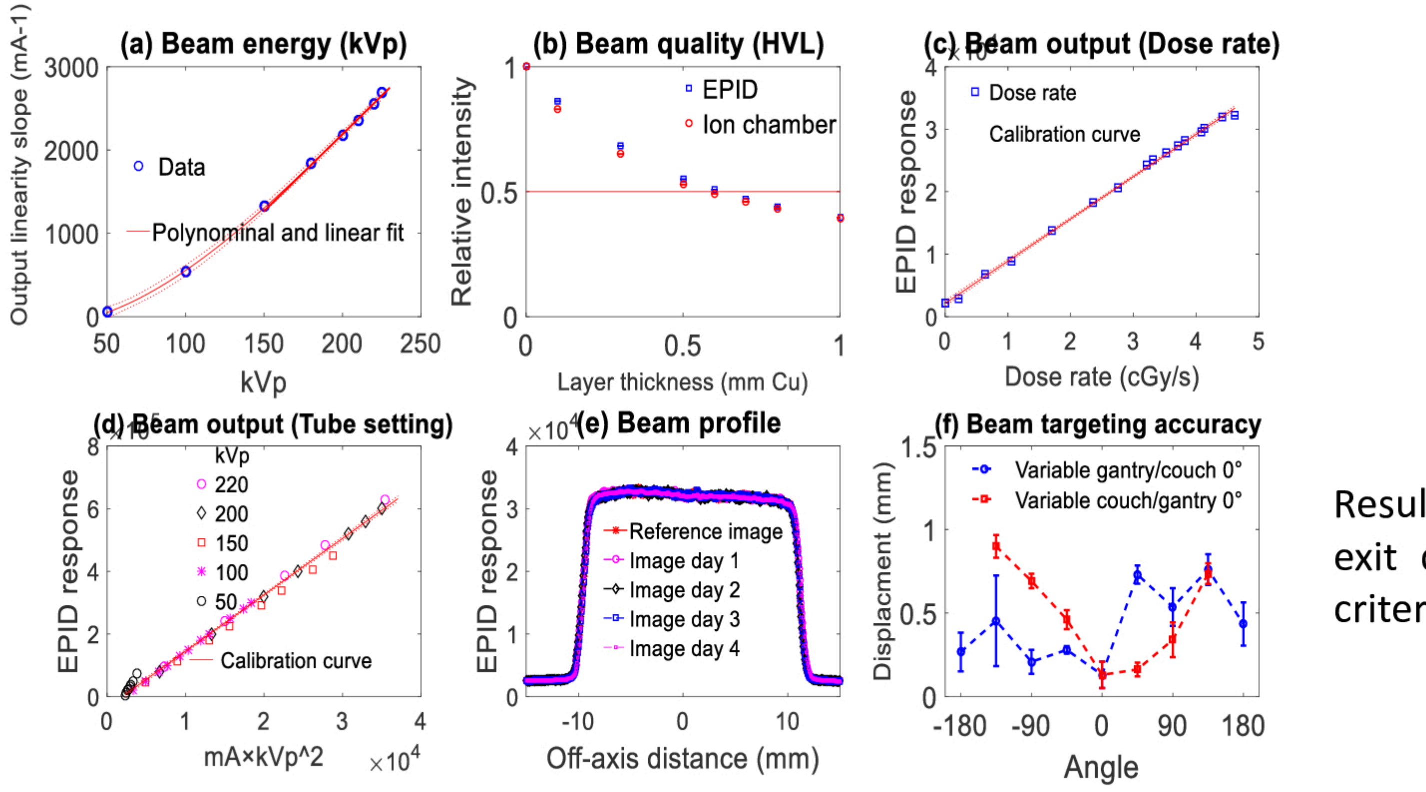

FIG. 1. EPID-based quality assurance tests; (a) relationship between output linearity slopes from linearity test and nominal tube peak potential for kVp measurement, (b) attenuation of the x-ray beam as a function of Cu thickness for HVL measurement using an ion chamber and the EPID, (c) calibration curve of EPID response; imager grayscale values as function of film dose measurements, (d) the EPID response as a function of tube settings (mAs and kVp) for output measurement, (e) beam profile constancy test by comparing daily portal images, (f) beam targeting accuracy as a function of gantry angle (blue) and couch angle (red).

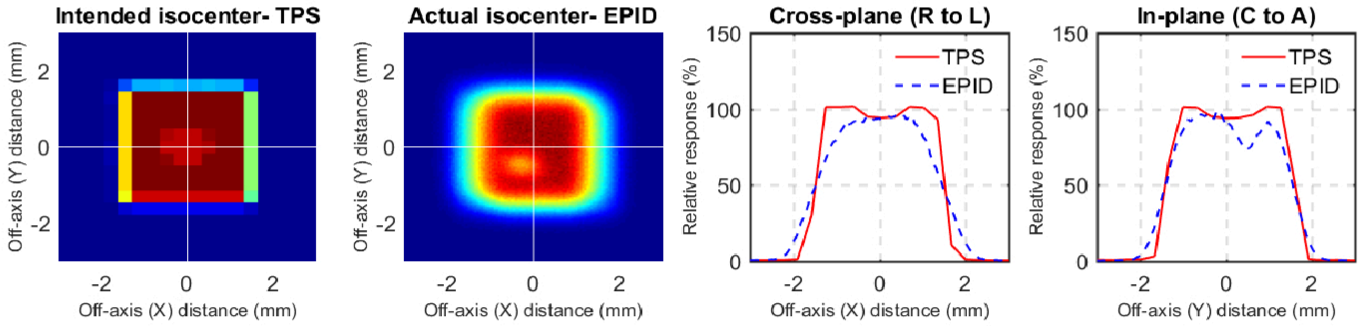

FIG. 2. End-to-end precision and accuracy of image-guided beam delivery test with 3 × 3-mm² collimator. Displacement of intended (planned in the TPS) and actual delivery (measured by EPID) isocenters.

Results of gamma analysis for 2D comparison between TPS-calculated and EPID-estimated exit dose distributions indicated an average of 90% passing rate with global gamma criterion of 2 mm/5%.

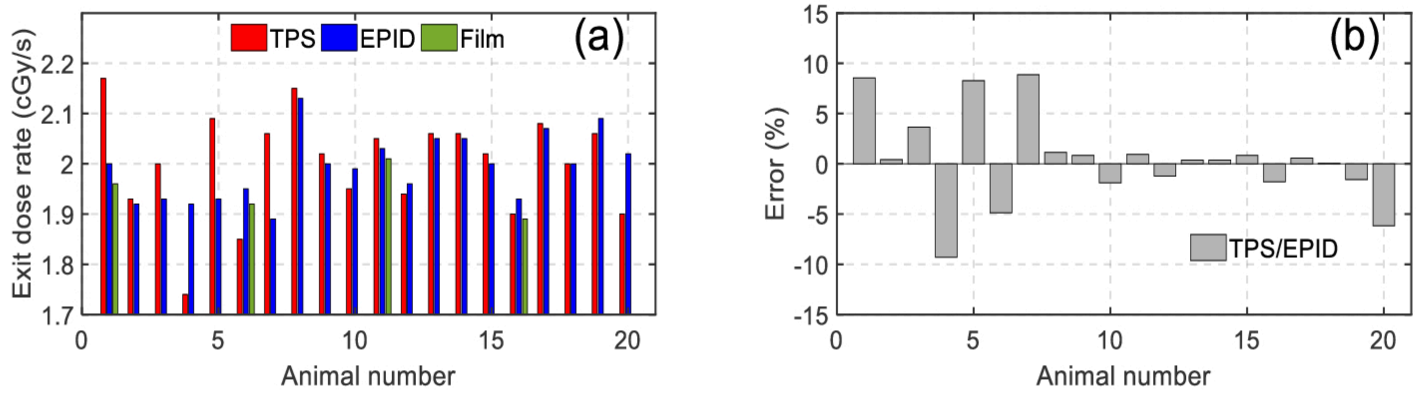

FIG. 3. Real-time animal treatment verification results during radiotherapy.

CONCLUSIONS

Our results indicate that the EPID can be utilized in preclinical kV radiotherapy as a simple, convenient device for QA of the SA-IGRT system performance.
We also showed that EPID can be used as a device for kV dose delivery verification in small animal radiotherapy.

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CONTACT INFORMATION

Akbar.Anvari@Pennmedicine.upenn.edu