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Using In-Vivo EPID Measurements to Detect Deviations and Track Trends in Machine Performance Per Treatment Day

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RETHINKING MEDICAL PHYSICS

INTRODUCTION

- Daily QA is performed to measure output/machine performance prior to any treatments being delivered.
  - In this approach changes in output and other changes in machine performance that occur during treatment will not be detected.
- In-vivo measurements are required to record machine performance over the course of a treatment day.
- In order to implement in-vivo measurements to monitor machine performance, measurements must be made throughout the day and data collection must be automated.

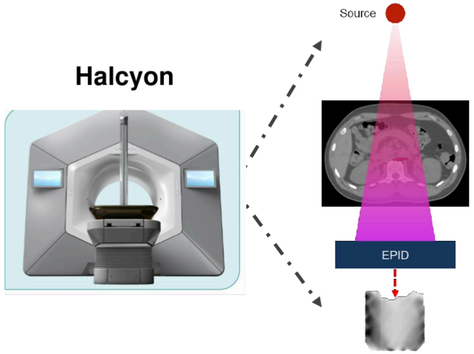
AIM

- To present a new method to analyse in-vivo EPID images for all patients on a given treatment day. An average of all patients treated on a given day is used to monitor machine performance in-vivo.

METHOD

- EPID images in this study were acquired on a Varian Halcyon linear accelerator, which comes equipped with a Varian aS1200 digital megavoltage imaging panel that is mounted directly opposite to the single energy 6X-FFF MV source.
- The size and position of the imager ensures that complete image data is collected for all treatment fields. During treatment, the EPID integrates the readout obtained from the entire treatment field.
- The transit EPID images are then exported automatically to the record-and-verify system .
- The EPID is calibrated in Calibrated Units (CU), 1 CU per 1 MU for a standard field size of 10x10 cm^2. Before calibration, dark field and flood field corrections are applied.
- The output recorded by the EPID was recorded daily with the machine performance check (MPC) and compared monthly to solid water output checks. All analyses performed made use of CU image values.

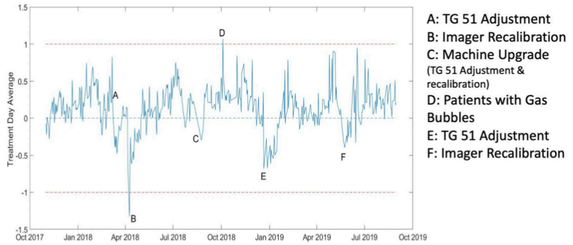
METHOD



- A pipeline using MATLAB, PowerShell, and C# scripts was developed to retrieve *in vivo* EPID images from the Halcyon machine and perform the analysis automatically.
- In-vivo EPID images were collected
  - Over a 23-month period
  - For 852 patients and 18,361 fractions
- For every patient and each fraction of treatment:
  - The first fraction of treatment was set as the reference image.
  - The relative difference between fraction 1 and fraction n was computed and the mean of the relative difference found, μ_{image}.
  - μ_{image} has been demonstrated to measure changes in transmission through the patient (1)
- A daily average (μ_{daily}) image was computed:
  - Averaging the μ_{image} over all patients treated on the same day
  - To reduce noise, a treatment day was included only if more than 20 patients were treated that day

RESULTS

- In total 437 treatment days were analyzed. The average and standard deviation of μ_{daily} was 0.04%±0.38%.
- Data points with a sudden change in the treatment day mean were investigated for possible causes. Time points A,B,C & E, F were attributed to output adjustments or imager recalibrations, while time point D had a large number of patients with gas bubbles that day.



- The machine maintenance records and the daily MPC were reviewed for the same period of treatment.
- The magnitude of TG-51 adjustments, or the change in the imager readings due to recalibrations were compared to the changes observed with μ_{daily}

Time Point	TG 51 Adjustment or Imager Recalibration	Change in μ_{daily}
A	-0.4% (TG 51)	-0.6%
B	-1.4% (Imager recalibration)	-1.3%
E	-1.6% (TG 51)	-1.4%
F	0.0% (Image recalibration)	-0.5%

- The change in μ_{daily} agreed with change in output, due to TG -51 adjustment or imager recalibration, to less than 1%

CONCLUSIONS

- Using in-vivo EPID images averaged over all patients on a treatment day provides additional machine quality assurance.
- The method can detect changes in the machine output and imager recalibration on the order of 1% by tracking a daily treatment average.
- This system is now implemented prospectively to analyze images of every treatment day. The download and analysis of images is automated and the physicist is alerted if a large deviation occurs.

REFERENCES

Poster BReP-SNAP-T-59 : Estimating the Dosimetric Impact of Patient Anatomy Changes with in-vivo EPID Images, Using the Gradient Dose Segmented Analysis Technique. Jennifer Steers, Jorge Zavala, Casey Bojechko

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